iV. INTERNA TIONAL APPLIED STATISTICS CONGRESS

The congress of held on the honor of
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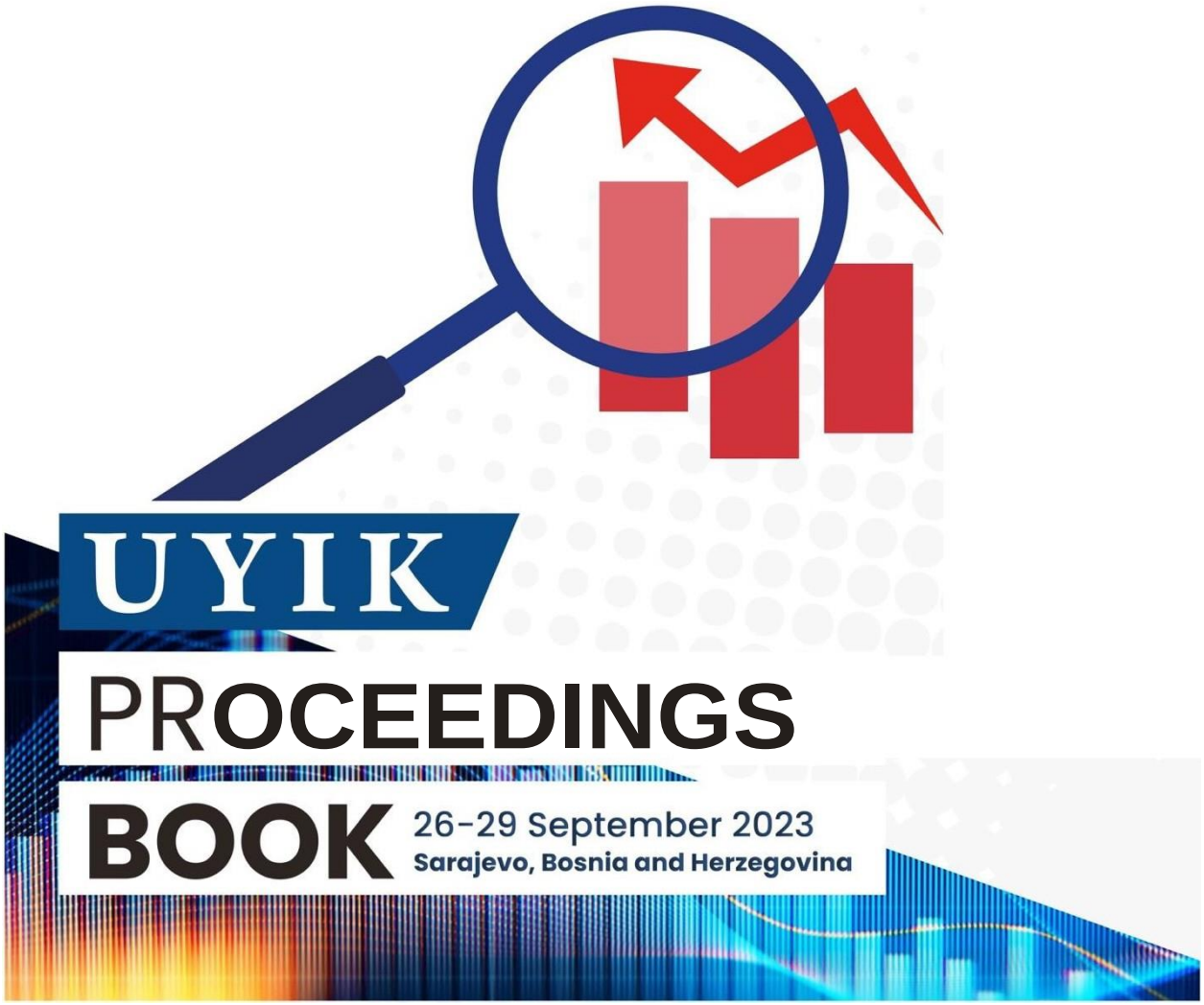

IV. INTERNATIONAL APPLIED STATISTICS CONGRESS

Proceedings Book of the UYIK-2023

ISBN: 978-975-7328-89-6

DOI: 10.5281/zenodo.10835021

HYBRID (ONLINE AND FACE TO FACE) - SARAJEVO / BOSNIA AND HERZEGOVINA

Note: All administrative, academic and legal responsibilities of the departments belong to their authors

Proceedings Book of the IV. International

Applied Statistics Congress

(UYIK-2023)

Publisher:
Tokat Gaziosmanpasa University
Editors:
Yalcin TAHTALI
E-Book Layout, Preparation and Composition:
Yalcin TAHTALI, Samet Hasan ABACI, Kaan KAPLAN, Lütfi BAYYURT,Ahmet Sinan GÜLER
All published articles were peer-reviewed by Scientific Committee
The organizers do not have any legal liability for to contents of the presentation texts
Organized by
Tokat Gaziosmanpasa University, Tokat, Turkey
International University of Sarajevo, Sarajevo / Bosnia and Herzegovina
Kayseri University, Kayseri, Turkey
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BIOGRAPHY OF PROF. DR. ORHAN KAVUNCU

He was born in 1949 in the Bahçe district of Osmaniye. He completed his primary, secondary and high school education in Kahramanmaraş. He graduated from Ankara University Faculty of Agriculture in 1971. In 1977, he received the Doctor of Science title with the thesis he wrote in the Department of "Agricultural Genetics and Statistics" of the same faculty. Between 1981-82, he studied Theoretical Population Genetics at the University of Alberta, Canada, with a postgraduate scholarship.

He became an associate professor in 1984 and professor in 1991. Between 1993-1995, he worked as the deputy rector of Kazakhstan Hoca Ahmet Yesevi University. In 2004, he became the Founding Rector of the Vocational Career and Economics University in Almaty, Kazakhstan. He worked in the Department of Biometrics and Genetics in Ankara University Faculty of Agriculture until April 2016. He is currently a lecturer at Kastamonu University, Faculty of Engineering and Architecture, Genetics and Bioengineering Department and the Director of the Turkish World Application Research Centre. He has published more than 30 research and review articles in the scientific field, 10 textbooks, 3 of which he is a co-author.

Orhan Kavuncu, who has carried out intellectual work since his student years in addition to his academic studies, wrote in magazines and newspapers such as Ocak, Töre, Devlet, Hasret, Genç Arkadaş before September 12, 1980. Later, his articles were published in Türk Yurdu magazine. He has two books and many articles on the Turkish world.

Orhan Kavuncu, who also worked in non-governmental organizations, was a member of the Turkish Agricultural Engineers Union, Ülkü-Bir and Ülkü-Tek Board of Management before 1980. He held

assumed positions in Turkish Hearths (Türk Ocakları) between 1985-1993 and 2005-2013. Between 2000-2002, he was the President of the European Nizam-ı Alem Organisation in Germany.

Kavuncu also got involved in politics for a period, served as the BBP (The Great Unity Party) Adana deputy in 1995-1999 and held various positions in the BBP Headquarters until 2003.

Orhan Kavuncu, who is currently the member of Turkish Hearths Education and Culture Foundation (TOEK) and president of Turkey Uzbekistan Friendship Group (TODD), is married and has three children and eight grandchildren.

PREFACE

The use of applied statistical methods is increasing in almost every branch of science. The papers presented at this conference alone confirm this statement, with 183 papers coming from medicine, climate change, agriculture, education, economics, sociology, psychology, forestry, biology, sports and several other fields, with some papers being interdisciplinary.

Why is there so much need for statistical methods? Because deterministic models cannot explain the results of many researches, in other words, the effect of factors that are assumed to have an effect on the phenomenon under study cannot be explained without taking into account the random factor. Models that take into account the random factor-are known as stochastic or statistical models.

Those who conduct scientific research should know the subject they are studying, well theoretically, so they often have an expectation about the outcome of the research. This expectation is known as a hypothesis in statistical terminology. Again, in most cases, this expectation of the researcher is not the statistical control (or null) hypothesis, but the alternative hypothesis. In some cases where the hypothesis cannot be established or when the statistical control hypothesis is rejected, the question of "which value" for the parameter comes to the fore, and the methods that answer this question are called estimation methods.

In all areas where scientific research is concerned, the decisions inferred by using statistical methods such as testing hypothesis and estimating parameters may be false. But you cannot get these conclusions by using methods other than statistical inference methods. The benefit of statistical methods is that they can calculate the probability of these conclusions being false. Statistical methods are needed in every situation where the concept of randomness is involved, and research topics where the concept of randomness is involved are found in almost every field of science. This is why statistical methods are used in almost every field of science.

A chance factor can be defined as the total effect of unknown factors and the factors that are known but not included in the model because their effect is considered to be insignificant. In cases where a stochastic model is needed, even if experiments are planned to investigate the effect of all such factors that can be considered, there is still a residual, unexplained variation called random variation. This "remainder" is the main reason why statistical methods are needed. It would not be an exaggeration to say that if there is no unexplained variation, there is no need for statistical methods. Therefore, researchers should not see statistical methods as an ornamental material to decorate their research, and statistical methods should be used only if there is an unexplained variation among the data obtained at the end of the research.

The 4 th International Congress on Applied Statistics, dedicated to me, was organized by Tokat Gaziosmanpasa University Faculty of Agriculture, hosted by International Sarajevo University and International Balkan University and Kayseri University contributed to the event as stakeholders. Tokat Teknokent A.Ş., Statistics Center, Ankara University Faculty of Agriculture and Turkish Journal of Applied Statistics supported the congress in some way.

I thank you all these institutions. I have seen the efforts of the chairmen of the Organizing Committee up close. As stated in the opening session of the meeting, these congresses have become a "loyalty" congress. I would like to express my gratitude to my friends who contributed to all four congresses, in the person of Assoc. Prof. Dr. Yalçın Tahtalı and especially to him.

Prof. Dr. Orhan KAVUNCU

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ORAL PRESENTATIONS

Should Social Sciences Need Statistics?: An Analysis Of The Somatic Method

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Abstract

Philosophy, which means the search for truth or the love of wisdom, aimed to reach true knowledge on the basis of abstract concepts such as existence, knowledge, values and language until the emergence of sciences. However, since the 19th century, science in general and the disciplines that make up the social sciences in particular have accepted that there are laws of society like the laws of nature or physics and have tried to reach real knowledge in this way. This philosophy, called positivism, claimed that there are certain methods of attaining true knowledge and that it is only possible to attain knowledge through these methods. Since the 20th century, the production of knowledge has revealed the need for statistics in the social sciences. Because knowledge, like societies, was changing. Therefore, reaching true knowledge required an archeology of knowledge through various statistical methods and techniques. Research in the social sciences has gained a systematic structure, first with quantitative methods and later with qualitative methods. However, in the process, important criticisms were made against quantitative methods based on objective sensory data. Some of these criticisms were tried to be eliminated by some of the techniques developed in the qualitative method. Today, research in the social sciences shows a major trend away from positivism-centered methodology towards post-positivism, interpretivism and phenomenological approaches. The somatic method emerged as a consequence of this tendency. In contrast to the objective sense data of positivism, the somatic method claims that each researcher can produce knowledge through subjective sense data. The relationship of the somatic method, which can be evaluated within the post-positivist approach, with the science of statistics has also been questioned. This study will try to present a general framework of the somatic method, which has recently been used as a method in many fields of science, especially in countries such as the USA. Apart from this, the need of the somatic method for the science of statistics will also be questioned in this context.

Key words: *Social sciences, methodology, statistical science, somatic method*

Etik Liderliğin Örgütsel Aidiyete Etkisinde Psikolojik Rahatlığın Aracı Rolü

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Özet

Yöneticilerin birer rol model olmalarından kaynaklı çalışanların bireysel ve örgütsel çıktılarının etkileneceği düşünülmekte olup, pozitif etik lider davranışları sayesinde örgütlerdeki pozitif davranışların artacağı değerlendirilmektedir. Bu kapsamda çalışmanın amacı, psikolojik rahatlığın aracı olduğu durumlarda etik liderlik davranışlarının örgütsel aidiyet üzerindeki etkisini incelemektir. Bu amaca yönelik Kayseri'de faaliyet gösteren imalat işletmelerinde çalışan 400 kişiye anket dağıtılmıştır. Halen veri toplama çalışması devam etmekte olup, sonuçların hakemli bir dergide yayınlanması planlanmıştır.

Anahtar Kelimeler: *Etik liderlik, örgütsel aidiyet, psikolojik rahatlık*

Abstract

It is thought that the individual and organizational outcomes of employees will be affected because managers are role models, and it is evaluated that positive behaviors in organizations will increase according to the positive ethical leadership behaviors. In this context, the aim of this study is to examine the effect of ethical leadership behaviors on organizational identification via the mediating role of psychological safety. For this purpose, a survey was distributed to 400 people working in manufacturing organizations that are operating in Kayseri city. Data collection is currently ongoing, and the results are planned to be published in a peer-reviewed journal.

Key words: *Ethicak leadership, organizational identification, psychological safety*

GİRİŞ

Gelişen ve hızla değişen teknolojik yenilikler, bilginin önemini daha da ön plana çıkartmış ve çeşitli sektörlerde faaliyet gösterilen, klasik dönemdeki beden gücünün ağır bastığı ve insanın makina gibi algılandığı dönemin yerine, bilgiye dayalı yaklaşımları işletme başarısında önemli bir faktör olarak ortaya çıkartmıştır. Sonuçta işletmeler, nitelikli insanı daha ön planda tutarak modern yönetim teknikleriyle birlikte sürdürülebilir bir büyüme sağlama kapsamında bulundukları çevreyi daya çok dikkate almaya başlamışlardır.

Etik ve ahlaki açıdan doğru kararları verebilmek bireysel, örgütsel hatta evrensel bir sorumluluktur. Günümüz ortamında çok çeşitli girdilere maruz kalan ve büyük bir ilişkiler ağını vurgulayan sosyal ortamının karmaşıklığı ve insan ilişkilerindeki açmazlar, yönetici pozisyonunda olan kişilere yeni ve zor görevler yüklemektedir. Bu rol, yönetilmesi çok zor olan insan unsurunu ele alırken liderlerin, etik değerler ve inançlar sistemine sahip olmasını ve örgütteki çaba ve eylemlerini bu sistemin süzgecinden geçirmesini gerektirmektedir.

Yöneticilerin birer rol model olmalarından kaynaklı çalışanların bireysel ve örgütsel çıktılarının etkileneceği düşünülmüş ve bu kapsamda pozitif etik lider davranışları sayesinde örgütlerdeki sapkın davranışların azalacağı, örgütsel aidiyetin ise artacağı değerlendirilmektedir. Bu kapsamda çalışmanın amacı, psikolojik rahatlığın aracı olduğu durumlarda etik liderlik davranışlarının örgütsel aidiyet üzerindeki etkisine yönelik değerlendirmelerde bulunmaktır.

Alan yazın incelendiğinde, çalışanların olumlu davranışlara yönlendirilmesi sürecinde örgütsel kültürün etkisini konu edinen çok sayıda çalışma yapıldığı görülmektedir, ancak, bu çalışma yoğunluğu örgütsel kültürün birer yansıması olan psikolojik rahatlık algısı (Edmondson ve Mogelof, 2006: 111) konularında görülmemektedir. Benzer şekilde, Aranzamendez ve diğerleri (2015: 176) psikolojik rahatlık algısının çalışan ve örgüt açısından çok sayıda pozitif çıktıya neden olduğunu belirtmektedirler. Bu çalışma, etik liderlik ve psikolojik rahatlığın çalışan davranışları üzerindeki yansımalarına odaklanmıştır.

KAVRAMSAL ÇERÇEVE VE LİTERATÜR ARAŞTIRMASI

Çalışma hayatında bireylerin iç dünyasında yaşadığı psikolojik durumların herhangi bir şekilde etkilendiği ve bu etkilerin de farklı şekillerde çalışma hayatına yansıtıldığı bilinmektedir. Bu nedenle, işletmelerin sahip olduğu en önemli kaynak olan bireyin; huzurlu, mutlu, tatmin olmuş, umutlu ve dengeli bir şekilde yönetimi için işyerinde psikolojik durumlarının analiz edilmesi ve bu yönde geri beslemelerin sağlanması önem arz etmektedir. Bu noktadan hareketle, mevcut çalışmada işletmelerde çalışan bireylerin etik liderlik davranışlarının psikolojik rahatlığın aracı olduğu durumlardaki örgütsel aidiyet üzerindeki etkisi incelenecektir.

Liderlik kavramı; insanları kendisine katılmaya ikna ederek yeni takipçiler oluşturma becerisi, ikna ve etkileme özelliğini kullanarak takipçileri bir amaca yöneltme kabiliyeti ve vizyon oluşturma yeteneği şeklinde tanımlanmaktadır (Biçkes vd., 2017: 61). Etik liderlik ise, kişisel eylemler ve kişilerarası ilişkiler yoluyla normatif olarak uygun davranışların sergilenmesi ve bu davranışların iki yönlü iletişim, güçlendirme ve karar verme yoluyla takipçilere aktarılması olarak tanımlanmaktadır (Walumbwa vd., 2017: 14). Shin (2012: 300) bir örgütte etik kuralları belirleyen ve örgütün etik uygulamalarını ve faaliyetlerini yönlendiren gücün liderler olduğunu ifade etmektedir. Walumbwa ve diğerleri (2017: 14) etik liderliğin, çalışanların biliş, tutum ve davranışları üzerinde belirleyici bir etkiye sahip olduğunu vurgulamıştır. Edmondson (2003: 1423) ise lider desteği ve teşviki olmaksızın çalışanların kişilerarası riskleri almakta zorluk çekebileceklerini dile getirmiştir. Açıklamalar ışığında, etkili bir liderlik algısına sahip çalışanların diğerlerine nazaran daha fazla gayret, fedakârlık ve adanmışlık sergileyecekleri söylenebilir (Biçkes vd., 2017: 61). Yukarıda dile getirilen açıklamalara benzer şekilde Zaal ve diğerleri (2017: 15), etik dışı davranışlara ve skandallara yol açan yanlış davranış kültürünün yaygınlaşmasında belirleyici olan en önemli faktörün etik olmayan davranışlar sergileyen bir lider olduğunu ifade etmektedirler. Bu açıklamalardan hareketle, çalışanların olumsuz davranışlardan uzak tutulup olumlu davranışlara yönlendirilmesi sürecinde etik liderliğin diğer liderlik tarzlarına nazaran daha önemli bir rol oynayacağı söylenebilir.

Yapılan uygulamalı çalışmalar, etik liderliğin birçok bireysel ve örgütsel değişkenin öncülü olduğunu ortaya koymuştur. Çalışmanın değişkenleri dikkate alınarak yapılan literatür incelemesinde, etik liderliğin psikolojik rahatlık algısı üzerinde pozitif (Walumbwa ve Schaubroeck, 2009) etkiye sahip olduğu bulgusunu ortaya koymaktadır. Liderler etik kurallar çerçevesinde hareket ettiklerinde, etiğin önemini vurgulamış olmaktadırlar. Aynı zamanda etik davranışı teşvik etmek için ödül ve ceza mekanizmasını kullanmaktadırlar. Böylelikle kabul edilebilir davranışlar için grup normları oluşur ve çalışanların etik olmayan davranışlar sergileme olasılıkları azalır (Mayer vd., 2012: 153). Dolayısıyla, güvenilir olarak algılanan liderlerin var olduğu ortamlarda çalışma grubuna ya da örgüte yönelik olarak hissedilen aidiyet duygusunun yüksek olması beklenmektedir. Özellikle etik liderler proaktif oldukları için bu liderlerin örgütsel aidiyeti teşvik edecek ortamı oluşturmaları çok daha olasıdır (Walumbwa vd., 2011: 206). Bu anlamda Demirtaş (2015), etik liderlerin örgütsel değerlerle çalışanların değerleri arasında uyum sağlamaları nedeniyle, etik liderliğe maruz kalan takipçilerin örgütlerine karşı daha yüksek düzeyde aidiyet hissedeceklerini belirtmektedirler.
Bu kapsamda mevcut araştırmada aşağıdaki hipotezler oluşturulmuştur.

- Hipotez 1: Etik liderlik davranışları örgütsel aidiyeti pozitif olarak etkilemektedir
- Hipotez 2: Etik liderlik davranışları psikolojik rahatlığı pozitif olarak etkilemektedir
- Hipotez 3: Etik liderlik davranışları ve örgütsel aidiyet ilişkisinde psikolojik rahatlık aracı role sahiptir.

SONUÇ

Öncelikle psikolojik rahatlık kavramının özellikle Türkçe literatürde yeni yeni kavramsallaştırılması ve çeşitli çıktılara etkisinin araştırılması çalışmanın önemli bir katma değer yönünü oluşturmaktadır. Ayrıca, psikolojik rahatlık kavramı liderlik açısından önemli bir konu olup ikisinin aynı modelde bireysel çıktılara etkisinin aracılık etkileriyle incelenmesi alana önemli katkı sağlayacaktır.

Araştırma, keşfedici bir çalışmadır. Araştırmada kullanılacak olan yöntem üç ana ayak üzerine oturtulacaktır. Kavramsal tarama özellikle önemli bir karakteristiktedir. Çünkü, kavramsal olarak örgütsel davranışlar kapsamında çok az çalışmada hizmetkar liderlik kavramı ve etkileri üzerine bir araştırma yapılmıştır. Bu da, çerçevesi yeni yeni ortaya konulmaya başlanan bu kavramın ne düzeyde hassas ve sağlam temeller üzerine oturtulması gerektiğinin önemini işaret etmektedir. Bu nedenle, diğer aşamalara da alt yapı teşkil edecek olan bu safhada literatürü sağlam temelli bir model oluşturulmuştur.

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Türkiye'deki Suriyeli Geçici Korunanlara Yönelik Algı Analizi: Hashtag Seçim 2023

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Özet

Literatürde Suriyeli geçici korunanlara yönelik toplumsal algının ölçülmesinde geleneksel iletişim araçları üzerinden analizler gerçekleştirilmiştir. Ancak içinde bulunduğumuz dijital çağ hasebiyle kamuoyunun nabzını ve bir konudaki yansımalarını direk ölçebileceğimiz sosyal medya araştırmaları iletişim çalışmaları alanına ivme kazandırmıştır. Bu sebeple ilgili çalışma ile Türkiye'nin uzun süredir yüz yüze olduğu Suriyeli geçici korunan meselesi 2023 seçimleri döneminde ne düzeyde yankı bulduğu ölçülmek istenmiştir. Çalışma kapsamında 23.02.2023-14.04.2023 tarihleri arasında Twitter Platformu üzerinden "secim2023" hashtag'ini içeren 1310 tweet toplanmış, nitel analiz programı olan MAXQDA programı aracılığıyla analizler gerçekleştirilmiştir. İlgili çalışma ile kullanıcı yorumları üzerinden Suriyeli geçici korunanlara yönelik kamuoyu algısı ölçülmek istenmiştir. Kullanıcı yorumlarının analizinde sık kullanılan kelimelerin frekansı görsel analiz araçlarından biri olan kelime bulutu ile sunulmuş, ilgili paylaşımların duygu yükleri ise duygu analizi ile açıklanmıştır. Çalışma için belirlenen kategorilerin kullanıcı yorumlarında ne sıklıkla bulunduğuna bakmak için içerik analizi kullanılmış, bulunan ilişkilerin sunulması için kategorilerin aralarındaki ilişkileri göstermek adına ağ analizi ve ilişkilerin sıklığı için ilişki matrisi ile sonuçlarla desteklenmiştir. Analizin sonucunda siyasi kategorisinin ekonomik ve sosyokültürel kategorilerine oranla daha fazla ön plana çıktığı görülmüştür. Suriyelilerin Türkiye'nin demografik yapısı üzerindeki etkileri ve Türk vatandaşlığına geçmelerine yönelik olumsuz bir söylem üretildiği görülmüştür.

Key words: *Suriyeli Geçici Korunanlar, Seçim 2023, Türkiye, Twitter, İçerik Analizi*

Türkiye İçin Göç ve İşsizlik Üzerine Bir Uygulama

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Özet

İnsanların zorunlu kaldıkları için yaşadıkları yerden başka yerlere gitmesi yani göç etmesi ekonomik ve sosyal olarak günümüz dünyasının en önemli sorunlarından biri olan işsizlik üzerinde yönü ve derecesine bağlı olarak her ülkenin bulunduğu koşullara göre farklı etkiler meydana getirebilmektedir. Mevcut akademik kaynaklar da incelendiğinde göç ve işsizlik arasındaki ilişkinin yönü ve derecesi hakkında ortak bir görüş olmadığı görülmüştür. Dolayısıyla bu çalışmada Türkiye için 2015:01 - 2022:01 dönemleri aylık veriler kullanılarak incelenen değişkenler arasında uzun ve kısa dönemli ilişki olup olmadığı analiz edilmiştir. Elde edilen bulgular sonunda değişkenler arasında uzun dönemli ilişki olmadığı ancak sadece göç sayısından işsizlik oranına doğru tek yönlü kısa dönemli ilişki saptanmış ve göç sayısının işsizlik oranını negatif yönde etkilediği veya işsizlik oranının göç sayısından etkilendiği anlaşılmıştır.

Key words: *Eşbütünleşme analizi, Nedensellik analizi, Dış göç, İşsizlik, Emek piyasaları.*

Yaşlı Nüfusun Sağlık Harcamaları ve GSYH ile İlişkisi: Panel Eşbütünleşme ve Nedensellik Analizi

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Özet

Nüfusun yaşlanması, ülkelerin işgücünde ve nüfusun yaş gruplamasında önemli değişikliklere yol açmaktadır. Bu değişiklikler, genel olarak ülkelerde ekonomik sorun olarak görülmektedir. Çünkü yaşlanan nüfusun daha az verimli olacağı ve daha fazla sağlık hizmetine ihtiyaç duyacağı açıktır. Benzer ilişkilerin araştırıldığı çalışmalarda net bir fikir birliği olmamakla birlikte, birbirinden farklılık gösteren sonuçlar mevcuttur. Bu çalışmanın amacı, yaşlı nüfus oranının sağlık harcamaları ve ekonomik büyüme ile ilişkisi hakkında literatürdeki mevcut tartışmaya yeni bir kanıt sunmaktır. Bu amaç doğrultusunda Dünya Bankası'nın Dünya Kalkınma Göstergeleri veri tabanından alınan verilerle 21 yıl (2000-2021) ve 609 gözlem içeren dengeli bir panel veri seti oluşturulmuştur. Çalışmaya 27 AB ülkesi ve AB aday statüsünde olan Türkiye ve Bosna-Hersek (29 ülke) dahil edilmiştir. Çalışmada iki farklı model kurulmuştur. İlk modelde yaşlı nüfus oranı (YN) ile kişi başına düşen sağlık harcamaları (SH) arasındaki ilişki incelenmiştir. İkinci modelde ise yaşlı nüfus oranı (YN) ile kişi başına düşen gayri safi yurtiçi hasıla (GSYH) arasındaki ilişki ele alınmıştır. YN bağımlı değişken olup, SH ve GSYH bağımsız değişkenlerdir. Değişkenler arasındaki ilişkinin tespiti için Westerlund ve Edgerton (2007) panel eşbütünleşme testi yapılmıştır. Eşbütünleşme ilişkisinin tespitinin ardından uzun dönem katsayı tahmini için Genişletilmiş Ortalama Grup (AMG) tahmincisi uygulanmıştır. Son olarak değişkenler arasındaki nedensellik ilişkisinin tespiti için, Dumitrescu-Hurlin panel Granger nensellik testi yapılmıştır. Analizler sonucunda, YN ile SH arasında ve YN ile GSYH arasında eşbütünleşme ilişkisi olduğu tespit edilmiştir. Katsayılar bazı ülkelerde anlamlı ve pozitif yönlü iken, sayılı birkaç ülkede anlamlı fakat negatif yönlüdür. Nedensellik analizi sonuçlarında ise, YN ile SH arasında çift yönlü bir nedensellik saptanmışken, GSYH ile YN arasında tek yönlü bir nedensellik saptanmıştır. Sonuç olarak, yaşlı nüfusun sağlık harcamaları ve gayri safi yurtiçi hasıla ile ilişkisi karmaşık ve çok yönlüdür. Ülkelerin ekonomik durumu, sağlık hizmetlerinin kalitesi, teknolojik gelişme seviyesi ve demografik yapısı gibi bir dizi faktör bu etkiyi şekillendirebilir. Politika yapıcılar, yaşlı nüfusun artışıyla başa çıkmak ve sürdürülebilir bir toplum oluşturmak için uygun stratejiler geliştirmelidir.

Anahtar kelimeler: *Yaşlı nüfus, Sağlık harcamaları, Ekonomik büyüme, Westerlund Eşbütünleşme, Nedensellik*

Türkiye'de Sağlık Arz ve Talebinin Sağlık Sonuçları Üzerindeki Etkisi: Yapısal Eşitlik Modeli Uygulaması

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Özet

Bu çalışmanın amacı, sağlık göstergeleri altında yer alan sağlık arz ve talebinin sağlık sonuçları üzerindeki etkisini belirlemektir. Belirlenen amaç çerçevesinde çalışmada, beş bağımlı (hastane sayısı, hekim sayısı, yatak sayısı, birinci basamak müracaat sayısı, ikinci ve üçüncü basamak müracaat sayısı) ve iki bağımsız (ölüm oranı, taburcu olan hasta sayısı) değişken yer almaktadır. Araştırma değişkenlerine ilişkin veriler, 2012-2020 periyodu göz önünde bulundurularak SPSS ve AMOS paket programları yardımıyla test edilmiştir. Tasarlanan yapısal eşitlik modeli aracılığıyla verilerinin test edilmesinde yol analizi kullanılmıştır. Araştırma sonuçlarına göre hekim sayısı ile ölüm oranı (0,33) ve taburcu olan hasta sayısı arasında olumlu (3,74) bir ilişki bulunmaktadır. Ayrıca birinci basamak müracaat sayısı ile ölüm oranı arasında olumsuz (-0,48); taburcu olan hasta sayısı ile de olumlu (0,61) bir ilişki olduğu sonucuna ulaşılmıştır. Yatak sayısı ile ölüm oranı arasında olumsuz (-0,04); hastane sayısı ile taburcu olan hasta sayısı arasında olumsuz (-0,03); ikinci ve üçüncü basamak müracaat sayısı ile ölüm oranı arasında da olumlu (0,45) bir ilişki olduğu elde edilen diğer sonuçlar arasındadır..

Key words: *Sağlık Arzı, Sağlık Talebi, Sağlık Hizmetleri, Sağlık Ekonomisi*

Abstract

The aim of this study is to determine the impact of health supply and demand that under health indicators on health outcomes. Within the framework of the determined purpose, the study includes five dependent (number of hospitals, number of physicians, number of beds, number of primary care applications, number of secondary and tertiary care applications) and two independent variables (mortality rate, number of discharged patients). The research data was tested with the help of SPSS and AMOS package programs, by taking into consideration the period 2012-2020. Path analysis was used to test the data with the designed structural equation model. According to the research results, the number of physicians has a positive relationship with the mortality rate (0,33) and the number of discharged patients (3,74). In addition, the number of primary care visits had a negative relationship with the mortality rate (-0,48), while it had a positive relationship with the number of patients discharged (0,61). Other results obtained include a negative relationship between the number of beds and the mortality rate (-0,04), a negative relationship between the number of hospitals and the number of discharged patients (-0,03) and a positive (0,45) relationship between the number of applications to secondary and tertiary care and the mortality rate.

Key words: *Health Supply, Health Demand, Health Services, Health Economics*

Jel Codes: I1, I11, I12.

GİRİŞ

Sağlık hizmetleri, ihtiyaç zamanının belirsizliği, arz ve talebinin eşzamanlı gerçekleşmesi ve ikamesinin bulunmaması gibi nedenlerden hareketle diğer hizmet türlerinden farklılık göstermektedir. Bu doğrultuda sağlık hizmetlerinin arz ve talep süreci, hasta ve doktor arasındaki iletişim doğrultusunda tasarlanmakta ve her hastaya gereksinimleri doğrultusunda farklı bir hizmet türü sunulmaktadır. Bu hizmet sürecinde birçok faktör rol oynamakta ve sağlık sonuçları üzerinde etki oluşturmaktadır.

Sağlık göstergeleri olarak da ifade edilen bu faktörler, sağlık hizmet sürecini ve hizmet sonrasını etkilemektedir. Bu etki, arz ve talebin orta noktada buluşma durumuna göre olumlu ve olumsuz sonuçlar doğurmaktadır. Bu bağlamda sağlık göstergelerine ilişkin çeşitli çalışmalar yapılmak suretiyle sağlık hizmet süreçleri ve sonuçları hakkında iyileşmeler elde edilmeye çalışılmaktadır.

Sağlık göstergelerinin sağlık sonuçları üzerindeki etkisine ilişkin literatürde birçok çalışma bulunmaktadır. Bu çalışmalar genel olarak, sağlık kurumları, sağlık personelleri, sağlık harcamaları gibi faktörlere ilişkin göstergelerin gerek istatistiksel gerekse de ekonometrik yöntemler ile analiz edildiği çalışmalar şeklindedir. Bu çerçevede sağlık arz ve talep unsurları kapsamında değerlendirilebilecek çalışmalar da yer almaktadır. Fakat sağlık arz ve talebi doğrultusunda değerlendirilen göstergelerin yapısal eşitlik modeli ile test edildiği bir çalışmaya literatürde rastlanılamamıştır. Bu durum çalışmanın özgün yönüne işaret etmektedir.

Yukarıda yapılan değerlendirme doğrultusunda çalışmada, sağlık arz ve talebi kategorisinde yer alan değişkenlerin sağlık sonuçları üzerindeki etkisini belirlemek amaçlanmaktadır. Belirlenen amaç çerçevesinde elde edilecek sonuçlardan hareketle sağlık hizmetlerine yönelik önerilerde bulunmak çalışmanın hedefleri arasındadır.

SAĞLIK HİZMETLERİNDE ARZ VE TALEP KAVRAMI

Sağlık personeli olarak değerlendirilebilen hekim, hemşire ve diğer sağlık çalışanları sağlık hizmetleri arzını oluşturmaktadır (Durmaz ve Erdem, 2017: 581-582). Sağlık hizmetlerinin arzı, çoğunlukla hizmetler ve piyasanın nitelikleri nedeniyle diğer mal ile hizmetlerden farklılık göstermektedir. Sağlık hizmetlerinde arz kavramı, sağlık kurum ve kuruluşlarınca üretilen sağlık hizmetlerinin tamamı olarak tanımlanabilir. Ayrıca tıbbi sarf, tıbbi cihaz ve ilaçların üretilmesi de sağlık hizmetleri arzı altında yer almaktadır. Sağlık hizmetlerinin arzı, ülkelerin sağlık sistemleri yapısı, finansman yöntem seçimleri ve uygulamada olan kamu politikalarına bağlı şekilde oluşturulmaktadır. Sağlık hizmetleri piyasasında kamu, sadece üretici olarak yer alabildiği gibi denetleyici ve düzenleyici olarak da bulunabilmektedir (Büyükşirin,2018: 9). Sağlık hizmetlerinde arzın yapısı ve kamu tarafından sunulma durumu, taleplerin şekillenmesinde rol oynamaktadır.

Talep kavramı, satın alma gücü ile desteklenen bir istek olarak tanımlanabilir. Fakat ekonomistlere göre söz konusu unsur sağlık hizmetleri talebi olduğunda, bu istek geçerli olmayabilmektedir. Sağlık hizmetleri talebine gereksinim duyan bireylerin, satın alma gücünün bulunmaması nedeniyle, hizmetin satın alınamaması kendilerinin yanı sıra çevreleri açısından da bir risk oluşturmaktadır. İfade edilen risk, bireyi ve dolayısıyla toplumu doğrudan ilgilendirdiği için kişilerin satın alma gücü göz önünde bulundurulmadan gereksinim duyulan sağlık hizmet talebinin

karşılanması gerekmektedir (Öztürk Yaprak ve Ecevit, 2019: 1485). Sağlık hizmetlerinde önceden türetilmiş talep ya da talebin arza bağlı şekilde ortaya çıkması durumu mevcuttur. Yani sağlık hizmetleri arzını sunan sağlık personelleri, bireylerin ilerleyen süreçte oluşacak sağlık taleplerinin şekillenmesinde rol oynamaktadır (Büyükşirin, 2018: 11). Sağlık hizmetlerinde arz ve talebin ortak amacı, kişilerin sağlıklı olmalarını sağlama, mevcut sağlık durumlarını koruma ve bireyin sağlık durumunun koruyup geliştirilmesi yoluyla toplumu sağlıklı kılmadır (Sargutan, 2005: 403).

LİTERATÜR TARAMASI

Sağlık göstergeleri kapsamında yer alan arz ve talep kavramları açıklandıktan sonra bu hususta literatürde yapılmış çalışmalara değinmek araştırma konusunun bütünlüğü açısından önem arz etmektedir.

Ersöz (2008) tarafından Türkiye ile OECD ülkelerinin sağlık düzeyleri ve sağlık harcamaları çok boyutlu ölçekleme analizi yardımıyla test edilmiştir. Araştırma sonuçlarına göre Türkiye'nin Kore Cumhuriyeti, Meksika, Polonya ve Slovak Cumhuriyeti ile benzerlik, Avusturya, Almanya ve Norveç ile farklılık gösterdiği belirlenmiştir.

Tüylüoğlu ve Tekin (2009) tarafından gelir düzeyi ve sağlık harcamalarının beklenen yaşam süresi ve bebek ölüm oranı üzerindeki etkileri çoklu regresyon analizi yardımıyla test edilmiştir. Araştırmada sağlık harcamalarının gelir düzeyine bağlı olarak beklenen yaşam süresi ve bebek ölüm oranı üzerinde etki oluşturduğu sonucuna ulaşılmıştır.

Yumuşak ve Yıldırım (2009) tarafından sağlık harcamaları iktisadi büyüme ilişkisi ADF testi yardımıyla analiz edilmiştir. Araştırma sonuçlarına göre sağlık harcamaları ve doğuşta yaşam beklentisinden hasılaya yönelik bir nedensellik bulunmaktadır.

Nesanır ve Erkman (2010) tarafından Kahramanmaraş aile sağlık merkezlerinde çalışan sağlık personellerinin sağlık ocakları ve aile hekimliği sistemini değerlendirmelerine yönelik karşılaştırmalı bir araştırma yapılmıştır. Katılımcıların çoğunluğunun aile sağlığı merkezlerinde çalışmaktan memnun olmasının yanı sıra koruyucu sağlık hizmetlerinde aile hekimliği sisteminin eski sisteme kıyasla daha uygun olduğu sonucuna ulaşılmıştır.

Ay ve diğerleri (2013) tarafından sağlık göstergeleri ile ekonomik büyüme arasındaki ilişki araştırılmıştır. Araştırmada değerlendirilen sağlık göstergelerinin çoğunluğu ile ekonomik büyüme arasında bir ilişki olduğu sonucuna ulaşılmıştır.

Gediz Oral ve Sayın (2013) tarafından sağlık göstergeleri kullanılarak Manisa'nın sağlık statüsü araştırılmıştır. Araştırma sonuçlarına göre Manisa, bölgede en fazla hasta yatağı bulunan ve yıllara bağlı olarak en fazla sağlık personelinin istihdam edildiği il konumundadır. Ayrıca uzman hekim ve pratisyen hekim başına düşen nüfus açısından değerlendirildiğinde ise Manisa'nın sadece bölge değil aynı zamanda Türkiye açısından da ortalamanın üzerinde olduğu elde edilen sonuçlar arasındadır.

Akar (2014) tarafından Türkiye'de sağlık harcamaları, sağlık harcamalarının nisbi fiyatı ve ekonomik büyüme arasındaki ilişki araştırılmıştır. Elde edilen sonuçlara göre, sağlık harcamaları ve harcamalara ilişkin nispi fiyat ile ekonomik büyüme değişkenleri arasında uzun dönemli bir ilişki bulunmaktadır. Öte yandan kısa dönemde söz konusu ilişkinin bulunmadığı ise elde edilen diğer sonuçlar arasındadır.

Daştan ve Çetinkaya (2015) tarafından OECD ülkeleri ile Türkiye'nin sağlık sistemleri, sağlık harcamaları ve sağlık göstergeleri karşılaştırılmıştır. Araştırma sonuçlarına göre kişi başı sağlık harcamaları ile bu harcamaların GSYİH'daki oranları bakımından OECD ülkelerinde son 30 yılda önemli artışlar bulunmaktadır. Ayrıca farklı sağlık sistemleri doğrultusunda sağlık harcamalarında farklılıklar bulunsa da, bu farklılıkların sağlık göstergeleri ile sağlık sistemlerinin başarısı ya da verimliliği ile doğrudan bir ilişki içerisinde olmadığı belirlenmiştir.

Sonğur (2016) tarafından OECD ülkelerinde sağlık göstergeleri kümeleme analizi yardımıyla test edilmiştir. Analiz sonuçlarına göre Türkiye'nin sağlık göstergeleri ile Şili, İsrail ve Meksika arasında benzerlikler bulunduğu belirlenmiştir. Öte yandan Türkiye'nin benzerliği bulunan ülkeler ile sağlık finansmanı bakımından da benzer grupta yer aldığı sonucuna ulaşılmıştır.

Güleryüz ve Köse (2017) tarafından Türkiye'de işsizlik ve sağlık göstergeleri panel veri analizi yardımıyla test edilmiştir. Elde edilen sonuçlara göre, işsizlik oranı ile yaşam beklentisi arasında olumsuz ve konjonktür yanlısı, işsizlik oranı ile bebek ölüm, kaba ölüm ve doğum oranı arasında ise olumlu ve konjonktür karşıtı bir ilişki olduğu belirlenmiştir. Ayrıca yapılan zaman serisi analizine göre işsizlik oranı ile bebek ölüm, doğum oranıyla ekonomik nedenlere bağlı intihar sayısı arasında olumlu ve konjonktür karşıtı ilişki olduğu sonucuna ulaşılmıştır.

Mut ve Akyürek (2017) tarafından OECD ülkeleri kümeleme analizi yardımıyla sınıflandırılmıştır. Araştırma sonuçlarına göre Türkiye'nin sağlık göstergelerine bağlı olarak Şili ve Meksika ile aynı kümede bulunduğu tespit edilmiştir. Türkiye'nin bulunduğu küme doğumda beklenen yaşam yılı ortalaması açısından en düşük, bebek ölüm hızı ortalaması bakımından ise en yüksek küme konumunda yer almaktadır.

Sayılı ve diğerleri (2017) tarafından Türkiye ile OECD ülkeleri sağlık göstergeleri ve sağlık harcamaları bakımından karşılaştırılmıştır. Araştırma sonuçlarına göre Türkiye, kadın ve erkek yaşam yılı beklentisi açısından düşük seviyede, anne ölüm hızı, beş yaş altı ölüm hızı ve neonatal ölüm hızı bakımından ise yüksek seviyede anlamlı farklılığa sahip olduğu tespit edilmiştir. Öte yandan sağlık harcamaları konusunda Türkiye bütçedeki pay açısından en düşük, hastane, yatak ve sağlık personeli bakımından da düşük seviyede yer almaktadır. Bununla birlikte tespit edilen sonuçlar istatistiksel açıdan anlamlıdır.

Şahin (2017) tarafından sağlık göstergeleri göz önünde bulundurularak Türkiye'nin Avrupa Birliği ülkeleri arasındaki yeri analiz edilmiştir. 2000-2014 yılları göz önünde bulundurularak yapılan araştırma sonuçlarına göre Türkiye, Slovakya, Letonya, Estonya, Polonya, Hırvatistan, Romanya, Bulgaristan, Litvanya, Çek Cumhuriyeti ve Macaristan ile aynı kümede yer almaktadır.

Bilir ve Gökdemir (2018) tarafından bireylerin yaşam beklentisi, kalkınma göstergeleri doğrultusunda incelenmiştir. Yapısal eşitlik modeli kullanılarak yapılan analiz sonuçlarına göre, tasarruf, sabit sermaye yatırımları, ekonomik büyüme ve doktor başına düşen nüfusun yaşam beklentisi üzerinde önemli bir etken olduğu tespit edilmiştir.

Türkoğlu (2018) tarafından Avrupa ülkelerinde sağlık göstergeleri TOPSİS yöntemiyle değerlendirilmiştir. 2010-2014 dönemi göz önünde bulundurularak yapılan çalışma sonuçlarına göre sağlık göstergeleri açısından Türkiye, Sırbistan ve Letonya ile birlikte son sıralarda yer almaktadır.

Işık ve Karaman (2019) tarafından Türkiye ve Şanhay İşbirliği Örgütü Üye Ülkeleri, sağlık harcamaları ve sağlık göstergeleri bakımından araştırılmıştır. Elde edilen sonuçlara göre Türkiye'de kişi başı sağlık harcamaları, araştırmada yer alan ülkelerin tamamından daha yüksektir. Doğumda beklenen yaşam süresi açısından ise Türkiye, Çin'den sonra ikinci sıradadır. Ayrıca bebek ölüm hızı bakımından değerlendirildiğinde Türkiye'nin Rusya, Çin ve Kazakistan'dan sonra en düşük değere sahip olduğu elde edilen diğer sonuçlar arasındadır.

Şener ve diğerleri (2019) tarafından sağlık göstergeleri yapısal eşitlik modeli yardımıyla test edilmiştir. Araştırma sonuçlarına göre sağlık harcamaları yaşam süresini olumlu etkilerken, bebek ölüm oranını olumsuz etkilemektedir. Ayrıca hekim sayısının sağlık harcamalarını olumlu etkilediği tespit edilen diğer sonuçlar arasındadır.

Değirmenci ve Yakıcı Akan (2020) tarafından OECD ülkeleri sağlık göstergeleri açısından değerlendirilmiştir. Kümeleme analizi sonucuna göre Türkiye'nin Meksika, Kore ve Polonya ile aynı kümede yer aldığı tespit edilmiştir. Ayrıca kişi başı yatak sayısı açısından Türkiye'nin sağlık kaynaklarının yetersiz olduğu sonucuna ulaşılmıştır.

Saygın ve Kundakçı (2020) tarafından OECD ülkeleri sağlık göstergeleri bakımından ARAS ve EDAS yöntemleri kullanılarak değerlendirilmiştir. Araştırma sonuçlarına göre belirlenen sağlık göstergeleri açısından Türkiye, OECD ülkeleri içerisinde alt sıralarda yer almaktadır.

Saygın ve Kundakçı (2020a) tarafından OECD ülkeleri sağlık göstergeleri açısından karşılaştırılmıştır. WASPAS ve CODAS yöntemi kullanılarak yapılan çalışmanın sonuçlarına göre Türkiye, İsrail, Meksika ve Şili ile aynı sıradadır. Öte yandan beklenen yaşam süresi açısından Türkiye, Polonya ve Meksika ile aynı sıralamada yer alarak OECD ülke ortalamasının altındadır. Sağlık harcamalarına ayrılan pay açısından ise Türkiye son sıralardadır.

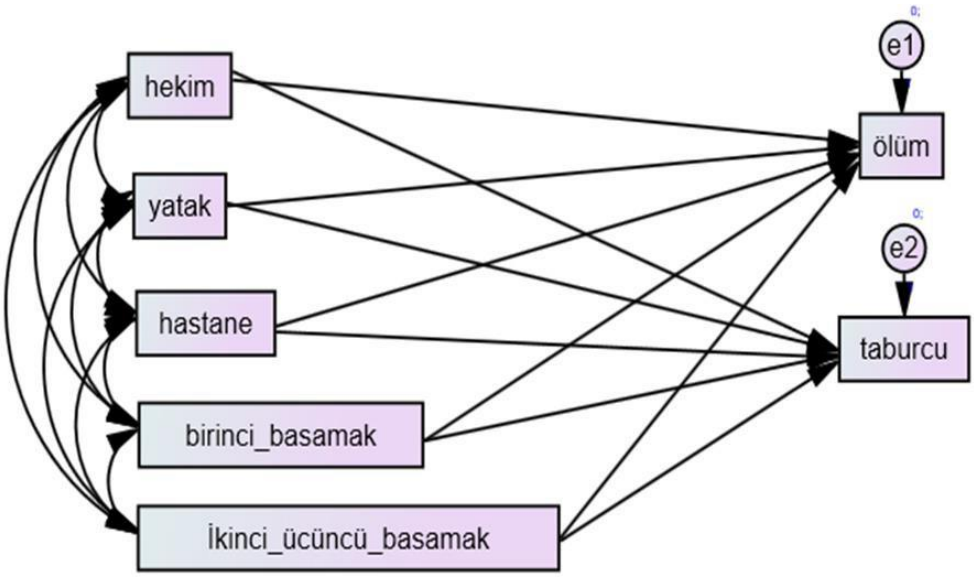
Tekin (2020) tarafından pandemi döneminde sağlık ve finansal göstergeler bakımından ülkeler sınıflandırılmıştır. Araştırma sonuçlarına göre Türkiye'de iyileşen hasta sayısı oranının en yüksek, bir milyon kişi başına ölüm oranının en az olduğu belirlenmiştir. Gelişmekte olan ülkeler grubunda bulunan Türkiye, Çin, Meksika, Kolombiya ve Hindistan arasında sağlık harcamasında ilk, hemşire sayısında üçüncü ve doktor sayısında ise dördüncü sırada olduğu tespit edilmiştir.

Alkaya ve Alkış (2021) tarafından OECD ülkeleri sağlık göstergelerine göre sınıflandırılmıştır. Araştırma sonuçlarına göre Türkiye, sağlıklı yaşam beklentisi, sağlık personelleri sayısı, sağlık harcaması, yeni doğan ölüm oranı ve yaşam boyu anne ölüm riski açısından gelişmiş ülkelerle karşılaştırıldığında yetersiz seviyedir.

METODOLOJİ

Yapısal eşitlik modeli, değişkenler arasındaki ilişkiyi açıklamasının yanı sıra modellerin bir bütün olarak da test edilebilmesine imkân tanıyan istatistiksel bir yöntem olarak ifade edilebilir (Alkış, 2016). Bununla birlikte gözlenen ve gizil değişkenler arasındaki ilişkilerin analizinde yapısal eşitlik modeli kapsamlı bir yöntem olarak değerlendirilmektedir (Bilir ve Gökdemir, 2018). Öte yandan hipotezlerin test edilmesinde ve değişkenler arasındaki ilişkinin analiz edilmesinde de yapısal eşitlik modeli bir yöntem olarak kullanılmaktadır (Şener vd., 2019: 270). Bu bağlamda yapısal eşitlik modeli, birden fazla bağımlı ve bağımsız değişkenler arasındaki ilişkinin incelenebilmesine olanak sağlamaktadır. Ayrıca yapısal eşitlik modeli, kapsamında bir değişkeni hem bağımlı hem de bağımsız değişken olarak test edebilmeye de olanak tanımaktadır (Aslan, 2018).

Çalışmanın amacı sağlık arz ve talebinin sağlık sonuçları üzerindeki etkisini belirlemektir. Değişkenler arasındaki etki durumu, SPSS 25.0 ve AMOS 24 paket programları kullanılarak yapısal eşitlik modeli yardımıyla test edilmiştir. 2012-2020 periyodunda yer alan araştırma verileri, 'Sağlık İstatistikleri Yıllığı' ve 'OECD Sağlık İstatistikleri' veri tabanından alınmıştır. Araştırmanın amacı çerçevesinde tasarlanan yapısal eşitlik modelinde değişkenler, yol analizi aracılığıyla test edilmiştir. Araştırma modeli Şekil 1'de yer almaktadır.



Şekil 1. Değişkenlerin Yapısal Eşitlik Modeli

Araştırmanın bağımlı değişkenleri, hekim sayısı, yatak sayısı, hastane sayısı, birinci basamak müracaat sayısı, ikinci ve üçüncü basamak müracaat sayısı; bağımsız değişkenleri ise ölüm oranı ve taburcu olan hasta sayısıdır. Bu doğrultuda tasarlanan model ile değişkenlerin etki durumları değerlendirilmiştir. Araştırmanın hipotezleri şu şekildedir;

- H_1: Hekim sayısı ile ölüm oranı arasında anlamlı bir ilişki vardır.
- H_2: Yatak sayısı ile ölüm oranı arasında anlamlı bir ilişki vardır.
- H_3: Birinci basamak müracaat sayısı ile ölüm oranı arasında anlamlı bir ilişki vardır.
- H_4: İkinci ve üçüncü basamak müracaat sayısı ile ölüm oranı arasında anlamlı bir ilişki vardır.
- H_5: Hekim sayısı ile taburcu olan hasta sayısı arasında anlamlı bir ilişki vardır.
- H_6: Hastane sayısı ile taburcu olan hasta sayısı arasında anlamlı bir ilişki vardır.
- H_7: Birinci basamak müracaat sayısı ile taburcu olan hasta sayısı arasında anlamlı bir ilişki vardır.

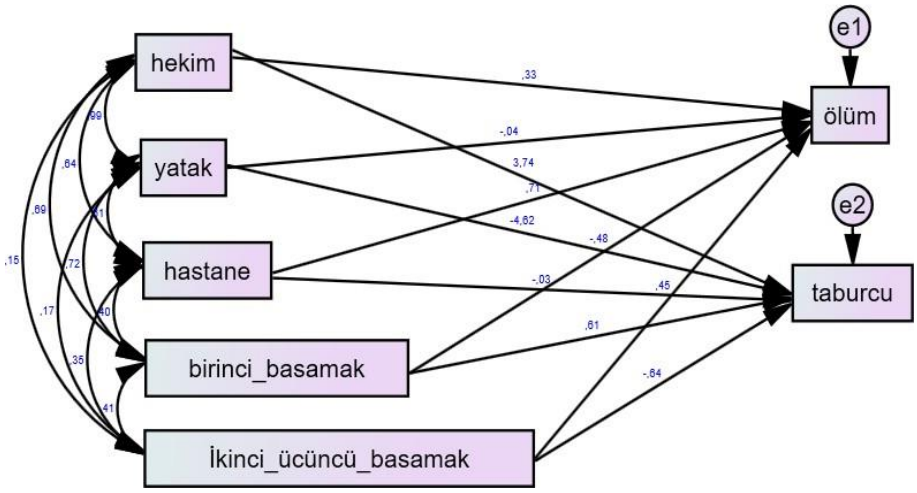
Araştırma değişkenlerinin etki durumları yapısal eşitlik modeli yardımıyla test edilmiştir. Modele ilişkin uyum iyiliği değerleri Tablo 1'de sunulmuştur.

Tablo 1. Uyum İyiliği Değerleri

Uyum İndeksleri	En İyi Uyum Değerleri	Kabul Edilebilir Uyum Değerleri	Modelin Uyum Değerleri
x^2/sd	≤ 3	**≤ 4-5**	4,4
RMSEA	**≤ 0,05**	0,06-0,08	0,06
NFI	**0,95 ≤ NFI ≤ 1**	**0,90 ≤ NFI ≤ 0,95**	0,95
CFI	**0,95 ≤ CFI ≤ 1**	**0,90 ≤ CFI ≤ 0,95**	0,95

Kaynak: Schermelleh-Engel vd., 2003; Tor-Kadıoğlu, 2021:68.

Modelin uyum iyiliği değerleri incelendiğinde; x2/sd değerinin 4,4; RMSEA değerinin 0,06; NFI değerinin 0,95; CFI değerinin 0,95 olmasından hareketle modelin kabul edilebilir bir uyum aralığında olduğu ifade edilebilir. Modele ilişkin yol analizi sonuçları Şekil 2'de hipotez sonuçları Tablo 2'de yer almaktadır.



Şekil 2. Yapısal Eşitlik Modeli Yol Analizi Sonuçları

Tablo 2. Modelin Hipotez Sonuçları

Hipotezler	Yollar	Yol katsayısı	P
H_1	Hekim => Ölüm	0,33	0,794
H_2	Yatak => Ölüm	-0,04	0,971

H_3	Birinci Basamak Müracaat => Ölüm	-0,48	**0,012**
H_4	İkinci ve Üçüncü Basamak Müracaat => Ölüm	0,45	**0,003**
H_5	Hekim => Taburcu Olan Hasta	3,74	**0,003**
H_6	Hastane => Taburcu Olan Hasta	-0,03	0,889
H_7	Birinci Basamak Müracaat => Taburcu Olan Hasta	0,61	**0,001**

Analiz sonuçlarına göre hekim sayısı ile ölüm oranı (0,33) ve taburcu olan hasta sayısı (3,74) arasında olumlu bir ilişki bulunmaktadır. Birinci basamak müracaat sayısı ile ölüm oranı arasında olumsuz (-0,48); taburcu olan hasta sayısı ile de olumlu (0,61) bir ilişki olduğu sonucuna ulaşılmıştır. Ayrıca yatak sayısı ile ölüm oranı (-0,04) ve hastane sayısı ile taburcu olan hasta sayısı (-0,03) arasında da olumsuz bir ilişki olduğu tespit edilmiştir. Öte yandan ikinci ve üçüncü basamak müracaat sayısı ile ölüm oranı arasında olumlu (0,45) bir ilişki olduğu elde edilen diğer sonuçlar arasındadır. Belirlenen sonuçlardan birinci basamak müracaat sayısı ile ölüm oranı (0,012 ≤0,05) ve taburcu olan hasta sayısı (0,001 ≤0,05); ikinci ve üçüncü basamak müracaat sayısı ile ölüm oranı (0,003 ≤0,05); hekim sayısı ile taburcu olan hasta sayısı değişkenleri (0,003 ≤0,05) arasında bulunan ilişkilerin istatistiksel açıdan anlamlı olduğu sonucuna ulaşılmıştır.

SONUÇ VE ÖNERİLER

Sağlık arz ve talebe ilişkin faktörlerin sağlıklı olma hali üzerinde etkisi olduğu bilinen bir gerçektir. Sağlık arzları konusunda sağlık hizmetlerinin sunulduğu kurum ve kuruluşların ekipmanlar bakımından eksiksiz, hizmetler açısından ise işlevsel olması önem arz etmektedir. Öte yandan sağlığa yönelik taleplerin doğru zamanda doğru kişi ya da kuruma yönelik yapılması, sağlıklı olma konusunda önemli rol oynamaktadır. Bu çerçevede sağlık arzına yönelik girişimler eksiksiz olsa dahi talep süreci doğru şekilde yönetilmediği zaman istenilen sağlık sonucuna ulaşılamamaktadır. Sağlık hizmetlerinin talebinde bireylerin demografik özellikleri, yaşadıkları yer ve kültür gibi unsurlarının yanı sıra sağlığın tanımı ve sağlık okuryazarlık seviyeleri de etki oluşturmaktadır. Bu bağlamda çalışmanın amacı, sağlık arz ve talep unsurlarının sağlık sonuçları üzerindeki etkisini belirlemek ve söz konusu etkiyi çeşitli açılardan değerlendirebilmektir.

Analiz sonuçlarına göre hekim sayısı ile ölüm oranı arasında olumlu (0,33) bir ilişki bulunmaktadır. Yani hekim sayısı arttıkça ölüm oranı azalmaktadır. Fakat ulaşılan sonuç, istatistiksel açıdan anlamlı değildir (0,794≥0,05). Sağlık hizmet sürecinde en önemli rol şüphesiz hekimlere aittir. Teşhis ve tedavi sürecinin belirlenip yönlendirilmesi konusunda hekimlerin rolü yadsınamaz derecede büyüktür. Bu bağlamda hekimlerin gerek tedavi sürecini gerekse de sağlık personellerini yönlendirmesi bakımından ölüm oranı üzerinde olumlu bir etkisi olması beklenilen bir durumdur. Ulaşılan sonuç, bu beklentiyi destekler nitelikte olmasına rağmen istatistiksel açıdan anlamlı değildir. Tespit edilen sonuçtan hareketle, "H_1: Hekim sayısı ile ölüm oranı arasında anlamlı bir ilişki vardır." hipotezi reddedilmiştir.

Yatak sayısı ile ölüm oranı arasında olumsuz (-0,04) bir ilişki bulunduğu sonucuna ulaşılmıştır. Başka bir ifade ile yatak sayısının artışı ölüm oranını artırmaktadır. Ancak tespit edilen bu sonuç, istatistiksel açıdan anlamlı değildir

(0,971≥0,05). Araştırmada ulaşılan sonuç, beklentilerin aksini ifade etmektedir. Yatak sayısı artışı ile daha iyi sağlık sonuçlarına ulaşılacağı, kişilerin sağlığın tanımı ve sağlık okuryazarlığı kavramları ile ilişkili bir durumdur. Bu bağlamda çok fazla sayıda yatağa sahip olmak, bazı yetkililerce daha iyi bir sağlık hizmeti sunulabileceğine yönelik bir anlam taşırken, diğer yetkililere göre bu durum, zaman ve maliyet israfı olarak değerlendirilebilmektedir. Dolayısıyla yatak sayısı ile ölüm oranı arasındaki ilişki durumu, değerlendirmeyi yapan kişilerin sağlık algılarına göre şekillenebilmektedir. Çalışmada ulaşılan sonuçtan hareketle yatak sayısının ölüm oranı üzerinde olumlu bir etkisi olmadığı söylenebilir. Dolayısıyla daha fazla yatağa sahip olmanın iyi bir sağlık hizmeti sonucunu oluşturmadığı, aksine çalışmada ulaşılan sonucun fazla yatak sayısının zaman ve maliyet israfına neden olduğu düşüncesini destekler nitelikte olduğu ifade edilebilir. Belirlenen sonuçtan hareketle araştırmanın hipotezlerinden olan "H_2: Yatak sayısı ile ölüm oranı arasında anlamlı bir ilişki vardır." hipotezi reddedilmiştir.

Birinci basamak müracaat sayısı ile ölüm oranı arasında olumsuz (-0,48); taburcu olan hasta sayısı arasında olumlu (0,61) bir ilişki olduğu belirlenmiştir. Ayrıca ulaşılan sonuçlar, istatistiksel açıdan anlamlıdır (0,012≤0,05; 0,001≤0,05). Birinci basamak sağlık hizmetleri, hastaların mevcut sağlık durumlarını koruma ve hastalıklarını erken teşhis etme konusunda önemli rol oynamaktadır. Bu kapsamda 'Sağlıkta Dönüşüm Programı' ile Türkiye'de sağlık hizmetlerinin sunumu, sevk sistemi şeklinde sunulmaya başlamıştır. Sevk sistemi doğrultusunda birinci basamak sağlık hizmetlerine yönelik aile hekimliği uygulaması başlatılmıştır. Sağlığın korunması ve hastaların diğer basamaklarda yer alan sağlık kurumlarına yönlendirilmesinde aile hekimlikleri aktif rol oynamaktadır. Dolayısıyla birinci basamak sağlık hizmetleri aracılığıyla sağlığın korunması, geliştirilmesi, hastalıkların engellenebilmesi ve sonuç olarak ölüm oranlarının azalması beklenmektedir. Fakat çalışmada ulaşılan sonuç bu beklentiye ters düşmektedir. Türkiye'nin sağlık sisteminde birinci basamak sağlık hizmetlerine başvuru konusunda bir zorunluluk bulunmamaktadır. Hastalar direk olarak ikinci ve üçüncü basamak sağlık hizmetlerine başvuru da yapabilmektedir. Bu durum zaman ve maliyet israfının yanı sıra gerçek hastaların randevu alabilmeleri üzerinde de olumsuz bir etki oluşturmaktadır. Dolayısıyla birinci basamak müracaat sayısı ile ölüm oranı arasında belirlenen olumsuz etki durumunun, birinci basamak sağlık hizmetlerine başvuruda bir zorunluluk bulunmaması ile ilgili olabileceği düşünülmektedir. Elde edilen sonuçlara bağlı olarak araştırmanın hipotezlerinden olan "H_3: Birinci basamak müracaat sayısı ile ölüm oranı arasında anlamlı bir ilişki vardır." ve "H_7: Birinci basamak müracaat sayısı ile taburcu olan hasta sayısı arasında anlamlı bir ilişki vardır." hipotezleri kabul edilmiştir.

İkinci ve üçüncü basamak müracaat sayısı ile ölüm oranı arasında olumlu (0,45) ve anlamlı (0,003≤0,05) bir ilişki bulunmaktadır. Başka bir ifade ile ikinci ve üçüncü basamak müracaat sayısı arttıkça ölüm oranı azalmaktadır. Sağlıkta Dönüşüm ile uygulamaya konulan sevk sistemi kapsamında sağlık hizmetlerinde çeşitli iyileşmeler meydana gelmiştir. Bu çerçevede ikinci ve üçüncü basamak sağlık hizmetlerinde personel, ekipman, teknoloji ve bilgi sistemleri gibi konularda gelişmelere yönelik adımlar atılmış ve kaliteli sağlık hizmeti hedeflenmiştir. Çalışmada ikinci ve üçüncü basamak müracaat sayısının artması ile ölüm oranının azalması, söz konusu hedefi destekler niteliktedir. Ulaşılan sonuçtan hareketle "H_4: İkinci ve üçüncü basamak müracaat sayısı ile ölüm oranı arasında anlamlı bir ilişki vardır." hipotezi kabul edilmiştir.

Hekim başvurularında -sağlık hizmetlerine yönelik taleplerin artışında- önemli rol oynamıştır. Bu çerçevede çalışmada, hekim sayısı ile taburcu olan hasta sayısı arasında olumlu (3,74) bir ilişki olduğu belirlenmiştir. Ayrıca tespit edilen ilişki, istatistiksel açıdan anlamlıdır (0,003≤0,05). Teşhis ve tedavi sürecinin yönetilmesi konusunda hekimlerin rolü yadsınamaz derecede büyüktür. Hekimlerin üstlendikleri rolü aktif olarak yerine getirmeleri,

hastaların tedavisi ve iyileşme süreci üzerinde olumlu bir etki oluşturmaktadır. Öte yandan Sağlıkta Dönüşüm Programı ile uygulamaya konulan 'Genel Sağlık Sigortası' aracılığı ile sağlık hizmetlerine başvuru konusunda eşitsizlikler giderilmiştir. Bu doğrultuda herkes, sosyal güvenceye sahip olarak sağlık hizmetlerinden ücretsiz şekilde faydalanabilmiştir. Belirlenen sonuca göre "H_5: Hekim sayısı ile taburcu olan hasta sayısı arasında anlamlı bir ilişki vardır." hipotezi kabul edilmiştir.

Hastane sayısı ile taburcu olan hasta sayısı arasında olumsuz (-0,03) bir ilişki bulunmaktadır. Ancak ulaşılan bu sonuç, istatistiksel açıdan anlamlı değildir (0,889≥0,05). Yani hastane sayısı arttıkça taburcu olan hasta sayısı azalmaktadır. Sağlık hizmetlerinde hastane sayılarına yönelik farklı görüşler bulunmaktadır. Çok fazla hastaneye sahip olmak ile daha iyi sağlık sonucuna ulaşılabileceğine yönelik görüşlere karşın çok fazla sayıda hastanenin bulunması maliyet israfı olarak da değerlendirilebilmektedir. Bu durum yetkili kişilerin 'sağlık algıları' doğrultusunda şekillenebilen bir durumdur. Bu durumun bireylerin fazla hastaneye sahip olunması ile daha iyi olabileceğine yönelik düşüncesinden kaynaklanabileceği düşünülmektedir. Nitekim elde edilen bulgu, bu düşünceyi desteklemektedir. Belirlenen bu sonuçtan hareketle "H_6: Hastane sayısı ile taburcu olan hasta sayısı arasında anlamlı bir ilişki vardır." hipotezi reddedilmiştir.

Çalışmada ulaşılan sonuçlardan hareketle şu önerilerde bulunulabilir;

- Sevk sistemi hakkında bireylerin bilgi seviyeleri artırabilir.
- Birinci basamak sağlık hizmetlerine başvuru konusunda zorunluluklar oluşturulmak suretiyle daha etkili bir sağlık sonucuna ulaşılabilir.
- Sağlık algı seviyesini belirlemeye yönelik çalışmalar gerçekleştirilebilir, elde edilen sonuçlardan hareketle hedef kitleye özel sağlık politikaları tasarlanabilir.
- Tasarlanan sağlık strateji ve politikalarında toplumun sağlık okuryazarlık seviyesi göz önünde bulundurulabilir.

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Deploying Method Of Moments Quantile Regression To Explore The Moderating Role Of Information And Communication Technology In Financial Inclusion-Environmental Deterioration Nexus

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Abstract

Financial inclusion has long been recognized as an important determinant of poverty reduction. Easy available financial services enable businesses to assess affordable financial products that will help them to produce goods and services to satisfy customers' wants raising a hot debate on the environmental impacts of financial inclusion in the research community. The discussion on the environmental outcomes of financial inclusion is even more critical considering its major role in reaching the targets of Sustainable Development Goals 7 and 17. Against this backdrop, this study collected the data for the six oil exporting countries (United Arab Emirates, Saudi Arabia, Russia, Kuwait, Canada, and the United States) in the time-period from 1995 to 2019 to evaluate whether financial inclusion aids in to environmental deterioration of the underlying sample of countries. Using the Method of Moments Quantile Regression, our study authenticates the presence of environmental Kuznets curve (EKC) phenomenon positing the positive association between human development index and environmental deterioration in the early stages of economic emancipation whereas higher levels of environmental emancipation are associated with ameliorated level of environmental quality divulging an inverted U-shape linkage amid these variables. Energy consumption is not found effective in reducing the environmental deterioration of the on-hand sample whereas information and communication technology (ICT) aids into environmental preservation. Lastly, our findings show that financial inclusion reduces the environmental deterioration of the six oil exporting countries via the channel of ICT.

Key words: *Environmental deterioration, Financial inclusion, Information and communication technology, Environmental Kuznets curve*

Google Trends Analysis of 2023 Türkiye-Syria Earthquake Sequence from a Disaster Management Approach

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Abstract

On 6 February 2023, two devastating earthquakes struck Türkiye and Syria, causing catastrophic loss of life and damage in the region. Türkiye is an active earthquake zone, and strategies for an effective disaster management have vital importance in the geography. In this study, Google search trends are analyzed for the period after the disaster in the region. Breakout search queries in the first week of the disaster are analyzed and categorized by topic. "General earthquake knowledge", "Comparison with previous disasters", "Situational awareness", and "Community disaster recovery" are 4 topics identified in queries. Interest in the topics are examined for the first week period. Additionally, community disaster resilience is assessed using YouTube search trends in Hatay, the province that had the largest damage. YouTube is considered here as a tool to measure resilient individual behaviors. Signs of community resilience and recovery are identified in search trends by the end of February. Lastly, distribution of Disaster and Emergency Management Authority (AFAD)-related search terms are analyzed to figure out the functions fulfilled by the authority in the aftermath of the earthquake. Results of this study has future implications for disaster management in phases of preparedness, resilience and recovery.

Key words: *Türkiye-Syria Earthquake Sequence, Google Trends, YouTube, Disaster Management*

Determınıng The Awareness Levels Of Togu Campus Users About Recyclıng And Use Of Renewable Energy Sources

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Abstract

There has been a great increase in environmental problems in the last century due to many reasons such as rapid population growth, unconscious and rapid consumption of natural resources and pollution. If measures are not taken against increasing environmental problems, it is impossible to leave a livable world to future generations. In order to ensure environmental sustainability and to propose solutions to environmental problems, individuals, institutions and organizations need to be conscious about resources and energy consumption. Improving individual and social environmental awareness can be possible by increasing the level of environmental awareness. In this study, it was aimed to determine the level of knowledge of the users of Tokat Gaziosmanpaşa University Taşlıçiftlik Campus about environmental problems and to reveal their preferences for behaviors such as recycling and the use of renewable energy sources, which are individual measures that can be taken against environmental problems. The methodology of the study is based on a questionnaire survey using a 5-point Likert scale that aims to measure the attitudes, tendencies and opinions of campus users. In the survey, demographic information such as age, gender, education level, income level, etc. was requested from the participants, and 26 questions were asked about their habits and preferences regarding recycling and renewable energy use. The sample of the survey consists of students, academic staff and administrative staff who use TOGU Taşlıçiftlik campus in their daily lives. The survey, which was prepared online and delivered to the units on campus, was applied to 516 of the campus users, with a total of approximately 22,000 students and staff, in the 2022-2023 academic year. The data obtained were evaluated with frequency analysis, descriptive analysis and chi-square analysis methods using SPSS software. As a result of the evaluation, 41.9% of the participants stated that they had a good level of knowledge about environmental problems, 13.4% stated that they had a very good level of knowledge, and a significant majority stated that environmental problems directly affected their lives. When the answers of the participants regarding the use of renewable energy sources in daily life are compared, it is observed that the preferences for the use of renewable energy sources increase with the increase in age, education level and income level. The majority of the participants selected options indicating that they recycle waste such as glass, paper and plastic in their daily lives and that there are insufficient recycling points in the campus. This situation did not vary with the demographic data. However, in the questions related to the evaluation of shopping preferences, it was observed that environmentally friendly products were preferred by participants with higher income and education levels than young participants residing in student dormitories. As a result of the study, the renewable energy use and recycling preferences of TOGU campus users were examined and it was revealed how these preferences vary based on gender, age, education level, income level, accommodation and position in the univercity.

Key words: *Environmental awareness, recycling, use of renewable energy*

Determine of time-depended flight activity in honey bee (Apis mellifera L.)

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Abstract

*In this study, it was aimed to determine the time-dependent flight efficiency of worker bees in honeybee (Apis mellifera L.) colonies. For this purpose, existing honey bee colonies in the Beekeeping Unit of Ondokuzmayıs University, Faculty of Agriculture, were used. Of the 15 randomly selected from the existing colonies, the workers who flew out of the hive and returned to the hive for 30 seconds at 10:00, 13:00 and 15:00 on the same day in the fourth week of May, the second and fourth week of June and July were counted. Mixed Pattern Analysis of Variance in Repeated Measurements was applied to the data. Sphericity was examined with Mauchly's Sphericity test. For those with equal variances (p>0.05), the Sphericity Assumed test was used. Epsilon value (Ɛ) was examined for cases where variances were not equal (p<0.05) and Greenhouse and Geisser tests were used when Ɛ<0.75 and Huynh-Feldt tests were used when Ɛ>0.75. Bonferroni test was used to determine the differences between the groups. The interaction groups were compared with Duncan multiple comparison test using one-way analysis of variance in the comparison of significant interactions. The number of worker bees flying during the measurement period differed between weeks (4.87±0.29B, 4.26±0.20B, 5.70±0.46A, 3.18±0.18C and 3.42±0.16C, respectively) and hour*week interactions. A difference was determined between the hour*week interactions among the number of worker bees returning to the hive. As a result of the evaluation of the pollen carriers from the worker bees returning to the hive, weeks (1.47±0.14A, 0.38±0.05C, 0.34±0.04C, 0.63±0.09B and 0.40±0.05C, respectively), hours (0.89±0.11X, 0.63±0.06Y and 0.42±0.05Z respectively) differences were determined between and hour*week interactions.*

Keywords: *Honey Bee, Apis mellifera L., Behavior, Flight Activity*

Türkiye'de Zeytinyağı Fiyatını Etkileyen Faktörlerin ARDL Model ile Analizi

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Abstract

Zeytinyağı fiyatını etkileyen faktörlerin analiz edildiği bu çalışmada; zeytinyağı fiyatı bağımlı değişken olarak alınmıştır. Araştırmanın materyalini, 1990-2021 yıllarına ait zeytin fiyatı (TL/kg), zeytin üretim alanı (da), ithalat (ton) ve ihracat (ton) veri olarak alınmıştır. Zaman serilerinde gerekli olan birim kök sınaması yapılmış ve düzeyde ihracat ile ürün fiyatı, birinci farkta ise diğer değişkenlerin durağan olduğu tespit edilmiştir. Farklı seviyelerdeki durağanlıklara yönelik analiz imkanı veren ARDL modelinin çalışma için uygun model olduğuna karar verilmiş ve uygulanmıştır. Kısa dönem ARDL modeli için en uygun gecikme uzunlukları ARDL (3,4,3,4) olarak belirlenmiştir. Ayrıca seriler arasında otokorelasyona ve değişen varyansa rastlanmamıştır. Uzun dönem ARDL modelinin uygun gecikme uzunluğu ise kısa dönem ARDL modeli ile aynı şekildedir. Yapılmış olan sınır testine göre f istatistik değeri 6.640481 bulunmuştur ve bu değere göre %5 düzeyinde seriler arasında bir eşbütünleşme ilişkisi söz konusudur. Son olarak hata düzeltme modelinde yer alan CointEq değerine göre kısa dönemde serilerin karşılaşacağı bir şok uzun dönemde 6 aylık bir sürede normal hale gelmektedir.

Keywords: *Zeytinyağı, ARDL modeli, Türkiye*

Giriş

İnsanların yaşamlarını sürdürebilmeleri için gıdaya olan ihtiyaçları gıdaları zorunlu tüketim maddesi haline getirmiştir. Bu nedenle gıdalar devamlı olarak talep görmektedirler. Tarım ve gıda ürünleri arzındaki açıklar ise fiyat artışlarına neden olmakta, bu da enflasyon gibi makroekonomik bir sorun yaratmaktadır (Çiftçi 2015).
Son yıllarda talep artışı olan zorunlu tüketim maddelerinden biri de yağlardır ve hem bitkisel hem de hayvansal kaynaklardan elde edilmektedir (Arıoğlu vd. 2003). Hayvansal kaynaklı yağların arzındaki yetersizlikler, yükselen fiyat trendi ile birleşince bitkisel yağlara olan talep te artmıştır. Bitkisel yağlar içinde önemli yer tutan zeytinyağının elde edildiği zeytin, Akdeniz ülkelerinin tarım sektörlerinde önemli yer tutan yüksek değerli bir tarım ürünüdür. Sofralık zeytin olarak kullanılmasının yanı sıra yağa dönüştürülebilmesi, yaşamsal bir besin maddesi olması ve özellikle son yıllarda insan sağlığı açısından ön plana çıkması zeytinin önemini artırmaktadır (Duman 2003).

Dünya genelinde yapılan zeytin üretimine baktığımızda bu üretimin yaklaşık %90'ı yağ yapımında, kalan %10'u ise sofralık zeytin yapımında kullanılmaktadır (ANONİM, 2021). Zeytinyağına olan talep, Zeytin üretiminde sürekli bir gelişmeyi beraberinde getirmiştir. Dünyada 2021 yılı itibariyle 10 milyon hektarlık alanda üretilen yaklaşık 23 milyon ton zeytinin %35'ini sağlayan İspanya, %9'unu karşılayan İtalya ile %7'sini karşılayan Türkiye ilk üç sırayı almaktadırlar (FAOSTAT,2021t.y.). Türkiye'nin zeytinyağı üretimi ise 225 bin ton kadardır (TEBGE,2021). Ancak yurtiçi talebini karşılayamadığı dönemlerde ithalat yapmak zorunda kalmaktadır. İthal etmek zorunda olduğumuz

ürünlerin yurt dışı üretim seviyeleri yeterli olmadığında ve ithalatçı ülkelerdeki ekonomik koşullarla birleştiğinde, ithalat yetersiz gelmekte ve zaman zaman yurt içi talebi karşılayamamamıza neden olmaktadır. Bunun sonucunda ürün fiyatlarında beklenmedik ve ani artışlar meydana gelmektedir. Tarım ve gıda ürünlerindeki fiyat artışlarının enflasyonu yükseltmesi, bu artışların kaynağına ilişkin spekülasyonları körüklemektedir (Gündüz 2021).

Türkiye'deki yağ fiyatlarındaki artış insanlar tarafından sıkça konuşulan ve uzmanlarında çözüm arayışı içinde olduğu bir konu haline gelmiştir. Yapılan araştırmalarda fiyat artışların nedenleri arasında; girdi fiyatlarındaki artışlar, üretim ağındaki üretici sayısının azalması, stokçuluk, asılsız haberlerle fiyat trendini değiştiren toptancılar ve işleme sanayisindeki maliyetleri gösterilmektedir.

Tarım ve gıda ürünleri özelinde fiyat, üretim alanı, ürüne ait ithalat ve ihracat miktarları gibi değişkenlerin etkileşimi ve nedenselliği üzerine yapılmış çalışmalar, ürün bazında gözlemlenen gelişmeleri anlamaya yardımcı olacaktır. Çalışmada ARDL model analizi ile Türkiye'de zeytinyağı fiyatını etkileyen faktörler analiz edilmiştir.

MATERYAL VE METOD

Materyal

Çalışmada zeytinyağı ürün fiyatı ile üretim alanı, ithalat ve ihracat miktarları arasındaki ilişkiyi incelemek ve ürün fiyatını etkileyen değişkenlerin belirlenmesi amacıyla 1990-2021 dönemlerine ait veri seti kullanılmıştır. Zaman serisi analizlerinde tarımsal istatistiklere geçmişe yönelik verilere farklı değişkenlerde ulaşılması zor olduğu için bu dönem tercih edilmiştir. Veriler Türkiye İstatistik Kurumu (TÜİK) ve Food and Agricultural Organization (FAO) elde edilmiştir.

Metod

Birim kök testlerine yönelim zaman serilerinin genellikle durağan olmadığı gerçeği ile gerçekleşmiştir. Dickey ve Fuller (1981) tarafından geliştirilen Genişletilmiş Dickey-Fuller (ADF) testi ile Phillips ve Perron (1988) tarafından geliştirilen Phillips-Perron (PP) tesleri ile serilerin hangi türden trende sahip oldukları belirlenmektedir.

Granger ve Newbold (1974) tarafından belirtildiği gibi, zaman serilerinin çoğunlukla ortak yönde eğilim içermesi, seriler arasında sahte ilişkilerin ortaya çıkmasına neden olmaktadır. Gerçekte var olmayan bu sahte regresyon yüksek R2, düşük Durbin-Watson değerleri ve yüksek t istatistikleri ile geçersiz istatistiki sonuçlara neden olmaktadır. Tüm bu yanlışlıkları gidermek için, serilerin durağanlıktan kurtulması yani farklarının alınması gerekmektedir. Ancak bu durumda kısa dönem bilgileri elde edilmekte fakat uzun dönem bilgisinin kaybolmaktadır.

Granger (1981) ile Engle ve Granger (1987), uzun dönem bilgisinin kaybolması durumundan kaynaklanarak hem sahte regresyon sorununu aşmak hem uzun dönem katsayılarını kullanabilmek için kointegrasyon yöntemini geliştirmişlerdir. Ancak geliştirilen bu yöntemde bir bağımlı ve bir bağımsız değişken bulunmaktadır. Johansen (1980), Stock ve Watson (1988) ve Johansen ve Juselius (1990) kointegrasyonun hesaplanmasına yönelik Johansen Eşbütünleşme Yöntemini geliştirmişlerdir ve böyle iki ya da daha fazla sayıda değişken arasındaki uzun dönem ilişkisini tespit edebilmişlerdir.

Ancak bu yöntemlerin uygulanabilmesi için serilerin aynı seviyede durağan olmaları gerekmektedir. Değişkenlerin farklı seviyelerde durağan olması durumunda Peseran ve Shin (1997) tarafından ortaya konulan ARDL (Autoregressive Distrubuted Lag) Yöntemi kullanılmaktadır. Bu test ayrıca Sınır (Bound) testi olarak bilinmektedir ve değişkenlerin hem düzey hem de birinci farkta durağan olmaları durumunda kullanılabilmektedir. Engle ve Granger'ın (1987) ortaya koyduğu yönteme benzer şekilde iki aşamada uygulanmaktadır.

Bu yöntemin çeşitli avantajları literatürde bahsedilmektedir. Diğer yöntemlere nazaran bu yöntemin en önemli avantajı kullanılacak serilerin düzeyde veya birinci farkında durağan olmasının sorun teşkil etmemesidir. Yöntemin bir diğer avantajı ise eşbütünleşme testlerine göre hata düzeltme modelinde istatistiksel olarak daha güvenilir sonuçlar vermesidir. ARDL modeli; aynı anda modele dahil edilen seriler arasındaki hem kısa hem uzun dönem ilişkilerine yönelik bilgi vermektedir (Belen ve Karamelikli, 2016: Akel ve Gazel, 2014). Kullanılmış olan ARDL modeli (1) numaralı denklemde gösterilmiştir.

$$\mathrm{Y_t} = \alpha_0 + \alpha_1 \mathrm{t} + \sum^{p}{}_{i=1} \alpha_{2i}\ \mathrm{Y}_{t-i} + \sum^{q}_{i=0} \alpha_{3i} X_{t-i} + \mu \qquad (1)$$

Ayrıca kısa dönem katsayıları tahmin etmek amacıyla yapılan hata düzeltme modeli ise (2) numaralı denklemde gösterilmiştir.

$$\Delta \mathrm{Y}_t = \alpha_0 + \alpha_1 \mathrm{t} + \alpha_1 \mathrm{EC}_{t-1} + \sum^{p}{}_{i=1} \alpha_{3i} \Delta \mathrm{Y}_{t-i} + \sum^{q}_{i=0} \alpha_{4i} \Delta \mathrm{X}_{t-i} + \mu_t \qquad (2)$$

Çalışmada yer alan tüm serilerin öncelikle doğal logaritmaları alınmış ve ardından serilerin durağan olup olmadığının kontrolü için Genişletilmiş Dickey-Fuller (ADF) ve Phillips-Perron (PP) birim kök testlerinden yararlanılmıştır. Sonrasında zeytinyağı fiyatı bağımlı değişken alınarak diğer değişkenlerin ekili alan üzerindeki etkilerini araştırmak amacıyla ARDL yöntemi kullanılmıştır.

ARAŞTIRMA BULGULARI

Serilerin durağanlıklarının test edildiği birim kök sınaması Çizelge 1'de verilmiştir. Buna göre düzeyde ADF ve PP birim kök testlerinde ekili alan, ürün fiyatı ve ithalat miktarı birim kök içermektedir. Ancak birinci farkları alındığında tüm değişkenlerin birim kök içermediği sonucunu ulaşılmıştır. Serilerin farklı düzeylerde durağan olması I(0) ve I(1) araştırmada ARDL modelinin kullanılması gerekliliğini doğurmuştur.

Çizelge 1. ADF ve PP birim kök sınaması

		Değişkenler	ADF	PP		*Değişkenler*	ADF	PP
Düzey	Sabit	Ekili Alan (ha)	-0.6624	-0.5643	*Birinci Farklar*	Ekili Alan (da)	-6.4586***	-6.6558***
		Ürün Fiyatı (TL/kg)	-1.2548	-1.2711		Ürün Fiyatı (TL/kg)	-4.1877***	-5.6369***
		İthalat (Ton)	-2.1645	-2.0467		İthalat (Ton)	-7.8759***	-8.2893***
		İhracat (Ton)	-4.5783***	-4.5818***		İhracat (Ton)	-5.3272***	-19.6697***
	Sabit+Trend	Ekili Alan (ha)	-2.6156	-2.5722		Ekili Alan (da)	-6.3452***	-6.5292***
		Ürün Fiyatı (TL/kg)	-3.8337*	-1.4218		Ürün Fiyatı (TL/kg)	-4.2512**	-5.7109***

		İthalat (Ton)	-2.6744	-2.5971		İthalat (Ton)	-5.0854***	-10.7952***
		İhracat (Ton)	-4.5807***	-4.5754***		İhracat (Ton)	-5.3968***	-21.9549***

*, **, ***, sırasıyla %10, %5 ve %1 düzeylerinde anlamlılığı ifade etmektedir.

Eşbütünleşme testine ait sonuçlara Çizelge 3'te yer verilmiştir. Eşbütünleşme ilişkisinin oluşabilmesi için Peseran tarafından belirlenen üst kritik değerlerinden F istatistik değerinin yüksek olması gerekmektedir. Çizelge yer alan sonuçlara göre F istatistik değeri 6.640481 olarak bulunmuştur ve serilerin arasında eşbütünleşme ilişkisinin varlığı kabul edilebilir. Sonuç olarak ARDL modelinin kurulması uygundur ve seriler arasında uzun ve kısa dönemde ilişkiler belirlenebilir.

Çizelge 2. Eşbütünleşme testi sonuçları (F Bound Test)

Test istatistiği	**Değeri**	**K**
F- istatistiği	**6.640481**	3
	Kritik Sınır Değerleri	
Anlamlılık Düzeyi	**Alt sınır**	**Üst Sınır**
%10	2.37	3.20
%5	2.79	3.67
%2.5	3.15	4.08
%1	3.65	4.66

ARDL modelinin optimum düzeyindeki gecikme uzunluğunun tespit edilmesinde AIC (Akaike Information Criterion) kullanılmıştır ve ayrıca SC (Schwarz Criterion) ve HQ (Hannan-Quinn Criterion) ilave olarak verilmiştir. Maksimum gecikmenin uzunluğu modelde yer alan değişkenlerin yıllık veri seti olduğu için 4 alınmış ve uygun gecikme uzunluğu ile tahminleme yapılmıştır. Ayrıca belirlenen gecikme uzunluğunun uygunluğuna yönelik otokorelasyonun ve değişen varyans testleri ile bu testlerin ortak sonucunda ARDL (3,4,3,4) şeklindeki modeli Çizelge 3'de verilmiştir. Uzun dönem tahmin sonuçlarına göre değişkenlerin farklı ölçütlerde bulunmasından kaynaklı düzeltilmiş R^2 0.993057 bulunmuştur. Değişkenlerin yıllar itibariyle farklarının alındığı gecikmeler anlamlı p değerlerini vermektedir.

Çizelge 3. ARDL (3, 4, 3, 4) modeli ile uzun dönem tahmini

Değişken	**Katsayı**	**Std. Hata**	**t-istatistiği**	**P. value**
Ürün Fiyatı (-1)	0.466520	0.251927	1.851805	0.1065
Ürün Fiyatı (-2)	0.609880	0.261140	2.335454	0.0522
Ürün Fiyatı (-3)	-0.231588	0.278463	-0.831665	0.4330
İhracat Miktarı	-0.098055	0.055355	-1.771376	0.1198
İhracat Miktarı (-1)	0.055415	0.054748	1.012174	0.3452
İhracat Miktarı (-2)	0.080642	0.057031	1.414005	0.2003
İhracat Miktarı (-3)	0.026709	0.050315	0.530849	0.6119
İhracat Miktarı (-4)	0.095136	0.049556	1.919782	0.0964
İthalat Miktarı	0.017437	0.019763	0.882303	0.4069
İthalat Miktarı (-1)	-0.007568	0.017375	-0.435562	0.6763
İthalat Miktarı (-2)	-0.002376	0.014596	-0.162811	0.8753
İthalat Miktarı (-3)	0.024381	0.014518	1.679339	0.1370

Üretim Miktarı	-1.033853	0.904020	-1.143617	0.2904
Üretim Miktarı (-1)	-0.887793	0.947130	-0.937351	0.3798
Üretim Miktarı (-2)	-0.095090	0.949233	-0.100176	0.9230
Üretim Miktarı (-3)	-0.780885	0.991387	-0.787669	0.4567
Üretim Miktarı (-4)	2.974669	0.916798	3.644068	0.0082
C	-3.827396	12.50049	-0.306180	0.7684
R^2				0.997975
Adjusted R^2				0.993057
Prob (F-statistic)				**0.000000**
Akaike info criterion				**-1.692074**
Schwarz criterion				-0.814483
Hannan-Quinn criterion				-1.448668

Çizelge 4'te ARDL (3, 4, 3, 4) modelinin uygunluğuna dair yapılmış olan sınamalara yer verilmiştir. Modelin anlamlılığına dair Breusch-Godfrey Otokorelasyon testi, ARCH Değişen varyans testi ve Jarque-Bera Normallik testine yer verilmiştir. Çizelgeye göre Otokorelasyon testi olasılık değeri 0.5939 bulunmuştur ve modelde otokorelasyon tespit edilmemiştir. ARCH değişen varyans testi olasılık değeri ise 0.9467 olarak bulunmuş ve modelde değişen varyans tespit edilmemiştir. Elde edilen bu sonuçlar uygulanan modelin çalışma için uygun bir model olduğu sonucunu doğurmaktadır.

Çizelge 4. Modelin geçerliliği için yapılmış olan sınamalar

Breusch-Godfrey (LM) Otokorelasyon Testi		
Gecikme Uzunluğu	**LM-Test İstatistiği**	**Olasılık Değeri**
(3, 4, 3, 4)	0.807716	0.5939
Heteroskedasticity ARCH Değişen Varyans Testi		
Gecikme Uzunluğu	**F-Test İstatistiği**	**Olasılık Değeri**
(3, 4, 3, 4)	0.177592	0.9467
Normallik Testi		
Gecikme Uzunluğu	**Jarque-Bera**	**Olasılık Değeri**
(3, 4, 3, 4)	2.994481	0.223747

ARDL (3, 4, 3, 4) modelinde uzun dönem katsayıları Çizelge 5'te verilmiştir. Test sonuçlarına göre zeytinyağı ürün fiyatı üzerinde analize konu olan değişkenlerin pozitif ya da negatif yönde bir etkisi söz konusu değildir.

Çizelge 5. ARDL (4, 4, 4, 3, 3) modelinden elde edilen uzun dönem katsayıları

Değişkenler	Katsayı	Std. Hata	t-istatistiği	P. value
Ekili Alan	1.152464	5.263861	0.218939	0.8329
İhracat Miktarı	1.030026	0.955317	1.078204	0.3167
İthalat Miktarı	0.205391	0.232368	0.883907	0.4061
C	-24.66307	78.40005	-0.314580	0.7622

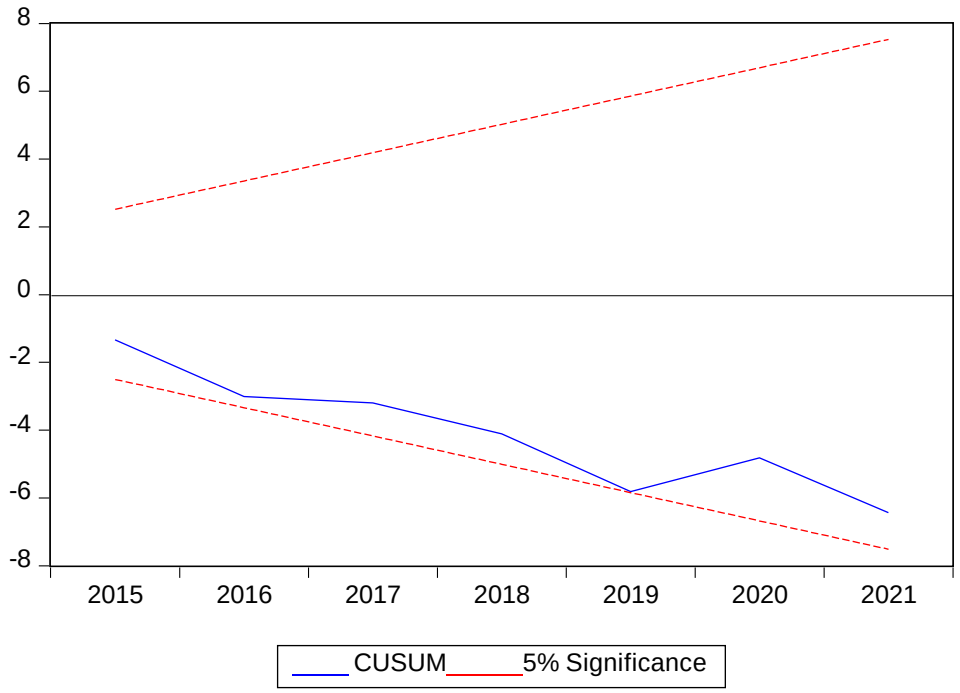
EC=Ürün Fiyatı –(1.0300*İhracat Miktarı + 0.2054* İthalat Miktarı + 1.1525*Ekili Alan – 24.6631)

Modelde kullanılan değişkenler arasında bir kısa dönemdeki ilişkisini tespit etmek amacı ile ARDL modeline bağlı hata düzeltme yönteminden faydalanılmıştır. ARDL (3, 4, 3, 4) modeline bağlı hata düzeltme modelinin sonuçları Çizelge 6'da verilmiştir. Hatanın düzeltilmesine yönelik katsayının negatif bir işarete sahip olması ve istatistiksel olarak anlamlı olması durumunda denge düzeyinden sapma durumunda tekrardan denge düzeyine yönelik bir hareket olduğu sonucu çıkmaktadır (Bozkurt, 2007). Elde edilen sonuçlara göre istatistiksel olarak anlamlı olan CointEq değeri -0.155187 olarak bulunmuştur ve negatif bir değer taşımaktadır. Bu sonuca göre kısa dönemde denge halinden bir sapma olması durumunda tekrardan dengeye yönelik bir hareketin varlığından söz edilebilir. Kısa dönem sonuçlarına göre kısa dönemde serilerin karşılaşacağı bir şokun uzun dönemde normale gelmesi 6 yılı bulabileceği söylenebilir.

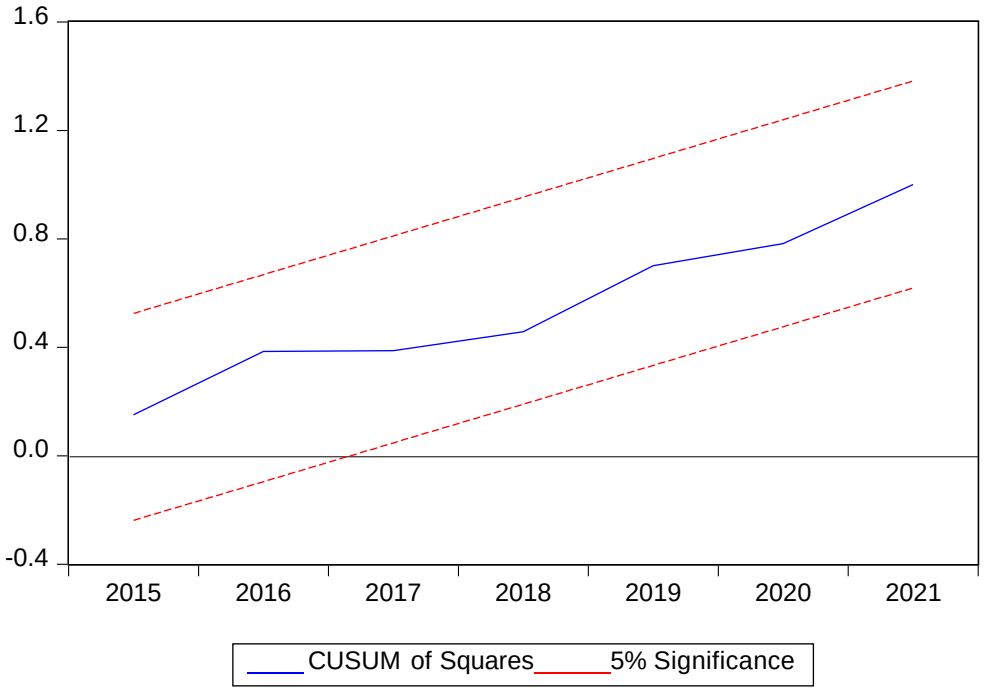
Çizelge 6. ARDL (4, 4, 4, 3, 3) modelinden elde edilen kısa dönem tahmini

Değişken	**Katsayı**	**Std. Hata**	**t-istatistiği**	**P. value**
Ürün Fiyatı (-1)	-0.378293	0.139007	-2.721386	0.0297
Ürün Fiyatı (-2)	0.231588	0.112159	2.064825	0.0778
İhracat Miktarı	-0.098055	0.030403	-3.225202	0.0145
İhracat Miktarı (-1)	-0.202487	0.035122	-5.763669	0.0007
İhracat Miktarı (-2)	-0.121846	0.036518	-3.336587	0.0125
İhracat Miktarı (-3)	-0.095136	0.030079	-3.162905	0.0159
İthalat	0.017437	0.008574	2.033734	0.0815
İthalat (-1)	-0.022005	0.010190	-2.159529	0.0667
İthalat (-2)	-0.024381	0.008760	-2.783249	0.0272
Üretim Miktarı	-1.033853	0.525284	-1.968181	0.0897
Üretim Miktarı (-1)	-2.100494	0.539490	-3.893484	0.0059
Üretim Miktarı (-2)	-2.195584	0.476057	-4.612024	0.0024
Üretim Miktarı (-3)	-2.976469	0.612697	-4.857976	0.0018
CointEq(-1)*	-0.155187	0.021848	-7.223241	0.0002
R^2				0.942974
Adjusted R^2				0.875579
Akaike info criterion				-2.012074
Schwarz criterion				-1.329504
Hannan-Quinn criterion				-1.822758

Şekil 1 ve Şekil 2'de CUSUM test sonucuna ve CUSUM of Squares Test sonucuna yer verilmiştir. Buna göre değişkenlere ait değerlerin %5 değer bandı içerisinde yer aldığı ve uzun dönem katsayılarının istikrarlı olduğunu göstermektedir.



Şekil 1. CUSUM Test Sonucu



Şekil 2. CUSUM of Squares Test Sonucu

Seçilmiş olan zeytinyağı ürün fiyatı (TL), zeytin ekili alan (ha), zeytinyağı ithalat ve ihracat miktarı (ton) değişkenleri ile uygun model seçilerek zeytinyağı ürün fiyatı (TL) üzerinde diğer değişkenlerin etkisi araştırılmıştır. Birim kök sınaması yapılarak değişkenlerin farkı düzeylerde durağanlık içerdikleri belirlenmiş ve farklı düzeyler için en uygun model olan ARDL modeli uygulanmıştır. Yıllık veri seti kullanıldığı için uygun gecikme uzunluğu 4 olarak alınmış ve ARDL (3, 4, 3, 4) modeli belirlenmiştir. Uzun dönemde test sonuçlarına göre bağımlı değişkenler ile bağımsız değişken arasında negatif veya pozitif yönde bir ilişki bulunmamıştır. Değişkenler arasında kısa dönem ilişkisini test etmek amacı ile ARDL modeline bağlı hata düzeltme yönteminden faydalanılmıştır. ARDL (3,4,3,4) modeline bağlı hata düzeltme modelinin sonuçlarına göre istatistiksel olarak anlamlı olan CointEq değeri negatif bir değer taşımaktadır. Bu sonuca göre kısa dönemde denge halinden bir sapma olması durumunda tekrardan dengeye yönelik bir hareketin varlığından söz edilebilir. Kısa dönem sonuçlarına göre kısa dönemde meydana gelen bir değişme uzun döneme 6 yıllık bir sürede etki ettiği söylenebilir.

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Canonical correlation analysis for the estimation of the relationship between soil properties

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Abstract

Canonical correlation analysis (CCA) is a multivariate method that examines the relationship between two sets of variables consisting of a large number of variables. In this study, the relationships between soil reaction (pH), salinity (EC), lime and organic matter contents of 36 soils taken from Konya province and micro and macro nutrients of soils, respectively, were determined using CCA. The micronutrient variable group (MiBE) includes iron (Fe), zinc (Zn), copper (Cu), manganese (Mn) and boron (B), while the macronutrient variable group (MaBE) includes soil properties such as inorganic nitrogen (NH4-N+NO3-N), plant-available phosphorus, extractable calcium (Ca), magnesium (Mg) and potassium (K) contents. There were 4 different pairs of canonical variables obtained both in the micronutrient variable group and in the macronutrient variable group and the first one was found to be significant (p<0.001). While the highest statistically significant canonical correlation coefficient within MiBE was determined as 0.936, the highest canonical correlation coefficient within MaBE was determined as 0.744. According to the results of CCA; soil salinity and boron content were the most contributing characteristics to the explanatory power of canonical variables for micronutrients, while soil reaction and calcium content were the most contributing characteristics for macronutrients.

Key words: *Canonical correlation analysis, Canonical variate, Macro nutrient element, Micro nutrient element, Soil properties*

Effect of Biochar and Rhizobacteria Applications on the Development and Bioactive Compound Content of Purple Pansy (Viola Wittrockiana) Plant

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Abstract

Edible varieties of pansy, which is widely used among ornamental plants, have also become widespread in recent years. The beneficial nutrients and biochemical content of their leaves and flowers make the consumption of these plants as food important. In this regard, it has become important to determine applications that will increase the nutrition of pansies. In this study, the effects of biochar and rhizobacteria applications on the development and bioactive compound contents of purple pansy (Viola wittrockiana) plant were examined. When the plants grown from seeds reached 4-6 leaves, they were placed in environments that would serve as trial subjects. Study, were carried out in different growing environments; Control (1:1 soil+peat mixture), PGPR (1:1 soil+peat mixture + PGPR), 2CBGPR (1:1 soil+peat mixture + 2% walnut biochar + PGPR), 5CBGPR (1:1 soil + peat mixture + 5% walnut biochar + PGPR), 2FBGPR (1:1 soil + peat mixture + 2% hazelnut biochar + PGPR) and 5FBGPR (1:1 soil + peat mixture + 5% hazelnut biochar + PGPR). A week later, a combination of the prepared rhizobacteria was applied to the potted plants, 50 ml per pot. The second and third applications were made one and two weeks after the first application. At the end of the growing season, the number of flowers per pot, flower diameters, stem lengths, stem weights, root lengths and root weights were determined. Individual phenolics, total phenol contents and antioxidant activities of the plants were analyzed. After the data obtained were analyzed by analysis of variance, the application averages were compared with the Duncan multiple comparison test. Statistical analyzes were performed using the SAS package program (9.0). As a result of the analyses, it was determined that biochar and PGPR provided significant increases in plant height and number of flowers when applied together. Lower flavonoid, phenolic substance and anthocyanin contents were determined in biochar and PGPR applications compared to the control application. Biochar and PGPR applications also caused decreases in the antioxidant capacities of plants. The effects of treatments on individual phenolics varied.

Key words: *Antioxidant activity, individual phenolic, rhizobacteria, edible flower, biochar*

Adalet İstatistikleri

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Özet

İstatistik, olayların ve olguların gözlemlenmesi yoluyla elde edilen tekniklerin tümünü belirli bir amaç için veri toplama, tablo ve grafiklerle özetleme, sonuçları yorumlama, sonuçların güven derecelerini açıklama, örneklerden elde edilen sonuçları kitle için genelleme, özellikler arasındaki ilişkiyi araştırma, çeşitli konularda geleceğe ilişkin tahmin yapma ve bilgi kirliliğinin önüne geçilerek ihtiyaç duyulan güvenilir bilginin oluşmasını sağlayan bir bilim dalı olarak çağımızın pusulası haline gelmiştir. Günümüzde bu pusulanın görevi; devletlere, araştırmacılara ve bilim adamlarına, dünü anlayıp bugünü yorumlama dolayısıyla geleceği inşa ederek bilgi toplumu olma yolunda rehberlik etmek olarak karşımıza çıkmaktadır.

İstatistik ve bilgi toplumu arasındaki bu ilişki, adalet alanındaki gelişim ve değişimleri de istatistik perspektifiyle yakından takip etmeyi gerekli kılmıştır. Dijitalleşmenin insan hayatını tüm yönleriyle kuşattığı çağımızda; istatistik; disiplinler arası bir iletişim aracı ve nesnel bir bilgi kaynağı olarak da değerlendirilmektedir. Bu bakımdan adalet istatistikleri, bu bilimin yargı alanına özgülenmesiyle ortaya çıkmış ve özellikle son dönemde yargı politikalarının belirlenmesinde en önemli unsurlardan biri haline gelmiştir.

Hukuk sistemimizin işleyişi ile ilgili eksikliklerin ve aksaklıkların giderilip düzeltilmesi, ileriye yönelik plan ve programların yapılması, yeni projelerin üretilmesi sürecinde bu alanla ilgili olarak göstergelere ihtiyaç duyulacağı inkar edilemez bir gerçektir. Bu göstergelerin hesaplanmasında kullanılan verilerin önemli bir kısmını adalet istatistiklerinde bulmak mümkündür. Bu anlamda adalet istatistiklerinin hukuk ile istatistik biliminin kesişme noktası olduğunu söylemek mümkün olabilecektir.

Anahtar Kelimeler: *Yargı sistemi, istatistik, yargı istatistikleri*

Liu Estimation in Geographically Weighted Regression

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Abstract

In this presentation, we remedy the problem of multicollinearity surrounding the local Geographically Weighted Regression (GWR) coefficients and the overall correlation between GWR coefficients associated with two or more exogenous variables. The consequence of local collinearity in GWR leads to a large standard error on estimated regression coefficients. Hence, the population values of the coefficients cannot be estimated with great precision or accuracy. Hence, we propose a new machine learning method to deal with the local collinearity effects in GWR models using Liu estimation. We investigate the performance of the suggested estimators via a Monte Carlo simulation study. As a result, we demonstrate the superiority of the proposed estimator.

Key words: *Spatial Regression, Machine Learning, Simulated Data*

Geopraphically Weighted Regression Using Minkoski Distance: An Application of European Union Carbon Footprint Data

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Abstract

Geographically Weighted Regression (GWR) is a spatial statistical analysis technique used to investigate geographical differences in the influence of one or more predictor variables on a response variable. The selection of distance metrics plays an important role in the performance of the model. The Euclidean distance is the most commonly used metric to determine geographical weights. This metric assumes the locations have a straight-line distance. However, in most applications, these statements are not valid. The Minkoski distance, which is an extension of the Euclidean distance, enables an optimal metric selection from a continuous range of metrics for a given GWR model. In this presentation, we investigate the use of the Minkowski distance approach by using carbon footprint data over European Union countries.

Key words: *Spatial Regression, Minkowski Distance, Carbon Footprint Data*

For Standardized Precipitation Evapotranspiration Index (SPEI) Calculation Algorithm (Muğla Province Example) to Determination of Theoretical Probability Distribution and Examination of Drought Tendency

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Abstract

Drought is a complex natural disaster that starts slowly and reveals its effects years later. Compared to other natural disasters, it seriously affects water resources, agriculture, ecosystems, and human society. Therefore, drought occurrence, prediction, and monitoring are significant. For drought analysis, the Standardized Precipitation Index, which depends only on the precipitation parameter, is often used in the literature. However, in recent years, the Standardized Precipitation Evapotranspiration Index (SPEI), which is based on many climate parameters other than precipitation, has been preferred. In this study, Mugla province drought analysis was made using the SPEI index. The appropriate statistical distribution for the index calculation algorithm has been determined. The Weibull distribution for the SPEI-12 time series and the Logistic distribution for the SPEI-24 time series were determined to be the best distributions representing the data. The existence of a statistically significant trend in the calculated SPEI values was investigated with the Innovative Trend Analysis (ITA) test and the Mann-Kendal Trend test. No statistically significant trend was detected in both SPEI drought series.

Key words: *Drought, Standardized Precipitation Evapotranspiration Index, Probability Distribution, Trend Analysis*

Ezz Distribution: A Novel One Parameter Model with Applications to Covid-19

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Abstract

n this article, a novel one parameter continuous model is proposed and called Ezz distribution. We investigate several properties of this distribution such as rth moment, moment generating function, skewness, coefficient of variation, kurtosis, index of dispersion, order statistics, survival function, hazard function, mean residual life function, reversed hazard rate function, odds function, Lorenz and Bonferroni curves, Gini index, stochastic ordering, Fisher information, Renyi entropy, mean deviations about mean and median. The parameter of the distribution is estimated using maximum likelihood method. Applications to COVID-19 data sets are presented to show the flexibility of the suggested distribution. It is found that the proposed distribution are more flexible than some other competitive distributions in fitting such data.

Key words: *Mixture distributions, Weighted distributions, Moments, Reliability analysis, Maximum likelihood estimation, Order statistics, Stochastic ordering, Stress-strength reliability, Lorenz and Bonferroni curves, R´enyi entropy, Fisher information.*

Many researchers have been proposed many distributions of one parameter or more for modeling data and statistical analysis. Some of these distributions are discrete and the other are continuous, as exponential distribution, gamma distribution, normal distribution, Poisson distribution, geometric distribution and binomial distribution. These distributions are also well used in the literature. But because of the evolution in this time we need more appropriate distributions for all types of real data. Therefore, many new distributions have been proposed based on some base distributions that could be more mathematically tractable and flexible which may give good fit in compare to other distributions. That is the main motivation for proposing new distributions and applying them to real data. In this thesis, the idea of mixture distributions is used in which we proposed a new one parameter distribution named Ezz Distribution (ED).

A mixture distribution is two or more probability distributions combined to form a new probability distribution, where these probability distributions are all continuous or are all discrete. The distribution $f(x)$ is a mixture of n components distributions $g_1(x), \ldots, g_n(x)$ if

$$f(x) = \sum_{i=1}^{n} p_i g_i(x), \qquad (1.1)$$

where p_i is the mixing weights, such that $\sum_{i=1}^{n} p_i = 1$ and $0 \le p_i \le 1$. As the mixture distributions were

of great interest; for example, Shanker (2017) suggested Akshaya distribution and its application. Benrabia and AlZoubi (2021) proposed Alzoubi distribution. Al-Omari and Shraa (2019) suggested Darna distribution and its application. Shanker and Mishra (2013) proposed new Quasi Lindley distribution. Shanker and Shukla (2017a) suggested Ishita distribution. Gharaibeh (2021) proposed Gharaibeh distribution with an application to real data, Gharaibeh and Sahtout (2022) suggested Karam distribution. Recently, Al-Taaniand Gharaibeh (2023) proposed Ola distribution with applications to Engineering and Covid-19 data.

This paper is organized as follows. The pdf and cdf of the proposed Ezz distribution are defined in Section 2. Moments and Associated measures of the ED are derived in Section 3. Bonferroni and Lorenz curves and Gini index of the ED are given in Section 4. Order statistics of the ED is discussed in Section
5. Mean deviation about mean and median are investigated in Section 6. Reliability analysis functions are provided in Section 7. Re´nyi entropy and Fisher information of the ED are studied in Sections 8 and 9. Maximum likelihood estimate is given in Section 10. Stress-strength reliability and Stochastic ordering ofthe ED are studied in Sections 11 and 12. Applications to Real Data for Covid-19 are presented in Section
13. The paper is concluded in Section 14.

Ezz Distribution

In this section, we define the suggested ED's probability density function and cumulative distribution function.

Ezz Distribution (ED) is defined by mixing of three distributions: exp (θ) , G (3, θ) *and* G(7, θ) with mixing

proportions $P_1 = \frac{\theta^6}{\theta^6+\theta^4+1}$, $P_2 = \frac{\theta^4}{\theta^6+\theta^4+1}$, and $P_3 = \frac{1}{\theta^6+\theta^4+1}$, respectively.

The pdf for the proposed ED is defined as by inserting the *pdf s* and their mixing proportions from in (1.1) .

$$f(x,\theta) = \frac{7}{720(\theta^6+\theta^4+1)}\left(720+360x^2+x^6\right)e^{-\theta x}, \quad x>0,\ \theta>0. \tag{2.1}$$

$$F(x,\theta) = 1 - \frac{\left[\begin{array}{l}\theta^6 x^6 + 6\theta^5 x^5 + 30\theta^4 x^4 + 120\theta^3 x^3 + \left(360\theta^2 + 360\theta^6\right) x^2 \\ + \left(720\theta^5 + 720\theta\right) x + 720\theta^6 + 720\theta^4 + 720\end{array}\right] e^{-\theta x}}{720(\theta^6 + \theta^4 + 1)}; x > 0; \theta > 0. \qquad (2.2)$$

Figure 1: The *pdf* and *cdf* of ED with different values of θ

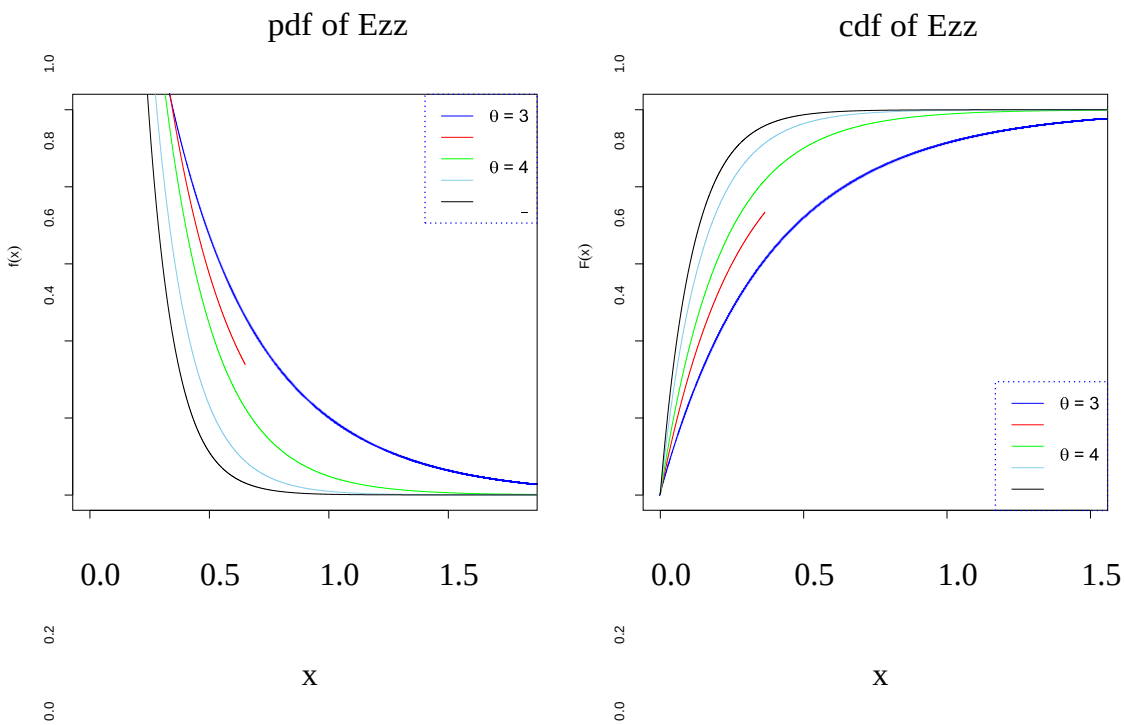


Figure (1) shows the *pdf* and *cdf* of ED with different values of the distribution parameter. It is clearthat the ED is skewed to the right.

Moments and Associated measures of the ED

For the ED, the nth moment and the moment generating function are deduced in this part. In addition, the exploration of the mean, variance, coefficient of variation, skewness, kurtosis, and index of dispersion are done. These measures evaluated at various distribution parameter values are also supplied.

Theorem 3.1. Assuming that X has an ED, the moment generating function of X is given by

$$M_X(t) = \frac{1}{\theta^6+\theta^4+1}\left[\frac{1}{\left(1-\frac{t}{\theta}\right)^7}+\frac{\theta^4}{\left(1-\frac{t}{\theta}\right)^3}+\frac{\theta^6}{\left(1-\frac{t}{\theta}\right)}\right]. \tag{3.1}$$

Proof. Using $f(x)$ in (2.1), the ED's moment generating function may be demonstrated to be

$$\begin{aligned}
M_X(t) &= E(e^{tX}) = \int_0^\infty e^{tx} f(x)dx \\
&= \int_0^\infty \frac{e^{tx}\theta^7}{720(\theta^6+\theta^4+1)}\left(x^6+360x^2+720\right)e^{-x\theta}dx \\
&= \int_0^\infty \frac{\theta^7}{720(\theta^6+\theta^4+1)}\left(x^6+360x^2+720\right)e^{-x(\theta-t)}dx \\
&= \frac{\theta^7}{720(\theta^6+\theta^4+1)}\left[\frac{720}{(\theta-t)^7}+\frac{720}{(\theta-t)^3}+\frac{720}{(\theta-t)}\right] \\
&= \frac{\theta^7}{(\theta^6+\theta^4+1)}\left[\frac{1}{(\theta-t)^7}+\frac{1}{(\theta-t)^3}+\frac{1}{(\theta-t)}\right] \\
&= \frac{\theta^7}{\theta^6+\theta^4+1}\left[\frac{1}{\theta^7\left(1-\frac{t}{\theta}\right)^7}+\frac{1}{\theta^3\left(1-\frac{t}{\theta}\right)^3}+\frac{1}{\theta\left(1-\frac{t}{\theta}\right)}\right] \\
&= \frac{1}{\theta^6+\theta^4+1}\left[\frac{1}{\left(1-\frac{t}{\theta}\right)^7}+\frac{\theta^4}{\left(1-\frac{t}{\theta}\right)^3}+\frac{\theta^6}{\left(1-\frac{t}{\theta}\right)}\right].
\end{aligned}$$

□

Theorem 3.2. The nth moment of the random variable X has ED is given by

$$E(X^n) = \left[\frac{(n+6)!+360\theta^4(n+2)!+720\theta^6 n!}{720(\theta^{(n+6)}+\theta^{(n+4)}+\theta^n)}\right]; \qquad n=1,2,3,..... \tag{3.2}$$

Proof. Using (2.1), the nth moment of the ED can be determined as follows:

$$\begin{aligned}
E(X^n) &= \int_0^\infty x^n f(x)dx \\
&= \int_0^\infty x^n \frac{\theta^7}{720(\theta^6+\theta^4+1)}\left[x^6+360x^2+720\right]e^{-\theta x}dx \\
&= \frac{\theta^7}{720(\theta^6+\theta^4+1)}\left[\int_0^\infty x^{n+6}e^{-\theta x}dx + 360\int_0^\infty x^{n+2}e^{-\theta x}dx + 720\int_0^\infty x^n e^{-\theta x}dx\right] \\
&= \frac{\theta^7}{720(\theta^6+\theta^4+1)}\left[\frac{(n+6)!}{\theta^{(n+7)}} + \frac{360(n+2)!}{\theta^{(n+3)}} + \frac{720n!}{\theta^{(n+1)}}\right] \\
&= \left[\frac{(n+6)!+360\theta^4(n+2)!+720\theta^6 n!}{720(\theta^{(n+6)}+\theta^{(n+4)}+\theta^n)}\right]
\end{aligned}$$

□

From (3.2), the first four moments of the ED, respectively, are

$$\mu = E(X) = \frac{1}{\theta(\theta^6+\theta^4+1)}\theta^6+3\theta^4+7\ , \quad (3.3)$$

$$E(X^2) = \frac{1}{\theta^2(\theta^6+\theta^4+1)}2\theta^6+12\theta^4+56\ , \quad (3.4)$$

$$E(X^3) = \frac{1}{\theta^3(\theta^6+\theta^4+1)}6\theta^6+60\theta^4+504\ , \quad (3.5)$$

$$E(X^4) = \frac{1}{\theta^4(\theta^6+\theta^4+1)}24\theta^6+360\theta^4+5040\ . \quad (3.6)$$

By (3.3), (3.4) the variance of ED is given by

$$\sigma^2 = E(X-\mu)^2 = E(X^2)-\mu^2 = \frac{2\theta^{12}+14\theta^{10}+12\theta^8+57\theta^6+65\theta^4+49}{\theta^2(\theta^6+\theta^4+1)^2}, \quad (3.7)$$

Therefore, the coefficient of variation (CV), skewness (SK), kurtosis (KU) and index of dispersion (DIS)

are given as follow

$$CV = \frac{\sigma}{\mu} = \frac{\left(2\theta^{12}+14\theta^{10}+12\theta^{8}+57\theta^{6}+65\theta^{4}+49\right)^{1/2}}{\theta^{6}+3\theta^{4}+7}$$

$$SK = \frac{E(X^3)-3\mu E(X^2)+2\mu^3}{\sigma^3} = \frac{\left[2\theta^{18}+30\theta^{16}+18\theta^{14}+348\theta^{12}+372\theta^{10}+138\theta^{8}-78\theta^{6}+18\theta^{4}+14\right]}{\left(2\theta^{12}+14\theta^{10}+12\theta^{8}+57\theta^{6}+65\theta^{4}+49\right)^{\frac{3}{2}}}.$$

$$KU = \frac{E(X^4)-4\mu E(X^3)+6\mu^2E(X^2)-3\mu^4}{\sigma^4}$$
$$\frac{\left[\begin{array}{l}3\left(3\theta^{24}+64\theta^{22}+102\theta^{20}+1176\theta^{18}+2347\theta^{16}+1832\theta^{14}+994\theta^{12}+1400\theta^{10}\right)\\ +554\theta^{8}+2027\theta^{6}+428\theta^{4}+63\end{array}\right]}{\left(\begin{array}{l}4\theta^{24}+56\theta^{22}+244\theta^{20}+564\theta^{18}+1982\theta^{16}\\ +3062\theta^{14}+4897\theta^{12}+8269\theta^{10}+4816\theta^{8}+5586\theta^{6}+5929\theta^{4}+2401\end{array}\right)}.$$

$$DIS = \frac{\sigma^2}{\mu} = \frac{2\theta^{12}+14\theta^{10}+12\theta^{8}+57\theta^{6}+65\theta^{4}+49}{\theta\left(\theta^{6}+\theta^{4}+1\right)\left(\theta^{6}+3\theta^{4}+7\right)}.$$

In Table (1), for the ED with various values of θ, we calculate the mean, variance, coefficient of variation, standard deviation, skewness, kurtosis, and index of dispersion values. Table demonstrates that when the value of the parameter θ increases, the mean and standard deviation and variance values drop. According

Table 1: The mean, variance, coefficient of variation, skewness, kurtosis, and index of dispersion for ED

θ	**mean**	**standard deviation**	**CV**	**SK**	**KU**	**DIS**
0.5	13.362	5.667	0.424	0.522	3.653	2.403
1.0	3.667	3.145	0.858	1.027	3.695	2.a697
1.5	1.283	1.381	1.077	2.057	8.627	1.488
2.0	0.735	0.788	1.073	2.222	10.434	0.845
2.5	0.518	0.549	1.059	2.191	10.309	0.582
3.0	0.402	0.423	1.051	2.170	10.129	0.444
3.5	0.330	0.344	1.044	2.158	10.045	0.359
4.0	0.280	0.290	1.038	2.148	9.991	0.301
4.5	0.243	0.251	1.033	2.137	9.938	0.259
5.0	0.215	0.222	1.028	2.126	9.879	0.228

to Figure (1), the right skewness of the ED is indicated by the positive values of skewness. Also, the higherθ values, the greater the kurtosis. Additionally, the *DIS* column highlights that the ED is under-dispersed when $\theta > 1.5$ and over-dispersed when $\theta < 1.5$.

Bonferroni and Lorenz curves and Gini index of the ED

In many fields including insurance, medicine, demography, and economics, especially when examining pat- terns of income and poverty, the Bonferroni and Lorenz curves and Gini index are used. They are defined,
respectively, as

$$\begin{aligned} B(p) &= \frac{1}{p\mu}\int_0^q xf(x)dx \\ L(p) &= \frac{1}{\mu}\int_0^q xf(x)dx \\ G &= 1-2\int_0^1 L(p)dp, \end{aligned}$$

where $q = F^{-1}(p)$; $p \in (0, 1]$ and $\mu = E(X)$
For ED with pdf in (2.1), we have

$$B(p) = \frac{1}{p} - \frac{\left[\begin{array}{l}(q^7+360q^3+720q)\,\theta^7+(7q^6+1080q^2+720)\,\theta^6+(42q^5+2160q)\,\theta^5 \\ +(210q^4+2160)\,\theta^4+840q^3\theta^3+2520q^2\theta^2+5040q\theta+5040\end{array}\right]e^{-q\theta}}{720p(\theta^6+3\theta^4+7)},$$

$$L(p) = 1 - \frac{\left[\begin{array}{l}(q^7+360q^3+720q)\,\theta^7+(7q^6+1080q^2+720)\,\theta^6+(42q^5+2160q)\,\theta^5 \\ +(210q^4+2160)\,\theta^4+840q^3\theta^3+2520q^2\theta^2+5040q\theta+5040\end{array}\right]e^{-q\theta}}{720(\theta^6+3\theta^4+7)},$$

$$G = \frac{2\left[\begin{array}{l}(q^7+360q^3+720q)\,\theta^7+(7q^6+1080q^2+720)\,\theta^6+(42q^5+2160q)\,\theta^5 \\ +(210q^4+2160)\,\theta^4+840q^3\theta^3+2520q^2\theta^2+5040q\theta+5040\end{array}\right]e^{-q\theta}}{720(\theta^6+3\theta^4+7)} - 1.$$

Order statistics of the ED

Let $X_1, X_2, \ldots, X_n$ be a random sample of size n. The corresponding order statistics is $X_{(1)} \leq X_{(2)} \leq \ldots \leq$

$X_{(n)}$. The pdf of the ith order statistics (see David and Nagaraja (2005)), is given as

$$f_{(i)}(x) \quad = \quad n\binom{n-1}{i-1} f(x)[F(x)]^{i-1}[1-F(x)]^{n-i}, for \quad i = 1, 2, ..., n \tag{5.1}$$

Therefore, by plugging (2.2) and (2.1) in (5.1) with using binomial series, the pdf of the ith order statistic

of ED is given by

$$\begin{aligned}
f_{(i)}(x) \quad &= \quad n\binom{n-1}{i-1} f(x)\left[\sum_{j=0}^{i-1}\binom{i-1}{j}(-1)^j(1-F(x))^j\right][1-F(x)]^{n-i} \\
&= n\binom{n-1}{i-1}\frac{\theta^7}{720(\theta^6+\theta^4+1)}\left(x^6+360x^2+720\right)e^{-\theta x}\sum_{j=0}^{i-1}(-1)^j\, e^{-\theta x(n+j-i)} \\
&\times \left[\frac{\theta^6x^6+6\theta^5x^5+30\theta^4x^4+120\theta^3x^3+\left(360\theta^2+360\theta^6\right)x^2+\left(720\theta^5+720\theta\right)x}{720(\theta^6+\theta^4+1)}+1\right]^{n+j-i} \\
&= n\binom{n-1}{i-1}\theta^7\left(x^6+360x^2+720\right)\sum_{j=0}^{i-1}\sum_{l=0}^{n+j-i}(-1)^j\, e^{-\theta x(n+j-i+1)} \\
&\times \frac{\left[\theta^6x^6+6\theta^5x^5+30\theta^4x^4+120\theta^3x^3+\left(360\theta^2+360\theta^6\right)x^2+\left(720\theta^5+720\theta\right)x\right]^l}{(720(\theta^6+\theta^4+1))^{l+1}}.
\end{aligned}$$

Mean deviation about mean and median of the ED

Mean deviations about mean and median are used in the statistical modelling literature and discussions onseveral controversial issues, they can be expressed as

$$\begin{aligned} M.D(\mu) &= \int_0^\infty |x-\mu| f(x)dx = \int_0^\mu (\mu - x) f(x)dx + \int_\mu^\infty (x-\mu) f(x)dx \\ &= 2\mu F(\mu) - 2\int_0^\mu x f(x)dx, \end{aligned} \tag{6.1}$$

and

$$\begin{aligned} M.D(\tilde{m}) &= \int_0^\infty |x-\tilde{m}| f(x)dx = \int_0^{\tilde{m}} (\tilde{m} - x) f(x)dx + \int_{\tilde{m}}^\infty (x-\tilde{m}) f(x)dx \\ &= \mu - 2\int_0^{\tilde{m}} x f(x)dx, \end{aligned} \tag{6.2}$$

where $\mu = E(X)$ and $\tilde{m}$ is the population median

The mean and median deviations for the ED are defined in Theorem (6.1) based on Equations (6.1) and(6.2).

Theorem 6.1. The mean and median deviations of the ED are, respectively given by

$$M.D(\mu) = \frac{2e^{-\mu\theta}}{720\theta\left(\theta^6+\theta^4+1\right)} \begin{bmatrix} \mu^6\theta^6 + 12\theta^5\mu^5 + 90\mu^4\theta^4 + 380\mu^3\theta^3 + \mu^2(360\theta^6 + 1800\theta^2) \\ + \mu(1440\theta^5 + 4320\theta) + (720\theta^6 + 2160\theta^4 + 5040) \end{bmatrix}, \tag{6.3}$$

and

$$M.D(\tilde{m}) = \frac{2e^{-\tilde{m}\theta}}{720\theta\left(\theta^6+\theta^4+1\right)} \begin{bmatrix} \left(\tilde{m}^7 + 360\tilde{m}^3 + 720\tilde{m}\right)\theta^7 + \left(7\tilde{m}^6 + 1080\tilde{m}^2 + 720\right)\theta^6 \\ + \left(42\tilde{m}^5 + 2160\tilde{m}\right)\theta^5 + \left(210\tilde{m}^4 + 2160\right)\theta^4 \\ + 840\tilde{m}^3\theta^3 + 2520\tilde{m}^2\theta^2 + 5040\tilde{m}\theta + 5040 \end{bmatrix} - \mu. \tag{6.4}$$

Proof. It is clear that

$$F(\mu) = 1 - \frac{\begin{bmatrix} \theta^6\mu^6 + 6\theta^5\mu^5 + 30\theta^4\mu^4 + 120\theta^3\mu^3 + \left(360\theta^2 + 360\theta^6\right)\mu^2 \\ + \left(720\theta^5 + 720\theta\right)\mu + 720\theta^6 + 720\theta^4 + 720 \end{bmatrix} e^{-\theta\mu}}{720(\theta^6+\theta^4+1)},$$

□

$$\int_0^{\mu} xf(x)dx = \mu - \frac{\begin{bmatrix} \left(\mu^7 + 360\mu^3 + 720\mu\right)\theta^7 + \left(7\mu^6 + 1080\mu^2 + 720\right)\theta^6 + \left(42\mu^5 + 2160\mu\right)\theta^5 \\ + \left(210\mu^4 + 2160\right)\theta^4 + 840\mu^3\theta^3 + 2520\mu^2\theta^2 + 5040\mu\theta + 5040 \end{bmatrix} e^{-\mu\theta}}{720\theta(\theta^6 + \theta^4 + 1)}.$$

Hence, the mean deviation for the ED is given by

$$M.D(\mu) = 2\mu F(\mu) - 2\int_0^{\mu} xf(x)dx = 2\mu\left[1 - \frac{\begin{bmatrix} \theta^6\mu^6 + 6\theta^5\mu^5 + 30\theta^4\mu^4 + 120\theta^3\mu^3 \\ + \left(360\theta^2 + 360\theta^6\right)\mu^2 + \left(720\theta^5 + 720\theta\right)\mu \\ + 720\theta^6 + 720\theta^4 + 720 \end{bmatrix} e^{-\theta\mu}}{720(\theta^6 + \theta^4 + 1)}\right]$$

$$-2\left[\mu - \frac{\begin{bmatrix} \left(\mu^7 + 360\mu^3 + 720\mu\right)\theta^7 + \left(7\mu^6 + 1080\mu^2 + 720\right)\theta^6 \\ + \left(42\mu^5 + 2160\mu\right)\theta^5 + \left(210\mu^4 + 2160\right)\theta^4 + 840\mu^3\theta^3 \\ + 2520\mu^2\theta^2 + 5040\mu\theta + 5040 \end{bmatrix} e^{-\mu\theta}}{720\theta(\theta^6 + \theta^4 + 1)}\right]$$

$$= \frac{2e^{-\mu\theta}}{720\theta\left(\theta^6 + \theta^4 + 1\right)} \begin{bmatrix} \mu^6\theta^6 + 12\theta^5\mu^5 + 90\mu^4\theta^4 + 380\mu^3\theta^3 \\ + \mu^2(360\theta^6 + 1800\theta^2) + \mu(1440\theta^5 + 4320\theta) \\ + (720\theta^6 + 2160\theta^4 + 5040) \end{bmatrix}$$

$$\int_0^{\tilde{m}} xf(x)dx = \mu - \frac{\begin{bmatrix} \left(\tilde{m}^7 + 360\tilde{m}^3 + 720\tilde{m}\right)\theta^7 + \left(7\tilde{m}^6 + 1080\tilde{m}^2 + 720\right)\theta^6 \\ + \left(42\tilde{m}^5 + 2160\tilde{m}\right)\theta^5 + \left(210\tilde{m}^4 + 2160\right)\theta^4 \\ + 840\tilde{m}^3\theta^3 + 2520\tilde{m}^2\theta^2 + 5040\tilde{m}\theta + 5040 \end{bmatrix} e^{-\tilde{m}\theta}}{720\theta(\theta^6 + \theta^4 + 1)}$$

Hence, the median deviation for the ED is given by

$$
\begin{aligned}
M.D(\tilde{m}) &= \mu - 2\int_0^{\tilde{m}} x f(x)dx \\
&= \mu - 2\left[\mu - \frac{\begin{bmatrix} \left(\tilde{m}^7 + 360\tilde{m}^3 + 720\tilde{m}\right)\theta^7 + \left(7\tilde{m}^6 + 1080\tilde{m}^2 + 720\right)\theta^6 \\ + \left(42\tilde{m}^5 + 2160\tilde{m}\right)\theta^5 + \left(210\tilde{m}^4 + 2160\right)\theta^4 \\ + 840\tilde{m}^3\theta^3 + 2520\tilde{m}^2\theta^2 + 5040\tilde{m}\theta + 5040 \end{bmatrix} e^{-\tilde{m}\theta}}{720\theta(\theta^6 + \theta^4 + 1)}\right] \\
&= \frac{2e^{-\tilde{m}\theta}}{720\theta\left(\theta^6 + \theta^4 + 1\right)} \begin{bmatrix} \left(\tilde{m}^7 + 360\tilde{m}^3 + 720\tilde{m}\right)\theta^7 + \left(7\tilde{m}^6 + 1080\tilde{m}^2 + 720\right)\theta^6 \\ + \left(42\tilde{m}^5 + 2160\tilde{m}\right)\theta^5 + \left(210\tilde{m}^4 + 2160\right)\theta^4 \\ + 840\tilde{m}^3\theta^3 + 2520\tilde{m}^2\theta^2 + 5040\tilde{m}\theta + 5040 \end{bmatrix} - \mu.
\end{aligned}
$$

Reliability analysis of the ED

In this part, we calculate the reliability function $R(x)$, hazard function $h(x)$, cumulative hazard function

$H(x)$, reversed hazard rate function $rh(x)$, odds function $O(x)$ and mean residual life function $MRL(x)$ for

ED. For ED with pdf in (2.1) and cdf in (2.2), the reliability function is defined as

$$R(x) = 1 - F(x) = \left[\frac{\theta^6 x^6 + 6\theta^5 x^5 + 30\theta^4 x^4 + 120\theta^3 x^3 + \left(360\theta^6 + 360\theta^2\right) x^2 + \left(720\theta^5 + 720\theta\right) x}{720(\theta^6 + \theta^4 + 1)} + 1\right] e^{-\theta x}$$

The hazard function is

$$h(x) = \frac{f(x)}{1 - F(x)} = \frac{\theta^7 \left(x^6 + 360x^2 + 720\right)}{\theta^6 x^6 + 6\theta^5 x^5 + 30\theta^4 x^4 + 120\theta^3 x^3 + (360\theta^2 + 360\theta^6)\, x^2 + (720\theta^5 + 720\theta)\, x + 720\theta^6 + 720\theta^4 + 720}$$

The cumulative hazard function is

$$H(x) = -\ln[1 - F(x)] = \theta x - ln\left[\frac{\theta^6 x^6 + 6\theta^5 x^5 + 30\theta^4 x^4 + 120\theta^3 x^3 + \left(360\theta^6 + 360\theta^2\right) x^2 + \left(720\theta^5 + 720\theta\right) x}{720(\theta^6 + \theta^4 + 1)} + 1\right]$$

The reversed hazard rate function is defined as:

$$rh(x) = \frac{f(x)}{F(x)} = \frac{\theta^7 \left(x^6 + 360x^2 + 720\right)}{\left[\begin{array}{l} 720(\theta^6 + \theta^4 + 1)\left(e^{\theta x} - 1\right) - \theta^6 x^6 - 6\theta^5 x^5 - 30\theta^4 x^4 - 120\theta^3 x^3 \\ \\ -\left(360\theta^2 + 360\theta^6\right) x^2 - \left(720\theta^5 + 720\theta\right) x \end{array}\right]}$$

The odds function is

$$O(x) = \frac{F(x)}{1 - F(x)} = \frac{720(\theta^6 + \theta^4 + 1)\, e^{\theta x}}{\theta^6 x^6 + 6\theta^5 x^5 + 30\theta^4 x^4 + 120\theta^3 x^3 + (360\theta^6 + 360\theta^2)\, x^2 + (720\theta^5 + 720\theta)\, x + 720(\theta^6 + \theta^4 + 1)} - 1$$

The mean residual life function is

$$MRL(x) = E(X-x|X>x) = \frac{1}{1-F(x)}\int_x^{\infty}(1-F(y))\,dy \tag{7.-4}$$

$$= \frac{\left[\begin{array}{l}(\theta^6x^6+12\theta^5x^5+90\theta^4x^4+480\theta^3x^3+\left(360\theta^6+1800\theta^2\right)x^2\\ +\left(1440\theta^5+4320\theta\right)x+720\theta^6+2160\theta^4+5040\end{array}\right]}{\theta\left[\theta^6x^6+6\theta^5x^5+30\theta^4x^4+120\theta^3x^3+\left(360\theta^2+360\theta^6\right)x^2+\left(720\theta^5+720\theta\right)x+720(\theta^6+\theta^4+1)\right]}.$$

Clearly, $MRL(0) = \frac{1}{\theta\left(\theta^6+\theta^4+1\right)}\left(\theta^6+3\theta^4+7\right) = E(X) = \mu.$

Figure 2: The reliability, hazard, and cumulative hazard functions of ED with different values of θ

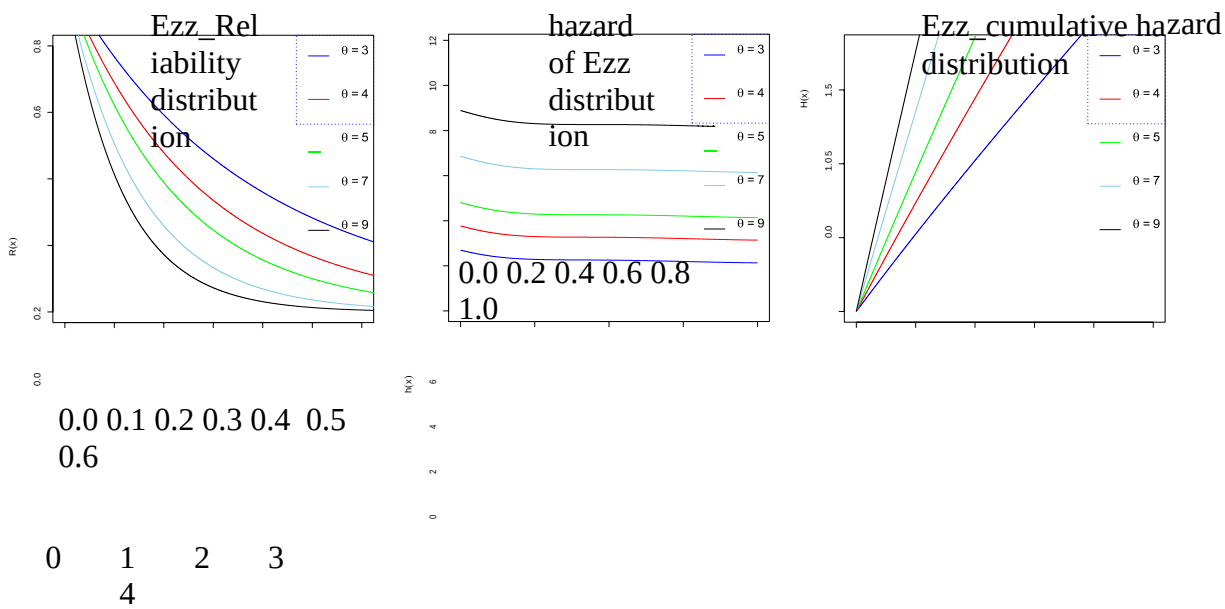
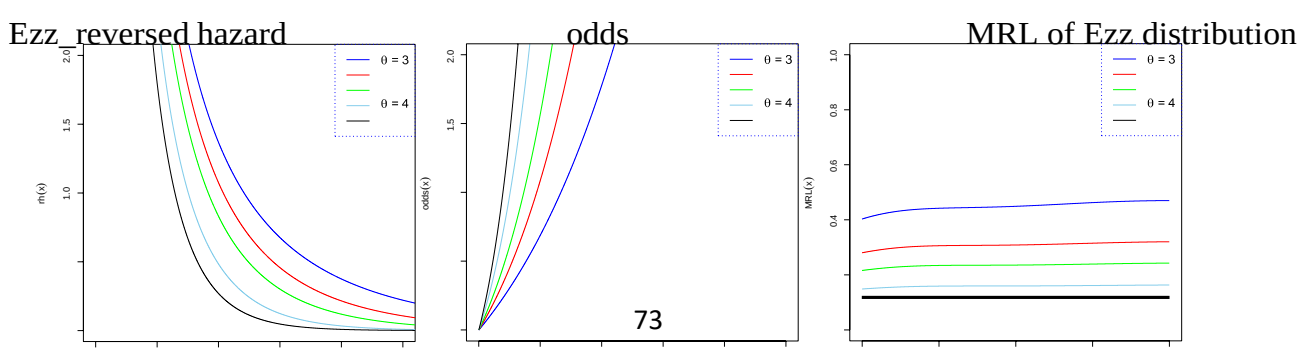


Figure 3: The reversed hazard, odds, and mean residual life functions of ED with different values of θ



0.5 0 0 0.4 0.6 0 1. 0.5 0. 0 0 0 0 1. 0.2 0 1 2 3 4
. . . . . 0 0 0
0.0 0 2 8 0.0 2 4 6 8 0.0
X x x

Figures (2) and (3), show the survival, hazard, cumulative, reversed, odds and mean residual life functions graphs for various values of θ. As can be observed, as the parameter θ increases, the values of the cumulative
hazard, and odds functions increase while the values of the survival, reversed hazard and MRL functionsdecrease.

Entropy is a fundamental concept in information theory and it is heavly used in the physics literature. It isa measure of uncertainty variation. The Re´nyi entropy (Renyi (1961)) can be defined as

$$RE(\rho) \quad = \quad \frac{1}{1-\rho} log \int_0^\infty (f(x))^\rho \, dx \, ; \rho > 0, \rho \neq 1. \tag{8.1}$$

The Re´nyi entropy for ED it is given in Theorem (8.1).

Theorem 8.1. The Re´nyi entropy of ED random variable X is

$$RE(\delta) = \frac{1}{1-\rho} log \left[\left(\frac{\theta^7}{720(\theta^6+\theta^4+1)} \right)^\rho \sum_{i=1}^{\rho} \sum_{j=1}^{i} \binom{\rho}{i} \binom{i}{j} \frac{(2i+4j)!}{(\theta\rho)^{2i+4j+1}} \right]$$

Proof. By plugging (2.1) in (8.1) and using the binomial series, we have

$$
\begin{aligned}
RE(\rho) &= \frac{1}{1-\rho} log \int_0^\infty \left[\frac{\theta^7}{720(\theta^6+\theta^4+1)} \left(x^6+360x^2+720\right) e^{-\theta x} \right]^\rho dx \\
&= \frac{1}{1-\rho} log \left[\left(\frac{\theta^7}{720(\theta^6+\theta^4+1)} \right)^\rho \int_0^\infty \left(x^6+360x^2+720\right)^\rho e^{-\theta\rho x} dx \right] \\
&= \frac{1}{1-\rho} log \left[\left(\frac{\theta^7}{720(\theta^6+\theta^4+1))} \right)^\rho \int_0^\infty \left(x^2(x^4+360)+(720)\right)^\rho e^{-\theta\rho x} dx \right] \\
&= \frac{1}{1-\rho} log \left[\left(\frac{\theta^7}{720(\theta^6+\theta^4+1)} \right)^\rho \int_0^\infty \sum_{i=1}^{\rho} \binom{\rho}{i} (x^2(x^4+360))^i (720)^{\rho-i} e^{-\theta\rho x} dx \right] \\
&= \frac{1}{1-\rho} log \left[\left(\frac{\theta^7}{720(\theta^6+\theta^4+1)} \right)^\rho \int_0^\infty \sum_{i=1}^{\rho} \binom{\rho}{i} x^{2i} \sum_{j=1}^{i} \binom{i}{j} x^{4j} (360)^{i-j} (720)^{p-i} e^{-\theta\rho x} dx \right] \\
&= \frac{1}{1-\rho} log \left[\left(\frac{\theta^7}{720(\theta^6+\theta^4+1)} \right)^\rho \sum_{i=1}^{\rho} \sum_{j=1}^{i} \binom{\rho}{i} \binom{i}{j} (720)^{p-i} (360)^{i-j} \int_0^\infty x^{2i+4j} e^{-\theta\rho x} dx \right] \\
&= \frac{1}{1-\rho} log \left[\left(\frac{\theta^7}{720(\theta^6+\theta^4+1)} \right)^\rho \sum_{i=1}^{\rho} \sum_{j=1}^{i} \binom{\rho}{i} \binom{i}{j} \frac{(2i+4j)!}{(\theta\rho)^{2i+4j+1}} \right]
\end{aligned}
$$

□

The Fisher information of the ED

The Fisher information is a method of calculating how much information a random variable X carries aboutan unknown parameter θ that affects its likelihood. Let $f(x; \theta)$ is the *pdf* of X. The Fisher information is defined as

$$I(\theta) = -\int_0^\infty \left[\frac{\partial^2 \ln f(x;\theta)}{\partial\theta^2} f(x;\theta)\right] dx. \tag{9.1}$$

The Fisher information for ED is given in Theorem (9.1)

Theorem 9.1. Assume that $f(X; \theta)$ denotes the probability density function of ED for X based on the valueof θ. The Fisher information is given by

$$\boldsymbol{I}(\theta) = \frac{\theta^{12} + 8\theta^{10} + 3\theta^8 + 44\theta^6 + 26\theta^4 + 7}{\theta^2\,(\theta^6 + \theta^4 + 1)^2}, \quad \theta > 0$$

Proof. By using Equation (2.1), we get

$$I(\theta) = -\int_0^\infty \frac{\partial^2 \ln\left[\frac{\theta^7}{720(\theta^6+\theta^4+1)}\left(720 + 360x^2 + x^6\right) e^{-\theta x}\right]}{\partial\theta^2} \left[\frac{\theta^7}{720(\theta^6+\theta^4+1)}\left(720 + 360x^2 + x^6\right) e^{-\theta x}\right] dx$$

The logarithm of $f(X;\theta)$

$$\begin{aligned}
\ln f(X;\theta) &= \ln\left[\frac{\theta^7}{720(\theta^6+\theta^4+1)}\left(720 + 360x^2 + x^6\right) e^{-\theta x}\right] \\
&= \ln\theta^7 - \ln 720 - \ln(\theta^6+\theta^4+1) + \ln(x^6 + 360x^2 + 720) + \ln e^{-\theta x} \\
&= 7\ln\theta - \ln 720 - \ln(\theta^6+\theta^4+1) + \ln(x^6 + 360x^2 + 720) - \theta x
\end{aligned}$$

The derivative of $\ln f(X;\theta)$ with respect to parameter θ is

$$\frac{\partial \ln f(X;\theta)}{\theta} = \frac{7}{\theta} - \frac{(6\theta^5 + 4\theta^3)}{\theta^6+\theta^4+1} - x$$

The second derivative of $\ln f(X;\theta)$ is given by

$$\begin{aligned}
\frac{\partial^2 \ln f(X;\theta)}{\theta^2} &= \frac{-7}{\theta^2} + \frac{(6\theta^{10} + 6\theta^8 + 4\theta^6 - 30\theta^4 - 12\theta^2)}{(\theta^6+\theta^4+1)^2} \\
&= \frac{-7(\theta^6+\theta^4+1)^2 + (6\theta^{10} + 6\theta^8 + 4\theta^6 - 30\theta^4 - 12\theta^2)\theta^2}{\theta^2(\theta^6+\theta^4+1)^2} \\
&= \frac{-\theta^{12} - 8\theta^{10} - 3\theta^8 - 44\theta^6 - 26\theta^4 - 7}{\theta^2\left(\theta^6+\theta^4+1\right)^2}.
\end{aligned}$$

Now,

$$\begin{aligned}
I(\theta) &= -\int_0^\infty \left[\frac{-\theta^{12} - 8\theta^{10} - 3\theta^8 - 44\theta^6 - 26\theta^4 - 7}{\theta^2\left(\theta^6+\theta^4+1\right)^2}\right] \times \left[\frac{\theta^7}{720(\theta^6+\theta^4+1)}\left(720 + 360x^2 + x^6\right) e^{-\theta x}\right] dx \\
&= \frac{\theta^{12} + 8\theta^{10} + 3\theta^8 + 44\theta^6 + 26\theta^4 + 7}{\theta^2\left(\theta^6+\theta^4+1\right)^2} \int_0^\infty \left[\frac{\theta^7}{720(\theta^6+\theta^4+1)}\left(720 + 360x^2 + x^6\right) e^{-\theta x}\right] dx \\
&= \frac{\theta^{12} + 8\theta^{10} + 3\theta^8 + 44\theta^6 + 26\theta^4 + 7}{\theta^2\left(\theta^6+\theta^4+1\right)^2}, \theta > 0.
\end{aligned}$$

□

Maximum likelihood estimate of the ED

Let $X_1, X_2, \ldots, X_n$ be a random sample from ED with pdf in (2.1) and parameter θ. The likelihood functionis defined as

$$\begin{aligned} L(\theta|x_1, x_2, \ldots, x_n) &= \prod_{i=1}^{n} \frac{\theta^7}{720(\theta^6+\theta^4+1)} \left(x_i^6 + 360x_i^2 + 720\right) e^{-\theta x_i} \\ &= \left(\frac{\theta^7}{720(\theta^6+\theta^4+1)}\right)^n \prod_{i=1}^{n} \left(x_i^6 + 360x_i^2 + 720\right) e^{-\theta \sum_{i=1}^{n} x_i}. \end{aligned}$$

Hence, the log-likelihood function is

$$\begin{aligned} L^\star &= lnL(\theta|x_1, x_2, \ldots, x_n) \\ &= nln\left(\frac{\theta^7}{720(\theta^6+\theta^4+1)}\right) + \sum_{i=1}^{n} ln\left(x_i^6 + 360x_i^2 + 720\right) - \theta \sum_{i=1}^{n} x_i. \end{aligned}$$

Recall that $\bar{x} = \sum_{i=1}^{n} x_i/n$. Thus,

$$L^\star = 7n\,ln(\theta) - 720n\,ln\left(\theta^6+\theta^4+1\right) + \sum_{i=1}^{n} ln\left(x_i^6 + 360x_i^2 + 720\right) - n\theta\bar{x},$$

and its derivative with respect θ is

$$\frac{\partial L^\star}{\partial \theta} = \frac{7n}{\theta} - \frac{720n(6\theta^5+4\theta^3)}{\theta^6+\theta^4+1} - n\bar{x},$$

The maximum likelihood estimate of θ is the solution of $\frac{\partial L^\star}{\partial \theta} = 0$ which can be obtained by solving the following polynomial equation

$$\bar{x}\theta^7 + 4313\theta^6 + \bar{x}\theta^5 + 2810\theta^4 + (\bar{x\theta} - 7) = 0.$$

which can be solved using numerical methods.

Stress-strength reliability of the ED

The stress-strength reliability defines the life of a component being exposed to random Y stress and random **X** having strength with pdf f(x) and cdf F(x) is defined as

$$R = P(Y < X) = \int_0^\infty P(Y < X|X = x)f(x)dx = \int_0^\infty f(x)F(x)dx. \qquad (11.1)$$

The stress-strength reliability of ED is defined as

$$\begin{aligned} R &= \int_0^\infty f(x)F(x)dx \\ &= \int_0^\infty \left[\frac{\theta^7}{720(\theta^6+\theta^4+1)} \left(720+360x^2+x^6\right) e^{-\theta x}\right] \\ &\times \left[1 - \frac{e^{-\theta x}}{720(\theta^6+\theta^4+1)} \begin{bmatrix} \theta^6x^6 + 6\theta^5x^5 + 30\theta^4x^4 + 120\theta^3x^3 + (360\theta^2 + 360\theta^6)x^2 \\ + (720\theta^5 + 720\theta)x + 720\theta^6 + 720\theta^4 + 720 \end{bmatrix}\right] dx \\ &= \frac{1}{2} \end{aligned}$$

Stochastic ordering of the ED

A useful method for comparing the behavior of two positive continuous random variables is stochasticordering. A random variable X is smaller than random

variable Y in

1- Likelihood ratio order ($X \leq_{LR} Y$) if $\frac{f_X(x)}{f_Y(x)}$ decreases in x.

2- Hazard rate order ($X \leq_{HR} Y$) if $h_X(x) \geq h_Y(x)$ for all x.

3- Mean residual life order ($X \leq_{MRL} Y$) if $MRL_X(x) \leq MRL_Y(x)$ for all x.

4- Stochastic order ($X \leq_{ST} Y$) if $F_X(x) \geq F_Y(x)$ for all x. Shaked and Shanthikumar (1994) showed that

$$X \leq_{LR} Y \Rightarrow X \leq_{HR} Y \Rightarrow X \leq_{MRL} Y$$

$$\Downarrow$$

$$X \leq_{ST} Y.$$

Theorem 12.1. Let $X \sim Ezz(\theta_1)$ and $Y \sim Ezz(\theta_2)$. If $\theta_1 > \theta_2$, then $X \leq_{LR} Y$ and thus $X \leq_{HR} Y$, $X \leq_{MRL}$

x and $X \leq_{ST} Y$.

Proof. Using the pdf of ED (2.1), we have

$$\frac{f_X(x;\theta_1)}{f_Y(x;\theta_2)} = \frac{\left[\frac{\theta_1^7}{720(\theta_1^6+\theta_1^4+1)}\left(x^6+360x^2+720\right)e^{-\theta_1 x}\right]}{\left[\frac{\theta_2^7}{720(\theta_2^6+\theta_2^4+1)}\left(x^6+360x^2+720\right)e^{-\theta_2 x}\right]} = \frac{\theta_1^7(\theta_2^6+\theta_2^4+1)}{\theta_2^7(\theta_1^6+\theta_1^4+1)}e^{-x(\theta_1-\theta_2)}.$$

Therefore,

$$log\frac{f_X(x;\theta_1)}{f_Y(x;\theta_2)} = log\left(\frac{\theta_1^7(\theta_2^6+\theta_2^4+1)}{\theta_2^7(\theta_1^6+\theta_1^4+1)}\right) - x(\theta_1-\theta_2),$$

and

$$\frac{\partial}{\partial x}\left[log\frac{f_X(x;\theta_1)}{f_Y(x;\theta_2)}\right] = (\theta_2-\theta_1).$$

Thus, for $\theta_1 > \theta_2$, $\frac{\partial}{\partial x}\left[log\frac{f_X(x;\theta_1)}{f_Y(x;\theta_2)}\right] < 0$. Therefore, $X \leq_{LR} Y$ which implies that $X \leq_{HR} Y$, $X \leq_{MRL} Y$ and $X \leq_{ST} Y$. □

Applications to Real Data

In this section, we justify the flexibility of the ED Goodness of fit in practical applications using two setsof real data. The first data (presented in Table (2)) represents the number of deaths due to COVID-19 in Europe from 1st March 2021 to 30 March 2021. The second data (presented in Table (3)) represents the number of deaths in Latvia from infection due to COVID-19 which is recorded from 12 May 2021 to 13 April 2021. These data sets are reported in (https://covid19.who.int/) .

The fit of the ED for the data sets is compared to the following distributions:

Exponential distribution:

$f(x) = \theta e^{-x\theta}\, x > 0.$

Lindley distribution (Ghitany et al. (2008)):

$f(x) = \frac{\theta^2}{\theta+1}(1+x)e^{-\theta x} \quad x > 0,\ \theta > 0.$

Akash distribution (Shanker (2016)) :

$f(x) = \frac{\theta^3}{\theta^2+2}(1+x^2)e^{-\theta x}, \qquad x > 0, \theta > 0.$

Ishita distribution (Shanker and Shukla (2017b)):

$f(x) = \frac{\eta^3}{\eta^3+2}(\eta + x^2)e^{-\eta x}, \quad x > 0, \eta > 0.$

Gharaibeh distribution (Gharaibeh (2021)) :

$f(x) = \frac{\theta^6}{120(\theta^6+\theta^4+\theta^2+1)}(x^5 + 20x^3 + 120x + 120\theta)e^{-\theta x};\ x > 0,\ \theta > 0.$

Karam distribution (Gharaibeh and Sahtout (2022)) :

$f(x) = \frac{\eta^6}{\eta^5 + 2\eta^3 + 24\eta + 120}\,(x^5 + x^4 + x^2 + 1)\, e^{-\eta x}; \qquad x > 0; \eta > 0$

Rose distribution (Tahat (2023)):

$f(x) = \frac{\theta^7}{\theta^6+6\theta^3+720}(1+ x^3 + x^6)\, e^{-\theta x},\ x > 0,\ \theta > 0$

Shanker distribution (Shanker (2015))

$f(x) = \frac{\theta^2}{\theta^2+1}(\theta + x)e^{-\theta x},\ x > 0, \theta > 0$

Table 2: The number of deaths due to COVID-19 in Europe from 1st March 2021 to 30 March 2021

18	29	28	47	55	40	150	129	184	236	237	336	219	612	434

648 706 838 1129 1421 118 116 1393 1540 1941 2175 2278 2824 2803 2667

Table 3: The number of deaths in Latvia due to COVID-19 from 12 March 2021 to 13 April 2021

11 9 11 10 2 8 12 12 10 10 5 2 12 11 13 3 5

6 5 10 6 14 9 1 8 3 3 9 17 18 5 0 4

using -2 log likelihood ($-2logL$), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Kolmogorov Smirnov (KS) statistic and p-value and the results are given in Table 5. It is found that the ED provides a better fit than all other distributions because it has the highest p-value and the lowststatistical values of $-2logL$, AIC, BIC and KS .

Table 4: -2logL, AIC, BIC, KS statistic and its p-value for ED and other fitted distributions.

	Distribution	$-2\log L$	***AIC***	***BIC***	***KS***	***p-value***
Data 1	***Lindley***	200.993	202.993	204.730	0.174	0.140
	Gharaibeh	198.566	200.566	202.303	0.148	0.286
	Exponential	195.006	197.006	198.744	0.116	0.584
	Karam	251.546	253.546	255.283	0.298	0.001
	Rose	264.521	266.521	268.259	0.321	0.000
	Akash	207.057	209.057	210.795	0.200	0.061
	Shanker	205.832	207.832	209.569	0.187	0.093
	Ishita	210.748	212.748	214.486	0.203	0.054
	Ezz	**193.067**	**195.067**	**196.805**	**0.111**	**0.634**

	Lindley	195.202	197.202	198.699	0.172	0.283
	Gharaibeh	190.561	192.561	194.057	0.146	0.487
	Exponential	203.243	205.243	206.740	0.222	0.076
	Karam	206.512	208.512	210.009	0.178	0.245
	Rose	215.711	217.711	219.208	0.209	0.113

Data 2	***Akash***	191.955	193.955	195.452	0.163	0.342
	Shanker	195.535	197.535	199.031	0.175	0.262
	Ishita	193.543	195.543	197.040	0.173	0.274
	Ezz	**188.621**	**190.621**	**192.117**	**0.116**	**0.762**

Table 5: The MLEs of the parameters of ED and other fitted distributions and their confidence intervals.

	Distribution	MLE	Erorr	CI lower limit	CI upper limit
Data 1	Lindley	0.451	0.050	0.352	0.549
	Gharaibeh	0.948	0.050	0.849	1.047
	Exponential	0.267	0.041	0.186	0.348
	Karam	1.462	0.087	1.292	1.632
	Rose	1.770	0.095	1.584	1.956
	Akash	0.696	0.060	0.579	0.813
	Shanker	0.502	0.050	0.404	0.600
	Ishita	0.745	0.057	0.632	0.858
	Ezz	0.992	0.048	0.897	1.087
Data 2	Lindley	0.227	0.028	0.172	0.282
	Gharaibeh	0.622	0.039	0.545	0.699
	Exponential	0.125	0.022	0.082	0.168
	Karam	0.731	0.052	0.629	0.832
	Rose	0.873	0.057	0.761	0.985
	Akash	0.360	0.036	0.290	0.429
	Shanker	0.245	0.029	0.188	0.302
	Ishita	0.372	0.036	0.301	0.443
	Ezz	0.712	0.039	0.636	0.788

Summary and Conclusions

In this paper, a new continuous distribution with one parameter is proposed and called Ezz distribution.The ED is introduced by mixing two well-known gamma and exponential distributions Several statistical properties of the ED have been demonstrated and described including The pdf, cdf, reliability analysis, moment and moment generating function, mean and median deviations, Bonferroni and Lorenz curves and Gini index, Renyi entropy, order statistics, stochastic ordering, Fisher information and MLE. Applications to real data sets for Covid-19 are presented, and it was found that the proposed distribution is more flexible for modeling such real data, as they showed good results in their compatibility with the real data sets compared to some other distributions considered in this study.

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Patterns In Twitter Use During a Disaster: Content Analysis of 2023 Türkiye-Syria Earthquake Tweets

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Abstract

Following the series of massive earthquakes struck Türkiye-Syria region on 6 February 2023 a huge amount of Tweets were posted both by victims and the community as a whole. Social media has long been used as a crisis communication tool and proved to supply valuable information in rescue management, and in delivering informative content as well, both by the government and the press. We analyze more than 400,000 tweets posted between 6-21 February 2023, and explore different use cases of Twitter networking site aftermath of the quake series. We handle Turkish and English tweets separately to distinguish between the topics discussed on-site and abroad. Retweet and like numbers are also analyzed to gain an overview on the possible information diffusion characteristics of tweets. We aim this study to shed some light on the possible opportunities social networking sites may offer in the aftermath of an earthquake.

Key words: *Türkiye-Syria Earthquakes, Content Analysis, Twitter, Disaster Management*

Geometric Connections Between Curves and the Hirota Equation in Euclidean Space

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Abstract

This work presents a novel connection between the integrable equation and the dynamics of curves in a three-dimensional Euclidean space. In this study, we demonstrate the relationship between the extended Landau-Lifschitz equation and the Hirota equation. This is achieved by the utilization of complex functions, which are generated based on the characteristics of three distinct curves and their corresponding Frenet frames in a 3-dimensional Euclidean space.

Key words: *Hirota Equation, Curve Flow, Euclidean Space*

New Geometric Methods for Integrable Equations in Minkowski Space

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Abstract

This study introduces an innovative connection between the motion of curves in 3-dimensional Minkowski space and integrable equations, utilizing the extension of the Heisenberg spin chain. As a result, we present a geometric logic to demonstrate the geometric origination of the derived integrable equations in 3-dimensional Minkowski space.

Key words: *Motion of Curve, Soliton Equations, Minkowski Space.*

Lucas Numbers and New Fractional Difference Sequence Spaces

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Abstract

In this article, we compound the fractional order difference operator $\Delta^{(\alpha)}$ *with the Lucas matrix* $\hat{H} = \left(L_{ij}\right)$ *and introduce the new difference sequence spaces. We investigate some topological properties, i.e., we show that our spaces are BK-spaces and linearly isomorphic to the space* ℓ_p*. Also, we give Schauder basis. Further, we determine Köthe-Toeplitz duals and also characterize some matrix classes. As the space* ℓ_p *is convex and reflexive, it can be naturally take into consideration the geometrical form of* ℓ_p*-type spaces. So, we examine the geometric structure of our spaces. At first, we show that the space* $\ell_p\left(H^{(\alpha)}\right)$ *possess the property* $(BS)_p$ *for* $1 < p < \infty$*. Besides, using Gurarii modulus of convexity, we say that* $\ell_p\left(H^{(\alpha)}\right)$ *is uniformly convex and strictly convex.*

Key words: *Lucas numbers, Fractional difference operator, Matrix transformation, Sequence space, Modulus of convexity*

Grouping of districts of Istanbul with cluster analysis based on damage and loss estimates

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Abstract

On February 6, 2023, two earthquakes with magnitudes of 7.8 Mw (± 0.1) and 7.5 Mw occurred in Pazarcık and Elbistan districts of Kahramanmaraş in Turkey. As a result of the earthquakes, at least 50 thousand 783 people died in Turkey, at least 8 thousand 476 people in Syria according to official figures, and more than 122 thousand people were injured in total. After this disaster, eyes turned to Istanbul. With its location and ancient architecture, Istanbul is one of the most attractive cities in the world. On the other hand, due to its proximity to fault lines, packed population, and high construction density, it is one of the cities with the highest earthquake risk. It is critical to recognize and mitigate the danger caused by an earthquake to be prepared for one. Pre-disaster research may minimize adverse outcomes to a minimum. In this context, as part of the "Istanbul Province Probable Earthquake Loss Estimates Update Project (2019)" developed in collaboration with Istanbul Metropolitan Municipality and Boğaziçi University Kandilli Observatory Earthquake Research Institute, building damages, possible deaths and injuries, infrastructure damages, and temporary accommodation needs in districts and neighborhoods in the event of an earthquake were assessed and reported in booklets created for each district.

In this study, it is aimed to group 39 districts of Istanbul according to possible 7.5 Mw earthquake damage and loss estimates with cluster analysis. Thus, depending on the risk levels of the districts within the obtained groups, suggestions can be made to determine the precautions to be taken beforehand and the emergency response points.

Key words: *Istanbul earthquake, cluster analysis, disaster management*

Multi-Objective Ergonomic Worker Assignment Model Proposal Supported by Binary Logistic Regression Model

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Abstract

It is necessary for firms to use their production resources effectively in order to maintain their existence in a competitive environment. Among the production resources such as raw materials, machinery, capital and information, it is the most difficult workforce to manage. Workforce affects production productivity more than other production resources. Therefore, it is necessary to take measures to ensure that the workforce can work comfortably in the production environment. Taking these precautions is possible with the implementation of ergonomics applications. The basic principle in ergonomics is to adapt the task to the worker. In this framework, it would be a correct approach to ensure the safety of the working environment and the comfort of the workers by assigning the workers to the appropriate tasks. In the production areas designed by considering ergonomic principles, it is aimed to assign appropriate tasks by considering the physical, mental capacities and individual characteristics of the worker. While determining the tasks to be performed by the worker, the probability of an occupational accident should also be considered. The probability of an occupational accident is affected by the individual characteristics of the workers. Accordingly, the assignment of workers to tasks where they can work at workload levels suitable for their physical and mental capacities will reduce the probability of work accidents and increase production productivity. Otherwise, fatigue will occur in the early period, and this fatigue will cause difficulties in systems that carry out basic functions of the body such as breathing, circulation, musculoskeletal system, and central nervous system. When fatigue lasts for a long time, negative consequences such as absenteeism, decreases in quality and motivation levels, and occupational accidents will occur. In this context, in the study, a worker assignment model has been proposed that considers the gender, age, experiences of the workers in the current firm and daily sleep times, together with the maximization of the production quantity and the minimization of the probability of work accident. Here, the individual characteristics of the workers, which define gender, age, experience, working time in the current firm and daily sleep time, are taken into account as occupational accident parameters. Accordingly, the Binary Logistic Regression Model (BLRM) was established based on these characteristics of the workers with the data obtained from a real production area. In the analysis, age, experience, working time in the current firm, average sleep time are constantly variable; gender was added to the model as a categorical variable. Within the scope of the model, reducing the probability of occupational accidents based on the characteristics of the workers is provided by the assignments to be made by minimizing the BLRM equation by taking place in the objective function of the model. However, the National Aeronautics and Space Administration Task load Index (NASA-TLX) was used for determining mental strain of workers. In the model, the level of mental strain is included in the constraints. In the solution of the model, PARETO Solutions (PSs) has been introduced and an approach that provides flexibility to decision makers is presented. The proposed model was used to assign workers to the tasks performed in the box letter production area of an advertising firm, and thus an assignment was made by considering ergonomic factors.

Key words: *Worker assingment, ergonomics, binary logistic regression*

Statistical Analysis of Subjective Workload Levels for Salespeople with Different Demographics

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Abstract

The subjective workload (SWL) effects the performance, reactions, attention, stress, fatigue and work satisfaction levels of the employees and it also effects the desire and loyalty levels of the employees towards their jobs. The SWL should be measured to establish comfortable, efficient, effective, and secure working environments. SWL evaluation is a multi-dimensional problem involving different sub-dimensions related to different work demands. There are many different SWL evaluation methods in the literature. Among them, National Aeronautics and Space Administration Task Load Index (NASA TLX) is a widely used one to determine SWL for in different work types. NASA TLX is a powerful tool to analyze SWL in terms of six sub-dimensions as physical demand, mental demand, temporal demand, performance level, effort level, frustration level NASA TLX is a scale with two parts. In the first part, employees make scoring between "0" and "100" for each sub-dimension of SWL. In the second part, pairwise comparisons are made between sub-dimensions. There are totally 15 pairwise comparisons between six sub-dimensions. Then, how many times each sub-dimension outweighs the other dimensions, this frequency is divided by the total number of pairwise comparisons, 15, and the weight of each sub-dimension is calculated. Outweighs means that the employee thinks about the job he/she is performing and determines which sub-dimension pushes his/her more in this job. Additionally, by multiplying weight of each sub-dimensions with their scores giving in the first part of the NASA TLX scale, the weighted score of the each sub-dimensions is obtained. Finally, the sum of weighted score of each dimension is computed. In this study, NASA TLX was used to determine the SWLs of 219 industrial salespeople. These employees are working in a large size firm which was among the first three firms in the machinery tools sector. The machinery tools sold by the firm have been used in various types of manufacturing firms. In this sector, technical knowledge is very important and this knowledge changes rapidly. Therefore, salespeople must be able to follow and master this rapidly changing technical information. In addition, it should be able to ensure that its products are requested by making visits to many different firms and transferring the information in question to its customers. Considering the mentioned conditions, it can be said that the sales job is a dynamic process that requires patience, knowledge and calmness. For this reason, it is necessary to take measures to determine the SWLs of the salespeople and to relieve the relevant employees when higher than expected levels are encountered. Otherwise, it is not possible to expect the same sales performance from the relevant employees. In this context, the related salespeople were evaluated in terms of different demographic features as gender, experience, age, the number of children, education level, having chronic occupational musculoskeletal disorders or not, having the other chronic diseases like diabetic, blood pressure etc. or not to determine theirs SWLs. For this aim, parametric and nonparametric tests were implemented to identify if groups of demographic features are significantly different for SWL scores. Results of the study showed that the experience affects the SWL score.

***Key words: S**ubjective workload, salespeople, data analysis, statistical tests*

Classification of OECD Countries According to Environmental Quality: Nonparametric Clustering Approach

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Abstract

One of the main problems in parametric clustering approaches is to need to determine the number of clusters a priori. Although there are various approaches to determine the number of clusters, the final decision mostly needs to be made by researchers. In this study, The CLUES nonparametric clustering algorithm suggested by Wang et al. (2007) was used. This method, which allows the number of clusters to be determined automatically within the algorithm, has advantages over parametric methods. In the study, OECD countries were classified to their environmental quality using the nonparametric clustering approach. The variables represent the environmental quality were determined within the framework of the IPAT (Impact - Population, Affluence and Technology) model. The variables determined in this context are per capita CO_2 emissions, per capita GDP, urbanization and total final energy consumption. In order to prevent the analysis results from being affected by global pandemic, 2018 data of 38 OECD countries were used. As a result, it was determined that the countries were divided into two clusters. Accordingly, it has been observed that countries with high economic levels and correspondingly high CO_2 emissions or having factors increasing air pollution are gathered together. It is noteworthy that Germany is the only exception and it is in the other cluster in spite of being an air polluted country. For comparison, parametric clustering methods, k-means and PAM, were also applied. As a result of parametric methods, unlike the nonparametric method, Germany was included in the first cluster, but the distinction of other countries remained the same. In February 2018, it was decided that states and municipalities could ban diesel-powered vehicles from the roads to reduce air pollution in Germany. This decision, implemented in various parts of the country, is thought to be effective in reducing air pollution. It is a remarkable result that, unlike parametric methods, the nonparametric method is successful in capturing the effect of this emission preventive decision. Therefore, it has been concluded that the nonparametric clustering method, in addition to the advantage of automatically determining the number of clusters, also enables more successful in selection of the cluster memberships.

Key words: *Nonparametric clustering, k – means, pam, CO_2 emission*

Tarım Alanlarının Yönetiminde Yapay Zekâ Uygulamasına Yönelik Bir Girişim

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Abstract

Yapay zekâ son zamanlarda hayatımızın vazgeçilmez parçalarından birisi haline gelmiştir. Son yıllarda her alanda olduğu gibi tarım alanında da önemli ve artan hızlı gelişmeler gerçekleşmektedir. Sadece tarımsal süreçleri değil, aynı zamanda hava ve iklim koşulları gibi diğer ilgili faktörleri de yönetmek kaçınılmaz olmaktadır. Yapay zekâ yöntemlerinin uygulanmasıyla daha verimli ve etkili tarımsal operasyonlar yürütülebilecektir. Bu bağlamda geliştirilecek AKTEMBİS adı verilen bir proje tanıtılmaktadır. AKTEMBİS Projesinin temel amacı, tarımda iklim kaynaklı kayıpları mümkün olduğunca en aza indirerek ekonomik zararları azaltmayı hedeflemektedir. Ayrıca iklim ilintili zamansız ve yanlış uygulanan tarımsal faaliyetlere rehberlik ederek verimliliği artırmaya yardımcı olmayı planlamaktadır. Üreticinin faaliyetlerini planlarken zamanı iyi yönetebilmesine katkı sunmaktadır. Projede Tarım operasyonlarının üretkenliğine katkıda bulunmayı amaçlayan teknolojik ilerlemenin avantajlarını denemek ve kullanmak için akıllı bir tarımsal-meteorolojik (agrometeorolojik) bilgi yönetim sistemi öngörülmektedir. Veri temini, Meteoroloji Genel Müdürlüğü veri tabanından veri temini yapılması amaçlanmaktadır. Tahmin verileri AKTEMBİS projesinin ön hazırlıkları hakkında bilgi verilecek, projenin amacı, gerekçesi ve kapsamı ayrıntılı olarak anlatılacaktır. Projenin hayata geçmesiyle birlikte bireyler ve ilgili tarım işletmeleri, iklim koşullarının ürünlerine olumsuz etkilerini en aza indirecek şekilde öneri ve uyarılar alabilecektir. Projenin ön hazırlık aşamasında özellikle veri toplamada izlenecek yöntem belirlenmiş ve kapsamlı bir literatür taraması yapılmıştır. Tarım alanlarına göre ölçeklendirilme ve çeşitlendirilmesini sağlayacak enterpolasyon algoritmalarına ihtiyaç vardır. Tokat bölgesindeki dokuz ürün mısır, kayısı, fındık, kiraz, ceviz, elma, buğday, ayçiçeği, şekerpancarı için ilgili algoritmalar geliştirilmektedir. Ayrıca olası kullanım durumlarını belirlemek ve akıllı operasyonların AKTEMBİS'teki kapsamını netleştirmek için yapay zeka üzerine yapılan çalışma ve ilgili uygulamalar gözden geçirilmektedir. Benzeri şekilde çiftçiyi tarlası ve ürettiği ürün bazında destekleyebilecek bir mobil sistem oluşturulması da hedeflenmektedir. AKTEMBİS kavramsal çerçevesi oluşturulmuş ve ilk sürüm için sistem gereksinimleri geliştirilmiştir. Çalışma, ilk versiyonun kodlanması ve algoritmaların yanı sıra gereksinimlerin iyileştirilmesi olmak üzere iki aşamada devam etmektedir.

Key words: *Akıllı tarım, mobil sistem,meteorolojik veri analizi*

Görüntü Sahteciliği Tespiti İçin Zeki Optimizasyon Algoritmalarına Dayalı Yeni Bir Yaklaşım

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Özet

Görüntü sahteciliği, bir görüntünün içeriğinin görüntüdeki kişilerin veya nesnelerin değiştirilmesi, gerçekte olmayan olayların olmuş gibi gösterilmesi veya görüntülerin istenilen şekilde görünmesinin sağlanması gibi çeşitli amaçlarla değiştirilmesi olarak tanımlanmaktadır. Görüntü sahteciliği, fotoğraf düzenleme yazılımlarının gelişmesi ile günümüzde oldukça yaygın ve kolay hale gelmiştir. Bu çalışmada, görüntüye dair herhangi bir ön bilgi olmaksızın görüntü sahteciliğini tespit etmek için zeki optimizasyon algoritmalarından yararlanan yeni bir yaklaşım önerilmektedir. Önerilen yaklaşımda, öncelikle görüntü öznitelikleri çıkartılmakta, ardından, elde edilen öznitelik haritalarında zeki optimizasyon algoritmaları ile kümeleme yapılarak görüntü bölütlenmektedir. Son olarak, elde edilen bölütlerin öznitelikleri değerlendirilerek sahtecilik yapılan konum tespit edilmekte ve sahtecilik haritası üretilmektedir. Çalışmada görüntü özniteliklerinin çıkartılmasında literatürde iyi sonuçlar veren hata seviye analizi, fotoğraf tepki düzensizliği, Laws doku enerji ölçütü gibi yöntemler kullanılmıştır. Elde edilen öznitelik haritalarının kümelemesinde ise Diferansiyel Gelişim algoritması ve Parçacık Sürü Optimizasyonu algoritmaları kullanılmış ve başarımları karşılaştırılmıştır. Önerilen yaklaşımın başarımını araştırmak için literatürde yaygın olarak kullanılan Columbia görüntü sahteciliği veri seti ile Erciyes arkaplan sahteciliği veri seti üzerinde deneyler gerçekleştirilmiştir. Yapılan deneylerin sonuçları önerilen yaklaşımın görüntü sahteciliği tespitinde kullanılabileceğini ve Parçacık Sürü Optimizasyonu algoritmasının bu problem için daha başarılı sonuçlar ürettiğini göstermektedir.

Key words: *Görüntü sahteciliği tespiti, zeki optimizasyon algoritmaları, görüntü kümeleme*

Exact Solutions for the Wick-Type Stochastic Zakharov–Kuznetsov Equation

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Abstract

In this study, exact solutions of the stochastic Zakharov-Kuznetsov equation are obtained using the Jacobi elliptic function method (JEFM). We use the Hermite transform to transform the Wick-type stochastic Zakharov-Kuznetsov equation into a deterministic partial differential equation. The inverse Hermite transform is also used to obtain a set of stochastic solutions in white noise space.

Key words: *Wick-product, Jacobi elliptic function method, Hermite transform, Inverse Hermite transform*

Estimate of inbreeding depression of the birth weight in the population of Pag sheep breed

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Abstract

The Pag sheep is a Croatian autochthonous sheep breed mainly reared for milk production. However, the lamb meat is also an important source of income for the breeders. It is desirable that lambs come into the world as heavier as possible to be more vital and disease resistant, but also to reach the slaughter weight as soon as possible. Previous studies conducted on different livestock populations suggest that inbreeding can lead to the serious decline in the birth weight of newborns, but this phenomenon has been scarcely investigated in sheep, especially in extensively managed dairy orientated populations. This study was part of the series of studies related to examination of the important population specific genetic parameters necessary to establish the optimum contribution selection (OCS), which is an ultimate long-term selection strategy in this population (project OPTI SHEEP, CSF, IP: 2019-04-3559). The specific aim of this study was to analyse the impact of inbreeding on the birth weight of lambs in the population included in selection improvement of milk gain. This population has been under comprehensive recording of genealogical and phenotypic data in the last two decades, which makes this population very suitable for investigation of this phenomenon. All data used in the analysis were provided by the Croatian Ministry of Agriculture. There was a total of 281760 animals in the pedigree, with maximally 11 generations traced back. All the available pedigree records were used for the estimation of the coefficient of inbreeding (F) for a total of 15186 lambs with known birth weight and sufficiently informative pedigree (number of equivalent generations >3). The inferential statistical analysis was conducted under the 3-way ANCOVA statistical model with gender, litter size, and parity used as categorical, and F (expressed in %) as continuous numerical predictor (covariate). The estimated regression coefficient of the birth weight (kg) on the F was -0.005 kg (P<0.001), indicating thus the presence of inbreeding depression. The obtained result calls for attention in making further mating plans in this population in order to prevent a genetically influenced decrease of the birth weight. However, more research, and more evidence is needed to generalize this effect, preferably under the framework of the animal genetic model in order to account for the mutual genetic relationship between the analysed lambs.

Key words: *Pag sheep, lambs, birth weight, inbreeding*

Genomic inbreeding in Istrian sheep – baseline for optimum contribution selection

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Abstract

The objective of this study was to examine genomic inbreeding based on the runs of homozygosity (ROH) in the population of Istrian sheep, a Croatian dual-purpose breed (milk and meat). The ROH is a kind of "state of the art" methodology in the conservation genetic studies, not only due to effective way to estimate inbreeding, but also due to possibility of distinguishing between distant and recent inbreeding based on the length of the homozygous segments of the genome and their share in the length of the total genome. In addition to estimate overall population genomic inbreeding (F_{ROH}), the aim was also to estimate within flock genomic inbreeding in order to provide baseline for implementation of the optimum contribution selection (OCS) which seeks to provide selection progress with minimal loss of genetic variability. This selection strategy for this native sheep population has been initiated under the project OPTI SHEEP (CSF, IP: 2019-04-3559), and numerous studies are ongoing to set up this selection strategy. This particular study was conducted on 719 genotyped (Ovine 50K SNP BeadChip) sheep from 11 flocks, but after quality control, 656 of them were retained in the inferential statistical analysis. Estimation of ROH segments lengths of different sizes was obtained using the PLINK toolset (v1.09), and post hoc analysis, i.e. estimation of genomic F_{ROH} ($F_{ROH} = \Sigma_i$ length $(ROH_i)/L_{\text{total length of genome covered by SNP}}$) was conducted in R programme. As suggested for medium density SNP data, only large ROH segments (> 4 Mb) were used to estimate F_{ROH}. Individual F_{ROH} ranged from 0.002 to 0.382 with an average of 0.068, and mean flock F_{ROH} ranged from 0.024 to 0.124. Only two flocks had F_{ROH} above 10% (F_{ROH} = 0.114 and 0.125). These results represent the first insights into genomic inbreeding at the flock level in this population and they will be used to set up the baseline for the OCS in the very near future. Development of the "pipeline" for including genomic inbreeding in the genetic evaluation system following the OSC principles is also an important practical and applicable contribution of the study.

Key words: *Istrian sheep, flocks, inbreeding coefficient, mating scheme*

Investigation of Readability Levels of Online Patient Information Texts Related to Jaw Cysts

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Abstract

In this study; In this study, it was aimed to investigate the readability levels of websites about jaw cysts on the internet. Health literacy is the individual's ability to access, understand and use online patient education materials and information to make an informed health decision. Individuals with health problems often use the Internet to search for information about diagnosis, management, and disease outcomes. "Ateşman Readability Index" was used to calculate the readability levels of the texts. The Kolmogorov-Smirnov test was used for the statistical analysis of the data's normal distribution. In addition, the data's mean, standard deviation, minimum and maximum values were calculated.

Key words: *jaw cysts, feasibility, health literacy, Kolmogorov-Smirnov test*

Classification of Coffee Beans Using Convolutional Neural Networks

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Abstract

Coffee is one of the most significant and economically valuable agricultural products on world markets. Evaluation of the color of coffee beans is an essential process in determining their quality and market price. Detection of coffee beans can be done using manual or electronic sorting machines, but these methods are either costly or inefficient; thus, automated systems are needed. This study aimed to classify four different coffee beans: dark, green, light, and medium by using their images with five different convolutional neural networks-based models, which are AlexNet, Inception-v1, MobileNet-v2, ShuffleNet, and SqueezeNet. AUC, accuracy, sensitivity, specificity, precision, F1-score, G-Mean metrics, and ROC curves were used to evaluate the models' performances.

Key words: *Classification, coffee beans, convolutional neural networks*

Determining the Similarity of the Provinces in Türkiye According to the Causes of Death by Cluster Analysis

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Abstract

Cluster analysis is a multivariate statistical method that aims to identify homogeneous groups with similar structures. In this study, it is aimed to cluster 81 provinces in Türkiye by using different clustering methods according to the causes of death selected by using the 2022 death and cause of death statistics published by the Turkish Statistical Institute (TUIK). In this context, it has been tried to reveal the causes of death of people in similar provinces and to reveal the cause of similar causes of death.

Key words: *Causes of death, cluster analysis, provinces in Türkiye*

Analysis of Covid-19 data with Unsupervised Learning Algorithms

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Abstract

Unsupervised learning is a technique that aims to discover unexplored structures and patterns in unlabeled data and is a sub-branch of machine learning. Unsupervised learning algorithms are widely used in data analytics and exploratory data analysis studies. These algorithms are used for many purposes such as revealing hidden structures in data, clustering similar data points, reducing the size and complexity of the data, and compression and visualization of data. In this study, the contributions of unsupervised learning algorithms were examined by using the health indicators compiled for the Covid-19 epidemic of countries. As a result; dimensionality reduction, clustering, anomaly detection, and uncovering unexpected or unusual trends in the data were performed by applying unsupervised learning techniques for health indicators data.

Key words: *Anomaly detection, Covid-19, unsupervised learning algorithms.*

Evaluation of COVID-19 related deaths using Generalized Linear Mixed Models

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Abstract

Generalized Linear Mixed Models (GLMM) are generalized versions of Generalized Linear Models (GLM) and Linear Mixed Models (LMM). GLMMs can be defined as regression models that allow researchers to choose from a variety of distributions and linkage functions to model a wide variety of dependent variables through linear combinations of one or more predictive variables (fixed effects). GLMMs allow modeling a linear relationship between one or more explanatory variable(s) and a continuous dependent variable, where observations are not independent but are aggregated given one or more random effect grouping factors. Because differences between groups can be modeled as a random effect, GLMMs provide a wide range of models for the analysis of grouped data. These models are useful in analyzing many types of data, including longitudinal data. They have utility for studies in the health field as they allow modeling of discontinuous response variables using different probabilities and linkage functions.

Considering the mortality of the Covid-19 epidemic, it is seen that many variables play a role in this period. Considering the studies in the literature, deaths in the Covid-19 pandemic can be explained by basic indicators such as the number of patients in intensive care, the number of patients admitted to the hospital, and the number of vaccinations. In this study, deaths caused by Covid-19 were modeled using generalized linear mixed models with some indicators specified in the literature.

Key words: *Generalized linear mixed models, Covid- 19, random effect, fixed effect*

The New Garima Distribution, Statistical Properties and Nuclear Data Sample

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Abstract

A two-parameter New Garima distribution is introduced and its structural, statistical properties are investigated. These include the compounding representation of the distribution, the shapes of the density and hazard rate functions, the moments and quantiles as well as the limiting distributions of extreme order statistics. We applied two-parameter New Garima distribution to the nuclear reactions including light (^{12}C + ^{28}Si at 65 MeV and ^{12}C + ^{40}Ca at 180 MeV), medium (^{12}C + ^{58}Ni at 300 MeV and ^{12}C + ^{90}Zr at 120 MeV) and heavy (^{12}C + ^{208}Pb at 180 MeV) that are important systems in the field of nuclear physics. Then, we compared the results of New Garima and and Exponential Garima and Garima distributions. We presented that the New Garima distribution are better than the Garima distribution and Exponential Garima

Key words: *Garima distribution, cumulative distribution function, survival function*

Estimation of Variance Components in a Gage R&R Study with Random Operators

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Abstract

A Gage R&R study plays a crucial role in evaluating the capability of a measurement system by identifying the sources of variation within it. This study focuses on constructing confidence intervals for the repeatability and reproducibility parameters, which account for variance components in the system. Additionally, confidence intervals are also studied for the precision-to-tolerance ratio (PTR), signal-to-noise ratio (SNR), and discrimination ratio (DR), which are commonly used indexes in measurement system analysis. The approach involves the use of likelihood ratio and bootstrap methods in a random two-factor design, where parts and operators are treated as random variables. To assess the performance of the proposed confidence intervals, a comprehensive simulation study is conducted, comparing them with existing methods in the literature, such as modified large sample and generalized confidence intervals. Finally, a numerical example is provided to illustrate the practical implications of the study's findings.

Key words: *Bootstrap, confidence intervals, gauge capability, likelihood ratio, maximum likelihood estimation, modified large sample, repeatability, reproducibility, variance components.*

Inference on Process Capability Index S_{pmk} for a new Lifetime Distribution

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Abstract

In this paper, a novel lifetime distribution is proposed. Some distributional properties of the new distribution, such as moments, kurtosis and skewness coefficients, and order statistics, are examined. Many estimation methods, such as the maximum likelihood, least squares, weighted least squares, Cramer-von Mises, Anderson-Darling, and maximum product spacing, for the parameters of the distribution are discussed. The efficiency of the estimators is assessed by a simulation based on bias and mean squared error criteria. In the simulation study, the sample is obtained with the acceptance-rejection algorithm, and the algorithm steps related to this algorithm are presented. Furthermore, the process capability index Spmk is examined when the underlying distribution is a new lifetime distribution. The maximum likelihood estimation of the Spmk is obtained. The asymptotic confidence interval is also constructed for Spmk. Some practical analyses are also performed on both the new distribution and the process capability index, Spmk, based on the new distribution.

Key words: *Lifetime distribution, monte carlo simulation, maximum likelihood estimation, process capability index, spmk.*

Parameter Estimation for Log Exponential-Power Distribution with two Applications

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Abstract

In this paper, many estimators are studied to estimate parameters of the log exponential-power distribution. The maximum likelihood, least squares, weighted least squares, Anderson-Darling, and Cramer-von Mises estimators are discussed. The efficiency of these estimators is validated through Monte Carlo simulation experiments. Also, two real data applications are conducted and Kolmogorov-Smirnov statistic results for all estimators are presented.

Key words: *Point estimation, log exponential-power distribution, maximum likelihood estimators, practical data application.*

Ultimate Ruin Probability for TRTG Claim Frequency and Geometric Claim Size

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Abstract

In this study, the probability of bankruptcy was calculated based on the discrete risk process, using the transmuted record type geometric distribution as the damage frequency distribution and the geometric distribution as the damage size distribution. In addition, some distributional properties are given for the transmuted record type geometric distribution and the total damage size distribution is obtained. The ruin probabilities for various values of the parameters in the damage frequency and damage size distributions are calculated and given in graphics.

Key words: *Damage size distribution, damage frequency distribution, discrete risk process, ruin probability.*

Analytical method development and validation for simultaneous estimation of drug active compounds analysis from it's pharmaceutical dosage form by three different methods

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Abstract

The analyst needs to know whether the result of measurement can be accepted with confidence or, on the contrary, rejected because it is wrong. It is essential, also, to know whether an analysis method is suitable for the intended use. Likewise, it is more important for the researcher to know if he can trust a new developed method and what are the criteria to respect to ensure its validity. A simple, rapid and reproducible first derivative, ratio-spectra derivative UV spectrophotometric method and HPLC method were developed for the simultaneous determination of olmesartan (OLM) medoxomil and hydrochlorothiazide (HCT) in combined tablets. The procedure is based on the use of UV spectrophotometry by using the linear relationship between standard solutions of olmesartan medoxomil or hydrochlorothiazide concentrations and the first derivative signals. The assay was linear and the method showed good recoveries and the relative Standard deviation (RSD) values for intra- and inter-day precision were calculated. The recovery test was succesfully applied from laboratory-prepared mixtures. The developed method was applied successfully for quality control assay of OLM and HCT in combined tablets and in vitro dissolution. The results were compared with official USP 24 HPLC method.

Key words: *Olmesartan medoxomil, hydrochlorothiazide, UV spectroscopy, derivative, simultaneous determination, HPLC, validation*

Comparison of the Performance of Missing Data Imputation Methods by Bootstrap Sampling in the Prostate Cancer Data Set

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Abstract

This study aimed to compare the prediction performances of different missing data imputation methods in the prostate cancer data set. Missing values with the missing at random (MAR) mechanism were created at rates of 10%, 20%, and 30% in the data set. Missing data were predicted using mean, median, random, k-nearest neighbors (KNN), missing value imputation with random forests (I-RF), multiple imputations by chained equations with classification and regression trees (MICE-CART), the direct use of regularized regression (DURR) and the indirect use of regularized regression (IURR) methods, which are among the missing data imputation methods, and errors were calculated. It was observed that as the missing rate increased, the prediction performances of the methods generally decreased. It was determined that the I-RF method was the method with the lowest error at all missing rates.

Key words: *Missing Data, Bootstrap, I-RF, DURR, IURR*

Effect of SMOTE Algorithm on Survival Prediction in Imbalanced Breast Cancer Dataset

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Abstract

Data sets in many fields, especially in the field of health, are generally unbalanced in terms of class variables. The problem of class imbalance arises when the number of samples of different classes in a data set is disproportionately distributed. This causes the minority class to be under-represented in the dataset and the trained classification models often produce biased predictions in favour of the majority class. SMOTE algorithm is a data balancing algorithm used to reduce the effect of skewed class distribution. In our study, we investigated the effect of the SMOTE algorithm on classification performance in breast cancer dataset that is unbalanced in terms of survival status. In the breast cancer dataset, survival status was estimated using Extreme Gradient Boosting (XGBoost), Random Forests (RF) and Support Vector Machine (SVM) methods before and after balancing with the SMOTE algorithm. As a result, it was observed that the SMOTE algorithm improved the classification performance for all classification methods, and it was concluded that balancing before classification in imbalanced data sets would improve the classification performance.

Key words: *SMOTE, Imbalanced data set, XGBoost, Random Forests, Support Vector Machine*

Balancing Covariate by Propensity Score Matching for Evaluation of Survival Risk Factors of Patients with Heart Failure Animals

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Abstract

The homogeneity of the study groups often cannot be controlled during the data collection process of studies conducted in the health field. The heterogeneous structure of the groups causes the real effects of the variables whose effects on a disease or an event to be investigated to be masked. The propensity score method obtains accurate results by balancing heterogeneous data. The aim of this study is to reveal the true effects of the demographic and clinical factors examined on the risk of death due to heart failure by using the propensity score matching method. After eliminating the effect of the age variable that caused heterogeneity between groups, the real effects of demographic and clinical factors were revealed, and it was determined that the significance levels of these factors on the risk of death due to heart failure changed. It was also determined that anaemia, ejection fraction, and serum creatinine levels significantly affected death due to heart failure.

Key words: *Propensity score, Matching, Logistic regression analysis, Heart failure*

Genetik Sistemlerin Bilgisayarda Simülasyonu

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Abstract

This is a simulation study conducted in preparation for the master's thesis in which the validity of a QTL mapping method. The aim of this presentation is to make a sampling of the gametes for one locus and two loci each with two alleles through a simulation program written by R language.

Keywords: *Segregation Gamete, Genotype, Random sampling, R Language.*

Özet

Bu çalışma, konusu bir QTL haritalama metodunun geçerliliğini araştırmak olan yüksek lisans tezine hazırlık olmak üzere yapılmış bir simulasyon çalışmasıdır. Bu tebliğin amacı, bilgisayarda R yazılım ile hazırlanan simulasyon programları ile bir ve iki lokus için üretilen gametlerin örneklemesidir. Programın her çalışmasında sonuçlar teadüfi değişiklikler gösterecektir. Programı her çalıştırmanızda değişik sonuçlar elde edeceksiniz. Gamet sayısını değiştirerek istediğiniz sayıda gamet üretmeniz mümkündür. Meselâ 12 denemede A geni taşıyan gametlerin sayısı sırasıyla, 9 5 7 13 5 13 5 16 10 7 6 9 olarak bulunmuştur.20 gametin 8'i AB (11) olsun beklenirken, üç denemede bu sayılar 6, 10 ve 9 olarak bulunmuştur. 50 gametin 12.5'inin AB (11) olsun beklenirken, dört denemede bu sayılar 13,13,17 ve 9 olarak bulunmuştur.

Anahtar Kelimeler: *Açılma, Gamet, Genotip, Tesadüf Örneklemesi, R yazılım*

GİRİŞ

Bilgisayarda simulasyon tekniklerinin canlı sistemler için kullanılması, 1950'li yıllarda başladı. Kantitatif genetik modeller, Monte Carlo Simulasyonu denilen bir teknikle bilgisayarda sınandı (Kavuncu ve Kesici 1980). Kantitatif bir özellik bakımından fenotipi belirleyen unsurlardan birisi olan genotiplerin oluşturacağı gametler, bilgisayarda üretilen standart uniform tesadüf sayılarına göre, ikinci unsur olan çevre etkisi ise ortalaması sıfır, varyansı da öngörülen bir değer olan normal dağılım gösteren tesadüf sayıları üretilerek atanıyordu.

Bu çalışmada R yazılım ile yazılan programlar yoluyla bilgisayarda belirli bir genotipteki bireyin üreteceği gametlerin nasıl simule edileceği gösterilecektir.

MATERYAL VE METOT

Materyal

Bilgisayarda R yazılım programı kullanılarak, aralarında uzaklık 15 HB kadar olan iki marker lokus ve bunlar arasında her iki marker lokusa uzaklığı ve fenotip ortalaması belli bir QTL lokusu planlanmıştır. İkişer allelli marker lokusları A ve B ile yeri belirlenmeye çalışılan QTL lokusu ise H ile gösterilmiştir.

Metot

Bu simulasyon çalışmasında, QTL lokusunun yerini belirlemek için yapılan çalışmalarda kullanılan klâsik bir yöntem tasarlanmıştır. Bu yöntemde yüksek fenotipli, AHB/AHB genotipinde bir hat ile düşük fenotipli, ahb/ahb genotipinde bir hattın AHB/ahb genotipli F1 melezleri, yüksek fenotipli hatla geriye melezlenir. QTL lokusu için, eklemeli bir model varsayılmış; büyük etkili H allelinin etkisi 15, küçük etkili h allelinin etkisi ise 5 birim kabul edilmiştir. Buna göre mümkün olan üç genotipin değerleri HH için 30, Hh için 20 ve hh için de 10 alınmıştır. Geri melezlemede elde edilen her bir genotip için, ortalaması sıfır, standart sapması 2 olan ve normal dağılan bir çevre değeri üretilerek, ilgili genotipin değerine eklenmiş ve böylece o bireyin fenotipi bulunmuştur.

AHB/ahb F1 bireyi ile AHB/AHB hattından bireyin melezlenmesinde elde edilecek geri melez bireylerinin genotipleri, standart uniform tesadüf sayıları yardımıyla belirlenmiştir. Buna göre meselâ A ve H lokusları arasında r1, H ile B arasında r2 kadar uzaklık varsa, geri melez bireylerinin genotiplerinin oluş ihtimalleri Tablo:1'deki gibi olacaktır. Buna göre rastgele üretilen bir standart uniform tesadüf sayısı, (1-r1)*(1-r2)/2'ye eşit veya daha küçükse genotip AHB/AHB olacaktır. Kümülatif ihtimal değerleri yardımıyla üretilen sayı hangi aralığa düşüyorsa, geri melez dölünün genotipi, o aralığa uygun genotipte olacaktır.

Tablo:1 - AHB/ahb * AHB/AHB Melezlemesinden Elde Edilecek Geri Melez Döllerinin Genotipleri (Gi), Frekansları (Fi), Kümülatif Frekansları (KFi), O Genotip İçin Üretilen Tesadüf Sayısının Düşmesi Gereken Aralık ve Genotipik Değerleri.

Genotip (Gi)	Frekans (Fi)	Kümülatif Fekans KFi)	Uygun Aralık	Genotipik Değer
AHB/AHB	F1=(1-r1)*(1-r2)/2	KF1	X<=KF1	30
AHb/AHB	F2=(1-r1)*r2/2	KF2=KF1+F2	KF1<x<=KF2	30
AhB/AHB	F3=r1*r2/2	KF3=KF2+F3	KF2<x<=KF3	20
Ahb/AHB	F4=r1*(1-r2)/2	KF4=KF3+F4	KF3<x<=KF4	20
aHB/AHB	F5=r1*(1-r2)/2	KF5=KF4+F5	KF4<x<=KF5	30
aHb(AHB	F6=r1*r2/2	KF6=KF5+F6	KF5<x<=KF6	30
ahB/AHB	F7=(1-r1)*r2/2	KF7=KF6+F7	KF6<x<=KF7	20
ahb/AHB	F8=(1-r1)?(1-r2)/2	KF8=KF7+F8=1	KF7<x<=KF8 (=1)	20

Bu tebliğde, böyle bir genetik sistemin simülasyonuna hazırlık mahiyetinde, belirli genotiplere sahip populasyonlardan iki allelli bir lokus ve her biri iki allelli iki lokus için n adet gamet örneği üretmek için hazırlanan simulasyon programları sunulacaktır.

SONUÇLAR

Tek Lokuslu bir Sistemin Simulasyonu

A/a genotipli bir bireyin vereceği 20 gametin 10'unun A, 10'unun da a geni taşıması beklenir. Ancak birçok denemede örnekleme yüzünden gerçek gamet sayıları bu beklenenler etrafında tesadüfi sapmalar gösterir. Bunun için R yazılımda hazırlanmış aşağıdaki gibi bir program yararlı olacaktır:

```
# parametreler n: gamet sayısı, agamet: üretilen gametler dizisi, Asay: A geni taşıyan gametlerin sayısı
n=20
A="A"
a="a"
agamet=array(rep("c"),n)
Asay=0
agamet
x=runif(20)
for (i in 1:n){
ifelse ((x[i]<=0.5),(agamet[i]=A),(agamet[i]=a))
ifelse ((x[i]<=0.5),(Asay=Asay+1),(Asay=Asay))
}
agamet
Asay
```

Bu programı her çalıştırmanızda farklı bir gamet dizisi elde edersiniz. Meselâ bir çalışmada üretilen 20 gamet aşağıdaki gibi çıkmıştır. Görüldüğü gibi 20 gametin 9 tanesinde A geni, dolayısıyla 11 tanesinde a geni bulunmaktadır.

```
> agamet
 [1] "a" "A" "A" "a" "a" "A" "A" "a" "a" "A" "a" "a" "a" "A" "A" "a" "A" "a" "a"
[20] "A"
> Asay
[1] 9
```

Programın her çalışmasında sonuçlar teadüfi değişiklikler gösterecektir. Programı bu şekilde her çalıştırmanızda değişik sonuçlar elde edeceksiniz. Gamet sayısını değiştirerek istediğiniz sayıda gamet üretmeniz mümkündür. Meselâ 12 denemede A geni taşıyan gametlerin sayısı sırasıyla, 9 5 7 13 5 13 5 16 10 7 6 9 olarak bulunmuştur.

İki Lokuslu Bir Sistemin Simulasyonu

İki lokus arasında ne kadar uzaklık olduğuna bağlı olarak yeni kombinasyonların oranı değişir. Parametreleri buna göre belirleyerek hazırlanan bir programla diheterozigot bir bireyin oluşturacağı gametler belirlenebilir. Diheterozigot birey coupling fazında bağlı ise AB/ab genotipindedir. İki lokus arasında 20 HB uzaklık varsa, oluşacak gametlerin %20'si yeni kombinasyon, %80'i ebeveyn kombinasyon olacaktır. Meyoz bölünme simetrik olduğundan %20 yeni kombinasyonun yarısı Ab, yarısı

aB, ebeveyn kombinasyonun da yarısı AB, diğer yarısı ab olacaktır. Buna göre standart uniform tesadüf değişkeninin tanım aralığı 0-1 uygun aralıklara bölünerek simulasyonla elde edilen sayının düştüğü aralığa göre gametin ne olacağı belirlenir. Meselâ sayı <=0.40 ise AB, 0.40<sayı<=0.50 ise Ab, 0.5<sayı<=0.6 ise aB ve 0.6'tan büyükse ab gameti oluşsun diye baştan kararlaştırılır. Aralığı çeşitli şekillerde düzenlemek mümkündür. Meselâ 0-0.4 ab, 0.4-0.8 AB, 0.8-0.9 Ab ve 0.9'dan büyük aB olacağı kararlaştırılabilir.

Buna göre iki lokus arasındaki uzaklık ve üretilecek gamet sayısı gibi parametreleri baştan belirleyerek aşağıdaki gibi bir R programı yazılmıştır:

```
# F1'in vereceği gametler; AB/ab=11/22
# r=0.20; n=20
# a: standart üniform tesadüf sayısı
# a<=p1 gamet 11
# p1<a<=p2 gamet 12
# p2<a<=p3 gamet 21
# p3<a<=1.0 gamet 22
p1=0.4
p2=0.5
p3=0.6
n=20
g=array(rep(0),n)
g
a=runif(n,0,1)
for (i in 1:n){
ifelse ((a[i]<=p1),(g[i]=11),(g[i]=g[i]))
ifelse ((a[i]>p1&a[i]<=p2),(g[i]=12),(g[i]=g[i]))
ifelse ((a[i]>p2&a[i]<=p3),(g[i]=21),(g[i]=g[i]))
ifelse ((a[i]>p3),(g[i]=22),(g[i]=g[i]))
}
g
```

Burada beklenen sayılar 20 gametin 8'i AB (programda 11 olarak gösterilmiştir), 8'i ab (22), 2'si Ab (12) ve 2'si aB (21) şeklindedir. Ancak programın her çalıştırılmasında bu sayılar etrafında rasgele değişen değerler elde edilecektir. Aşağıda üç deneme sonunda elde edilen sonuçlar gösterilmiştir:

```
> g
 [1] 11 12 12 22 21 12 11 11 22 22 21 11 11 12 22 21 21 11 22 22


> g
 [1] 11 11 22 11 22 11 11 22 22 11 22 11 11 22 11 21 22 22 11 22
```

```
> g
 [1] 11 22 11 11 22 11 22 12 11 22 11 22 21 22 12 11 11 22 11 22
```

Görüldüğü gibi 20 gametin 8'i AB (11) olsun beklenirken, üç denemede bu sayılar 6, 10 ve 9 olarak bulunmuştur. Parametreleri değiştirerek istediğiniz HB birimi uzaklık ve istediğiniz sayıda gamet üretebilirsiniz. Meselâ gamet sayısı n=50, HB uzaklık 0.50, yani A ve B lokusları bağlı değil ise, parametrelerde uygun değişikliklerle aşağıdaki gibi bir program çalıştırılabilir:

```
# F1'in vereceği gametler; AB/ab=11/22
# r=0.50; n=50
# a: standart üniform tesadüf sayısı
# a<=p1 gamet 11
# p1<a<=p2 gamet 12
# p2<a<=p3 gamet 21
# p3<a<=1.0 gamet 22
p1=0.25
p2=0.5
p3=0.75
n=50
g=array(rep(0),n)
g
ABsay=0
a=runif(n,0,1)
for (i in 1:n){
ifelse ((a[i]<=p1),(g[i]=11),(g[i]=g[i]))
ifelse ((a[i]<=p1),(ABsay=ABsay+1),(ABsay=ABsay))
ifelse ((a[i]>p1&a[i]<=p2),(g[i]=12),(g[i]=g[i]))
ifelse ((a[i]>p2&a[i]<=p3),(g[i]=21),(g[i]=g[i]))
ifelse ((a[i]>p3),(g[i]=22),(g[i]=g[i]))
}
g
ABsay
```

Dikkat edilirse bu programda ilgili parametreler n=50, p1=0.25, p2=0.5 ve p3=0.75 değiştirilmiş ve AB gametlerini sayısını veren bir sayaç (ABsay) eklenmiştir. Programı çalıştırdığınız zaman, 50 gametin 12.5'inin AB (11) olmasını beklersiniz. Gerçekten de gerçek sayılar, bu beklenen etrafında küçük değişiklikler göstermektedir:

```
> g
```

```
 [1] 12 11 11 11 11 21 22 11 11 12 12 12 21 12 11 22 21 21 22 21 21 12 11 12 22
[26] 21 12 21 22 11 12 21 22 11 22 21 21 11 22 21 11 12 12 12 22 21 11 12 22 22
> ABsay
[1] 13

> g
 [1] 12 11 11 21 12 12 11 21 11 22 21 12 21 21 11 12 12 22 22 11 12 12 21 12 21
[26] 22 12 12 12 12 22 22 12 21 11 22 11 11 22 11 22 21 12 21 22 22 11 21 11 11
> ABsay
[1] 13

> g
[1] 11 11 21 11 12 12 22 12 12 11 11 12 22 12 22 11 12 22 12 11 11 11 22 12 21
[26] 22 22 21 11 21 21 22 11 21 11 11 22 11 22 22 22 21 11 21 21 22 21 11 11 22
> ABsay
[1] 17

> g
 [1] 21 22 22 12 11 12 11 22 12 22 21 12 21 21 21 12 11 12 12 22 21 11 22 22 22
[26] 11 22 11 21 21 22 22 12 21 21 11 21 21 22 11 22 22 11 21 22 21 21 22 21 12
> ABsay
[1] 9
```

Görüldüğü gibi 50 gametin 12.5'inin AB (11) olsun beklenirken, dört denemede bu sayılar 13,13,17 ve 9 olarak bulunmuştur.

Yüksek Lisans tezi için bu programlar daha da geliştirilerek, Talo:1'deki genetik sistemin simulasyonu yapılmıştır. Bulunan sonuçların daha sonra yayınlanması planlanmaktadır.

Kaynaklar

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Çıkar Çatışması

Yazarlar çıkar çatışması olmadığını beyan etmişlerdir.

Yazar Katkıları

Çalışma, Prof.Dr.Orhan KAVUNCU hocamızın anlatımları, önerdiği makale ve çalışma örnekleri yardımıyla son halini bulumştur.

Bir DNA Dizisinin Bilgisayarda Simülasyonu

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Abstract

This is a simulation study on the difference between populations with respect to a certain DNA sequence. By the simulation program written on R, DNA sequences of various size sampled from two different populations are compared. The results are evaluated with respect to the similarities and differences. A program written to control the algorithm are run many times for a beginnimg sequence of nine nucleotides, six results randomly selected between them are evaluated, three of them have been observed no difference at the and twenty generatios, hile the other three have shown differences in each sequences and between them. A substation rate of 0.00055 is assumed equally from each site to the athers.

Keywords: *Population Genetics, Polymorphism, Genetic Divergence and Distance, Statistical Tests,* R Language.

Özet

Bu çalışma belirli bir DNA dizisi bakımından popülasyonlar arası farklılık üzerine bir simülasyon çalışmasıdır. R'da yazılan simulasyon programıyla iki farklı popülasyondan üretilen çeşitli büyüklükteki örnekler karşılaştırılıştır. Çalışma sonucunda ise benzerlik ve farklılıklar değerlendirilmiştir. Algoritmayı kontrol için yazılan program 9 nükleotidlik bir başlangıç dizisi için bir çok kereler çalıştırılmış, sonuçlardan rastgele altı tanesi incelenmiş, üç denemede 20 generasyon sonar hiç farklılık bulunmazken, üç denemede iki dizi arasında mutasyonla ortaya çıkan farklılıklar gözlenmiştir. Mutasyon hızı bütün siteler için eşit olarak 0.0005 kabul edilmiştir.

Anahtar Kelimeler: *Populasyon Genetiği, Polimorfizm, Genetik Çeşitlilik ve Uzaklık, İstatistik testler, R yazılım.*

GİRİŞ

Popülasyon genetiği, popülasyonlar arası farklılık ve benzerlikleri inceler; bunların sebepleri üzerinde durur. Bu benzerlik ve farklılıklar, popülasyonların genetik kompozisyonlarını karşılaştırarak ölçülür. Genetik kompozisyon, bir lokus için iki parametre setiyle ifade edilir: Genotip frekansları ve gen frekansları. Çok lokuslu modellerle ilgili çalışmalarda popülasyonun genetik kompozisyonuna gen ve genotip frekanslarına ek olarak bir de bağlantı dengesizliği parametresi eklenir. Moleküler genetikteki gelişmelerle genlerin DNA dizilerini belirleme imkanı ortaya çıkınca, popülasyon genetiği, popülasyon içi varyasyonu (polimorfizm) ve popülasyonlar arası varyasyonu (genetik uzaklık) bu DNA dizileri bakımından çalışmaya yöneldi ve moleküler popülasyon genetiği bir alt disiplin halinde gelişmeye başladı. Popülasyon genetiği bulgularından çokça yararlanan evrim çalışanları arasındaki tartışmaya, doğal olarak, moleküler popülasyon genetiği bulguları da katkı yapmakta gecikmedi. Tartışmalar iki ayrı ekol arasında

gelişmişti: Bir tarafta neo Darwin'cilerin babası olarak nitelenen "Dobzhansky'yi takip eden Lewontin ve Hubby gibi araştırıcılar, popülasyonları dengede tutan bir seleksiyon mekanizması öngörürken, Kimura ve Nei gibi araştırıcılar, moleküler seviyede müşahede edilen polimorfizmin, selektif olarak nötr allellerden ileri geldiğini, dolayısıyla bir popülasyonda gen frekanslarındaki değişmelerin şanstan, yani örneklemeden ileri geldiğini kabul eder. Mutasyonla meydana gelen yeni allellerin selektif olarak nötr oldukları durumda bunların geleceğinin tamamen şansla belirleneceğini düşünerek model geliştiren Kimura, mutantların selektif olarak nötr olmayabileceği durumları da dikkate almış ancak zararlı mutantların hızla yok olacağını, çok az orandaki selektif üstünlüğe sahip mutantların da hızla sabitleneceğini kabul etmiştir." (Kavuncu 2021). Aynı başlangıçtan neşet etmiş popülasyonların genetik kompozisyonunda, zaman içinde farklılaşma olur; bu popülasyonlar birbirinden uzaklaşır; buna genetik çeşitlenme (diversity) denir. Bu çeşitliliği ölçmek üzere kullanılan muhtelif genetik uzaklaşma veya mesafe (distance) ölçüleri vardır. Bilgisayarda simulasyon tekniklerinin canlı sistemler için kullanılması, 1950'li yıllarda başladı. Kantitatif genetik modeller, Monte Carlo Simulasyonu denilen bir teknikle bilgisayarda sınandı (Kavuncu ve Kesici 1980).

Bu çalışma, popülasyonlar arasındaki farklılıkları karşılaştırmak için geliştirilmiş testlerin geçerliliğini belirlemeyi hedefleyen bir simülasyon çalışmasıdır. Çalışmada, buğday bitkisinin bazı belirteç lokuslarında görülen belirli diziler için popülasyonların karşılaştırıldığı literatür taranmış ve başlangıç olarak seçilen AAA tandem tekrarlı küçük bir diziden ayrılan iki hat 20 generasyon boyunca bilgisayarda R yazılım programı ile simüle edilmiş, generasyon başına mutasyon hızının (ikame oranının) Juke&Cantor modeline göre tahminlerinin gerçek sonuçlarla uyumu incelenmiştir.

MATERYAL VE YÖNTEM

R yazılım programı kullanılarak, belirli bir DNA başlangıç dizisinden replike edilen dizilerin birbirinden şansın ve mutasyonun etkisiyle farklılaşması, bilgisayarda simulasyonla takip edilmiştir. Her nükleotidin başka bir nükleotide dönüşme ihtimali (mutasyon hızı veya eş anlamlı olarak ikame oranı) eşit alınmıştır. Aynı başlangıçtan ayrılan eşit büyüklükteki iki dizinin, her generasyon kendi kopyalarını üreterek generasyonlar boyunca evrilmesi takip edilmiş ve t generasyon sonra her dizi içinde ve iki dizi arasında farklılaşan nükleotidler sayılmıştır. Bu farklı nükleotidlerin sayısı kullanılarak gerçek ve Jukes&Cantor modeline göre tahmin edilen mutasyon hızları (ikame oranları) hesaplanmış, bu değerlerin simülasyonda kullanılan gerçek mutasyon hızı ile karşılaştırmaları yapılmıştır. Bu gerçekleşmiş ve tahmin edilmiş mutasyon hızlarının varyansları da karşılaştırılmıştır. Böylece modelim geçerliliği ve bu geçerliliğin bağlı olduğu şartlar belirlenmeye çalışılmıştır.

1.1 Simülasyonla Üretilen DNA Dizileri

Çalışmanın amacına uygun olarak, belirli bir DNA dizisine sahip bir başlangıç hattından alınan dolayısıyla özdeş olan iki dizinin birbirinden farklılaşması, çeşitli senaryolarda incelemek üzere, bilgisayarda simulasyonla takip edilmiştir. Bu senaryolar, iki parametrenin çeşitli seviyelerinin kombinasyonlarından oluşmuştur. Bu parametrelerden ilki generasyon sayısı t=10, 100 ve 1000, ikinci parametre seti mutasyon hızı α= 0.00055 ($55*10^{-5}$) ve 0.000055 ($55*10^{-6}$) olarak ele alınmıştır. Böylece 3*2=6 parametre kombinasyonunun her birisi için iki dizi karşılaştırılmıştır. Simulasyon 10 kere, 30 kere, 50 kere ve 100 kere tekrarlanmış, 100 denemenin mutasyon hızının gerçeğe yakın tahmini bakımından yeterli olduğu görülmüştür. Jukes&Cantor modeline göre olması beklenen değerlerle simulasyonla üretilen tekrarlardan hesaplanan değerler karşılaştırılmıştır. Materyalin üretildiği başlangıç dizisinin, 100 kodon (300 nükleotid sitesi) büyüklüğünde bir AAA tandem tekrarından oluşan bir dizi olduğu varsayılmıştır.

1.2 Jukes&Cantor Modeli

Jukes&Cantor modeli, aşağıdaki gibi özetlenebilir (Kavuncu, 2021 ve Hartl and Clark, 2007): Bir nükleotidin başka bir nükleotide dönüşme hızı (mutasyon hızı veya ikame oranı) dört nükleotid için de

sabit bir α sayısı kadar olsun. Buna göre başlangıçta A olan bir nükleotidin, birim zaman (bir generasyon) sonra T'ye, C'ye veya G'den her birine dönüşme ihtimalleri α, A'nın bu nükleotidlerden herhangi birine dönüşme ihtimali 3α, A olarak kalma, yani mutasyona uğramama ihtimali de 1-3α kadar olacaktır. Buna göre t+1 generasyonda belirli bir sitenin A olma ihtimali

$$P_{A(t+1)}=(1-3\alpha)P_{A(t)}+\alpha(1-P_{A(t)})$$

Eşitliğin sağ tarafındaki birinci terim, t generasyonda sitenin A olma ve mutasyon olmama ihtimali, ikinci terim ise A olmama ve mutasyonla A'ya dönüşme ihtimalidir. Buradan iki generasyon arasındaki fark

$$P_{A(t+1)}-P_{A(t)}=\alpha-4\alpha P_{A(t)}$$

şeklinden bir diferansiyel eşitliktir. Bu eşitliğin çözümü, başlangıçtaki ihtimal cinsinden

$$P_{A(t)}=\frac{1}{4}-(P_{A(0)}-\frac{1}{4})e^{-4\alpha t}$$

şeklinde yazılabilir. Başlangıçta A nükleotidi olduğu varsayımıyla $P_{A(0)}=1$ olacağından

$$P_{A(t)}=\frac{1}{4}-\frac{3}{4}e^{-4\alpha t}$$

bulunur. Bu eşitlik t zamanda A'dan A'ya geçiş ihtimalini verir, bunu P_{AA} olarak gösterebiliriz. Eğer t zamanda ayrılmış olan iki diziyi gözleyecek olursak, belirli bir sitede iki dizinin de aynı N nükleotidi taşıma ihtimali,

$$P_{NN}=\frac{1}{4}-\frac{3}{4}e^{-8\alpha t}$$

İki dizi arasında farklı olan nükleotid sitelerinin oranını d olarak gösterelim:

$$d=1-P_{NN}$$

ve bu durumda, başlangıçta müşterek cedden dolayı özdeş (mcdö) olan iki DNA dizisinin t zamanda farklılaşan nükleotid sitelerinin, dizi büyüklüğünde (toplam site sayısında) nisbi miktarı $\hat{d}=\frac{3}{4}(1-e^{-8\alpha t})$ olarak verilir. Eşitliği üstel bir ifade olmak yerine logaritmik bir ifade olarak yazabiliriz:

$$8\alpha t=-\ln(1-\frac{4}{3}\hat{d})$$

ve

$e^{-8\alpha t}=1-\frac{4}{3}\hat{d}$. Buradan da Başlangıçta mcdö olan iki DNA dizisinin her birinde t zaman sonra farklılaşan nükleotidlerin nisbi miktarı 3αt, dolayısıyla iki dizide toplam 6αt kadar olacaktır. Bu sayıya k denirse:

$$k=6\alpha t=\frac{3}{4}(8\alpha t)$$

ve k'nın beklenen değeri, gözlenen ikame oranın d'nin beklenen değerinden

$$\hat{k}=-\frac{3}{4}\ln(1-\frac{4}{3}\hat{d})$$

Tahminin varyansı var($\hat{k}$)

$$var(\hat{k}) = \left[\frac{\hat{d}(1-\hat{d})}{L\left(1-\frac{4\hat{d}}{3}\right)^2} \right]$$

Burada L, karşılaştırılan dizilerin uzunluğunu, demeli kaç adet nükleotid olduğunu vermektedir.

Örneğin; 300 nükleotidlik bir dizinin nfark12= 6 nükleotidinde değişimin olması halinde,

d= 6/300=0,02. Buradan, çoklu değişmeleri dikkate alan bir düzeltmeyle,

Gerçek Değişme Oranı k=-3/4ln(1-4/3*d)

k= 0.005 bulunur.

10 birim zamanda nükleotid ikame ortalama hızı α, k=6αt α=‘k/6t=k/6t=0.005/6*10=0.0003378584

kadar hesaplanır.

R programla da bu sonuç hesaplanabilir:

```
nfark12=6
d12=nfark12/nb
k=-3/4*log(1-(4/3)*d12)
alfa12=k/(6*t)
alfa12
0.0003378584
```

SONUÇLAR

Simulasyon Programı

Dizinin generasyonlar boyunca takibi yapılırken, nükleotidler harfler yerine rakamlarla gösterilmiştir. A yerine 1, T yerine 2, C yerine 3 ve G yerine 4 rakamı kullanılmıştır.

Simulasyon programı yapılırken, 300 nükleotidlik DNA dizisinde her nükleotid için standart uniform dağılımdan bir tesadüf sayısı üretilmiştir. Bu sayı mutasyon hızından (α’dan) küçük veya ona eşitse nükleotid 1’den 2’ye dönüşmüş, α’dan büyük fakat 2* α’dan küçük veya ona eşitse 3’e, 2* α’dan büyük fakat 3* α’dan küçük veya ona eşitse 4’e dönüşmüştür. Tesadüf sayısı, 3* α’dan da büyükse mutasyon olmamış, 1, 1 olarak kalmıştır.

Önce R yazılımla hazırlanan programın doğru çalışıp çalışmadığı test edilmiştir. Bunun için başlangıçta mcdö olan her biri 9 sitelik iki küçük dizi 20 generasyon boyunca her sitede mutasyon olup olmadığı her generasyon belirlenerek sonuçlar yazdırılmış. Kontrol için hazırlanan bu program Tablo: 1’de görülmektedir. Program birçok kere çalıştırılarak doğruluğundan emin olunmuştur. Beklendiği gibi bu denemelerin çoğunda, generasyon sayısı ve dizideki site sayısı az olduğu için hiç mutasyon olmamıştır. Bunlardan mutasyon da olan 6 denemeden çıkan sonuçlar Tablo: 2’de görülmektedir.

Tablo: 1- R Yazılım ile Hazırlanan Programın Kontrol Versiyonu

```
# odev nkodon adet kodon (bir kodon üç
nukleotid), n adet dizi
nden=1
t=20
n=1
c1="A"
c2="T"
c3="C"
c4="G"
nkodon=3
nb=3*nkodon
nfsay1=array(rep(0),nden)
nfsay2=array(rep(0),nden)
nfsay12=array(rep(0),nden)
for (k in 1:nden){

# ilk dizi
bd1=matrix(rep(1),ncol=nb,nrow=n)
cat("            başlangıç dizisi",bd1,"\n")
for (m in 1:t){
for (j in 1:n){
x=runif(nb,0,1)
for (i in 1:nb){
ifelse
(x[i]<=0.00055,(bd1[j,i]=2),(bd1[j,i]=bd1[j,i]))
ifelse
(x[i]>0.00055&x[i]<=0.00110,(bd1[j,i]=3),(bd1[j,i]
=bd1[j,i]))
ifelse
(x[i]>0.00110&x[i]<=0.00165,(bd1[j,i]=4),(bd1[j,i]
=bd1[j,i]))
}
}}
#ikinci dizi
bd2=matrix(rep(1),ncol=nb,nrow=n)
for (m in 1:t){
for (j in 1:n){
x=runif(nb,0,1)
for (i in 1:nb){
ifelse
(x[i]<=0.00055,(bd2[j,i]=2),(bd2[j,i]=bd2[j,i]))
ifelse
(x[i]>0.00055&x[i]<=0.00110,(bd2[j,i]=3),(bd2[j,i]
=bd2[j,i]))
ifelse
(x[i]>0.00110&x[i]<=0.00165,(bd2[j,i]=4),(bd2[j,i]
=bd2[j,i]))
}
}}
cat ("\n",t, "generasyon sonra    ilk dizi",bd1,"\n",
t, "generasyon sonra ikinci dizi",bd2,"\n")
# başlangıçtakinden farklı olan baz sayıları ve
değişim oranları
nfark1=0
nfark2=0
nfark12=0
for (j in 1:n){
for (i in 1:nb){
ifelse
(bd1[j,i]<=1,(nfark1=nfark1),(nfark1=nfark1+1))
ifelse
(bd2[j,i]<=1,(nfark2=nfark2),(nfark2=nfark2+1))
ifelse
(bd1[j,i]==bd2[j,i],(nfark12=nfark12),(nfark12=nfa
rk12+1))
}}
d12=nfark12/(nb*t)
d1=nfark1/(nb*t)
d2=nfark2/(nb*t)
ksay12=-3/4*log(1-4*d12/3)
ksay1=-3/4*log(1-4*d1/3)
ksay2=-3/4*log(1-4*d2/3)
}
cat ("iki dizide ve aralarında farklılaşmış nukleotid
sayıları", "\n"
,"ilk dizi        ", format(nfark1, width=2),"\n",
"ikinci dizi      ", format(nfark2, width=2),"\n",
"iki dizi arasında", format(nfark12, width=2),"\n",
 "iki dizi ve aralarında generasyon başına
farklılaşmış nukleotid oranları",
"\n","  ilk  dizi  ",format(d1,width=2),"\n","
ikinci dizi",format(d2,width=2),"\n","iki dizi
farkı",format(d12,width=2),"\n")
```

Tablo: 2- Kontrol Programı ile Elde Edilen Sonuçlar (6 Deneme)

Birinci Deneme:	Dördüncü Deneme: başlangıç dizisi 1 1 1 1 1 1 1 1 1

başlangıç dizisi 1 1 1 1 1 1 1 1 1 20 generasyon sonra ilk dizi 1 1 1 2 1 1 1 3 1 20 generasyon sonra ikinci dizi 1 1 1 1 1 1 1 1 1 iki dizide ve aralarında farklılaşmış nukleotid sayıları ilk dizi 2 ikinci dizi 0 iki dizi arasında 2 iki dizi ve aralarında generasyon başına farklılaşmış nukleotid oranları ilk dizi 0.01111111 ikinci dizi 0 iki dizi farkı 0.01111111	20 generasyon sonra ilk dizi 1 1 1 1 1 1 1 1 1 20 generasyon sonra ikinci dizi 1 1 1 1 1 1 1 1 1 iki dizide ve aralarında farklılaşmış nukleotid sayıları ilk dizi 0 ikinci dizi 0 iki dizi arasında 0 iki dizi ve aralarında generasyon başına farklılaşmış nukleotid oranları ilk dizi 0 ikinci dizi 0 iki dizi farkı 0
İkinci Deneme: başlangıç dizisi 1 1 1 1 1 1 1 1 1 20 generasyon sonra ilk dizi 1 1 1 1 1 1 1 1 1 20 generasyon sonra ikinci dizi 1 1 1 1 1 1 1 1 1 iki dizide ve aralarında farklılaşmış nukleotid sayıları ilk dizi 0 ikinci dizi 0 iki dizi arasında 0 iki dizi ve aralarında generasyon başına farklılaşmış nukleotid oranları ilk dizi 0 ikinci dizi 0 iki dizi farkı 0	Beşinci Deneme: başlangıç dizisi 1 1 1 1 1 1 1 1 1 20 generasyon sonra ilk dizi 1 1 1 2 1 1 1 3 1 20 generasyon sonra ikinci dizi 1 1 1 1 1 1 1 1 1 iki dizide ve aralarında farklılaşmış nukleotid sayıları ilk dizi 2 ikinci dizi 0 iki dizi arasında 2 iki dizi ve aralarında generasyon başına farklılaşmış nukleotid oranları ilk dizi 0.01111111 ikinci dizi 0 iki dizi farkı 0.01111111 >
Üçüncü Deneme: başlangıç dizisi 1 1 1 1 1 1 1 1 1 20 generasyon sonra ilk dizi 1 1 1 1 1 1 1 1 1 20 generasyon sonra ikinci dizi 1 1 1 1 1 1 1 1 1 iki dizide ve aralarında farklılaşmış nukleotid sayıları ilk dizi 0 ikinci dizi 0 iki dizi arasında 0 iki dizi ve aralarında generasyon başına farklılaşmış nukleotid oranları ilk dizi 0 ikinci dizi 0 iki dizi farkı 0	Altıncı Deneme: başlangıç dizisi 1 1 1 1 1 1 1 1 1 20 generasyon sonra ilk dizi 3 2 1 4 1 1 1 1 1 20 generasyon sonra ikinci dizi 1 1 1 3 1 1 1 1 1 iki dizide ve aralarında farklılaşmış nukleotid sayıları ilk dizi 3 ikinci dizi 1 iki dizi arasında 3 iki dizi ve aralarında generasyon başına farklılaşmış nukleotid oranları ilk dizi 0.01666667 ikinci dizi 0.005555556 iki dizi farkı 0.01666667

Bu sonuçlar, R program algotimasını kontrol amacıyla elde edilmiştir. Dizideki site sayısı 9 ve generasyon sayısı 20 oldukça küçükolduğu içim denemeden denemeye sonuçlar oldukça farklı çıkmaktadır. Nitekim tahminin varyan fromülünde, dizinin büyüklüğü L ve genrasyon sayısı t arttıkça varyansın küçlüdüğü görülmektedir. Yüksek Lisans tezi için bu programlar daha da geliştirilerek, Talo:1'deki genetik sistemin simulasyonu yapılmıştır. Bulunan sonuçların daha sonra yayınlanması planlanmaktadır.

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Çıkar Çatışması

Yazarlar çıkar çatışması olmadığını beyan etmişlerdir.

Yazar Katkıları

Çalışma, Prof. Dr. Orhan KAVUNCU hocamızın anlatımları, önerdiği makale ve çalışma örnekleri yardımıyla son halini bulmuştur.

Interpreting Interaction Effect with a Biological Perspective

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Abstract

Factorial experiments are commonly employed in agricultural researches as in other branches of applied sciences. In these experiments, inferences related to the interaction are essential. However, many researchers are still unable to analyze this type of experiment, and interpret the results in correct way. This is because, researchers focus on interpreting main effects although there is a significant interaction effect. Of course, meaningful main effects can exist even in the presence of an interaction, especially if interactions do not affect main effects. Therefore, it is extremely important to understand thoroughly that in which situations only the interaction effect (s), in which cases only main effect(s), and in which cases interpretation of the main effects will be able to meaningful although interaction effect is significant. In this study, evaluating factorial experiments have been discussed in detail especially in studies related to animal science. It has also been focused on the importance of considering both statistical and practical significance while interpreting the statistical analysis results.

Key words: *Factorial experiments, interaction, main effect, effect size*

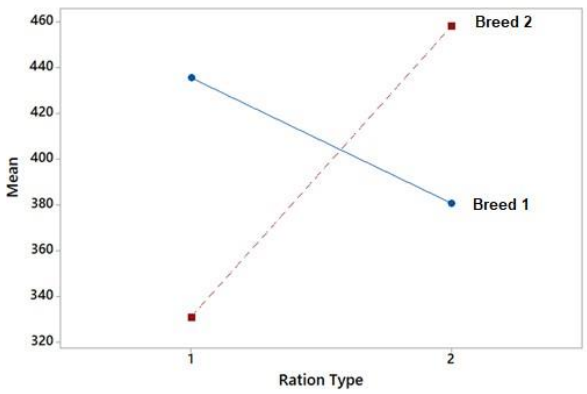
INTRODUCTION

Due to some advantageous of the factorial experiments they are commonly conducted by scientists and researchers wishing to investigate the effect of two or more independent variables on a single dependent variable almost in all branches of applied sciences (Yassin et al., 2002; Rocha et al., 2012; Mendeş, 2019). In factorial experiments, although evaluating the interaction effect is essential, it is noticeable that many researchers only do consider main effects rather than interaction effects even if significant interaction effect. And, it has been also noticed that many researchers are still unable to analyze and interpret the factorial experiments in proper way (Bezerra Neto et al., 2002; Yassin et al., 2002; Bertoldo et al., 2008a, 2008b; Mendeş and Yiğit, 2013; Mendeş, 2019). However, ignoring the significant interaction effect(s) may cause crucial problems especially in the stage of interpreting the results and making inference. It is because when there is a significant interaction effect, the factors are dependent, and thus, the combinations of the factors levels may affect the data in various ways (Siemiatycki and Thomas, 1981; Cardellino and Siewerdt, 1992; Wechsler, 1998; Santos et al., 1998; Nogueira and Corrente, 2000; Bezerra Neto et al., 2002; Bertoldo et al., 2008a; 2008b; Mendeş, 2019).

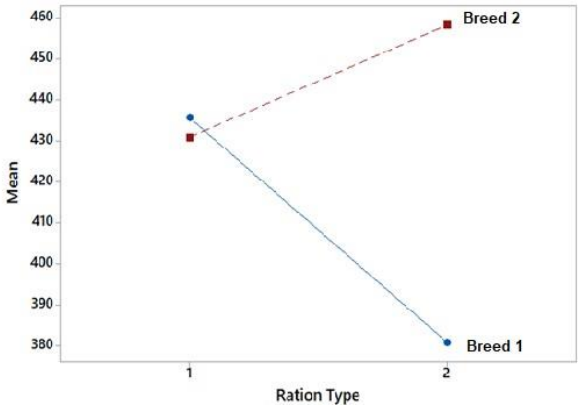
On the other hand, although trying to interpret the main effects are always not appropriate in the presence of an interaction (figure 1 and 2), in some cases, interpretation of the main effects can be meaningful even if interaction effect is significant. For example, consider a study which was carried out to investigate effect of two different ration types on live weight gain of the lambs in two different breeds. And suppose there is a significant interaction between ration type and breed (ration type x breed interaction). For such cases, since the effect of ration type on live weight gain will be different for the lambs in breed 1 and breed 2, trying to make a general statement about the effect of ration type and breeds separately (main effects) will

be misleading. Therefore, a significant main effect of the ration type does not necessarily indicate that live weight gain of the lambs who fed with ration 1 is significantly higher than that of the lambs who fed with ration 2. In this case, there will be two simple effects of the ration types: the effect of ration types for breed 1 and the effect of ration types for breed 2. Since the presence of interaction means that the main effect is not representative of the simple effects, the effect of the ration type should be compared for each breed separately. As a result, when a researcher wants to know whether a factor has an effect at each level of a second factor, he / she should test the simple effects. It is possible to see these situations from the interaction plots (graph 1 and 2) easily.

Graph 1. Interaction Plot for Live Weight Gain

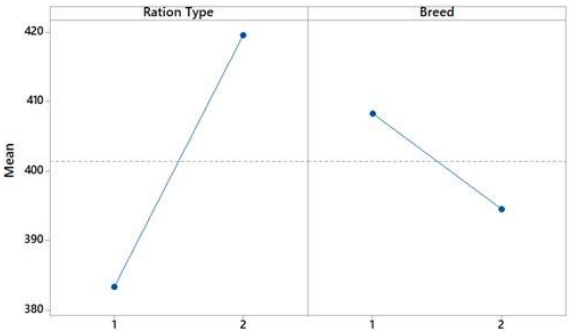


Gaph 2. Interaction Plot for Live Weight Gain

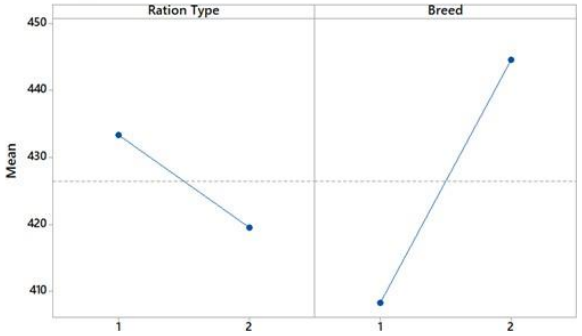


The crossed lines on the graph suggest that there may be a Ration x Breed interaction effect. However, it should not be forgotten that the final result will be reached by hypothesis testing procedure (P-value) (Starmer, 2004; Mendeş and Yiğit, 2013; Mendeş, 2019). For example, the graph 1 shows that the live weight gains of the lambs in the breed 1 are higher when the first ration type is used. Conversely, the live weight gain of the lambs in the breed 2 are higher when the second ration type is used. Therefore, the desired live weight gains will not be achieved for such cases if the lambs in the Breed 1 feed with the second ration and the lambs in the Breed 2 with the first ration type. Likewise, it can be understood from the graph 2, the live weight gains of the lambs in the breed 1 and breed 2 are quite similar when the first ration type is used or significance differences are not observed between live weight gains of the lambs in both breeds when ration 1 is used in feeding the lambs. Live weight gains of the lambs in the breed 2, however, are higher when the second ration type 2 is used. Therefore, the desired live weight gains will not be achieved for such cases if the lambs in the breed 2 feed with the first ration and the lambs in the breed 1 feed with the second ration. In this case, the question of which ration type is better comes to your mind. Or which type of ration should be used in feeding lambs in the breed 1 and breed 2? It depends on the breed. That is why an interaction effect is also known as '**it depends effect**'. Thus, since it can be able to cause getting unreliable results and limit the generalizability of the results, it will not be convenient trying to interpret the main effect(s) without considering the interactions if there is a statistically significant interaction effect(s). As it can be easily seen in the above examples, they cannot answer the question about which ration type is better without knowing the breed. Let’s assume a researcher wants to determine which ration is the best to lambs in breed 1 and breed 2. However, suppose that he forgot to include the interaction effect and assessed only the main effect of type ration and breed. In this case, he’ll make his decision only based on the main effects plots (Graph 3 and 4) below.

Graph 3. Main Effects Plot for Live Weight Gain



Grap 4. Main Effects Plot for Live Weight Gain

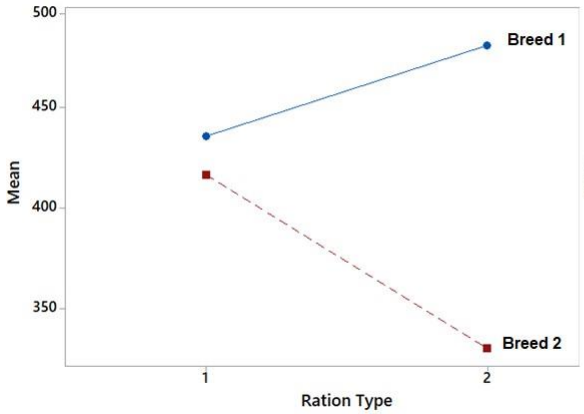


Based on main effect plots, the researcher would choose the second ration for the lambs in Breed 1 because they each produce higher live weight gain (Graph 3). For the situation presented in graph 4, the researcher would choose the first ration for the lambs in Breed 2. However, since the interaction effects are significant for both cases, it will be quite misleading to reach such conclusions. A main effect here is the effect of a factor on an interested variable (dependent variable) – ignoring all other factors. Therefore, a main effect for breeds says that there is a difference between the breeds, regardless of ration types. Likewise, a main effect for ration types says that there is a difference between the ration types, regardless of the breeds. As it can be seen from graph 1, there is clearly an interaction effect here (P=0.000). As it is noticed from the graph 1, there is an obviously large change in the mean of the live weight gain for the breed 2, but not for the breed 1. Actually, this is a good example for a case where both main effects will be significant (P=0.000 and P=0.002) alongside interaction effect, but main effects are not meaningful here (Starmer, 2004; Mendeş, 2019).

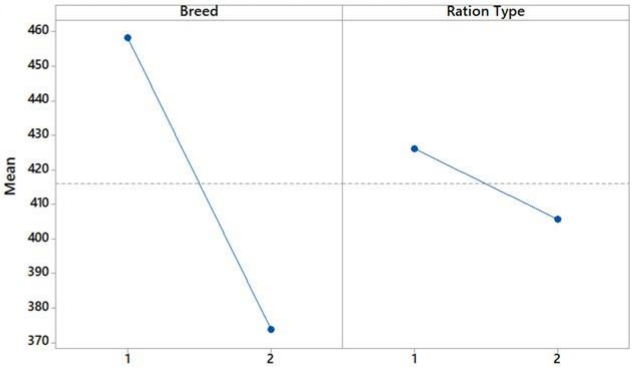
Although there is a statistically significant interaction effect, in some cases, it is possible to interpret the main effects (for example, if there is no parallelism in the interaction chart, but one level of a factor is always higher in all levels of the other factor). However, in general (especially there is a cross line on the graph) interpretation of the main effects will not be appropriate in case of the presence of an interaction effect. As a result, when you have statistically significant interactions, you cannot interpret the main effect without considering the interaction effects. Likewise, when graph 2 is examined, it is also clear that there is a significant interaction effect. If one tries to interpret the main effect of the breed without considering the Rasyon Type x Breed interaction he or she will conclude that there is a significant difference between the means of the live weight gains of the breeds, regardless of ration types. That may be technically true if averages of the breeds are compared regardless of the ration types. However, this conclusion or approach is only valid on average across the ration types because of the large difference in the second ration. Therefore, it is not true at each ration type. As a result, to conclude that the means generally differ across the breeds, regardless of ration types, isn't really accurate. However, there are some situations where the interaction does not affect the main effects. In such cases, interpretation of the main effects can be meaningful (Graph 5 and 6). As it is well known that parallel lines in the interaction plots indicate that there is no interaction effect while different slopes suggest that one might be present. As it can be seen from the graph 5, the lines are not parallel. This shows that a significant interaction effect might be occurred. Although this graph is basically identical to the graph 2, what makes the main effect of breed meaningful here, despite the interaction, is that the first breed's mean is always higher than the second breed's for both ration types. Therefore, that's a meaningful main effect here and it says that the lambs in the first breed does generally have

higher live weight gain means, regardless of types of ration you feed the lambs. Therefore, it will be useful to consider main effects as well in such cases although there is a significant interaction effect. It is because if the main effects are ignored in such cases, it might cause to ignore the fact that the lambs in the first breed not only changed more, but started higher (graph 5).

Graph 5. Interaction Plot for Live Weight Gain



Graph 6. Main Effects Plot for Live Weight Gain



Therefore, it will be beneficial to keep in our mind that in cases where the interaction effect is significant, it might be useful also to consider main effect(s) alongside interaction effect. As a result, if one has both a significant main effect and a significant interaction, it will be useful does not assume the main effect will meaningless. It may be important.

One of the other important points need to consider is the researchers should consider effect size when they interpreting the results. That way, it will be possible to get information for both statistical and practical significance of the observed differences. Considering the effect sizes for interaction and main effects might help us to decide if the focusing on main effects is meaningful or not even if the presence of interaction. Therefore, in this study we will discuss the factorial experiments with different perspective to show how to we get more detailed and generalizable results. All discussions will be done based on three different scenarios generated from using mean and standard deviation of a real data set which obtained an experiment conducted to investigate the effect of two factors (ration type and breed) on live weight gain of lambs.

MATERIALS AND METHODS

Material of this study consisted of random numbers generated from three normal distributed populations with equal variances for two factors namely ration type and breed. Average and standard deviations of a real study which carried out to investigate the effect of different ration types on live weight gains of lambs in two different breeds were used in generating random numbers.

Since there are two factors namely ration type and breed following statistical models has been used in analyzing data sets.

$$\boldsymbol{Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}}$$

Where

$\boldsymbol{Y_{ijk}}$ is the live weight gain of the kth lamb

$\boldsymbol{\mu}$: General population mean

$\boldsymbol{\alpha_i}$: Effect of ith breed (I=1, 2)

$\boldsymbol{\beta_j}$: Effect of jth ration type (j=1, 2)

$(\boldsymbol{\alpha\beta})_{ij}$: Effect of breed by ration type interaction

$\boldsymbol{\varepsilon_{ijk}}$: Random error term

RESULTS

Results of factorial ANOVA for three experimental cases and interaction plots for ration type by breed have been presented in Table 1, 2, 3 and figure 7, 8, and 9 respectively. How the results of the factorial experiments should be interpreted and in which cases it may be meaningful to interpret the main effects together with the interaction effect are discussed in detailed on these results. The question if interpreting main effects might be meaningful despite a significant interaction effect rises especially when both interaction and main effect(s) are important. In order to answer this question we will focus on the results of three scenarios namely case 1, 2, and 3, respectively. That way, it will be able to possible to give answer of this question more easily and clearly. When interaction plots and ANOVA results related to case 1, case 2, and case 3 are evaluated together, it can be easily seen that interaction terms are significant for all three cases. Let's begin evaluate the results of case 1.

1.1. Results of Case 1.

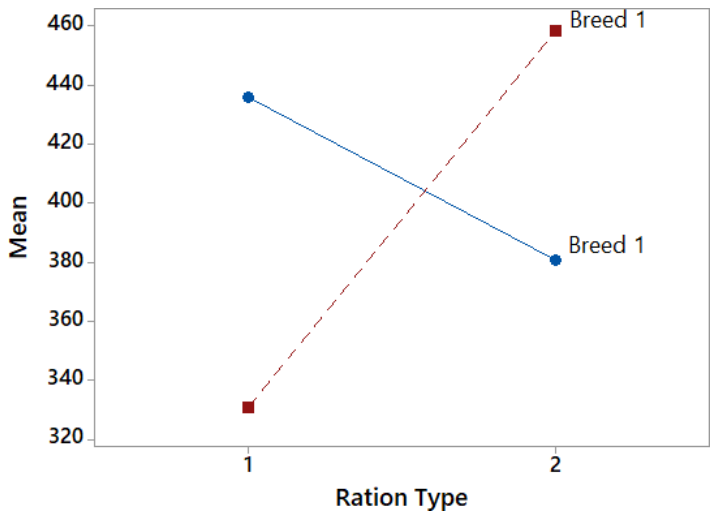
Table 1. ANOVA Results for the first scenario

Source of Variation	P-Value	Effect Size (Contribution)	Total Effect Size
Breed	0.142	1.65	85.88
Ration Type	0.001	11.48	
Breed x Ration Type Int.	0.000	72.75	

Note 1: Contribution stands for effect size values

Note 2: The effect size value of above 0.20 is generally evaluated as practical significant as well

Figure 7. Interaction Plot for Live Weight Gain for Case 1



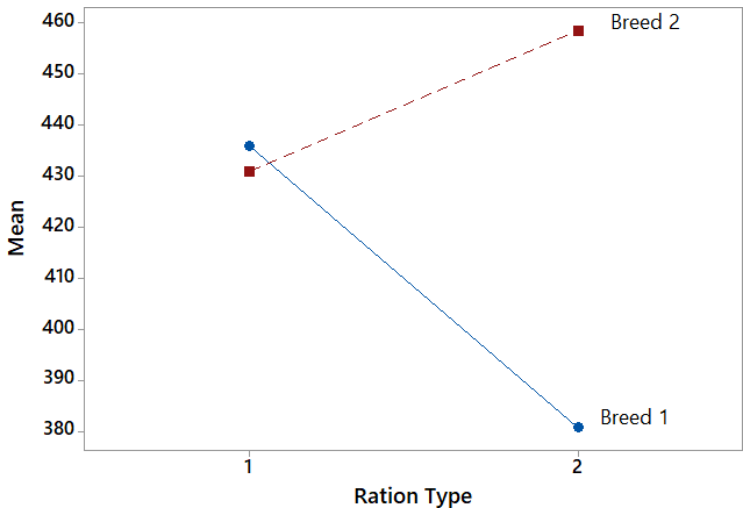
For the case 1, both interaction effect (P=0.000) and main effect of Ration Type are significant (P=0.001). That means, effect of Ration Type on weight gain of the lambs varies depend on Ration Type. In this case, it will not be appropriate to evaluate effect of Breed and Ration Type separately. The effect sizes related to the interaction and Ration Type are another indication that it is not appropriate to interpret the main effects separately. As can be seen from the ANOVA table, effect size value of interaction (72.75%) is obviously higher than that of the Ration Type (11.48%). Therefore, 72.75% of the variation in the weight gains of the lambs can be explained by interaction while only a little part of variation can be explained by the Ration Types. This result is also one of the important indicators that interaction effect is both statistically and practically significant and it shows that interpreting main effects will not be meaningful.

1.2. Results of Case 2.

Table 2. ANOVA Results for the second scenario

Source of Variation	P-Value	Effect Size (Contribution)	Total Effect Size
Breed	0.002	3.92	66.48
Ration Type	0.142	27.26	
Breed x Ration Type Int.	0.000	35.30	

Figure 8. Interaction Plot for Live Weight Gain for Case 2



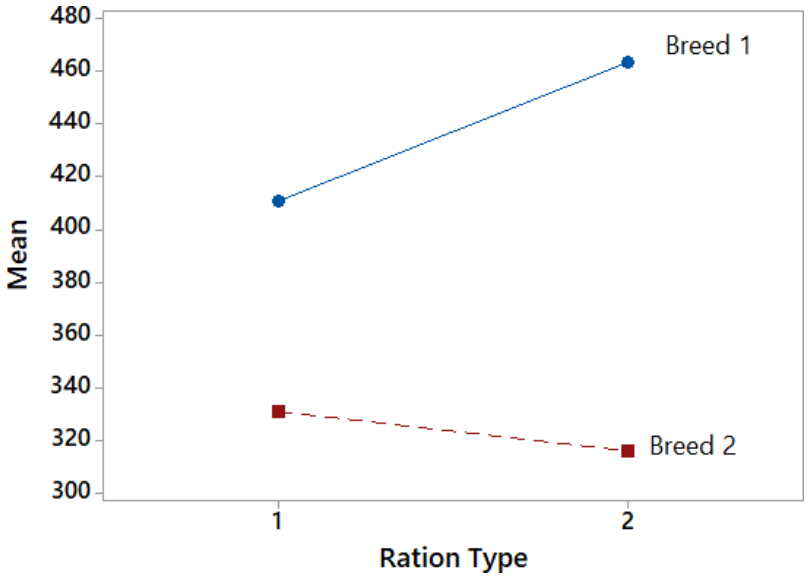
When ANOVA table related to case 2 is examined, it is seen that the interaction effect is significant as in the case 1. However, interaction plots for case 1 and case 2 show a little bit different patterns. This is because, in the case 1, while the effects of interaction and Ration Type are significant, in the case 2, however, the effects of the Breed and interaction are significant. However, since there is a cross line in both charts (figure 7 and 8), mean of one level of one factor will always not higher in both levels of the other factor. As can be seen from the ANOVA table, effect size value of interaction (35.30%) is still higher than that of the Breed (27.26%). This is also one of the indicators that interaction effect is both statistically and practically significant.

1.3. Results of Case 3.

Table 3. ANOVA Results for the third scenario

Source of Variation	P-Value	Effect Size (Contribution)	Total Effect Size
Breed	0.000	2.34	96.33
Ration Type	0.002	86.29	
Breed x Ration Type Int.	0.000	7.60	

Figure 9. Interaction Plot for Live Weight Gain for case 3



When ANOVA table and interaction plot related to case 3 are examined, it is seen that the interaction effect is significant as in the case 1 and case 2. However, interaction plot for case 3 is obviously shows a different pattern. As it can be seen from the interaction plot, mean of the first breed is always higher than the second breed's for both ration types. Therefore, interpreting of the main effect might be meaningful in such cases even presence of significant interaction effect. The obviously high effect size value of the Breed is another indication that especially interpreting the main effect of the breed might be meaningful. It is because; the breed can explain 82.69 % of the variation in the live weight gains of the lambs. However, very small part of variation (only 7.60 %) in the weight gains of the lambs can be explained by the interaction term (despite presence of a significant interaction effect). This amount of variation is not evaluated as practically significant. Therefore, it will be beneficial to keep in our mind that in cases where the interaction effect is significant, it might be useful also to consider main effect(s) alongside interaction effect. As a result, if one has both a significant main effect and a significant interaction, it will be useful does not assume the main effect will meaningless. It may be important.

DISCUSSION

Because of different advantages of the factorial experiments, they are commonly used in agricultural researches as in other branches of applied science. One of the biggest advantages of the factorial designs is that they allow researchers to look for interactions between the factors (Wu and Hamada, 2000; Lewis and Dean, 2001; Collins et al., 2010; Mendeş, 2019). Factorial experiments are also very efficient, can have high test power even if they have relatively few observations per experimental condition or sub-group and provide extra information which cannot be obtained when using single factor designs. Although important advantages of factorial experiments over single factor experiments, many researchers still unable to analyze factorial experiments, interpret and the present the results in correct and efficient way.

In practice, especially in the agriculture and biological science-based studies, one of the most frequency questions to statisticians is that when the interaction effect is significant, whether the main effect(s) can be interpreted or not. In the statistician point of view, if the interaction effect is significant, in this case, the interpretation of the main effects is meaningless. Since presence of interaction effect indicates that the effect of one factor depends on the other factor(s), and thus it will not be appropriate to evaluate main effect of each factor separately. This is because it will be difficult to make a general statement about the effect of a factor when the size of the effect depends on the level of a second factor. When an interaction is large, the corresponding main effects have very little practical meaning. Consequently, when interaction is present, the main effects of the factors involved in the interaction may not have much meaning. As it is stated by De Gonzales and Cox (2007) interaction is one of the fundamental concepts of statistical analysis of factorial experiments. Establishing the presence or absence of interaction may be a key to correct interpretation of data. Therefore, since the presence of interaction between the factors limits the generalizability of main effects, it will not be appropriate focusing on main effects when there is a significant interaction. If the interaction is present, there is an indication that the differences among the levels of a factor depend on the level of the other factor (Chew, 1976). However, due to the difficulty and inability of the researchers to interpret results of factorial experiments, erroneous inferences about the effect of treatments on response were observed (Bezerra Neto et al., 2002). Cardellino and Siewerdt (1992) reported that a comparison of marginal averages without considering possible interactions is an example of such an error. Bertoldo et al. (2008a) noted that 72% of the published studies in the factorial experiments were incorrect when tests of average comparison were conducted. They reported that the reason for this problem was that the significant interaction effect was ignored and the factors were evaluated separately (Rocha et al., 2012). As Silva (1999) reported that for experiments designed in a factorial scheme, conclusion to be drawn will be changed depending directly on the presence or absence of interaction. If ANOVA results show non-significant interaction effect, in this case, complementary procedures of the main effects of factors are carried out, and the effect of the interaction is disregarded (Perecin and Cargnelutti Filho, 2008). However, in the presence of significant interaction, an evaluation of the results requires a comparison of the levels of a factor inside the fixed levels of another factor (Nogueira and Corrente, 2000). In other words, the inferences about one of the factors depend directly on the level of the other factor (Rothman et al., 1980; Rocha et al., 2012).

As a result, the factorial experiments are the only way to discover interactions between variables. The presence of interaction shows how the factors or independent variables work together in terms of impacting the dependent variable. In other way, the presence of a significance interaction indicates that the effect of one factor depends on the level of the other factor. Therefore, including interaction terms in model is extremely important since it provides the researcher with a better representation and understanding the relationship between the dependent and independent variables and helps explain more of the variability in the dependent variable. An omitted interaction effect from a model where a nonnegligible interaction does in fact exist may result in a misrepresentation of the relationship between the independents and dependent variables. It could also lead to a bias in estimating model parameters. However, it will not always be a correct approach to think that the main effects will not have any meaning in cases where the interaction is

significant. As shown in case 3 above, in some cases the interpretation of the main effects may be meaningful, despite a significant interaction effect. Of course, when deciding on this, it should be remembered that ANOVA results, interaction plots and effect size values should be evaluated together.

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Hierarchical Linear Models and An Application

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Abstract

The aim of most of the models developed in statistics is to reveal the cause-effect relationship between the variables under study. At the stage of revealing the cause-effect relationship, it is expressed in a mathematical model as a combination of explanatory variables that are thought to have an impact on the expected value of the response variable(s) in question. The answer to the question of what kind of model this model should be varies depending on the structure of response variable, the type of explanatory variable effects and whether the relationship is linear or not. Hierarchical Linear Models are used instead of General Linear Models when the variables are not continuous or normally distributed, the dependent variable or variables to be examined are correlated and there is clustered or hierarchical(nested) data. Hierarchical Linear Models are very important because they can be applied to data with clustered or hierarchical structure and can better reflect cause-effect relationships. Since the assumption of independence of observations, which is one of the assumptions of the classical linear regression method, is broken for data with clustered structure, Hierarchical Linear Models are applied to such data. HLM was applied with a level-3 dataset of blood parameters of people in different patients, in different hospitals and in different cities. For this application, HLM for Windows 6.08 Student Version was used and 4 different models were created and when these models were compared with each other, it was seen that Model-2 had a better fit. As a result, ignoring the clustered effect when analyzing data with a clustered structure may lead to erroneous inferences.

Key words: *Hierarchical Linear Models, Multilevel Models, Clustered Data*

Outlier Detection for Dairy Production in European Countries via DBSCAN Algorithm

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Abstract

An outlier can be defined in the data science literature as a value that is abnormal, deviant or incompatible with the data set to which it belongs. Outliers can greatly affect the prediction performance of machine learning techniques, so it is important to detect and evaluate them appropriately. DBSCAN (Density-Based Spatial Clustering of Noisy Applications) is a commonly used outlier detection technique. DBSCAN is a clustering algorithm that brings together points that are close to each other, while identifying points that are not close to any cluster as outliers. In this study, we aim to detect to outlier countries for dairy production in European areas by using DBSCAN algorithm. The dataset obtained from EUROSTAT consist of amount of dairy production in 35 European countries from 2016 to 2021 years. The results of the analysis indicate that a structure with 2 clusters and 2 outliers for the values Eps=1 and MinPts=5 is obtained. While 28 countries in Cluster 1 and 5 countries in Cluster 2, Germany and France remained outside the cluster as outliers. Turkey, Poland, Italy, England and Netherlands are located in Cluster 2. The rest of European countries are in cluster 1. In terms of the amount of milk picked up from farms per year, the average for Cluster 1 is 1.914,50 and the average for Cluster 2 is 12.574,83. The outliers for Germany and France are 32.222,83 and 24.590,67, respectively.

Key words: *Density-based clustering, Outlier analysis, Data mining, Dairy yield*

INTRODUCTION

An outlier can be defined in the data science literature as a value that is abnormal, deviant or incompatible with the data set to which it belongs (Sikder & Batarseh, 2023). To detect an outlier, we can use statistical detection methods and clustering analysis techniques (Thang & Kim, 2011). There are many statistical methods and tests for outlier detection such as Dixon, Rosner, Discordance, Grubbs and Walsh tests. In addition, outliers can be also identified using graphical methods such as Box-plot, Q–Q plot and run sequence graph (Alpar, 2017; Singh & Upadhyaya, 2012).

The statistical detection methods first determine the probability distribution function of the data set and then test whether any data point is generated by the model. These statistical methods are generally model-based techniques that early find the distribution of the data later assess the fit between the data sample and the model. If the probability of the data point being generated by this model is low, the data point is accepted as an outlier (Das & Nayak, 2013).

In addition, graphical methods such as Box-plot are widely used to detect outliers. Box-plots characterize a sample using the quantiles and the interquartile range (IQR=Q3 – Q1), which covers the central 50% of the data (Krzywinski & Altman, 2014). We can consider that a data point is an outlier if it is lower than $Q1 - 1.5 \times IQR$ or higher than $Q3 + 1.5 \times IQR$ (Figure 1).

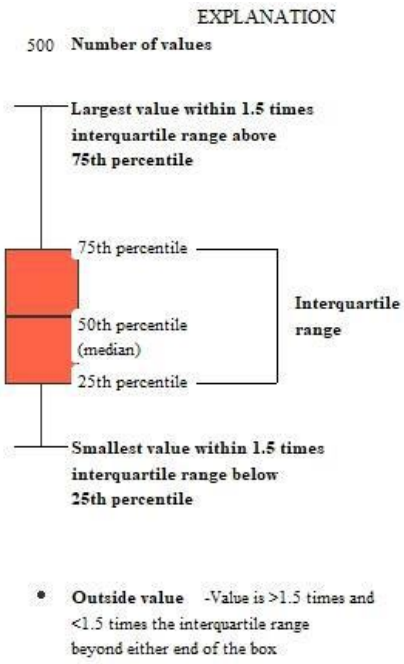

Figure 1. Detection of outliers with box plot graph

Nowadays, clustering analysis techniques, including density-based clustering (e.g. DBSCAN) and distance-based clustering (e.g. *k*-means), are often used for outlier analysis (Charu, 2019). In density-based clustering techniques, a data point is considered an outlier if it is located in an area of low object density, i.e. isolated from the rest of the data. Objects are defined as outliers by calculating the inverse of the surrounding density (Liu et al., 2019).

The aim of this study is to detect outlier countries for dairy production in European areas by using DBSCAN (Density-Based Spatial Clustering of Applications with Noise), one of the density-based clustering algorithms.

MATERIALS AND METHODS

Material

The dataset obtained from EUROSTAT consist of amount of dairy production in 35 European countries from 2016 to 2021 years. The European countries included in the study are Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom. Countries with missing values (Iceland, Liechtenstein) and those presented by region rather than by country are excluded from the study. Dairy production is given in 1000 litres per year. Data includes cow's milk collected on farms by approved dairies (EUROSTAT, 2023).

Methods

Statistical Analysis

All statistical analyses are conducted with *R* statistical language (version 4.2.1; The *R* Foundation for Statistical Computing, Vienna, Austria; https://www.r-project.org). The "*dbscan*", "*fpc*", "*dplyr*" and

"*ggplot2*" packages are used to obtain the results. One of the density-based techniques, the DBSCAN algorithm is used for detecting outlier countries for dairy production in European areas. Cluster structures are examined by determining *Eps* (ε-radius) and *MinPts* (minimum number of points) values. Silhouette analysis is performed to determine the separation distance between the clusters obtained. The silhouette coefficient takes a value in the range [-1, 1]. The closer this value is to +1, the greater the distance between neighbouring clusters. All data are standardised prior to analysis.

Density-based Cluster Techniques

Cluster analysis is a technique that classifies similar observations into a set of clusters by considering the observation values of the variables (Sinharay, 2010). There are several approaches for clustering analysis, including density-based clustering, distance-based clustering, hierarchical clustering, and model-based clustering. Density-based clustering techniques are often used for outlier detection. In density-based clustering, a data point is considered as an outlier if it is found in an area of low data density, i.e., it is isolated, and there are not many surrounding data points (Altunkaynak, 2019). Data points are identified as outliers by calculating the inverse of the surrounding density. The most commonly used density-based techniques are DBSCAN, OPTICS (Ordering Points to Identify the Clustering Structure) and DENCLUE (Density-based Clustering Algorithm). The DBSCAN algorithm has several advantages over other algorithms, such as the ability to detect groups of irregular shapes and sizes, resistance to outliers, and relatively low computational complexity (Nowak-Brzezińska & Xięski, 2017). DBSCAN algorithm makes clustering by taking into account the distances between points and the densities of data points at a certain distance (Ester, Kriegel, Sander, & Xu, 1996). In the DBSCAN algorithm, a point *p* is selected, and the input parameters are the proximity radius *Eps* (ε-radius) and the *MinPts* value, which specifies how many member neighbours to consider. In this algorithm, if there are as many or more objects as the *MinPts* value within the determined *Eps* boundaries, it is called the core point, otherwise another *p*-point is selected, and the same process is repeated. The process is terminated when there is no more data entry to any cluster. If there is still data not assigned to any cluster after the assignment process is finished, it is considered an outlier (Ester & Wittmann, 1998). One of the main challenges in using this algorithm is determining the proximity radius. If too small a value is selected, many data points that are not outliers (around a dense region) will have low density and will be determined as outliers. Conversely, if the radius value is chosen too large, many points will not be regarded as outliers as they have very similar densities to non-outliers (Lara, Lizcano, Rampérez, & Soriano, 2020).

RESULTS

In the study, the data are analysed with the DBSCAN method. The analysis continued with *Eps* = 1 and *MinPts* = 5 to determine the ideal cluster structure and to detect outliers. When the *Eps* graph in Figure 2 is analysed, it is determined that the Eps value made a break around 1. Therefore, the Eps value is set as 1 and the results are evaluated. When the silhouette graph in Figure 3 is analysed, the silhouette coefficient is obtained as 0.75.

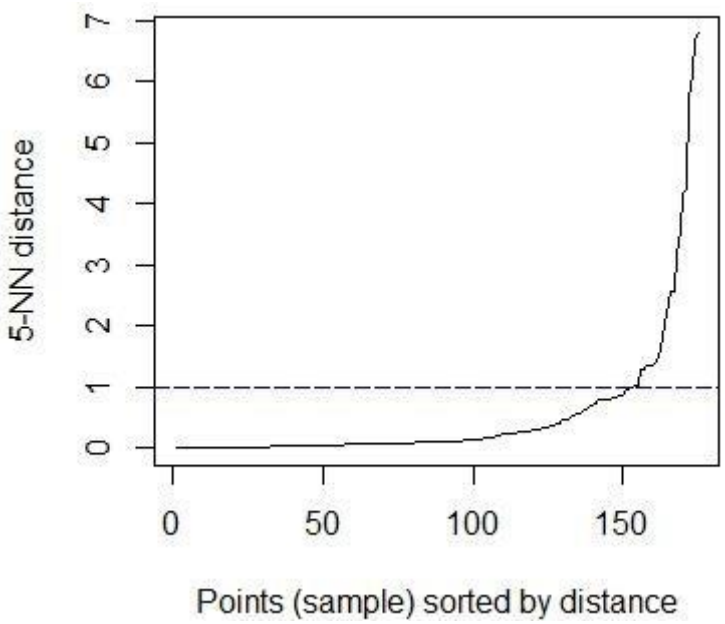

Figure 2. 5-nearest neighbour distances for dataset

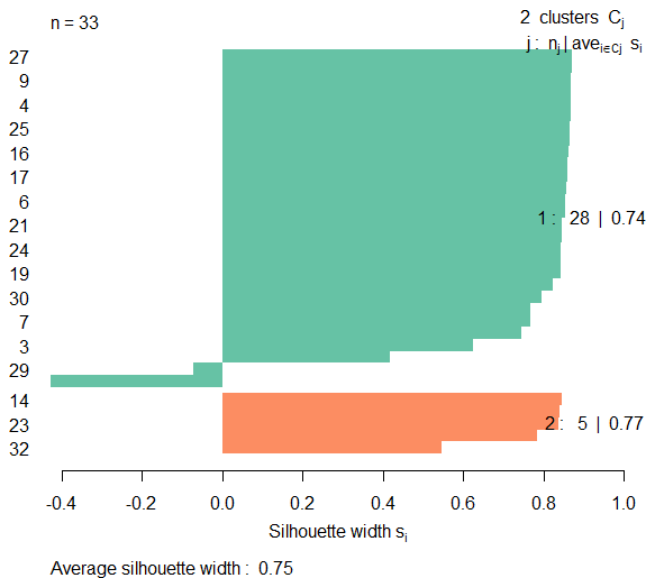

Figure 3. Demonstration of cluster structures using silhouette analysis

As a result of the statistical analysis, a structure with 2 clusters and 2 outliers is determined for the *Eps* = 1 and *MinPts* = 5 values. There are 28 countries in Cluster 1 and 5 countries in Cluster 2. Figure 4 shows that Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Montenegro, North Macedonia, Norway, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden and Switzerland form Cluster 1, and Italy, Poland, Turkey, the United Kingdom and, the Netherlands form Cluster 2. France and Germany are identified as outliers and are not included in any group.

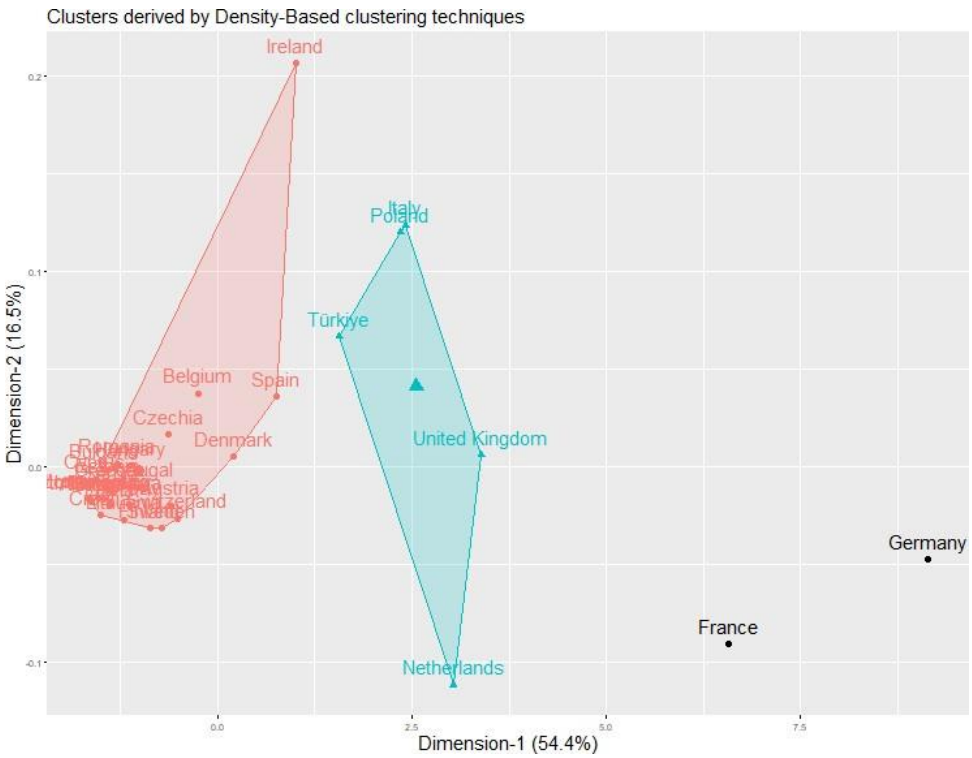

Figure 4. Cluster structures and outliers obtained by the DBSCAN algorithm

The average amount of cow's milk collected from farms in Cluster 1 countries in 2016 - 2021 (1000 lt) is 1.914,50 and for Cluster 2 it is 12.574,83 (1000 lt). Analysing the outliers for Germany and France, the average for Germany is 32.222,83 and for France 24.590,67.

DISCUSSION AND CONCLUSION

Bilgin and Çamurcu compared the cluster structures obtained with DBSCAN and OPTICS, which are density-based clustering methods, and the K-Means clustering method using synthetic database. As a result of the study, DBSCAN and OPTICS algorithms were found to be more successful in detecting outlier data compared to the K–Means algorithm. In this study, Germany and France were identified as outliers by using the DBSCAN algorithm for outlier detection algorithm. In 2016 – 2021, the average amount of cow milk collected from farms is significantly higher than the cluster averages for these two countries (Bilgin & Çamurcu, 2005).

Outlier analysis is extremely important in statistics in terms of test assumptions and reliability of results. Density-based clustering is the most widely used clustering technique with the best results in outlier detection (Akın, 2008). As a result of the study, Germany and France are identified as outliers and milk production in these countries is found to be high compared to other European countries. By expanding the scope of the study and increasing the number of data, the differences and similarities between the data groups can be better identified. In order to evaluate the consistency of the results, it is recommended to perform performance comparisons using other density-based clustering techniques on large data structures. The study serves as an example of the use of data mining methods in the detection of outliers in the field of veterinary medicine and contributes to the literature in this field.

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Classification of Death Cases in Turkey between 2009 and 2017 by Cities Using K-Means Clustering Method

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Abstract

Death can be defined as the destroying of human physiological and mental functions. Knowing the causes of death provides information on many issues, including health systems, levels of development and the epidemiological status of diseases. In this study, cluster analysis is performed by using data from the TUIK database for the years 2009-2017, including the causes of death for 81 cities. In the study, clustering analysis, a data mining method, is aimed to group the cities according to their similarities by considering the causes of death. For this purpose, the K-means clustering technique is used. This technique is one of the non-hierarchical clustering techniques. Elbow method is used to determine the optimum number of clusters. As a result of the analysis, 81 cities formed a structure with 3 clusters. There are 66 cities in Cluster 1, 14 cities in Cluster 2 and 1 city in Cluster 3. Istanbul creates a single cluster separately from other cities. 14 cities including large cities such as Konya, Adana, Izmir, Bursa, Antalya, and Ankara are located in Cluster 2. The remaining 66 cities are created Cluster 1 with the lowest number of deaths. When analysing the number of causes of death by cluster, the highest number of deaths for all causes occurred in cluster 3. Then deaths occur in Cluster 2 and least in Cluster 1. Top 3 causes of death in Turkey are diseases of the circulatory system, benign and malignant tumours and diseases of the respiratory system. In order to generalise of the results, it is recommended that studies are carried out using other hierarchical and non-hierarchical clustering techniques and the inclusion of different variables.

Key words: *K – Means, Data mining, Causes of death*

INTRODUCTION

Death in general means that the body is deprived of its physical and cognitive functions (Özer, 2017). In the field of health, the collection and statistical analysis of mortality rates is an important indicator for determining the level of health of a society (Bolat & Lorcu, 2009). The determination of the number of deaths provides information on the level of the health care systems in the countries and on the areas in which there are deficiencies. It also provides information on the main causes of death and the factors which have an impact on the structure of the population. In underdeveloped countries, mortality rates among young people are high and life expectancy is low compared to developed countries (Tepetaş, Arslantaş, & Ünsal, 2021).

The determination of mortality rates provides information about the functioning of the health system of countries. It also emerges as an important factor in countries health planning. Knowledge of diseases that cause death is important for the development of preventive and therapeutic services. It also enables the development of regional health policies by identifying which types of disease are most prevalent in which regions. In developed countries, these statistics are collected and shared with the World Health Organization (WHO) (Akturan, Gümüş, Ömer, Balandız, & Erenler, 2019).

Causes of death can be due to a variety of causes, such as diseases of the respiratory system, the circulatory system, the nervous system and the endocrine system When analysis the causes of death in Turkey between 2009 and 2016, diseases of the circulatory system are the most common cause of death. Tumours come second and respiratory diseases third (Yalçın & Kaan, 2019). The aim of the study is to group cities in Turkey according to their similarity in terms of the number of deaths by means of the K-Means clustering method.

MATERIALS AND METHODS

Material

The study used the number of deaths due to diseases of the respiratory system, the nervous system, the endocrine system, the tumour system, the circulatory system and injuries in 81 cities in Turkey for the years 2009 – 2017. Data are obtained from the cause of death statistics in the TUIK database (TÜİK, 2023). The study population consisted of 81 cities and no city is excluded (Table 1).

Table 1. Data used in the study

Year	Region	Cause of Death
2009 – 2017	All Cities (Turkey)	Circulatory system diseases Respiratory system diseases Tumours Nervous system diseases Endocrine system diseases Injuries and Poisoning Other causes

Methods

Statistical Analysis

All statistical analyses are performed with R statistical language (version 4.2.1; The R Foundation for Statistical Computing, Vienna, Austria; https://www.r-project.org). The "readxl", "factoextra", "ggfortify", "clusterR" and "ggplot2" packages are used to obtain the results. The K-Means clustering technique, one of the non-hierarchical clustering analysis techniques, is used in the study. Elbow method is used to determine the optimum number of clusters. The Euclidean distance, which is frequently used in studies, is used to determine the distance matrix (Akın, 2008). Data on the number of deaths are standardised and included in the analysis.

Cluster Analysis

Clustering is the process of dividing irregular data into homogeneous groups by similarity (Akın, 2008). Clustering techniques are subdivided into hierarchical, partitioned, density-based and model-based clustering techniques. Hierarchical clustering techniques are also divided into two according to the direction of the merger: aggregation and partitioning techniques (Ferreira & Hitchcock, 2009; Murtagh & Legendre, 2014). Hierarchical clustering techniques are determined the number of clusters by examining the dendrogram graph. In other methods, the number of clusters is determined by optimal cluster number determination techniques. Clustering methods use distance matrices such as Euclidean, Minkowski and Canberra to determine the distance between objects. The equation for Euclidean distance is given below (Abdulhafedh, 2021; Altunkaynak, 2019).

$$d_{euc}(\mathrm{x}, \mathrm{y}) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \quad (1)$$

K-means is one of the partitioned clustering methods. Other partitioned clustering methods are K-medoids and CLARANS (Clustering Large Applications based on Randomized Search). K-means tries to classify observations into clusters that are separated from each other. Thus, observations within the same cluster can form a homogenous group. The k-means algorithm starts with a randomly selected cluster centre for each cluster and then performs iterative calculations to optimise the positions of the centres (Kassambara, 2017).

RESULTS

In this study, the number of deaths according to their causes for the years 2009 – 2017 are analysed with the K-Means technique. When the Elbow method is applied, it is seen in Figure 1 that the optimum number of clusters is 3, which is the breaking point.

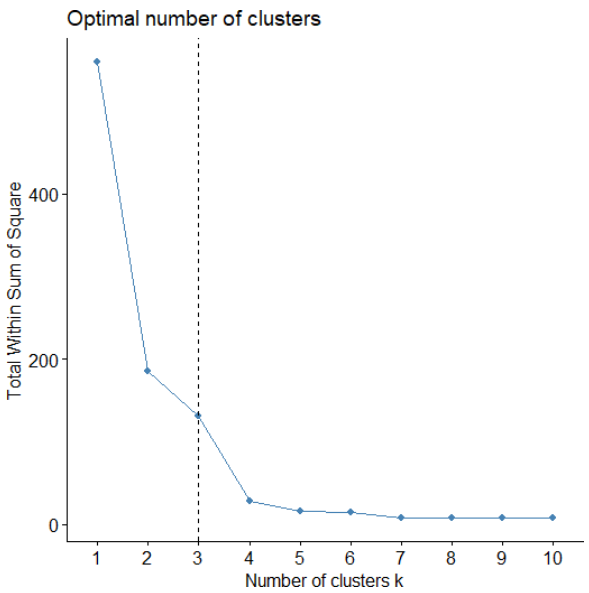

Figure 1. Determination of the optimal number of clusters using the Elbow

After the number of clusters is determined as 3, the structure in Figure 2 is obtained with the K-Means clustering technique for the 3-cluster structure.

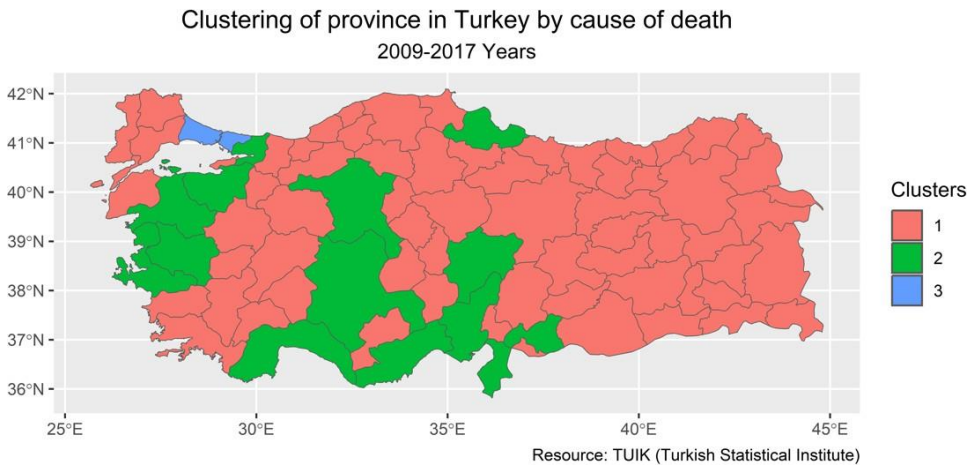

Figure 2. Cluster structure obtained with K-Means clustering technique

When the cluster structure obtained by the K–Means technique is examined, it is seen that there is a 3-dimensional structure and 66, 14 and 1 cities in dimensions. Istanbul, the most developed city in Turkey, is not in the same cluster as any other city.

Table 2. Classification of cities according to the cluster they are located in

Clusters	Cities
1	Adıyaman, Afyonkarahisar, Ağrı, Amasya, Artvin, Aydın, Bilecik, Bingöl, Bitlis, Bolu, Burdur, Çanakkale, Çankırı, Çorum, Denizli, Diyarbakır, Edirne, Elazığ, Erzincan, Erzurum, Eskişehir, Giresun, Gümüşhane, Hakkari, Isparta, Kars, Kastamonu, Kırklareli, Kırşehir, Kütahya, Malatya, Kahramanmaraş, Mardin, Muğla, Muş, Nevşehir, Niğde, Ordu, Rize, Sakarya, Siirt, Sinop, Sivas, Tekirdağ, Tokat, Trabzon, Tunceli, Şanlıurfa, Uşak, Van, Yozgat, Zonguldak, Aksaray, Bayburt, Karaman, Kırıkkale, Batman, Şırnak, Bartın, Ardahan, Iğdır, Yalova, Karabük, Kilis, Osmaniye, Düzce
2	Adana, Antalya, Gaziantep, Balıkesir, Bursa, Hatay, Mersin, Kayseri, Kocaeli, Konya, Manisa, Samsun, Ankara, Izmir
3	Istanbul

Table 2 shows in detail which cities are in the same cluster with each other in terms of the number of deaths. Large cities such as Konya, Bursa, Ankara, Izmir, Adana and Kayseri are in Cluster 2.

Table 3. Average number of cases in clusters by cause of death

Cause of Death	Cluster 1 (*n*=66)	Cluster 2 (*n*=14)	Cluster 3 (*n*=1)
Circulatory System	8634	35765	178281
Tumor	4011	18900	122711
Respiratory System	2303	9069	49410
Nerve	833	3965	24247
Endocrine	1172	5046	26404
Injury and Poisoning	939	4538	18007
Other	3093	13084	78111

Data are expressed as mean.

The averages for the causes of death and cluster structures are given in Table 3. When the arithmetic averages of the cluster structures according to the causes of death are examined, it is seen that the ranking of the circulatory system, respiratory system, nervous system, endocrine system, tumour, external injury and poisoning and the number of deaths due to other causes is in the form of Cluster 3 > Cluster 2 > Cluster 1. Istanbul has formed a cluster of its own, with a population of around 15 million. When the average number of deaths in Istanbul is examined, it is seen that the highest number of deaths occurred from circulatory system diseases with 178.281 people, followed by benign and malignant tumours with 122.711 people.

DISCUSSION AND CONCLUSION

When similar studies were examined, Emik and Önal carried out an epidemiological analysis of the deaths, they found that the majority of deaths in Turkey are caused by diseases of the circulatory system, followed by tumours. These results support the results of our study (Emik & Önal, 2019). According to a WHO report, 3 million people die each year from respiratory diseases. However, respiratory diseases are the third leading cause of death worldwide. According to the results of our study, diseases of the respiratory system are in third place in terms of the number of deaths in Turkey (Yalçın & Kaan, 2019).

Knowledge of the causes of death is essential for the evaluation of the development of countries health care systems and for the improvement of the systems in place (Tepetaş et al., 2021). As a result of the study, 81 cities formed a 3-cluster structure. The results show that large cities tend to be in the same cluster. 66 cities are in the same cluster and are found to be similar in terms of the number of deaths. The circulatory system is the most common cause of death in cities such as Konya, Bursa, Ankara, İzmir, Adana and Kayseri, where agriculture and industry are developed, followed by tumours. Industrial wastes are thought to be effective in these results (Dündar, Altundağ, Kaygaldurak, Şar, & Acar, 2012). In terms of all causes of death, Istanbul is found to have the most deaths. In order to generalise of the results, it is recommended that studies are carried out using other hierarchical and non-hierarchical clustering techniques and the inclusion of different variables.

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Investigating Relations Between Milk Yield and Fertility Parameters with Multidimensional Scaling Analysis

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Abstract

The study focused on the relationship between lactation length, 305-day milk yield, actual milk yield and peak remaining days from milk yield characteristics, and service period, dry period, insemination per conception and calving interval from fertility traits, as well as the influencing factors such as calving age, lactation number, birth season, and birth year. When the MDS results were examined, it was discovered that all the traits had close Euclidean distances from each other, save for the birth season and birth year. As a result of MDS analysis, R^2 and Stress Coefficient were calculated as 88.4% and 0.099, respectively. Consequently, the selection direction was tried to be identified by determining the milk yield and fertility traits and the relationship between these traits and the influencing factors through the MDS analysis and it was concluded that the MDS method could be employed in this field.

Keywords: *305-day milk yield, multidimensional scaling analysis, prediction, dairy cows*

INTRODUCTION

The milk yield and fertility traits are the most significant topics that researchers studying on animal improvement have focused on in recent years (Berry *et al*., 2007; Khalid *et al.,* 2007; Kuthu *et al.,* 2007; Genç and Soysal, 2018, 2019; Öztürk *et al.,* 2021). Therefore, the studies in the literature have aimed to improve milk and fertility parameters in future generations and to identify the influencing factors and to identify the environmental and genetic factors that affect milk yield and fertility traits in livestock (dairy, cattle, sheep, goat, buffalo, etc.), particularly dairy cattle, and to determine the relationship between them (Van Vleck and Henderson, 1961; Ashmawy *et al.,* 1985; Mendes and Akkartal 2009; Genç and Mendeş, 2021). The proper implementation of these works depends on keeping the yield records and pedigree regularly. Many environmental factors affect milk yield and fertility traits. The factors, such as age, lactation number, birth season, calving year, calving month, calving age, and farm size are the most significant ones. The preceding environmental factors directly or indirectly affect the milk yield traits, such as overall milk yield, 305-day milk yield, peak milk yield, and lactation length, as well as fertility traits, such as service period, dry period, and insemination per conception (Olori *et al*., 1999; De'ath and Katharina, 2000; David and Paul, 2004; Kocak *et al*., 2007; Zheng *et al*., 2009; Genç and Mendeş, 2021). In recent years, several mathematical and statistical methods have been frequently utilized to identify these effects. The identification of the milk yield and fertility traits, as well as the influencing factors with these methods, will improve the efficiency in breeding improvement, and it will be utilized in later studies. Therefore, the Multidimensional Scaling Method (MDS) has been used frequently in recent years (Kruskal and Wish, 1978; Başpınar *et al*., 2000; Borg and Groenen, 2005).

MDS is one of the statistical methods that is used to determine the correlation between the variables by utilizing the distances in cases where the correlation between the traits is not known exactly but the distances between them can be calculated (Özdamar, 2004). MDS can help to determine the relationship between variables represented in a k-dimensional space by displaying them very close to their original positions in a less dimensional (two, three, …) conceptual space. When these features of MDS are evaluated, identifying the distances of the milk yield and fertility traits, as well as the influencing factors,

will constitute the framework of the study (Kruskal and Wish, 1978; Başpınar *et al*., 2000; Yiğit and Mendeş, 2018; Genç and Mendeş, 2021).

The relationship between lactation length, 305-day milk yield, actual milk yield, peak milk yield and peak remaining days from milk yield characteristics, and service period, drying period, insemination per conception, and calving interval from fertility traits, as well as the influencing factors such as calving age, lactation number, birth season, and birth year were determined through MDS method. The main purpose of this study is to investigate the relationships among the milk yield and fertility parameters by using multidimensional scaling technique".

MATERIALS AND METHODS

The material of the study contained data from 2936 lactation records of Holstein dairy cattle raised between 2011 and 2019 on a private enterprise, a member of the Cattle Breeders' Association of Turkey. These records consisted of the variables of lactation length, 305-day milk yield, actual milk yield, peak milk yield and peak remaining days from milk yield characteristics, service period, drying period, insemination per conception and calving interval from fertility traits, as well as the variables of calving age, lactation number, birth season and birth year.

While preparing the data, animals whose numbers were less than 100 in the groups of year and lactation number, as well as animals that were separated from the herd due to the reasons such as stillbirth, abortion, disease, or disability were excluded from the evaluation. Animals with unknown maternal and paternal ear tags were also excluded. Animals with a lactation length longer than 550 days and less than 220 days, as well as those with a calving age less than 20 months for the first lactation and greater than 40 months, as well as those remaining outside by adding 12 months to the previous lower limit and 14 months to the upper limit in successive lactations were excluded from the analysis. However, those with calving intervals less than 310 days and more than 550 days were not utilized as an observation value (Kumlu and Akman, 1999).

The MDS aims to obtain a graphical result by analyzing the distances and differences between n points in a p-dimensional (p=2, 3, …) space, as well as their proximity to each other and positions in Euclidean space. This is utilized to gain a better understanding of the dimensions of the conceptual space and data, as well as to generate new knowledge. The MDS method may analyze data without requiring the relevant distribution assumption. It enables the determination of the configuration distances (configuration distances, map distances, d_{ij}) that would represent the distance between the variables (data distances, δ_{ij}) with the least error through one of the regression methods (linear, polynomial, monotonic). The original and geometric display distances between N objects are calculated. These distances are processed as configuration (configuration coordinate system) and original distances and are displayed in the coordinate system. The stress measure refers to the metric between the original and configuration distances (Kruskal and Wish, 1978; Breiman *et al*., 1984; Başpınar *et al*., 2000; Bevilacqua *et al*., 2003; David and Paul, 2004; Özdamar, 2004; Camdeviren *et al*., 2005; Mendes and Akkartal, 2009; Karabag *et al*., 2010; Yiğit and Mendeş, 2018). The distances are calculated as follows:

$$d_{ij} = a + b\delta_{ij} + e$$

The SPSS software was utilized in the study to identify the factors that affect the milk yield and fertility traits by the MDS method (Statistical…, 2008).

RESULTS AND DISCUSSION

Table 1 shows descriptive statistics. According to these findings, 305-day milk yield and Actual milk yield were found above the average herds when milk yield traits were considered. When the fertility traits were

reviewed, they are found to be in accord with the average herd fertility parameters. When these results are examined, it appears that MDS, one of the graphical methods to be utilized on these data, can operate with sufficient reliability.

The descriptive statistics of independent and dependent variables are given in Table 1. The mean and standard error of lactation length, 305-day milk yield, actual milk yield, peak remaining day, peak milk yield and drying period of the cows were obtained as 357.6±1.33, 9317.6±35.10, 10450±51.70, 81.8±0.85, 40.5±0.14 and 55.4±0.50 respectively. And also, insemination per conp., service period, calving age and calving interval were calculated as 2.6±0.026, 147.8±1.3, 37.6±0.26 and 385.4±2.22 respectively.

Table 1. Descriptive statistics for fertility and milk yield parameters

		n	$\bar{X} \pm S_{\bar{X}}$	CV (%)	Minimum	Maximum
Mil yield parameters	Lactation length (day)	2936	357.6±1.33	20.1	220	550
	305-day milk yield (kg)	2936	9317.6±35.10	20.4	2394	15176
	Actual milk yield (kg)	2936	10450±51.70	26.8	2209	21679
	Peak remaining day	2879	81.8±0.85	55.9	2.00	240.0
	Peak milk yield (kg)	2924	40.5±0.14	18.7	20.60	66.62
	Drying period (day)	2225	55.4±0.50	41.8	20.00	101.0
Fertility yield parameters	Insemination per conp.	2498	2.6±0.026	50.6	1.00	5.0
	Service period (day)	2787	147.8±1.3	47.8	33.00	120.0
	Calving age (month)	2936	37.6±0.26	37.8	20.40	39.6
	Calving interval (day)	475	385.4±2.22	12.5	310.00	550.0

$\bar{X} \pm S_{\bar{X}}$:Mean±SE Mean; CV% :coefficient of variation

MDS analysis was performed to investigate the relations between milk yield parameters and some fertility parameters (Figure 1. and Table 2.). Two different goodness-of-fit criteria namely: R^2 and stress coefficient have been used to determine the suitability of MDS technique for investigating the relations investigate the relations between milk yield parameters and some fertility parameters (Kruskal and Wish, 1978; Başpınar *et al*., 2000; Yiğit and Mendeş, 2018). R^2 and stress coefficient values (88.4% and 0.099) indicated that MDS technique was one of a good choice in evaluating interested relations (Berry *et al*., 2007; Mendes and Akkartal, 2009).

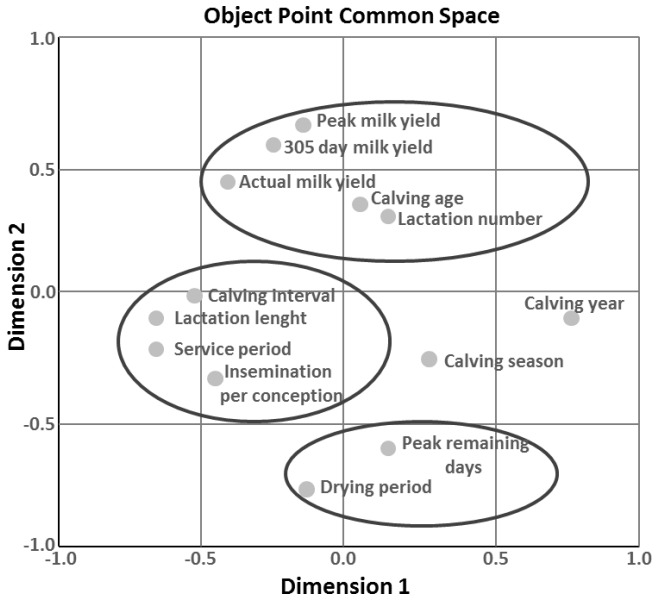

Figure 1. MDS map for investigating the relation between some milk yield and fertility parameters

MDS results are presented in Figure 1. According to the MDS results, these parameters have been divided into three groups. As it can be seen from the Figure 1, peak milk yield, 305-day milk yield, actual milk yield, calving age and lactation number are placed in the same group that means these parameters are related each other. And there is a positive relationship between these parameters. Likewise, the calving interval, lactation length, service period and insemination per conception are in the same group. Therefore, these parameters are related or correlated. The peak remaining day and drying period have been placed in another group. On the other hand, the calving year and calving season are in different places (Kruskal and Wish, 1978; Başpınar *et al*., 2000; Yiğit and Mendeş, 2018).

Table 2. MDS final coordinates for milk and fertility yield

Final Coordinates		
	Dimension	
	1	2
Lactation length	-0.580	-0.139
305-day milk yield	0.583	-0.195
Actual milk yield	0.437	-0.312
Peak remaining days	0.527	**-0.659**
Peak milk yield	0.642	-0.121
Service period	-0.583	-0.198
Dry period	-0.071	**-0.764**
Insemination per conception	-0.481	-0.395
Calving interval	-0.486	0.069
Calving age (month)	0.516	0.422
Lactation number	0.603	0.413
Calving season	0.306	-0.284
Calving year	0.877	-0.127

MDS final coordinates for milk and fertility yield were given in Table 2. As it can be seen from the Table 2, dimensions 1 for milk yield parameters were obtained as 305-day milk yield and peak milk yield; 0.583 and 0.642 respectively. And also, fertility yield parameters were calculated as lactation number and calving year; 0.603 and 0.877 respectively.

The results obtained by MDS analysis have shown us which milk or fertility yield parameters can be used primarily in zootechnical practice. According to these results, peak remaining days for from milk yield parameters and the dry period from the fertility parameters should be used first.

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Selection of Normalization Method for Microarray Data with Different Types

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Abstract

Microarray is a technology that allows simultaneous measurement of the expression levels and interactions of thousands of genes in cells, tissues, and organs. Microarray data may contain variations due to experimental conditions such as sample preparation, labeling, hybridization, screening, etc. or due to biological reasons. Therefore, normalization of microarray data before analysis is an important factor for the analysis results. Normalization minimizes technical and systematic differences, allowing biological differences between genes and sequences to be seen more clearly. Many normalization methods are used in microarray data, but there is no conclusive evidence on which method is more appropriate. Accordingly, in our study, synthetic microarray data were generated in the Madsim package of the R program with different sample sizes (10, 40, 200) and gene numbers (100, 1,000, 10,000) as two independent groups. The data initially showed a homogeneous distribution of up- and down-regulated genes with low variation and noise, then the noise was increased, the number of up-regulated genes was increased and finally the coefficient of variation was increased. The data with these different structures were normalized with Cyclic Loess, Quantile and Median methods and analyzed with the Multilayer Perceptron method, which is one of the deep learning models and consists of 3 hidden layers, and the F1 score values obtained as a result of the analysis were compared. It was observed that the normalization methods are not different from the raw data and there is no difference between the methods in case of high noise in the microarray data and the number of genes regulation up and down is different. However, the best results in classification were obtained when the number of genes was 1,000. As the coefficient of variation increased and the number of gene was 100, the Quantile normalization method was initially found to be less successful compared to other methods and raw data. However, when the number of genes increased to 1,000 and beyond, it became apparent that Quantile normalization yielded highly successful results in comparison to other methods and raw data. Compared to other types of research, microarray experiments are usually designs with a small number of samples and a large number of genes. However, when we examined microarray datasets, it was seen that keeping the number of genes at a lower level, increasing the sample size, and applying the Quantile normalization method gave more successful results in advanced analysis methods such as deep learning.

Key words: *Microarray, Normalization, F1 Score*

INTRODUCTION

Important advances have been made in health research due to developing technologies. The rapid progress in genomic technologies has led to a frequent utilization of genetic analysis in clinical applications and research. Especially with the advances in computer technology, genetic testing methods have become widely accessible and applicable even in small-scale laboratories (Collins and Fink, 1995; Durmaz et al., 2015).

Although initial gene sequencing involved only single-gene analysis, modern technological advancements have made it possible to examine all genes within an organism simultaneously. Microarray technology, for example, allows for the measurement of thousands of gene expressions simultaneously within tissues, organs, or cells (Dufva, 2009; Tamazian et al., 2016). However, microarray experiments require the use of various data mining tools to investigate relationships between genes or to reveal expression level patterns (Quackenbush, 2002). Thanks to both advances in technologies with high-scale data structure and developments in artificial intelligence, there has been an increase in the use of artificial neural networks, machine learning and deep learning models in microarray research. These statistical methods can be used to classify and predict microarray data.

The results obtained via microarray technology exhibit variations based on biological or experimental conditions. Common variations may appear even in repeated experiments. Therefore, direct comparisons and statistical models are not suitable for expression measurements derived from microarray technologies (Butte, 2002). To analyze microarray technology measurements, data must undergo normalization or regularization to eliminate sources of variation. The normalization process plays a pivotal role in the early stages of data analysis and heavily impacts subsequent analysis results. Numerous normalization methods exist for microarray data; however, it remains unclear which method best performs (Park et al., 2003).

The aim of this study is to investigate the effect of different normalization methods on microarray data sets with different types, sample size and number of genes using deep learning.

MATERIAL AND METHODS

Material

The Generating of the Data

The R program Madsim package is used to generate synthetic microarray data (Dembélé, 2013). In this study, 4 different single colour microarray data sets were generated using this package. In the first data set, the coefficient of variation and noise were low and the ratios of up-regulated and down-regulated genes were equal, in the second type of data set we increased the noise ratio, in the third type of data set we increased the ratio of up-regulated genes in addition to the second data set, and in the fourth type of data set we increased the coefficient of variation in addition to all these. For each type of data set, sample size was created as two independent groups of 5:5, 20:20 and 100:100, and the number of genes was 100, 1,000 and 10,000. For each data type, we generated 1,000 different data sets with different sample sizes and gene counts.

Methods

There are several normalization methods utilized in microarray data, with the most widely used being Cyclic Loess, Median, and Quantile normalization. Each of these methods were applied separately to the created data sets and recorded. Additionally, the Multilayer Perceptron (MLP) model, which is one of the deep learning models, was applied to both the raw data without normalization and to the normalized data sets. Three hidden layers were implemented in the MLP, utilizing the ReLu activation function for the hidden layers and the Sigmoid function for binary classifications in the output layer. Binary crossentropy served as the loss function, and the activation function Adam was chosen with an epoch value of 100. Through 1,000 repetitions of each data set and a test rate of 0.40, the average F1 score values were obtained as a result of the MLP.

Cyclic Loess Normalization

Loess (Local Regression) normalization is a widely used method for correcting microarray data. In this method, a corrected signal intensity is calculated that corrects for differences between the signal intensity on each microarray chip and the signal intensity of other microarrays on the same chip. Loess normalization

helps to reduce the variation between microarray chips. Cyclic Loess Normalization is obtained by repeating Loess normalization. More specifically, the data is first subjected to Loess normalization, then repeated in a cyclic manner to obtain corrected data. These cycles help to normalize the data in a more stable way. The cyclic Loess steps can be listed as follows (Ballman et al., 2004; Boes and Neuhäuser, 2005)

(1) Select two arrays and create an MA plot of the data

(2) A smooth f (x) loess curve is constructed through the data, with the x-axis being the average probe expression value of the two arrays and the y-axis being the difference of one point for each spot.

(3) Subtract f (x)/2 from the first sequence and add f (x)/2 to the second sequence.

(4) This process is repeated until all different binary pairs have been compared.

The disadvantage of this method is the time required to normalize a set of data. The time grows exponentially as the number of arrays increases.

Median Normalization

Median normalization is another method used to make gene expression data in microarrays comparable. The median value of gene expression in each microarray chip is calculated. A scaling factor is then calculated to compensate for differences in these median values between microarray chips. This factor is used to appropriately correct the gene expression data of each microarray chip. Median normalization, where X_{np} is the log ratio of the nth gene on the pth slide, is calculated by the following formula.

$$X_{np} - \underset{p}{\text{median}}(X_{np})$$

The global median of the normalized log density ratios is equal to zero (Bolstad et al., 2003; Hao et al., 2016).

Quantile Normalization

Quantile normalization was first developed for microarray gene expression. In this normalization method, the distributions of each sample are forced to be the same. The average distribution obtained by averaging each quantile across samples is used as a reference. The application steps of quantile normalization are as follows (Bolstad et al., 2003; Hick, 2014).

(1) The gene expression values within each sample are ranked from smallest to largest.

(2) For each gene, the average values between rows are calculated.

(3) The raw data are replaced with the newly calculated average gene expression values.

(4) The obtained averages are placed back in the original order of the raw data.

Multilayer Perceptron

Multilayer Perceptron is a deep learning model belonging to the artificial neural network family. MLP is an artificial neural network with at least one input layer, at least one hidden layer and an output layer. Each layer contains a number of artificial neurons or perceptrons. The main function of an MLP is to learn and model complex relationships between features and use this learning process to make a prediction or classification.

Input Layer: The input layer takes the data into the network. Usually, each input attribute corresponds to a neuron, and these neurons produce an output by multiplying the incoming data by its weights and plugging it into the activation function.

Hidden Layers: Hidden layers allow the model to learn features in more complex ways. Each hidden layer takes the outputs from the previous layer, processes them with weights and puts them into an activation function. By using multiple hidden layers, the model can learn more complex functions.

Output Layer: The output layer produces the final prediction or classification of the model. Neurons in the output layer generate the results using the learned features of the model. The configuration of the output layer depends on the type of problem; for regression problems there may be a single neuron, while for classification problems there may be multi-class outputs.

Activation Functions: The outputs of the neurons in each layer are organized by an activation function. Functions such as sigmoid, ReLU (Rectified Linear Unit), or tanh are commonly used. These functions determine the output of the neurons and affect the learning capacity of the network.

Backpropagation: MLP usually learns from training data. The backpropagation algorithm calculates the error by comparing the network's predictions with the actual results and updates the weights to minimize this error. This process increases the network's ability to learn.

MLP is considered the basic unit of deep learning and can be used in a variety of tasks, especially suitable for classification and regression problems. As a subset of artificial neural networks, this model forms the basis of more complex neural network architectures (Arı and Berberler, 2017; Taud and Mas, 2018).

F1 Score

Several statistical ratios exist for assessing binary classifications and their matrices in machine learning and deep learning methods. Among these classification methods, one of the most favored is the F1 score, obtained by calculating the harmonic mean of precision and recall scores. While precision emphasizes false positives and recall focuses on false negatives, the F1 score considers both (Chicco and Jurman, 2020).

$$F1\ Score = 2 * \frac{Precision * Recall}{Precision + Recall}$$

RESULTS

The mean F1 scores obtained as a result of MLP are given with 95% confidence intervals. Table 1 shows the F1 score values for data sets with low variation, low noise, and equal up-down regularization ratios. When each sample size is examined within itself, it is seen that the F1 score values are calculated very close to each other between the data sets with and without normalization. At sample sizes of 10 and 200, the highest ratios were observed in the 1,000 gene case, while at sample sizes of 40, the highest ratios were observed in the 100 gene case.

Table 1. F1 Scores for the Data Set with Low Variation, Low Noise and Equal Up-Down Regulated Ratio

Normalization	**Gene size**		**100**			**1,000**			**10,000**	
Methods	**Sample size**	**10**	**40**	**200**	**10**	**40**	**200**	**10**	**40**	**200**
	Mean	0.669	0.749	0.745	0.710	0.710	0.852	0.374	0.423	0.343
None	95% Lower	0.650	0.737	0.729	0.688	0.687	0.833	0.353	0.403	0.324
	95% Upper	0.689	0.761	0.761	0.733	0.732	0.870	0.396	0.443	0.362
	Mean	0.667	0.737	0.752	0.719	0.712	0.847	0.374	0.415	0.365
Cyclic Loess	95% Lower	0.647	0.724	0.737	0.696	0.689	0.829	0.352	0.395	0.346
	95% Upper	0.687	0.750	0.767	0.741	0.734	0.865	0.396	0.435	0.384
	Mean	0.658	0.733	0.743	0.705	0.681	0.836	0.385	0.419	0.383
Quantile	95% Lower	0.639	0.720	0.727	0.683	0.659	0.817	0.362	0.399	0.364
	95% Upper	0.678	0.745	0.758	0.728	0.704	0.855	0.407	0.439	0.401
	Mean	0.668	0.739	0.753	0.684	0.707	0.854	0.395	0.406	0.377
Median	95% Lower	0.648	0.727	0.737	0.661	0.684	0.836	0.373	0.385	0.359
	95% Upper	0.688	0.752	0.769	0.708	0.729	0.872	0.417	0.426	0.396

Table 2 shows the F1 score values for data sets with low variation, high noise and equal up-down regularization ratios. When each sample size is examined within each sample size, it is seen that the F1 score values are calculated very close to each other between the data sets with and without normalization. In all sample sizes, the highest ratios were observed in the 1,000 gene case.

Table 2. F1 Scores for the Data Set with Low Variation, High Noise and Equal Up-Down Regulated Ratio

Normalization	**Gene size**		**100**			**1,000**			**10,000**	
Methods	**Sample size**	**10**	**40**	**200**	**10**	**40**	**200**	**10**	**40**	**200**
	Mean	0.534	0.610	0.682	0.716	0.713	0.908	0.497	0.414	0.350
None	95% Lower	0.515	0.599	0.671	0.700	0.696	0.895	0.473	0.393	0.332
	95% Upper	0.554	0.620	0.693	0.732	0.730	0.921	0.521	0.435	0.367
	Mean	0.539	0.610	0.685	0.700	0.702	0.895	0.433	0.382	0.402
Cyclic Loess	95% Lower	0.519	0.600	0.675	0.683	0.684	0.882	0.409	0.362	0.385
	95% Upper	0.558	0.621	0.696	0.718	0.720	0.909	0.458	0.402	0.419
	Mean	0.527	0.602	0.680	0.708	0.695	0.896	0.520	0.447	0.320
Quantile	95% Lower	0.508	0.592	0.670	0.690	0.678	0.883	0.496	0.428	0.303
	95% Upper	0.547	0.613	0.690	0.725	0.712	0.910	0.544	0.466	0.338
	Mean	0.518	0.614	0.677	0.713	0.709	0.906	0.463	0.403	0.383
Median	95% Lower	0.499	0.603	0.666	0.696	0.692	0.893	0.440	0.382	0.365
	95% Upper	0.537	0.624	0.689	0.731	0.726	0.919	0.486	0.423	0.400

Table 3 shows the F1 score values for the data sets with low variation, high noise and high up-regulation rates. When each sample size is examined within each sample size, it is seen that the F1 score values are calculated very close to each other between the data sets with and without normalization. In all sample sizes, the highest ratios were observed in the 1,000 gene case.

Table 3. F1 Scores for the Data Set with Low Variation, High Noise and High Down Regulated Ratio

Normalization	**Gene size**	**100**			**1,000**			**10,000**		
Methods	**Sample size**	**10**	**40**	**200**	**10**	**40**	**200**	**10**	**40**	**200**
	Mean	0.510	0.630	0.675	0.710	0.742	0.917	0.500	0.378	0.373
None	95% Lower	0.490	0.619	0.664	0.692	0.726	0.904	0.477	0.357	0.354
	95% Upper	0.530	0.640	0.685	0.728	0.758	0.930	0.523	0.400	0.392
	Mean	0.519	0.618	0.664	0.731	0.733	0.919	0.484	0.412	0.357
Cyclic Loess	95% Lower	0.499	0.607	0.653	0.715	0.716	0.908	0.461	0.391	0.339
	95% Upper	0.538	0.629	0.675	0.747	0.749	0.931	0.507	0.434	0.375
	Mean	0.516	0.618	0.665	0.712	0.726	0.899	0.395	0.418	0.383
Quantile	95% Lower	0.497	0.608	0.654	0.694	0.710	0.885	0.371	0.398	0.364
	95% Upper	0.535	0.628	0.676	0.729	0.743	0.914	0.419	0.439	0.401
	Mean	0.527	0.617	0.674	0.726	0.713	0.920	0.451	0.418	0.377
Median	95% Lower	0.508	0.606	0.662	0.710	0.696	0.908	0.428	0.396	0.359
	95% Upper	0.547	0.627	0.685	0.742	0.731	0.932	0.473	0.439	0.396

Table 4 shows the F1 score values for data sets with high variation, high noise and high up-regulation rates. In the case of 100 genes with a sample size of 10, the Quantile normalization method has lower F1 scores compared to raw data and other methods, while in the case of 1,000 and 10,000 genes, it has higher F1 scores compared to raw data and other methods. With a sample size of 40, the Quantile norms coalition method has lower F1 scores compared to raw data and other methods for 100 genes, while it has higher F1 scores compared to raw data and other methods for 1,000 and 10,000 genes. With a sample size of 200, while there was no difference between Quantile normalization and raw data and other methods in the case of 100 genes, it had higher F1 scores in the case of 1,000 genes and higher F1 scores in the case of 10,000 genes compared to raw data and other methods and was the only method that made successful separation.

Table 4. F1 Scores for the Data Set with High Variation, High Noise and High Down Regulated Ratio

Normalization	Gene size	100			1,000			10,000		
Methods	Sample size	10	40	200	10	40	200	10	40	200
	Mean	0.725	0.820	0.885	0.708	0.762	0.894	0.661	0.568	0.466
None	95% Lower	0.712	0.809	0.874	0.703	0.759	0.892	0.657	0.550	0.441
	95% Upper	0.738	0.830	0.896	0.712	0.765	0.897	0.666	0.585	0.491
	Mean	0.717	0.824	0.889	0.678	0.763	0.893	0.667	0.590	0.469
Cyclic Loess	95% Lower	0.704	0.814	0.878	0.676	0.760	0.891	0.667	0.576	0.446
	95% Upper	0.731	0.833	0.899	0.681	0.767	0.896	0.667	0.605	0.492
	Mean	0.623	0.711	0.870	0.791	0.865	0.983	0.777	0.824	0.886
Quantile	95% Lower	0.605	0.700	0.859	0.781	0.860	0.981	0.763	0.808	0.870
	95% Upper	0.641	0.722	0.881	0.801	0.871	0.984	0.790	0.840	0.903
	Mean	0.722	0.824	0.885	0.709	0.764	0.897	0.663	0.574	0.451
Median	95% Lower	0.708	0.814	0.875	0.704	0.761	0.894	0.658	0.557	0.427
	95% Upper	0.736	0.834	0.896	0.713	0.767	0.900	0.667	0.591	0.475

Figure 1 displays the F1 score values for all data types when the number of genes is 100. Nearly all models exhibit improved results with high variation, high noise, and unequal up-down regulation ratio. Nevertheless, Quantile normalization produces lower results than raw data and other methods.

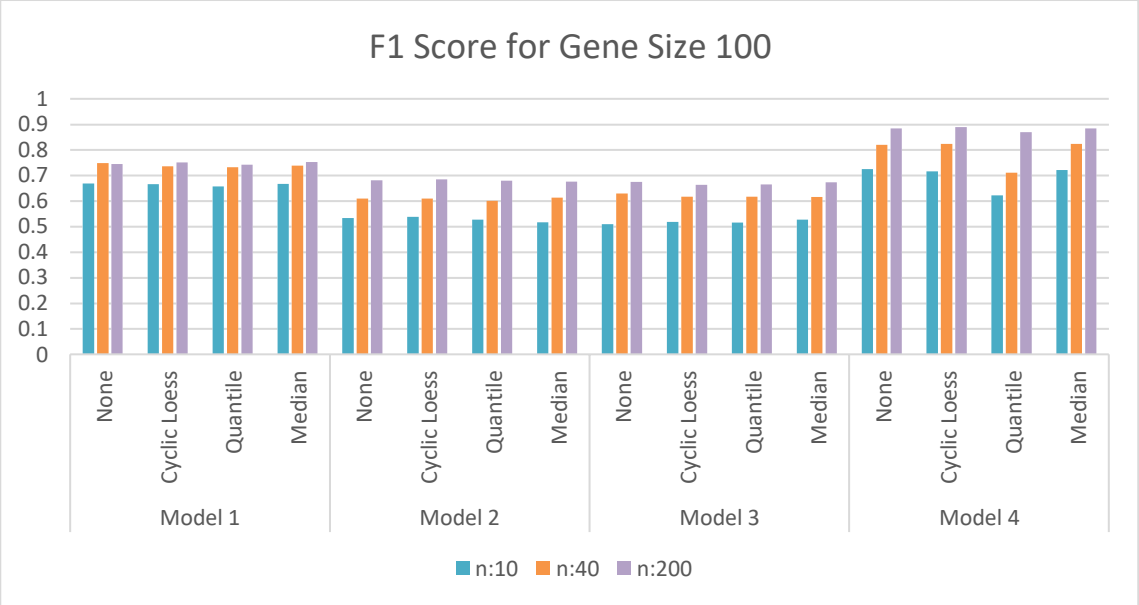

Figure 1. F1 score values when the number of genes is 100.

Figure 2 displays the F1 score values across all data types at a gene count of 1,000. It is evident that Quantile normalization consistently produced superior results for all models and sample sizes, outperforming raw data and other methods.

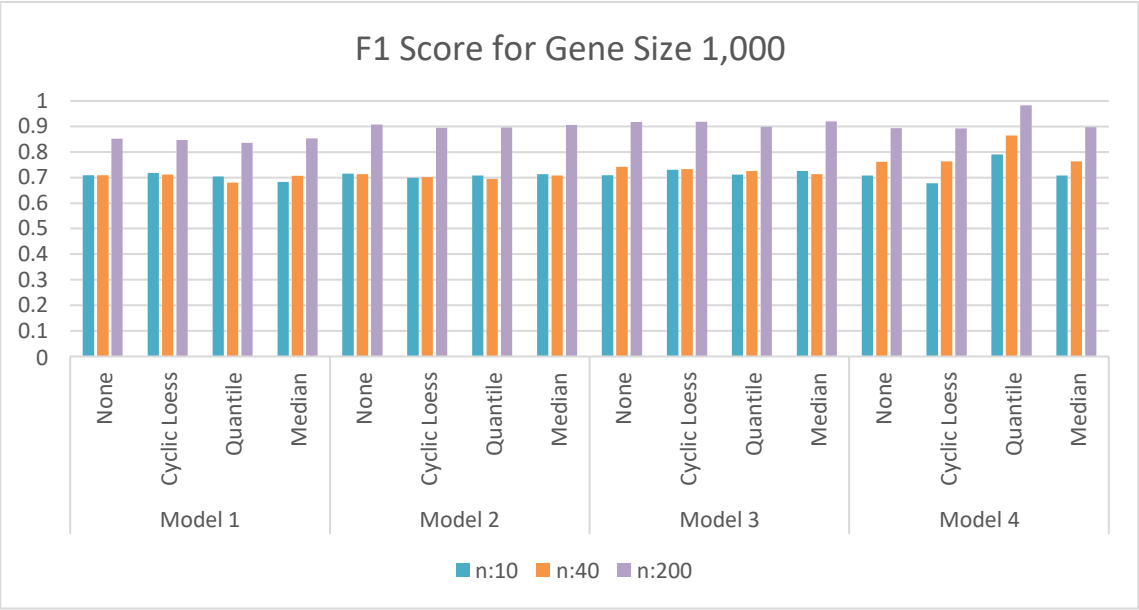

Figure 2. F1 score values when the number of genes is 1,000.

Figure 3 displays the F1 score values for all data types when the number of genes is 10,000. In scenarios with high variation, high noise, and unequal up-down regulation ratio, most show improved results. Nonetheless, in model 4, Quantile normalization shows superior and favorable outcomes, in comparison to raw data and other techniques.

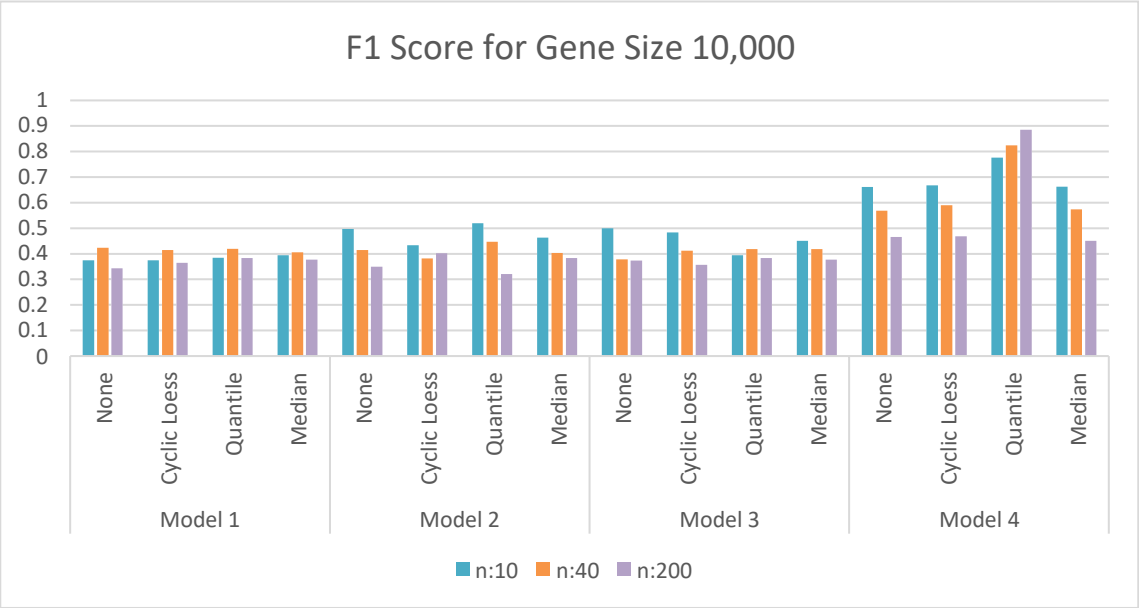

Figure 3. F1 score values when the number of genes is 10,000.

DISCUSSION AND CONCLUSION

The results show that the F1 scores calculated as a result of deep learning are higher, especially when the variation increases. Noise in microarray datasets with low gene counts negatively affects deep learning performance. When the number of genes is increased to 1,000, it is seen that the same normalization methods give very close results in all data types at the same sample size, but the Quantile normalization

results are slightly higher when the variation increases. Also, increasing the sample size improves the classification performance. When the number of genes was increased to 10,000, both the raw data and normalization methods gave very poor results in data sets with low variation, low noise and equal up-down regulation ratio, and it was seen that low sample size had better results with increasing noise and up regulation ratio. However, while the increase in the coefficient of variation leads to an increase in classification performances, it is seen that the Quantile normalization method increases considerably and is more successful compared to other methods. When the literature was examined, it was found that in single colour microarray data, the Quantile normalization method worked best in reducing the differences in miRNA expression values, Cyclic Loess was slightly less successful compared to Quantile normalization, no normalization and median normalization gave similar results and were less successful than Quantile and Cyclic Loess methods (Rao et al., 2008). In another study, Cyclic Loess, Median, Quantile and Qspline normalization methods were compared in order to provide a guide for practitioners in selecting a 'suitable' normalization method for single colour microarray data that removes noise and retains the signal efficiently. It was found that the Cyclic Loess method outperformed the Quantile and Median methods in terms of both variability reduction and signal retention. The Median normalization method was found insufficient to eliminate the noise problem. They also found that more genes were differentiated in the Cyclic Loess method (Wu et al., 2005). On the RNA microarray of 178 mice, it was found that Median normalization and Loess-based normalization methods did not give successful results in data with up-regulated structure (Fardin et al., 2017). Our research is in line with the literature at some points and diverges at some points. When we look at the research in general, Quantile normalization method was found to be more successful compared to other methods and raw data in data sets with unbalanced regulation, high noise and high coefficient of variation, medium and high number of genes. The highest F1 scores were observed in the Quantile normalized data set at gene number 1,000 and sample size 200. Unlike other types of research, microarray experiments are designed with a small number of samples and a large number of genes. In microarray datasets, keeping the number of genes at a lower level, increasing the sample size and normalizing the data with the Quantile method will enable more successful results in advanced analysis methods such as deep learning.

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Acknowledgment

This study was produced from a doctoral thesis at Mersin University, Institute of Health Sciences.

Conflict of Interest

The authors have declared that there is no conflict of interest.

Evaluation of Rainfall in Different Climate Regions of Turkey Using CLIGEN

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Abstract

Turkey, with its geographical diversity and climate variations, is a country of great significance. The purpose of this study is to examine long-term rainfall data observed in different climate regions of Turkey, specifically in Ankara, Bafra, and Erzurum, using the CLIGEN climate model. This research aims to demonstrate the applicability of the CLIGEN model beyond the United States by conducting tests in other regions. Long-term precipitation data obtained from the Turkish State Meteorological Service were utilized in this study. The study focused on the analysis of rainfall data observed over extended periods in Erzurum (1983-2020), Bafra (1980-2020), and Ankara (1967-2020) cities. Various essential parameters, including monthly rainfall averages, the number of wet days, and rainfall amounts on wet days, were extracted from the data. Additionally, the standard deviation of the data for each month was calculated. The analysis results indicate that, except for the months of August, September, and October, there is no significant difference between the averages and distributions of observed and simulated rainfall data. However, for these three months, K-S_Test results and M-W_Test values are more variable, displaying high fluctuations in certain months. These fluctuations play a crucial role in applications such as water resource management and environmental analyses, as abrupt changes can impact planning and management processes. This study underscores the importance of evaluating rainfall in different climate regions of Turkey using the CLIGEN model. The calibration of erodibility parameters of the model and model validation are essential steps for future research. This research emphasizes the significance of sudden changes in applications such as water resource management and environmental analyses. Understanding Turkey's climate change processes and being prepared for these changes are critical, emphasizing the importance of continued research in this area.

Key words: *Ankara, Bafra, CLIGEN, Erzurum, Rainfal pattern*

Machine Learning Approach for Breast Cancer Detection

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Abstract

Early detection and diagnosis play a important role in the treatment of breast cancer. Instead of relying on a single variable for cancer detection, it is more beneficial to consider all relevant variables to make a more effective and distinctive diagnosis. Therefore, the aim of this study is to model and compare the variables used in the detection of breast cancer using the artificial neural networks (ANN) algorithm, a machine learning technique. The results revealed that ANN has very competitive outcomes in terms of accuracy and AUC.

Key words: *Breast cancer, Artificial Neural Network, Machine Learning*

Orta Anadolu Merinosu Koyun Irkında CAST Polimorfizmi

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Özet

Dünya nüfusunun sürekli artması ile birlikte talepler de sürekli artmakta bu yüzden gıda ihtiyacı da her geçen gün artmaktadır. Artan gıda ihtiyacının karşılanmasında bitkisel ve hayvansal üretim ilk sıralarda yer almaktadır. Çiftlik hayvanlarından yetiştiriciliği yapılan koyunun tarih boyunca yapağı, süt ve et gibi veriminden yararlanılmaktadır. Ancak yetiştiricilerin koyundan elde ettikleri kazancın büyük bir bölümünü et verimi karşılamaktadır. Günümüzde artan gıda ihtiyacının karşılanması için hayvan başına düşen verimler istenildiği kadar yüksek olmamaktadır. Hayvan yetiştiriciliğinde önemli olan hayvan sayısını yükseltmek yerine her hayvan başına düşen verimi yükseltmektir. Yetiştiriciliği yapılan hayvanın verimini, üzerinde durulan özellik bakımından belirlenen genler belirler. Bu verimi hayvanın genotipi belirler ve bu ilerleme genotipin müsaade ettiği ölçüde olur. Hayvanlarda verim ve et kalite niteliklerini belirleyen genlerin saptanması, bu genlerin hayvan seleksiyonu ve klasik ıslah yöntemlerinde kullanılabilmesi için moleküler genetik alanındaki araştırmalar artmaya başlamıştır. Yapılan araştırmalarda koyunlarda et verimi ve kalite üzerine yararlı olan genlerden biri Calpastatin (CAST) genidir. CAST geni, hayvanlarda kas gelişimi olaylarında ve kesim sonrası etin yumuşamasında önemli rol oynamaktadır. CAST geni koyunlarda 5. kromozom üzerinde bulunur. Bu çalışmada Eskişehir'de halk elinde yetiştiriciliği yapılan Orta Anadolu Merinosu koyun ırklarında CAST genotipinin belirlenmesi amaçlanmıştır. CAST polimorfizminin belirlenmesi için MspI restriksiyon endonükleaz enziminden faydalanılarak PCR-RFLP yöntemi ile yapılmıştır.

Anahtar Kelimeler: *CAST, PCR, Polimorfizm, Koyun*

Orta Anadolu Merinosu Koyun Irkında DGAT1 Polimorfizmi

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Özet

Sürekli artan Dünya nüfusu nedeniyle hayvansal protein ihtiyacı her geçen gün artmaktadır, bu ihtiyacın yeterli miktarda alınması için koyun yetiştiriciliğinin çok önemli yeri vardır. Kişi başına düşen hayvansal protein ihtiyacının karşılanması için hayvan sayısının artırılması değil hayvanlardan elde edilen et verimi ve miktarının artırılması gerekliliğini ortaya çıkmıştır. Hayvanlarda et verimini artırmak için uygulanan klasik ıslah yöntemleri çok uzun zaman almaktadır. Son zamanlarda klasik ıslah yöntemlerinin yanında moleküler genetik alanında yaşanan gelişmeler de kullanılmaktadır. Hayvanlarda verim veya fizyolojik özellikleri belirleyen önemli özelliklerden biri kantitatif karakterlerdir. Bu bölgelerde görülen mutasyonlar moleküler genetik çalışmaların temelini oluşturur. Hayvan yetiştiriciliğinde, verim özelliklerini belirleyen genlerdeki polimorfizmlerin araştırıldığı çalışmalar önem kazanmaya başlamıştır. Son zamanlarda et verimi ve kalitesini geliştirebilmek için çok sayıda genler belirlenmiş ve bu genlerle araştırma yapılmaktadır. Yapılan çalışmalarda koyunlarda et verimi üzerine etkili olan genlerden biri Diacylglycerol acyltransferase1 (DGAT1) genidir. DGAT1 geni, yağ ve enerji metabolizmasındaki göreviyle koyunlarda sütteki yağ oranı, et kalite özellikleri ve karkasta yağ birikimi özelliklerini etkilemesinde rol oynar. DGAT1 geni koyunlarda 9. kromozom üzerinde yer alır. DGAT1, yağ hücrelerinde trigliseritlerin sentez oranını kontrol etmede anahtar enzimdir. DGAT1 geninin sığırlarda süt verimi ve süt kompozisyonu üzerine etkisi vardır ancak koyunlarda DGAT1 geni ile et verim özellikleri arasındaki ilişkilerin araştırıldığı çalışmalar azdır. Bu çalışmada Eskişehir'de halk elinde küçük işletmelerde yetiştiriciliği yapılan Orta Anadolu Merinosu koyun ırklarında DGAT1 genotipinin belirlenmesi amaçlanmıştır. DGAT1 polimorfizminin belirlenmesi için AluI kesim enziminden yararlanılarak PCR-RFLP yöntemi ile yapılmıştır.

Anahtar Kelimeler: *DGAT1, PCR, Polimorfizm, Koyun*

A Consistent Nonparametric Normality Testing for High Dimensional Data with Generalized Gaussian Distributions

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Abstract

A key issue in statistics is normality testing. Given that many statistical techniques assume normality, it is crucial to ascertain if a dataset is normally distributed. But in high-dimensional environments, conventional normality tests are sometimes unreliable, especially when the data has a generalized Gaussian distribution. This study suggests a brand-new normality test for high-dimensional data that is resistant to outliers, such as extended Gaussian distributions. The suggested test is based on a nonparametric method called the nearest neighbour approach, which makes no assumptions about the distribution of the data. The suggested test is applicable for huge datasets because it is computationally effective as well. Both simulated and actual data are used to evaluate the proposed test. The findings demonstrate that, even when the data has a generalized Gaussian distribution, the suggested test is more effective than conventional normality tests in high dimensions. This piece significantly advances the subject of statistics. For researchers that need to verify for normality in high-dimensional data, the proposed test is a useful tool. The test is computationally effective and resilient to deviations from normality, including modified Gaussian distributions. This makes a variety of applications possible.

Key words: *Generalized Gaussian Distribution, Normality Testing, High-Dimensional Data, Nearest Neighbour Approach*

Classification Decision Trees with Functional Data: Analysis of COVID-19 Data

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Abstract

Thanks to the improvements in the capacity of collecting and storing large amounts of data, data can be measured and recorded. In addition, large data sets can be converted into functional data forms. Functional data (curve, object) is reached by converting the raw data into functional form. The aim of this study is to analyze the raw and functional data comparatively as classification decision trees from machine learning approaches. Thus, functional and non-functional classification trees are compared. In addition, the functions obtained by changing the basis function numbers and the changes in the decision tree model are examined. For this purpose, COVID-19 data obtained from Our Word in Data site was used. Data from January 2020 to December 2022 were analyzed. Functionally fitted raw data are represented by functional objects obtained for 5, 10, 15, 20 and 30 basis functions, respectively. In this study, the classification decision tree model achieved the highest accurate classification rate with the 10-basis function approach. This result shows that with the basis function approach consisting of a reasonable number of bases, fit to data can obtain a decision tree model with higher performance than raw data. In this way, a purer decision tree can be obtained in which the most important functional variables are selected. In addition, in this study, it was observed that as the number of bases decreases, the tree development rule with functional data becomes pure in the early stages and relatively small and simple trees are produced.

Key words: *Functional Data Analysis, Machine Learning, Classification Tree with Functional Data, Smoothing, COVID-19.*

GİRİŞ

Çin Halk Cumhuriyeti'nde 2019 yılının aralık ayında ortaya çıkan Koronavirüs (COVID-19) salgını, küresel düzeyde etki oluşturmuştur. Hızla tüm dünyaya yayılan COVID-19, Dünya Sağlık Örgütü tarafından Mart 2020'de pandemi olarak ilan edilmiştir. Pandemi, dünyanın neredeyse her yerinde görülebilen ve çok sayıda insanı etkileyen salgın hastalık olarak tanımlanabilir. Bu sebeple bu çalışma Ocak 2020'den Aralık 2022'ye kadar olan 3 yıllık pandemi sürecini kapsamaktadır.

COVID-19 taşıyanların sayısının artmasıyla ülkelerin vaka sayıları artırmıştır. Bu durumun COVID-19 sebebiyle olan ölüm sayılarını da etkilediği görülmüştür. Bu sebeple bu çalışmada bağımlı/çıktı/hedef değişken olarak ölüm sayıları dikkate alınmaktadır.

Kesikli ham verilerin fonksiyonel biçime dönüştürülmesiyle fonksiyonel veriler (eğri, nesne) elde edilmektedir. Fonksiyonel veri kavramı ilk olarak Ramsay ve Dalzell ile ortaya çıkmıştır. Ardından Ramsay ve Silverman başta olmak üzere birçok çalışmada geliştirilmiştir (Ramsay ve Dalzell, 1991; Ramsay ve Silverman, 1997, 2002, 2005).

Çok değişkenli istatistiksel analizlerin çoğunun fonksiyonel karşılığı bulunmaktadır. Bu çalışmanın amacı makine öğrenimi yaklaşımlarından sınıflandırma karar ağaçları ile ham ve fonksiyonel verileri karşılaştırmalı olarak incelemektir. Böylece fonksiyonel verilere karar ağaçları analizi uygulanıp uygulanamayacağı ve uygulandığı takdirde performansın nasıl olacağı araştırılmaktadır. Ayrıca baz fonksiyon sayıları değiştirilerek elde edilen fonksiyonlar ve sınıflandırma ağacı modelindeki değişimler incelenmiştir.

MATERYAL VE METOD

Materyal

Bu çalışmada Our Word in Data sitesinden edinilen COVID-19 verileri analiz edilmiştir. Bu çalışmada ham veriler sırasıyla 30, 20, 15, 10 ve 5 baz fonksiyon ile oluşturulan fonksiyonel nesnelerle temsil edilmektedir. Analiz, R programlama dili ile gerçekleştirilmiştir.

Öncelikle Avrupa Birliği ülkelerine (27 ülke) ait zaman boyutunda kesikli gözlenen 12 girdi değişkenine göre (milyonda yeni vaka sayıları, COVID-19 çoğalma (üreme) oranı, milyonda yoğun bakım hastası sayıları, milyonda hastane hastası sayıları, binde test sayısı, pozitif çıkan günlük COVID-19 testlerinin oranı, doğrulanmış vaka başına yapılan test sayısı, yüzde günlük aşı dozu, yüzde ilk aşılarını olan insan sayısı, yüzde ilk aşılarını tamamlayan insan sayısı, yüzde takviye doz aşı olan insan sayısı, sıkılık indeksi) eğriler baz fonksiyon yaklaşımı ile düzgünleştirilerek tahminlenmiştir.

10 sabit değerli değişken de (yaş (medyan), 65 yaş üstü oranı, 70 yaş üstü oranı, kişi başı GSYİH, kardiyovasküler ölüm oranı, diyabet prevalansı, binde hastane yatak sayısı, yaşam beklentisi, insani gelişmişlik indeksi, nüfus) analize dahil edilmiştir. Hedef değişken bir milyonda yeni COVID-19 ölüm sayıları olup sınıflandırma ağaçları elde edilirken ortalama ölüm sayısı eğrisinin altında olan değerler için ölüm oranı düşük, üstünde olan değerler için ölüm oranı yüksek etiketi ile iki kategoriliye dönüştürülmüştür.

Kesikli veri matrisi verilerin fonksiyonel eğriye dönüştürülmesi ile her değişken için her biri T = [1, 1094] zaman aralığında tanımlanan 27 fonksiyonel gözleme dönüşmektedir. Ülke eğrileri 5 baz fonksiyon için 135, 10 baz fonksiyon için 270, 15 baz fonksiyon için 405, 20 baz fonksiyon için 540, 30 baz fonksiyon için 810 fonksiyonel nesne katsayısı ile temsil edilmektedir. Ardından sınıflandırma karar ağacı analizleri fonksiyonel nesneler ile gerçekleştirilmiştir.

Metod

Fonksiyonel Veri Analizi

Gözlenmiş kesikli verilerin fonksiyonel veriye dönüştürülmesi ile veriler, gözlem noktaları olarak değil fonksiyonlar olarak dikkate alınır. Fonksiyonel veri, j = 1, 2, …, N olmak üzere, (N: örnek hacmi),

$$y_j(t) = \delta(t) + v_j(t) + \varepsilon_j(t)$$

olarak gösterilebilir (Zhang ve Chen, 2007; Koymen Keser ve Deveci Kocakoç, 2021). Veriye uyumu sağlanan fonksiyonu elde etme yöntemlerinden biri belirli sayıda baz fonksiyondan oluşan bir sistem belirlemektir. Böylece uyum fonksiyonu baz fonksiyonların bir birleşimi olarak ifade edilmektedir (Keser, 2008). Fonksiyon, k tane baz fonksiyonun c_i $(i = 1,2, \dots, k)$ katsayılarla ağırlıklanmış doğrusal toplamı şeklinde aşağıdaki gibi ifade edilebilir.

$$x_i = c_1\theta_1(t) + c_2\theta_2(t) + \cdots + c_k\theta_k(t)$$

Modelde, $\theta_i(t)$ fonksiyonu i'nci baz fonksiyon olup c_i katsayısı ise bu baz fonksiyona karşılık gelen katsayıyı göstermektedir. Gerçek fonksiyonların tahmini, $x(t)$ fonksiyonuna benzer niteliklere sahip

olması beklenen baz fonksiyonlarının seçilmesine bağlıdır (Yaraee, 2011). Küçük k değerlerine başvurup en iyi yaklaşımı sağlayarak uyumu artıran bir baz seçmek istenir (Ramsay ve Silverman, 1997). Fonksiyonel veri için sıklıkla Splayn baz fonksiyon yaklaşımı kullanılmaktadır. d-inci dereceden j-inci B-Splayn aşağıdaki döngüsel ilişki ile hesaplanmaktadır (Eilers ve Marx, 1996).

$$B_{j,d}(t) = \frac{t - t_j}{t_{j+d} - t_j} B_{j,d-1}(t) + \frac{t_{j+1+d} - t_j}{t_{j+1+d} - t_{j+1}} B_{j+1,d-1}(t)$$

Eğrinin pürüzlülüğü ile veriye uyumu arasındaki dengeyi sağlamak amacıyla Pürüzlü Ceza Yöntemi yardımıyla c_i katsayıları tahminlenebilmektedir. Bu amaçla Artık Kareler Toplamı ile pürüzlülük ölçüsünün düzgünleştirme parametresi ile λ çarpımı toplanarak Cezalı Artık Kareler Toplamı bileşik terimi elde edilir.

$$\text{Cezalı Artık Kareler Toplamı} = \sum_j (y_j - x(t_j))^2 + \lambda \, \|D^2 x\|^2$$

$$y_{ij} = \sum_{i=1}^{k} \sum_{j=1}^{n} c_i \theta_i(t_j) + \varepsilon_j$$

Literatürde gözlem sayısının (n_i) yüksek olduğu çalışmalarda $\sqrt{n_i}$ adet baz fonksiyona başvurulmuştur (Ramsay ve Silverman, 1997). Artık orijinal veriler geride bırakılıp yeni elde edilen fonksiyonel veri eğrileriyle analize devam edilir.

Sınıflandırma Karar Ağacı Analizi

Karar ağaçları, sınıflandırıcıları temsil etmek için popüler bir yaklaşımdır. Bir karar ağacı büyütmek veri setini belirli karar kuralları çerçevesinde görsel olarak oldukça anlaşılır ve kolay yorumlanabilir küçük alt kümelere ayırmaktır (Dunham, 2002). Karar ağacı; kök düğüm, iç düğümler, dallar, terminal düğümler/uç düğümler ve yapraklar/çıktı etiketleri ile oluşmaktadır (De Ville, 2013). Bir karar ağacı kategorik bir hedef değişken söz konusu olduğunda sınıflandırma karar ağacı adını almaktadır. Literatürde en sık karşılaşılan karar ağacı algoritmalarından biri Sınıflandırma ve Regresyon Ağaçları (CART) algoritmasıdır. CART algoritma aşamaları aşağıdaki gibidir (Breiman ve ark., 1984).

1. Aşama: Her değişken iki temsili kategoriye bölünür. Sol ve sağ dal elde edilir.

2. Aşama: Sol (a) ve sağ (b) dala ait olan ‘‘Gini’’ değeri hesaplanır. Burada ‘‘k’’ hedef değişken kategori sayısını temsil etmektedir.

Tablo 1. Gini değeri hesaplama

k = 2 için	Değişkenin a kategorisi	Değişkenin b kategorisi
Hedef Sınıf 1	a_1	b_1
Hedef Sınıf 2	a_2	b_2
	$a_1 + a_2$	$b_1 + b_2$

$$Gini_a = 1 - \sum_{i=1}^{2} \left(\frac{a_i}{a_1 + a_2}\right)^2 \qquad Gini_b = 1 - \sum_{i=1}^{2} \left(\frac{b_i}{b_1 + b_2}\right)^2$$

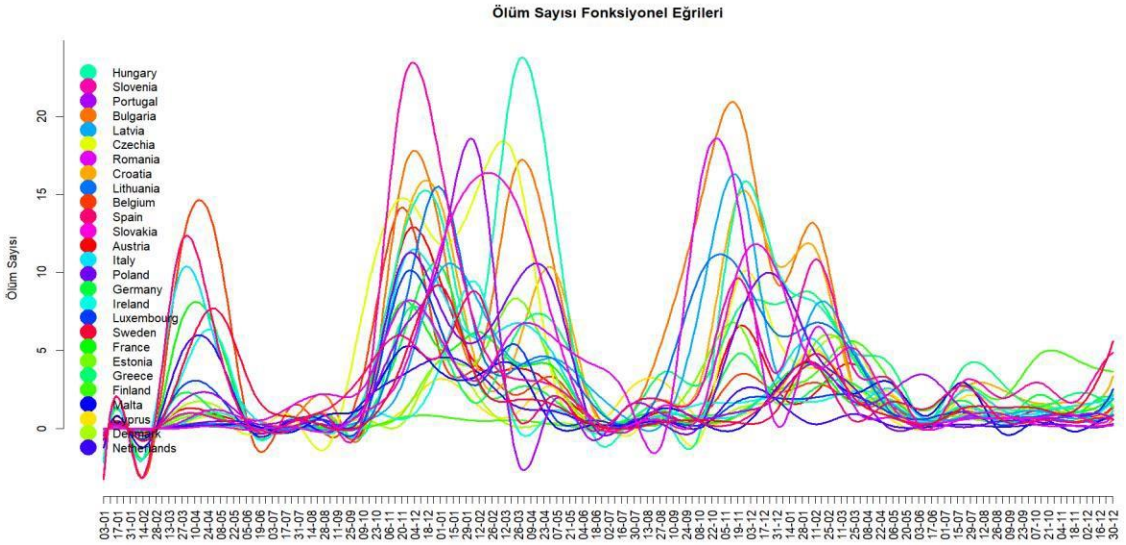
3. Aşama: j-inci değişken için $Gini_j$ değerleri elde edilir. (n toplam gözlem sayısı)

$$Gini_j = \frac{1}{n}[(a_1 + a_2) * Gini_a + (b_1 + b_2) * Gini_b]$$

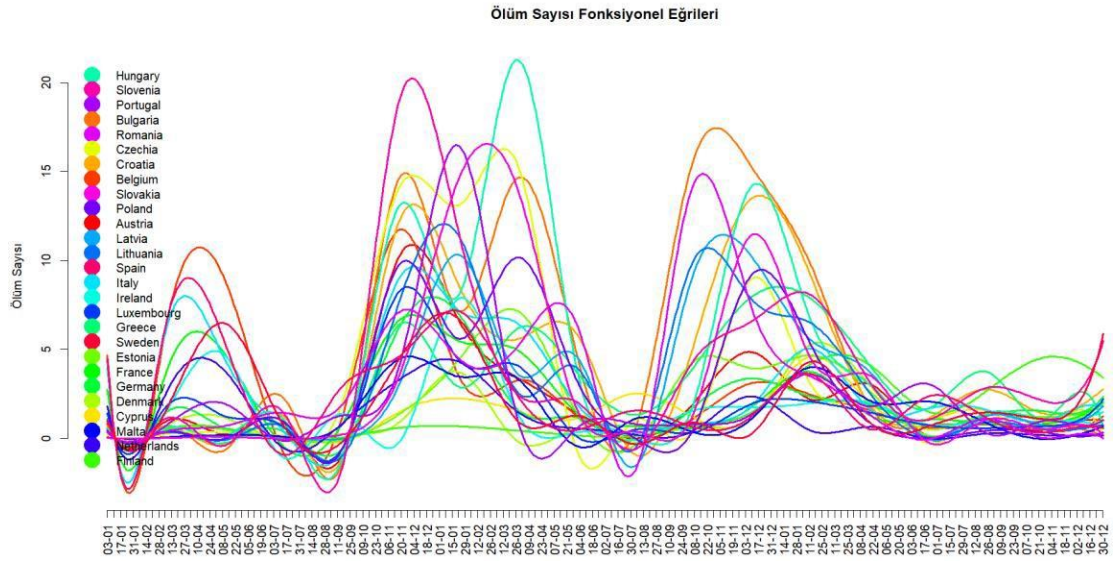
4. Aşama: Gini değeri en küçük olan j değişkeni düğüme yerleştirilir ve bölünme bu değişkene göre gerçekleşir.

BULGULAR

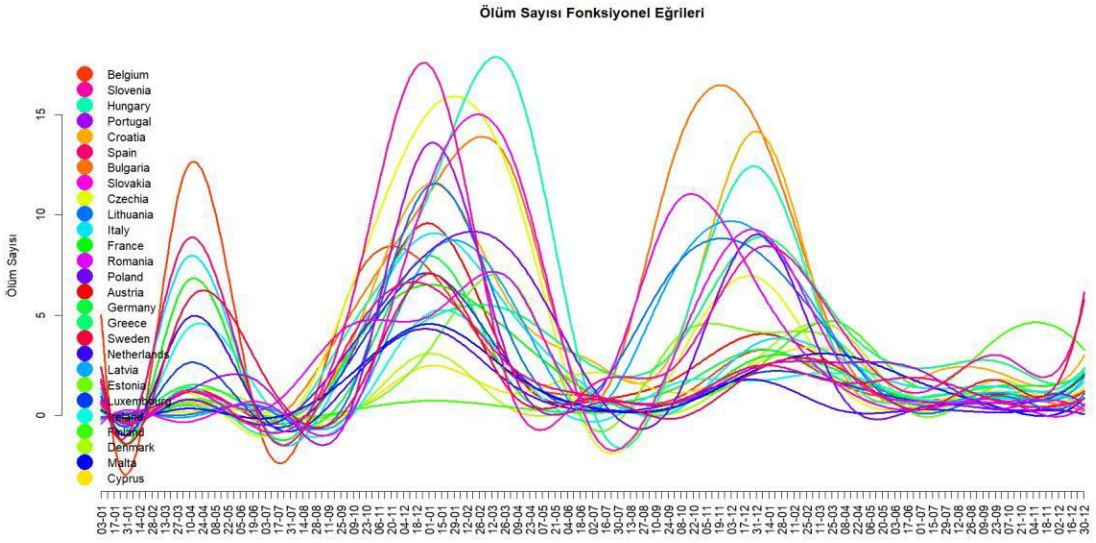
Bu çalışmada $\sqrt{1094} \cong 33$ olması sebebiyle 30 baz fonksiyon ile düzgünleştirme yapılmaya başlanmıştır. Elde edilen fonksiyonel eğrilerin ham veriye benzerliği dikkat çekmiş ve modelin veriye aşırı uyumundan süphe edilmiştir. Bu sebeple pürüzlülüğü azaltarak karmaşıklığı azaltan bir uyum sağlamak amacıyla baz fonksiyon sayısı kademeli olarak azaltılmış ve ham veriyi en iyi temsil eden fonksiyonel eğriler araştırılmıştır. Tüm değişkenler düzgünleştirilmiş ancak burada sadece ölüm sayısı hedef değişkeni için olan değişim Şekil 1-5 ile sunulmuştur. Detaylı inceleme için Kocarık Gacar (2023) çalışmasına baş-vurulabilir.



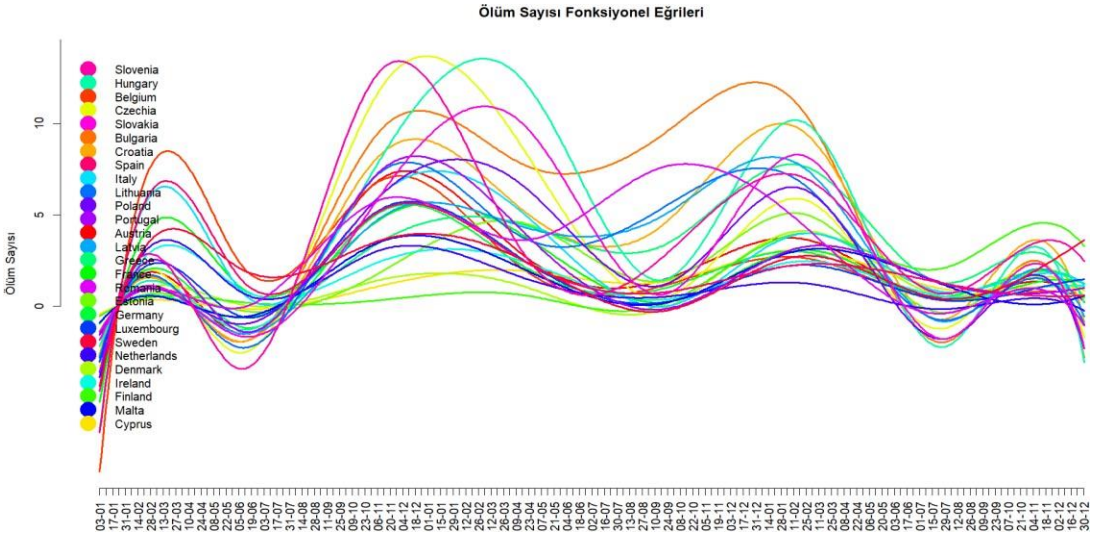
Şekil 1. 30 baz ile ölüm sayısı eğrileri



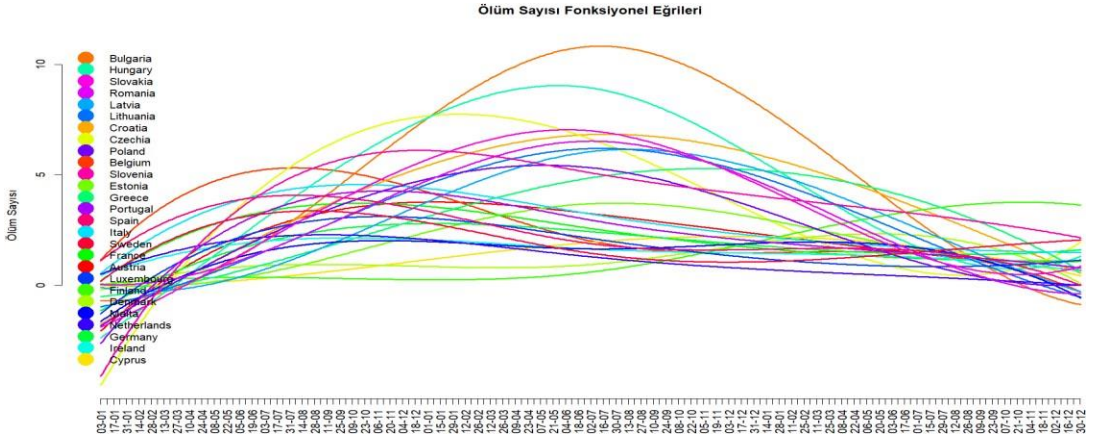
Şekil 2. 20 baz ile ölüm sayısı eğrileri



Şekil 3. 15 baz ile ölüm sayısı eğrileri

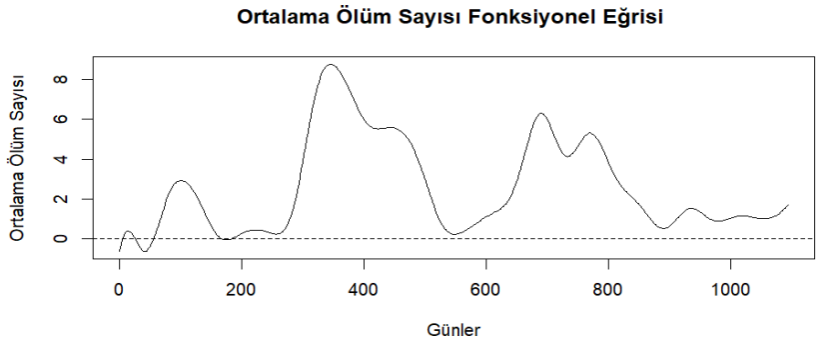


Şekil 4. 10 baz ile ölüm sayısı eğrileri

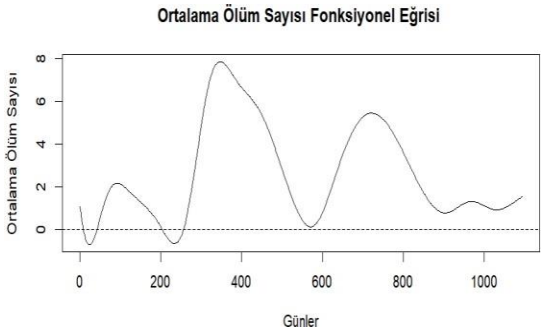


Şekil 5. 5 baz ile ölüm sayısı eğrileri

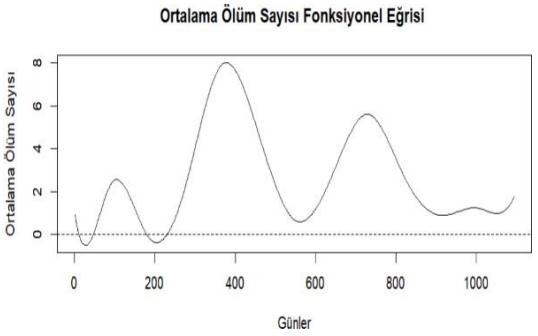
Elde edilen ülke eğrilerinin her aşamada önceki eğrilere göre bir miktar daha düzgünleşmiş olduğu görülmektedir. 5 baza kadar uyumun ham verideki tepe noktaları temsil edilebilmekte olduğu 5 baz ile düzgünleştirme yapılması sonucu elde edilen fonksiyonel eğrilerin ise oldukça düzgünleşmiş olduğu görülmektedir. Bu durumda ham veriyi temsiliyeti oldukça zayıfladığı görülen eğrilerin yüksek bilgi kaybına sebep olabileceği söylenebilir.



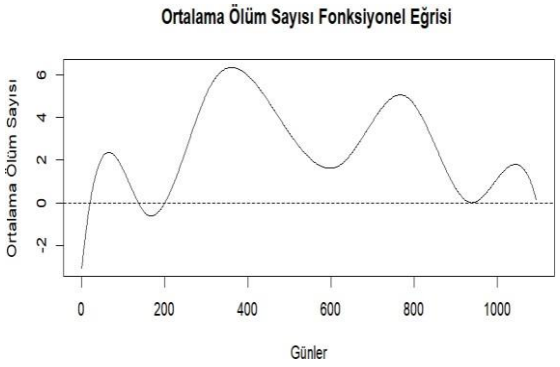
(30 baz)



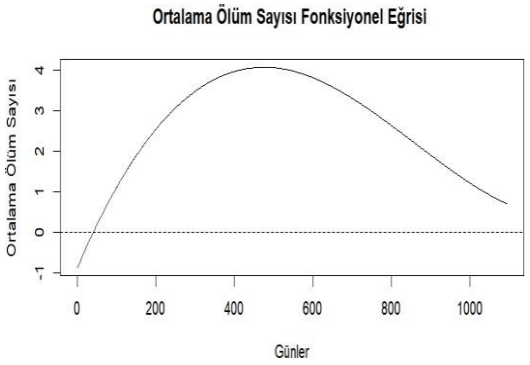
(20 baz)



(15 baz)



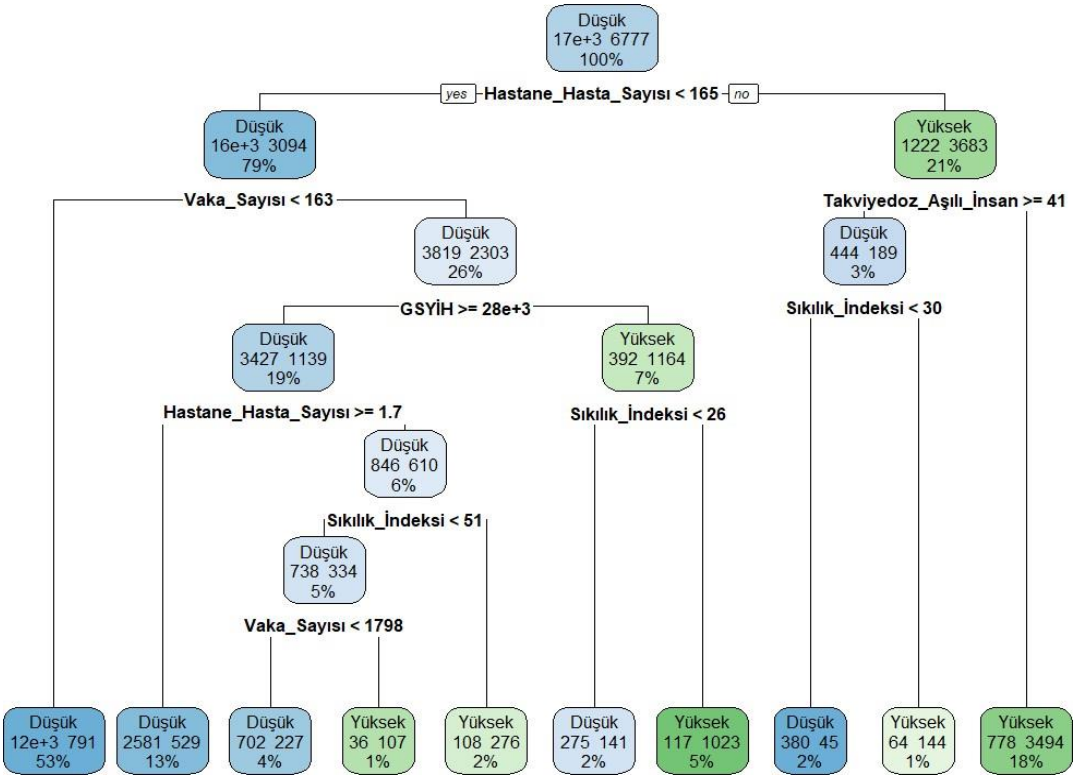
(10 baz)



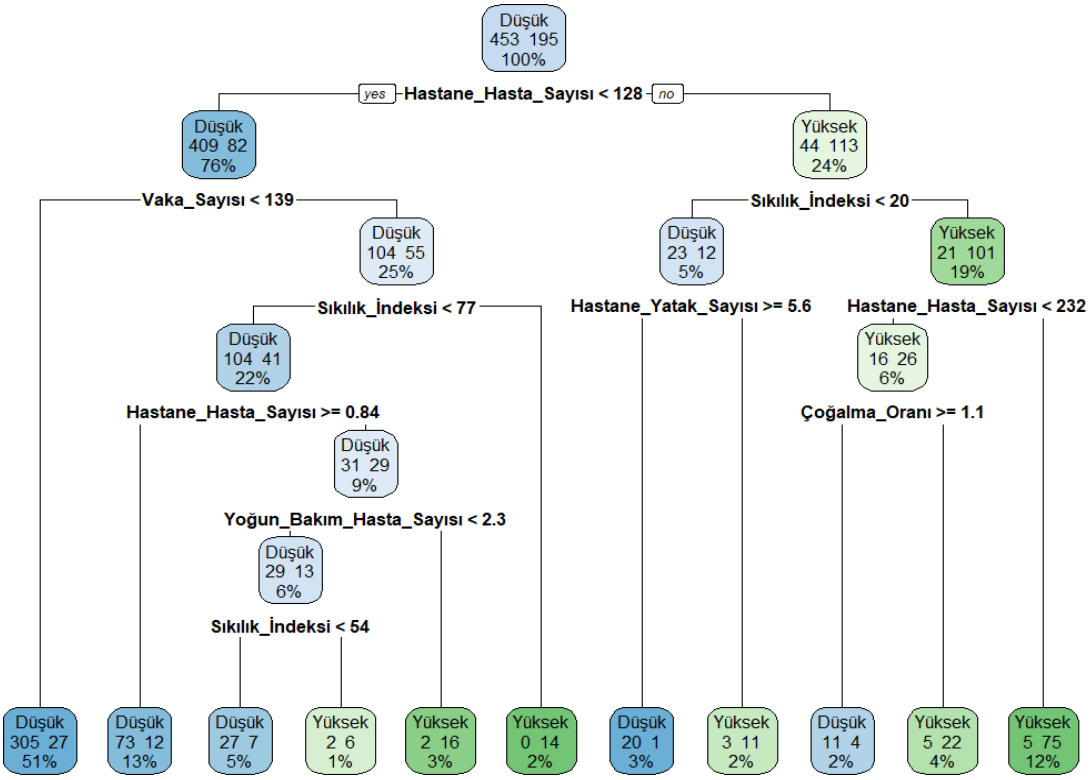
(5 baz)

Şekil 6. Ortalama ölüm sayısı eğrileri

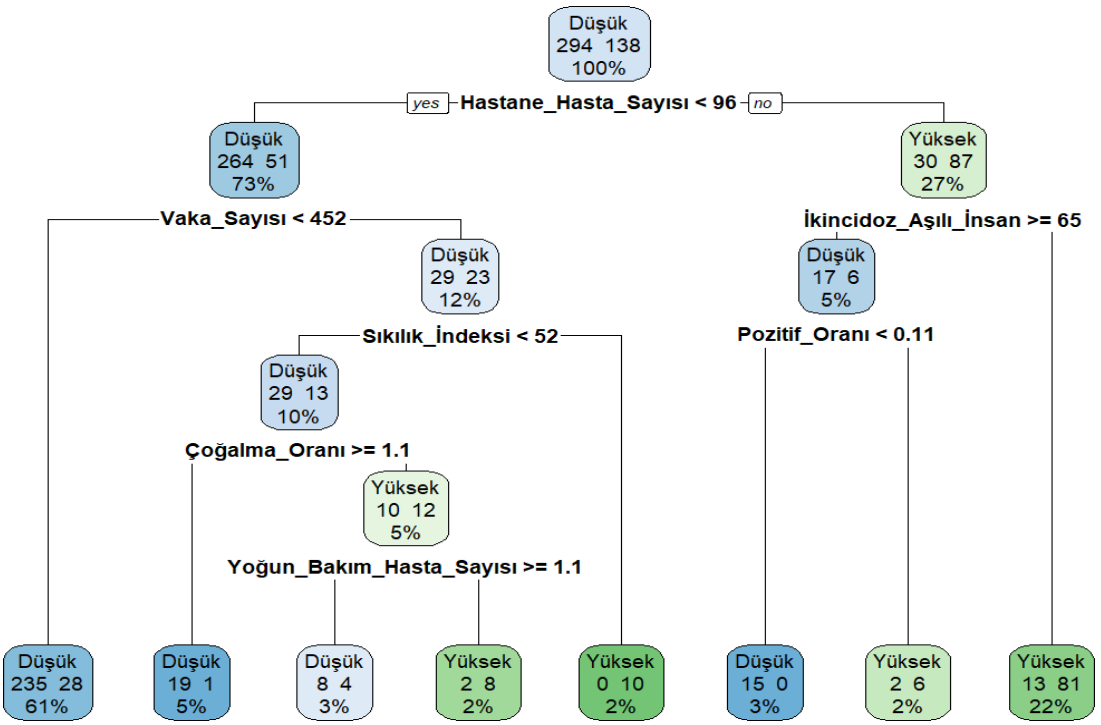
Fonksiyonel verilerle elde edilen karar ağaçları sırasıyla aşağıda verilmiştir. Veri setinin rassal olarak %80'i eğitim, %20'si test verisi olarak belirlenmiştir. Sınıflandırma analizinden önce ülkelerin günlük ölüm sayısı değerleri Şekil 6 ile verilen ortalama ölüm sayısı eğrilerine göre düşük ve yüksek olarak iki sınıfa ayrılmıştır.



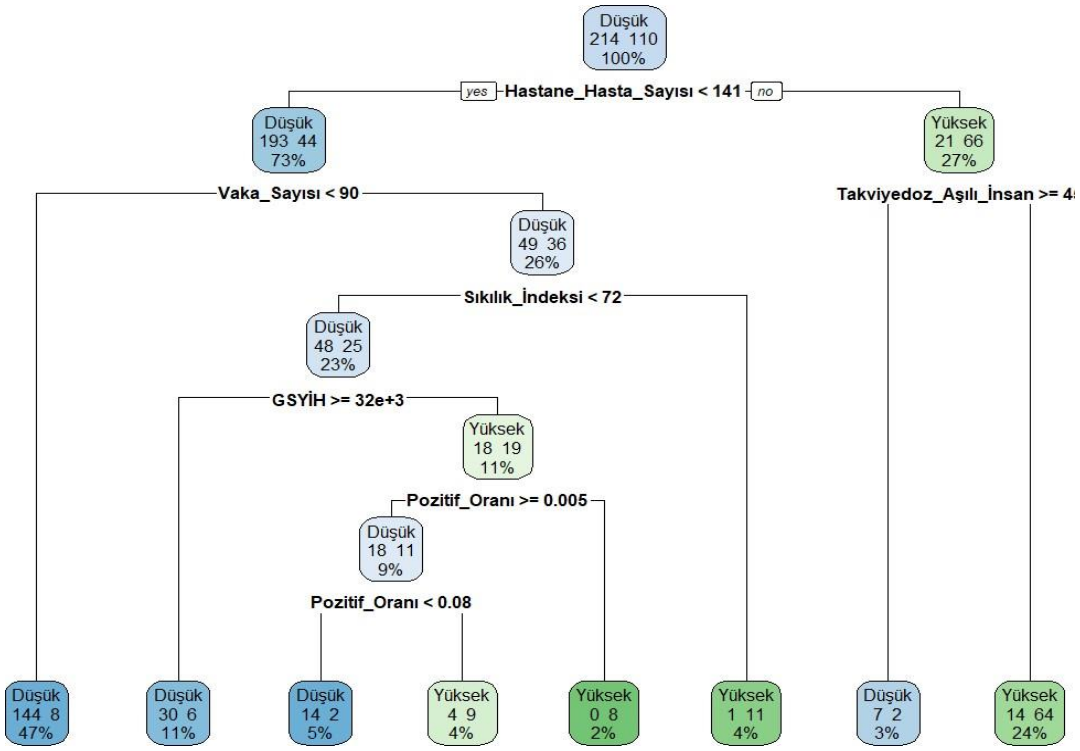
Şekil 7. Ham veri sınıflandırma ağacı



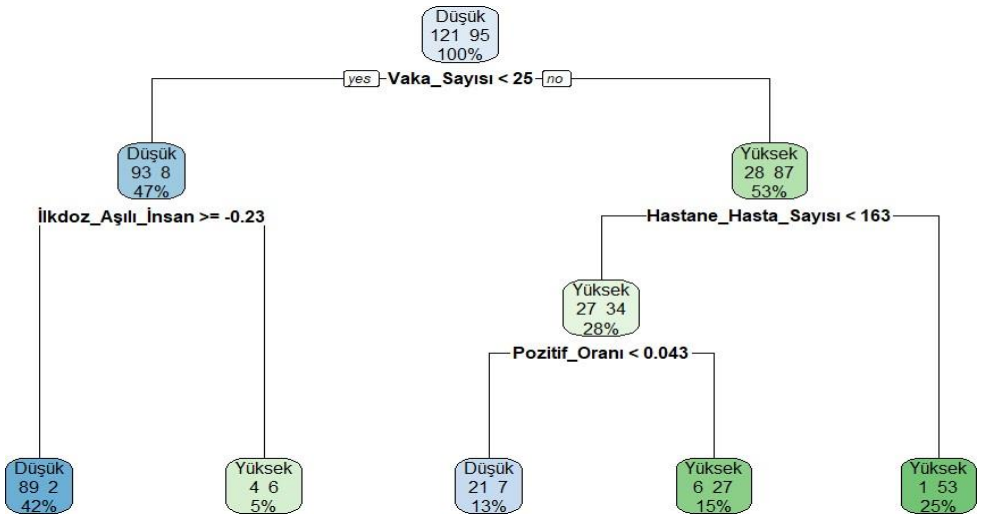
Şekil 8. 30 baz fonksiyonel veri sınıflandırma karar ağacı



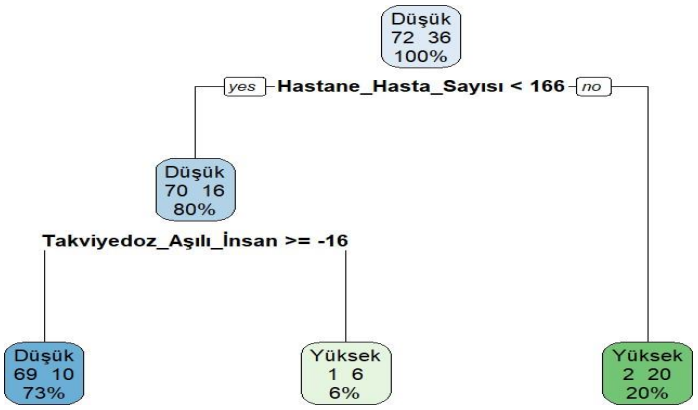
Şekil 9. 20 baz fonksiyonel veri sınıflandırma karar ağacı



Şekil 10. 15 baz fonksiyonel veri sınıflandırma karar ağacı



Şekil 11. 10 baz fonksiyonel veri sınıflandırma karar ağacı



Şekil 12. 5 baz fonksiyonel veri sınıflandırma karar ağacı

Karar ağacı modellerine göre baz sayısı azaldıkça fonksiyonel verilerle ağaç geliştirme kuralının erkenden saf hale geldiği ve nispeten küçük ve basit ağaçlar üretildiği görülmektedir. Ölüm sayısı üzerinde etkili olan en önemli değişkenler genel olarak hastane hasta sayısı, vaka sayısı, sıkılık indeksi, aşı sayıları değişkenleri olarak bulunmuştur. Bu sonuç, ağaç üzerinde kök düğümden itibaren yerleşen düğüm değişkenlerinden de görülebilir.

Tablo 2'ye göre yalnızca 5 bazlı karar ağacı için $p - değeri > 0{,}05$ olduğundan dolayı bu model için doğruluk oranının bilgisizlik oranından istatistiksel olarak anlamlı derecede büyük (Acc > NIR) olduğu söylenemez. Bu durum modelde bilgisizliğin doğruluk oranından büyük olduğunu göstermektedir. Bu sonuç 5 bazlı karar ağacı modelinin anlamlı olmayacağı yönündeki beklentiyi doğrular şekildedir. Ek olarak bilgisizlik oranı ile doğruluk oranı arasındaki uyumu ölçen kappa istatistiğinin düşük (0,43) olması uyumun rassal bir uyum olma yönünde ve düşük seviyede olduğunu göstermektedir.

Tablo 2. Sınıflandırma karar ağaçları performanslarını karşılaştırma

	Karar Ağaçları					
İstatistikler	Ham	30 Baz	20 Baz	15 Baz	10 Baz	5 Baz
Doğruluk (Accuracy)	0,8674	0,8704	0,8056	0,8765	0,8889	0,7407
95% Güven Aralığı	(0,8585, 0,876)	(0,8087, 0,9179)	(0,7183, 0,8754)	(0,7847, 0,9392)	(0,7737, 0,9581)	(0,5372, 0,8889)
Bilgisizlik Oranı (NIR)	0,7132	0,6975	0,6852	0,6543	0,5556	0,6667
P-Değeri (Acc > NIR)	2,2e-16	2,067e-7	0,00362	5,112e-6	1,305e-7	0,2755
Kappa	0,6658	0,6719	0,5457	0,7224	0,775	0,4324
Duyarlılık (Sensitivity)	0,9276	0,9558	0,8649	0,9245	0,90	0,7778

Sonuç olarak, anlamlı $(p - değeri < 0{,}05)$ sınıflandırma modelleri içinde en yüksek kappa istatistiği (0,77), en düşük bilgisizlik oranı (0,55) 10 bazlı fonksiyonel sınıflandırma ağacı ile sağlanmaktadır. Aynı zamanda elde edilen fonksiyonel veri sınıflandırma karar ağaçları içerisinde 10 baz fonksiyon, ölüm oranı için yaklaşık %89 oranında doğru sınıflandırma başarısı ile en iyi performansa sahip bulunmuştur.

SONUÇ VE TARTIŞMA

Sınıflandırma karar ağacı modeli 10 baz fonksiyon yaklaşımıyla en yüksek doğru sınıflandırma oranına ulaşmıştır. Bu sonuç, makul sayıda bazdan oluşan baz fonksiyon yaklaşımı ile verilere uyumun, ham verilere göre daha iyi performansa sahip bir karar ağacı modeli elde edilebileceğini göstermektedir. Böylece hedef değişken üzerinde en önemli değişkenlerin belirlendiği daha öz bir karar ağacı elde edilebilir. Ayrıca bu çalışmada baz sayısı azaldıkça fonksiyonel veri içeren ağaç geliştirme kuralının erken aşamalarda saf hale geldiği ve nispeten küçük ve basit ağaçlar üretildiği görülmüştür. Bu çalışma fonksiyonel veri ile karar ağaçlarını orijinal sınıflandırıcıyı temsil etmek için başvurulan yaklaşımlardan biri yapabilir.

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Çıkar Çatışması

Yazarlar çıkar çatışması olmadığını beyan ederler.

Yazar Katkısı

Yazarlar çalışmaya eşit oranda katkı yapmışlardır.

Smoothed Data Approach to Bayesian Classification and An Application on European Union Countries COVID-19 Data

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Abstract

In machine learning prediction is based on a process where algorithmic rules are developed using a training set. Supervised machine learning is the process of training the algorithm with defined input data for a specific target (output) value. When new data is added, target values can be estimated with the trained model. Bayesian classification is a supervised machine learning technique. It is also a simple probabilistic classification method developed from the conditional probability function of Bayes' theorem. The (naive) Bayesian classification algorithm, based on the Bayesian theorem, evaluates the probabilities of events occurring and performs classification according to probabilities. Smoothed data are obtained by smoothing the raw data. This data is also called a functional object or curve. The aim of this study is to investigate whether the functional data obtained by smoothing with the basis function can be used for naive Bayes classification. For the analysis, COVID-19 data from the European Union countries were obtained from the Oxford University Our World in Data site. The 3-year period covering 2020-2022 was included in the analysis. The 30 Base B-Spline Smoothing method was used to smooth the data. The analysis was carried out with the R programming language. Variables of the countries such as the number of cases, reproduction rate, number of intensive care and hospital patients, positive rate, number of tests, number of tests per case, number of vaccine doses, and stringency index were used. The death rate variable was determined as the target variable. Within the scope of the analysis, the probabilities of the target class to which the observation units will be assigned were determined with the help of conditional probabilities. As a result, the smoothed data are estimated with about 90% accurate classification performance for the death rate through naive Bayesian classification algorithm.

Key words: *Machine Learning, Naive Bayes Classification, Smoothing, EU Countries, COVID-19.*

GİRİŞ

Pandemi, çok sayıda insanı etkileyen ve küresel düzeyde görülebilen salgın hastalık olarak açıklanabilir. 2019 yılının aralık ayında Çin Halk Cumhuriyeti'nde ortaya çıkan Koronavirüs (COVID-19) salgını, dünyanın neredeyse her yerinde etkili olmuştur. Hızla tüm dünyaya yayılan COVID-19, Dünya Sağlık Örgütü tarafından Mart 2020'de pandemi olarak ilan edilmiştir.

Bu çalışma, Avrupa Birliği ülkeleri (Avusturya, Belçika, Bulgaristan, Çekya, Danimarka, Estonya, Finlandiya, Fransa, Hırvatistan, Almanya, Yunanistan, Hollanda, İrlanda, İspanya, İsveç, İtalya, Güney Kıbrıs Rum Yönetimi, Letonya, Litvanya, Lüksemburg, Macaristan, Malta, Polonya, Portekiz, Romanya, Slovakya, Slovenya olmak üzere 27 ülke) için Ocak 2020'den Aralık 2022'ye kadar olan 1094 günlük pandemi verisini kapsamaktadır.

COVID-19 vaka sayılarındaki artışın COVID-19 sebebiyle olan ölüm sayılarını etkilediği görülmüştür. Bu çalışmada hedef (bağımlı) değişken olarak ölüm sayıları analiz edilmektedir.

Kesikli ham verilerin düzgünleştirilmiş (smoothed) forma dönüştürülmesiyle fonksiyonel eğriler elde edilmektedir. Bu kavram Ramsay ve Dalzell tarafından ilk olarak kullanılmıştır (Ramsay ve Dalzell, 1991). Literatürde çok değişkenli istatistiksel tekniklerin fonksiyonel biçiminin elde edilebilmekte olduğu görülmüştür. Bunlardan bazıları fonksiyonel (lojistik) regresyon analizi, fonksiyonel diskriminant analizi, fonksiyonel kümeleme analizi vb. şeklindedir.

Bu çalışmanın amacı makine öğrenmesi yöntemlerinden biri olan sınıflandırma yaklaşımlarından naive bayes ile fonksiyonel verileri analiz etmektir. Böylece baz fonksiyon ile düzgünleştirilerek elde edilen fonksiyonel verilerin, bayesyen sınıflandırma kapsamında kullanılıp kullanılamayacağını araştırılmaktadır. Fonksiyonel verilere naive bayes analizi uygulanıp uygulanamayacağı ve uygulandığı takdirde performansın nasıl olacağı ile ilgilenilmektedir.

MATERYAL VE METOD

Materyal

Bu çalışmada kullanılan veriler Our World in Data sitesinden edinilmiştir. Analiz, R programlama dili ile gerçekleştirilmiştir. Bu çalışmada ham veriler düzgünleştirilip 30 baz fonksiyon ile oluşturulan fonksiyonel nesnelerle temsil edilmektedir.

Öncelikle Avrupa Birliği ülkelerine ait zaman boyutunda kesikli gözlenen 13 girdi (bağımsız) değişkene göre eğriler baz fonksiyon yaklaşımı ile düzgünleştirilerek tahminlenmiştir. Bu değişkenler sırasıyla; milyonda yeni vaka sayıları, COVID-19 çoğalma (üreme) oranı, milyonda yoğun bakım hastası sayıları, milyonda hastane hastası sayıları, binde yeni test sayısı, pozitif çıkan günlük COVID-19 testlerinin oranı, doğrulanmış vaka başına yapılan test sayısı, yüzde günlük aşı dozu, yüzde ilk aşılarını olan insan sayısı, yüzde ilk aşılarını tamamlayan (ikinci aşı) insan sayısı, yüzde takviye doz (üçüncü) aşı olan insan sayısı, sıkılık (katılık) indeksi şeklindedir.

Hedef değişken bir milyonda yeni COVID-19 ölüm sayıları olup sınıflandırma elde edilirken ortalama ölüm sayısı eğrisinin altında olan değerler için ölüm oranı düşük, üstünde olan değerler için ölüm oranı yüksek etiketi ile iki kategoriliye dönüştürülmüştür. Benzer şekilde tüm girdi değişkenler değerleri de düzgünleştirme işleminin ardından düşük ve yüksek olarak iki kategoride tanımlanmıştır.

Kesikli veri matrisi verilerin düzgünleştirilerek fonksiyonel eğriye dönüştürülmesi ile her değişken için her biri T = [1, 1094] zaman aralığında tanımlanan 27 fonksiyonel gözleme dönüşmektedir. Ülke eğrileri 30 baz fonksiyon için 810 fonksiyonel nesne katsayısı ile temsil edilmektedir. Ardından naive Bayes sınıflandırma analizi fonksiyonel nesneler ile gerçekleştirilmiştir.

Metod

Kesikli Verilerin Düzgünleştirilmesi

Ham verilerin düzgünleştirilmesi ile düzgünleştirilmiş veriler elde edilmektedir. Bu veriye fonksiyonel nesne ya da eğri adı verilir. İşaretlenmiş noktaları birleştiren düzgün (pürüzsüz) bir eğri elde etmek amacıyla oluşturulan esnek çizim aracına Splayn adı verilmektedir. Splayn aynı zamanda bir interpolasyon aracıdır. Bu durumun matematiksel modellemeye yansıması ile Splayn fonksiyonlar ortaya çıkmıştır. Splayn fonksiyonlar, tanımlandığı aralığı gözlem değerlerinden faydalanarak alt aralıklara ayırmakta ve her bir alt aralıkta farklı bir polinom fonksiyonu ile bağımlı ve bağımsız değişkenler arasındaki ilişkiyi modellendirme yoluyla sürekli bir fonksiyon oluşturmaktadır (Reinsh, 1967; Zhang ve Chen, 2007). Böylece hızlı iniş çıkış görünümünde olan veriye düzgünleştirme işlemi uygulanmaktadır.

Veriye uyumu sağlanan düzgün fonksiyonu elde etme yöntemlerinden biri belirli sayıda fonksiyondan oluşan bir baz sistemi belirlemektir. Literatürde gözlem sayısı ile $\sqrt{n_i}$ adet baz fonksiyon önerilmiştir (Ramsay ve Silverman, 1997). Böylece uyum fonksiyonu baz fonksiyonların lineer birleşimi olarak ifade

edilmektedir. Elde edilen fonksiyon, k tane baz fonksiyonun c_i katsayılarıyla ağırlıklanmış toplamı olarak aşağıdaki gibi gösterilebilir (Keser, 2008; Koymen Keser ve Deveci Kocakoç, 2021). Burada temel fikir veri setinin gerçekte var olan bir fonksiyondan ( ) örnek k denmiş olabileceği ve bu fonksiyonun tahminlenebileceği şeklindedir.

$$x = c_1 B_1(t) + c_2 B_2(t) + \cdots + c_k B_k(t)$$

Modelde, $B(t)$ baz fonksiyonları, c ise bu baz fonksiyonlara karşılık gelen parametreyi simgelemektedir. Gerçek fonksiyonun tahmini, bu fonksiyona benzer niteliklere sahip olan baz fonksiyonların seçilmesi ile yakından ilişkilidir (Yaraee, 2011). Düzgünleştirilmiş veri elde etmek için sıklıkla Splayn baz fonksiyon yaklaşımına başvurulmaktadır. j-inci B-Splayn (d derece) aşağıdaki tekrarlı ilişki ile hesaplanmaktadır (Eilers ve Marx, 1996).

$$B_{j,d}(t) = \frac{t - t_j}{t_{j+d} - t_j} B_{j,d-1}(t) + \frac{t_{j+1+d} - t_j}{t_{j+1+d} - t_{j+1}} B_{j+1,d-1}(t)$$

Eğrinin düzgünlüğünün ölçüsü ile veriye sağladığı uyum arasında bir uzlaşı sağlamak amacıyla Pürüzlü Ceza Yöntemi kullanılabilir. Böylece c katsayıları tahminlenebilir. Burada Cezalı Artık Kareler Toplamı (CAKT), Artık Kareler Toplamı (AKT) cezalandırılarak elde edilmektedir. Bu işlem, (λ düzgünleştirme parametresi) ile düzgünlük ölçüsünün çarpımı aracılığıyla sağlanmaktadır.

$$\text{CAKT} = \text{AKT} + \lambda * \|D^2 x\|^2$$

Artık kesikli veriler yerine yeni elde edilen fonksiyonel verilerle analize devam edilir.

Bayesyen Sınıflandırma Analizi

Makine öğreniminde sınıflandırma, öğrenme ve tahmin sürecinden oluşur. Öğrenme aşamasında mevcut veriden bir model eğitilir. Tahmin aşamasında eğitilen modelin test verisini doğru tahminleme performansı değerlendirilir. Model eğitimi sürecinde Bayesyen (naive Bayes) sınıflandırma algoritmasına başvurulabilir. Bu algoritma veri madenciliği ve makine öğrenmesi için etkili bir tümevarımsal öğrenme sağlamaktadır (Zhang, 2004). Naive Bayes sınıflandırma, denetimli bir makine öğrenmesi tekniği olup bir denetleyici tarafından bilinen bir hedef değer için tanımlanmış girdi verileri ile algoritmanın eğitilmesidir (McCallum ve Nigam, 1998). Karmaşık yöntemlerin sınıflandırma sonuçlarına naive Bayes ile daha kolay bir şekilde yaklaşmak mümkün olabilmektedir. Bu sebeple naive (basit) ismini almıştır.

Naive Bayes, verinin özelliklerinin belirli bir sınıfa bağımlılığını korur ve uygun olan sınıflandırmayı gerçekleştirir. Bununla birlikte olayların meydana gelme olasılıklarını değerlendirir ve her yeni durumda elde edilen yeni bilgiler ile olasılıkları yeniden hesaplar (Lantz, 2013; Adem ve Orhan, 2012). Naive Bayes sınıflandırma Bayes teoremine dayanmaktadır. Değişkenlerin koşulları söz konusu olduğunda gözlemin bir sınıfa ait olma olasılığı Bayes formülü ile hesaplanacak olasılığın bir genişlemesinden oluşur. Birçok değişkenin kesişimi olan gözlem için çıktı sınıfı tahminlenirken tüm değişkenlerin koşullu olasılıklarının çarpımı dikkate alınmaktadır. Böylece Bayes teoremi ile elde edilen olasılıkların ötesinde sınıf kategorileri elde edilebilmektedir. Bu olay naive Bayes sınıflamanın Bayes teoreminden temel farkıdır.

Bayes teoremi, olasılık teorisi ile ilişkili olarak gözleme dayanan olasılık dağılımlarındaki parametreleri tahminlemeye yarayan bir yöntemdir (McNamara ve ark., 2006). Bayes teoremi, ön olasılıklardan yola çıkarak çeşitli koşullu olasılıkları gösterir. Bir olayın başka bir olayla ilişkili olarak meydana gelmesi olasılığı koşullu olasılık kavramı ile açıklanabilir. $P(A|B)$ şeklinde gösterilen koşullu olasılık, B olayının meydana gelmesi koşuluyla A olayının meydana gelmesi olasılığı şeklinde ifade edilebilir (Oral Erbaş, 2013).

Bayes teoreminde süreçten elde edilen sonucun sebebi araştırılmaktadır. Böylece Bayes teoreminin bir sonuç-sebep ilişkisini araştırdığı söylenebilir. Böylece $P(B|A_i)$ koşullu olasılığı biliniyorken, $P(A_i|B)$

koşullu olasılığı araştırılmaktadır. B olayının oluşmasına bağlı olarak, i-inci A olayının oluşması olasılığı aşağıda verilen genel Bayes teoremi yardımıyla elde edilmektedir (Bayes, 1764).

$$P(A_i|B) = \frac{P(B|A_i) * P(A_i)}{\sum P(B|A_i) * P(A_i)} = \frac{P(A_i \cap B)}{\sum P(B|A_i) * P(A_i)}$$

Burada paydada yer alan formül farklı A olaylarından doğabilecek B olaylarının toplam olasılığını elde etmektedir. O halde yeni bir gözlemin hangi sınıfa ait olduğunun tahminlenmesinde Bayes teoremine başvurulabilir. Böylece yeni verinin hangi sınıfta olma olasılığı daha yüksek tahminleniyorsa o yönde karar verilebilir. Bayes teoreminde hesaplanan olasılıkların sınıflandırma amacıyla kullanılmasına (Naive) Bayesyen sınıflandırma adı verilmektedir.

Bayes teoreminde paydada bulunan toplam olasılık ifadesi çıktı sınıflarının olasılık hesaplarında ortak kullanıldığından dolayı Naive Bayes'te göz ardı edilebilir (Adem ve Orhan, 2012). Böylece Naive Bayes yöntemi koşullu bağımsızlık varsayımıyla gerçekleştirilir. Hesaplamada bütün koşullu olasılıkların çarpımı ele alınır. Değişkenlere ait değerlerin k tane sınıftan oluşan S_i sınıflandırıcısının hangi sınıfına ait olduğu $P(S_i|X)$ koşullu olasılıkları ile elde edilir. Bu olasılıklardan en yükseğinin hangi sınıfa ait olduğu araştırılır. Değişkenlerin koşullarına bağlı olarak S_i sınıflarının gerçekleşmesi olasılıkları aşağıdaki denklemle verilen Naive Bayes formülü ile hesaplanmaktadır (Engin, 2022). X değişkenler vektörü $X' = [x_1 \quad x_2 \quad \dots \quad x_n]$ şeklindedir. Değişken vektörlerinin ait olduğu sınıfın olasılığı pay ile verilen formülle hesaplanmaktadır.

$$P(S_i|X) = \frac{P(X|S_i) * P(S_i)}{P(X)}$$

$P(X|S_i)$ olasılığı, eğitim veri seti ile aşağıdaki gibi hesaplanır.

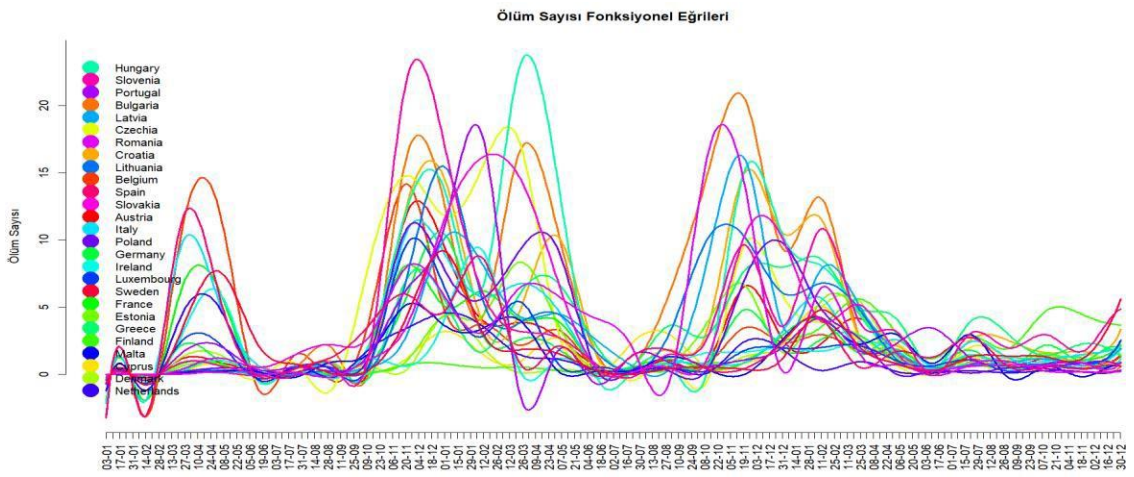
$$P(X|S_i) = P(x_1|S_i) * P(x_2|S_i) * \dots * P(x_n|S_i) = \prod P(x_j|S_i), \quad j = 1,2,\dots n$$

i-inci gözlemin ait olduğu sınıf etiketi S_i aşağıda verilen maksimizasyon ile hesaplanmaktadır. Bu işleme en büyük sonsal sınıflandırma adı verilmektedir (Balaban ve Kartal, 2018).

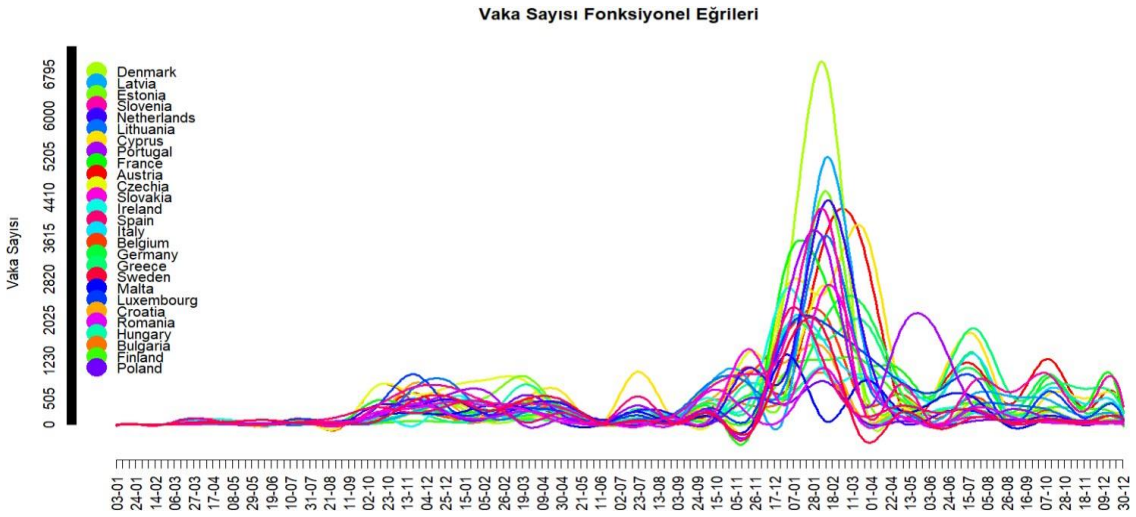
$$S_i = argmax_{S_i} \prod_{j=1}^{n} P(x_j|S_i) * P(S_i), \quad i = 1, \dots, k$$

BULGULAR

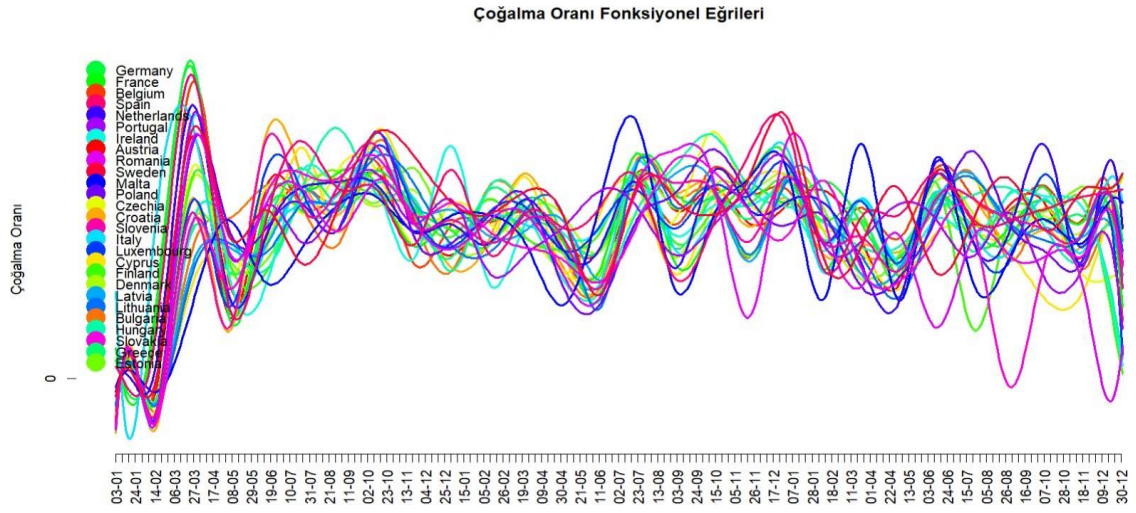
Bu çalışmada literatürde önerilen $\sqrt{1094}$ değerinin yaklaşık değeri olarak 30 baz fonksiyon ile düzgünleştirme yapılmıştır. Aşağıdaki şekillerde (Şekil 1-13) 1 hedef ve 12 girdi değişkenine göre ülkeler için elde edilen düzgün eğriler sunulmuştur.



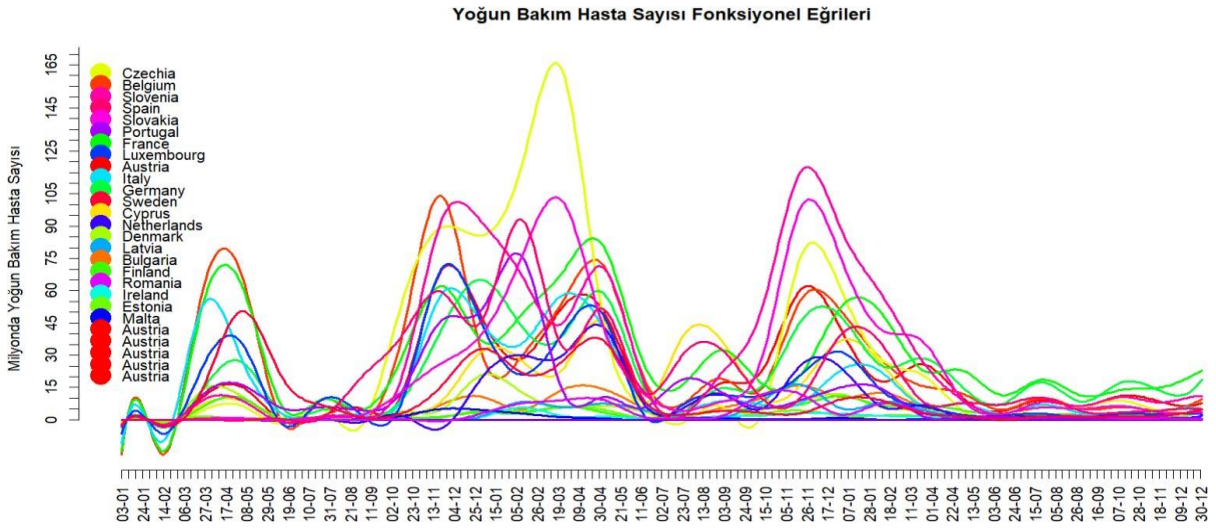
Şekil 1. Ülkelerin ölüm sayısı düzgünleştirilmiş eğrileri



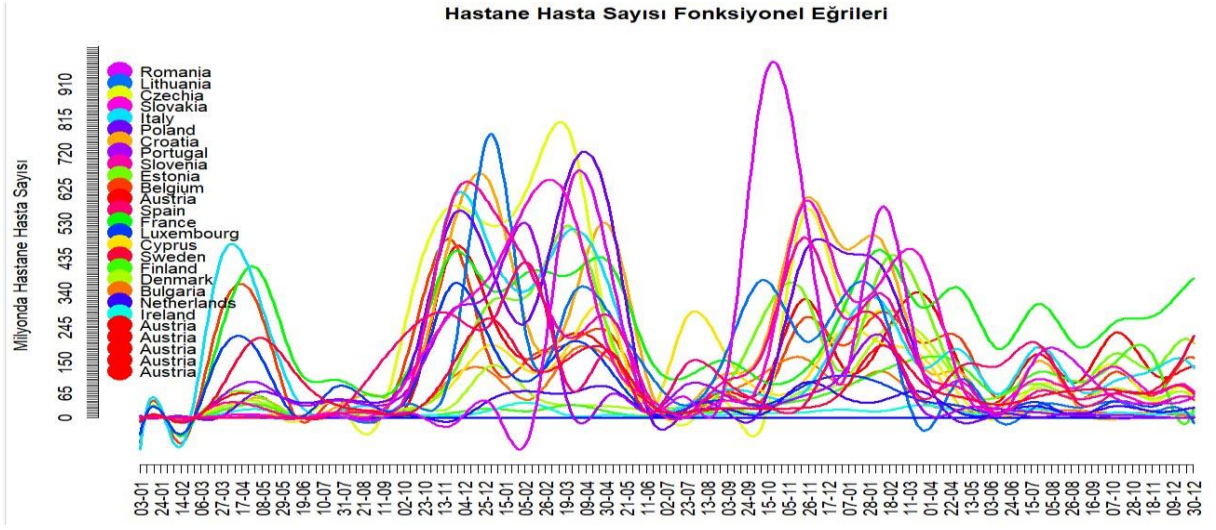
Şekil 2. Ülkelerin vaka sayısı düzgünleştirilmiş eğrileri



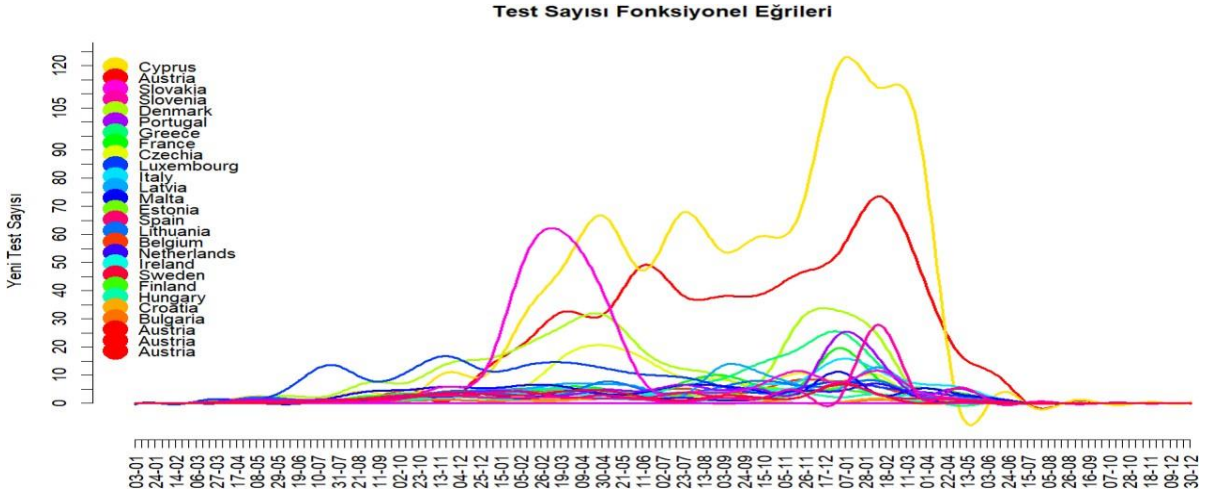
Şekil 3. Ülkelerin çoğalma oranı düzgünleştirilmiş eğrileri



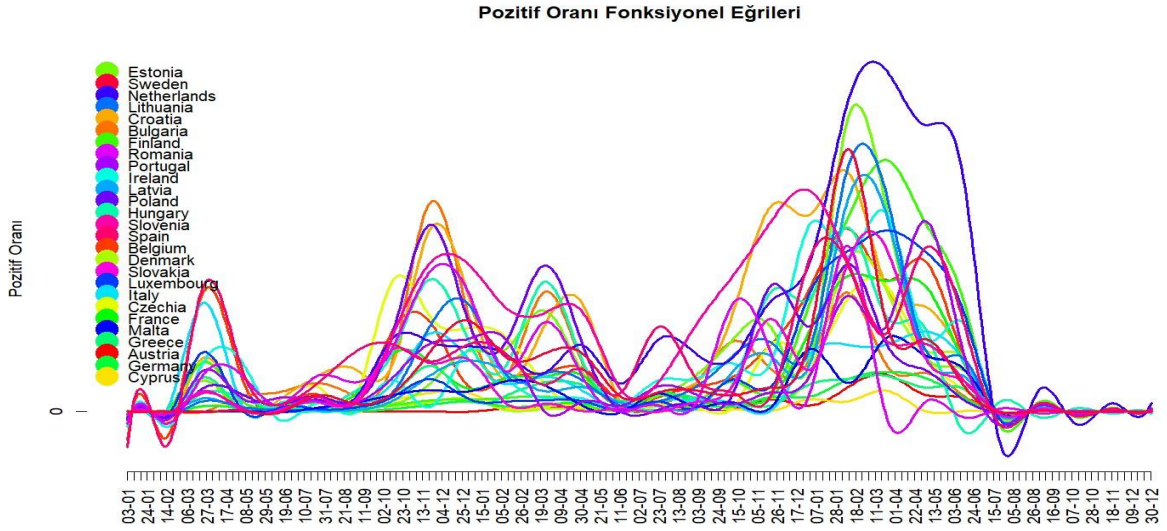
Şekil 4. Ülkelerin yoğun bakım hasta sayısı düzgünleştirilmiş eğrileri



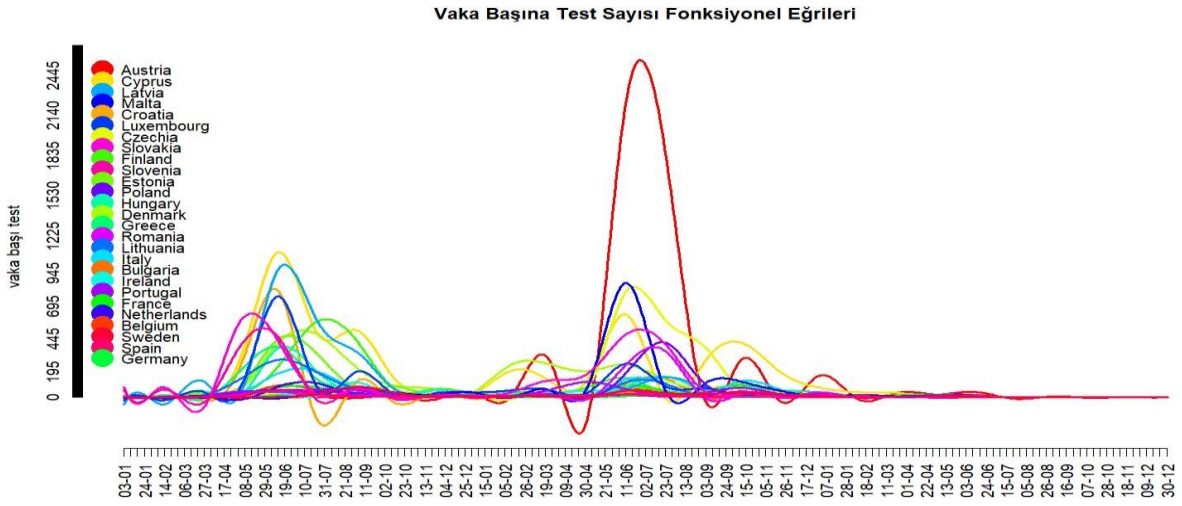
Şekil 5. Ülkelerin hastane hasta sayısı düzgünleştirilmiş eğrileri



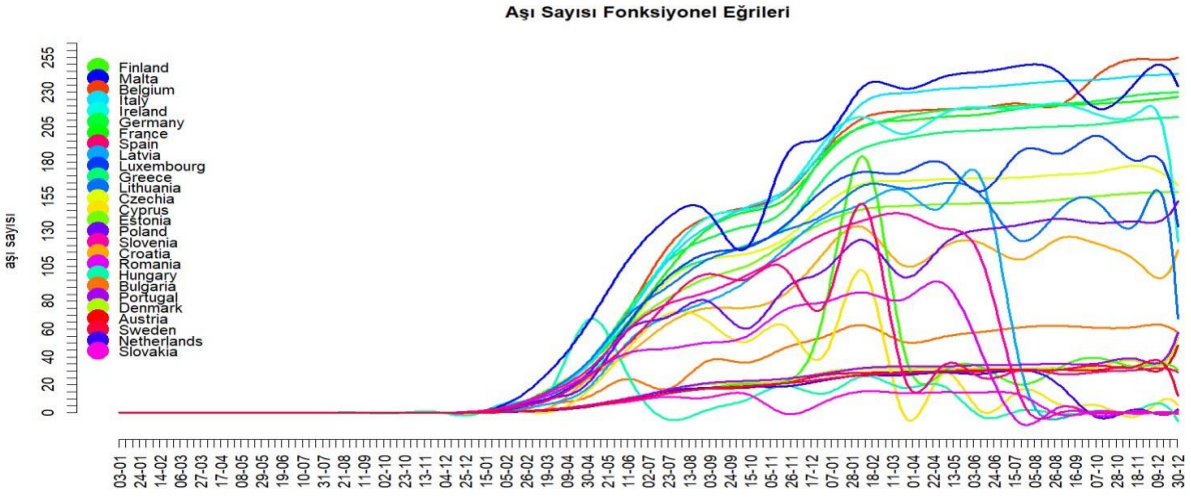
Şekil 6. Ülkelerin test sayısı düzgünleştirilmiş eğrileri



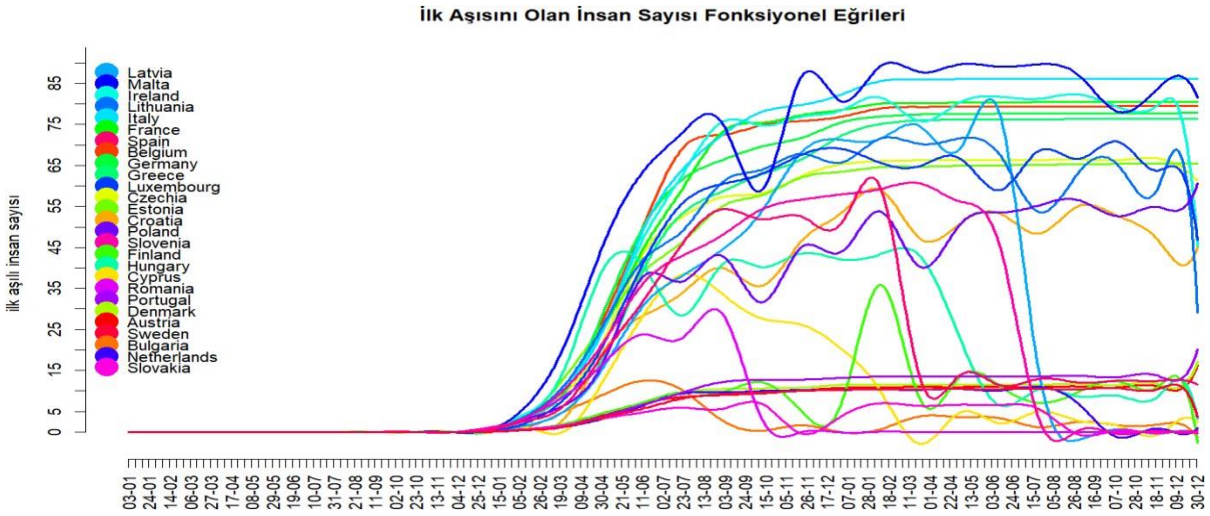
Şekil 7. Ülkelerin pozitif oranı düzgünleştirilmiş eğrileri



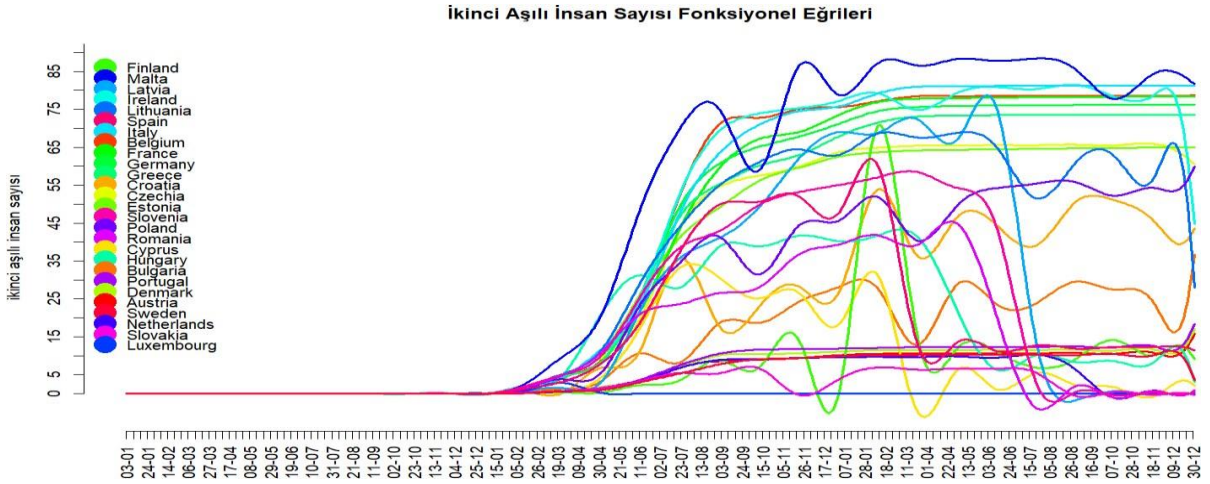
Şekil 8. Ülkelerin vaka başına test sayısı düzgünleştirilmiş eğrileri



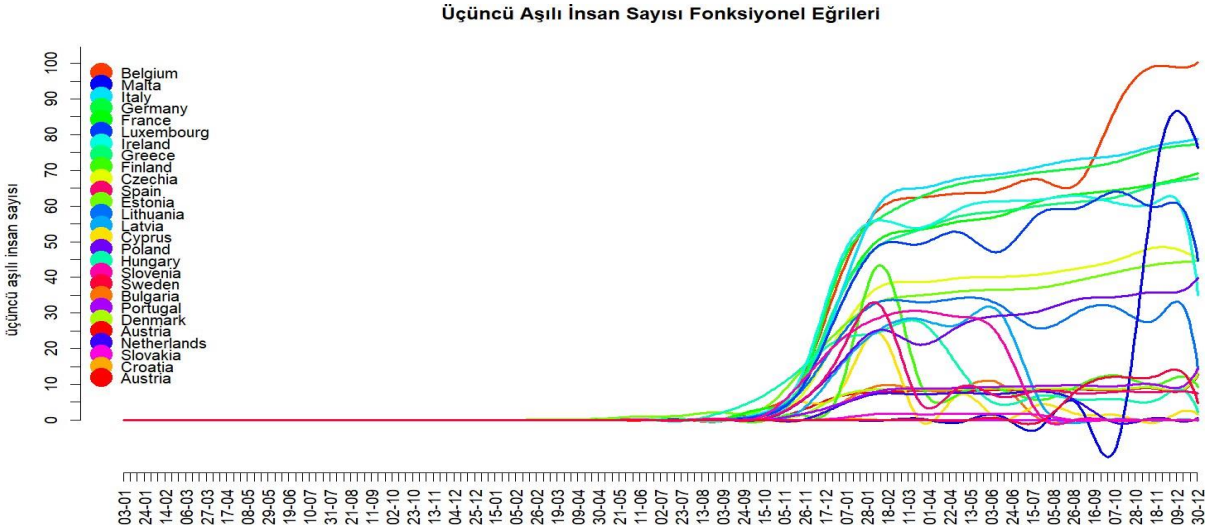
Şekil 9. Ülkelerin aşı sayısı düzgünleştirilmiş eğrileri



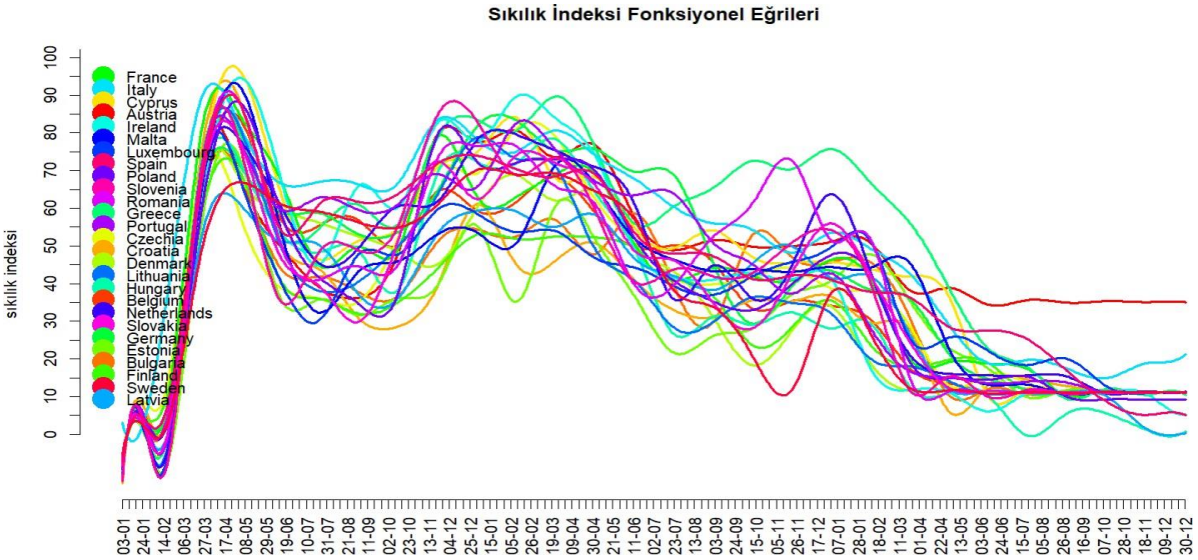
Şekil 10. Ülkelerin ilk aşılarını olan insan sayısı düzgünleştirilmiş eğrileri



Şekil 11. Ülkelerin ikinci aşılarını olan insan sayısı düzgünleştirilmiş eğrileri



Şekil 12. Ülkelerin üçüncü aşılarını olan insan sayısı düzgünleştirilmiş eğrileri



Şekil 13. Ülkelerin sıkılık indeksi düzgünleştirilmiş eğrileri

B-Splayn 30 baz ile uyumu sağlanan fonksiyonel eğrilerin ham veriye oldukça benzediği söylenebilir. Yapılan düzgünleştirme işlemi ile hızlı iniş çıkış hareketine sahip olan ham veri bir miktar düzleşmiştir. Düzgünleştirilmiş veriler ile elde edilen naive Bayes sınıflandırma bulguları aşağıda verilmiştir. Veri setinin %80'i eğitim, kalanı test verisi olarak belirlenmiştir. Analizden önce ülkelerin değişken değerleri ortalama eğrilerine göre altta kalanlar için düşük, üstte kalanlar için yüksek olarak iki sınıfa ayrılmıştır.

İlk olarak Şekil 14'te görüldüğü gibi R'da değişkenler ikili faktör olarak tanımlanır. Veri setlerinin ayrılması ve modelin kurulması için kullanılan kodlar Şekil 15'te sunulmuştur. Ayrıca veri kümelerinin değişken kategorilerine göre istatistikleri Şekil 16'da görülmektedir.

```
> str(naivebayesveri)
tibble [810 × 13] (S3: tbl_df/tbl/data.frame)
 $ Vaka_Sayısı              : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 2 ...
 $ Çoğalma_Oranı            : Factor w/ 2 levels "düşük","yüksek": 1 1 1 2 1 2 2 2 2 2 ...
 $ Yoğun_Bakım_Hasta_Sayısı: Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 2 1 1 1 1 2 ...
 $ Hastane_Hasta_Sayısı     : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 2 ...
 $ Test_Sayısı              : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 1 ...
 $ Pozitif_Oranı            : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 1 ...
 $ Vaka_Başı_Test           : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 1 ...
 $ Günlük_Aşı_Sayısı        : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 1 ...
 $ İlkdoz_Aşılı_İnsan       : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 1 ...
 $ İkincidoz_Aşılı_İnsan    : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 1 ...
 $ Takviyedoz_Aşılı_İnsan   : Factor w/ 2 levels "düşük","yüksek": 1 1 1 1 1 1 1 1 1 1 ...
 $ Sıkılık_İndeksi          : Factor w/ 2 levels "düşük","yüksek": 1 1 1 2 2 2 1 1 1 2 ...
 $ Ölüm_Oranı               : Factor w/ 2 levels "Düşük","Yüksek": 1 1 1 1 1 1 1 1 1 2 ...
```

Şekil 14. Fonksiyonel değişkenlerin R'da faktör olarak tanımlanması

```
split = sample.split(naivebayesveri$Ölüm_Oranı, SplitRatio = 0.80)
naivebayesegitimkümesi = subset(naivebayesveri, split == TRUE)
naivebayestestkümesi = subset(naivebayesveri, split == FALSE)
installed.packages("e1071")
library(e1071)
model=naiveBayes(Ölüm_Oranı~.,data = naivebayesegitimkümesi)
install.packages('caret')
library(caret)
tahmin=predict(model, naivebayestestkümesi[-13], type='class')
sonuç=confusionMatrix(tahmin, naivebayestestkümesi$Ölüm_Oranı)
```

Şekil 15. R ile naive Bayes sınıflandırma kod parçaları

```
> summary(naivebayesveri)
 Vaka_Sayısı  Çoğalma_Oranı Yoğun_Bakım_Hasta_Sayısı Hastane_Hasta_Sayısı Test_Sayısı  Pozitif_Oranı Vaka_Başı_Test
 düşük :576   düşük :370    düşük :597               düşük :584           düşük :556   düşük :552    düşük :605
 yüksek:234   yüksek:440    yüksek:213               yüksek:226           yüksek:254   yüksek:258    yüksek:205
 Günlük_Aşı_Sayısı İlkdoz_Aşılı_İnsan İkincidoz_Aşılı_İnsan Takviyedoz_Aşılı_İnsan Sıkılık_İndeksi  Ölüm_Oranı
 düşük :452        düşük :443         düşük :470            düşük :576             düşük :389      Düşük :566
 yüksek:358        yüksek:367         yüksek:340            yüksek:234             yüksek:421      Yüksek:244
```

```
> summary(naivebayesegitimkümesi)
 Vaka_Sayısı  Çoğalma_Oranı Yoğun_Bakım_Hasta_Sayısı Hastane_Hasta_Sayısı Test_Sayısı  Pozitif_Oranı Vaka_Başı_Test
 düşük :455   düşük :303    düşük :477               düşük :461           düşük :441   düşük :445    düşük :488
 yüksek:193   yüksek:345    yüksek:171               yüksek:187           yüksek:207   yüksek:203    yüksek:160
 Günlük_Aşı_Sayısı İlkdoz_Aşılı_İnsan İkincidoz_Aşılı_İnsan Takviyedoz_Aşılı_İnsan Sıkılık_İndeksi  Ölüm_Oranı
 düşük :345        düşük :341         düşük :365            düşük :448             düşük :320      Düşük :453
 yüksek:303        yüksek:307         yüksek:283            yüksek:200             yüksek:328      Yüksek:195
> summary(naivebayestestkümesi)
 Vaka_Sayısı  Çoğalma_Oranı Yoğun_Bakım_Hasta_Sayısı Hastane_Hasta_Sayısı Test_Sayısı  Pozitif_Oranı Vaka_Başı_Test
 düşük :121   düşük :67     düşük :120               düşük :123           düşük :115   düşük :107    düşük :117
 yüksek: 41   yüksek:95     yüksek: 42               yüksek: 39           yüksek: 47   yüksek: 55    yüksek: 45
 Günlük_Aşı_Sayısı İlkdoz_Aşılı_İnsan İkincidoz_Aşılı_İnsan Takviyedoz_Aşılı_İnsan Sıkılık_İndeksi  Ölüm_Oranı
 düşük :107        düşük :102         düşük :105            düşük :128             düşük :69       Düşük :113
 yüksek: 55        yüksek: 60         yüksek: 57            yüksek: 34             yüksek:93       Yüksek: 49
```

Şekil 16. Veri, eğitim ve test kümesi için iki kategoriye ayrılmış değişkenlerin özet istatistikleri

```
Naive Bayes Classifier for Discrete Predictors

Call:
naiveBayes.default(x = X, y = Y, laplace = laplace)

A-priori probabilities:
Y
    Düşük     Yüksek
0.6990741 0.3009259

Conditional probabilities:
        Vaka_Sayısı
Y            düşük    yüksek
  Düşük  0.8035320 0.1964680
  Yüksek 0.4666667 0.5333333

        Çoğalma_Oranı
Y            düşük    yüksek
  Düşük  0.4348786 0.5651214
  Yüksek 0.5435897 0.4564103

        Yoğun_Bakım_Hasta_Sayısı
Y            düşük    yüksek
  Düşük  0.8543046 0.1456954
  Yüksek 0.4615385 0.5384615

        Hastane_Hasta_Sayısı
Y            düşük    yüksek
  Düşük  0.8432671 0.1567329
  Yüksek 0.4051282 0.5948718

        Test_Sayısı
Y            düşük    yüksek
  Düşük  0.7505519 0.2494481
  Yüksek 0.5179487 0.4820513

        Pozitif_Oranı
Y            düşük    yüksek
  Düşük  0.799117 0.200883
  Yüksek 0.425641 0.574359

        Vaka_Başı_Test
Y            düşük    yüksek
  Düşük  0.7174393 0.2825607
  Yüksek 0.8358974 0.1641026

        Günlük_Aşı_Sayısı
Y            düşük    yüksek
  Düşük  0.5320088 0.4679912
  Yüksek 0.5333333 0.4666667

        İlkdoz_Aşılı_İnsan
Y            düşük    yüksek
  Düşük  0.5209713 0.4790287
  Yüksek 0.5384615 0.4615385

        İkincidoz_Aşılı_İnsan
Y            düşük    yüksek
  Düşük  0.5629139 0.4370861
  Yüksek 0.5641026 0.4358974

        Takviyedoz_Aşılı_İnsan
Y            düşük    yüksek
  Düşük  0.6975717 0.3024283
  Yüksek 0.6769231 0.3230769

        Sıkılık_İndeksi
Y            düşük    yüksek
  Düşük  0.5739514 0.4260486
  Yüksek 0.3076923 0.6923077
```

Şekil 17. Naive Bayes modeli sınıflandırma koşullu olasılık değerleri

Şekil 17'de naive Bayes sınıflandırma modeli görülmektedir. Modelde girdi değişkenlerinin ölüm sayısı hedef değişkeni (Y) ile olan koşullu olasılık değerleri hesaplanmıştır. Böylece analiz kapsamında koşullu olasılıklar yardımıyla gözlem birimlerinin atanacağı hedef sınıfın olasılıkları belirlenmiştir. Bu model ile test verisi üzerinde elde edilen tahmin sonuçları Şekil 18'de görülmektedir.

```
> summary(tahmin)
 Düşük Yüksek
   120     42
```

Şekil 18. Naive Bayes modeli test verisi tahmin sonuçları

Karmaşıklık matrisi (confusion matrix) istatistikleri Şekil 19'da verilmiştir. Buna göre $p - değeri < 0{,}05$ olduğundan dolayı elde edilen model için doğruluk oranının (accuracy) bilgisizlik oranından (no information rate) istatistiksel olarak anlamlı derecede büyük olduğu söylenebilir. Bu sonuç, 30 baz fonksiyon ile düzgünleştirilmiş veri yaklaşımı sağlanan naive Bayes sınıflandırma modelinin anlamlılığını doğrular niteliktedir. Bilgisizlik oranı ile doğruluk oranı arasındaki ilişkiyi ölçen kappa istatistiğinin %74 olup yüksek olması uyumun tesadüfi olmayıp önemli seviyede olabileceğini göstermektedir. Ayrıca elde edilen model, ölüm sayısını %89,5 oranında doğru sınıflandırma performansı ile tahminlenmektedir. Modelin duyarlılık (sensitivity) oranı ise %95,6 olarak bulunmuştur.

```
> sonuç
Confusion Matrix and Statistics

          Reference
Prediction Düşük Yüksek
    Düşük    108     12
    Yüksek     5     37

               Accuracy : 0.8951
                 95% CI : (0.8373, 0.9377)
    No Information Rate : 0.6975
    P-Value [Acc > NIR] : 1.793e-09

                  Kappa : 0.7408

 Mcnemar's Test P-Value : 0.1456

            Sensitivity : 0.9558
            Specificity : 0.7551
         Pos Pred Value : 0.9000
         Neg Pred Value : 0.8810
             Prevalence : 0.6975
         Detection Rate : 0.6667
   Detection Prevalence : 0.7407
      Balanced Accuracy : 0.8554

       'Positive' Class : Düşük
```

Şekil 19. Düzgünleştirilmiş veri ile naive Bayes modeli tahmin performansı

Ölüm sayısı üzerinde etkili olan en önemli değişkenler genel olarak vaka sayısı, yoğun bakım hasta sayısı, hastane hasta sayısı, test sayısı, pozitif oranı, takviye (üçüncü) doz aşılı insan sayısı ve sıkılık indeksi değişkenleri olarak bulunmuştur. Bu değişkenler koşullu olasılıkların iki hedef sınıf arasında seçim yapma kuvvetine bağlı olarak tespit edilmiştir.

SONUÇ VE TARTIŞMA

Düzgünleştirilmiş veri yaklaşımı ile naive Bayes sınıflandırma modeli yüksek bir doğru sınıflandırma oranı sağlamıştır. Bu sonuç, yeterli sayıda baz ile kesikli verilere fonksiyon uyumu sağlayarak -hatta eksik ve kayıp gözlemleri olan verileri düzgünleştirme yoluyla tahminleyerek- bayesyen sınıflandırma ile tahminlemenin yolunu açabilir. Böylece hedef değişkeni sınıflara ayırmada olasılıksal olarak önemli olan değişkenlerin belirlendiği bir sınıflandırma modeli elde edilebilir.

Kaynaklar

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The Cluster Analysis of Countries' Happiness Using the CoClust Algorithm

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Abstract

The World Happiness Report, first published in 2012, emerges as an intriguing study concerning the state of global happiness. In recent times, governments, organizations, and civil society have increasingly utilized happiness indicators in shaping policies, contributing to the global recognition of this research. It serves as an effective study primarily aimed at evaluating the progress of countries in areas such as financial matters, various social policies, national insights, and well-being. To achieve these objectives, the 2022 World Happiness Report, utilizing data from the Gallup World Poll, has been assessed, and this report was accessed from the Kaggle website. The dataset includes variables such as happiness score and the factors used to explain this score (GDP per capita, social support, healthy life expectancy, freedom to make life choices, generosity, perceptions of corruption, and scores regarding life evaluations being higher than dystopia). The main focus of this study is to cluster countries in the report based on happiness indicators. For this purpose, a copula-based clustering algorithm called CoClust has been employed in the analysis. CoClust is an innovative model-based clustering algorithm that assumes data is generated by a multivariate copula model. In the application phase of the CoClust algorithm, the Frank copula model from the Archimedean copula family has been preferred. The number of clusters in CoClust algorithm has been set to vary between 2 and 7. The log-likelihood that best fits the final clustering for the Frank copula was found to be 1827.803. Unlike traditional clustering approaches, CoClust focuses on relationships between clusters rather than relationships within clusters. Based on this approach, in all tested clusters for k=[2:7], the countries that are related to each other in the first row stand out as Denmark, Finland, Switzerland, Netherlands, Sweden, New Zealand, and Austria. As a result, the copula-based CoClust algorithm successfully identified countries with similar happiness indicators. This study provides insights into both the cluster groups that countries belong to and countries that are related but located in different clusters. Thus, the distinctiveness and importance of the CoClust algorithm compared to other clustering approaches are clearly highlighted. Additionally, the results of this research can assist governments and policymakers in shaping their policies and encouraging the adoption of common policies worldwide.

Key words: *Clustering, Coclust, Copula, Happiness Report*

Multivariate Modeling of Insurance Compensation Payments with Regression Models and Copulas via Machine Learning Techniques: A Comparison Study

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Abstract

Traffic insurance is one of the most fundamental legal obligations for all vehicle owners. Insurance companies are obligated to provide compensation payments such as material, death and invalidity compensation, under the umbrella of traffic insurance following the occurrence of a claim. In this study, insurance compensation payments which are pivotal expenses for insurance companies are modeled using multivariate statistical methods. The assumption of gamma distribution for logarithmic compensation payments are used with both regression-based and copula-based multivariate methods. Regression-based models are considered as bivariate gamma regression which is established using the bivariate gamma distribution, and the mixture of bivariate gamma regressions with the mixture of experts, one of the machine learning techniques. Copula-based multivariate models are discussed as bivariate copula regression and finite mixture of copula regression models which are designed using Gumbel and Frank copula functions. A comparative analysis is conducted using insurance compensation payments for Turkish motor vehicles compulsory third party liability insurance between 2018 and 2022 by mvClaim package in R. It is noticed that, the mixture of copula-based models is more suitable for the multivariate modeling of insurance compensation payments.

Key words: *Bivariate Gamma Distribution, Generalized Linear Model, Copula Regression, Insurance Compensation Payments, Mixture of Experts Model.*

Development and Environmental Health Risks: An Econometric Analysis For Azerbaijan

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Abstract

In today's world, economic development brings with it environmental problems. Today, environmental pollution, which includes water, soil and air pollution, irreversible loss of biological diversity, the gradual disappearance of natural resources such as water, fertile agricultural lands and fish are among the most serious threats to economic development and sustainable development. The environment is exposed to violence and destruction. However, little attention is paid to the significant consequences of environmental problems, including adverse effects on human health. However, human capital theory emphasizes that healthy people are essential for economic development. Sustainable development attaches great importance to the protection of the environment for the welfare of current and future generations. The understanding of sustainable development makes the protection of natural resources and the environment the helper of development and the protector of the interests of future generations.

Environmental health risks, which have become a global problem, have been the subject of investigation recently. One way of solving environmental problems caused by economic development is to identify these problems and reduce risks by ensuring stable economic development. In the study, the relationship between economic development and environmental health risks was examined based on the period of 1995-2021 for the Azerbaijan economy. In the established econometric model, the variables of GDP per capita, carbon dioxide emissions per capita and health expenditures were used. VAR analysis, which is one of the time series methods, was used in the study. First, the econometric model was established and the stationarity of the variables in the model was examined. VAR analysis was performed after it was determined that the variables were integrated to the same degree. As a result of the basic assumption tests for the VAR analysis, it has been determined that there is no specification error in the model. Finally, action-response graphs were examined in the study and variance decomposition analysis results were explained. As a result, it has been determined that economic development in the Azerbaijan economy, like other developing countries, causes some environmental health risks.

Keywords: *Development, Environment, Azerbaijan, Impulse-Response, VAR*

INTRODUCTION

In the process that started with the Industrial Revolution and continued until the 1970s, countries used more natural resources to increase their economic growth, based on the assumption that natural resources are unlimited in their development policies. In addition, the development of technology, especially after the Second World War, led to a rapid increase in production, and the increase in population caused an increase in consumption. This situation, on the one hand, ensured development, and on the other hand, caused environmental problems to gradually shift from the regional to the global dimension.

Economic development also brings environmental problems. Today, environmental pollution including water, soil and air pollution, irreversible loss of biodiversity, and the gradual disappearance of natural resources such as water, fertile agricultural lands and fish are among the most serious threats to economic development and sustainable development (Cedefop, 2009: 8). The environment is exposed to violence

and destruction. However, little attention is paid to the important consequences of environmental problems, including their negative effects on human health.

Since the 1970s, the idea of striking a balance between development and the natural environment has been gaining ground. In this context, the "Sustainable Development" model, which is the only long-term development model that considers the environment and human capital, includes all factors affecting the lives of humans and other living things and aims to reach the most appropriate one.

THE RELATIONSHIP BETWEEN ECONOMIC DEVELOPMENT AND ENVIRONMENT

The concept of "development" is known as one of the important issues not only in economics but also in many social, cultural and political disciplines. Unlike the concept of economic growth, it is necessary to mention the concept of economic growth when explaining the concept of development. While growth is a quantitative concept that expresses the numerical increase in national income, the concept of development includes changes in the socio-economic structure, including an increase in income as well as a fair share of income.

In recent years, ecology and development issues have occupied the world agenda so much that it is not possible to address these two phenomena separately. When considered as a concept, it is clear that environment and development are terms that contain vital elements necessary for the continued existence of humanity and trigger each other (Baykal, 2010: 11). This relationship between environmental protection and development is one of the most discussed issues in environmental management today.

The capitalist system is human-centered and in this system, in the relationship between humans and the environment, humans are the rulers of the environment. While the capitalist system tries to meet human needs in the most beneficial way, it considers the environment as an unlimited and unrequited resource. From the very beginning, he could not see or did not want to see that the gases and chemical particles emitted into the atmosphere from factory pipes could cause global problems. If we relate the ecological phenomenon to the world age, or at least look at the problem from the perspective of human history or the history of economic relations, it will be better understood that the economic system is short-term.

ECONOMETRIC ANALYSIS

It is very important to obtain data from a common database so that the results obtained from the tests to be applied during empirical investigation are reliable and consistent. For this reason, the data used in the study was obtained from the official website of the Azerbaijan Statistical Institute. The variables used in the study and their explanations are as follows.

Table 1. Variables used in the study

Variable Name	Database	Variable Name Abbreviation
Gross National Product Per Person	Azerbaijan Statistical Institute	GNPPP
Carbon Dioxide Emission Per Person (metric tons)	Azerbaijan Statistical Institute	CDEPP
Health Expenditures (share in GNP)	Azerbaijan Statistical Institute	HE

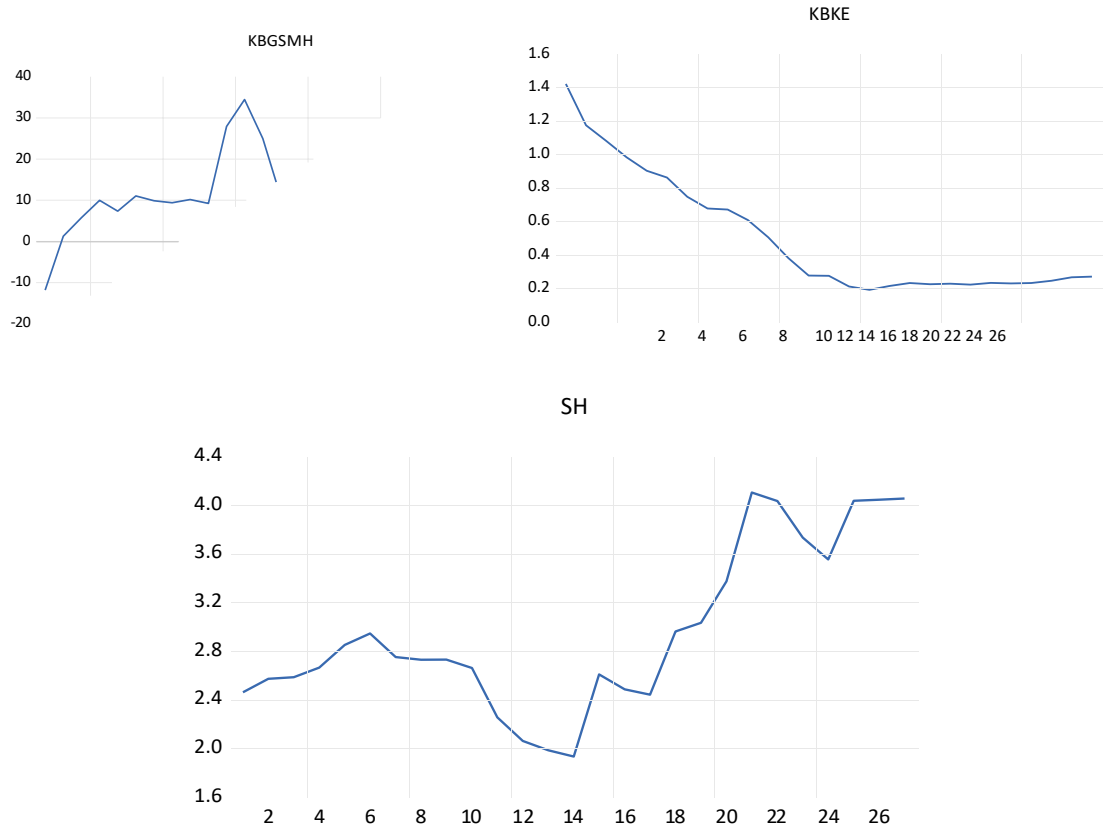
While determining the relevant variables in the study, similar studies in the literature were examined. When studies in the literature are evaluated, it is seen that the GNP per capita variable is used to represent

economic development (Erden and Turan, 2014; Akın, 2016). At the same time, per capita carbon emissions are widely preferred in the literature for the environment-development relationship. Ridzuan et al. (2020), Wang and Feng (2021), Ağır and Özbek (2021), Sibel and Ekiz (2021), Turan and Aksoy (2021) used per capita carbon emissions in their studies on the relationship between environment and economic development. Health expenditures are also used to dataize environmental health risks (Keyifli and Recepoğlu, 2020). For this reason, the per capita gross national product variable was used to represent economic development, per capita carbon emissions were used to represent the environmental phenomenon, and the health expenditure variable was used to represent environmental health risks. In addition, the natural logarithm of the GNİPP and CDEPP variables was taken.

As in the study, the VAR model with 3 variables and its simplest form can be expressed in matrix form as follows.

$$\begin{bmatrix} y_{GNPPP,t} \\ y_{CDEPP,t} \\ y_{HE,t} \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \\ b_{30} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} + \begin{bmatrix} y_{GNPPP,t-1} \\ y_{CDEPP,t-1} \\ y_{HE,t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \end{bmatrix}$$

In the analysis conducted for the Azerbaijani economy, first the stationarity of the variables in the model was examined. Both graphical analysis and unit root tests were performed to detect stationarity situations. Graph 1 below shows the level-level graphs of the variables.



Graph 1. Graphs of Level Values of Variables

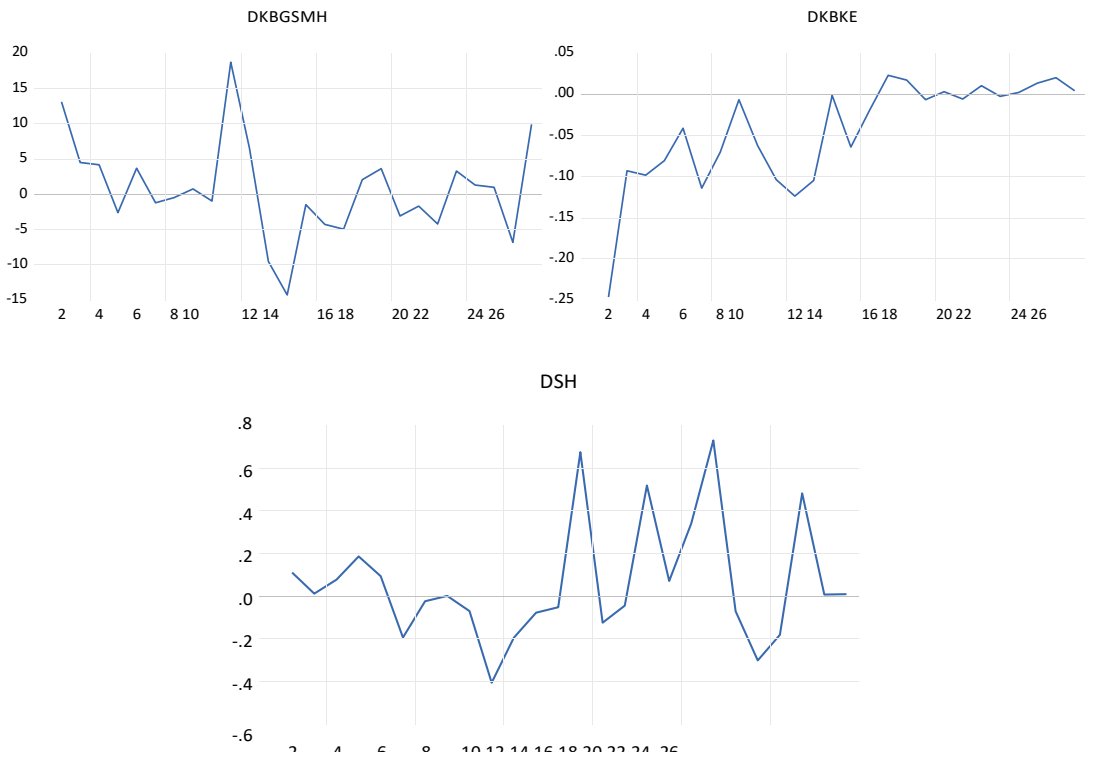
When looking at the graphs, it is seen that all variables follow a non-stationary structure, that is, they contain unit roots. The stationarity of the variables should also be examined with unit root tests. Table 2 shows the unit root test results for the level values of the variables. Augmented Dickey-Fuller (ADF) and

Phillips-Perron (PP) unit root tests were used in the study.

Table 2. *ADF and PP Unit Root Test Results*

VARİABLES	ADF (cons)	ADF (trend and cons)	PP (cons)	PP (trend and cons)
GNPPP	-2.491657 [0.1289]	-2.526220 [0.3138]	-2.592230 [0.1073]	-2.972156 [0.1584]
CDEPP	-2.508330 [0.1255]	-2.090656 [0.5267]	-2.526613 [0.1035]	-2.019732 [0.5639]
HE	-0.514044 [0.8731]	-1.404455 [0.8354]	-0.607221 [0.8526]	-1.487696 [0.8078]
Critical Value %1	-3.711457	-4.374307	-3.711547	-4.356068
Critical Value %5	-2.981038	-3.603202	-2.981038	-3.595026
Critical Value %10	-2.629906	-3.238054	-2.629906	-3.233456
Note: Critical values for ADF and PP were obtained by MacKinnon (1996). Values in [ ] indicate probability values.				

ADF and PP unit root test results for the level values of the variables are summarized in Table 2. According to the test results, GNİPP, CDEPP and HE variables contain unit roots in their level values. It was examined whether the variables containing unit roots in their level values became stationary when their first differences were taken. Below are the graphs of the first differences of the variables.



Graph 2. Graphs of First Differences of Variables

When Graph 2 is examined, it is seen that the variables whose first differences are taken are free of unit roots, that is, they become stationary. In addition, ADF and PP unit root tests were performed for the first differences of the variables. The results obtained are seen in Table 3.

Table 3. Unit Root Test Results of First Differences of Variables

VARİABLES	ADF (cons)	ADF (trend and cons)	PP (cons)	PP (trend and cons)
DGNPP	-4.144080 [0.0038]	-3.884135 [0.0283]	-4.112013 [0.0041]	-3.723696 [0.0393]
DCDEPP	-4.091578 [0.0043]	-5.409798 [0.0010]	-4.091578 [0.0043]	-5.326834 [0.0012]
DHE	-4.402031 [0.0020]	-4.435266 [0.0088]	-4.379418 [0.0021]	-4.400925 [0.0094]
Critical Value %1	-3.724070	-4.374307	-3.724070	-4.374307
Critical Value %5	-2.986225	-3.603202	-2.986225	-3.603202
Critical Value %10	-2.632604	-3.238054	-2.632604	-3.238054
Note: Critical values for ADF and PP were obtained by MacKinnon (1996). Values in [ ] indicate probability values.				

ADF and PP unit root test results for the first differences of the variables are summarized in Table 3. According to the test results, when the first differences of the variables are taken, the variables become stationary. As a result of the stationarity analysis for the variables used in the study, it was seen that the variables were integrated of the same order. Therefore, it would be appropriate to continue the study with VAR analysis. First, the appropriate lag length for VAR analysis must be determined. Table 4 shows the appropriate lag length test results for the VAR model.

Table 4. VAR Model Delay Length Determination Criteria

Delay	LogL	LR	FPE	AIC	SC	HQ
0	-91.5555	NA	1.086016	8.595959	8.744737	8.631007
1	-15.6472	124.2136*	0.002509	2.513383	3.108497	2.653574
2	-9.84983	7.905516	0.003551	2.804530	3.845980	3.049864
3	5.26036	16.48385	0.002359	2.249058	3.736843	2.599535
4	24.8974	16.06664	0.001228	1.282057	3.216178	1.737678
5	**42.5955**	**9.653545**	**0.001061***	**0.491315***	**2.871771***	**1.052079***

Lag length determination criteria for the VAR model are given in Table 4. According to the test results, the appropriate lag length for the VAR model is 5 lags. In other words, the VAR(5) model will be preferred in the study. In line with the VAR(5) model, the stationarity of the error terms for the model was examined and the results obtained are summarized in the table below. For the number of observations used in the study, the Eviews package program determines the information criteria up to 5 delays to determine the appropriate delay length. For this reason, when determining the lag length in the study, the selection is made based on the information criteria obtained in line with 5 lags. According to the results, the delay length with the lowest FPE, AIC, SC and HQ value is 5 delay. In other words, it would be appropriate to

use the VAR(5) model in the study. In line with the VAR(5) model, the stationarity of the error terms for the model was examined and the results obtained are summarized in the table below.

Table 5. *Stationarity Analysis of Error Terms*

VARIABLES	ADF (cons)	ADF (trend and cons)	PP (cons)	PP (trend and cons)
Error Term (1)	-4.119784 [0.0049]	-4.481688 [0.0110]	-4.065734 [0.0055]	-3.811332 [0.0365]
Error Term (2)	-5.299900 [0.0004]	-5.112798 [0.0030]	-7.414603 [0.0000]	-7.040375 [0.0001]
Error Term (3)	-5.049303 [0.0008]	-5.861726 [0.0008]	-8.245508 [0.0000]	-8.378152 [0.0000]
Critical Value %1	-3.788030	-4.532598	-3.788030	-4.467895
Critical Value %5	-3.012363	-3.673616	-3.012363	-3.644963
Critical Value %10	-2.646119	-3.277364	-2.646119	-3.261452
Note: Critical values for ADF and PP were obtained by MacKinnon (1996). Values in [ ] indicate probability values.				

When we look at the information given in Table 5, it is seen that the error terms do not contain unit roots, that is, they exhibit a stationary structure. For this reason, it would be appropriate to conduct appropriate analyses in line with the VAR (5) model using the variables in the model.

In the study, the VAR(5) model will be established and then specification tests will be carried out for the model. First, a stability test will be performed for the VAR(5) model. For this, the unit circle graph will be examined. Graph 3 shows the unit circle graph for the VAR(5) model.

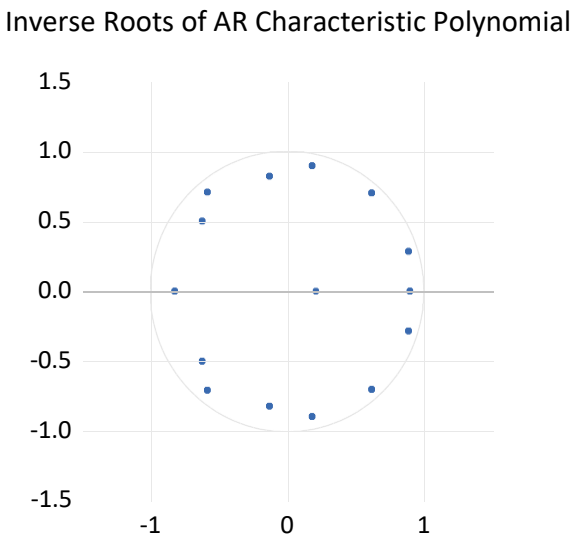


Chart 1. Unit Circle Chart for VAR(5) Model

The unit circle graph was examined to examine whether the VAR(5) model met the stability condition. According to the results obtained, all characteristic roots are within the unit circle. Therefore, the VAR(5) model satisfies the stability condition.

Whether there is an autocorrelation problem in the model will be examined with the help of the LM autocorrelation test. Table 6 summarizes the LM autocorrelation test results for the VAR(5) model.

Table 6. Autocorrelation LM Test

Lag	LRE*stat	df	Prob.	Rao F-stat	df	Prob.
1	10.33976	9	0.3237	1.283755	(9, 2.6)	0.4822
2	13.98280	9	0.1229	2.571665	(9, 2.6)	0.2628
3	14.38567	9	0.1093	2.767370	(9, 2.6)	0.2444
4	8.220284	9	0.5121	0.821677	(9, 2.6)	0.6475
5	25.11328	9	0.0028	17.52306	(9, 2.6)	0.0293
6	9.355619	9	0.4051	1.049147	(9, 2.6)	0.5567

Table 6 shows the LM autocorrelation test results. According to the findings, there is no autocorrelation problem in the VAR(5) model with up to 6 lags.

White heteroscedasticity test was used to examine heteroskedasticity in the VAR(5) model. White heteroscedasticity test results are summarized in the following table.

Table 7. White Heteroscedasticity Test

Chi-Square	df	Probability
107.5125	81	0.4951

White heteroscedasticity test results are seen in Table 7. According to the test results, the basic hypothesis H_0, which states that there is no heteroscedasticity problem in the model, cannot be rejected. In other words, there is no heteroskedasticity problem in the VAR(5) model. According to the specification test results for the VAR(5) model, the model meets the stability condition and there is no autocorrelation and heteroscedasticity problem in the model. Since there is no problem in the model as a result of the specification tests, the VAR (5) model results can be examined. VAR(5) model results are given below for all three models.

Table 8. VAR(5) Model Results

Dependent Variable: GNPPP	
Variables	**Coefficient**
GNPPP (-1)	1.24* [2.16]
GNPPP (-2)	0.91 [1.02]
GNPPP (-3)	0.57 [1.17]
GNPPP (-4)	0.03 [0.07]
GNPPP (-5)	0.18 [0.43]
CDEPP (-1)	210.08 [1.44]
CDEPP (-2)	66.95 [0.73]
CDEPP (-3)	-66.77 [-0.73]
CDEPP (-4)	-232.51* [-1.73]
CDEPP (-5)	71.52 [1.12]
HE(-1)	-6.16 [-0.69]
HE (-2)	4.98 [0.55]
HE (-3)	11.94 [1.06]
HE (-4)	-3.95 [-0.45]
HE (-5)	-1.25 [-0.18]
C	-34.94 [-0.81]
R^2	0.88
F-statistic	3.15*
Akaike statistic value	6.63
Schwarz statistic value	7.42

When looking at the VAR(5) model results, it can be seen that only the first lag of the GNPPP variable and the fourth lag of the CDEPP variable are statistically significant. It is seen that the R^2 variable, which shows the explanatory power of the model, is 88%. At the same time, the model as a whole is significant according to the F statistic value, which expresses the significance of the model. VAR(5) model results for model 2 and model 3 are shown in the Appendix.

Finally, action-reaction graphs were examined to examine the interaction between the variables in the model. The results obtained are shown in the graph below.

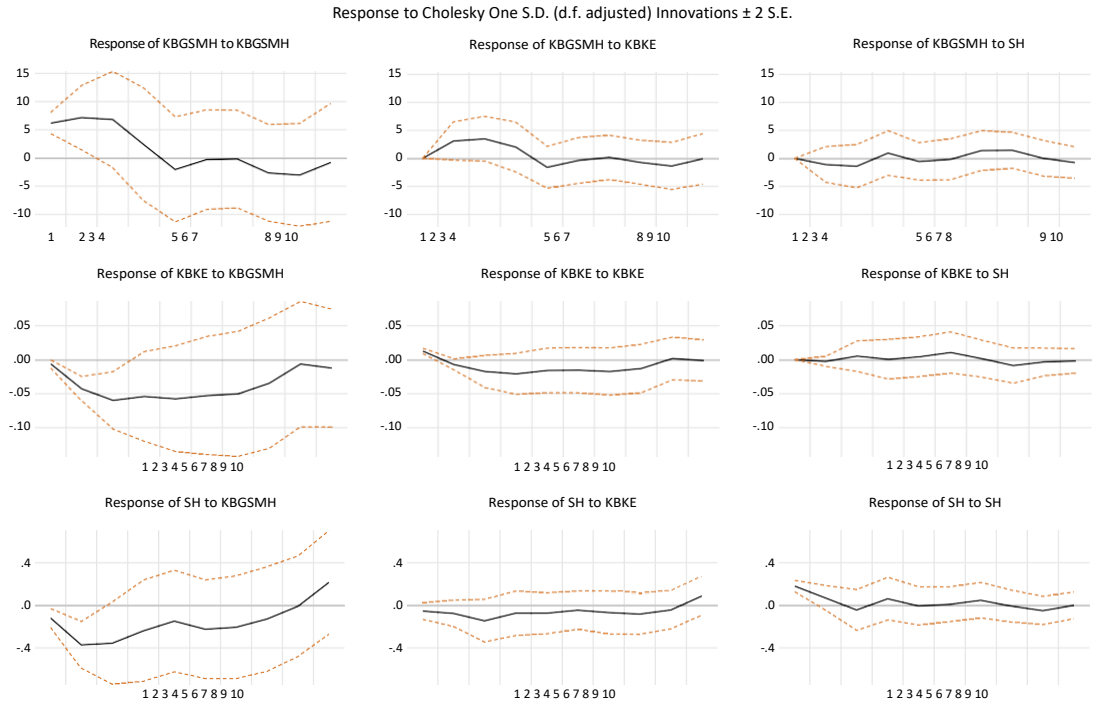


Chart 4. Action-Response Functions

Chart 4 shows the action-response functions obtained in line with the VAR(5) model. The red lines in the chart show the lower and upper limits. For the resulting action-response functions to be statistically significant, they must be within these limits. Since all impulse-response functions are within the limits, the impulse-response functions are statistically significant. A shock to per capita carbon emissions will have a positive effect on per capita gross domestic product until the third period and will have a decreasing effect in subsequent periods. Per capita gross domestic product responds similarly to a one-unit shock in health expenditures throughout all periods.

Table 9. Variance Decomposition Analysis Results for GNPPP

Period	S.E.	GNPP	CDEPP	HE
1	6.161694	100.0000	0.000000	0.000000
2	9.975622	89.26437	9.514232	1.221394
3	12.64288	84.48281	13.50839	2.008801
4	13.04725	82.54555	15.05126	2.403198
5	13.31917	81.59695	15.91769	2.485364
6	13.33057	81.52067	15.97866	2.500664
7	13.40383	80.65883	15.81810	3.523068
8	13.75474	80.30994	15.29671	4.393354
9	14.15140	80.46807	15.38118	4.150747
10	14.19535	80.28120	15.29115	4.427650

Table 9 above shows the variance decomposition analysis results for GNPP. In other words, the table expresses the explanation of the total change in the variance of the GNPP variable on a periodic basis. When we look at the table, it can be seen that all the total change in the variance of GNPP in the first period is explained by itself. In subsequent periods, it was determined that this change was also explained by CDEPP and HE. In other words, as time progresses, the change in the CDEPP and HE variables causes a certain change in the GNPP variable. This is an expected result. As in the economies of other countries in the world, carbon emissions and health expenditures have a significant impact on economic growth over time in the Azerbaijani economy. Looking at the last period, approximately 80.2% of the total change in

the variance of the GNPP variable is explained by itself, 15.3% by CDEPP and 4.5% by HE. This shows that changes in CDEPP and H.E variables have a significant change on GNPP in the Azerbaijani economy.

CONCLUSION

The most important goal of development is to ensure that human welfare and humanity reach their maximum potential. Leaders from developed and developing countries, non-governmental organizations, development experts and international aid agencies agree that four main challenges must be met to achieve the overarching goal outlined above. Short; A healthy and growing economy that is in structural change, an economy that provides a broad and balanced income distribution, a political system that secures human rights and freedoms, good governance and an economic policy that takes care of the protection of the environment. This new and multifaceted approach to development actually stems from the experience of the last 50-60 years.

The relationships between economic development and environmental health risks have been made for various countries in the literature. However, the study in question has not been done yet for the Azerbaijani economy. For this reason, this study makes a significant contribution to the literature. In the study, first the econometric model was determined and the variables in the model were obtained from the official website of the Azerbaijan Statistical Institute. Appropriate time series analyses were conducted using the variables included in the econometric model. EViews 12 package program was used when making the analyses.

In the analysis conducted for the Azerbaijani economy, first the stationarity of the variables in the model was examined. Both graphical analysis and unit root tests were performed to detect stationarity situations. The graphs of the level values of the variables were examined and it was seen that all variables followed a non-stationary structure, that is, they contained unit roots. According to the ADF and PP unit root test results for the level values of the variables, GNPP, CDEPP and H.E variables contain unit roots in their level values. It was examined whether the variables containing unit roots in their level values became stationary when their first differences were taken. According to the graphs of the first differences of the variables, it is seen that the variables whose differences are taken are free from unit roots, that is, they become stationary. According to the ADF and PP unit root test results for the first differences of the variables; When the first differences of the variables are taken, the variables become stationary.

As a result of the stationarity analysis for the variables used in the study, it was seen that the variables were integrated in the same order. Therefore, first of all, the appropriate lag length for VAR analysis must be determined. According to the test results, the appropriate lag length for the VAR model is 5 lags. In other words, the VAR(5) model was preferred in the study.

First, the VAR(5) model was established, and specification tests were performed on the model. By examining the unit circle graph, it was determined whether the characteristic roots of the model met the stability condition. According to the results obtained, the characteristic roots of the VAR(5) model meet the stability condition. Then, autocorrelation and heteroskedasticity tests were performed for the model. According to the findings, no autocorrelation or heteroscedasticity problems were detected in the model.

Action-reaction graphs were examined to determine the interaction of the variables in the VAR(5) model. Since all impulse-response functions are within the limits, the impulse-response functions are statistically significant. A shock to per capita carbon emissions will have a positive effect on per capita gross domestic product until the third period and will have a decreasing effect in subsequent periods. Per capita gross domestic product responds similarly to a one-unit shock in health expenditures throughout all periods.

Finally, according to the variance decomposition test results, it is seen that all of the total change in the variance of GNPP in the first period is explained by itself. In subsequent periods, it was determined that this change was also explained by CDEPP and H.E. In other words, as time progresses, the change in the

CDEPP and H.E variables causes a certain change in the GNPP variable. This is an expected result. As in the economies of other countries in the world, there is a significant relationship between carbon emissions, health expenditures and economic growth over time in the Azerbaijani economy. Looking at the last period, approximately 80.2% of the total change in the variance of the GNPP variable is explained by itself, 15.3% by CDEPP and 4.5% by H.E. This shows that there is a significant relationship between the change in the CDEPP and H.E variables and the change in the GNPP variable in the Azerbaijani economy.

As a result, economic development in the Azerbaijani economy brings with it some environmental problems. This finding is supported by other studies in the literature. In addition, necessary measures must be taken during economic development to reduce the increases in carbon emissions, which are the biggest threat to the global world.

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Modelling the Volatility of Cryptocurrencies

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Abstract

The cryptocurrency is defined as a type of money that can be defined digitally or virtually using encryption technology. Volatility is an important measure of risk for cryptocurrency markets. Therefore, it has always been attractive for investors to predict models that provide the most realistic estimates of financial time series such as cryptocurrencies and reveal volatility structures.

The main purpose of this study is to model the volatility of cryptocurrencies such as Bitcoin, Ethereum and Tether by using econometric models, deep learning methods and their hybrid models. For the relevant purpose, it has been used econometric models such as Generalized Autoregressive Conditional Heteroscedasticity Model (GARCH) and Exponential GARCH (EGARCH) model; Deep learning methods such as Long Short Term Memory Networks (LSTM) and hybrid models such as LSTM + GARCH and LSTM + EGARCH. then to determine the most successful model by comparing estimation methods.

For the purposes stated in the study, data for the periods of 18.07.2010 - 25.08.2023 for Bitcoin, 10.03.2016 - 25.08.2023 for Ethereum and 14.04.2017 - 25.08.2023 for Tether were used. Models providing the best volatility estimation were evaluated using models such as LSTM, GARCH, EGARCH, LSTM + GARCH and LSTM + EGARCH for the relevant periods of cryptocurrencies.

Key words: *Volatility, Cryptocurrency, Long Short-Term Memory Networks, Generalized Autoregressive Conditional Heteroscedasticity Model.*

Examining The Effect of Satisfaction Levels on Happiness

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Abstract

While the absence of emotions such as pain, sorrow and suffering and the presence of emotions such as joy and satisfaction are generally defined as the state of being satisfied with life or happiness; the feeling of satisfaction arising from meeting needs and desires is expressed as satisfaction.

The happiness of individuals and therefore the societies formed by individuals has an impact on many issues, especially sociological and economic. These effects show that econometric modeling of the relationship between happiness and satisfaction is important, especially for decision makers and relevant field workers who have a major role in social welfare.

The main purpose of the study was to examine the relationship between individuals' happiness and satisfaction in the different categories and to reveal the effect of satisfaction on happiness. For this purpose, Turkish Statistical Institute Life Satisfaction Survey 2020 data was used. The impact of individuals' satisfaction levels such as personal, working life, environmental and service categories on their happiness was modeled using the Generalized Ordered Logit Model and the findings were evaluated in detail.

Key words: *Happiness, Life Satisfaction, Generalized Ordered Logit Model.*

Examining The Relationship Between Bank Credit Volume, Inflation Rates, and Economic Growth in Turkey: A Fourier Cointegration Approach

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Abstract

The objective of this study is to analyze relationship between bank credit volume, inflation rates, and economic growth in Turkey using quarterly data covering the period from 2005:Q4 to 2023:Q1. The selected variables underwent unit root testing through the application of both the conventional Augmented Dickey-Fuller (ADF) unit root test and the Fourier ADF unit root test proposed by Enders-Lee (2012). The outcomes of the unit root tests indicated that all the variables in question attained stationarity when analyzed in first differences. Subsequently, the study employed the Fourier Autoregressive Distributed Lag (Fourier ADL) cointegration test introduced by Banerjee et al. (2017) to examine the cointegration relationship among bank credit volume, inflation rates, and economic growth. The results of this test provided support for the existence of a long-term relationship between bank credit and the other selected variables. Furthermore, the estimated coefficients obtained through the application of the Fully Modified Ordinary Least Squares (FMOLS) and Canonical Cointegrating Regression (CCR) methods revealed that inflation rates had a statistically significant and negative impact on bank credit at a 1% significance level, while economic growth had a statistically significant and positive effect on bank credit.

The findings obtained provide important insights for the Turkish economy. Firstly, the support for the existence of a long-term relationship between bank credit, inflation rates, and economic growth demonstrates the sustainability of the connection between these factors. The negative impact of inflation rates on bank loan volume can be associated with the uncertainty created in financial markets and the reduction in credit demand due to high inflation. Additionally, the positive effect of economic growth on bank credit indicates that an increase in economic activity and improved confidence can lead to a higher demand for credit.

Keywords: *Bank Credit, Inflation, Fourier Unit Root Test, Fourier Cointegration Test.*

JEL Classification: *C21, C32, E31, G21*

Generalized Process Capability Index Estimation Via Metaheuristic-Optimization Techniques

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Abstract

Process capability indices are widely used by manufacturing industries and supplier companies in process evaluations and evaluation of purchasing decisions. Industrial systems are becoming more powerful, effective and efficient depending on technological and scientific developments. Parallel to these developments, the number of elements that make up the systems is increasing and they have a much more complex structure. The increase in the number of design variables, which are the basic elements of the systems, and the modeling of the complex relationships between these variables make it difficult to optimize the problems. In this paper, we propose a new generalized process capability index Cpyk for discrete processes. Optimization and metaheuristic-optimization methods performance were investigated in the maximum likelihood estimation method to estimate the discrete generalized process capability index Cpyk for the natural discrete Lindley distribution. In the simulation study, the mean square errors the average running times for metaheuristic-optimization technique and bias values were examined.

Key words: *Process capability index, estimation, natural discrete Lindley distribution, Monte Carlo simulation, metaheuristic-optimization*

An Application of Deep Learning Algorithms for DefectType Identification in Steel Manufacturing

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Abstract

In the manufacturing sector, product quality and overall reliability of business hold significant importance for customers. Many businesses employ various quality control methods throughout the production process to meet these quality and reliability requirements. However, existing processes are predominantly carried out manually, leading to issues such as human error, time inefficiencies, and reduced accuracy. To overcome these challenges and prevent the recurrence of errors, the establishment of continuously learning automated control systems has become indispensable for contemporary businesses. In this study, deep learning techniques were utilized with the aim of eliminating common errors encountered in manual quality control processes and automating the procedure. Within the scope of this study, an analysis was conducted to identify various types of errors present in the final product, using deep learning algorithms. The dataset used for this research was obtained from the Kaggle platform. This publicly accessible dataset contains a total of 7095 steel plate surface images, each featuring various types of defects. The types of defects are categorized into four groups, namely Pitted Surface, Crazing, Scratches, and Patches, and all images have been pre-labeled accordingly. In this study, Convolutional Neural Networks (CNN) were employed for the automated identification of the types of defects present in the dataset. Various predictive models were developed using the CNN algorithm, and to determine the final model to be employed, several modifications were made to the dataset, including pre-processing, Solution to theclass imbalance problem, and hyperparameter tuning. The results obtained from the various developed models are presented in a comparative manner. The study demonstrates that when artificial intelligence and deep learning techniques are effectively employed in the industrial production sector, error types can be accurately identified, and this will serve as a foundation for future research endeavors.

Key words: *Deep Learning, CNN, Steel Manufacturing, Quality Control*

INTRODUCTION

Quality control is one of the most critical processes that companies operating in today's manufacturing sector must successfully execute. Any flaw or discrepancy that emerges in the production system can manifest as inferior quality in the final product. When such deficiencies are detected by customers, it often results in them discontinuing their business relationship with the company, and they frequently share their negative experiences within their social circles. Such adverse reputation, when heard by other existing or potential customers, invariably leads to a decline in the company's clientele and a consequentdrop in sales. The cost of poor quality thus accumulates and snowballs over time (Çolak et al., 2018).

In certain industries, even if a product of inferior quality goes unnoticed and does not reach theend customer, its progression to the next stage of production can lead to significant complications for the company, often resulting in substantial costs. In such sectors, quality control needs to be meticulously planned and flawlessly executed. The steel industry is a prime example where rigorous quality control is indispensable. Imperfections on steel surfaces, such as scratches, cracks, or wear, canadversely impact the steel's load-bearing capacity and durability. While certain defects on the steel surface can lead to structural deformities in the final product, others might result in the product wearingout prematurely (Güçlü et al., 2022). Hence, in steel manufacturing, the stages of quality control shouldbe more frequent and closely monitored.

Traditionally, in steel production, the identification of imperfections on the surface has been carried out manually by experts. However, these manual inspection processes are highly subjective, time-consuming, and demand significant labor (Xu et al., 2018). The development of fully automated systems capable of automatically detecting flaws and categorizing their types is essential for modern industries operating under intense competitive conditions.

In recent decades, computer vision-based surface defect inspection systems have become a prevalent research topic for researchers, aiming to assist or even replace human-controlled quality processes. Notably, in challenging areas like object recognition and defect detection, accuracy rates achieved with deep learning techniques are highly commendable (Fu et al., 2019). Convolutional Neural Networks (CNN) and its variants are frequently used algorithms in image processing studies and are often seen in the literature (Yang et al., 2020).

This study aims to explore how an automatic approach can be developed for quality control in industrial production processes. The research utilizes a dataset obtained from the Kaggle platform, consisting of 7,095 steel plate surface images. Efforts have been made to detect various types of defectson these images, and different CNN models have been trained for this purpose. The study seeks to evaluate the efficacy and performance of the CNN algorithm used for automatic detection of such defects.

In the subsequent Materials and Methods section of the study, detailed information is providedregarding the characteristics of the dataset and the parameters used in constructing the CNN models. Inthe Results section, metrics obtained from the developed models are presented and evaluated. Add In the Discussion and Conclusion section of our paper, we delved into the significant impact of addressingclass imbalances on model accuracy, underscoring the value of meticulous preprocessing and the nuances of our customized deep convolutional neural network model.

MATERIAL AND METHODS

Material

Data Set

The dataset used in this study, named "Severstal: Steel Defect Detection", was obtained from the Kaggle platform. Although this dataset contains a vast array of images of steel surfaces, both with and without defects, our research is solely focused on identifying the types of defects present on the images. Therefore, only the subset of images showing defective steel surfaces was utilized. This subsetcomprises a total of 7095 defective steel sheet surface images. The types of defects identified on the surface are categorized into four groups, named sequentially as "pitted surface", "crazing", "scratches",and "patches". Figure 1 displays some sample images from the dataset along with their respective defect types.

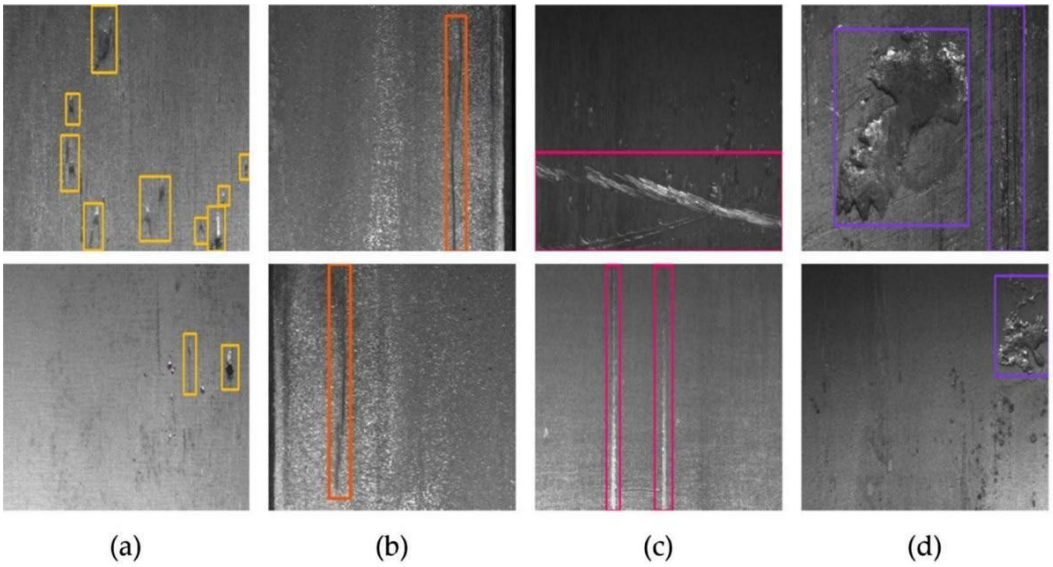


Figure 1. Dataset samples for each class: (a) pitted surface, (b) crazing, (c) scratches, (d) patches(Wang et al., 2021).

Methods

Data Reading and Resizing

For this study, the Python programming language and various libraries were utilized. In the original dataset downloaded from the Kaggle platform, images are in JPG format with dimensions of 1600 x

256. In the initial phase of our study, all images were read using the OpenCV library, resized to 120 x 120 dimensions, and then saved again. The rationale behind this resizing was to both reduce training time when performing calculations on images and to decrease memory usage. Additionally, images sourced from different places or of varying dimensions might exist in the dataset. By resizing all imagesto a consistent dimension, we can enhance the generalization capability of the model.

Normalization

Data normalization is a common preprocessing step when training machine learning and deep learning models, and it significantly influences the performance of the model (Hurtik et al., 2019). The pixel values of image data typically lie between 0 and 255. To normalize the pixel values of our dataset images between 0 and 1, each pixel value was divided by 255. The mathematical formula for this normalizationprocess is given in Equation 1. This normalization step accelerates the model's training process while also ensuring numerical stability during the learning phase (Pratiwi et al., 2021).

$$x_{norm} = \frac{x}{255} \qquad (1)$$

Label Encoding

Class labels are typically given in text format; however, artificial neural networks and many machine learning algorithms operate with numerical values. Consequently, numerical labels in datasets need to be converted to numerical values (James et al., 2013). Since the original dataset already had the values numerically encoded, there was no need for us to re-encode the data labels in this study.

Data Visualization

Data visualization serves as a vital tool for rendering intricate datasets more comprehensible, interpretable, and usable (Çelik & Akdamar, 2018). In this study, initially, various graphs depicting thedistribution of labels have been produced to gain a deeper understanding of the dataset. Figure 2a Bar

Graph, displays the number of images for each defect type present in the dataset, while Figure 2b Pie Chart, presents their percentage distribution. As discerned from the figures in the dataset, there are 897images labeled with defect number 1, 247 images with label 2, 5150 images with label 3, and 801 images with label 4, culminating in a total of 7,095 images. The distribution percentages of these labels withinthe total dataset are 12.6%, 3.5%, 72.6%, and 11.3%, respectively.

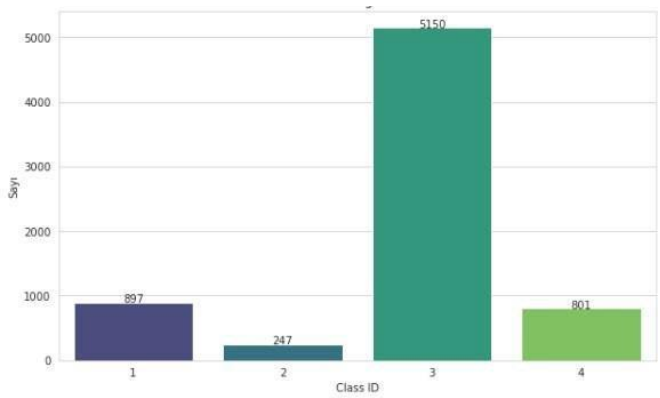


Figure 2a. Class distribution bar graph.

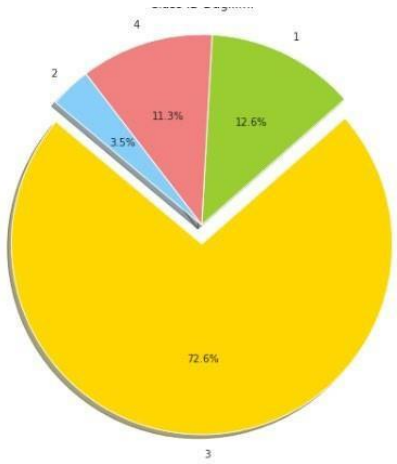


Figure 2b. Class distribution ratio pie chart.

Class Imbalance

Class imbalance is a frequently encountered situation in classification problems and usually manifests as one class containing more samples than the other classes (He & Garcia, 2009). Such an imbalance can adversely affect the performance of classification models because the model may tend to correctly classify samples of the majority class (Chawla et al., 2002). As can be seen from Figure 2a and Figure 2b, there is a class imbalance situation in this dataset as well. In this study, the Random Over Sampler method was employed to address the class imbalance issue. This method selects random samples from the minority class and duplicates them, thus balancing the sample count of all classes (López et al., 2013). Equation 2 demonstrates how the RandomOverSampler method operates. Here, X and y represent the original feature matrix and the label vector, respectively. $X_{nenn,}$ and y_{nenn} signify the balanced feature

matrix and the label vector.

$$X_{nenn,}y_{nenn,} = RandomOverSampler(X, y) \quad (2)$$

The RandomOverSampler method was employed to increase the sample size of under- represented classes to match that of the majority class. Utilizing this approach assists in minimizing theadverse impacts of class imbalance (He & Garcia, 2009). In our study, we established a predictive modelby both overlooking the issue of class imbalance and by utilizing the RandomOverSampler technique. A comparative analysis is elaborated in detail in the results section.

Model Architecture

The Convolutional Neural Network (CNN) employed in this study is tailored for multi-class image classification tasks. The architecture is heavily inspired by the standard CNN architectures commonly used in image recognition tasks, as noted by LeCun et al. (1998). The specific model architecture consists of the following layers;

First Convolutional Layer: The layer uses 32 filters of kernel size 3×3, followed by a RectifiedLinear Unit (ReLU) activation function (Nair & Hinton, 2010). Mathematically representation of the convolution operation is shown in Equation 3. Where W_1 represents the 32 filters, b_1 is the bias term,

and $*$ denotes convolutional operation. The decision to use 32 filters in the first convolutional layer is not arbitrary but is grounded in empirical evidence and computational practicality. Moreover, this configuration is commonly encountered in the literature and is considered to be a standard practice for capturing low-level features such as edges and corners in image-based tasks (Simonyan & Zisserman, 2014).

$$Output = ReLU\,(W_1 * Input + b_1) \qquad (3)$$

Second Convolutional Layer: 64 filters are used, each of size 3×3, followed by a ReLU activation function shown in Equation 4. In our neural network architecture, the first layer employs 32 filters, while the following second and third layers utilize 64 filters each. The decision to increase the filter count from the initial layer to the subsequent layers is driven by the need to detect more intricate and diverse features as the data moves deeper into the network. Maintaining 64 filters in both the second and third layers is not only a design choice but also a practice commonly observed in the literature. Thisapproach serves two primary goals: firstly, it allows for a more consistent feature representation acrosslayers, making it easier for subsequent layers to build upon this information; and secondly, it optimizescomputational efficiency. Such a configuration is consistent with empirical studies in the field, includingthe seminal work by He et al. (2016).

$$Output = ReLU\,(W_2 * Input + b_2) \qquad (4)$$

Third Convolutional Layer: This layer uses 64 filters of 3x3 dimensions, followed by ReLU activation shown in Equation 5. In our convolutional neural network architecture, we employed 3x3 convolutional filters in all our layers for several important reasons. Firstly, 3x3 filters are computationally efficient while maintaining the capability to capture essential spatial features in the image. Secondly, filters such as 3x3 size allow for a larger effective receptive field with fewer parameters, making the network more parameter-efficient (Szegedy et al., 2015). Therefore, the use of 3x3 filters in our network is both theoretically sound and empirically validated.

$$Output = ReLU\,(W_3 * Input + b_3) \qquad (5)$$

In our neural network architecture, each convolutional layer is followed by a Max-Pooling operation designed to reduce the spatial dimensions of the input volume. The first and second Max- Pooling layers use 3×3 pool sizes for moderate dimensionality reduction while preserving spatial details.The third layer uses a 4×4 pool size for a more aggressive reduction, focusing on high-level features. These choices are in line with common practices in image classification (Simonyan & Zisserman, 2014).The pooling operation can be shown in Equation 6.

$$Pooled\ Output = \underset{(ii,\,jj)}{Max}\,(Subregiion) \qquad (6)$$

Flatten: After the convolutional and pooling stages, the neural network transitions to a series of fully connected layers, aiming to perform high-level reasoning. Initially, a Flatten operation is employed. This operation reshapes the 3D output matrix from the previous layer into a 1D vector of size. A small matrix representation of this process as an example is given in Figure 3.

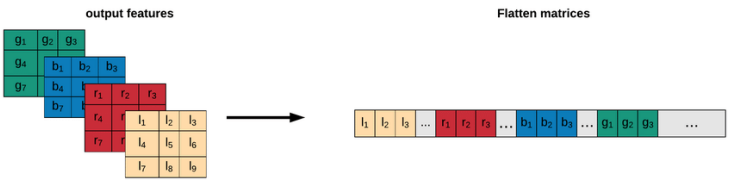


Figure 3. Flatten operation example (Loukadakis et al., 2018).

Dense Layer 1: A fully-connected layer with 128 neurons and ReLU activation function shownin Equation 7. Here, W_1 represents the weight matrix, X is the input vector from the Flatten layer, and b_1 is the bias vector. The number of neurons in the initial Dense layer, which is a hyperparameter of themodel, has been intuitively set at 128 based on empirical experience. This decision influences the model's learning capacity and performance. The choice of 128 neurons is often considered a reasonable starting point, for its computational efficiency nature and its empirical effectiveness (Nair & Hinton, 2010).

$$h_1 = ReLU\,(W_1X + b_1) \quad (7)$$

Dense Layer 2: The next Dense Layer is constructed with 128 neurons, again activated by the ReLU function shown in Equation 8.

$$h_2 = ReLU\,(W_2 h_1 + b_2) \qquad (8)$$

Dropout: Dropout layers is subsequently integrated into both the first and the second dense layers with a 0.3 dropout rate to prevent overfitting. This technique was initially introduced by Srivastava et al. (2014) and has since become a standard regularization method.

Dense Layer 3: In the third Dense layer of our architecture, we employed 256 neurons to augment the model's representational power. The choice of increasing the neuron count to 256 serves toenhance the model's ability to learn complex feature interactions more effectively. This practice is commonly observed in the literature, corroborating its effectiveness in capturing complex feature hierarchies. The mathematical representation is shown in Equation 9.

$$h_3 = ReLU\,(W_3 h_2 + b_3) \qquad (9)$$

Output Layer: Since our study involves classifying into four distinct error types (pitted surface,crazing, straches, and patches), the output layer of our neural network architecture consists of 4 neuronswith a Softmax activation function shown in Equation 10**.**

$$y = SoSStmax\,(W_4 h_3 + b_4) \qquad (10)$$

Using Softmax in the output layer is standard practice for multi-class classification problems, as it provides a probabilistic confidence measure for each class. The mathematical formulation of the Softmax function for a given vector x of dimension K is shown in Equation 11. Where x_{ii} is the ii^{th}

element of the input vector x, and e is the base of the natural logarithm. This function takes the logits

and scales them in a way that they can be interpreted as probabilities (Zang & Zhang, 2011).

$$SoSStmax(x)_{ii} = \frac{e^{xii}}{\sum_{k-1}^{K} e^{xk}} \qquad (11)$$

Optimization Algorithm and Loss Function: The choice of the optimization algorithm playsa important role in training deep neural networks efficiently. In this study, we employed the Adam optimizer, which is an Adaptive Learning Rate Optimization Algorithm that's been designed specificallyfor deep learning tasks (Kingma & Ba, 2014). In addition, we employed Categorical Cross-Entropy (CCE) as the loss function. For multi-class classification problems, the Categorical Cross-Entropy (CCE) loss is frequently employed in the literature (De Boer et al., 2005)**.** The mathematical representation of CCE is shown in Equation 12, where C is the number of classes, y is the true label in one-hot encoded form, and $\hat{y}$ is the predicted probability distribution from the model.

$$L\,(y, \hat{y}) = -\sum_{ii-1}^{C} y_{ii} \log(\hat{y}_{ii}) \qquad (12)$$

In this section, the architecture of the model and the underlying motivations for our hyperparameter decisions have been discussed. In the subsequent section of our study, we will provide an in-depth evaluation of the performance of our model, presenting the outcomes of our analyses on how our choices manifest on practical datasets.

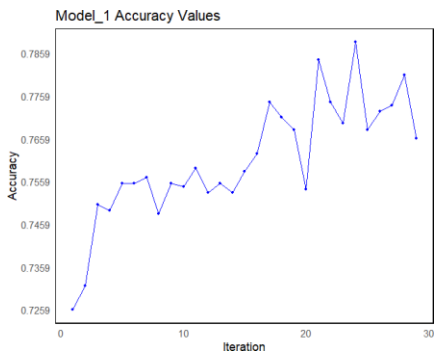
RESULTS

In our study, we trained two prediction models based on the architectural features mentioned above and compared their results. In our first prediction model, we used our dataset as it is with its imbalanced class distribution. Before training the second model, as a solution to the problem of class distribution imbalance, we applied the RandomOverSampling method we mentioned in the previous section and equalized all classes with the image count of class number 3. In this way, we trained our model with a total of 20,600 images, with 5,150 from each class.

During the training of our model developed using the Convolutional Neural Network algorithm,we divided the dataset into 80% training and 20% testing. Such a division ratio is commonly used in machine learning and deep learning algorithms because it provides an adequate amount of dataset to evaluate the model's generalization capability and ensures that the model works on a sufficiently large dataset for training. This division strategy is a frequently encountered approach in the literature and is considered a critical step for reliably evaluating model performance (Hastie et al., 2009).

Throughout the training of our model, we used an early stopping strategy to reduce the risk of overfitting. This approach ensures the cessation of the training process when the loss function value of the test dataset does not improve for a specified period. The early stopping condition we used specifiesthat the training of the model should be halted if the loss function does not improve by at least 0.001 over 5 consecutive epochs (iterations) and allows for the reloading of the model with the highest accuracy value. This method is effective in preventing the model from overfitting and preserving its generalization capability. In the literature, early stopping is commonly recommended as a means to alleviate the overfitting problem encountered during the model's training process (Jabbar & Khan, 2015).

When we examine the metrics of the models we developed, we obtain significant results regarding the importance of training a model with a dataset that does not have class distribution inequality. Firstly, in the model we developed without using the RandomOverSampler method, the algorithm halted the training process in the twenty-ninth iteration since there was no improvement in the loss function value consecutively for 5 times. The maximum accuracy rate of our test dataset with this developed model was found to be 78.86%. We named this first model "Model 1". However, when we reorganized our dataset using the RandomOverSampler method to solve the class imbalance problem, the model's training process ended in the forty-second iteration. This time, the accuracy rate of the model we developed on the test dataset rose to 93.76%. We named this model "Model 2". The results we obtained from the test dataset for Model 1 and Model 2 are significant evidence of the profound impact of data imbalance on model performance. In Figure 4a, there is a visualized graph of the results for Model 1, and in Figure 4b, there is a graph of accuracy values for Model 2.



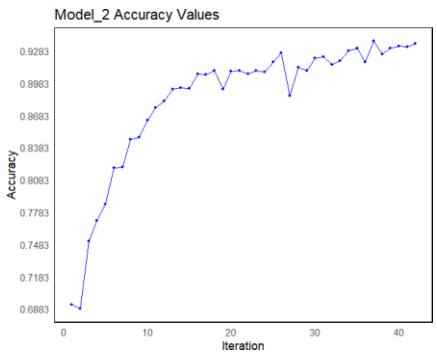


Figure 4a. Model_1 accuracy chart **Figure 4b.** Model_2 accuracy chart

Upon examining the loss function values of our developed Model 2, we observed a consistent decrease throughout the training period, with no indications of overfitting. This suggests that our modelpossesses a commendable generalization capability and does not excessively fit to the training data. Figure 5 displays the graph of loss function values for both test and training datasets pertaining to Model

2. Findings derived from this graph corroborate the absence of overfitting in our model.

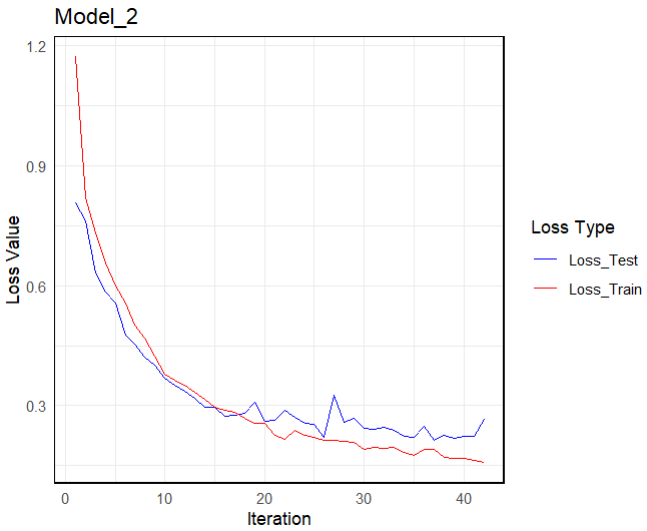


Figure 5. Model_2 Loss Function value chart

DISCUSSION AND CONCLUSION

In this study, two models, namely Model 1 and Model 2, were developed. While both models share identical parameters, Model 1 was trained without addressing the class imbalance issue, utilizing the original dataset as-is. Conversely, in Model 2, the class imbalance issue was tackled using the RandomOverSampler method, ensuring equal and balanced sample sizes across all classes. Upon evaluating the accuracy rates on the test datasets for both models, Model 1 exhibited an accuracy of 78.86%, whereas Model 2's accuracy escalated to 93.76%. Addressing the class imbalance issue resulted in an 18.88% enhancement in performance. This research underlines the profound influence of appropriate preprocessing steps on model performance when working with imbalanced datasets, and theresults obtained firmly corroborate this assertion.

In our study, we presented the design and evaluation of a customized deep convolutional neuralnetwork model tailored for classifying specific error types. We emphasized the significance of each architectural decision through a systematic approach and delineated its impact on the model's performance.

In conclusion, when working with real-world datasets, it is imperative to address inherent challenges such as class imbalances with meticulous design considerations. Through iterative evaluations and fine-tuning, we succeeded in obtaining a model with commendable accuracy and robustness. Insights garnered from this study can serve as guiding principles for future research endeavors in this domain. Furthermore, the demonstrated efficacy of the model suggests its potential for practical applications, significantly contributing to the automatic classification of errors.

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İnşaat Şantiyelerinde İş Sağlığı Ve Güvenliği Açısından Risklerin Değerlendirilmesi, Örnek Risk Analizi

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Özet

İnşaat sektörü doğası gereği birçok riskli çalışma alanlarını içinde barındırır. Yapılan istatistik araştırması neticesinde ölümlü iş kazalarının en çok yaşandığı iş kolu olarak inşaat şantiyeleri karşımıza çıkmaktadır. Yaşanan kazaların sonuçlarını onarmak, önlemekten maddi ve manevi daha yıpratıcı bir süreçtir. Bu durumun fark edilmesiyle iş sağlığı ve güvenliği çalışmalarına proaktif yaklaşım geliştirilmiştir. İş kazalarının önlenmesi adına yapılacak ilk adım kapsamlı bir risk analizi çalışması gerçekleştirmektir. Kapsamlı ve titizlikle yönetilen risk değerlendirmesi süreci sonrasında şantiyelerdeki iş kazalarının en aza indirilmesi mümkündür. Yapılan bu çalışmanın amacı; sektörde çalışan iş sağlığı ve güvenliği profesyonellerine kapsamlı bir kaynak oluşturmak ve şantiyelerde karşılaşılabilecek tehlikeleri belirleyerek çalışmalarına katkıda bulunmaktır. Yapılan çalışma kapsamında Tokat ili merkez ilçesinde bulunan 4000m^2 inşaat alanına sahip küçük ölçekli bir şantiyede risk analizi yapılarak tehlikeler belirlenmiştir. Yapılan çalışmada çok tehlikeli çalışma alanlarında sıkça kullanılan Fine-Kinney risk analizi yöntemi tercih edilmiştir. Risk analizi sonucunda 365 tane tehlike tanımı yapılmıştır. Belirlenen tehlikelerin sebep olabileceği riskler puanlanarak önem sırası oluşturulmuştur. Bu tehlikeli durumlardan 60 tanesi çok yüksek risk, 211 tanesi yüksek risk, 81 tanesi önemli risk, 11 tanesi orta risk ve 2 tanesi düşük risk olarak elde edilmiştir. Tüm riskli durumlar için uygun iş sağlığı ve güvenliği tedbirleri önerilmiştir.

Anahtar Kelimeler: *İş Sağlığı Ve Güvenliği, İnşaat İşlerinde İş Sağlığı Ve Güvenliği, Fine-Kinney Risk Analizi Yöntemi*

GİRİŞ

İnşaat sektörü birbirinden farklı nitelikteki birçok iş kolunun uyum içinde çalışması ile üretimin gerçekleştiği iş koludur. Şantiyeler genel olarak iş kazası ihtimalini artıran çalışma ortamlarına sahiptir. Yüksekte çalışma, elektrikli aletlerle çalışma; kesici, delici vs. el aletleri ile çalışma tehlikeli bazı çalışma alanları olarak örnek verilebilir. Ayrıca sektörde çalışan profili genel olarak iş sağlığı ve güvenliği (İSG) kültürünün tam olarak yerleşmediği vasıfsız işçi ve göçmen işçilerden oluşmaktadır. Bu durum dikkatsiz ve tehlikeli davranışların sıkça yaşanmasına ve neticesinde iş kazalarına neden olmaktadır. Sosyal Güvenlik Kurumunun (SGK) yıllık yayınladığı istatistiklere göre 2011-20 yılları arasındaki veriler incelendiğinde; inşaat sektöründe yaşanan iş kazalarının sıklık oranı 2016 yılına kadar diğer tüm sektörlerin toplamıyla yakın sonuçlar vermiş 2016 ve sonrasında daha yüksek sonuçlar vermiştir. Kaza ağırlık oranı ve ölümlü iş kazası sıklık oranları ise tüm yıllarda diğer tüm iş kollarının toplamından daha fazla sonuç vermiştir (Zengin, 2022).

Risk analizi çalışmaları ile işyerinde bulunan telikeler ve bu tehlikelerin sebep olabileceği riskler belirlenir. Belirlenen risklerin olumsuz etkilerini en aza indirmek için iş sağlığı ve güvenliği uygulamaları ortaya konur. Risk değerlendirmesi sonucunda çalışma ortamında hayata geçirilen İSG tedbirleri ile iş kazası ve meslek hastalıkları önlenir. Yapılan araştırmalar yaşanan iş kazalarının uygun İSG tedbirleri alınması

halinde %98'inin, meslek hastalıklarının da %100'ünün önlenebileceğini ortaya koymuştur (Camkurt, 2007; Ceylan, 2012).

İnşaat sektöründe yaşanan iş kazalarını daha az indirmek ve güvenli çalışma ortamları oluşturmak için risk değerlendirmesi sürecine önem verilmelidir.

Bu çalışma şantiyelerde kullanılabilecek örnek bir risk analizi gerçekleştirmek ve İSG profesyonellerinin çalışmalarında faydalanabileceği bir kaynak oluşturmak amacıyla hazırlanmıştır.

Tokat ili merkez ilçesinde bulunan 4000m^2 inşaat alanına sahip bina yapım şantiyesinde risk analizi yapılmış ve 365 adet tehlike tanımlanmıştır. Bu tehlikeli durumların puanlama sonrası risk sonuçları şu şekildedir;

- 60 tane çok yüksek riskli,
- 211 tane yüksek riskli,
- 81 tane önemli riskli,
- 11 tane orta riskli ve 2 tane düşük riskli.

YÖNTEM

Yapılan çalışmada risk analizi yöntemlerinden Fine- Kinney yöntemi tercih edilmiştir. Fine–Kinney yöntemi kantitatif (nicel) bir yöntemdir. Yöntem ilk olarak 1971 yılında W.T. Fine tarafından "Mathematical Evaluations for Controlling Hazards" metodu olarak ortaya konmuştur. 1976 yılında Kinney ve Wiruth tarafından geliştirilerek "Practical Risk Analysis for Safety Management" adıyla yayınlanmıştır. Bugün Fine–Kinney metodu olarak bilinen yöntem ülkemizde 2012 yılından itibaren İSG çalışmalarının artmasıyla kullanımı yaygınlaşmıştır (Erzurumluoğlu ve ark., 2015; Birgören, 2017). Bu yöntemde işyeri hakkında elde edilen veriler sayısal olarak ifade edilir ve matematiksel yöntemler kullanılarak risk puanı belirlenir.

Risk puanı hesaplanırken olasılık, frekans, şiddet değerleri kullanılarak hesap yapılır. Bu parametreler için Stankovic vd. yaptığı tanımlar şu şekildedir;

- Olasılık (O): Bir kaza veya hasarın olasılığını
- Frekans (F): Tehlikenin oluşma sıklığını
- Şiddet (Ş): Kaza sonucunda yaşanacak şiddeti ifade eder.

Wiruth ve Kinney tarafından yapılan tanımlarla Stankovic vd. yaptığı tanımlar ötüşmektedir (Stankovic ve Stankovic, 2013; Kinney ve Wiruth, 1976).

Risk puanı formülü şu şekildedir;

$$\text{Risk} = \text{Olasılık x Frekans x Şiddet}$$

Kullanılan bu parametreler için değer tanımları tablosundan yararlanılarak uygun puanlar seçilir ve her parametre için seçilen puanların çarpımıyla risk puanı elde edilir.

Olasılık değerlerinin tanımlandığı tablo aşağıda verilmiştir. Bu tablodan yararlanılarak tehlikeli durum için kaza veya hasarın olasılığı belirlenir.

Tablo 1. Olasılık değerleri

OLASILIK DEĞERLERİ (O)	
0,2	Pratik olarak imkânsız
0,5	Zayıf ihtimal
1	Oldukça düşük ihtimal
3	Nadir fakat olabilir
6	Kuvvetle muhtemel
10	Çok kuvvetli ihtimal

(Sargın, 2019)

Frekans değerlerinin tanımlandığı tablo aşağıda verilmiştir. Bu tabloladan yararlanılarak tehlikeli durumun oluşma sıklığı değeri belirlenir.

Tablo 2. Frekans değerleri

FREKANS DEĞERLERİ (F)		
0,5	Çok nadir	Yılda bir ya da daha az
1	Oldukça nadir	Yılda bir ya da birkaç kez
2	Nadir	Ayda bir ya da birkaç kez
3	Ara sıra	Haftada bir ya da birkaç kez
6	Sıklıkla	Günde bir ya da daha fazla
10	Sürekli	Saatte bir ya da birkaç kez

(Sargın, 2019)

Şiddet değerlerinin tanımlandığı tablo aşağıda verilmiştir. Bu tablodan yararlanılarak kaza olması durumunda yaşanacak şiddetin değeri belirlenir.

Tablo 3. Şiddet değerleri

ŞİDDET DEĞERLERİ (Ş)		
1	Dikkate alınmalı	Hafif-Zararsız veya önemsiz
3	Önemli	Minör-düşük iş kaybı, küçük hasar ilk yardım
7	Ciddi	Majör-Önemli Zarar, Dış tedavi, işgünü kaybı
15	Çok ciddi	Sakatlık, uzuv kaybı, çevresel etki
40	Çok kötü	Ölüm, Tam maluliyet, ağır çevre etkisi
100	Felaket	Birden çok ölüm, önemli çevre felaketi

(Sargın, 2019)

Elde edilen risk puanı için aşağıdaki tablodan risk seviyesi tanımı yapılır ve uygun koruyucu veya önleyici İSG tedbirleri belirlenir ve uygulanır. Önleyici tedbirler risk puanı parametrelerinden olasılık değerini, koruyucu tedbirler ise şiddet değerini düşürmeye yönelik İSG çalışmalarını ifade eder (Erzulumluoğlu ve ark., 2015).

Risk puanına göre risk seviyeleri tanımı aşağıdaki tabloda verilmiştir.

Tablo 4. Risk seviyesi tanımı

RİSK SEVİYESİ TANIMI		
R < 20	Düşük Risk	Acil tedbir gerekmeyebilir.
20 ≤ R <70	Orta Risk	Eylem planına alınmalı
70 ≤ R < 200	Önemli Risk	Dikkatle izlenmeli ve yıllık eylem planına alınarak giderilmeli
200 ≤ R< 400	Yüksek Risk	Kısa vadeli eylem planına alınarak giderilmeli
400≤ R	Çok Yüksek Risk	Çalışmaya ara verilerek derhal tedbir alınmalı

(Şengül ve Tokal, 2021)

Fine – Kinney yönteminde elde edilen risk puanı 0-20 arasında ise herhangi bir iyileştirme yapmaya ihtiyaç olmayabilir ancak bazı durumlarda bu aralıkta çıkan riskler için de iyileştirici uygulamalar yapılabilir. 20-70 arasında çıkan risk değerleri için yasal bir gereklilik olmadığı takdirde İSG tedbiri almak gerekmez. İstisnai durumlar hariç bu aralıkta sonuç veren riskler genelde alınmış bir önlem sonrası tekrar hesaplanan risk puanını gösterir. 70'den yüksek çıkan tüm riskler için uygun İSG planlaması yapılmalıdır. Düzeltici faaliyetler ve termin süreleri belirlenmeli, aksiyonların uygunluğu kontrol edilmelidir. 200-400 arası sonuç veren durumlar için kısa vadede İSG gereklilikleri planlanıp riskli durum kabul edilebilir seviyeye indirilmelidir. 400 ve üzeri değerde çıkan riskli durumlar için iş durdurulmalı ve acil İSG tedbirleri alınmalıdır. İşin durdurulmasının mümkün olmadığı durumlar için çalışmanın ne şekilde devam edeceği tarif edilmelidir (Koçak, 2022; Demirel, 2016).

SONUÇ

Örnek şantiyeye yapılan ziyaretlerde elde edilen veriler kullanılarak tehlikeli durumlar tanımlanmış ve risk puanları oluşturulmuştur. Toplamda 365 tane tehlikeli durum tanımlanmıştır. Bu tehlike durumlar için hiçbir önlem alınmadığı takdirdeki olasılık, frekans ve şiddet değerleri belirlenmiş ve risk puanı elde edilmiştir. Risk puanlarına göre tehlikeli durumların önem sırası oluşturulmuştur. Tehlikeli her durum için olması gerekenler ile koruyucu ve/veya önleyici iş sağlığı ve güvenliği uygulamaları önerilmiştir. Önerilen kontrol tedbirlerinin uygulanması sonrasında elde edilecek yeni risk puanları öngörülerek yeniden hesaplanmıştır (Zaimoğlu, 2022).

Elde edilen sonuçlara göre risk dağılımı aşağıdaki grafikte verilmiştir.

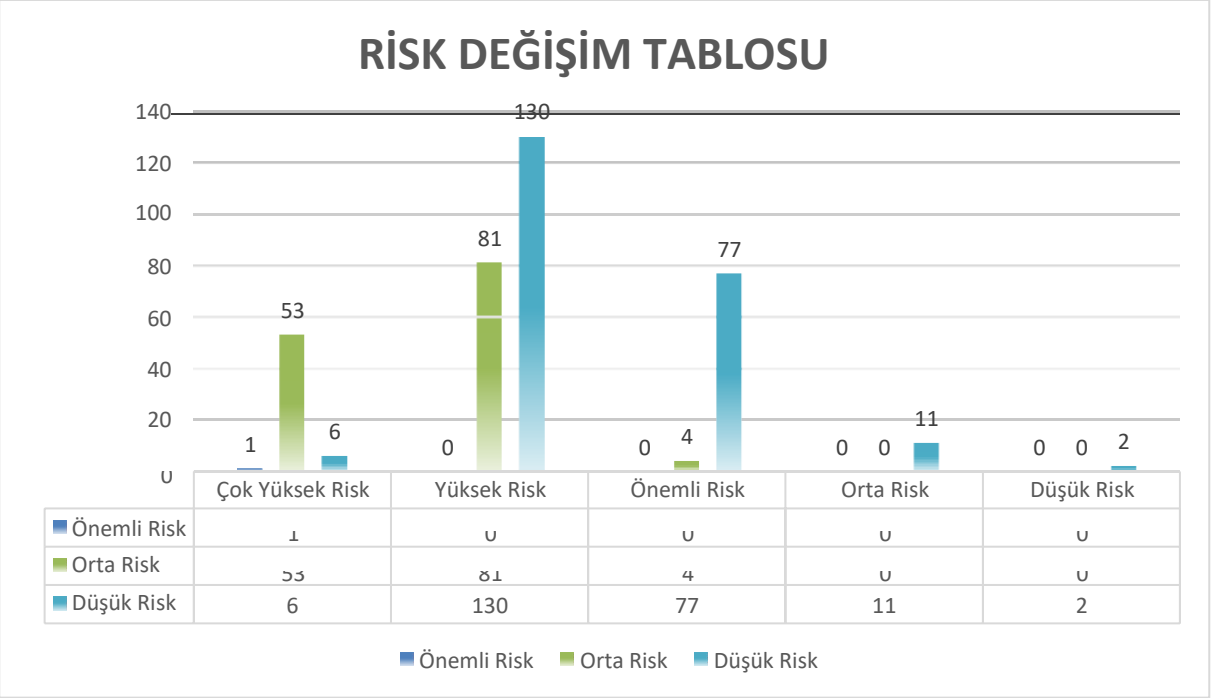
Grafik 1. Risk dağılımı

Risk analizi sırasında toplam 365 tane tehlikeli durum tanımlanmıştır. Bu tehlikeli durumların 60 tanesi çok yüksek riskli, 211 tanesi yüksek riskli, 81 tanesi önemli riskli, 11 tanesi orta riskli ve 2 tanesi düşük riskli sonuç vermiştir. Her tehlikeli durum için uygun İSG önlemleri belirlenmiştir. Bu önlemler alınması halinde elde edilecek yeni risk puanları değişiminin analizi Grafik 2. ile özetlenmiştir.

Grafik 2. Kontrol tedbirlerinden sonra risk puanı değişimleri

Risk puanlaması sonrası 60 tane çok yüksek riskli sonuç veren tehlikeli durumların risk kontrol önlemleri alındıktan sonraki öngörülen puanlamaları; 1 tane önemli risk, 53 tane orta risk ve 6 tane düşük risk olarak değişim sonucu vermiştir.

Yüksek riskli puanlanmış 211 tane tehlikeli durumların risk kontrol önlemleri alındıktan sonraki öngörülen

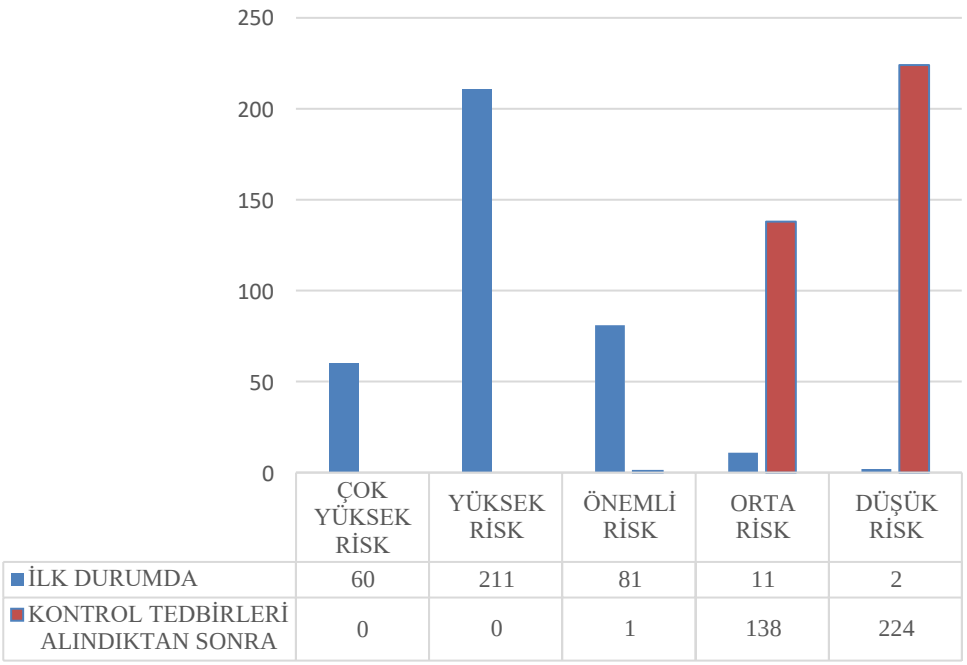


puanları; 81 tane orta risk, 130 tane düşük risk olarak değişmiştir.

Önemli risk olarak sonuç veren 81 tane tehlikeli durumların risk kontrol önlemleri alınması halinde öngörülen yeni puanlamaları; 4 tane orta risk, 77 tane düşük risk olarak sonuç vermiştir.

Orta riskli olarak puanlanan 11 tane tehlikeli durum risk kontrol önlemleri alınması halinde yeni risk puanları düşük riskli sonuç vermiştir.

Değişimin risk seviyelerine göre dağılımı Grafik 3'te verilmiştir.



Grafik 3. Kontrol tedbirleri alındıktan sonraki risk dağılımı

Belirlenen kontrol tedbirlerinin uygulanması halinde çok yüksek ve yüksek riskli durumların ortadan kalktığı öngörülmüştür. Kontrol tedbirlerinin uygulanması halinde belirlenen tehlikeli durumların %99'un orta ve düşük risk grubunda kümelenmiştir.

SONUÇ VE TARTIŞMA

İnşaat sektöründe gerçekleşen iş kazaları incelendiğinde en çok kaza sebebi olarak yüksekten düşme karşımıza çıkmaktadır (Müngen, 2011). Yapılan çalışmada yüksekten düşmeye sebep olabilecek tehlikeli durumların puanları hesaplandığında çok yüksek riskli sonuç vermiştir. Bu açıdan yapılan çalışma literatürdeki istatistiklerle örtüşmektedir.

Benzer diğer çalışmalarla yapılan çalışma genel olarak aynı sonuçları verse de bazı durumlarda farklılar görülmüştür. Örneğin; yangın ekipmanlarının eksik ya da yetersiz olması durumunda oluşabilecek büyük bir yangın olayı meydana gelebilir. Bu durumda birden çok ölüm yaşanması muhtemeldir. Bu sebepten tehlikeli durum için şiddet değeri 100 olarak seçilmiştir. Ancak Baykul'un (2022) yaptığı risk analizi çalışmasında benzer tehlikeli durum için şiddet değerini 40 seçilmiştir. Yine Koçak (2022) yangın ekipmanlarının yetersizliği için şiddet değerini 40 olarak belirlemiştir. İş yerleri için yangın felaketinin birden çok ölüme sebep olabileceği varsayımı ile şiddet değerinin 100 olarak belirlenmesi daha uygun olacaktır.

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Comparison of Machine Learning Algorithms in Predicting Heart Disease

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Abstract

Heart diseases are among the leading causes of death worldwide. According to the World Health Organization (WHO), approximately 17.9 million people die from these diseases each year. The high mortality rates make predicting heart diseases crucial. It has been observed that machine learning methods are frequently used for this purpose. Machine learning methods are typically used to unveil hidden relationships within large datasets via computer programs. In this study, machine learning methods such as Naïve Bayes, Adaboost, Random Forest, and Neural Network were applied for the prediction of heart disease. The "Heart Disease" dataset from the Kaggle database was utilized in this research. The dataset consists of 13 independent variables, with one being the dependent variable. However, due to missing data, one variable was excluded from the analysis. The dataset comprises 1025 individuals, of which 499 are not patients (48.7%) and 526 are patients (51.3%). Among the non-patient individuals, 86 are females and 413 are males, while among the patients, 226 are females and 300 are males. Performance metrics such as accuracy, precision, recall, F1-score, and AUC values were used. The methods were implemented using the Python-based Orange program. Analysis results indicated that the Adaboost method provided more accurate predictions compared to other methods.

Key words: *(Heart disease, Machine Learning, Orange)*

Data Mining Application in Online Food Orders

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Abstract

The Cultivated as essential tools within contemporary research, data mining and statistical methodologies have garnered widespread recognition and growing significance. These methodologies, in concert with their associated techniques, facilitate the exploration of valuable and confidential insights concealed within datasets. In the realm of online food ordering, a multifaceted decisionmaking process transpires, influenced by numerous considerations. These considerations encompass not only the attributes of the respective digital platforms but also extend to broader factors. Of particular note are attributes associated with user experience and privacy, alongside pivotal factors with the service provider, notably the restaurant. Service quality, delivery speed, and the freshness of the food are all taken in account. In the context of this study, a two-fold analytical approach was undertaken. Firstly, a Classification Model, specifically Decision Trees (CHAID & CART), was used to ascertain the preeminent factors guiding customers' decisions when placing online food orders. Subsequently, Statistical Techniques, encompassing Descriptive Statistics and the Analysis of Validity, Reliability, and Exploratory Factor Analysis (EFA), were used to interrogate the Likert-scale responses provided by customers and determine the number of the formed factors from the participants answers. The ensuing results, derived from this methodological framework, were presented as follows: The CHAID and CART analyses converged on the variable "DAIUT (Daily Average Internet Usage Time)" as the principal determinant significantly impacting participants' decisions to engage in online food ordering. The analysis indicated that as the DAIUT value increases, the likelihood of online food order placement proportionally rises. Concurrently according to EFA results, it was determined that three factors were formed.

Key words: *Data mining, Statistical methods, Multivariate techniques, Online food orders.*

Assessment of Impact of the COVID-19 Pandemic on Countries' Sustainable Development Level with Hybrid of Data Mining and MCDM Models

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Abstract

The Sustainable Development Goals (SDGs) established by the United Nations aim to provide a peaceful, safe, healthy, sustainable environment world, without inequalities. COVID-19 pandemic caused tremendous adverse effects on social, economy, environment, energy life of human. The aim of the study is to evaluate 43 countries in terms of the impact of COVID-19 on part of sustainable development (SD) indicators. GDP per capita, male and female life expectancy, environmental performance index, environmental health, air quality, water resources, emissions of CO_2, ecosystem vitality, biodiversity and habitat were study indicators. For this aim, the countries were grouped using K-Means clustering analysis to determine their similarities and differences. After that, they were compared with MCDM (Multi-Criteria Decision-Making) methods of, VIKOR, MULTIMOORA (Multi-Objective Optimization on the Basis of Ratio Analysis Plus Full Multiplicative Form), and WASPAS (Weighted Aggregated Sum Product Assessment). Ensemble MCDM method is used to find optimal rank by using half-quadratic (HQ) theory. The optimal cluster was found as four according to Silhouette and Davies–Bouldin indexes. It was found that Luxemburg and Sweden were ranked as the first and second and Russia, China, Indonesia, India, and South Africa were ranked as last countries for before and after pandemic terms. Although there has been a change in the averages of SD variables with the pandemic worldwide, there has been no change in the relative evaluations of the countries when compared to before and after pandemic.

Key words: *cluster analysis, ensemble MCDM, VIKOR, MULTIMOORA, WASPAS*

Does Competitiveness Enhance the Innovation? Modeling the Innovation Index via a Novel Approach

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Abstract

The Global Innovation Index (GII) and the Global Competitiveness Index (GCI) assess aspects of a country's economic performance, they have different focuses and are published by different organizations. Since the GII offers a comprehensive assessment of a country's innovation ecosystem, informs policy decisions, attracts investment, fosters collaboration, and promotes a culture of innovation that can drive economic growth, it is important to determine the factors affecting it directly or indirectly. Thus, this study aims to determine the impact of GCI pillars such as competitive pressures, market dynamics, regulatory environments, and access to resources on countries' ability and motivation to innovate. To reach this aim, four different machine learning algorithms are performed. Also, a novel ensemble approach named the Super Learner (SL) algorithm is used to increase the model performance. The data consists of 120 different countries' statistics from 2017 to 2019. The data has 348 observations after excluding missing values. Based on the results obtained from the SL algorithm, R^2 statistics of the training and testing sets are 98.3% and 94.8% respectively, which shows the model can explain the GII by GCI Pillars accurately. According to the model, the top three important factors affecting GII are Pillar 1: Institutions, Pillar 2: Infrastructure, and Pillar 3: ICT adoption, from the most to the least important, respectively. According to these results, five different policy implications are determined: (i) Policymakers should prioritize strengthening institutional frameworks, including governance and regulatory environments, to reduce corruption and enhance transparency; (ii) Investing in infrastructure, both physical and digital, is imperative to create an environment conducive to innovation; (iii) Promoting widespread adoption of Information and Communication Technology (ICT) and digital literacy is essential for modern economies; and (iv) Investments in healthcare infrastructure and research can drive innovation in the healthcare sector, contributing to overall competitiveness.

Key words: *Economic Development, Innovation, Competitiveness, Super Learner*

Data Mining in The Digital Shops

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Abstract

In this study, the concept of data mining, which is the stage of obtaining useful information from raw data, has been investigated. The study is aimed to evaluate the best-selling book genres with classification algorithms. In this direction, it has been tried to determine which factors effectively classify the books in the best-selling book lists taken from the websites selling books in Turkey according to their genres. Data from the best-selling book lists of twenty-one websites selling books in Turkey in January 2019 were classified using distance-based algorithms from predictive data mining models. In the study, the k-Nearest Neighborhood (k-NN) algorithm, one of the data mining classification algorithms, was chosen because it gave the most successful result. By determining which factors are effective in classifying the books in the best-selling book lists in Turkey according to their genres, it has been tried to contribute to the genre classifications carried out during the sale of the books on the internet sites through data mining. In this context, it has been seen that the types of books with the best scores are novels literature, and children's books.

Keywords: *Data Mining, Classification, the K-Nearest Neighborhood (k-NN) Algorithm*

Biclustering and an Application

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Abstract

Biclustering method is one of the most important methods of the data mining techniques. Biclustering can be used to discover similar patterns in datasets especially gene expression datasets or any datasets that can be presented as a matrix. Starting with Block clustering algorithm in 1972 until now a good number of the biclustering algorithms have been introduced. In biclustering methods, similar rows and columns in the data matrix are grouped simultaneously according to their subsets. The parameters used in biclustering algorithms are very important in determining the biclusters to be obtained. Because biclustering algorithms obtain different biclusters according to parameter values. There are many evaluation measures in the literature to obtain meaningful and effective biclusters.

Biclustering methods, which are popular recently, are used in the clustering analysis for this data. The performance of these algorithms needs to be examined in order to measure the effectiveness of the biclusters obtained for the purpose of the study. In this study, the performances of the most commonly used CC, Bimax algorithms are compared. Calculation of evaluation measures was made with Python, R functions and analyzes were applied to these codes. Artificial and real data are used to compare different data structures. As a result of the analysis, it was determined which algorithm obtained more meaningful biclusters in which data set.

Key words: *Biclustering, Bimax, CC*

Financial Management of Insurance Companies using MODM

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Abstract

It is significant for insurance companies to have an effective financial management to avoid various risks such as the ruin probability. Numerous targets may be desired for these companies, such as optimizing profits, ensuring financial ratios, minimizing losses and avoiding certain risks. In this case, the use of multi-objective decision making (MODM) models can be beneficial. In this study, Dynamic Financial Analysis is performed for an insurance company with a MODM technique, Goal Programming. Türkiye insurance data is used in the application.

Key words*: MODM, Dynamic Financial Analysis, Goal Programming, Insurance.*

Comparative Financial Performance Analysis of SMEs Traded on BIST with MCDA Techniques During the Pandemic Period

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Abstract

Small and medium-sized enterprises (SME) play a vital role in the revitalization of national economies. In fact, SMEs in Turkey provide 71% of employment and these group of companies are traded on a separate index at Borsa Istanbul. The determination of the performance values of financial instruments are vital for all stakeholders, and it becomes even more critical, especially during periods of increased volatility, like in the infamous pandemic of COVID-19. Financial performance measurement serves as an important reference point for financial stakeholders in making complex decisions. Because of this evaluation process includes many criteria and alternatives, multi-criteria decision analysis (MCDA) applications have become widespread and used in the recent years. For this purpose, TOPSIS, MABAC, and VIKOR methods were preferred for the financial performance analysis in this study, due to their success in uncertain situations. 32 companies traded on the BIST SME index were analyzed for 8 periods through 6 criteria. Then, the relationships between the method results and stock returns were observed, and the method with the highest relationship was recommended to financial decision-makers. As a result of this comparative study, a higher and significant relationship was found between stock returns and the final results of VIKOR method. MABAC and TOPSIS followed this method with the association levels of 60% and 57% respectively, indicated by the Spearman's correlation.

Key words: *Financial performance, Capital markets, VIKOR, Share returns.*

INTRODUCTION

Small and medium-sized enterprises (SME), although more common than large companies on a global scale, have been classified in a more special category because their values such as employment capacity and active size are relatively modest compared to latter group of larger companies (Özdemir et al., 2007). They play a pivotal role in stimulating entrepreneurship, increasing productivity and employment, integrating globalization, and also the power they create at the regional level cannot be denied. In other words, SMEs have the potential to dramatically affect the employment and economic well-being of countries (Bayülken & Kütükoğlu, 2012).

In both developed and developing countries around the world, enterprises with a certain level of employment and production capacity are classified as SMEs, albeit with varying numbers. According to the latest data, 99.7% of all businesses in Turkey are SMEs, while 71% of employment in Turkey is provided by them (TÜİK, 2022). Moreover, over 30% of exports in 2021 were realized by SMEs, and almost half of these exports were made to European countries. On the other hand, the import rate of SMEs in the same year was 14.7%. Additionally, more than 20% of all patents registered in Turkey in the same year belonged to SMEs. In terms of global numbers, over 95% of all businesses worldwide are SMEs, and they account for an average of 65% of global employment according to the United Nations (Globalnaps, 2020).

From this perspective, SMEs, which play a crucial role in economies, undoubtedly have a vital place in the capital markets. To illustrate, the SME Industrial Index has been operating on Borsa Istanbul since December 2013. SMEs are publicly offered and traded in capital markets in order to increase their export potential and improve their prestige. The number of companies trading on this index in Borsa Istanbul is 46. Increasing competitive environment of the globalized world, financial instabilities and the difficulty of finding new financing opportunities make SMEs a riskier investment group (Yoshino & Taghizadeh-Hesary, 2016; Wu & Olson, 2020). In this sense, it is of great importance for financial stakeholders who follow the companies trading on this index to distinguish the financial health indicators of the relevant firms.

In this study, financial performance analysis of 32 companies traded in the BIST SME Industry Index was carried out. For this purpose, 8 quarters between 2020 and 2022 were examined through 6 criteria determined based on previous literature, TOPSIS, MABAC and VIKOR methods along with Standard Deviation weighting technique were used to perform these analyses.

The general framework of the study can be summarized as follows: In the second section, the literature related to financial performance and the methods used in this study will be summarized. In the third section, the application stages of the methods used in the analysis will be explained in detail, and the role of criteria in financial performance studies will be discussed. In the fourth section, the comparative analysis findings will be presented, and the most appropriate among the analyzed methods will be determined. In the fifth and final section, the results of this study will be summarized, and potential route of the future studies will be discussed.

LITERATURE REVIEW

The financial performance of three hotels operating under a holding company in Turkey has been analyzed in a study (Yükçü & Atağan, 2010). Using the TOPSIS method and four criteria, the hotels located in Istanbul, Izmir, and Antalya were ranked according to their performance.

In a study evaluating the performance of four automotive parts suppliers in Iran based on seven criteria, the TOPSIS analysis method was preferred (Shahroudi & Rouydel, 2012). The study established the weights of the criteria according to the ANP technique, and the suppliers were ranked based on their performance scores computed with TOPSIS method.

In a study made in Türkiye on the selection of robots used in production systems, analyses were carried out based on five criteria (Ahmad et al., 2020). Using the MABAC method and the CRITIC weighting technique, the robots were ranked according to their performance.

In an analysis conducted to create a ranking that could assist decision-makers in their choice of electric vehicles, the MABAC method was used to compare the results obtained (Ecer, 2021). In the study where 10 electric vehicles were evaluated on 11 criteria, the vehicle price was identified as the most important criterion, and the most suitable vehicles were ranked according to all methods.

In a study conducted for material selection in the process of producing the highest quality product at minimum cost, the MABAC and ARAS methods were used (Bose et al., 2019). In the study, which included 48 material samples, the most suitable material portfolio was made based on the methods used.

In Serbia, 8 suppliers were analyzed using the BWM subjective weighting technique and the MABAC method after determining the criterion weights (Muravev & Mijic, 2020). The results of the MABAC method were also compared with VIKOR and MAIRCA, and the most suitable supplier was selected according to all analyzed methods.

In a study examining the impact of COVID-19 on the sustainable development levels of OECD countries, the MABAC method was used in conjunction with the MAIRCA and WASPAS methods (Kaya, 2020). In

the analysis carried out using 5 quarterly data from the last quarter of 2019 through 2020, all methods have found that the pandemic had a negative impact on sustainable development, with the overall result that developed countries were less affected than developing countries.

In another research conducted with multiple MCDA methods to create a support system that would facilitate customers' decision-making processes on e-commerce websites, one of the applied methods was also MABAC (Bączkiewicz et al., 2021). Accordingly, analyses were conducted over 12 criteria to enable customers to select the most suitable smartphone. In the study where the CRITIC weighting technique was used, alternative smartphones were ranked based on the results obtained from different methods.

In a study evaluating the 8 logistics villages in Turkey, a fuzzy variation of the MABAC method was used (Zolfani et al., 2021). In the research, which applied the subjective weighting technique SWARA, gross national product was determined as the most significant criterion among 9 criteria, and the performance of logistics villages was ranked according to MABAC in order to determine the optimal alternative.

In another research evaluating the performance of 12 airlines operating in the US based on 11 criteria, the VIKOR analysis method was used (Pineda et al., 2018). As a result of the study, companies were ranked according to the performance results calculated by this method.

In a study investigating the innovative contribution of Fintech applications to the sustainability of the Chinese banking sector, the VIKOR analysis method was used (Zhao et al., 2019). In the study, which evaluated 4 banks based on 6 main criteria, banks were compared according to their service performance scores.

RESEARCH METHODOLOGY

Among the many different factors that influence the confidence of investors, the most critical one is financial performance, which is measured through financial ratios (Tey et al., 2019). Return on assets (ROA) is an important and traditional ratio that shows how much profit a company can generate from its assets over a specific period. The debt-to-equity (D/E) ratio is a pre-investment indicator that shows the level of debt a company has. For investors, this ratio is crucial in measuring investment risk (Muhammad et al., 2013). Earnings per share (EPS) represents the portion of a shareholder's earnings from all the profits generated by the company over a specific period. It is an important indicator as it provides information on the activity of shareholder value. Market value/book value (MV/BV) is a performance metric that shows how much a company adds to its capital value. Market value added (MVA) is a valuation-based, important ratio used in performance analysis that explains the difference between a company's total value and invested capital (De Wet & Hall, 2004). Net profit growth (NPG) is an essential parameter that focuses on whether a company can sustainably create profits for investors. It also shows how effectively and efficiently the company utilizes its resources (Nariswari and Nugraha, 2020).

In a study where the financial performance of 30 companies to be included in the portfolio was evaluated, the TOPSIS method was used. Among the 6 criteria determined as performance metrics in the study, ROA, EPS, and D/E are included (Liew, 2022).

In another research where the financial performance of 30 companies traded on the Dow Jones Index was evaluated, D/E is among the 7 criteria used (Lam et al., 2023).

In a study evaluating the financial performance of 22 hotel businesses and 9 travel agencies listed on the capital markets and operating in India using the CoCoSo method, MV/BV, D/E, and ROA were among the criteria preferred (Ghosh & Bhattacharya, 2022).

In another research where the financial performance of 18 construction companies traded on the Tokyo Stock Exchange was analyzed using the TOPSIS method, EPS, MVA, and ROA are among the accounting and valuation-based ratios implemented (Aduba, 2022).

In this study, the details and application stages of the preferred TOPSIS, MABAC, and VIKOR methods for producing effective results in solving quantitative problems which involves uncertainty, and the Standard Deviation weighting technique used due to its ability to make objective calculations based on purely statistical relationships will be explained below.

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS method is flexible and practical to utilize, which also has an infrastructure that can solve distinctive problems in various fields (Ferreira et al., 2016). In this method, which takes into account the mutual dependence between criteria, alternatives are evaluated and ranked (Vinodh & Swarnakar, 2015; Liu et al., 2017).

Preliminarily, the normalization process applied in the first stage of each MCDA technique is performed with the equation (1) given below. Calculations are made via vector normalization in TOPSIS.

$$F_{ij} = \frac{f_{ij}}{\sqrt{\sum_{i=1}^{m} f_{ij}^2}} \tag{1}$$

Thereafter, each value in the normalized decision matrix is weighted by the corresponding criterion weight in order to create a weighted and normalized decision matrix.

$$v_{ij} = F_{ij} \times w_j \tag{2}$$

In this method, proximity and distance to positive and negative ideal solutions are of critical importance, as they lead to the most optimal results. To this end, positive and negative ideal solutions are calculated using the formulas (3) and (4) respectively, as given below.

$$A^+ = \{(Max_i(v_{ij}) \mid j \in J), (Min_i(v_{ij}) \mid j \in J') \mid i \in 1, 2, \dots, m\} = \{v_1^+, \dots, v_j^+, \dots, v_n^+\} \tag{3}$$

$$A^- = \{(Min_i(v_{ij}) \mid j \in J), (Max_i(v_{ij}) \mid j \in J') \mid i \in 1, 2, \dots, m\} = \{v_1^-, \dots, v_j^-, \dots, v_n^-\} \tag{4}$$

Distances to positive and negative solutions are obtained using equations (5) and (6) respectively.

$$S_{i+} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2} \qquad i = 1, 2, 3, \dots, m \tag{5}(5)$$

$$S_{i-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2} \qquad i = 1, 2, 3, \dots, m \tag{6}(6)$$

Finally, the relative proximity to the ideal solution is obtained using equation (7).

$$C_i = \frac{S_{i-}}{S_{i-} + S_{i+}} \tag{7}(7)$$

For this method, rankings are obtained by sorting the final method results, as calculated in the above steps, in a descending order.

Multi-Attributive Border Approximation Area Comparison (MABAC)

A relatively new method that determines the most suitable alternative by defining a boundary proximity area is MABAC (Pamučar & Cirovic, 2015). The distance of the alternatives analyzed to the boundary proximity area is taken into consideration. The alternatives that are above the boundary proximity area are dominant and therefore preferred, and the alternative with the highest value is considered as the most optimal and ultimately the final rankings are determined accordingly.

The MABAC method is highly effective in the rational decision-making process due to its practicality and consistency (Xue et al., 2016). Therefore, it appears as a method evaluated and examined in many different fields of science and preferred in solving various types of problems (Gigovic et al., 2016; Shi et al., 2017; Yu et al., 2017).

In the decision matrix determined according to the relevant alternatives and criteria, a normalized decision matrix is created by using equation (8) for benefit-based criteria and equation (9) for cost-based criteria for the min-max normalization process.

$$n_{ik} = \frac{x_{ik} - x_i^-}{x_i^+ - x_i^-} \tag{8}$$

$$n_{ik} = \frac{x_{ik} - x_i^+}{x_i^- - x_i^+} \tag{9}$$

Afterwards, a weighted and normalized decision matrix is formed by multiplying the relevant values in the normalized decision matrix with the previously determined relevant criteria weights, as shown in formula (10).

$$v_{ik} = w_k(n_{ik} + 1) \tag{10}$$

Then, the calculation of the boundary proximity area is carried out by taking into account equations (11) and (12), and thus the boundary proximity area matrix is created.

$$g_k = \left(\prod_{i=1}^{m} v_{ik}\right)^{1/m} \tag{11}$$

$$G = [g_1, g_2, \dots, g_n] \tag{12}$$

Later, distances to the border proximity area are determined according to the formula given in equation (13), in compliance with the constraints given in equation (14). Accordingly, G^+ contains the most ideal alternatives.

$$Q = V - G = \begin{bmatrix} v_{11} & \cdots & v_{1n} \\ \vdots & \ddots & \vdots \\ v_{m1} & \cdots & v_{mn} \end{bmatrix} - \begin{bmatrix} g_1 & \cdots & g_n \\ \vdots & \ddots & \vdots \\ g_1 & \cdots & g_n \end{bmatrix} = \begin{bmatrix} q_{11} & \cdots & q_{1n} \\ \vdots & \ddots & \vdots \\ q_{m1} & \cdots & q_{mn} \end{bmatrix} \tag{13}$$

$$A_i \in \begin{cases} G^+ \; if \; q_{ik} > 0 \\ G \; if \; q_{ik} = 0 \\ G^- \; if \; q_{ik} < 0 \end{cases} \tag{14}$$

Ultimately, the calculated distance scores are added together, as shown in equation (15), to obtain the final S_i values.

$$S_i = \sum_{k=1}^{n} q_{ik} \quad i = 1,2,3,\dots,m \tag{15}$$

Rankings are obtained by arranging the relevant scores calculated in a descending order.

Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR)

VIKOR, which measures the distance to the ideal alternative, is a compromise-based method for solving complex problems (Opricovic, 1998). Since the alternative closest to the ideal alternative is chosen as the most optimum, rankings are made from least to the greatest (Opricovic & Tzeng, 2007).

The best and worst values for each criterion are calculated using equations (16) and (17), given below.

$$F_j^+ = Max_{i \in m} f_{ij} \text{ ve } F_j^- = Min_{i \in m} f_{ij} \quad \textit{for maximization} \tag{16}$$

$$F_j^+ = Min_{i \in m} f_{ij} \text{ ve } F_j^- = Max_{i \in m} f_{ij} \quad \textit{for minimization} \tag{17}$$

S_i and R_i values for each alternative are determined through formulas (18) and (19), respectively.

$$S_i = \sum_{j=1}^{n} w_j \left(\frac{F_j^+ - f_{ij}}{F_j^+ - F_j^-}\right) \tag{18}$$

$$R_i = Max_{j \in n} \left[w_j \left(\frac{F_j^+ - f_{ij}}{F_j^+ - F_j^-}\right)\right] \tag{19}$$

Finally, Q_i values are calculated for all alternatives using equation (20).

$$Q_i = \gamma\left(\frac{S_i - S^+}{S^- - S^+}\right) + (1-\gamma)\left(\frac{R_i - R^+}{R^- - R^+}\right) \tag{20}$$

$$S^+ = Min_{i\in m} S_i, S^- = Max_{i\in m} S_i, R^+ = Min_{i\in m} R_i, R^- = Max_{i\in m} R_i \tag{21}$$

Thus, all alternatives are ranked in an ascending order according to their Q_i results.

Standard Deviation Weighting Technique (Std. Dev.)

This technique enables objective weighting of criteria by making use of standard deviation (Jahan et al., 2012). Initially, the decision matrix is normalized using the min-max normalization technique according to equations (22) and (23), respectively, based on the benefit and cost-based criteria integrated into the analysis.

$$F_{ij} = \frac{f_{ij} - min_{i\in m} f_{ij}}{max_{i\in m} f_{ij} - min_{i\in m} f_{ij}} \quad \textit{For benefit-based criteria} \tag{22}$$

$$F_{ij} = \frac{max_{i\in m} f_{ij} - f_{ij}}{max_{i\in m} f_{ij} - min_{i\in m} f_{ij}} \quad \textit{For cost-based criteria} \tag{23}$$

Standard deviations, which give the weighting technique its name, are calculated for each alternative using formula (24).

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}(F_{ij} - \overline{F_j})^2}{m}} \quad j \in \{1,2,\dots,n\} \tag{24}$$

Finally, the weight of each criterion is determined through equation (25).

$$w_j = \frac{\sigma_j}{\sum_{k=1}^{n} \sigma_k} \quad j \in \{1,2,\dots,n\} \tag{25}$$

FINDINGS AND RESULTS

In this study, the financial performances of 32 companies traded in the Borsa Istanbul SME Industry index were analyzed for 8 quarters between 2020 and 2022. Criterion weights were calculated using the Standard Deviation weighting technique, which is an objective weighting technique. For this purpose, calculations were made based on 6 criteria with TOPSIS, MABAC and VIKOR methods, which are used in MCDM studies due to their practicality, user-friendliness and calculation capabilities. The characteristics of the study is summarized in Table 1 below.

Table 1. Sample, Method and Descriptive Data of the Analysis

Capital Market	Alternatives	Weighting Technique	Methods	Time Frame	Periods	Criteria
BIST SME Index	32 Companies	Standard Deviation Weighting Technique	TOPSIS, MABAC, VIKOR	2020-2022	8 Quarters	ROA, EPS, MV/BV, D/E, NPG, MVA

Afterwards, the relationship levels of the method results with the stock returns of the relevant companies were revealed together with their statistical significance levels using the Spearman correlation coefficient. The decision matrix used in the first stages of all methods in the analysis phase of this study are given in Table 2 below.

Table 2. Decision Matrix of the First Quarter used for the Analysis in this Study

	ROA	EPS	M/B	Debt	NPG	MVA
ACSEL	0,613648	0,830413	-0,2867	0,146334	-1,80141	-0,28738
BAYRK	0,498044	0,779418	0,427461	0,501241	-0,80503	0,674973

BRKSN	0,473249	0,480771	0,400663	-0,11546	0,31413	0,710948
BFREN	0,075173	0,307458	0,316967	0,301004	0,219618	0,423753
BURCE	-0,22287	-0,25021	0,004339	0,001561	-0,18326	-0,02768
BURVA	-0,42407	-0,65337	-0,10031	-0,43151	-0,36518	-0,17996
DAGI	-0,37034	-0,16119	-0,53022	-0,26761	-0,73448	-0,52199
DNISI	0,07228	0,12162	0,073106	-0,11877	-0,81292	0,191163
DOBUR	0,689853	0,525005	0,318028	0,011007	0,437374	0,196617
DOGUB	-0,04602	0,034699	0,168227	0,297169	0,494105	0,196823
EMKEL	-0,49846	-0,49868	0,566486	-0,07201	-0,32047	1,187836
ERSU	0,237408	0,338952	-0,12587	0,160544	-0,12322	-0,12245
FADE	14,50046	15,17366	-0,1178	-0,09224	-0,41205	-0,15518
FMIZP	0,271237	0,496972	-0,1976	-0,18402	-0,5692	-0,01995
FORMT	6,746749	6,942455	0,157154	0,00969	-0,01414	0,216692
FRIGO	0,422909	1,879467	-0,3684	0,782346	-3,73512	-0,17819
GEDZA	0,322882	0,464614	0,388698	0,020957	0,249978	0,821943
LUKSK	-1,9632	-1,98262	-0,20358	-0,30016	-0,77412	-0,11201
MAKTK	0,413606	0,387088	0,423107	-0,10156	-0,25817	0,615834
NIBAS	-7,71641	-6,93923	1,337408	-0,04012	-2,66494	1,180944
OYLUM	0,234755	0,249387	-0,07426	-0,01222	0,154176	-0,0936
PRKME	-0,13158	-0,16725	0,152743	-0,21041	0,515849	-9,57801
PRZMA	6,931854	6,957686	0,032836	-0,42375	0,124453	0,247565
SAFKR	1,00491	1,032525	0,727446	-0,17061	0,854453	1,259332
SANFM	4,252279	5,338717	0,217626	-0,06328	15,19568	0,612331
SAMAT	2,364759	2,290511	1,029452	-0,16873	-0,06383	1,544623
SAYAS	8,961106	24,5304	-0,30737	0,379326	-65,3262	0,324139
SELGD	0,720853	0,602689	0,012684	-0,38468	-3,04878	0,027459
SEYKM	0,93086	1,340597	0,595395	-0,21076	0,207494	1,291489
TMPOL	0,435164	0,579723	0,138854	-0,01258	-0,24665	0,329093
VANGD	0,772215	1,004878	0,118285	0,261339	0,263176	0,262897
YAPRK	0,027279	0,020709	0,230351	-0,02021	-0,43022	0,253292

Standard deviation weighting technique was used in order to obtain objective results for the period examined in this study where uncertainty was intense. The criterion weights found according to this weighting technique are shown in Table 3. Within the 8 periods examined, the criteria that produced more weight coefficient were found to be MV/BV, D/E and MVA. Calculations made according to the relevant technique show that valuation-based ratios produce more significant weights in the examined period.

Table 3. Standard Deviation Weighting Technique Results for Each Quarter

	20/IV	21/I	21/II	21/III	21/IV	22/I	22/II	22/III
ROA	0,153829	0,139395	0,164569	0,152111	0,143638	0,158553	0,155594	0,162409
EPS	0,158443	0,145314	*0,168836*	0,152761	0,135736	0,165171	0,150299	*0,167114*
MV/BV	*0,196575*	*0,192827*	*0,23451*	*0,167699*	0,168064	0,166613	*0,184021*	0,165836
D/E	*0,20277*	0,166422	0,156194	*0,214877*	*0,233844*	*0,177914*	*0,201039*	0,15962
NPG	0,136653	0,177942	0,127482	0,150393	0,131402	0,135985	0,143769	0,156386
MVA	0,15173	*0,178101*	0,14841	0,162159	*0,187317*	*0,195763*	0,165278	*0,188635*

The final results calculated according to the TOPSIS method are shown in Table 4 below. Fade Gıda (FADE) was the highest performing SME company in the first quarter. Afterwards, Say Renewable Energy (SAYAS), Doğusan Boru (DOGUB), Burçelik Çelik Döküm (BURCE), Doğan Burda Yayıncılık (DOBUR), Saray Matbaacılık (SAMAT) and Oylum Sınai Yatırım (OYLUM) companies showed the most significant performance in the other quarters, respectively. In the last quarter of the examined period, DOBUR again surpassed other SMEs in the same index and rose to the first place.

Table 4. Final Results Calculated by TOPSIS Method for Each Quarter

	20/IV	21/I	21/II	21/III	21/IV	22/I	22/II	22/III
ACSEL	0,49935	0,538048	0,536957	0,343727	0,346547	0,765694	0,610321	0,475686
BAYRK	0,516188	0,496849	0,558302	0,448842	0,325018	0,511153	0,546225	0,500179

BRKSN	0,588224	0,532605	0,491271	0,425674	0,311267	0,622199	0,564588	0,481637
BFREN	0,527439	0,495646	0,531629	0,354025	0,36739	0,603914	0,507756	0,475668
BURCE	0,531687	0,500684	0,506932	*0,612015*	0,403765	0,632116	0,527276	0,50988
BURVA	0,56241	0,464708	0,668891	0,258364	0,344235	0,550325	0,519077	0,483712
DAGI	0,518622	0,468484	0,589938	0,501829	0,284649	0,556514	0,521659	0,530404
DNISI	0,554533	0,606887	0,572156	0,379506	0,369249	0,456233	0,513577	0,465279
DOBUR	0,565035	0,449683	0,529605	0,438511	*0,592676*	0,576151	0,313827	0,457162
DOGUB	0,514015	0,524467	*0,702297*	0,343819	0,376689	0,592575	0,550123	*0,613513*
EMKEL	0,586722	0,472866	0,567651	0,408276	0,369483	0,71165	0,544549	0,463802
ERSU	0,508813	0,536591	0,51626	0,389713	0,443093	0,47168	0,504068	0,273737
FADE	*0,678838*	0,692461	0,589912	0,352956	0,346812	0,605134	0,548769	0,497261
FMIZP	0,543473	0,41746	0,537526	0,454434	0,38005	0,63051	0,57962	0,491648
FORMT	0,624219	0,439322	0,591739	0,404636	0,290283	0,724544	0,543192	0,433711
FRIGO	0,430436	0,577552	0,431052	0,490877	0,385543	0,589757	0,586567	0,583088
GEDZA	0,572406	0,539842	0,583281	0,395681	0,422464	0,634626	0,533538	0,480021
LUKSK	0,530668	0,592872	0,534922	0,409696	0,320503	0,682696	0,548864	0,489449
MAKTK	0,58566	0,44585	0,419746	0,457797	0,323588	0,571598	0,548257	0,583109
NIBAS	0,547377	0,443997	0,511838	0,368463	0,386436	0,508268	0,578442	0,437606
OYLUM	0,532542	0,540852	0,584859	0,514532	0,286277	0,451186	*0,879378*	0,448352
PRKME	0,450924	0,488942	0,421253	0,407501	0,439905	0,696395	0,549494	0,417674
PRZMA	0,656189	0,500693	0,511117	0,325299	0,367311	0,56187	0,492199	0,591741
SAFKR	0,627051	0,463723	0,615621	0,405965	0,382072	0,603515	0,566002	0,506652
SANFM	0,636826	0,531832	0,598447	0,451172	0,437257	0,60244	0,508628	0,473996
SAMAT	0,661303	0,422258	0,633226	0,377782	0,389768	*0,826845*	0,582105	0,470725
SAYAS	0,509356	*0,801439*	0,559523	0,426307	0,402165	0,595546	0,550697	0,517008
SELGD	0,576787	0,506373	0,584397	0,361103	0,473874	0,598766	0,56003	0,449816
SEYKM	0,623153	0,604683	0,534123	0,423942	0,362736	0,52909	0,494016	0,515082
TMPOL	0,554223	0,49976	0,556393	0,410414	0,349376	0,629068	0,550092	0,47824
VANGD	0,524365	0,533693	0,43099	0,50312	0,352079	0,587673	0,428308	0,361457
YAPRK	0,555175	0,551957	0,506903	0,379652	0,394608	0,638052	0,526763	0,463679

Table 5. Final Results Generated by MABAC Method for Each Quarter

	20/IV	21/I	21/II	21/III	21/IV	22/I	22/II	22/III
ACSEL	-0,07816	0,038803	0,000531	-0,09767	-0,0708	0,15389	0,111419	-0,00896
BAYRK	-0,04852	-0,01002	0,074074	0,06893	-0,06675	-0,10897	0,015744	0,029081
BRKSN	0,052394	0,028903	-0,03148	0,038533	-0,05498	0,029904	0,044757	-0,00229
BFREN	-0,03369	-0,01133	0,016874	-0,07332	0,007745	0,02726	-0,05024	0,020496
BURCE	-0,02829	-0,01881	-0,05601	0,283925	0,064944	0,084553	-0,01284	0,044574
BURVA	0,027231	-0,06227	0,183088	-0,13336	-0,00698	-0,11762	-0,01989	0,016412
DAGI	-0,04784	-0,06195	0,03576	0,125026	-0,13096	-0,03297	-0,02159	0,090752
DNISI	0,004883	0,130381	0,02004	-0,03038	0,011002	-0,16926	-0,02297	-0,00124
DOBUR	0,017487	-0,08417	-0,03298	0,03573	0,293199	-0,03387	-0,28635	-0,03516
DOGUB	-0,05355	0,016671	0,262222	-0,10232	0,022544	0,013252	0,020945	0,139084
EMKEL	0,05636	-0,13916	0,041705	0,00742	0,006691	0,098774	0,014851	0,00217
ERSU	-0,06359	0,01957	-0,09714	-0,02413	0,107878	-0,02915	-0,04922	-0,21143
FADE	0,151997	0,272314	0,096929	-0,1012	-0,01067	0,009943	0,023319	0,041727
FMIZP	-0,01191	-0,09806	-0,06485	0,076981	0,028125	0,021877	0,076267	0,001982
FORMT	0,07453	-0,09647	0,015828	-0,00202	-0,09292	0,159301	0,017907	-0,0635
FRIGO	-0,19083	0,076686	-0,22619	0,138199	0,038801	0,096219	0,081383	0,159014
GEDZA	0,02863	0,043088	0,129852	-0,01556	0,082519	0,042202	-0,0051	-0,00768
LUKSK	-0,0227	0,154003	-0,04613	0,012793	-0,05311	0,080654	0,02129	0,007614
MAKTK	0,049281	-0,05887	-0,1262	0,083381	-0,0668	-0,01734	0,017858	0,163234
NIBAS	0,045699	-0,08995	-0,01541	-0,06332	0,052619	-0,09737	0,074499	-0,04683
OYLUM	-0,0289	0,050392	0,08418	0,139755	-0,11094	-0,12836	0,398722	-0,03398
PRKME	-0,1053	-0,014	-0,10768	0,01225	0,028916	0,116165	0,016046	-0,10092
PRZMA	0,135865	-0,00713	-0,02913	-0,14107	0,019756	-0,1449	-0,07254	0,179149
SAFKR	0,11086	-0,04908	0,059533	0,009257	0,022074	0,037265	0,044602	0,050712
SANFM	0,098948	0,032791	0,089668	0,070867	0,102279	-0,00247	-0,0381	0,022262
SAMAT	0,160416	-0,10631	0,210537	-0,04137	0,04058	0,205011	0,071661	-0,01509
SAYAS	-0,0416	0,317156	-0,01352	0,032752	0,059913	0,023481	0,024446	0,06112
SELGD	0,043827	-0,00448	0,118715	-0,07254	0,085611	-0,00805	0,034486	-0,03301

SEYKM	0,104047	0,108519	-0,00809	0,026369	-0,01293	-0,03474	-0,07237	0,059571
TMPOL	0,001727	0,001778	0,016708	0,015002	-0,01063	0,02526	0,020457	-0,00371
VANGD	-0,04176	0,028121	-0,12674	0,151702	-0,04727	-0,01509	-0,1338	-0,17435
YAPRK	0,005648	0,056957	-0,0666	-0,03544	0,04488	0,097529	-0,0124	-0,02187

The results obtained according to the MABAC method are shown in Table 5 above. According to the relevant results, SAMAT in the first quarter and Prizma Pres Matbaacılık (PRZMA) in the last quarter were found to be the top-performer companies. Compared to TOPSIS results, the top performing companies in the interim periods remained unchanged for the MABAC method.

The results of the calculations made according to the VIKOR method are given in Table 6. In the first period, SAMAT showed good performance as observed by the MABAC method, while in the last period DOGUB showed best performance, as indicated by the TOPSIS method. The top performing companies in the interim periods are the same for all 3 analyzed methods.

Table 6. Final Results Produced by VIKOR Method for Each Quarter

	20/IV	21/I	21/II	21/III	21/IV	22/I	22/II	22/III
ACSEL	0,664349	0,598318	0,364389	0,820572	0,927091	0,068293	0,572071	0,434108
BAYRK	0,538827	0,699176	0,328191	0,364296	0,689636	0,708606	0,647715	0,350426
BRKSN	0,203943	0,644581	0,413583	0,417027	0,650945	0,384626	0,629198	0,477932
BFREN	0,333524	0,758013	0,357429	0,649301	0,581569	0,435776	0,827673	0,300634
BURCE	0,424667	0,652172	0,50015	0	0,287522	0,313567	0,675414	0,274896
BURVA	0,406294	0,829942	0,206528	0,637539	0,4566	0,690926	0,679392	0,305509
DAGI	0,762333	0,80469	0,347761	0,290179	1	0,583497	0,675362	0,207972
DNISI	0,337591	0,4937	0,39457	0,471071	0,505837	0,933817	0,758047	0,730925
DOBUR	0,252408	0,824782	0,521126	0,402042	0,042538	0,517517	0,875786	0,534177
DOGUB	0,367118	0,627406	0	0,613995	0,465298	0,450772	0,646748	0,05129
EMKEL	0,225454	0,932754	0,311714	0,401895	0,600433	0,205108	0,655704	0,326335
ERSU	0,55039	0,657781	0,8463	0,632994	0,218456	0,591172	0,703909	0,735388
FADE	0,238829	0,259195	0,264303	0,694551	0,545065	0,437629	0,651374	0,276991
FMIZP	0,518397	0,853467	0,737701	0,335581	0,431367	0,425253	0,605723	0,518878
FORMT	0,189734	0,953034	0,553651	0,482182	0,740616	0,124771	0,629873	0,596397
FRIGO	1	0,431173	1	0,223296	0,467068	0,425964	0,601801	0,126301
GEDZA	0,238219	0,564253	0,223212	0,520888	0,367587	0,351794	0,665278	0,471816
LUKSK	0,537224	0,621554	0,626932	0,440816	0,699933	0,235154	0,648364	0,441928
MAKTK	0,210972	0,781551	0,684	0,318224	0,896497	0,497715	0,648868	0,226269
NIBAS	0,419198	0,946078	0,37278	0,60234	0,401253	0,705132	0,610848	0,455116
OYLUM	0,471098	0,649866	0,265912	0,292649	0,754104	0,945358	0	0,495215
PRKME	0,597182	0,796267	0,589718	0,365662	0,619082	0,265368	0,617477	0,742989
PRZMA	0,174481	0,689274	0,414798	1	0,504166	0,854017	0,803214	0,097276
SAFKR	0,105421	0,73708	0,429271	0,421646	0,547766	0,458028	0,625696	0,260341
SANFM	0,119924	0,603145	0,213354	0,289173	0,275404	0,429697	0,724524	0,302521
SAMAT	0	0,858335	0,237167	0,612973	0,456949	0,016725	0,608123	0,506641
SAYAS	0,624286	0	0,543991	0,413165	0,307454	0,464883	0,644129	0,24892
SELGD	0,317175	0,699628	0,23259	0,810075	0,492853	0,470849	0,633162	0,477477
SEYKM	0,106577	0,416698	0,409019	0,374728	0,644357	0,63656	0,830788	0,247913
TMPOL	0,303975	0,689334	0,357994	0,430411	0,492744	0,364046	0,646065	0,432868
VANGD	0,377799	0,646276	0,635356	0,195967	0,658825	0,49821	0,764549	0,756273
YAPRK	0,283242	0,535525	0,590999	0,505464	0,420332	0,326965	0,673214	0,431577

According to the 3 models examined, the highest performing companies over the entire period are given in Table 7. In the 6 quarters at the middle of the examined period, the same companies shared the first place in performance for all analyzed methods. Although the top companies in the first and last quarters vary for the methods, the company that came top in the first quarter according to the VIKOR method also showed higher performance in MABAC, while the company that performed best in the last quarter according to the VIKOR method also showed superior performance in TOPSIS. In the first and last quarters, MABAC and TOPSIS methods did not place exact companies for the best position in ranking.

Table 7. Top-Performer SMEs during the Analyzed Period for TOPSIS, MABAC and VIKOR

	20/IV	21/I	21/II	21/III	21/IV	22/I	22/II	22/III
TOPSIS	FADE	**SAYAS**	**DOGUB**	**BURCE**	**DOBUR**	**SAMAT**	**OYLUM**	*DOGUB*
MABAC	*SAMAT*	**SAYAS**	**DOGUB**	**BURCE**	**DOBUR**	**SAMAT**	**OYLUM**	PRZMA
VIKOR	*SAMAT*	**SAYAS**	**DOGUB**	**BURCE**	**DOBUR**	**SAMAT**	**OYLUM**	*DOGUB*

The correlation levels between the final scores produced by the methods and stock returns are given in Table 8. Accordingly, the highest relationship was achieved in the VIKOR method in 4 of the 8 periods examined. On the other hand, both TOPSIS and MABAC scores reached superior relationship levels with share returns for 2 periods.

Table 8. Comparative Final Results for Analyzed Methods with their Relation to Share Returns

	20/IV	21/I	21/II	21/III	21/IV	22/I	22/II	22/III	Average
TOPSIS	49,00%	72,50%	43,50%	**63,00%**	56,50%	**76,80%**	60,70%	33,10%	56,89%
	0,01	0,00	0,01	**0,00**	0,00	**0,00**	0,00	0,07	0,011
MABAC	55,00%	77,40%	64,40%	62,00%	**60,20%**	61,90%	59,50%	**40,30%**	60,09%
	0,00	0,00	0,00	0,00	**0,00**	0,00	0,00	**0,02**	0,003
VIKOR	**67,30%**	**82,40%**	**73,30%**	62,50%	57,00%	71,10%	**61,80%**	36,40%	***63,98%***
	0,00	**0,00**	**0,00**	0,00	0,00	0,00	**0,00**	0,04	***0,005***

Considering all periods, the highest average correlation observed in the VIKOR method was 64% with significance level of $p<0,01$. The results found with the methodology applied in this study are in line with other MCDA studies previously conducted on capital markets and stock returns (Baydaş et al., 2022; Baydaş & Pamučar, 2022; Elma, 2023). By testing different methods for different scenarios, the most appropriate method can be selected to help financial decision makers in their complex decisions. The superiority of a method is determined according to the relationship between stock returns and final method scores, shaped by the consensus of millions of shareholders (Baydaş & Elma, 2021). Thus, according to the above results, VIKOR was determined to be the most suitable for financial decision-makers, in terms of the methods examined in this study.

DISCUSSION AND CONCLUSION

It is surely challenging to make the right financial decisions in constantly changing market conditions. In certain periods where volatility increases, such as the pandemic, the existence of decision support systems for company managers, creditors and shareholders helps mitigate the complexity in the decision-making phase. In this sense, MCDA methods come to the fore in terms of evaluating and ranking alternatives with various criteria. The use of multiple MCDA methods, which have proven their effectiveness in different scientific fields, is important in terms of comparability and demonstrating the superiority between methods for solving specific problems.

In this study, 32 companies traded in the BIST SME index were examined in order to guide financial stakeholders during the pandemic process. The final scores produced by TOPSIS, MABAC and VIKOR method for the relevant companies showed that exactly the same companies were the best performers in 6 of the 8 periods examined. When the methods were ranked according to their relationship with stock returns, VIKOR was determined as the method which has the superior relationship with share returns.

The fact that this study was conducted only in the BIST SME index draws the limitations of the research. Additionally, the 3 MCDA methods preferred for comparison purposes, also identify other constraints. On the other hand, 6 accounting and valuation-based ratios used in the analysis can also be considered among the limitations of the research. In potential future studies, companies in developed markets can be analyzed

and the relationship between stock returns in different markets and various methods can be compared, in order to better understand the capacity of the methods for financial decision-makers. In this way, MCDA methods that can function as the most appropriate decision support system in different types of capital markets can be revealed.

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Determination of Causality Relationship Between Red Meat Prices and Fattening Feed Prices in Turkey by Toda-Yamamoto Test

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Abstract

The aim of this study is to determine the causality relationship between red meat prices and fattening feed prices in Turkey. The causality relationship is analyzed using the Toda-Yamamoto Test. The research material consists of 180 months of data on red meat prices and fattening feed prices between January 2008 and December 2022. ADF and PP unit root tests are performed, which are concluded to contain unit roots in the level. This result indicates that our series contain unit root at the level. However, it was found that there is no unit root in first differences. The lag length of the series is 3 months and there is no variance and autocorrelation. According to the results of the study, a significant causality relationship was found between fattening feed prices and red meat prices with an accuracy level of 1%. However, no significant relationship was found from red meat prices to fattening feed prices. It can be said that the increase in red meat prices is a function of the increase in feed prices. In this case, it can be stated that measures that can be taken to increase feed production and reduce import dependency should be increased in terms of price stability.

Key words: *Toda-Yamamoto, Red Meat Prices, Fattening Feed Prices, Causalit Analysis*

The Impact of Milk and Dairy Production and Export during the Covid-19 Pandemic in Turkey

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Abstract

In this study, the impact on the production and export of milk and dairy products in Turkey during the Covid-19 pandemic was examined. The data covers the period from January-2013 to April-2023. In the study, the 24-month period between March-2020 and February-2022 was taken into account as the "pandemic period", taking into account the statements of the World Health Organization. To ascertain the effect of the pandemic on production and exports, the data from the pandemic period is comparatively analyzed with a 24-month period before the pandemic and a 12-month period after the pandemic.Average data, changes, standard deviations, and coefficient of variations are calculated for these periods, and comparisons are made. In addition, a trend analysis was made by taking into account the monthly data after January 2013, and the estimated values of milk and milk products production and exports in the short term were tried to be revealed. The analyses reveal that during the pandemic, there was an increase in the production of cow's milk, drinking milk, cow cheese, milk powder, skimmed milk powder, butter, cream, and butterfat compared to the pre-pandemic period. On the other hand, a decrease in the production of yogurt, buttermilk, and cheese from small ruminants was observed. Additionally, it was determined that during the pandemic period, Turkey's overall exports of milk and dairy products increased, while imports decreased. Specifically, during the pandemic, Turkey experienced an increase in the exports of ice cream, whey, and other milk composite products, but a decrease in the exports of milk and cream, fresh and processed cheese, whey butter, yogurt, kefir, and other dairy products.

Key words: *Trend Analysis, Covid-19, Pandemic Period, Milk and Dairy Products, Production and Export, Turkey*

Investigating the Impact of Climate Change on Agricultural Income with an ARDL Model

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Abstract

This study aims to determine the impact of climate change on agricultural income in Turkey. Annual time series analyses for the period 1990-2021 in Turkey were conducted in the study. Agricultural income, which takes into account agricultural gross domestic product values, is used as the dependent variable. The variables that are considered to affect agricultural income and represent climate change are greenhouse gas emissions, average temperature and average precipitation. In addition, the impact of the decrease in Turkey's agricultural area on agricultural income was also investigated. The stationarity test performed on the series in the study revealed stationarity at different levels. Therefore, the impact of climate change on agricultural income is explained by ARDL model. According to the results of the analysis, a statistically significant relationship was found between greenhouse gas emissions, average temperature, agricultural area variables and agricultural income in the long run. The error correction coefficient is negative and significant at 1% level. In the short run, the negative coefficients of greenhouse gas and average temperature data have a negative impact on agricultural income.

Key words: *ARDL, Climate Change, Agricultural income, greenhouse gases*

Çok değişkenli istatistik yöntemlerden biplot tekniğinin biyometri verilerine uygulanması

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Özet

Bu çalışma, tarımsal denemelerde iki yönlü veri yapısında interaksiyon etkisinin istatistiksel olarak önemli olduğu durumlarda, genotip çevre ilişkilerini çok değişkenli yöntemlerden Biplot tekniği kullanarak göstermek amacıyla yapılmıştır. Çalışma, tesadüf blokları deneme desenine göre 25 buğday hattının 6 lokasyonda elde edildiği varsayılan tane verimleri, 6 çiftlikte 25 boğanın sperması ile yapılan yapay tohumlama sonucu doğan kızların 1.laktasyon süt verimleri ve kıl keçilerinde ana yaşının (2,..,7) oğlaklarda doğum ağırlığına etkisini tespit etmek için 25 çiftlikte oluşturulan hipotetik veri seti kullanılarak gerçekleştirilmiştir. Sonuç olarak, biplot grafikleri ile genotip çevre ilişkilerinin biyometri verilerinde uygulanabilirliği gösterilmiştir.

Anahtar kelimeler: *Genotip x çevre etkileşimi, Biplot, Toplamalı ana etki ve çarpımsal etkileşim analizi (AMMI), Site regresyonu (SREG), Tekil değer ayrıştırması (SVP)*

1967-2020 Yılları Arası Gözlenen İklim Verileri Işığında Gelecek Yıllara Yönelik Trend Analizi İle Küresel Isınma ve İklim Değişiklikleri Tehdidinde Sürdürülebilir Tarımsal Ekonomi: Yozgat İli Örneği

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Özet

Bu çalışmada, Yozgat ilinin 1967-2020 yılları arasında gözlenen iklim verileri değerlerinden yola çıkılarak gelecek yıllara yönelik projeksiyon açısından Trend Analizi yapılmıştır. Böylelikle, bilimsel çevrelerce de kabul edilen küresel ısınma ve iklim değişiklikleri tehdidinin sürdürülebilir tarımsal ekonomiye olan etkileri ve alınacak önlemler ortaya konulmuştur. İklim elemanları faktörlerinin tarımsal üretime olan etkileri, geçmiş dönem ve gelecek açısından değerlendirilmiş ve gerekli önerilerde bulunulmuştur. Analizler için çeşitli İstatistik programları kullanılarak çıkarımlar yapılmış ve iki hipotezde bulunulmuştur. Birinci hipotez H_o= ''İklim değişikleri meydana gelmiş, geçmişten bugüne tarımsal üretim ve ekonomiyi etkilemiştir ve bugünden geleceğe de etkileyecektir'' şeklîndedir. İkincisi ise, H_1=''İklim değişikleri minimal ölçüde olup, geçmişten bugüne tarımsal üretim ve ekonomiyi etkilememiştir ve bugünden geleceğe de etkilemeyecektir'' şeklinde belirlenmiştir. Çalışma sonucunda Türkiye'nin Orta Anadolu kısmı küresel ısınma ve iklim değişiklikleri açısından illeri benzer iklimler göstermesi nedeniyle değerlendirilmeye tabi tutulmuştur.

Anahtar kelimeler: *Yozgat, Küresel ısınma, Trend analizi, İklim elemanları, Tarımsal ekonomi*

Multi fuzzy rough soft sets and similarity measure applications

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Abstract

In this article, first of all, rough sets, fuzzy rough sets and interval rough sets that exist in the field of mathematics are introduced and examples and theorems are shown. Then, the definition of multi fuzzy rough sets is made and their properties are mentioned. The focus was on the evaluation of multi fuzzy rough approximation operators in the process of making sense of uncertainty. It was also emphasized that multi fuzzy rough sets are equivalent when reduced to 2-dimensional fuzzy rough sets. The Similarity measure definition was made in multi fuzzy rough soft sets. The similarity measure to be used in multi fuzzy rough sets is given and the application is made. In the application, it provided information about the parameter selection for the uncertain data group in multi-fuzzy rough soft sets. In indefinite data, as the similarity measure increases, clearer interpretations can be made because the complexity decreases. Therefore, it is important to use the similarity measure in decision making of multi fuzzy rough sets.

Keyword*: Fuzzy set, Rough set, Fuzzy rough set, Interval rough set, Multi fuzzy rough set.*

Lamb Temperament Through a Digital Lens: Automating Temperament Classification Using Facial Images with Computer Vision and Deep Learning

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Abstract

Animal temperament, an inherent disposition that influences how animals respond to environmental stimuli, plays a crucial role in determining livestock behavior, productivity, and overall welfare. Historically, behavioral tests and focal observations have been the primary methods for determining the livestock temperament. Although these traditional methods are functional, they are time-consuming, laborious, and frequently tainted by subjective bias. This study investigated the feasibility of deploying a framework that intrgrates computer vision and deep learning to automate the classification of lamb temperament based on facial images. Based on a set of quantitative and qualitative behavioral variables, lambs' temperament was classified as proactive, intermediate, or reactive using an open field test, which is a commonly employed behavioral testing procedure. Following the test, frontal facial images of the lambs representing all three temperament classes were captured. To predict temperament from facial images, the performance of a custom deep convolutional neural network (C-DCNN) model was compared to that of the pretrained VGG19 and Xception models. Compared to VGG19 and Xception, the C-DCNN model attained the highest test accuracy, indicating a superior generalization capability. Precision, recall, and F1-scores were also highest for C-DCNN compared to VGG19 and Xception indicating superior performance in correctly classifying the three temperament categories. In light of these findings, it is evident that combining behavioral data obtained from temperament tests with computer vision and deep learning-based analysis of facial images has the potential to revolutionize our understanding and evaluation of animal temperament. The proposed methodology has the potential to facilitate the continuous monitoring of temperament on farms to support livestock management and welfare.

Keywords: *Computer Vision, Deep Learning, Facial Images, Lamb, Temperament*

Applications of Tactile Technology: Gaming, Teleoperation, Medical Procedures, Augmented Reality and Virtual Reality

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Abstract

Recent advances in technology have enhanced communication between computers and users, providingthe ability to manipulate objects in a virtual environment while receiving haptic feedback. Current virtual reality systems offer highly realistic visual and auditory feedback. Various haptic device designshave led to the exploration of electromechanical devices. The main criteria underpinning the creation of an interactive interface are to generate kinesthetic feedback and to actively transfer information fromthe haptic device. Sensors and feedback apparatus are of great importance in the design and productionof haptic devices. Generally, haptic technology is widely used in various applications such as gaming, teleoperation, medical surgeries, augmented reality (AR), and virtual reality (VR). This article discusses the structure and functionality of haptic devices in various fields.

Key words: *Haptic, Devices, Augmented, Reality, Wearable Devices, Kinesthetic Feedback, Manipulation)*

INTRODUCTION

The term 'haptic' derives from the Greek word 'haptikos,' meaning 'related to the sense of touch.' It is defined as the technology of creating a sense of touch during interaction with physical or virtual environments (Sreelakshmi & Subash, 2017). Physical interaction can be achieved through teleoperation, which involves operating from a distance, while virtual environments are created through computer- based programs. Rapid advancements in technology have greatly contributed to the development of haptic devices (Giri et al., 2021). The increasing necessity for quick response to actions has significantlyelevated the importance of tactile devices (Baghdadi et al., 2020). Tactile devices enable users to interactwith virtual environments, creating a sense of reality and tangibility (Sreelakshmi & Subash, 2017).

Virtual and augmented reality (VR/AR) technology provides interactive visual and auditory experiences in simulated virtual worlds or computer-enhanced real environments. With advancements in graphics and information processing technologies, the VR/AR industry has experienced rapid growthin the past decade. The VR/AR market has also expanded into various industry domains, including tele-manipulation, medical training, virtual collaborative product design, smart manufacturing, gaming entertainment, and product advertising. Moreover, with advancements in computer graphics, sensor/tracking technologies, and integrated circuit manufacturing techniques, it has become an emerging technology in today's interactive computing. People are now connecting and interacting withothers virtually in immersive environments for more effective communication(Jin et al., 2021).

Haptic technology is rapidly growing, and considering the latest advancements in VR technologies,haptics play a significant role in providing multi-sensory feedback to enhance the user experience.

Instead of using large equipment to generate kinesthetic feedback, vibrotactile-based haptic actuators such as eccentric rotating mass (ERM), linear resonant actuator (LRA), and piezoceramic actuators arewidely preferred. There is a demand for more compact materials with high-resolution tactile feedback to ensure portability and freedom of interaction in user engagement with virtual environments. In addition to vibration-based haptic actuators, new materials and technologies that can generate compact,lightweight, and high-quality tactile feedback are preferred. Elastic form factors that provide comfortable and natural interactions for wearable applications have gained significant attention (Williams & Gilbert, 2020). Tactile devices operate based on tactile feedback, allowing users to remotelymanipulate objects in a computer-generated environment through Human-Machine Interface (HMI). The use of haptic devices is efficient in collaboration with computer systems, thanks to their bidirectional and symmetric interaction capabilities, enabling real-time feedback in a remote setting(Iijima et al., 2020).

Haptics can be divided into three types;

- Human Haptics: Related to the human sense of touch and control,
- Computer Haptics: Based on software and algorithms to create a sense of touch for virtual objects,
- Machine Haptics: Describes the use of machines in touch-based interactions (Khushal Rane & Ulhas Sutar, 2019).

The foundation of haptic technology, which is more closely related to the materials science and engineering community, lies in tactile sensing and feedback. Advanced functionalities and features areexpected from tactile sensors and actuators to provide intuitive and immersive tactile experiences. For instance, they should be able to obtain and transmit complex and sophisticated texture information, adhering to deformable skin-like surfaces of the user without compromising form factors. In recent years, tactile sensor technology has significantly advanced and achieved commercial success, demonstrating skin-like stretchability, high sensitivity, and reliability(Jin et al., 2021). One of the drawbacks in the design of tactile interfaces is limited workspace and low dexterity (Giri et al., 2021). Existing tactile actuators largely rely on traditional electromechanical motors, which are often too rigid,bulky, or heavy for compact, flexible, and wearable haptic applications. Factors such as how the deviceresponds, feels, or interacts should also be considered in the design stage for efficient operation (Seifi et al., 2019). The wearability of robotic devices has enabled new forms of communication, collaboration,and integration between humans and robots, making wearable haptics popular in the field of robotics (Giri et al., 2021). Various applications of haptic devices have been examined, including studies that focus on the usage of haptic devices in a single application. The main contribution of this article is to categorize the applications of tactile devices used in the fields of medicine, research, and industry, and provide insights into how the design and features of a haptic device can be modified to fit the requirements of its application. Different fields' applications of haptic devices are discussed, highlighting the significance of haptic devices in each domain. Additionally, this article addresses various challenges associated with the implementation of haptic devices in real-time applications, illustrating the scope of applications, manufacturing of haptic devices, and the trade-offs that need to bemade in the production process withexamples.

Working Principles of Haptic Devices

Haptic feedback is a technology that creates a tactile sensation on the skin, perceived and interpreted bythe brain, facilitating interaction between humans and their environment. Haptic, encompassing both tactile and kinesthetic (force) feedback, plays a significant role in our way of interacting with and

perceiving the environment (Ozioko et al., 2020). Haptic devices involve the combination of various concepts from different fields such as engineering, computer science, human perception, physics, and information technology (Seifi et al., 2019). Essentially, haptic devices consist of actuators (such as electric motors), interface devices, and sensors. These devices provide operators with a sense of touch while remotely controlling a virtual or real object through a teleoperation system. Haptic devices offer tactile and/or kinesthetic feedback and, in some cases, thermal feedback as well (Tan et al., 2020). Tactile feedback is also known as cutaneous feedback and can be defined as feedback obtained from various mechanoreceptors attached to the external surface of the user's body, typically the skin (Tai et al., 2018).

Kinesthesia refers to the sensory experience associated with the body's moving parts. This self- awareness sensation is provided by mechanosensor neurons found in the muscles, joints, and tendons. A wearable device that manipulates kinesthetic feedback has a range of applications in virtual and augmented reality, education, training, and physical therapy fields. Kinesthetic feedback is a different type of feedback that plays an important role in the haptic domain as well (Carpenter et al., 2019). Unliketactile feedback, the sensory receptors are applied to the muscles and joints of the user's body rather thanthe surface. Interaction with a haptic device is typically bidirectional, with the operator engaging with the device. The operator moves the haptic device, and this movement is detected by sensors (e.g., motorencoders) and used to generate motion commands (e.g., speed commands for a remotely operated robot).The interaction force between a robotic arm and the operator's hand can be detected by force/torque sensors and reproduced by the actuators of the haptic device to be applied back to the operator's hand. This force feedback is an additional connection that immerses the user in the task environment. The development of haptic devices has focused on acquiring information and manipulating objects throughtouch, both by machines and humans, for many years (Gabardi et al., 2016). A variety of commercial haptic devices with different mechanism types are shown in Figure 1 (WANG et al., 2019).

Fig.1 Haptic Devices with Different Types of Mechanisms

APPLICATIONS OF HAPTIC

Smart technologies are rapidly revolutionizing our interaction with the real and virtual world through various virtual and augmented reality (VR/AR) systems (WANG et al., 2019) and supporting advancements in fields such as healthcare technologies, impacting smart homes, assistive technologies (Chan et al., 2008), and robotics (Shakthivel et al., 2021) (Iqbal et al., 2021). Notable advancements inkey technologies such as 5G/6G communication (You et al., 2021) create promising expectations for smart wearable technologies, including the Internet of Things (IoT) (Wortmann & Flüchter, 2015), tactile Internet (Fettweis, 2014), machine learning, and neural computing (Zhu et al., 2020). Smart

Human-Machine Interfaces (HMIs) play a central role in facilitating efficient collaboration between humans and the rapidly evolving digital world (Luo et al., 2017).

Haptic Devices for Micromanipulation

A micro-manipulation system performs operations such as sensing, manipulation, stiffness testing, and conductivity testing, which are utilized in the fields of electronics, medical treatment, biology, and materials science (Saju et al., 2022). In these systems, the master-slave manipulator is implemented with tactile feedback using a multi-degree-of-freedom piezo-actuated device. These devices include a planar 3PRR mechanism and 1DOF, which can be used for the design of micro-electromechanical applicationsor micro-teleoperated with biological cells (Mohand-Ousaid et al., 2020). Some of the remotely operatedrobots are listed below:

1. Mitsubishi RV-1a (Mitsubishi Electric Corp., Tokyo, Japan)
2. Mikro (DLR, Cologne, Germany) - 7DOF
3. KUKA KR 6/2 (KUKA AG, Augsburg, Germany) - 6DOF
4. PUMA (Unimation Inc.) - 6DOF
5. Mitsubishi MELFA 6Sl - DOF
6. Mitsubishi PA-10 - 7DOF
7. Mitsubishi MELFA RV-E2 - 6DOF
8. Mitsubishi PA10 - 6DOF9.Mitsubishi PA10-7DOF
10. Rockwell Samsung AS2-6DOF

Medical and Surgical Applications

Tactile exploration during surgical procedures enhances the surgeon's performance by providingadditional information alongside visual cues. For instance, information about pressure and forcemagnitude provides insights into pre-existing physiological stresses at the organ level and iatrogenic stresses generated on organic structures during diagnostic or therapeutic procedures. The force applied to a unit surface is directly proportional to the physical resistance of tissues in various physiological andpathological conditions. Parenchymal organs are fragile, requiring smaller grasping and/or traction forces compared to hollow organs or organs that exhibit more resistance to traction/torsion. Blood vessels are delicate structures, and the magnitude of forces acting on them should be significantly smaller than the forces applied to ligament/bone structures. Among the most popular haptic devices areSensable's PHANToM® Omni™ and Desktop™ devices, which can apply force through a mechanicallinkage in the form of a probe tip. Novint, a company founded by researchers from Sandia National Laboratories in 2007, introduced the first commercial haptic device to the market. The Falcon Novint (novint.com) was launched at a very low price alongside computer games in the United States, Asia, and Australia. Novint licensed significant portions of the technology used in the Falcons from Force Dimension, the leading Swiss developer of advanced haptic devices, known for their Omega.x or Delta.xfamilies (Hamza-Lup et al., n.d.).

One application of haptic devices in the neuroArm surgical system is demonstrated in Figure 3 withthe Omega 7. The platform utilizes two haptic devices to convey the sense of touch to both hands of thesurgeon.

The application of haptic devices in the neuroArm surgical system, Omega 7, is shown in Figure.2.

The platform uses two haptic devices to convey the sense of touch to both hands of a surgeon.

Fig.2 The Workstation of NeuroArm II Prototype Used in Telerobotic Microsurgery

A tactile intracorporeal palpation has been suggested using a robotic system operated by a cable, incorporating a remote sensing strategy (Saracino et al., 2020). The platform uses a remotely controlled cable-operated parallel manipulator, a new, simple, and cost-effective approach, to restore haptic sensation during intracorporeal palpation performance. Tests conducted demonstrated reasonable accuracy in force estimation. In another study, the authors integrated a 7-DoF master device into the daVinci Research Kit, and experienced surgeons, surgical assistants, and non-surgeons performed tissue grasping, palpation, and incision tasks using robot-assisted surgery(Saracino et al., 2019). Statistical analysis showed that tactile feedback improved surgical outcomes, proving important for tasks that required a significant cognitive load for the surgeon (Giri et al., 2021).

Bostick et al. (Bostick, 2016) designed an AR-based control framework to send manipulation signalsto a prosthetic device. The system uses an algorithm that identifies an object and sends corresponding grasping commands to the upper limb prosthesis. Qian et al. (Qian et al., 2018) developed an AR-based'ARssist' composed of a remotely operated robot assist module and a tactile feedback interface. It can generate visual instructions during minimally invasive surgery. The system converts real-time 3D models of the endoscope inside the patient's body, the tools used, and hand tools into the surgeon's view.Additionally, with the aid of projector-camera technology, AR-assisted surgery is making rapid progress(Bostick, 2016). An AR system was used in the creation of the surgical field during urological robot- assisted surgery for 'radical prostatectomy' (Porpiglia et al., 2019). In (Bernhardt et al., 2017), a generaloverview of the literature addressing surgical AR topics in intraabdominal minimally invasive surgery is presented.

Dental Applications

Simulations in dental education date back to the 1990s. Currently, with the evolution of virtual reality, the use of robotic and haptic simulations is revolutionizing dental studies, as shown in Figure.3. Virtualreality offers a promising future in dental education, and due to its capability of providing immediate feedback and an exceptional training environment, it garners global interest, thereby offering immenseopportunities for students to acquire standard skills. At present, technology-enhanced, simulation-based learning is recognized worldwide as a fundamental tool for delivering dental education. Since the beginning of training, dentists are expected to develop high psychomotor skills to become competent clinicians. However, there is a need for technological advancements in this field to enhance the learningcurve before working on a patient (Imran et al., 2021).

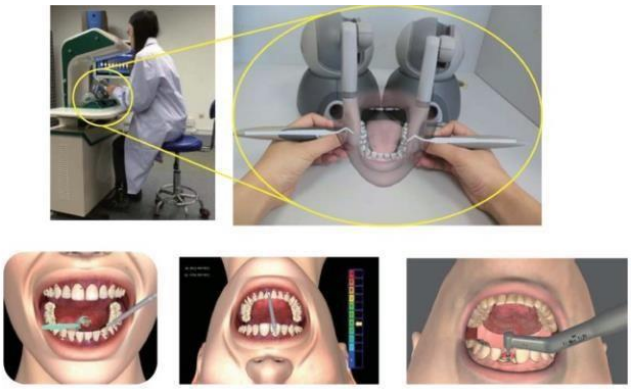

Fig.3 Simulation Demonstration in Dental Studies

The hardware of the dental surgical simulation system and graphic scenarios of three typical dental operations, including dental examination, periodontal depth probe, and implant surgery, are illustrated.The purpose of the simulation system is to simulate the physical contacts between dental tools and various tissues, including teeth, gums, and tongue, as well as various pathological changes like tartar and decay. The difference in hardness and friction coefficient among these tissues can be simulated, andthe haptic device can provide force feedback to the pen (WANG et al., 2019).

DenTeach is a portable and compact vibrational haptic platform developed to facilitate entirely remote and physically distanced teaching and learning in dentistry. This platform consists of an instructor workstation (DT-Performer), a student workstation (DT-Student), advanced wireless networktechnology, and cloud-based data storage and retrieval operations. The platform procedurally synchronizes the instructor and student with real-time video, audio, touch (haptic), and posture (VAFP).DenTeach offers three modes: teaching, shadowing, and practicing. The teaching mode provides hapticfeedback to each student from the instructor workstation (inside the laboratory or remotely), and the shadowing mode allows the student to start watching, feeling, and repeating tasks before entering practice mode, with the option to download enhanced videos (Cheng et al., 2021).

Wearable Haptic Devices

Many industries have started to design and develop haptic devices considering portability and wearability. These developed wearable haptic devices provide better communication and integration between people and interfaces (Pacchierotti et al., 2017). A haptic glove is a typical icon of wearable haptic devices. Its primary functions are to monitor the entire hand movement of multiple force tasks' degrees of freedom (DoF) and provide force and haptic feedback distributed to the fingertips and palm.Compared with desktop haptic force feedback devices like Phantom Desktop, haptic gloves allow usersto intuitively and directly touch and manipulate remote or virtual objects through the successful manipulation and precise sensing capabilities of our hands. A well-designed glove, while beinglightweight and low-cost, can provide force and haptic feedback that realistically simulates touching objects and manipulating them at a high update rate (Wang et al., 2019).

CyberGlove (Zhou et al., 2010) is one of the gesture-based smart gloves using haptic sensors. About18-22 bending sensors are integrated into various parts of this glove to measure hand postures. Its use as an interface for VR/AR, in addition to rehabilitation, is suggested. A similar approach has also been used to implement a haptic glove for gesture recognition (Kumar et al., 2012). Considering the placement of the sensors in these gloves, they are seen to be more suitable for VR/AR and game consolesrather than accurately measuring the joint angles needed for rehabilitation. In this context, researchers discovered more suitable haptic gloves, like knitted piezoresistive sensors, to track the bending,

extending, and motion of the thumb's metacarpophalangeal (MCP) joint (Carbonaro et al., 2014). The glove helps monitor patients' daily activities.

Haptic Processing

In the early days of touch sensor development, work related to touch was limited to whether the sensorwas in contact with the object or the degree of contact (Dudem et al., 2019). After great efforts, more detailed studies have been conducted on design, principles, and methods to improve the performance ofsensors (Hwang et al., 2012). Tactile processing and visual processing are the fundamental components in developing a virtual tactile system. Tactile processing means determining tactile force, and visual processing allows us to visually represent the interaction of a virtual object (Yu et al., 2019). A VR or AR system is usually built with head-mounted displays like goggles, accelerometers, and speakers, andrelies on these elements to create a computer-based environment for an operator to interact with the environment (Makhataeva & Varol, 2020).

Until now, high-performance tactile sensors have been a crucial element in smart systems. In the working process of a smart system, tactile sensors are used to convert physical, chemical, and biologicalinformation obtained directly from sensory perception into digital information that can be easily recognized, processed, and analyzed, and then transmitted to the backend platform. As a typical example, Takashima and colleagues (Boutry et al., 2019) designed a piezoelectric three-dimensional touch force sensor mounted on the tip of a robot's intelligent finger. Marcus Meyer from Germany developed an octopus-like underwater robot with a new tactile system capable of accurately perceivingobstacle conditions and automatically conducting investigations of the seafloor environment (Kumar etal., 2012). The new furry electronic skin developed by Seoul National University in Korea is widely used in prostheses, heart rate monitors, and robots (Lei et al., 2017).

Haptics in Remote Operated Robotic Systems

Robots were initially developed in the medical field to allow surgeons to operate on their patients remotely and with advanced precision, and the history of this field is well-documented in the literature (Simaan et al., 2018). The first studies were observed in the fields of brain surgery (Kwoh et al., 1988) and orthopedic surgery. The very first long-distance telesurgery conducted 20 years ago was a transatlantic cholecystectomy (Marescaux et al., 2001). Although early progress in this field was erratic,as one might expect with the introduction of a radically new technology, medical robot technology hasreached a level of development that encourages significant investment in health industry development activities (Dupont et al., 2021).

Retinal microsurgery presents challenges that exceed the capabilities of current manual surgical systems. Researchers have adopted three approaches to overcome these difficulties: tremor-filtered handrobots, hand-in-hand (collaborative) robots, and telemanipulated robots with a remote motion center. Hand-held robots, as in (Edwards et al., 2018), have been refined for retinal surgery. In this approach, the tremor occurring in the surgeon's hand-held instrument is detected, and a sensor at the tip of the instrument will be able to cancel out and resist the tremor.

CHALLENGES IN HAPTIC TECHNOLOGY

While the development in haptic devices continues to grow exponentially, it also brings with it its ownset of challenges. Design complexity, feedback processing, and operation safety are some of the factorsin haptic devices that require improvement. The design of a haptic interface is a highly complex process,due to multiple criteria and often overlapping functional and performance specifications. The design and development of a haptic device that provides acceptable, high-quality tactile sensation in terms of force

and haptic feedback for industrial applications is still an open question in the research field (Giri et al., 2021).

Haptic devices used in the surgical field provided insufficient realism and did not properly train doctors for complex surgeries. Haptic devices could not provide adequate force feedback, and the benefits of these devices still haven't been properly documented (Kim & Schneider, 2020). Haptic devicesare still far from being used in medical fields. The application of haptic devices in medicine is still a topic of debate today, and the lack or limitation of haptic feedback is one of the reasons hindering the expansion of the use of haptic devices. Skin-based haptic devices have significant variations in design,frequency response, spatial field, and haptic feedback. Unlike kinesthetic interfaces, these variations arenot suitable for commercial applications(Sreelakshmi & Subash, 2017).

Surgeons typically practice more than a hundred times on a certain type of surgery to minimize error. Patient safety is one of the important issues that need to be considered for the application of haptic devices in medical training. In addition, other factors such as financial, psychological, technical, and organizational should also be seriously considered. So far, only a representation of the real workstationhas been obtained. Haptic simulators that can record sessions providing in-depth feedback should be developed to increase their usage in medical applications (Mathias et al., 2020).

FUTURE DIRECTIONS

Data-based approaches based on large-scale datasets will be beneficial for the modeling, processing, and evaluation of haptic devices. Various haptic texture databases have been developed based on tool- mediated interaction for texture construction or recognition and classification of texture properties. Culbertson et al. have created a haptic texture database containing material of 100 haptic texture interaction signals measured with a pen-type measurement tool held in the hand, sliding along materialsurfaces (Culbertson et al., 2014).

The development of multimodal haptic devices to support highly immersive virtual reality experienceis an important issue. This device should be able to reproduce multiple properties of virtual/remote objects, support multiple movements of the human hand to perform precise manipulation, and stimulatemultiple receptors of the human haptic channel (including cutaneous and kinesthetic receptors). The haptically perceivable properties of an object fall into three categories: material and geometric properties. Basic material properties include five aspects (Okamoto et al., 2013): hardness (hard/soft), temperature (hot/cold), macro roughness (irregular/smooth), fine roughness (coarse/smooth), and friction (wet/dry, sticky/slippery). Geometric properties should generally include shape (both sphericalshape and local geometric features) and size (area, volume, perimeter, bounding box volume, etc.) (Lederman & Klatzky, 2009)

As an alternative to allow the application of new procedures, technology that provides a previously unused way for a medical robot to add value can have a significant impact. The positive interaction of preoperative and intraoperative imaging integrated with flexible and ergonomically improved surgical tools represents a major contribution of this approach over the past decade. The value of this approach is likely to continue in the future. Translating cellular and molecular imaging methods from the laboratory to in vivo-in situ surgical environment will further expand the functional capacities of surgicalinterventions by providing improved tissue detection, labeling, and targeting for both macroscopic andcell-based therapies (Dupont et al., 2021).

CONCLUSIONS

With the advancement of technology, the emergence of innovative ideas and inventions in the field of engineering has gained momentum. Haptic technologies based on various application areas, includ

VR/AR, rehabilitation, augmentative and alternative communication, have been drawing considerable attention recently. Haptic technology has become mandatory not only in the field of engineering but alsoin other various branches. Most applications, especially medical science, have seen enormous interest in the application of haptic technology. Thanks to this evolving technology, the work of surgeons couldbecome easier and more applicable with great skill, advanced precision, and real-time visual feedback. Consequently, doctors may have access to 3D imaging health data showing patients' clinical outcomes using haptics on a computer. On the other hand, patients experience the satisfaction of better and faster medical results with less pain and discomfort. The recovery time is reduced, and thus, patients leave the hospital earlier and continue their normal activities. Additionally, the precise actions of robotic technology lead to decreased infection risk and less blood loss by operating with smaller incisions. In conclusion, to increase the applications of haptic technology, more research about the technical aspectsof haptic devices needs to be conducted, and awareness about these devices needs to be raised.

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Acknowledgment

I would like to express my endless gratitude to my advisor, Dr. Yeliz Durgun, for guiding me in my study, never withholding her support and effort, and making me always proud to be her student.

Fuzzy Analysis of Variance and Applications

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Abstract

Fuzzy analysis of variance is the generalization of the classical variance analysis. Sometimes the data we actually obtain from experiments may not be accurate. For example, the response variable may be impossible to measure precisely or may be better expressed with qualitative rather than quantitative data. At this time, it may be more appropriate to use Fuzzy Analysis of Variance. By converting the obtained data into fuzzy numbers and then applying fuzzy analysis of variance on these data, the error in hypothesis testing is reduced. In this study, information about fuzzy numbers and sets is given, the theoretical principles of the fuzzy variance analysis method are introduced, and examples from the applications are discussed. The applicability of the method in the field of agriculture was examined.

Key words: *FANOVA, Fuzzy sets, Fuzzy numbers, Vagueness, Experiment*

Bulanık FUCOM Yönteminde Bulanık Sayıların ve Bulanık Dilsel Ölçek Seçiminin Önemine Dair Bir Değerlendirme

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Abstract

FUCOM, çok kriterli karar verme problemlerinde kullanılacak kriterlerin değerlendiricilerin sübjektif yargılarına dayalı olarak ağırlıklandırıldığı yöntemlerdendir. Bu değerlendirmelerin dilsel (sözel) ifadeler yardımıyla yapıldığı durumlarda, yöntemin bulanık küme işlemleri kullanılarak uyarlandığı Bulanık FUCOM yöntemiyle daha başarılı sonuçlar elde edilebilmektedir. Ancak bulanık sayı tipinin seçilmesi ve bulanık dilsel ölçek kullanılması yöntemin önemli aşamalarından olup kriter ağırlıklarının belirlenmesini etkileyebilmektedir. Bu çalışmada, Bulanık FUCOM yönteminde farklı bulanık sayı tipleri ve bulanık dilsel ölçek seçimleri için yöntemin vereceği sonuçlar, bir tedarikçi seçim probleminde kriter ağırlıklarının belirlenmesi örneği üzerinde incelenmiştir. Elde edilen bulgular, bu seçimlerin kriter ağırlıklarının hesaplanmasını önemli ölçüde etkilediğini ve kriter sayısı arttığında bu tercihlerin daha önemli hale geldiğini göstermektedir.

Key words: *Bulanık FUCOM, Bulanık Mantık, Bulanık Sayılar, Çok Kriterli Karar Verme*

Pilot scale experimental study and statistical data treatment of the anaerobic digestion process using some organic wastes for methane production

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Abstract

The controlled anaerobic digestion process is ideal for reducing emissions and energy (Methane) development of organic waste. Anaerobic digestion can be applied, among others, to agricultural waste and waste from the industry of transforming such products. Among those wastes are food waste, organic manure, agricultural waste, crop surplus, etc. These wastes can be treated individually or together utilizing so-called co-digestion. Anaerobic digestion is also suitable for treating wastewater discharges with a high organic load, such as those generated in many food industries.

The process is widely used to treat aqueous waste sludge and organic solid waste due to less remaining volume and input material mass.

The digestion process (or biodegradation) begins with bacterial hydrolysis of input materials to break down organic polymers such as carbohydrates and make them available to different bacteria. These bacteria can further degradate the present sugars and amino acids into carbon dioxide, hydrogen, ammonia and organic acids. Methanogenic bacteria can finally convert these products into methane and carbon dioxide. Control of digester temperature, pH and feed rate is essential for efficient material separation.

For this study, six experiments were carried out in the computer-controlled pilot plant for biogas production with recipes modelled with different compositions of substances in the mixture and different sources of microorganisms, from which different results were obtained, very indicative for a future application on an industrial scale.

Keywords: *Bio digestion, Pilot process, Statistics, Organic wastes, Anaerobic process, Methane production*

Physico Chemical Characterization of Selected Fruit Juices and Mathematical Modelling of their Mixing Process

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Abstract

It's important to note that while some fruits contain potentially beneficial compounds, the concentration and specific composition of these compounds in the juices could influence their chemical, antioxidant and other activities. In our laboratory experiments, we could follow the general experimental approach outlined earlier. It's a good idea to conduct a series of tests using different concentrations of each juice and other different conditions.

We have got some findings, data treatment, and comments that might provide for those performed experiments. Then we performed the data treatment: Statistical Analysis: since we have multiple replicates for each type of fruit juices, consider performing statistical analysis (e.g., PCA). Then it has been done the graphical representation. Implications and Further Research and Practical Applications: considering the potential practical applications of these findings, such as incorporating these fruit juices as natural preservatives in food products or exploring their use in food safety practices. The physicochemical characterization of fruit juices is important for understanding their properties and behavior during processing and storage. This research will focus on the characterization of the physical and chemical properties of some common fruit juices as following: Plum Juice (Sample 1), Peach Juice (Sample 2), Apple Juice (Sample 3), Smothie Carrot + Apple + Peach Juice (Sample 4). The characterization of the complex properties of these food liquids has been performed through the following instrumental laboratory analysis: a. Free Total Acidity: b. Reducing Sugars: c. Sucroze content: d. Formol Number: e. Refraction Index and C vitamin content. The properties that will be characterized include: Composition: Rheology: Stability. The mixing process of fruit juices is also important to understand, as it can affect the quality of the final product. This research was intended to develop a mathematical model to simulate the mixing process of fruit juices. The model will be used to study the effects of different mixing parameters, on the uniformity of the mixture. The results of this research provide valuable information for the production and processing of fruit juices. The characterization of the physicochemical properties of fruit juices helps to ensure the quality and safety of the products. The mixing model will be used to optimize the mixing process and improve the uniformity and nutrition values of the mixtures. In addition to the above, the research may also investigate the following topics: The effect of different processing conditions, such as temperature and pH, on the physicochemical properties of fruit juices; the use of additives, to improve the stability of fruit juices; the development of new methods for the extraction and concentration of fruit juices. The research used to make a contribution to the field of fruit juice processing. The findings will be of interest to researchers, manufacturers, and consumers of fruit juices.

Keywords: *fruit juices, characterizing, modelling, properties, mixing process*

Bibliometric Analysis of Research About Health Information System

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Abstract

The healthcare sector is substantially embracing digital solutions for the purpose of overseeing clinical, administrative, and financial operations. This study aimed to provide a comprehensive overview of research concerned with health information systems regarding bibliometric analysis and to produce a comprehensive picture of this topic. Data were collected from the Pubmed database comprising health sciences literature. The document type was set as studies consisting of clinical trials, meta-analyses, randomized controlled trials, reviews, and systematic reviews, and the publication language was set as "English." Finally, a total of 7,034 studies were examined between 2018 and 2023, using the latest 5 years as the period. 22.373 keywords were obtained at a high frequency in the WoS databases provided by research. The minimum number of occurrences of a keyword is 110. The data underwent analysis through the application of bibliometric analysis techniques. In conclusion, the trends of the research coincident with the time and the development of health information systems. Key terms analysis could show the research directions in a particular discipline. As a result of the analysis, the most repeated terms are collected in 5 different clusters in total, with approximately 20 terms in each cluster (min=6, max=32). The first cluster addresses labels related to developing health information topics, for example, electronic health records, medical informatics, decision support systems, algorithms, machine learning, artificial intelligence, mobile applications, computer security and privacy. Terms in the second cluster focus on the perspective of healthcare/hospital. The third cluster is mainly related to the COVID-19 pandemic process, including incidence, epidemiology, risk factors, vaccination, surveillance etc. While the fourth cluster consists of several social-demographic characteristics age-specific, the fifth cluster includes patient-reported outcome measures, prospective studies, quality of life and mental health.

Key words: *Information Systems, Health Information System, Bibliometric Analysis*

INTRODUCTION

The healthcare sector is substantially embracing digital solutions for the purpose of overseeing clinical, administrative, and financial operations. This adoption facilitates the storage of health information, personnel data, and inventories, thus raising the quality of patient care, decreasing operational expenses, and improving internal management procedures.

Information is essential for patient management, health unit administration, health system planning, and management at all healthcare system levels. This means that all decision-makers must use information, including policymakers, managers, and healthcare professionals, such as physicians, technologists, and community health workers. The initial definitions described health information systems as intended to gather information about diseases (surveillance) and healthcare outcomes. Hurtubise (1984) identifies them as systems that provide specific information support to each organizational-level decision-making process. Health information systems aim to "improve action" rather than "gain information." When applied to the health sector, health information systems may currently be defined as a set of components and procedures arranged to create information that will improve healthcare management decisions at all health system levels (Lippeveld, Sauerborn and Bodart, 2000). Health Information Systems is defined as "a system for

collecting and/or processing data from various sources and using the information for policymaking and management of health services." It could be paper-based or electronic (NCBI, 2023).

This study aimed to provide a comprehensive overview of research concerned with health information systems regarding bibliometric analysis and to produce a comprehensive picture of this topic.

MATERIAL AND METHODS

Data were collected from the Pubmed database comprising health sciences literature. Search criteria include Health Information Systems as the main category of Information Science (Tree Number(s): L01.313.500.750.300.361; MeSH Unique ID: D063005) (Information Science, Informatics, Medical Informatics, Medical Informatics Applications, Information Systems, Health Information Systems) (NCBI, 2023).

The document type was set as studies consisting of clinical trials, meta-analyses, randomized controlled trials, reviews, and systematic reviews, and the publication language was set as "English." Finally, a total of 7,034 studies were examined between 2018 and 2023, using the latest 5 years as the period. 22.373 keywords were obtained at a high frequency in the WoS databases provided by research. The minimum number of occurrences of a keyword is 110. All studies were downloaded as a TXT format file, including titles, MeSH codes, authors, abstracts, descriptors, etc. VOSviewer (version 1.6.16) was used to perform visualization and bibliometric analysis.

The data underwent analysis through the application of bibliometric analysis techniques. Recently, bibliometric analysis has become a popular method for quantitatively and objectively evaluating studies in literature. This systematic statistical analysis method visualizes scientific studies' methodologies, topics, and frameworks, allowing for the evaluation of publications from research articles, books, reviews, and conference proceedings (Balaban et al., 2023; Akintunde et al., 2021; Chahrour et al., 2020).

RESULTS

22.373 keywords were obtained at a high frequency in the WoS databases provided by research. The minimum number of occurrences of a keyword is 110. The most frequent keywords related to health information systems were humans, mainly some demographic characteristics such as female, male, adult, middle-aged, child, adolescent, and young adults, following electronic health records, COVID-19, health information system, survey and questionnaire etc.

Table.1

No	Label	Cluster	Weight (Links)	Weight (Total link strength)	Weight (Occurrences)
1	Humans	1	98	26978	7015
2	Female	4	98	11838	1770
3	Male	4	98	9576	1328
4	Adult	4	98	7279	959
5	Middle Aged	4	98	5901	699
6	Child	4	97	4943	815
7	Aged	4	98	4734	639
8	Adolescent	4	97	4477	551
9	Young Adult	4	97	3865	425
10	Electronic Health Records	1	96	3787	939
11	Delivery Of Health Care	2	98	3710	935
12	Covid-19	3	98	3710	899
13	Health Information Systems	2	98	3452	774
14	Retrospective Studies	4	96	3137	540
15	Surveys And Questionnaires	1	98	2956	546
16	United States	4	97	2938	587
17	Cross-Sectional Studies	2	97	2924	508
18	Pandemics	3	98	2546	481
19	Infant	4	88	2500	311
20	Child, Preschool	4	92	2427	272
21	Information Systems	5	97	2218	472
22	Geographic Information Systems	3	92	2162	568
23	Aged, 80 and over	4	95	2062	222
24	Sars-Cov-2	3	96	2053	377
25	Infant, Newborn	4	86	2028	282

Figure 1 demonstrates the network related to key terms discussed in the current study. The codes network map displays distinct clusters of categorized phrases, each with a different color. In Figure 1, the 110 co-occurrence terms were allocated into five clusters: humans, COVID-19, public health, pregnancy and adolescent. The red cluster contains 32 items that show the terms related to humans (e.g., 'electronic health records, telemedicine, hospitals, medical informatics, patient safety, etc.), the green cluster contains 24 items related to pregnancy (delivery of health care, health information system, cross-sectional studies, primary health care etc.). The blue cluster consists of COVID-19, including pandemics, public health, risk factors, incidence, China, and prevalence. The yellow cluster includes 18 terms related to socio-demographic age characteristics such as young age, male, adult, middle-aged, child, adolescent, infant, aged 80 and over etc., and the purple cluster includes information system, reproducibility of results, patient-reported outcome measures, quality of life and mental health.

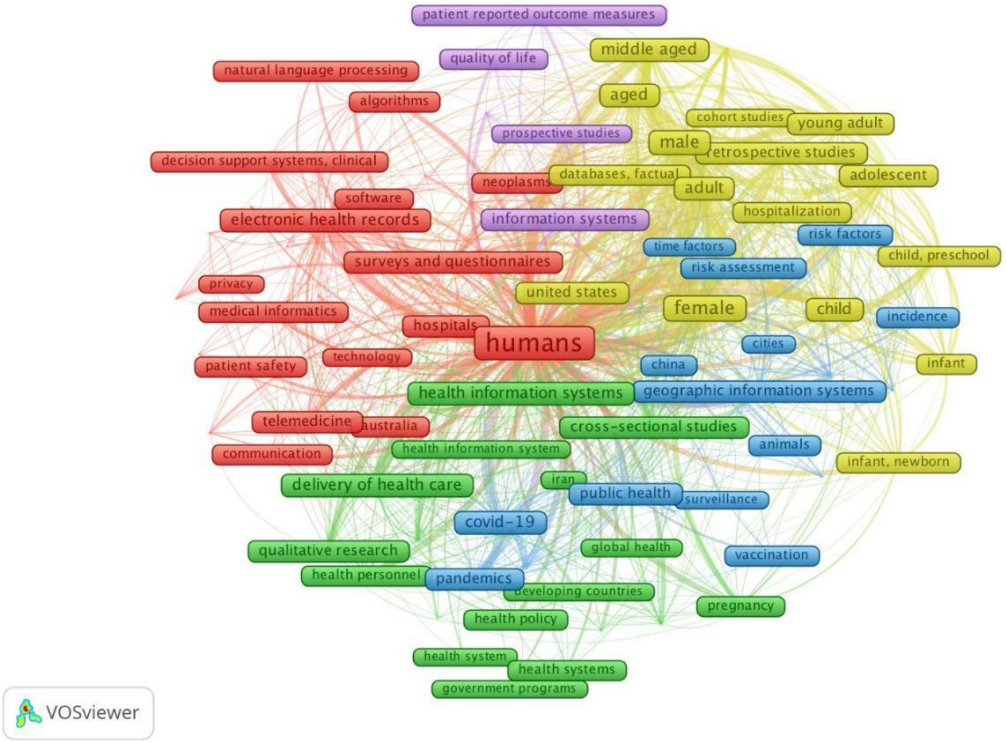

Figure 1. Health Information System codes network representation

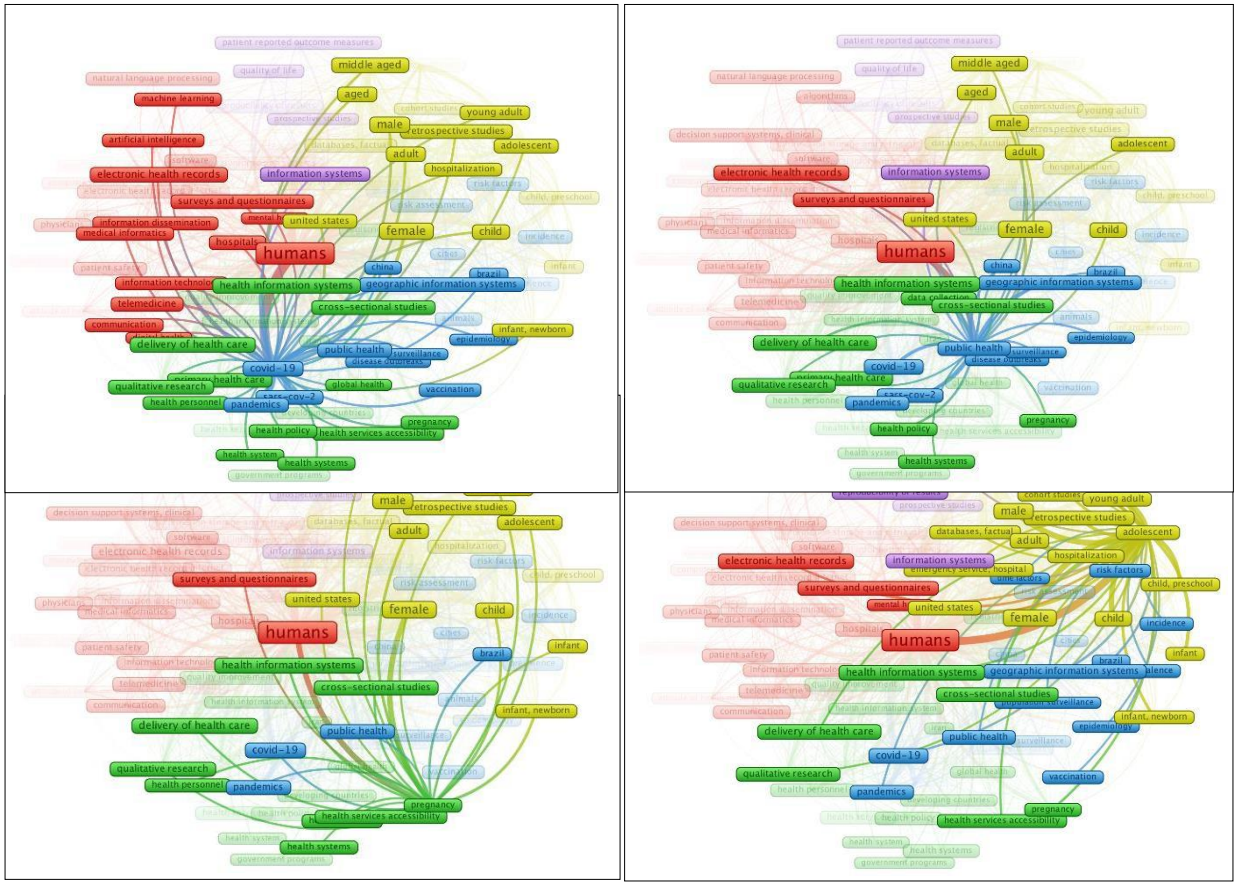

Figure 2. Network map of the most repeated key terms

Table 2 shows the most frequently repeated key terms according to five clusters. The first cluster addresses labels related to developing health information topics, for example, electronic health records, medical

informatics, decision support systems, algorithms, machine learning, artificial intelligence, mobile applications, computer security and privacy. Terms in the second cluster focus on the perspective of healthcare/hospital. The third cluster is mainly related to the COVID-19 pandemic process, including incidence, epidemiology, risk factors, vaccination, surveillance etc. While the fourth cluster consists of several social-demographic characteristics age-specific, the fifth cluster includes patient-reported outcome measures, prospective studies, quality of life and mental health.

Table 2. Clusters and most frequently key terms

Cluster	Number of key terms in the set	Most Frequently Repeated Key Terms
1	32	Humans, electronic health records, surveys and questionnaires, telemedicine, hospitals, medical informatics, decision support systems, clinical, algorithms, communication, hospital information systems, machine learning, artificial intelligence, software, patient safety, internet, neoplasms, physicians, attitude of health personnel, information storage and retrieval, Australia, information dissemination, information technology, user-computer interface, electronic health record, health information technology, health information exchange, mobile applications, natural language processing, computer security, privacy, technology and decision making.
2	24	Delivery of health care, health information systems, cross-sectional studies, pregnancy, qualitative research, primary health care, health personnel, health services accessibility, health policy, quality improvement, registries, health facilities, data collection, quality of health care, data accuracy, health services research, health systems, health services, developing countries, Iran, global health, government programs, health information system and health system.
3	19	Covid-19, pandemics, geographic information systems, sars-cov-2, public health, Brazil, risk factors, incidence, China, prevalence, population surveillance, epidemiology, time factors, risk assessment, animals, vaccination, cities, disease outbreaks and surveillance.
4	18	Young adult, male, adult, middle-aged, child, aged, adolescent, young adult, retrospective studies, United States, infant, child, preschool, aged, 80 and over, infant, newborn, databases, factual, hospitalization, emergency service, hospital and cohort studies.
5	6	Information systems, reproducibility of results, patient-reported outcome measures, prospective studies, quality of life and mental health.

DISCUSSION AND CONCLUSION

This study aimed to provide a comprehensive overview of research concerned with health information systems regarding bibliometric analysis and to produce a comprehensive picture of this topic. VOSviewer was utilized in the current study to create categorized research clusters and trends related to the main research topic.

In conclusion, the trends of the research coincident with the time and the development of health information systems. Key terms analysis could show the research directions in a particular discipline. As a result of the analysis, the most repeated terms are collected in 5 different clusters in total, with approximately 20 terms

in each cluster (min=6, max=32). The first cluster addresses labels related to developing health information topics, for example, electronic health records, medical informatics, decision support systems, algorithms, machine learning, artificial intelligence, mobile applications, computer security and privacy. Terms in the second cluster focus on the perspective of healthcare/hospital. The third cluster is mainly related to the COVID-19 pandemic process, including incidence, epidemiology, risk factors, vaccination, surveillance etc. While the fourth cluster consists of several social-demographic characteristics age-specific, the fifth cluster includes patient-reported outcome measures, prospective studies, quality of life and mental health.

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Acknowledgment

The author sincerely thanks Muhammed Fevzi Esen, who provided technical guidance for this research.

Conflict of Interest

The author has declared that there is no conflict of interest.

Author Contributions

The author made a contribution of 100% to the study.

Comparison and Analysis of Logistic Regression, Naive Bayes and Random Forest Machine Learning Algorithms for Predicting Child Labor in TURKEY

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Abstract

This study aims to compare and analyze the performance of three popular machine learning algorithms - logistic regression, Naïve Bayes, and random forest - in predicting child labor in Turkey. The statistics on working children status in Turkey in 2019 were derived from the micro database of the Turkish Statistical Institute (TURKSTAT). The study leverages big data analysis, artificial intelligence, and classification algorithms to gain insights into the complex dynamics of child labor and inform effective interventions. The research explores the intersection of these fields, emphasizing their significance in addressing societal challenges. Using a comprehensive dataset on child labor in Turkey, we apply supervised learning techniques to develop and evaluate predictive models. The findings reveal that while logistic regression and Naïve Bayes offer valuable insights, the random forest algorithm demonstrates superior performance in accurately predicting child labor instances. The model achieves an impressive accuracy rate of 97%, highlighting its ability to capture intricate feature interactions. The Study adds to the body of knowledge by demonstrating the effectiveness of machine learning algorithms in preventing child labor and by offering evidence-based advice to decision-makers. But it's important to identify some restrictions, such the generalizability and quality of the data. To improve prediction accuracy and broaden our understanding of the dynamics of child labor, future study should investigate more sophisticated algorithms and incorporate extra information.

Key words: *Machine Learning Classification Algorithms, Logistic Regression, Naïve Bayes, Random Forest, Child Labor*

INTRODUCTION

Machine learning (ML) classification algorithms play a crucial role in social science research by providing crucial insights into societal phenomena such as social patterns and societal phenomena due to their ability to analyze big and complicated datasets. As a result, today, a lot of real-world problems in different domains, stretching from retail and banking to medicine and healthcare, are tackled while using machine learning models (Linardatos et al., 2020). These algorithms enable researchers to categorize and classify diverse data points, such as survey responses, textual data, or social media posts, into meaningful groups. Social scientists may now uncover hidden patterns, spot trends, and make predictions that were previously difficult or impossible to do using only traditional statistical methods by using the power of machine learning. This makes it easier to understand how people interact, prioritize, and make decisions, which eventually advances knowledge in disciplines like sociology, psychology, political science, and economics. According to Ballestar et al. (2019), in order for big data to maximize its effectiveness in policy studies, it is crucial to employ multi-disciplinary approaches. These approaches should not only rely on the latest computational algorithms derived from machine learning literature but also incorporate the methodologies and practical knowledge gained from decades of multi-disciplinary research that utilizes empirical evidence to guide policy-making choices. Additionally, automated analysis is a potential benefit of machine learning classification algorithms. This cuts down on the time and labor needed for data

processing and creates new opportunities for extensive research that may adequately represent the complexity and diversity of social phenomena. The advantage of ML methods over traditional statis-tical tools is that they provide new approaches to improve the estimation of causal effects, thus reducing the reliance of these estimates on modeling assumptions and enhancing the credibility of policy analysis (Mumtaz, 2022). Overall, the use of machine learning classification algorithms in social science research has enormous potential for improving our understanding of human behavior and guiding solutions that are based on solid research for societal improvement.

Child labor is a serious problem that affects everyone in the world and has negative social, economic, and ethical effects. It entails putting kids to work in jobs that are bad for their social, mental, or physical growth. Like many other nations, Turkey has struggled with the issue of ending child labor and protecting the rights and welfare of its young people.

The purpose of this study is to develop a predictive model that can effectively identify instances of child labor in Turkey. We use logistic regression, naive bayes, and random forest machine learning techniques to do this. These algorithms have been successfully used to classification problems in many different fields and have yielded encouraging results.

This study attempts to increase the precision and effectiveness of identifying child labor situations in Turkey by using machine learning techniques. The results of this study can ultimately guide targeted initiatives and policies meant to discourage child work, advance child welfare, and defend children's rights in Turkey.

A Comparative Analysis of Performance Measures

Hussain et al. (2019) give an evaluation of a range of machine learning categorization approaches for recognizing activities in their research. To evaluate the efficacy of five machine learning algorithms for classification, a previous hierarchical activity identification system was modified. Numerous studies conducted and discovered that classification techniques surpass classic activity recognition algorithms substantially. The work's objective is to promote independence amongst older society, specifically individuals with Alzheimer's disease.

In the study we conducted, Khanam and Foo (2021) combine data mining methods, machine learning (ML) techniques, and Neural Network (NN) methodologies are applied to anticipate diabetes. For this study, we utilized the Pima Indian Diabetes (PID) data from the UCI Machine Learning Repository. The collection includes information on 768 patients and their nine distinct characteristics. On the data set, we utilized seven ML algorithms for estimating diabetes. We discovered that the model based on Logistic Regression (LR) and Support Vector Machine (SVM) predicts diabetes effectively. We created the NN model with each hidden layer having a distinct epoch and found that the NN with two hidden layers delivered 88.6% accuracy.

Each year, crashes involving vehicles cause countless casualties, injuries, and deaths as well as financial losses, making it one of the world's most pressing challenges. Effective algorithms to anticipate the severity of traffic accidents, according to Al et al. (2019), is a key job for transportation networks. This inquiry attempt provides methods for selecting a collection of significant criteria and developing a model for categorizing the severity of accidents. Several machine learning is used to create these models. On traffic accident info, machine learning techniques with supervision such as AdaBoost, Logistic Regression (LR), Naive Bayes (NB), and Random Forests (RF) are used. The SMOTE method is used to deal with data imbalances. The results of the research suggest that the RF model might be a useful tool for forecasting the extent of traffic injuries. The RF method outperformed the LR algorithm (74.5% accuracy), the NB algorithm (73.1% accuracy), and the AdaBoost algorithm (74.5% accuracy).

Dropout is a severe problem in countries with limited resources like India, especially at the secondary level, and it is caused by a variety of socioeconomic and educational variables. Algorithms based on machine

learning have been applied to learning for predicting student dropouts so that probable dropouts may be identified, and corrective steps can be implemented to avoid the dropout. Mirza and Hassan (2020) assess the primary variables that cause school dropout and give a comparison of five supervised classification methods used for predicting school dropout pupils. Such algorithms can be utilized to rapidly identify and predict dropouts or students in danger of leaving schools, allowing corrective strategies to be deployed to decrease the possibility of dropout or preventing students from actually dropping out.

Stress has an impact on mental as well as physical wellness, and as a result, stress is one of the leading causes of pregnancy issues such as hypertension. As a result, it is vital to determine the impact of stress on the health of both the mother and the baby to identify potential difficulties during the course of pregnancy and delivery. It may also be effective in predicting and avoiding birth malformations, as there have been several cases of stress-related difficulties resulting in cognitive impairments in children. Madhusri et al. (2023) used social, physical, environmental, and biological components to construct a model for the prediction of stress-related problems during pregnancy. The data set was created by administering a customized interview-based assessment to women who had previously undergone pregnancies and deliveries. The inquiries depended on the previously indicated variables. The produced data is utilized to validate the hypothesis and assess the performance of the suggested stress prediction framework utilizing machine learning methods such as Support Vector Machine (SVM), Naive Bayes (NB), KNearest Neighbor (KNN), and Decision Tree (DT). When the Naive Bayes approach was utilized, the experimental findings showed that the suggested model attained an accuracy of 90%. The other methods yielded less accurate but still near findings.

Gebreyohans and Gandhi (2018) divide children into four categories: orphans, solitary abandoned children, vulnerable kids, and protected children. The objective of this categorization is to assist the Love for Children Organization's outside supporters and to obtain complete information about each kid for internal purposes. To do this, three types of categorization approaches were applied within the context of the KDD (Knowledge Discovery in Databases) data mining model: decision tree, Bayesian learning, and neural network. For testing with the categorization method, the children's datasets were gathered, cleaned, processed, and merged. The final dataset contains 17044 recordings that have been examined and compared to their effectiveness. The dataset gathering was tested using a ten-fold cross-validation procedure and divided into 70/30%, 66/44%, and 50/50% for both testing and training, correspondingly. Furthermore, the total accuracy of classification and advantages of decision tree (98.83%), Bayesian learning (98.32%), and neural network (98.86%) models were compared. The study finds that a decision tree (98.83%) ought to be used as a framework since it outperforms Bayesian learning (98.32%) and outperforms Neural Networks (98.86%) in the categorization of organizational children.

S and Dornadula (2019) The primary goal of this article is to build and create a unique fraudulent activity detection algorithm for Streaming Transaction Data, to analyse customers' prior purchase information and extract patterns of behaviour. Cardholders are divided into categories according to the volume of their transactions. Then, utilizing a sliding window method, combine the transactions done by cards from various categories to extract the behavioural patterns of the groupings. They used European credit card theft datasets in their article.

Child Labor in Turkey

Child labor definitions vary across countries due to cultural factors. The International Labor Organization (ILO, 2021) defines child labor as work that poses risks and harm to the physical, mental, or moral well-being of children, and that interferes with their education. As per the labor legislation in Turkey, children who have finished their primary education and are no longer enrolled in school are permitted to work for up to 7 hours per day or 35 hours per week, with the possibility of extending to 40 hours per week. However, children who are currently attending school are only allowed to work for a maximum of 2 hours per day or 10 hours per week. During school closures, their work hours may be the same as those of children who are not attending school (Koçali, 2022).

In Turkey, despite efforts to combat it, child labor persists as a complex issue with socio-economic and cultural roots. According to the International Labor Organization (ILO, 2022), "A total of 160 million children – 63 million girls and 97 million boys – are in child labor globally, accounting for almost one in ten of all children worldwide. Nearly half of all those in child labor – 79 million children in absolute terms – are in hazardous work that directly endangers their health, safety, and moral development." Based on the results of the Turkish Household Labor Force Survey (THLFS) 2020 survey (TURKSTAT, 2021), it was found that the labor force participation rate for children aged 15-17 in Turkey was 16.2%, which corresponds to approximately 600,000 individuals. Among these children, boys had a labor force participation rate of 23.4%, while girls had a rate of 8.6%. The total number of children engaged in economic activity in Turkey was 720,000, with boys comprising 70% and girls 30% of this population. Among the working children status, the majority (80%) were aged 15-17, with 16% aged 12-14 and 4% between 5-11 years old. The primary sectors of employment for these children were agriculture (31%), manufacturing (24%), and services (45%). However, the sector distribution varied based on age, with 61% of children aged 5-14 working in agriculture and 51% of those aged 15-17 working in services. Despite their economic activity, a significant proportion of working children (66%) also attended school, with a higher attendance rate among females (66%) compared to males (57%). The main reasons for children engaging in economic activity included assisting with household economic activity (36%), seeking vocational training and occupational skills (35%), contributing to household income (23%), and meeting personal needs (6%). The International Labour Organization (ILO) reported a decline in the number of children engaged in economic activity in Turkey over the years. In 1994, approximately 2.3 million children were involved in economic activities, accounting for around 15% of the total child population. This number decreased to nearly 1 million (6%) in 2006 and further dropped to 720,000 children (4.4%) in 2019. The period between 1994 and 2006 witnessed a significant decrease in the number of children engaged in economic activity.

Child labor in Turkey has been extensively studied in the literature, covering various aspects. Gerşil (2017) has examined the occurrence of child labor in Turkey in different sectors, including agriculture, manufacturing, and informal urban settings, and have identified different forms of child labor, such as hazardous work, domestic labor, and street work. The agricultural sector is one of the worst in the country for seasonal migrant and agricultural labor in the workplace and in the environment, where occupational diseases and accidents are most prevalent (Koçali, 2022). The literature highlights several contributing factors, such as poverty, limited access to education, weak enforcement of labor laws, migration, and the presence of an informal economy. Numerous studies conducted globally and within Turkey emphasize that poverty is widely recognized as the primary underlying factor leading to child labor when examining its causes (Gürses, 2009; Kahraman & Sallan Gül, 2015; Öngel, 2017).

MATERIAL AND METHODS

Dataset Definition

The data used in practice, Turkey Statistics Institute (TURKSTAT) in 2019 "Working Child Statistics" were obtained from the micro database. The joint implementation of the Working Children Survey (WCS) and the Turkish Household Labor Force Survey (THLFS) took place in the year 2019. The HLFS involved interviewing 14,277 households, and data from 25,190 children was obtained as a result of this study. The definition of child labor for the purposes of this study according to TURKSTAT is children between the ages of 5 and 17. In this thesis, the application of a machine learning classification algorithm was implemented using the dataset of 7,934 children aged between 12 and 17 years. In this binary dependent variable (Working Children Status: WCS) given in the classifier scale, W: if the child works (1); NW: Coded as if child does not work (0). While the number of not working children was 6,860 (NW = 86%), the number of those who work was found to be 1,072 (W = 14%).

Working Children Status is a binary variable and is considered as the dependent variable. The model includes 14 independent variables, 2 of which are continuous variables and 12 are categorical variables. These continuous variables are household size and family composition. According to Libaque-Saenz et al., (2018), the neural network model shows that geographical indicators, income levels, gender, family composition and educational levels significantly predict child labor. Family composition is computed and included in the model since it is an important variable in predicting child labor. The categorical variables are; gender, age group, mother age group, father age group, the status of attending school, educational status of mother, educational status of father, sector of household leader, homework 1(Shopping for households, laundry-dishwashing, ironing, cooking, cleaning of household items etc.), homework 2 (Caring for younger children in the household), working status of the mother and working status of the father.

Machine Learning Classification

Datasets have untapped knowledge that may be used to build smart systems for making decisions. (Witten et al. 2016) Most sorting and forecasting techniques are used in systems that support decisions. It is possible to determine major categories of info, derive modelling from data, or forecast foreseeable data patterns using the two types of data analysis known as classification and prediction. These analyses can aid us in comprehending the larger body of data. Categorization models foretell category labels. In contrast, continuous-valued variables are specified in estimating frameworks. As an illustration, the bank may develop a classification model to categorize applications for loans as safe or dangerous, and the model's output could be a categorized listing of new applications that are either safe or hazardous. The bank can develop a prediction algorithm to determine clients' daily or monthly costs by taking into account their income and line of work (Witten et al., 2016). Experts have created a variety of categorization and forecasting techniques that are utilized in machine learning, detection, diagnosis, and analytics. These algorithms are employed in data mining studies and the extraction of information, sequences, and meanings from large data sets.

Logistic Regression

Binary categorization is handled by the statistical model of logistic regression. Based on one or more predictor variables, it estimates the likelihood of a binary result (such child labor occurring or not). The logistic function, commonly referred to as the sigmoid function, converts a linear combination of predictors into a probability between 0 and 1.

For Binary Logistic Regression:

$$[P(Y=1) = \frac{1}{1+e^{-(\beta_0+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_k X_k)}}]$$

Based on predictor variables, logistic regression is a method used to model the risk of child labor occurring. The model's coefficients $(\beta_0, \beta_1, \ldots, \beta_k)$ are estimated during training.

Naive Bayes

A probabilistic classification algorithm based on the Bayes theorem is called Naive Bayes. It makes the naive assumption that all features are independent. It determines a class's conditional probability based on the values of its features.

For Gaussian Naive Bayes:

$$[P(Y|X) = \frac{P(X|Y)P(Y)}{P(X)}]$$

Instances of child labor can be categorized using Naive Bayes based on the likelihood that specific features will occur together. For each class, it calculates the conditional probabilities.

Random Forest

An ensemble learning technique called Random Forest uses several decision trees to produce predictions. It is strong and can manage data with complex relationships. Each decision tree develops its own predictions after being trained on a bootstrap sample of the data.

Without assuming a particular functional form, Random Forest can be used to predict child labor based on a variety of factors. To increase precision and decrease overfitting, it combines the predictions from various trees.

Confusion Matrix

A confusion matrix is a table used to evaluate the performance of classification models. It summarizes the true positive (TP), true negative (TN), false positive (FP), and false negative (FN) predictions.

- $[\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}]$
- $[\text{Precision} = \frac{TP}{TP+FP}]$
- $[\text{Recall (Sensitivity)} = \frac{TP}{TP+FN}]$
- $[\text{F1-Score} = 2 \cdot \frac{\text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}}]$

The confusion matrix quantifies how well the models categorize instances of child labor, which aids in evaluating the models' performance. It offers a thorough description of the right and wrong predictions, making it possible to assess the model's performance in its entirety.

RESULTS

Descriptive Statistics

The initial step in data analysis involves organizing and defining the data. Considering that certain variables associated with Working Children Status (WCS) exhibit similarities and correlations, the number of variables was reduced by examining the correlation matrix. Based on this matrix, it was determined to include categorical variables such as “gender”, “age group”, “mother age group”, “father age group”, “the status of attending school”, “educational status of mother”, “educational status of father”, “sector of household leader”, “homework 1”, “homework 2”, “working status of the mother” and “working status of the father “as well as dependent variable for "Working Children Status" classifier. The significance coefficients were set at alpha levels of 0.10 and 0.05. Python-based software Jupyter Notebook was used to analyze the data.

The results in Table 1. indicates a statistically significant difference in the distributions of the continuous variable across the categories ($p < 0.05$). Therefore, we reject the null hypothesis and conclude that there is evidence of a significant difference in the distributions of the continuous variable among the categories. These findings contribute to our understanding of factors influencing child labor and have implications for formulating policies to combat child labor.

Table 1. Mann-Whitney U test p-values for FACOM variables

Variable	U-statistics	P Value
WCS*FACOM	62881036.5	0.000

Degrees of Freedom: 15866, Independent Sample T-test: 240.08, Z-test Statistics:36.56

Given that the variables in our study do not exhibit a normal distribution except for Family Composition (FACOM), and are categorical in nature, we utilized the Cramer's Vu correlation coefficient in Figure 1 as a more suitable measure. Recognizing the significance of the statistical properties of the dataset in both data analysis and pre-processing stages, we present the chi-square p-values in Table 2. This table displays the frequencies of the selected categorical variables and their associations with the Working Children Status (WCS) variable.

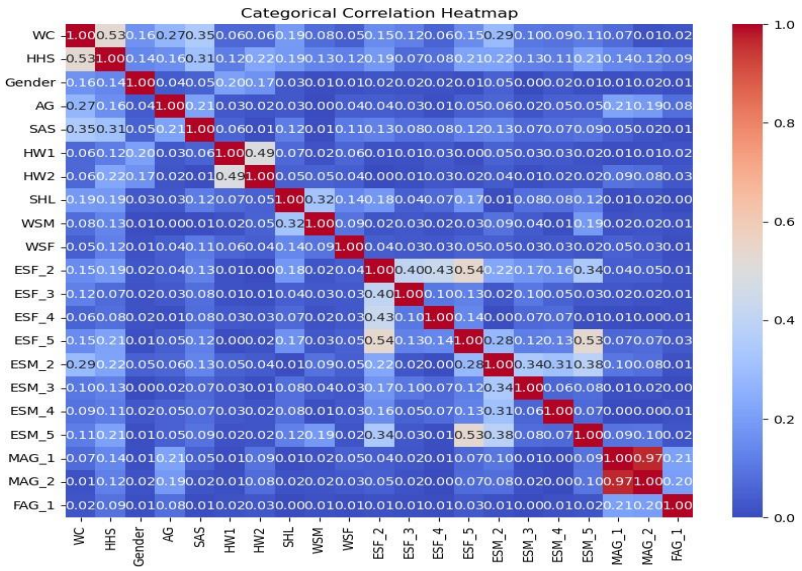

Figure 1. Cramer's V correlation Heat Map

Table 2. presents a comprehensive analysis of categorical independent variables, showcasing frequencies, percentages, and chi-square p-values. Moreover, it assesses the connection between these independent variables and Working Children Status (WCS) through chi-square testing. The table provides a clear representation of the statistical information, enabling a thorough understanding of the relationship between the variables.

Table 2. Frequencies, Percentages and Chi-Square p-values For Independent Variables

	Working (W) n (%)	Not Working (NW) n (%)	Total n (%)	P-values
Gender				
1: Male	779	3332	4111(51.8)	0.000
0: Woman	294	3529	3823(48.2)	
Age Group (AG)				
1: 15-17	902	3025	3927(49.5)	0.000
0: 12-14	171	3836	4007(50.5)	
HHS				
5=<: HHS	666	4785	5451(68.8)	
6=>: HHS	407	2076	2483(31.2)	0.000
Mother Age Group (MAG)				
1: 25-34	71	929	1000(12.6)	0.013*
2: 35-54	943	5932	6875(86.6)	0.000
0: 55 +	59	0	59(0.8)	
Father Age Group (FAG)				

1: 25-34	9	120	129(1.62)	
2: 35-54	950	6741	7691(96.9)	0.000
0: 55 +	114	0	114(1.48)	
The Status of Attending School (SAS)				
1: Attending School	669	6432	7101(89.5)	0.000
0: Not Attending School	404	429	833(10.5)	
Educational Status of the Mother (ESM)				
1: Illiterate	769	585	1354(17.0)	
2: Less than high school	304	4727	5031(63.4)	
3: High school	0	507	507(6.3)	0.000
4: Vocational or technical high school	0	419	419(5.6)	
5: Higher education graduate	0	623	623(7.7)	
Educational Status of the Father (ESF)				
1: Illiterate	129	169	298(4.0)	
2: Less than high school	873	4124	4997(62.9)	0.000
3: High school	0	692	692(8.7)	
4: Vocational or technical high school	59	731	790(9.9)	
5: Higher education graduate	12	1145	1157(14.5)	0.007*
Sector of the household Leader (SHL)				
1: Agriculture	356	896	1252(15.8)	0.000
0: Not-Agriculture	717	5965	6682(84.2)	
Homework 1 (HW1)				
1: Yes	523	3975	4498(56.6)	0.000
0: No	550	2886	3436(43.4)	
Homework 2 (HW2)				
1: Yes	236	2100	2336(29.5)	0.000
0: No	837	4761	5598(70.5)	
Working status of the Mother (WSM)				
1: Employed	531	2641	3172(40.0)	0.000
0: Unemployed	542	4220	4762(60.0)	
Working status of the Father (WSF)				
1: Employed	932	6232	7164(90.2)	0.000
0: Unemployed	141	629	770(9.8)	

The statistical relationships between the variables were examined using the chi-square test. The chi-square test hypotheses for each relationship are provided below, indicating the proposed statements that were tested for statistical significance.

The chi-square test was conducted to examine the statistical independence between variables. The hypotheses for each relationship are as follows:

H0: Status of Attending School and Working Children Status are statistically independent.

H1: Status of Attending School and Working Children Status are not statistically independent.

The chi-square test revealed a significant statistical relationship between Status of Attending School and Working Children Status at a 95% confidence level (p-value = 0.000, which is less than the significance level $\alpha = 0.01$).

Similarly, for the other variables, the hypotheses and results are as follows:

H0: Sector of Household Leader and Working Children Status are statistically independent.

H1: Sector of Household Leader and Working Children Status are not statistically independent.

The chi-square test indicated a significant statistical relationship between Sector of Household Leader and Working Children Status at a 95% confidence level (p-value = 0.000).

In summary, according to the chi-square test, all variables exhibited a statistically significant relationship with Working Children Status at a 95% confidence level. This result confirms our main thesis about the variables that influence the likelihood of child labor. The chi-square analysis further highlights these determinants' statistical independence, underscoring their crucial role in determining the dynamics of child work.

Performance Comparisons of Logistic Regression Model, Naïve Bayes Model and Random Forest Model

This section aims to compare the performance of three classification algorithms, namely Logistic Regression, Random Forest, and Naive Bayes, in predicting child labor. The dataset used in the analysis includes features described in table 2. Prior to model training, the dataset undergoes thorough preprocessing steps, including handling missing values, outliers, and categorical variable encoding. The pre-processed data is then split into training and test sets, with 80% of the data used for training and the remaining 20% for testing.

The training set is used to train the algorithms. A linear model called logistic regression presupposes a linear relationship between the features and the desired outcome. An ensemble method called Random Forest combines the forecasts of several decision trees to increase accuracy. A probabilistic classifier called Naive Bayes bases its predictions on the conditional probabilities of the target variable given the characteristics, assuming independence between the features.

To assess algorithm performance, commonly used metrics include accuracy, precision, recall, F1 score, and AUC-ROC. The ability to properly identify all positives and prevent false negatives is measured by recall, while the ability to identify positive instances while avoiding false positives is measured by precision, which strikes a balance with recall, and accuracy, which evaluates total correctness. At different classification thresholds, AUC-ROC measures how well the algorithm distinguishes between positive and negative cases.

Table 3. provides a summary of the evaluation metrics for each algorithm:

Table 3. Performance Comparison of Machine Learning Classification Algorithms

Algorithm	Accuracy	Precision	Recall	F1 Score	AUC-ROC
Logistic Regression (LR)	0.91	0.71	0.57	0.63	0.76

Naïve Bayes (NB)	0.86	0.5	0.55	0.52	0.67
Random Forest (RF)	0.97	0.9	0.87	0.89	0.92

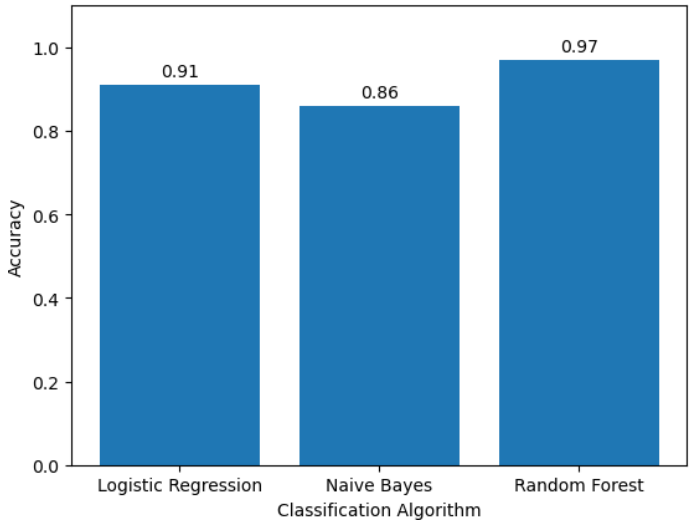

Figure 2. Accuracy Comparison of Machine Learning Classification Algorithms

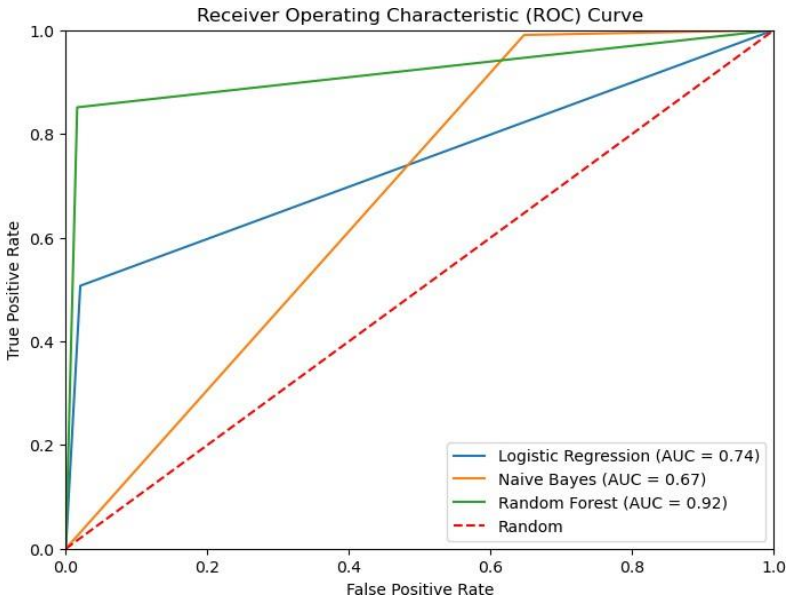

Figure 3. ROC Curve of Machine Learning Classification Algorithms

Three alternative machine learning models—Logistic Regression, Naive Bayes, and Random Forest—are compared in Table 3 to see how well they work, and numerous important metrics offer useful information. Figure 2. shows that Random Forest emerges as the most effective model, achieving an impressive accuracy of 0.97, outperforming both Logistic Regression (0.91) and Naive Bayes (0.86). Random Forest also exhibits the highest precision (0.9), indicating that when it predicts a positive class, it is correct 90% of the time. Furthermore, Random Forest demonstrates superior recall (0.87) compared to Logistic Regression (0.57) and Naive Bayes (0.55), correctly identifying 87% of positive instances. The F1 Score reinforces Random Forest's performance, measuring an impressive 0.89, indicating a favorable balance between precision and recall. Moreover, demonstrating its capacity to rank predicted probabilities, Figure 3. shows that Random Forest produces the greatest AUC-ROC score of 0.92. In contrast, Logistic Regression performs admirably, with respectable values for F1 Score, Accuracy, Precision, Recall, and AUC-ROC. Naive Bayes, on the other hand, falls short with worse precision, recall, F1 Score, and AUC-ROC. In summary, in this study, three classification methods for predicting child labor are thoroughly

compared. The statistical study, coupled with the table and graphics, show how well Random Forest performs in correctly identifying cases of child labor. The study emphasizes Random Forest's potential as a powerful prediction tool for preventing child labor.

DISCUSSION AND CONCLUSION

In this study, we undertake a thorough analysis and comparison of three well-known machine learning classification algorithms in the fields of big data analysis and artificial intelligence: logistic regression, Naive Bayes, and random forest. Our goal is to create precise predictive models and assess how well they forecast cases of child labor in Turkey. We hope to gain insightful understanding of the intricate dynamics and root causes of child labor by utilizing the power of machine learning.

We examine the convergence of big data, artificial intelligence, and the use of machine learning throughout our inquiry, acknowledging their critical roles in addressing societal issues like child labor. The potential of machine learning in the public sphere is grounded in the tremendous data availability and policy prediction needs of this field (Pi, 2021). To create and assess the effectiveness of categorization algorithms, we make use of the enormous amount of data on child labor in Turkey that is now available. ML's predictive power allows the policy makers to anticipate a policy's impact before implementing, supporting the decisions of policy adoption (Pi, 2021). We are able to take use of these algorithms' prediction powers and shed light on many different aspects of child labor by using supervised learning approaches.

We concentrate primarily on classification algorithms, which are a key component of the machine learning framework and are essential for predicting categorical outcomes. In the field of machine learning, methods such as random forest, naive bayes, and logistic regression are well known and often used. These algorithms offer various ways of comprehending the links and patterns found in the data, and they may be able to reveal important information about the causes of child labor.

Through our comprehensive analysis and evaluation of these algorithms, we gain significant insights into the prediction of child labor instances in Turkey. The statistical correlations between various factors and the incidence of child labor can be better understood through the use of logistic regression. Naive Bayes efficiently predicts occurrences of child labor using probabilistic reasoning, demonstrating its effectiveness as a baseline technique for classification tasks. But when it comes to predicting child labor, the random forest algorithm shows the most promise, demonstrating its capacity to recognize complicated linkages and make precise predictions.

By leveraging the random forest algorithm, we achieve an impressive accuracy rate of 97% in identifying child labor cases. This outcome demonstrates the robustness and effectiveness of the random forest model in capturing intricate interactions among features and producing reliable predictions. Furthermore, the feature importance analysis within the random forest framework gender, education level, and parental occupation as the most influential factors contributing to child labor in Turkey. In order to establish effective initiatives and policies to combat child labor, policymakers and stakeholders can use these findings as important assistance.

In conclusion, our research emphasizes the enormous potential of big data analysis, AI, and machine learning classification algorithms in addressing difficult societal problems like child labor. Through the evaluation of logistic regression, Naïve Bayes, and random forest algorithms, we identify the random forest algorithm as the most effective in accurately predicting child labor instances. Thanks to its powerful data processing capabilities, ML can help the public sector automate many highly labor-intensive data processing and analysis activities, thereby increasing the efficiency and speed of government services and actions (Pi, 2021). The insights gained from this study contribute to the existing body of knowledge and provide evidence-based guidance for policymakers, enabling them to implement targeted interventions and policies that effectively combat child labor in Turkey. According to Libaque-Saenz et al., (2018), this could be useful for governmental agencies to develop more effective strategies and to be more efficient in investing scarce resources to deal with this problem.

Future study should investigate more complex algorithms, include more pertinent features, and make use of cutting-edge methods for data pretreatment and model improvement as machine learning techniques advance. Continued data gathering efforts and the use of cutting-edge machine learning techniques will improve the precision and application of prediction models, helping to eradicate child labor practices and safeguard children's rights in Turkey and around the world.

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Acknowledgment

This study is presented as a Master thesis by M. Rohat Bingöl, Marmara University, Istanbul, TURKEY

Advisor: Prof. Dr. Ahmet Mete Çilingirtürk.

Conflict of Interest

The authors have declared that there is no conflict of interest.

Covid-19 Pandemi Döneminde Durumluk Kaygıda Log-Lineer Model Kullanımı

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Abstract

The Covid-19 pandemic, as one of the largest global health crises faced in human history, has caused many losses and many negative effects on society. The countries and people have to set boundaries and distance from each other due to some economic, social, psychological, etc. has revealed problems. This study aims to examine the social and psychological effects on individuals in our country of the pandemic. For this purpose, individuals' scores from the state anxiety scale developed by Spielberger et al. (1970) were examined and three sub-factors (self-confidence, cognitive and somatic) were encountered. It is thought that examining the significant interactions between these sub-factors and proposing possible models will contribute to the literature. Relationship structures were investigated with log-linear models on the data obtained by Sari et al. (2022). Although the impact of the Covid-19 pandemic has decreased, it is thought that it is important to identify significant risk factors in every area where society is affected by new pandemic-type diseases and to model the relationships between these risk factors.

Key words: *Covid-19, State Anxiety Scale, Log-Linear Model*

GİRİŞ

İnsan tutum ve davranışlarını anlamlandırabilmek için hiç kuşkusuz duygu durumu, yaşanılan zorluklarla mücadele şekli, travmatik dönem veya olaylarla başa çıkabilme gücünü sorgulamak önemlidir. Bireyin öznel huzuru veya toplumun diğer bireyleriyle ilişkilerini anlamlandırmada tanımlanabilen veya tanımlanamayan içsel güdüleri davranışlarına yön verebilir.

Kaygı her insanın hayatında belirli zamanlarda değişik nedenlere bağlı olarak meydana gelen doğal bir tepki olan içsel huzursuzluktur. Kaygı, insanların yakından tanıdığı bir alarm duygusudur. Kişiler kendilerini tehdit altında hissettiğinde kaygı belirtileri gösterir ve bu hisler geçici ya da sürekli olabilir (Abuqamar ve ark., 2016). Spielberger ve ark. (1983) tarafından geliştirilmiş durumluk ve sürekli anksiyete ölçeği (STAI), durumluk ve sürekli kaygı olmak üzere iki alt boyuttan oluşmaktadır. Durumluk kaygı, istenmeyen, tehlikeli bir durum söz konusu olduğunda ortaya çıkan aşırı kaygı halidir. Sürekli kaygı ise belirgin bir neden olmaksızın hissedilen orantısız kaygı durumudur (Şahan ve Tangılntız, 2022).

Dünyayı etkileyen COVID-19 salgını, Aralık 2019'da Çin'in Wuhan kentinde başlamış ve 10 Mart 2020'de Türkiye'ye ulaşmıştır. Türkiye'de ve dünyada bu salgının insanlar üzerindeki etkisini belirlemek için tıbbi araştırmalar, sosyal ve politik araştırmalar halen devam etmektedir. İnsanların salgın risklerini nasıl algıladıkları ve büyük krizlerin bireysel davranışları nasıl şekillendirdiğini anlamak, karar vericilerin sosyal ve politik stratejilerini belirlemeyebilmeleri için çok önemlidir. Salgın, ülkemizde pek çok insanının fiziksel ve zihinsel refahı üzerinde önemli bir etkisi olmuştur. Karar vericilerin COVID-19'u kontrol altında tutulabilmek için uyguladığı sosyal izolasyonun insanların yaşamları üzerinde önemli etkileri olmuştur. Bu nedenle, COVID-19 pandemisi sonucunda artan sayıda vakalar, yeni ölümler, ekonomik krizler ve diğer stres faktörlerini yaşayan bireylerde duygu durumları incelenmeye değer bir kavramdır (Rosen ve ark., 2020).

Bu çalışmada Sari ve ark. (2022)'nin Türkiye'de COVID-19 döneminin sosyal ve psikolojik etkilerini değerlendirmek için hazırladığı çalışmasından alınan veriler kullanılmıştır. İlgilenilen değişken durum kaygı düzeyi ile ilişkisi olabileceği düşünülen kronik hastalık durumu ve cinsiyet değişkeni birlikte ele alınarak kontenjans tablolarında analiz yöntemine başvurulmuştur.

MATERYAL VE METOT

Kategorik bir değişken, birbiriyle örtüşmeyen bir grup kategoriden oluşur. Kategorik veriler ise bu kategorilere düşen gözlem sayılarıdır (Agresti ve Kateri, 2011). Elde edilen gözlem değerleri iki veya daha fazla kategorik değişken üzerinde çapraz sınıflandırıldığında, farklı kategori kombinasyonları için sayım tablosu bir kontenjans tablosunu oluşturur (Agresti ve Kateri, 2011). İkiden fazla çapraz sınıflandırma değişkeninin varlığında elde edilen çok yönlü kontenjans tabloları uygulamada oldukça yaygındır (Kateri, 2010).

Bir kontenjans tablosundan bilgi özetlenebileceği gibi uygun ilişki ve modelleme yoluyla daha fazla analize başvurulabilir (Agresti ve Kateri, 2011). İki yönlü kontenjans tabloları için kategorik değişkenler arasındaki bağımsızlığın araştırılmasında Pearson ki-kare, olabilirlik oran gibi geleneksel yaklaşımlar kullanılmaktadır (Öğüş ve Yazıcı, 2011; Çilan, 2013; Öncel ve Erdugan, 2015). Standart ki-kare analizleri ile verilerin tam olarak anlaşılmasının sağlanamadığı durumlarda, log-lineer modeller sıklıkla kullanılan bir yöntemdir (Howell, 2012; Çilan, 2013).

Çoğu çalışma ise bir veya daha fazla yanıt değişkeni ile bir dizi açıklayıcı değişken veya faktör arasındaki ilişkiyi incelemeye yöneliktir (Agresti ve Kateri, 2011). Örneğin lojit modeller bir yanıt faktörünün tahminine odaklanırken, log-lineer modeller tüm değişkenleri simetrik olarak ele alır ve aralarındaki tüm önemli ilişkileri modellemeye çalışır. Bu anlamda, log-lineer modeller, amacın bir dizi değişken arasındaki bağımlılık ve bağımsızlık yapılarını belirlemek olduğu, sürekli değişkenlerin korelasyon analizine benzer (Friendly ve Course, 2003). Analiz edilecek kriter, araştırmadaki tüm değişkenlerin bir fonksiyonu olarak beklenen hücre frekanslarıdır (Brzezińska, 2013). Bu modeller, kategorik değişkenler arasındaki ilişki ve etkileşimleri incelemenin, kategoriler arasındaki ilişkilerin kontenjans tablolarının her bir hücresindeki frekanslara olan etkisini tanımlamanın bir yoludur. ANOVA'nın kesikli bir benzeri olarak kabul edilebilirler (Agresti ve Kateri, 2011).

Üç yönlü kontenjans tablosunun I satır, J sütun ve K tabakadan (eş değişken) oluşan $(I \times J \times K)$ sayıda hücresi vardır. X satır, Y sütun ve Z tabaka değişkeni için, düzeyler $i = 1, \cdots, I, j = 1, \cdots, J$ ve $k = 1, \cdots, K$ indisleri ile gösterilirse üç yönlü bir kontenjans tablosunun genel gösterimi Tablo 1 ile verilmiştir. n_{ijk} ilgili hücrenin gözlenen frekansıdır (Kateri, 2010).

Tablo 1. Üç Yönlü Kontenjans Tablosu

		Sütun Değişkeni Y				
Tabaka Değişkeni Z	Satır Değişkeni X	Y_1	Y_2	$\cdots$	Y_J	Toplam
Z_1	X_1	n_{111}	n_{121}	$\cdots$	n_{1J1}	n_{1+1}

	X_2	n_{211}	n_{221}		n_{2J1}	n_{2+1}
	$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
	X_I	n_{I11}	n_{I21}		n_{IJ1}	n_{I+1}
	X_1	n_{112}	n_{122}		n_{1J2}	n_{1+2}
	X_2	n_{212}	n_{222}		n_{2J2}	n_{2+2}
Z_2				$\cdots$		
	$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
	X_I	n_{I12}	n_{I22}		n_{IJ2}	n_{I+2}
$\vdots$	$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
				$\ddots$		
	X_1	n_{11K}	n_{12K}		n_{1JK}	n_{1+K}
	X_2	n_{21K}	n_{22K}		n_{2JK}	n_{2+K}
Z_K				$\cdots$		
	$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
	X_I	n_{I1K}	n_{I2K}		n_{IJK}	n_{I+K}
	Toplam	n_{+1+}	n_{+2+}		n_{+J+}	n_{+++}

Log-lineer model, kategorik değişkenler arasındaki ilişki yapısını ortaya koyan istatistiksel bir model elde etmek için kullanılan bir yöntemdir. Üç yönlü kontenjans tablosu için önerilebilecek model yapıları Tablo 2 ile verilmiştir.

Tablo 2. Log-Lineer Model Denklemleri

Model	**Model Gösterimi**	**Model Denklemi**	
M_0	(Z, X, Y)	$log(\mu_{ijk}) = \mu + \lambda^X_i + \lambda^Y_j + \lambda^Z_k$	Tam bağımsız
M_1	(Z, XY)	$log(\mu_{ijk}) = \mu + \lambda^X_i + \lambda^Y_j + \lambda^Z_k + \lambda^{XY}_{ij}$	
M_2	(X, ZY)	$log(\mu_{ijk}) = \mu + \lambda^X_i + \lambda^Y_j + \lambda^Z_k + \lambda^{YZ}_{jk}$	Kısmi bağımsız
M_3	(Y, ZX)	$log(\mu_{ijk}) = \mu + \lambda^X_i + \lambda^Y_j + \lambda^Z_k + \lambda^{XZ}_{ik}$	
M_4	(ZY, XY)	$log(\mu_{ijk}) = \mu + \lambda^X_i + \lambda^Y_j + \lambda^Z_k + \lambda^{XY}_{ij} + \lambda^{YZ}_{jk}$	
M_5	(ZX, XY)	$log(\mu_{ijk}) = \mu + \lambda^X_i + \lambda^Y_j + \lambda^Z_k + \lambda^{XY}_{ij} + \lambda^{XZ}_{ik}$	Koşullu bağımsız
M_6	(ZX, ZY)	$log(\mu_{ijk}) = \mu + \lambda^X_i + \lambda^Y_j + \lambda^Z_k + \lambda^{XZ}_{ik} + \lambda^{YZ}_{jk}$	

M_7	(ZX, ZY, XY)	$log(\mu_{ijk}) = \mu + \lambda^X_i + \lambda^Y_j + \lambda^Z_k + \lambda^{XY}_{ij} + \lambda^{XZ}_{ik} + \lambda^{YZ}_{jk}$	Homojen ilişki

Örneklem

Sari ve ark. (2022) çalışması ile pandemi döneminde (13 Nisan 2020 tarihinden 25 Kasım 2020 tarihine kadar) çevrimiçi anket formu ile toplam 2853 kişiye anket yapılmıştır. Bu çalışmada yer alan anket formu, kişisel bilgilerle ilgili (demografik) sorular (25 adet), Durum Kaygı Ölçek soruları (20 adet) ve Sıkıntıya Toleranssızlık Ölçek soruları (10 adet) olmak üzer 3 bölümden oluşmaktadır. Anket verileri 18-65 yaş ve üstü yetişkinlerden toplanmıştır ve yaşadığı yerleşim yeri (il ve kırsal-kentsel), gelir, istihdam durumu, meslek, çalıştığı sektör, aile geçmişi, çocuk sahibi olup olmama, cinsiyet ve medeni durumu kapsayan demografik değişkenler yer almaktadır.

Veri Toplama Aracı

Durumluk Sürekli Kaygı Envanteri (STAI): Kaygı düzeyini değerlendirmek amacıyla Spielberger ve ark. (1983) tarafından geliştirilmiş, Oner ve Le Compte (1985) tarafından Türkçe geçerlik ve güvenirlik çalışması yapılmış bir ölçektir. STAI, durumluk ve sürekli kaygı ile ilgili 20'şer soruluk iki alt faktörden oluşmaktadır. Tüm sorular, dörtlü Likert tipindedir. Ölçeklerde doğrudan ve tersine çevrilmiş ifadeler vardır. Durum Kaygı alt boyutu (STAI-S), bireyin belli bir anda ve belirli koşullarda kendini nasıl hissettiğini belirlemeye çalışır. Bu alt boyutta 10 tane (1,2,5,8,10,11,15,16,19 ve 20. maddeler) tersine çevrilmiş ifade vardır. Bazı sorular olumsuz duyguları, bazıları olumlu duyguları sorgulamaktadır. Olumlu duyguları yansıtan soruların cevapları tersine çevrilerek puanlanır. 20–80 arasında toplam puanlar elde edilir. Yüksek puanlar, daha yüksek kaygı düzeyini gösterir.

BULGULAR

Çalışmada yer alan katılımcıların %65,4'ü kadın, %34,6'sı ise erkektir. %43,4'ü kronik hastalığa sahip olduklarını, %56,6 sı ise kronik hastalıklarının olmadığını belirtmişlerdir. Katılımcıların STAI-S puanı $47{,}6 \pm 11{,}8$ şeklinde elde edilmiştir. Log-lineer modelller için değişkenler ve düzeyleri

Satır değişkeni X:

Durum kaygı düzeyi	1	Düşük	"50'nin altı"
	2	Yüksek	"50'nin üstü"

Sütun değişkeni Y:

Kronik hastalık durumu	1	Evet
	2	Hayır

Eş değişken (covariate) Z:

Cinsiyet	1	Kadın
	2	Erkek

şeklinde belirlenmiştir.

Tablo 3'e göre kadınların %45,7'sinin durum kaygı düzeyi yüksek kategorisinde iken, erkeklerde %27,7 olduğu görülmüştür. Cinsiyet açısından durum kaygı düzeylerinin, kadınlarda erkeklere göre daha fazla olduğu söylenebilir. Ayrıca kronik bir rahatsızlığının olmadığını belirten erkekler %63,5 iken, kadınlar %52,9 dur.

Tablo 3. Cinsiyet, Durum Kaygı Düzeyi, Kronik Hastalık Durumu Kontenjans Tablosu

Cinsiyet			Kronik Hastalık Durumu Evet	Hayır	Toplam
Kadın	Durum Kaygı Düzeyi	20-50	441	572	1013
			(23,7)	(30,7)	(54,3)
		51-80	437	414	851
			(23,4)	(22,2)	(45,7)
	Toplam		878	986	1864
			(47,1)	(52,9)	(100)
Erkek	Durum Kaygı Düzeyi	20-50	239	474	713
			(24,2)	(48,1)	(72,3)
		51-80	121	152	273
			(12,3)	(15,4)	(27,7)
	Toplam		360	626	986
			(36,5)	(63,5)	(100)

Parantez içindeki değerler yüzdelikleri göstermektedir.

Ana etkiler ve/veya etkileşim terimlerinin hangilerinin modelde olacağına karar vermek için Tablo 4 ile verilen cinsiyet, durum kaygı düzeyi ve kronik hastalığa sahip olma durumu değişkenlerine göre oluşturulan log-lineer modeller incelenmiştir.

Tablo 4. Cinsiyet (Z), Durum Kaygı Düzeyi (X), Kronik Hastalık Durumu (Y) İçin Log-Lineer Modeller

Model	**Model Gösterimi**	G^2	χ^2	**Serbestlik Derecesi**	p **değeri**
M_0	(Z, X, Y)	140,261	146,413	4	0,000
M_1	(Z, XY)	111,222	109,309	3	0,000
M_2	(X, ZY)	110,564	107,271	3	0,000
M_3	(Y, ZX)	50,838	50,324	3	0,000
M_4	(ZY, XY)	81,525	79,627	2	0,000
M_5	(ZX, XY)	21,799	21,660	2	0,000
M_6	(ZX, ZY)	21,141	21,280	2	0,000
M_7	(ZX, ZY, XY)	0,679	0,680	1	0,410

Tablo 4'ten M_7 ile verilen modelin en iyi model olduğu, modelin istatistiksel olarak anlamlı olduğu (p=0,410>0,05) görülmektedir.

Tüm ikili etkileşimler istatistiksel olarak anlamlıdır ve modelde yer almalıdır. Üç yönlü kontenjans tablosu için oluşturulan model denklemi

$$log(\mu_{ijk}) = \mu + \lambda_i^X + \lambda_j^Y + \lambda_k^Z + \lambda_{ij}^{XY} + \lambda_{ik}^{XZ} + \lambda_{jk}^{YZ}$$

şeklindedir. Bu denklem

$$\begin{aligned} log(\mu_{ijk}) = {} & Sabit + DurumKaygı_i + KronikHastalık_j + Cinsiyet_k \\ & + DurumKaygı_i \times KronikHastalık_j + DurumKaygı_i \times Cinsiyet_k \\ & + KronikHastalık_j \times Cinsiyet_k \end{aligned}$$

olarak da ifade edilebilir. Modelin standardize edilmiş artıkları incelendiğinde minimum değerin -0,38 ve maksimum değerin 0,44 olduğu, hiçbirinin 2 veya 3'ü aşmadığı (Çilan, 2013), modelin uygun olduğu görülür.

Üç yönlü kontenjans tablosu için en uygun modelin kaçıncı dereceden etkileşim terimlerini içerdiğini belirlemek amacıyla yapılan hiyerarşik test sonuçları Tablo 5 ile verilmiştir. Tablo 5'e göre bir yönlü ve daha yüksek dereceli etkiler önemsizdir şeklinde oluşturulan sıfır hipotezi (p =0,000<0,05) red edilir. İki yönlü ve üç yönlü etkileşimler önemsizdir şeklinde oluşturulan sıfır hipotezi (p =0,000<0,05) red edilir. Üç yönlü etkileşimler önemsizdir şeklinde oluşturulan sıfır hipotezi (p =0,410>0,05) red edilemez. Benzer yorumlar K-yönlü etkiler bölümü için de yapılabilir. Buna göre ana etkiler ve iki yönlü etkileşimler istatistiksel açıdan anlamlıdır.

Tablo 5. Cinsiyet (Z), Durum Kaygı Düzeyi (X), Kronik Hastalık Durumu (Y) İçin K-yönlü ve Daha Yüksek Dereceli Etkiler

			Olabilirlik Oranı		**Pearson**	
	K	**SD**	χ^2	***p* değeri**	χ^2	***p* değeri**
K-yönlü ve daha yüksek dereceli etkiler	1	7	592,540	0,000	528,448	0,000
	2	4	140,261	0,000	146,413	0,000
	3	1	0,679	0,410	0,680	0,410
K-yönlü etkiler	1	3	452,279	0,000	382,035	0,000
	2	3	139,582	0,000	145,733	0,000
	3	1	,679	0,410	0,680	0,410

Tablo 6. Cinsiyet (Z), Durum Kaygı Düzeyi (X), Kronik Hastalık Durumu (Y) İçin Kısmi İlişki Testi

		Kısmi İlişki	
Etki	**SD**	χ^2	***p* değeri**
Cinsiyet× KronikHastalık	1	21,120	0,000
Cinsiyet×DurumKaygı	1	80,846	0,000
KronikHastalık ×DurumKaygı	1	20,461	0,000
Cinsiyet	1	274,935	0,000
KronikHastalık	1	49,221	0,000
DurumKaygı	1	128,122	0,000

İkinci dereceden etkileşim terimlerinin önemi belirlendikten sonra, Tablo 6 ile de tüm ana etkiler ve ikili etkileşimlerin modelde olması gerektiği görülmektedir.

Tablo 7 ile en iyi modelin parametre tahminleri verilmiştir. p=0,225>0,05 olan etkileşim teriminin modele katkısı istatistiksel olarak anlamlı değildir. İstatistiksel olarak anlamlı olan diğer etkileşim terimleri için ise kronik hastalık durumu ne olursa olsun, erkeklerde durum kaygı düzeyinin düşük olma olasılığı, durum

kaygı düzeyi yüksek olan erkeklere göre 3 kat daha fazladır. Kadınlarda ise düşük durum kaygı düzeyinin olması olasılığı, yüksek düzeyli kadınlara göre 3,7 kat daha fazladır. Kadınlarda yüksek durum kaygı düzeyine sahip olma olasılığı, düşük durum kaygı düzeyine sahip erkeklere göre 2,6 kat daha fazladır. Kronik hastalığa sahip olmayan bireylerin durum kaygı düzeyinin düşük olma olasığı, kronik hastalığa sahip durum kaygı düzeyinin düşük olma olasığına göre 1,4 kat fazladır.

Tablo 7. Cinsiyet (Z), Durum Kaygı Düzeyi (X), Kronik Hastalık Durumu (Y) İçin Parametre Tahminleri

					95% Güven Aralığı	
Parametre	**Tahmin**	**Std. Hata**	**z**	***p* değeri**	**Alt Sınır**	**Üst Sınır**
Sabit	5,055	,071	71,341	,000	4,916	5,194
[Cinsiyet = 1,00] × [DurumKaygı = 1,00]	1,303	,086	15,151	,000	1,134	1,471
[Cinsiyet = 1,00] × [DurumKaygı = 2,00]	,960	,079	12,163	,000	,805	1,114
[Cinsiyet = 2,00] × [DurumKaygı = 1,00]	1,096	,078	14,047	,000	,943	1,249
Tablo 7. Devamı						
[Cinsiyet = 2,00] × [DurumKaygı = 2,00]	0a	.	.	.	.	.
[Cinsiyet = 1,00] × [KronikHastalık = 1]	,076	,063	1,214	,225	-,047	,200
[Cinsiyet = 1,00] × [KronikHastalık = 2]	0a	.	.	.	.	.
[Cinsiyet = 2,00] × [KronikHastalık = 1]	-,299	,087	-3,457	,001	-,469	-,130
[Cinsiyet = 2,00] × [KronikHastalık = 2]	0a	.	.	.	.	.
[DurumKaygı= 1,00] × [KronikHastalık = 1]	-,356	,079	-4,523	,000	-,510	-,202
[DurumKaygı= 1,00] × [KronikHastalık = 2]	0a	.	.	.	.	.
[DurumKaygı= 2,00] × [KronikHastalık = 1]	0a	.	.	.	.	.
[DurumKaygı = 2,00] × [KronikHastalık = 2]	0a	.	.	.	.	.

SONUÇ

İnsanın varoluşundan beri, üzerinde stres yarattığı tehlikeye, uyarana karşı gösterdiği en temel tepkilerden birisi kaygıdır. Kişide hoş olmayan bir duygu durumu yaratır, uyarılmışlık seviyesini artırır. Belirli bir durum karşısında hissedilen kaygı, durumluk kaygı olarak adlandırılır. Küresel olarak bir anda tüm insanlığı tehdit eden ve çözümü için tüm dünyanın büyük mücadele verdiği Covid-19 pandemisi, ülkelerin uyguladığı önleyici politikaların birbirinden farklılık göstermesinden kaynaklı olarak toplumlar üzerinde farklı etkilere yol açmıştır.

Bu çalışmada pandemi dönemi için insanlarda oluşan durum kaygısının incelenmesi hedeflenmiştir. Bunun için kategorik veri analizinden yararlanılmıştır. Kişinin cinsiyeti, durum kaygı düzeyi ve kronik hastalığa sahip olma durumu değişkenleri ele alınarak üç yönlü kontenjans tablosunun log-lineer model ile analizi yapılmıştır. Kategorik olarak ele alınan değişkenler arasındaki etkileşimlerin araştırılması uygulamalı olarak verilmiştir.

Elde edilen bulgulara göre iki yönlü etkileşimleri içeren homojen ilişki modeline uyum sağlandığı görülmüştür. Hiyerarşik modeller, kısmi ilişki testleri ile sonuçlar desteklenmiştir. Kadınlarda durum kaygı düzeyinin erkeklere kıyasla daha fazla olmasının beklendiği görülmüştür.

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Çıkar çatışması

Yazarlar herhangi bir çıkar çatışması yoktur.

Yazar Katkıları

Yazarların çalışmaya katkıları eşit oranda olmuştur.

Some Approaches in Functional Data Analysis and Paradoxical Perspectives on Structures

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Abstract

Due to its functional data analysis structure, it is available for some data types. The explanatory variable space defined by the created differential structure naturally defines the statistical model. Similarly, the differential properties provided by the explanatory variables define the differential nature of the event. In this study, we will touch on some structures that can be used in functional data analysis. The use of similar functional structures interchangeably forms the basis of our study.

Key words: *Functional Data Analysis, Kernel Estimator, Bernstein Polynomial*

Uygun Küme Sayısının Belirlenmesi ve Kümelemenin Değerlendirilmesinde Kullanılan İndeks ve İstatistiklerin Karşılaştırılması

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Özet

Bölümlemeli kümeleme algoritmaları genel olarak dört aşamayı takip eder: Kümelemeye uygunluğun incelenmesi, en iyi küme sayısına karar verilmesi, kümelerin elde edilmesi ve elde edilen kümelemenin değerlendirilmesi. Bu aşamalarda uygun küme sayısının belirlenmesi ve dolayısıyla elde edilen kümelemenin geçerliliğinin sınanması çeşitli istatistiksel ölçütler ve indeksler kullanılarak yapılabilmektedir. Küme sayısının başlangıçta bilinmediği denetimsiz öğrenme algoritmalarından olan bölümlemeli kümeleme yöntemlerinde bu istatistik ve indekslerin seçimi önem kazanmaktadır. Bu çalışmada, k-means ve k-medoids algoritmalarıyla bir örnek veri setinde R paketleri kullanılarak kümeleme uygulaması yapılmış ve elde edilen bulgular üzerinden hesaplanan indeks ve istatistikler karşılaştırılmıştır. Sonuçlar, uygun küme sayısı ve kümeleme yapısının belirlenmesinde indekslerin araştırmacılara kolaylık sağladığını ancak farklı alternatifler incelenerek karar verilmesi gerektiğini göstermektedir.

Anahtar kelimeler: *Bölümlemeli Kümeleme, K-Means, K-Medoids, Denetimsiz Öğrenme*

Forecasting Consumer Price Index With ARIMA, Prophet And Xgboost: A Comparative Analysis

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Abstract

Consumer Price Index (CPI) is a widely used measure to reflect the changes in the average cost of living in a particular country. In Albania, the CPI serves as the primary indicator of inflation and is divided into 12 main groups, including food, housing, and medical care, education, transporta-tion and other services. In this study, we investigate the effectiveness of machine learning and conventional models in predicting CPI time-series data, for total CPI and each of its 12 groups. We compare the performance of ARIMA models, with Prophet, and ARIMA and Prophet models combined with XGBOOST algorithms. Our results show that while ARIMA models are straight-forward to use, they demonstrate inadequate performance in forecasting CPI time-series data. In contrast, Prophet and Prophet Boosted exhibit higher accuracy and require less tuning time. According to empirical data, Albania's CPI will continue to increase for the following 36 months. This study highlights the importance of model selection for accurate and reliable CPI forecasting and emphasizes the potential of machine learning models in forecasting accuracy. The findings of this study can contribute to the development of more accurate and reliable forecasting models and provide policymakers with more comprehensive insights into economic stability and well-being.

Key words: *Consumer Price Index, Statistical, Time-Series, Forecasting, Machine Learning*

INTRODUCTION

In economic terms, the practice of consistently raising prices for both products and services over a given period of time is known as inflation, and it has a substantial impact on a nation's economy. Inflation is assessed using a price index (Nopirin, 1987). The Consumer Pricing Index (CPI) is one of the most widely used price indices to measure inflation. By calculating the purchasing power of a single unit of currency, the CPI aims to quantify and measure the average cost of living in a particular nation. Consequently, it serves as the primary macroeconomic indicator for determining inflation (or deflation). As a result, the CPI has a significant impact on a wide range of market dynamics and is a key economic driver. Inflation can be viewed as advantageous under certain circumstances, but it can also be viewed negatively. However, inflation generally has the potential to cause economic instability, a failure to further development, as well as poorer standards of living and welfare. The base year used to calculate the CPI is used to compare prices from one month to the next. Both policymakers and market participants are keenly interested in having a reliable forecast of the impending disaggregated inflation rate. A crucial instrument for changing monetary policies globally is inflation forecasting (Friedman, 1961). To support interest rate decisions and to manage and keep inflation around its goal, central banks forecast future inflation trends. Statistical analysis can be used to forecast monthly CPI values for the upcoming few periods.

While inflation has generally become easier to forecast in recent decades, this is primarily due to the lower overall variability of inflation as evidenced by lower out-of-sample mean square errors across a variety of univariate and multivariate models. At the same time, it has become more challenging to successfully include data other than inflation itself in order to provide projections that outperform basic benchmark models, see (Atkeson and Ohanian, 2001; Stock and Watson, 2007). The question of whether forecast

combining can enhance inflation projections is explored in another area of the literature. In some circumstances, it has been demonstrated that combining many forecasts for the same variable outperforms the best single estimate, by Hendry and Clements (2004). The hybrid specification of the New Keynesian Phillips curve and its empirical performance in the Euro Region are examined in (Paloviita, 2006). The findings imply that the European inflation process can be described using the forward-looking New Keynesian Phillips curve once the rational expectations hypothesis is relaxed and directly measured expectations are used.

Time-series forecasting has historically received a lot of attention in data science and has numerous useful applications. In general, the ARIMA (auto regressive integrated moving average) model is used to forecast economic data, such as CPI, see (Wigati et al., 2015; Mohamed, 2020). In their study, Du et al., (2014), proposed a novel divide-and-conquer model approach by combining ARIMA (for global trend), Gray prediction model (for partial, seasonal trend) and back propagation neural network (BPNN) model (for predicting residual sequence) to predict the national Consumer Price Index (CPI) and eight sub-indexes of CPI. Espasa and Senra (2017), experienced forecasters over 22 years at the Bulletin of EU & US Inflation and Macroeconomic Analysis, use a methodology that take account of series' heterogeneity, to evaluate inflation and inflation uncertainty. The authors evaluate the accuracy of their own forecasts for the Euro Area, the US and Spain, show the suitability of the methods they used, and also give a review on sophisticated alternatives to the measurement of real time uncertainty and risk in inflation. A functional coefficient autoregressive (FAR) model, which permits the coefficient to fluctuate over time, to study the issue of forecasting China's inflation rate is used in (Wang et al., 2012). By using comprehensive simulation experiments, they contrast the FAR model, which is based on the B-splines estimate approach, with the autoregressive moving average (ARMA) model. In (Purbasari et al., 2021), authors compare the ARIMA and Artificial Neural Network (ANN) methods on forecasting consumer price index(CPI). The study makes use of CPI data from Statistics Indonesia (BPS) for the period of 2015 to 2020. The experiment result showed that the ANN method outperforms the ARIMA method in terms of forecasting accuracy. The potential of using coffee as an identifier of inflation in selected US agglomerations is explored by (Vochozka et al., 2023). They do this by analysing time-series data on coffee prices and corresponding inflation rates in these agglomerations. They demonstrated that in most of the cities it is possible to use coffee to forecast inflation. In (Shinkarenko et al., 2021), authors examine the use of time series models for forecasting the Consumer Price Index using CPI data in Ukraine from 2010 to 2020. They compared the performance of ARIMA, Holt-Winters, and the hybrid Sarima-Garch models in terms of forecast accuracy. A holistic approach for predicting inflation using a structural model to captures simultaneous equations and relationships between macroeconomic variables like prices levels, interest rates, wages and others is performed by (Avdiu and Unger, 2022). They tested their approach on US data and concluded that the model has good performance for forecasting inflation. Authors in (Jiang et al., 2022) used time series data to analyse construction cost index (CCI) and investment planning. Using the Holt Model, the study anticipates CCI and calculates R-squared coefficients and mean average percentage errors. The findings show the global trend in transportation delays as well as the current state of the building industry. The results of this study also comprise the variables that were chosen based on the literature evaluation, as well as the variables' affecting elements, market trends, and accurate prediction models. The most precise prediction model is ARIMA model.

The use of well-known, conventional econometric approaches does not necessarily work well for the study and forecasting of huge, noisy time-series data. This has raised interest in data-driven procedures, particularly machine learning techniques, which support a number of methodologies and have the advantage of not relying on prior assumptions and data expertise. The literature has demonstrated that models using machine learning perform better than models using statistical and economic data (Hsu et al., 2016; Patel et al.,2015). Machine learning approaches have the ability to recognize the underlying patterns of time-series data and do not require the confirmation of distributional assumptions, which is a major advantage. Additionally, machine learning models' decreased variance and increased prediction accuracy

have increased their popularity in inflation prediction. Wang et al., (2018) propose a novel methodology for predicting the consumer price index (CPI) using a support vector regression (SVR) model. The study involves in construction of Financial Conditions Index (FCI) due to the fact that CPI is affected by multiple financial factors such as interest rates, stock prices, etc. The performance of the proposed SVR model is evaluated with CPI data collected in China between 2006 and 2011 and performs best among the other methods they have also tested. Pincheira and Medel (2012), show that when a stationary variable is forecasted using forecasts based on drift less unit-root processes, bounded mean squared prediction errors are produced at every single horizon. Additionally, they offer an empirical example of their conclusions in the context of forecasts for the consumer price index for six industrialized economies. The use of various alternative methods including Artificial Neural Networks, Random Forests, and Gradient Boosting, two variants of K-nearest neighbors algorithm and a long short-term memory (LSTM) model, to forecast inflation in Costa Rica is explored in (Rodríguez-Vargas, 2020). They discovered that the forecasts from the LSTM model, univariate KNN, random forests and severe gradient boosting, have the best performance. At all-time horizons, a combination of forecasts outperforms a single forecast while, more importantly, outperforming projections derived from univariate approaches. The performance and accuracy of different forecasting models — Prophet, Long Short-Term Memory (LSTM), Convolutional Neural Networks (CNN) with ARIMA models— in predicting wholesale food prices is compared in (Menculini et al., 2021). The authors used weekly wholesale food prices data from Italy collected between 2005 and 2019, use Prophet, a deep learning model, and ARIMA to each one generate a forecast, and then compared the forecast accuracy of different models. The combination of CNNs and LSTMs, according to their findings, produces the most accurate results, but tweaking it takes the longest and is computationally more expensive. In contrast, while Prophet's performances weren't exceptionally strong, model development and data preparation went rather quickly. The performance of various forecasting models to predict US inflation in real time, more specifically the Personal Consumption Expenditure Index (PCE) deflator is evaluate by (Fulton and Hubrich, 2021). The authors consider traditional econometric approaches time and factor models. They compared the performance of these models with a machine learning-based approach with LASSO and Random forest, and found that their models performed similarly relative to each other in terms of forecast accuracy. Soybilgen and Yazgan (2021), propose an approach that combines tree-based ensemble models and dynamic factor models to now cast US GDP. They use real-time data from major macroeconomic indicators to train and test their models. They found that their models performed better than benchmark models in terms of forecast accuracy. Indicators of inflation forecasting using lasso regression, random forests, and deep neural networks were compared by (Medeiros et al., 2019). In their study (Xiao and Su, 2022) aiming to research on prediction of stock prices makes use of a hybrid model that combines deep learning and the autoregressive integrated moving average (ARIMA) model for time-series forecasting. In this model linearity is filtered out in ARIMA modelling, and nonlinear trends are predicted in LSTM recursive neural networks. The authors evaluated the performance of the proposed model using daily stock prices from Chinese major stock indexes from 2010 to 2020, the result showed the hybrid model exceed the performance of other models. Authors in (Gjika et al., 2018; Gjika et al., 2020), model the Albanian CPI indices using multivariate methods combined with time series forecasting models, while (Gjika et al., 2016), looked at Albania's economic growth and its connections consumer price index (CPI), unemployment rate, inflation, and life expectancy.

The Consumer Price Index (CPI) is the official measure of inflation in Albania. The Index measures the relative changes in the prices of goods and services used by households for personal consumption and is calculated using the final consumption structure of Albanian households. The base period is now December 2020 (December 2020=100). The main source of information on expenditure is the Household Budget Survey. The first official Consumer Price Index was calculated in December 1991 having the based period December 1990. In 2007 the basket of items was updated based on the results of Household Budget Survey realized during September 2006 to October 2007. From January 2016 the CPI calculation is based on the new basket of items, whose weights are based on the Households Budget Survey. The international

ECOICOP classification of consumer goods and services is used to organize the list of items for consumption. Based on this classification the expenditures are classified in 12 main groups such as: Food and non-alcoholic beverage; Alcoholic beverages and tobacco; Clothing and footwear; Housing, water, electricity gas and other fuel; Furniture household and maintenance; Medical care; Transportation; Communication; Recreation and culture; Education; Hotels, coffee-house and restaurant; Other goods and service, see INSTAT.

In this study, we compare the performance of standard Seasonal Autoregressive Integrated Moving Average (SARIMA) models, which we use as a benchmark, to Boosted ARIMA, as a way to produce a specification of a time series model that uses boosting to improve modelling errors, to Prophet—a forecasting tool created by Facebook and based on a Generative Additive Model—and to Prophet Boost algorithm, which combines Prophet with XGBoost. The primary objective of the study was to examine the efficacy of ARIMA models, which are classical time series models, and Prophet, a newer time series forecasting method, in modelling and predicting the Consumer Price Index (CPI) in Albania from January 2007 to December 2022. Given the seasonal patterns of this economic indicator, the study aimed to assess the accuracy of these models, which are commonly used by econometricians. The study sought to determine which model could provide the most reliable and accurate forecasts for CPI, and therefore provide a useful tool for economists and policymakers seeking to make informed decisions based on these forecasts. Based on the performance of each model, the best model has been chosen to forecast the CPI in Albania for the next three years. This work has also been carried out for the 12 main CPI groups in Albania. The comparison is interesting because the models under comparison are quite distinct, as are the datasets they accept as input; yet, they also call for some data pre-processing. Our findings show that the Prophet Boost requires the shortest tuning and also produces the best accurate results. Contrarily, although model tweaking and data preparation were fast, ARIMA and Boosted ARIMA's performances weren't very strong. Prophet performed well in terms of accuracy and the amount of time needed for model selection and training. The research was designed to contribute to the ongoing effort to improve the accuracy of economic forecasts and to advance our understanding of the strengths and weaknesses of different time series forecasting methods.

The rest of the paper proceeds as follows. Section 2 explains models methodologies; we give a brief introduction of the four models mentioned above. In Section 3, we present our data and results. Finally, we conclude in Section 4 by discussing potential implications of the current research and several future directions.

MATERIAL AND METHODS

SARIMA, Prophet and XGboost models are popular and powerful techniques for forecasting time series data, such as CPI or inflation data. Each of these models has its own strengths and weaknesses, and may be more or less effective for different types of CPI or inflation data. To achieve a more accurate forecast, we consider using a combination of these models, such as Boosted SARIMA and Prophet Boost.

Seasonal Autoregressive Integrated Moving Average (SARIMA)

Seasonal Autoregressive Integrated Moving Average (SARIMA) is a statistical model that can capture and analyze complex time series patterns, including trend, seasonality, and noise. It is a linear model which can accurately estimate the present and future values of the time series based on past observations, see (Box et al., 2015; James et al., 2013). This model is an extension to ARIMA that supports the direct modeling of the seasonal component of the series. The seasonal ARIMA model, SARIMA (p, d, q) (P, D, Q) m, incorporates both non-seasonal (p, d, q) and seasonal factors (P, D, Q) in a multiplicative model. With p = non-seasonal Auto Regressive order, d = non-seasonal differencing, q = non-seasonal Moving Average order, P = seasonal Auto Regressive order, D = seasonal differencing, Q = seasonal Moving Average order, and m = time span of repeating seasonal pattern. The seasonal part of the model is made up of terms

that resemble its non-seasonal parts but also involve backshifts in the seasonal period. According to Clarke and Clarke (2018), the non-seasonal ARIMA (p, d, q) model can be mathematically represented as follows:

$$\Delta^{d}_{x_t} = \varphi_{\phi 1}\Delta^{d}_{x_{t-1}} + \cdots \varphi_{p}\Delta^{d}_{x_{t-p}} + \gamma_1\varepsilon_{t-1} + \cdots \gamma_q\varepsilon_{t-q} + \varepsilon_t \quad (1)$$

where Δ_d is the differential operator, x_t are the terms of the time series, φ is the coefficient for each parameter p and q, γ is the coefficient for each parameter q, and ε_t is a white noise process with zero mean and the variance of σ^2.

The seasonal SARIMA (p, d, q) (P, D, Q) m model can be written as follows:

$$\varphi_p(B)\Phi_p(B^m)(1-B)^d(1-B^m)^D X_t = \theta_q(B)\Theta_q(B^m)\varepsilon_t \quad (2)$$

where

$$\varphi_p(B) = (1 - \varphi_1 B - \cdots \varphi_p B^p)$$
$$\theta_q(B) = (1 - \theta_1 B - \cdots \theta_q B^q)$$
$$\Phi_P(B)^m = (1 - \Phi_1 B^m - \cdots \Phi_P B^{mP}) \quad (3)$$
$$\Theta_Q(B^m) = (1 - \Theta_1 B^m - \cdots \Theta_Q B^{mQ})$$

B is the backward shift operator, φ (.), Φ (.), θ (.), and Θ(.) are polynomials of degree p, q, P and Q,

Focus only on the seasonal lags while choosing the proper seasonal orders for a seasonal ARIMA model. The modeling process is much the same as for non-seasonal data, with the exception that we must choose seasonal AR and MA terms in addition to the non-seasonal model components.

Prophet

Prophet is a forecasting model developed by Facebook in 2018, it is a flexible additive regression model that allows for forecasting with seasonality, holidays, and trend components. Prophet can account for missing data and data points that don't evenly spaced in time. It performs best for datasets with strong seasonal effects (Taylor and Letham, 2018). It stands out due to its fully autonomous forecasting process and flexible parameter value selection that may be changed without being aware of the specifics of the base model. Prophet is unaffected by incomplete data and shifting trends. It often handles outliers effectively. The Python and R environments both make the model implementation available to the general audience. Prophet is an additive model with three parts: a component for holidays, a seasonality component, and a non-linear trend component:

$$y(t) = a(t) + s(t) + h(t) + \varepsilon_t \quad (4)$$

where ε_t is a residual component with a normal distribution, *s(t)* reflects seasonal variations (such as weekly and annual seasonality), *h(t)* represents holiday impacts, and *a(t)* is a trend function simulating non-periodic changes in the value of the time series. If not expressly given, the knots (or change points) for the piecewise-linear trend are chosen automatically. To place an upper bound on the trend, a logistic function is one option. The appropriate Fourier terms of the relevant periods make up the seasonal component. Simple dummy variables are added as holiday effects. In order to enable the automatic selection of the change points and other model properties, the model is estimated using a Bayesian methodology.

The growth function models have three main options: Linear Growth; Logistic Growth; and Flat (Hastie and Tibshirani, 1986). When logistic growth is used, the growth term will resemble a conventional logistic curve equation, with the exception that the carrying capacity (C), growth rate (k), and offset (m) are all variable and will change value at each change point:

$$a(t) = \frac{C(t)}{1 + x^{-k(t-m)}} \tag{5}$$

The seasonality function is a Fourier Series as a function of time:

$$s(t) = \sum_{n=1}^{N} (a_n \cos(\frac{2\pi nt}{P}) + b_n \sin(\frac{2\pi nt}{P})) \tag{6}$$

where P is the length of the seasonal cycle, and a_n and b_n are the coefficients (Taylor and Letham, 2018). In the present study, we have also explored ensemble machine learning models.

XGboost

XGboost is a tree-based model, it is a boosting algorithm, which can combine multiple weak models into a larger ensemble model. This can be particularly useful for nonlinear, high-dimensional data, which has a different way to model nonlinear relationships between the target and the predictors. The Gradient Boosting model has been improved by the XGBoost algorithm. The approach minimizes the computing cost while attempting to reduce the issue of over-fitting. The predictive and regularization terms are combined into a single objective function without slowing down computation. The residuals are delivered to the second learner in order to address the error of the weaker ones after the whole input data are given to the first learner. The ultimate forecast is created by adding up all of the learners' predictions, see (Chen and Guestrin, 2016). The following equation is used by the XGBoost model to determine its level of quality:

$$obj(t) = \sum_{k=1}^{n} l(y_{predicted}, y_{actual}) + \sum_{k=1}^{n} \wp(p_i) \tag{7}$$

where $l(y_{predicted}, y_{actual})$ is the training loss, which measures how well the model matches the training set of data, and $\wp(p_i)$ is the regularization factor measuring the complexity of the trees, and n is the total samples. The forecasting function at step t works like this:

$$p_i(t) = \sum_{k=1}^{t} p_k(x_i) = p_i(t-1) + p_t(x_i) \tag{8}$$

x_i is the input variable, where the learner is presented as $p_t(x_i)$, the predictions at step $t-1$ are represented $p_i(t)$ and $p_i(t-1)$ and $\wp(p)$ can be written as:

$$\wp(p) > \alpha T + \frac{1}{2}\beta\|\omega\|^2 \tag{9}$$

where ω is the score-vectors at the leaf nodes, α is the lowest loss for dividing a node, and β is the control parameter for regularization. The algorithm cycles back and forth. It tests the existing models on a validation set in the initial stage, adds a new model to increase prediction accuracy, tests the new model along with the existing models again on a validation set, and repeats this cycle until an ideal ensemble method is found.

"Boosted" ARIMA: is a way to generate a specification of a time series model that uses boosting to improve modelling errors (residuals) on Exogenous Regressors. The fitting process becomes more complex when gradient boosting is added to ARIMA models, although accuracy can be increased if new parameters are optimized for each iteration of boosting.

The Boosted PROPHET algorithm: To achieve the best of both worlds—Prophet Automation and Machine Learning—the Prophet Boost algorithm combines Prophet with XGBoost. The method first uses Prophet to model the univariate series. After that, the Prophet Residuals are regressed using the regressors from the pre-processing recipe and the XGBoost model. The regularized formalization to control over-fitting is what gives the *Prophet Boost algorithm* model its higher performance.

To evaluate the effectiveness of the models, a variety of error metrics including mean absolute error (MAE), mean absolute scaled error (MASE), mean absolute percentage error (MAPE), and root-mean-square-error (RMSE) have been utilized.

RESULTS

Dataset Description and Preparation

For the study conducted in this paper, we decided to focus on the Consumer Price Index (CPI) in Albania, for the period January 2007 to December 2022. The monthly CPI data including *total CPI (Gr.0)* and 12 main groups such as: *Food and non-alcoholic beverage (Gr.1); Alcoholic beverages and tobacco (Gr.2); Clothing and footwear (Gr.3); Housing, water, electricity gas and other fuel (Gr.4); Furniture household and maintenance (Gr.5); Medical care (Gr.6); Transportation (Gr.7); Communication (Gr.8); Recreation and culture (Gr.9); Education (Gr.10); Hotels, coffee-house and restaurant (Gr.11); Other goods and service (Gr.12);* are collected from the official website of Institute of Statistics, INSTAT. A preliminary data analysis revealed that the dataset did not contain missing values. Additionally, time series anomaly identification, an analysis for the examination of the series components, the stationarity properties of the time series and descriptive statistics of the data have all been provided. We then split the data in two sets, the first 80% is used for model training, and the 20% is used for model prediction. The decision to treat the modelling as 80-20 was taken after the discussion on the lack of data available. And since we dealt with monthly time series the references suggested the split of the data in a training and testing. Another possible approach would be using rolling forecasts, which fix the horizon for the test set prediction and use an expanding set of training data as more data become available. We decided to use the first option since the Prophet time series forecasting algorithm incorporates the concept of rolling forecasts. In fact, the algorithm implements a method known as cross-validation, which is a variant of rolling forecasts. By using this approach, the algorithm is able to test the performance of the model on different periods of the test set while using an expanding set of training data as more data become available. This helps to provide a more accurate assessment of the model's performance and allows for the selection of the best prediction model. After organizing the data, we built the seasonal ARIMA, Prophet, Boosted ARIMA and Prophet Boost, for total CPI and each of 12 main groups time series.

Model Results for total CPI

First we studied total CPI time series, for the period January 2007 to December 2022, monthly data. The Consumer Price Index in December 2022 reached 111.4 against December 2020, Figure 1. Year 2022, and especially September and October had the biggest monthly change in the CPI in Albania. The annual change of the CPI in September 2022 is 8.1%, a year ago this change was 2.5%.

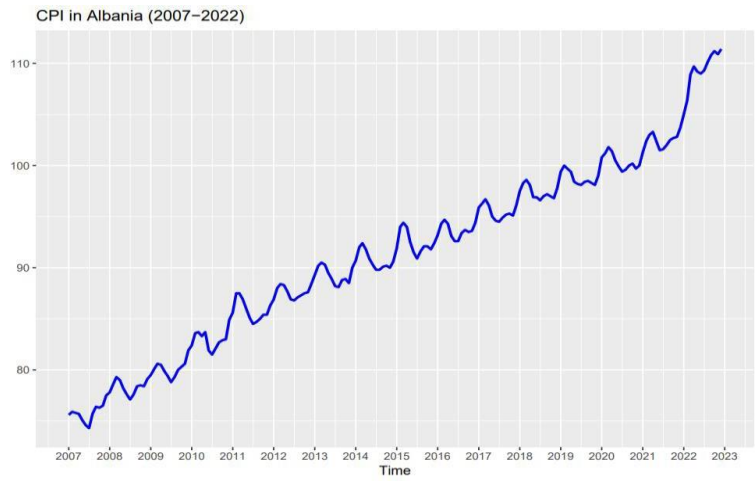


Figure 1. Consumer Price Index in Albania from January 2007 to December 2022

The monthly change of CPI in September 2022, compared to August 2022, is 0.6%. The annual change of CPI in October 2022 is 8.3%, and in December 2022 is 7.4%, a year ago this change was 3.7%. The monthly change of the Consumer Price Index in December 2022, compared to November 2022, is 0.4%. Average annual price growth in 2022 is 6.7% from 2.0% in 2021. The CPI in Albania, has its lowest value on July 2007, with a value equal to 74.3, and its larges value on December 2022, with a value equal to 111.4. From January 2007 to December 2022, the CPI in Albania has changed with 37.1.

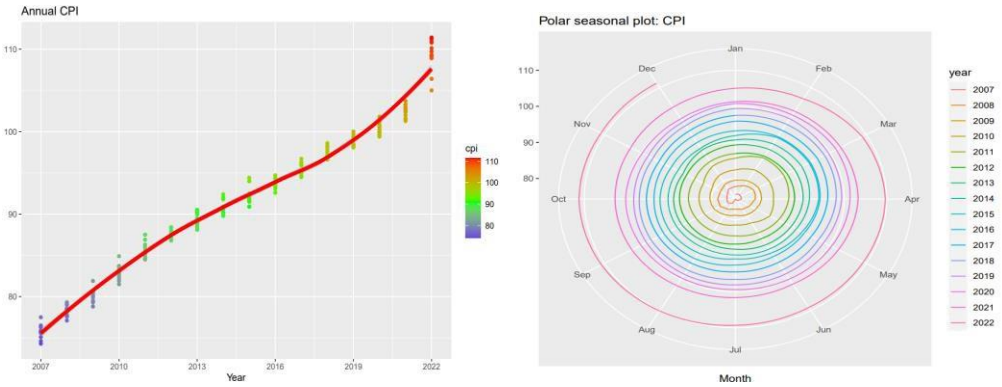


Figure 2. (a) Annual CPI and (b) Seasonal plot

From the seasonal plot and time series graph we can see that the CPI in Albania has a linear trend, and a seasonality with 12 months. Figure 2(a) enables us to evaluate the annual cycles' shape similarity over time and discover their distinguishing characteristics. The forms of the annual cycles are comparable even though the amplitude of the yearly oscillations decreased in succeeding years. In comparison to other months, December's CPI is higher. In July, the CPI is seen to be understated. The seasonal graph can be compiled in polar coordinates, Figure 2(b).

Results of SARIMA and Boosted ARIMA model

In this phase of the work, we compare the performance of Seasonal Autoregressive Integrated Moving Average (SARIMA), Boosted SARIMA, Prophet and Prophet Boost models. For the analysis we have used R/RStudio software. Since the time series represents trend and seasonality, Figure 1, the first proposed model is SARIMA. We found that the best-performing SARIMA model is SARIMA (0,1,0) (1,1,2) [12]. The maximum likelihood estimation method was used to estimate the model parameters, shown in Table 1.

Table 1. Parameter estimation of the SARIMA model for total CPI

	sar1	**sma1**	**sma2**
coefficients	-0.3070	-0.1974	-0.2564
s.e.	0.6521	0.6468	0.3353
accuracy	AIC=120.39	BIC=132.16	

The next stage is to assess the diagnostic checking of the model after it has been estimated. The models were selected by using a least AIC and BIC criterion. The Ljung-Box test, see (Box and Pierce, 1970; Ljung and Box, 1978), reveals non-significant residual probability values (p = 0.7255), which is consistent with the diagnostic examination of residuals' conclusion that they are white noise (Figure 3).

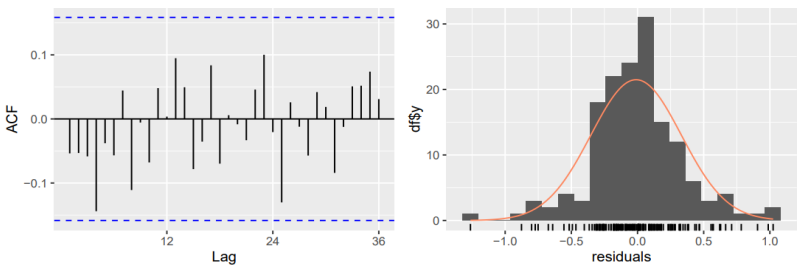


Figure 3. Residuals for the chosen SARIMA model.

The fitting process becomes more complex when gradient boosting is added to ARIMA models, so we have used Boosted ARIMA models. The best boosted ARIMA model is ARIMA (1,1,1) (0,1,1) [12] w/ XGBoost Errors, with the coefficients given in Table 2.

Table 2. Parameter estimation of the Boosted ARIMA model for total CPI

	ar1	ma1	sma1
coefficients	0.7706	-0.9133	-0.5301
s.e.	0.0952	0.0603	0.0901
accuracy	AIC=115.07	BIC=126.80	

From the accuracy of the model, we can see that the model is more suitable compared to the SARIMA model.

Results of Prophet and Prophet boost model

To ensure that the Prophet model best fits the data, we adjust the trend change points prior scale and seasonality prior scale hyper parameters. The CPI for the upcoming months was first forecasted by fitting the model over the training dataset. The squared difference between expected and observed values was calculated. Finally, using both the first data point from the validation set and the second data point, we ran a new fit and forecasted the CPI for the upcoming months. Up until the validation dataset was finished, the entire process was repeated, and the RMSE was determined. In other words, this approach is nothing more than a cross validation that begins with fitting the entire training dataset—predicting the values of the series for the next time step—and concludes with fitting the full training plus validation dataset.

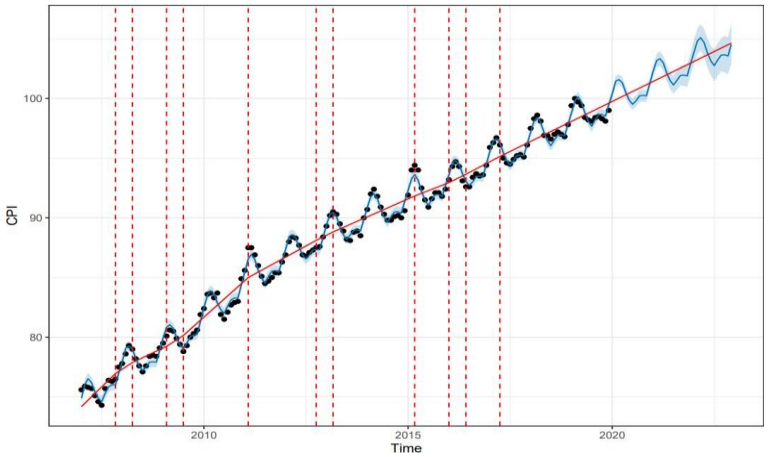


Figure 4. Prophet fit over the entire dataset for total CPI.

In Figure 4, the actual fit is shown in light blue, the red line shows the trend function, while trend change points are indicated by red dashed vertical lines. The Prophet model was specified in the test phase using the parameter's best values, which we had already chosen. Testing was conducted as follows: first, the model was fitted to the whole training plus validation dataset, followed by the prediction of the first data entry in the test dataset and calculation of the squared error. We carried out the process again for each entry

in the test dataset, utilizing all prior data, and at the conclusion we calculated the attained RMSE (along with the other metrics). The results of the total CPI fit for the complete dataset are shown in Figure 4 on a graph.

By using more efficient parallel computing and optimized techniques, XGBoost can strengthen the weaker learner. Gradient boosting machine framework has been enhanced by XGBoost through system optimization and algorithmic improvements. The results obtained from the Prophet Boost model for our data show that the most suitable model is the additive model, with linear growth and number of change points: 25. Adjusts the flexibility of the trend component by limiting change point range to 80% of data before the end of the time series.

Result Comparison and Prediction

Now that different models have been tried, we may compare the outcomes that have been found. Putting the outcomes in Table 3 together allows for a comparison to be made. As done for all the models, besides the RMSE parameter used in the fine tuning, we also report values for the MAE and MAPE, MASE, for testing set.

Table 3. Performance of the models for total CPI

MODEL	MAE	MAPE	MASE	RMSE
ARIMA(0,1,0)(1,1,2)[12]	2.14	1.97	3.27	3.51
ARIMA(1,1,1)(0,1,1)[12]/ XGBOOST	1.96	1.81	2.99	3.15
PROPHET	1.86	1.72	2.84	3.05
PROPHET / XGBOOST	1.89	1.75	2.89	3.07

Based on the results of Table 3, we can conclude that the best model for our data is the Prophet model, followed by Prophet Boost. Prophet model shows the best performance both for training and testing data. In two datasets of this study's data, the standard time series models (SARIMA) performed more poorly than the machine learning models in both datasets (training and testing), but it still remains a good model for the data.

In the field of predictive modelling, accuracy is an important measure of how well a model performs in decision making. This accuracy can be measured using in-sample data, which refers to the data used to train the model, or out-of-sample data, which can be unobserved data or a set of observations used for testing. It has been seen from many research studies, (Gjika et al., 2021) that models have a higher accuracy in in-sample data than in out-of-sample data, as the model may have over fit to the training data. However, another point of reference when analysing the accuracy are external factors that can affect the accuracy of a predictive model, such as social, demographic, and meteorological conditions. Therefore, in order to develop models that can accurately predict indices such as CPI for countries with similar economic, social, demographic, and meteorological conditions, it is important to carefully consider the factors that can affect the accuracy of the model and to choose appropriate modelling techniques that can account for these factors.

Gjika et al., (2018) studied the consumer price index in Albania (from January 1994 to December 2017) using exponential smoothing methods, along with some other models. The accuracy of the model is good, but not better than that of other used models.

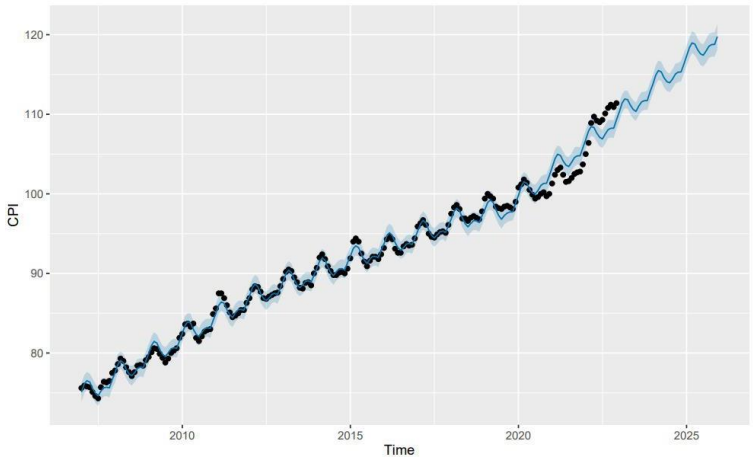


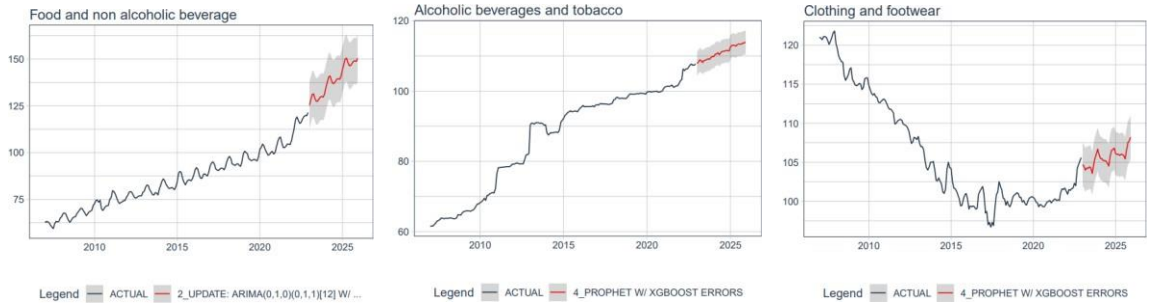
Figure 5. Forecasted values for total CPI, January 2023-December 2025 and observed data

Since the Prophet model was the model with the best accuracy among the models studied for the total CPI, then we used this model to make the forecast for the next 24 months. Figure 5 shows instead the plot of the predicted and observed data taken from Prophet model for January 2023 to December 2025.

Model Results for 12 main groups

CPI is divided into 12 main groups, including food, housing, medical care, education, transportation and other services. In September, compared to August 2022, the prices of the group "Clothing and footwear" increased by 2.1%, followed by the groups "Education" by 1.6%. In October, the prices of the group "Transportation" increased by 1.5%, followed by the groups "Furniture household and maintenance" by 0.8%, "Housing, water, electricity gas and other fuel" by 0.6 %. The annual price increase in December was mainly influenced by the "Food and non-alcoholic beverages" group with +4.98 percentage points, followed by the " Housing, water, electricity gas and other fuel" group with +0.54 percentage points. Compared to November 2022, the prices of the group "Food and non-alcoholic beverages" increased by 1.5%. For each of the 12 main groups, the same process used for the total CPI was followed. The data was first subjected to pre-processing, a descriptive analysis and a time series analysis. Afterwards the aforementioned models were created and assessed.

According to the results shown in the table A1 (Appendix A), the Prophet XGBOOST model performs the best across the majority of the groups, especially for the “Alcoholic beverages and tobacco”; “Clothing and footwear”; “Housing, water, electricity, gas and other fuel”; “Household furniture and maintenance”; “Medical care”; “Recreation and culture”; “Hotels, coffee-houses and restaurants”; “Other goods and services”; groups. For “Communication”; and “Education”; groups, the Prophet model has been determined to be the most effective. The best model for the group “Food and non-alcoholic beverages” has been determined to be the ARIMA Boosted model, while the ARIMA model has been picked for the group “Transportation”. In almost every group, the machine learning models taken into consideration in this study outperformed the traditional time series models in the training and testing sets.



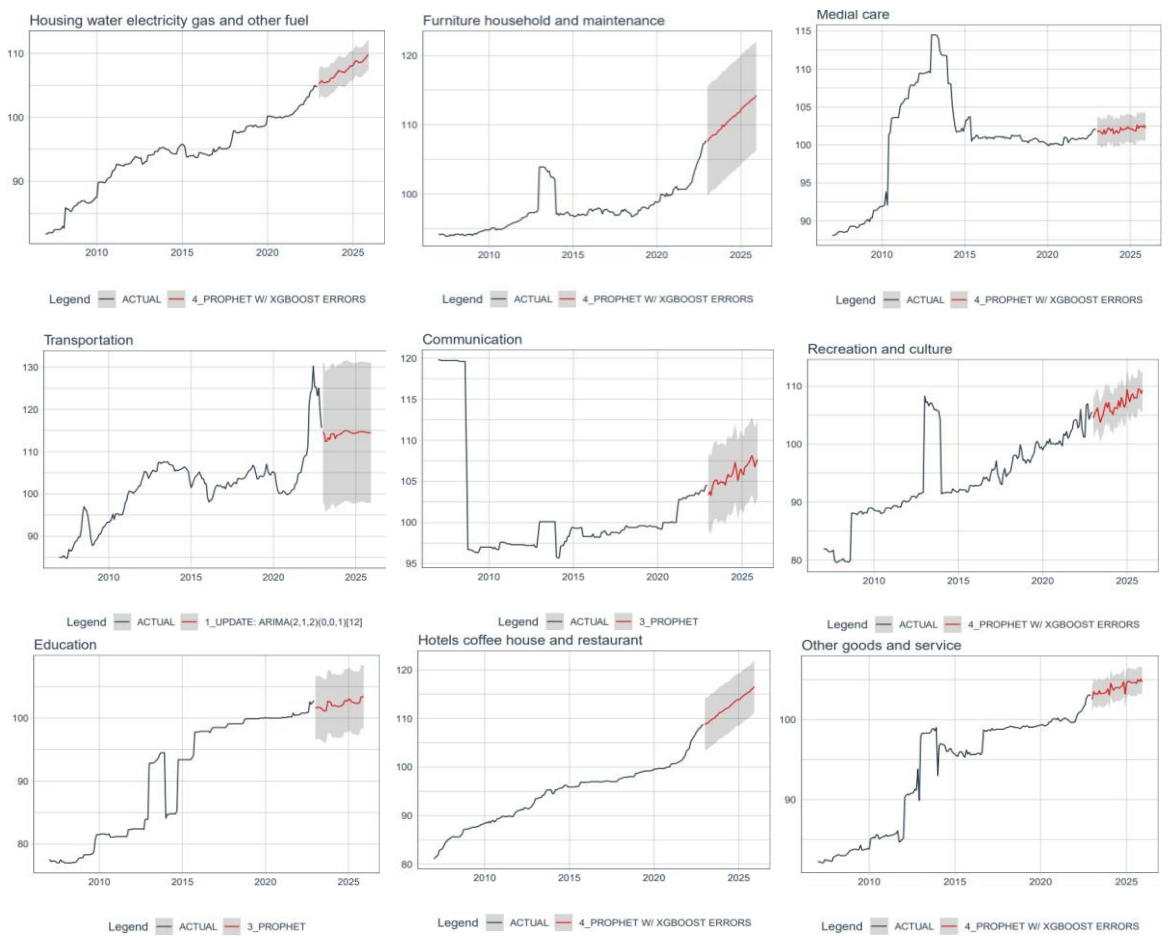


Figure 6. CPI for 12 main groups, from January 2007 to December 2022 and the forecast for January 2023 to December 2025.

Finally, throughout the following 36 months, the CPI for each group was predicted using the model with *the highest accuracy*. Figure 6 shows the CPI, from January 2007 to December 2022, in Albania, for each of the 12 main groups and the forecasted values (red line) together with confidence interval, where the forecast horizon is fixed at $h \in \{1, 2, \ldots, 35, 36\}$. Food and non-alcoholic beverage (Gr.1); Alcoholic beverages and tobacco (Gr.2); Recreation and culture (Gr.9); Education (Gr.10); Hotels, coffee-house and restaurant (Gr.11); Other goods and service (Gr.12) groups are presented with a linear upward trend, over the months the Consumer Price Index for these groups is increasing more and more. For all groups, there seems to be an increase in the CPI for the next 3 years.

CONCLUSION

Being the official indicator of inflation in Albania, the Consumer Price Index (CPI) is a significant indicator for both policymakers and economists. As a result, CPI forecasting has long attracted interest from a variety of areas. In this paper, we have discussed the application of different methods to the forecast CPI in Albania and its 12 main groups: Food and non-alcoholic beverage; Alcoholic beverages and tobacco; Clothing and footwear; Housing, water, electricity gas and other fuel; Furniture household and maintenance; Medical care; Transportation; Communication; Recreation and culture; Education; Hotels, coffee-house and restaurant; Other goods and service. We compare three distinct methods for time-series forecasting with an established econometric model (ARIMA). They ranged from a straightforward additive model employing a piecewise linear trend and Fourier series seasonality (Prophet) to the combination of ARIMA and Prophet with XGBOOST algorithms. Our data meet the conditions for using these methods, due to their trend and seasonality. The outcomes showed that the Prophet Boost algorithm was able to overcome the performance of the other, well-known time-series forecasting models, also was quick to setup and tune and requiring no data preprocessing.

To evaluate the effectiveness of the models, a variety of error metrics including mean absolute error, mean absolute scaled error, mean absolute percentage error, and root-mean-square-error have been utilized. These metrics show that Prophet model has the best performance, between the models used for total CPI; Communication; and Education; groups. According to the results, the Prophet XGBOOST model performs the best across the majority of the groups, especially for the Alcoholic beverages and tobacco; Clothing and footwear; Housing, water, electricity, gas and other fuel; Household furniture and maintenance; Medical care; Recreation and culture; Hotels, coffee-houses and restaurants; Other goods and services; groups. After testing the models, the model which has the best performance and accuracy, for total CPI and for each group, was used to predict CPI for the next months. The results of this study show that the total CPI in Albania will continue to increase for the next 36 months. Also for the 12 main groups, there seems to be an increase in the CPI for the next 3 years. In summary, this is the first study using machine learning approaches to predict CPI and its groups in Albania. Our technique and findings offer policymakers and market participants more forecasting tools and options on sector and component-specific pricing fluctuations. In this study one of the key aims was to analyze and evaluate different predictive modeling techniques and determine which ones perform better in similar economic, social, demographic, and meteorological conditions. By doing so, we hope to provide valuable insights and information to decision makers who are interested in predicting indices such as CPI for countries in the same region. This information can help them make better informed decisions about how to allocate resources, design policies, and plan interventions to address issues related to inflation and other economic indicators. Ultimately, our goal is to contribute to the development of more accurate and effective predictive models that can support decision making.

The work done in this paper can be extended in many directions. First, it would be interesting to combine the outputs of the ARIMA, Prophet, and Boosted models and build a stacking model to get a performance that is well-balanced. There are numerous approaches to create model stacks, including averaging, weighted averaging, and a meta-learner trained on individual learners using other machine learning models. Second, another point of view may be used for prediction. The CPI for each group can be forecasted, and these forecasts can be used for the total CPI forecast using the weights that each of the 12 groups has.

Appendix A

In this appendix we synthetically report the results for the models we have used for each of the 12 main groups of CPI in Albania, and their accuracy metrics.

Table A1. Performance of the models for each group

Group	MODEL	MAE	MAPE	RMSE
Food and non-alcoholic beverage	ARIMA(2,0,1)(0,1,1)[12] WITH DRIFT	4.17	3.62	6.55
	ARIMA(1,0,0)(0,1,1)[12] WITH DRIFT W/ XGBOOST	***3.96***	***3.43***	***6.32***
	PROPHET	4.24	3.70	6.52
	PROPHET / XGBOOST	4.15	3.60	6.54
Alcoholic beverages and tobacco	ARIMA(0,1,0)(0,0,2)[12] WITH DRIFT	1.60	1.58	1.93
	ARIMA(0,1,1)(2,0,0)[12] WITH DRIFT W/ XGBOOST	2.20	2.17	2.48
	PROPHET	1.42	1.36	1.87
	PROPHET / XGBOOST	***1.34***	***1.29***	***1.72***
Clothing and footwear	ARIMA(2,1,0)(0,1,1)[12]	1.92	1.88	2.64
	ARIMA(0,1,0)(0,1,2)[12] W/ XGBOOST ERRORS	2.29	2.24	3.17
	PROPHET	***1.27***	***1.26***	***1.41***
	PROPHET / XGBOOST	1.30	1.29	1.41
Housing, water, electricity gas and other fuel	ARIMA(3,1,0)(1,0,0)[12] WITH DRIFT	1.00	0.99	1.18
	ARIMA(0,1,0) WITH DRIFT W/ XGBOOST ERRORS	1.16	1.15	1.36
	PROPHET	0.65	0.63	0.90
	PROPHET / XGBOOST	***0.64***	***0.63***	***0.78***
Furniture household and maintenance	ARIMA(0,1,0)(0,0,1)[12]	3.74	3.62	4.54
	ARIMA(0,1,0)(0,0,1)[12] W/ XGBOOST ERRORS	3.35	3.24	4.20
	PROPHET	3.54	3.44	4.30

	PROPHET / XGBOOST	***3.18***	***3.08***	***3.99***
Medical care	ARIMA(0,1,0)	0.66	0.65	0.86
	ARIMA(0,1,0) W/ XGBOOST ERROR	0.66	0.65	0.88
	PROPHET	0.72	0.72	0.93
	PROPHET / XGBOOST	***0.48***	***0.48***	***0.60***
Transportation	***ARIMA(0,1,1)(2,0,0)[12] WITH DRIFT***	***6.33***	***5.57***	***8.41***
	ARIMA(1,1,0) W/ XGBOOST ERRORS	6.98	6.00	10.07
	PROPHET	6.68	5.96	8.29
	PROPHET / XGBOOST	6.53	5.79	8.31
Communication	ARIMA(0,1,1)	2.35	2.28	2.96
	ARIMA(0,1,1) W/ XGBOOST ERRORS	2.10	2.03	2.67
	PROPHET	***1.88***	***1.83***	***2.28***
	PROPHET / XGBOOST	1.96	1.90	2.39
Recreation and culture	ARIMA(0,1,0)(0,0,1)[12] WITH DRIFT	1.82	1.80	2.06
	ARIMA(0,1,0)(0,0,1)[12] WITH DRIFT W/ XGBOOST	2.15	2.13	2.42
	PROPHET	1.85	1.79	2.26
	PROPHET / XGBOOST	***1.34***	***1.30***	***1.73***
Education	ARIMA(0,1,0)(0,0,1)[12] WITH DRIFT	2.71	2.69	3.00
	ARIMA(0,1,0)(1,0,0)[12] WITH DRIFT W/ XGBOOST	3.04	3.02	3.29
	PROPHET	***2.34***	***2.32***	***2.54***
	PROPHET / XGBOOST	2.43	2.42	2.58
Hotels, coffee-house and restaurant	ARIMA(0,2,2)	1.80	1.69	2.96
	ARIMA(0,2,2) W/ XGBOOST ERRORS	1.74	1.65	2.75
	PROPHET	1.68	1.58	2.79
	PROPHET / XGBOOST	***1.67***	***1.57***	***2.72***
Other goods and service	ARIMA(1,1,0) WITH DRIFT	1.06	1.06	1.28
	ARIMA(1,1,0)(1,0,0)[12] WITH DRIFT W/ XGBOOST ERRORS	1.59	1.59	1.75
	PROPHET	0.60	0.59	0.91
	PROPHET / XGBOOST	***0.58***	***0.57***	***0.86***

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An Application Of Panel Var Model For Estimating The Relationship Between Environmental And Resources Productivity And Energy

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Abstract

The aim of this research article is to demonstrate an application of Panel Var Model, pointedly for Estimating the Relationship between Environmental and Resources Productivity and Energy. The Panel VAR Model is a dynamic multivariate extension of the univariate autoregressive models and most recently used in the general perspectives, especially in the field of macroeconomics. Specifically, this type of model is more flexible and applicable for illustrating the dynamics of the economy and designing forecasting of the same. Seeing the worth of environment sustainability this study uses data of 38 OECD countries for the period 1990-2022, to predict its relationship with energy indicators. The empirical results indicate that there is a strong correlation between environmental and resources productivity as a representative factor of green growth and renewable energy.

Key words: *Panel VAR, Environmental, Resources Productivity, Energy*

Zero-inflated Poisson-chris-jerry Regression Model: Simulation And Applications

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Abstract

In this paper, a new zero-inflated regression model is introduced based on the Poisson-Chris-Jerry distribution introduced by Ahmad and Wani (2023). Some basic properties of the new regression model are examined, such as mean, variance, skewness, kurtosis, etc. The unknown parameters of the new model are estimated using the maximum likelihood methodology. Furthermore, some confidence intervals are constructed with asymptotic distributions of maximum likelihood estimators and bootsrap techniques. A Monte Carlo simulation is performed to demonstrate the effectiveness of maximum likelihood estimates and to evaluate the performance of confidence intervals. Finally, the applicability of the new regression model and its superiority over existing regression models are demonstrated by some real data analyses.

Key words: *Count regression model, Zero-inflated regression model, Monte Carlo simulation, Bootsrap*

Number Of Binary Sequences Intersecting The Line Y = T At Least Once

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Abstract

Random sequences are used widely in cryptographic applications and hence it is vital to use a proper random number generator to produce keys. Randomness testing is usually performed by statistical randomness tests. One of the most important statistical randomness tests for binary strings produced by pseudorandom bit generators is the random walk statistics. In this work, we define graph of a binary sequence and compute the exact number of binary sequences of length n whose graph intersect the line y=t at least once, depending on the value of t. The basis of this computation is the following fact we state and prove: Let n,t and q be positive integers with t ≤q ≤n. The number of strings of length n which contain q zeros and which intersect the line y=t at least once is given by the combination n chooses q-t if q is less than half of n+t, and in the case q is between half of n+t and n, it is the combination n chooses q.These values can be used in place of approximations when designing a random walk test for long binary sequences. Our future work plan is to compute the corresponding number for the sequences intersecting the line exactly k times, in a recursive manner so that one can design a randomness test using random walk statistics without employing any mathematical approximation formulas when dealing with long sequences.

Key words: *Cryptography, Random Walk, Statistical Randomness Testing, NIST Test Suite.*

Liu-type Regularization With Cross-validation

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Abstract

The Liu-type regularization has become a popular alternative to the traditional ordinary least squares estimator as it reduces the negative effects that arise when explanatory variables exhibit significant multicollinearity. Many methods have been proposed in the literature for estimating the tuning parameter contained in Liu-type regularization. The performance of the proposed methods varies depending on the structure of the dataset. In this study, the cross-validation method is used to estimate the tuning parameter in Liu regression from a machine-learning perspective. A simulation study was conducted to examine the level of success of the cross-validation method on the test sets compared to other tuning parameter selection methods. Also, the performances of different tuning parameters were compared on a real dataset. In order to speed up the parameter estimation process, the calculations were performed in C++ and the results were extracted from the R program. As a result, parameter estimation based on cross-validation in Liu regression is found to be successful depending on the nature of the data.

Key words: *Linear Regression, Multicollinearity, Regularization, Liu Regression*

Post Lasso Method For Zero-inflated Data With An Experimental Study

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Abstract

Poisson regression is the basic regression method that is used in modeling counting data where the response variable represents the number of occurrences of an event. Negative binomial regression may be preferred as an alternative to Poisson regression when the data are overdispersed. It is appropriate to use zero-inflated Poisson (ZIP) or zero-inflated negative binomial (ZINB) regression in modeling data where the observed event never occurs. In the literature, various regularization methods are proposed, which deal with the overfitting problem by shrinking the coefficient estimates. Depending on the type of regularization, these methods can perform automatic variable selection. The LASSO (least absolute shrinkage and selection operator) is one of the regularization methods that perform both shrinkage and variable selection. The post-LASSO two-step method has been proposed as a generalization of LASSO. It is based on the principle of applying classical least squares regression on the response variable using explanatory variables selected by LASSO. This method yields results where new estimates perform at least as well as estimates using regularized coefficients. Recently, the zero-inflated Poisson regression for LASSO (ZIP-LASSO) and zero-inflated negative binomial regression for LASSO (ZINB-LASSO) methods have been proposed as regularized versions of the ZIP and ZINB models. In the regression with count response, ZIP-LASSO and ZINB-LASSO methods can perform automatic variable selection depending on the structure of the dataset. Thus, these methods increase the level of interpretability of the model. In addition, these methods can give more accurate results in the prediction of new observations, provided that the tuning parameter included in the methods is determined appropriately. In this study, the new Post-ZIP-LASSO and Post-ZINB-LASSO methods as hybrid versions of ZIP-LASSO and ZINB-LASSO methods are considered and their properties are examined. In addition, the methods are compared with other counting regression methods using a health dataset. The performances of the models are investigated using the criteria of mean squared error, mean absolute error and selected variables. According to the findings, the Post-ZINB-LASSO gives the best result in prediction performance as well as variable selection.

Key words: *Poisson Regression, Negative Binomial Regression, Zero-Inflated Regression, LASSO, Post-LASSO.*

Statistical ModelİNg Of Monthly Rainfall In Black Sea Region Of Turkey Between 1965 And 2022

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Abstract

Abstract The objective of this study is to evaluate the potential of exponential, gamma, and lognormal distributions modeling of monthly rainfall in black sea region of Turkey. Recent flood disasters in Turkey has prompted us to further investigate distribution models for rainfall. We used a set of monthly rainfall between 1965 and 2022. Since rainfall data typically contains outliers, we applied a robust method, specifically minimum density power divergence estimators (MDPDE), for parameter estimation. The results indicated that, in the context of city-month pairs and regional basis for rainfall, the lognormal distribution is mostly observed. Moreover, truncated distribution approaches are also discussed in terms of the quality of estimates and their practical applicability.

Key words: *MDPDE, Exponential Distribution. Gamma Distribution. Lognormal Distribution. Truncated Normal Distribution.*

INTRODUCTION

Climate change makes heavy rainfall more common around the world. Since Black Sea Region of Turkey is one of the areas in Turkey that receives the highest amount of rainfall ,sudden local and heavy rains in this region cause floods and landslides resulting in loss of life and property,too. Some of the recent flood disasters in Turkey are listed as follow:

In July 2023, there was a flood after the heavy rain that was effective in the West Black Sea Region. Kastamonu, Karabük, Zonguldak, Düzce and Bartın were the cities affected by heavy rain.

In August 2021, the Black sea region in Turkey was affected by catastrophic flooding, as a series of thunderstorms that began on 7 August 2021 and continued until the 14th in northern Turkey caused several floods and landslides. The water rose to 4 metres (13 ft) in some locations, and the floods have been described as the worst in Turkey's history. 97 people died and about 228 more were injured in thefloods, and more than 1800 people were evacuated as many people were rescued from rooftops (“2021Turkish floods,” 2023).

Figure 1. Zonguldak after heavy rain in July,2023 **Figure 2.** Kastamonu in August, 2021

These two floodings from the recent past show that in Turkey, particularly in Black Sea Region, flood disasters not only negatively affect people's lives, but also cause loss of life and property. In this study, monthly rainfall data collected by the Turkish State Meteoorological Service for the the period spanning from 1965 to 2022 in millimeters (mm), is considered, encompassing a total of 57 years. This dataset is utilized in appropriate statistical modeling for the future rainfall conditions.

Examining rainfall data statistically provides insights into the past and is also crucial for making future predictions. "Statistical modeling of rainfall data is an important research area in meteorology over the decades" (Hazra and Ghosh, 2019). In this study, robust statistical modeling methods were discussed to make a preliminary assessment of rainfall intensity in order to minimize the damage caused by flooding. A similar study had been conducted by Hazra and Ghosh (2019), and we inspired from this study to apply similar approach to the rainfall data we obtained from Black Sea Region of Turkey. Hazra and Ghosh (2019) analyzed areally-weighted monthly rainfall data from the 36 meteorological subdivisions of India for the years 1951-2014, they fit exponential, gamma, lognormal and Weibull probability distributions and estimate model parameters by employing minimum density power divergence estimator (MDPDE) for all subdivision-month combinations. MDPDE (Minimum Density Power Divergence Estimation) is a robust estimation procedure. The estimates are derived by minimizing a density-based divergence measure known as the density power divergence (DPD) over the parameter space. This method introduced by Basu et.al. in 1998. Firstly, we presented visual and statistical results indicating the presence of outliers. Subsequently, we provide the best fit models based on 'optimum' MDPDE estimates for all cities in Black Sea Region in Turkey.

MATERIAL AND METHODS

Material

In this subsection, we briefly provided information about the probability distributions we fit for our dataset and explained how MDPDE was applied to the rainfall data by Hazra and Ghosh (2019).

Exponential Distribution

The exponential distribution is a probability distribution commonly used in many different fields, including the analysis of rainfall data. In the context of rainfall data analysis, the exponential distribution can be employed to model interarrival times of rainfall events. For instance, if you are interested in modeling the time between rainfall occurences, the exponential distribution can be appropriate choice. The probability distribution function (PDF) of the exponential distribution is given by:

$$f(x;\lambda) = \begin{cases} \lambda \exp(-\lambda x), & x \geq 0 \\ 0 & , \quad x < 0 \end{cases}$$

where $\lambda > 0$ is the rate parameter of the distribution.

The mean and variance of the exponential distribution is respectively

$$E(X) = \frac{1}{\lambda} \text{ and } Var(X) = \frac{1}{\lambda^2}.$$

Rainfal data can be complex and influenced by factors such as geographic location,climate, and time of the year. Therefore, alternative distributions like the gamma distribution or log-normal distribution may also be appropriate, depending on the specific context.

Gamma Distribution

The gamma distribution is a probability distribution commonly used for modeling continuous, positively skewed data, including rainfall data. Gamma distribution is appropriate for representing the total amount of rainfall over a given time period, for examples daily or monthly rainfall totals.

The probability distribution function (PDF) of gamma distribution is given by:

$$f(x;\alpha,\beta)=\frac{\beta^{\alpha}}{\Gamma(\alpha)}x^{\alpha-1}e^{-\beta x}$$

where α is the shape parameter, which controls the shape of the distribution. β is the scale parameter, which controls the spread or variability of the distribution and $\Gamma(\alpha)$ is the gamma function.

Lognormal Distribution

The lognormal distribution is another probability distribution often used for modeling rainfal data, specifically when dealing with variables which cannot be negative, such as rainfall amounts. In the lognormal distribution, the logarithm of the variable follows a normal distribution.

The probability distribution function (PDF) of lognormal distribution is given by:

$$f(x;\mu,\sigma)=\frac{1}{x\sigma\sqrt{2\pi}}\exp\left(-\frac{(lnx-\mu)^2}{2\sigma^2}\right)$$

Where μ explains the location of the distribution on the logaritmic scale and σ controls the shape and spread of the distribution.

The MDPDE Method

As we mention earlier MDPDE employed by Hazra and Ghosh (2019) for rainfall data. MDPDE is mainly based on DPD (Basu et.al. 1998). The density power divergence between two density functions

f and g is as follows;

$$d_{\alpha}(f,g)=\begin{cases}\int\left[f^{1+\alpha}(x)-\left(1+\frac{1}{\alpha}\right)f^{\alpha}(x)g(x)+\frac{1}{\alpha}g^{1+\alpha}(x)\right]dx, & \alpha>0\\ \lim_{\alpha\to 0}d_{\alpha}(f,g)=\int g(x)[\log g(x)-\log f(x)]dx, & \alpha=0\end{cases}$$

and $d^*(f,\ g)$ is known as Kullback-Leibler (KL) divergence. As a parametric estimation method model density $f+$ is used instead of f and g is the unknown true density funciton. Since g is unknown, estimate of the density is used instead. DPD can be written as

$$d_{\alpha}(f,g)=\begin{cases}\int\left[f^{1+\alpha}(x)dx-\left(1+\frac{1}{\alpha}\right)E(f^{\alpha}(X))+\frac{1}{\alpha}E(g^{\alpha}(X))\right], & \alpha>0\\ E(\log g(X))-\mathrm{E}(\log f_{\theta}(X)) & ,\ \alpha=0.\end{cases}$$

When the expressions independent of the parameter are disregarded and optimization is applied the minimum DPD estimator MDPDE is defined as

$$\hat{\theta}_{\alpha}=arg\min_{\theta\in\Theta}H_{\alpha,n}(\theta)$$

$$H_{\alpha,n}(\theta)=\frac{1}{n}V_{\alpha}(\theta,X_i)$$

$$V_{\alpha}(\theta,X_i)=\begin{cases}\int\left[f^{1+\alpha}(x)dx-\left(1+\frac{1}{\alpha}\right)E(f^{\alpha}(X))\right], & \alpha>0\\ -\log f_{\theta}(X) & ,\ \alpha=0.\end{cases}$$

For α = 0 which is special case of MDPDE is known as MLE. The function to be optimized given by exponential distribution;

$$V_\alpha(\lambda;x)=\begin{cases}\dfrac{\lambda^\alpha}{1+\alpha}-\left(1+\dfrac{1}{\alpha}\right)\lambda^\alpha\exp(-\alpha\lambda x), & \alpha>0\\ \lambda x--\log(\lambda) & ,\quad \alpha=0\end{cases}$$

for gamma distribution;

$$V_\alpha(a,b;x)=\begin{cases}\dfrac{\Gamma((a-1)(1+\alpha)+1)b^\alpha}{\Gamma(a)^{\alpha+1}(1+\alpha)^{(a-1)(1+\alpha)+1}}- \\ \left(1+\frac{1}{\alpha}\right)\frac{b^{\alpha^2}}{\Gamma(a)^\alpha}x^{\alpha(a-1)}\exp(-\alpha bx), & \alpha>0\\ log\Gamma(a)-alog(b)+bx-(a-1)\log(x) & ,\alpha=0\end{cases}$$

for lognormal distribution;

$$V_\alpha(\mu,\sigma;x)=\begin{cases}\dfrac{1}{\sqrt{\alpha+1}(\sqrt{2\pi}\sigma)^\alpha}\exp\left(-\alpha\mu+\dfrac{\alpha^2\sigma^2}{2(\alpha+1)}\right)- \\ \left(1+\dfrac{1}{\alpha}\right)\dfrac{1}{(2\pi)^{\frac{\alpha}{2}}\sigma^\alpha x^\alpha}\exp\left(-\alpha\dfrac{(\log(x)-\mu)^2}{2\sigma^2}\right) & ,\quad \alpha>0\\ \log(\sqrt{2\pi}\sigma x)+\dfrac{(\log(x)-\mu)^2}{2\sigma^2} & ,\alpha=0\end{cases}$$

Parameters are obtained by plugging in these objective functions to $H_{\alpha,}(\theta)$ and applying numerical minimization. See Hazra and Ghosh (2019) for more details.

Robust model selection criterion, Robust Information Criterion (RIC) (Mattheou et.al. , 2009), is employed for choosing the suiatable model for given rainfall data. In the applications for our study, written R software by Hazra and Ghosh (2019) is utilized for implementing MDPDE. Similar to this study, we employed Cramer -von Mises (CVMD) distance to evaluate rainfall models for different α and select its optimal value.

METHODS

In this study, robust statistical modeling methods were discussed to make a preliminary assessment of rainfall intensity in order to minimize the damage caused by flooding.

We first, depict outliers for rainfall data observed in 1965-2022. An observation, the average rainfall for each month, is an outlier if it is larger than the 1.5 interquartile range above the third quartile, or smaller than the 1.5 interquartile range below the first quartile. The proportion is highest for August at Sinop (10.34). Averaging across cities, the outlier proportion is highest for August (4.38) and lowest for November (1.95). Averaging across months, the outlier proportion is highest for Bolu (3.75) and lowest for Rize (1.00). The existence of such outliers inspired us adapt the similar practice to Hazra and Ghosh (2019) in their study to our dataset.

RESULTS

We first visually display the monthly rainfall data through a boxplot, dividing it into three groups based on regions. As a second step, we create a table listing the proportions of outliers for each city. We willchoose an appropriate robust parametric model for the rainfall data collected from Black Sea Region inTurkey in between 1965-2022. Throught out this study we choose 4 city - month combinations which have higher

outlier rates according to 1.5 IQR rule for outliers.

Figure 3. Monthly Rainfall data (mm) East Black Sea Region in1965-2022.

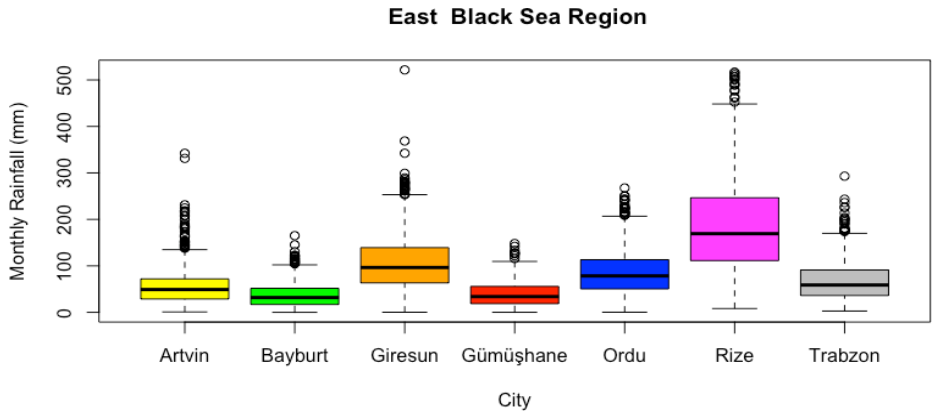

Figure 4. Monthly Rainfall data (mm) Central Black Sea Region in 1965-2022

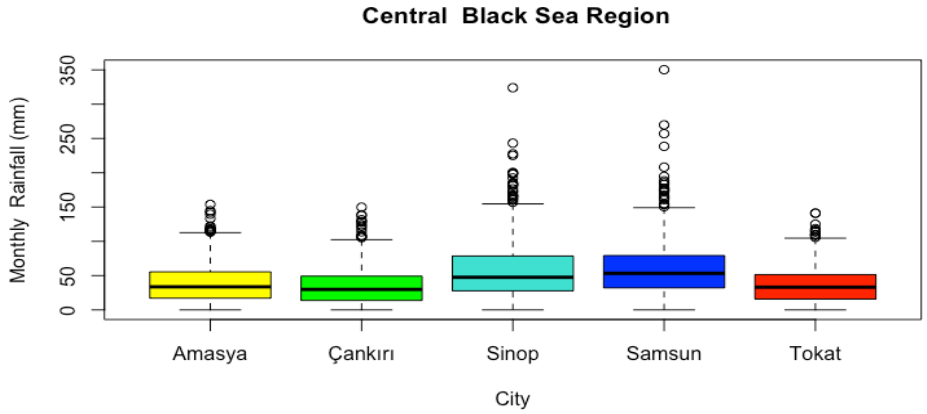

Figure 5. Monthly Rainfall data (mm) West Black Sea Region in 1965-2022

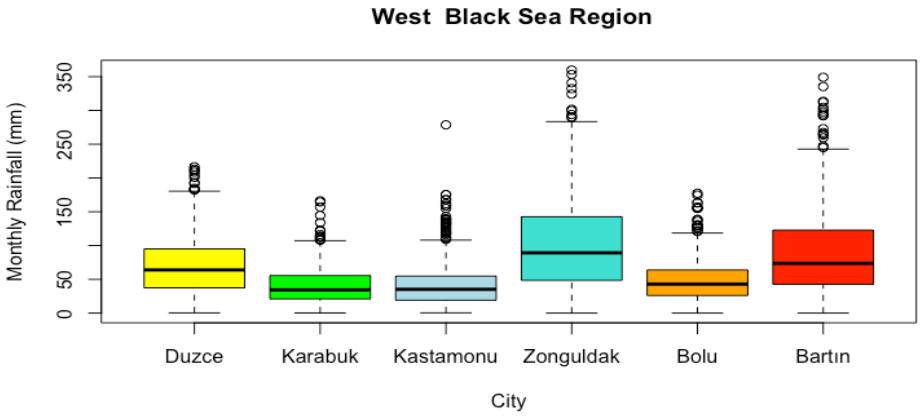

Table 1. Proportion of outliers for each month in 1965-2022 at East, Middle and West Black Sea Region cities in Turkey.

Region	City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
West	Bartın	5.17	0.0	0.0	1.72	3.45	5.17	1.72	10.71	1.72	0.0	3.45	1.72
Black Sea	Bolu	6.9	6.9	0.0	3.45	3.45	8.62	3.45	1.85	3.51	1.72	3.45	1.72
Region	Düzce	5.17	0.0	0.0	1.72	1.72	3.51	5.17	3.7	3.45	3.45	3.45	0.0
	Kastamonu	1.72	5.17	5.17	0.00	3.45	1.75	5.17	3.51	3.45	3.45	5.17	3.45
	Zonguldak	0.00	1.72	0.00	6.90	3.45	3.51	6.90	3.45	3.45	0.00	1.72	0.00
Middle	Amasya	1.72	3.45	0.00	1.72	0.00	1.72	5.88	5.77	5.26	6.90	0.00	1.72
Black Sea	Çankırı	3.45	5.17	1.72	0.00	5.17	0.00	1.82	1.79	3.64	3.45	1.72	3.45
Region	Sinop	0.00	5.17	0.00	0.00	3.45	7.02	3.51	10.34	1.72	1.72	5.17	0.00
	Samsun	3.45	0.00	1.72	1.72	1.72	3.45	5.36	8.77	0.00	6.90	1.72	1.72
	Tokat	1.72	3.45	1.72	1.72	0.00	0.00	3.85	3.92	1.79	6.90	0.00	5.17
East	Artvin	5.17	5.17	3.45	1.72	5.17	1.72	5.17	0.00	3.45	5.17	0.00	3.45
Black Sea	Bayburt	3.45	1.72	3.45	0.00	3.45	1.72	0.00	5.66	0.00	0.00	0.00	5.17
Region	Giresun	0.00	3.45	5.17	1.72	0.00	1.72	1.72	3.45	0.00	3.45	0.00	0.00
	Gümüşhane	1.72	0.00	0.00	1.72	3.45	0.00	0.00	3.77	3.45	5.17	3.45	0.00
	Ordu	5.17	0.00	3.45	1.72	1.72	3.45	3.45	1.72	1.72	1.72	0.00	1.72
	Rize	0.00	1.72	1.72	1.72	0.00	0.00	5.17	0.00	0.00	0.00	0.00	1.72
	Trabzon	0.00	0.00	0.00	0.00	2.00	10.00	4.00	6.00	0.00	2.04	4.00	4.08

MDPDE with exponential distribution assessment for rainfall data.

Figure 6. Histograms with fitted exponential densities with parameters estimated using MDPDE at α = 0,0.1,0.5,1.

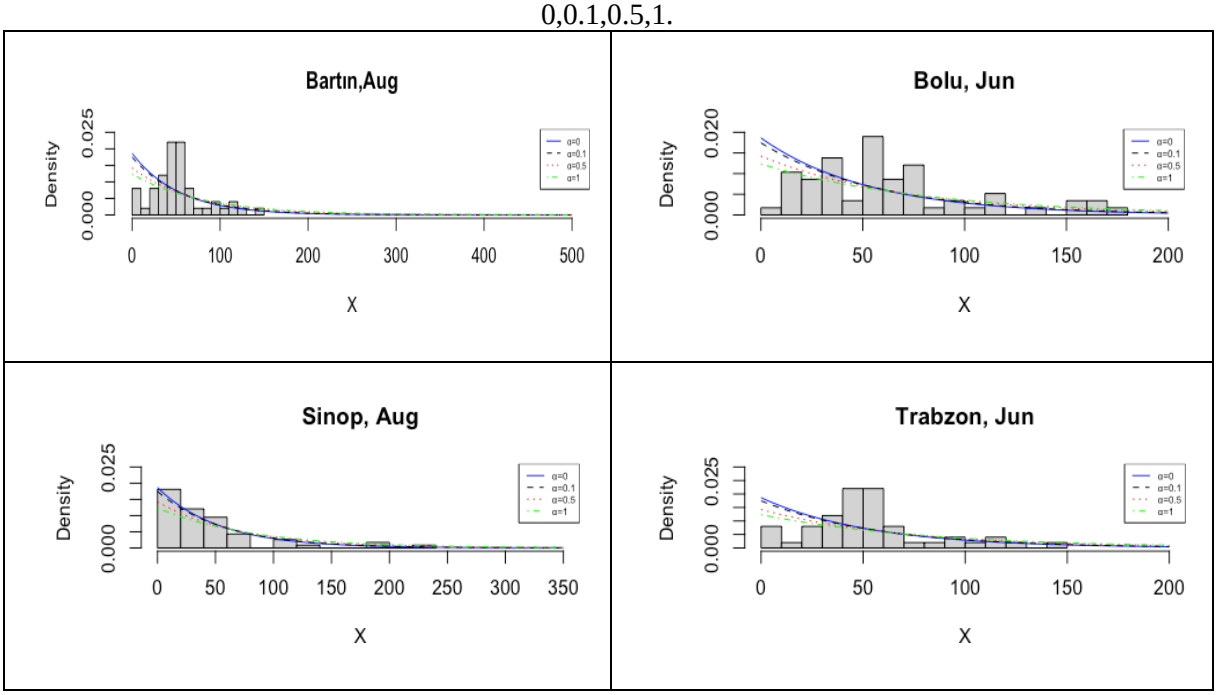

Table 2. Results for fitting exponential distributions on selected city and month pairs

City, Month	Results	$\alpha = 0$	$\alpha = 0.1$	$\alpha = 0.5$	$\alpha = 1$
Bartı,Aug	Estimate	0.0129	0.0130	0.0139	0.0145
	SE	0.0019	0.0020	0.0027	0.0033
	CVMD	0.0016	0.0016	0.0015	0.0018
Bolu,Jun	Estimate	0.0156	0.0148	0.0125	0.0110
	SE	0.0013	0.0013	0.0011	0.0011
	CVMD	0.0102	0.0084	0.0071	0.0098
Sinop,Aug	Estimate	0.0227	0.0229	0.0230	0.0223
	SE	0.0032	0.0032	0.0035	0.0039
	CVMD	0.0009	0.0009	0.0008	0.0009
Trabzon,Jun	Estimate	0.0186	0.0175	0.0143	0.0124
	SE	0.0015	0.0014	0.0012	0.0011
	CVMD	0.0202	0.0174	0.0149	0.0186

From figure 6. we observe that for given α = 0, 0.1, 0.5, 1, fitted densities overestimate small values. However, for Sinop, August combination, fitted densities underestimate small values and still overestimate large values. CVMD values drop with between α=0.1-1, which explains the reduction in bias with increasing α. Thus, an optimal α between 0.1 and 1 would provide the best fit for the data in each case.

	Bartın, Aug	Bolu, Jun	Sinop, Aug	Trabzon, Jun
Optimum α	0.3688	0.3727	0.6544	0.3820
CVMD	0.0014	0.0069	0.0008	0.0146
MDPDE	0.0136	0.0130	0.0229	0.0150

MDPDE with gamma distribution assessment for rainfall data.

Figure 7. Histograms with fitted gamma densities with parameters estimated using MDPDE at α = 0,0.1,0.5,1.

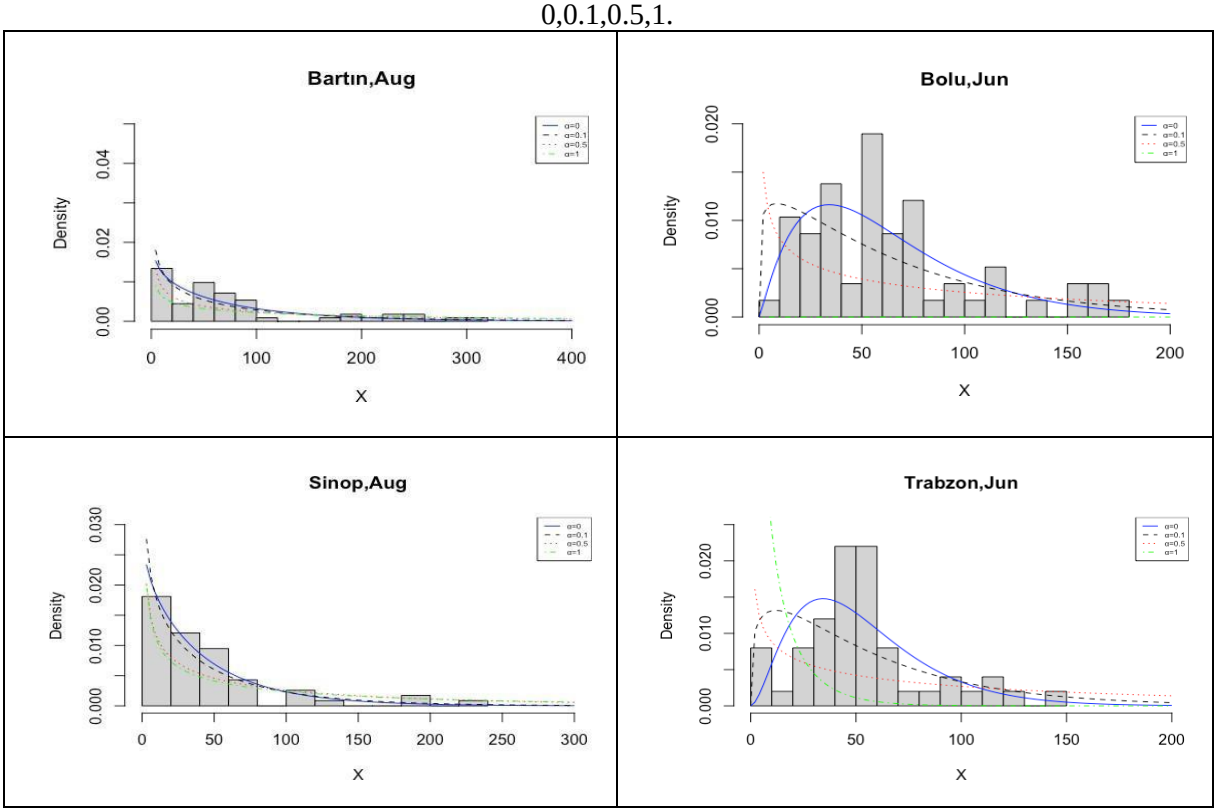

Table 3 Results for fitting gamma distributions on selected city and month pairs with the form of parameters (shape,rate)

City, Month	Results	α = 0	α = 0.1	α = 0.5	α = 1
Bartın,Aug	Estimate	(0.8347,0.0108)	(0.8249,0.0105)	(0.8169, 0.0103)	(0.8238, 0.0104)
	SE	(0.1508, 0.0025)	(0.1534,0.0027)	(0.1716,0.0042)	(0.4225, Inf)
	CVMD	0.0013	0.0013	0.0012	0.0012
Bolu,Jun	Estimate	(2.1381,0.0334)	(2.1592,0.0335)	(2.3000,0.0358)	(2.4094,0.0377)
	SE	(0.4815,0.0081)	(0.4886,0.0085)	(0.6021,0.0109)	(0.9063,0.01480.)
	CVMD	0.0008	0.0008	0.0007	0.0008
Sinop, Aug	Estimate	(0.9136,0.0207)	(0.9125,0.0207)	(0.8795,0.0191)	(0.8176,0.0161)
	SE	(0.2012,0.0058)	(0.2188,0.0063)	(0.3269,0.0098)	(0.4783, Inf)
	CVMD	0.0013	0.0013	0.0015	0.0023
Trabzon,Jun	Estimate	(2.7775,0.0518)	(2.8227,0.0521)	(3.5581,0.0647)	(9.2860,0.1773)
	SE	(0.7521, 0.0142)	(0.8837,0.0168)	(6.5669,0.1300)	(8.0626,0.1584)
	CVMD	0.0041	0.0039	0.0032	0.0042

we explore mode on similar city -month combinations for Gamma distribution. The fitted gamma densities based on MDPDE given with figure 7. Shape and scale parameter estimates of MDPDE their SE and CVMDs are given with the Table 3. In this case we expect optimum α to be between 0.1 and1.

	Bartın, Aug	Bolu, Jun	Sinop, Aug	Trabzon, Jun
Optimum α	0.9147	0.5957	0.1360	0.5316
CVMD	0.0012	0.0007	0.0013	0.0032
MDPDE	(0.8203,0.0103)	(2.3318, 0.0364)	(0.9113, 0.0206)	(3.7298, 0.0679)

MDPDE with lognormal distribution assessment for rainfall data

Figure 8. Histograms with fitted lognormal densities with parameters estimated using MDPDE at α = 0,0.1,0.5,1.

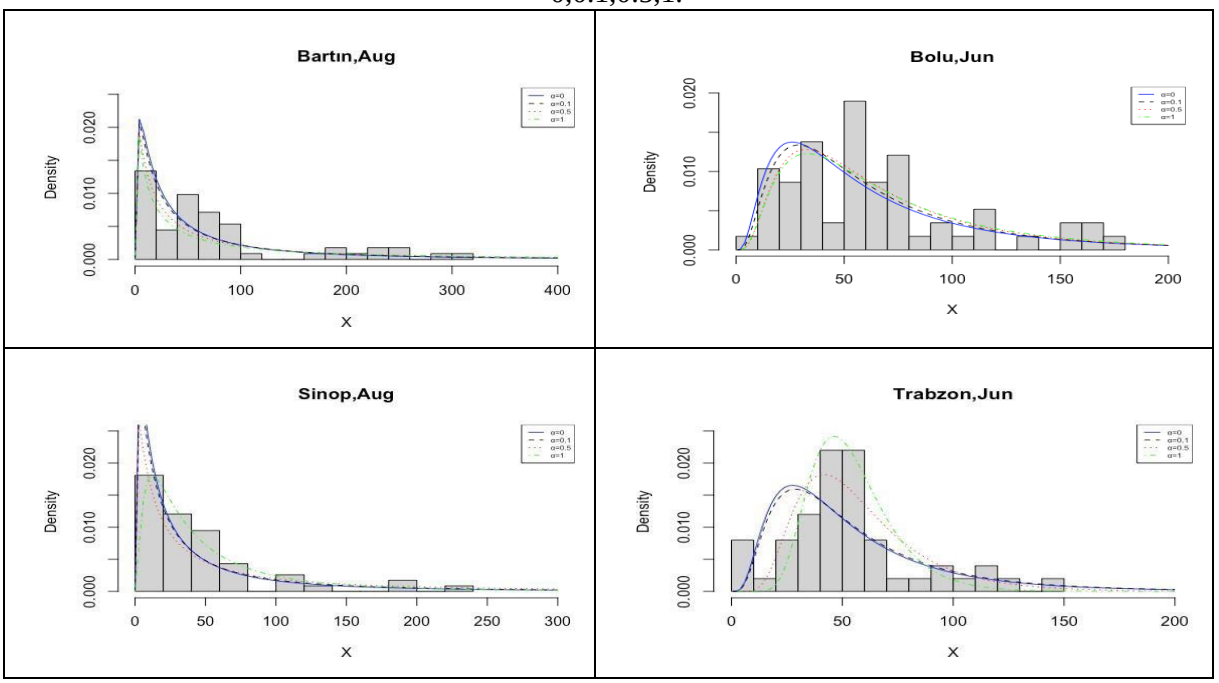

Table 4. Results for fitting lognormal distributions on selected city and month pairs with the form of parameters (meanlog,sdlog)

City, Month	Results	$\alpha = 0$	$\alpha = 0.1$	$\alpha = 0.5$	$\alpha = 1$
Bartın,Aug	Estimate	(3.6420,1.4882)	(3.7303,1.5600)	(4.0248,.8329)	(4.2616,2.1042)
	SE	(0.1972,0.1874)	(0.1938,0.2232)	(0.2157,0.3916)	(0.3075,0.5429)
	CVMD	0.0043	0.0034	0.0071	0.0149
Bolu,Jun	Estimate	(3.9074,0.8071)	(3.9527,0.7703)	(4.0181,0.7321)	(4.0512,0.7489)
	SE	(0.1015,0.1267)	(0.0943,0.1204)	(0.0978,0.0968)	(0.1101,0.1235)
	CVMD	0.0023	0.0014	0.0013	0.0020
Sinop,Aug	Estimate	(3.1487,1.4594)	(3.2641,1.5102)	(3.6265,1.7178)	(3.6003,1.0508)
	SE	(0.1899,0.2202)	(0.1772,0.2823)	(0.1828,0.6510)	(0.3298,0.8640)
	CVMD	0.0060	0.0048	0.0116	0.0054
Trabzon,Jun	Estimate	(3.7920,0.6903)	(3.8301,0.6881)	(3.9525,0.4695)	(3.9478,0.3367)
	SE	(0.0954,0.0916)	(0.0931,0.1089)	(0.0742,0.2175)	(0.0585,0.2032)
	CVMD	0.0068	0.0057	0.0046	0.0059

As α increases MDPDE fit becomes better. From the Table 4. CVMD s corresponding to $\alpha = 0 - 0.1$ is drop between for four cases. In this case we expect optimum α to be in between 0.1 and 0.5.

	Bartın, Aug	Bolu, Jun	Sinop, Aug	Trabzon, Jun
Optimum α	0.1357	0.2387	0.1205	0.4149
CVMD	0.0034	0.0011	0.0048	0.0044
MDPDE	(3.7616, 1.5863)	(3.9878, 0.7350)	(3.2873, 1.5205)	(3.9389, 0.5518)

We first applied MPDE for model selection using RIC criteria to the Black sea region rainfall data based on three regions, and the results are displayed in the following table. The letters refer to the distributions for L 'Log Normal', G 'Gamma ', E 'Exponential'.

Table 5. Monthly based probability models selected by RIC criteria.

Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
West BlackSea Region	G	L	L	L	L	L	L	G	L	L	L	L
Middle BlackSea Region	L	L	L	L	L	L	E	G	L	L	L	L
East BlackSea Region	L	L	L	L	L	L	L	L	L	L	L	L

Most months follow lognormal distribution. Similarly, we applied RIC criteria for model selection to city-month pairs. Results are displayed with the following table.

Table 6. Cith-month pairs model selection by RIC criteria.

Region	City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
West Black SeaRegion	Bartın	L	L	L	L	G	L	G	L	L	L	L	L
	Bolu	G	L	L	L	L	L	L	L	L	E	L	L
	Düzce	L	L	L	L	G	L	L	L	L	G	G	L
	Kastamonu	E	L	L	L	G	L	G	L	L	L	L	L
	Zonguldak	L	L	L	L	G	G	L	L	L	L	L	L
Middle Black SeaRegion	Amasya	L	L	L	E	L	L	L	G	L	L	L	L
	Çankırı	L	L	L	L	L	L	L	E	E	L	L	L
	Sinop	L	L	G	L	L	L	E	L	L	E	L	L
	Samsun	L	L	L	G	G	L	L	L	L	L	L	G
	Tokat	L	L	L	L	G	L	G	G	L	L	L	L
East Black SeaRegion	Artvin	G	L	G	L	L	G	L	L	L	L	L	L
	Bayburt	G	L	L	L	L	L	E	E	L	L	L	L
	Giresun	L	G	L	E	L	L	L	L	E	G	L	L
	Gümüşhane	L	L	L	G	L	L	L	L	L	L	L	L
	Ordu	L	L	L	L	E	L	E	L	L	L	L	L
	Rize	G	L	L	L	L	E	E	L	L	G	L	G
	Trabzon	L	L	L	L	L	E	G	G	G	L	L	E

Most cases follow lognormal distribution.

Rainfall data have natural lower bound of zero because it is not possible to have negative rainfalls. Since our dataset follow lognormal distribution in most cases, we wanted to display lognormal and truncated lognormal distribution pdf functions in four city-moth pairs which have highest outlier rates.

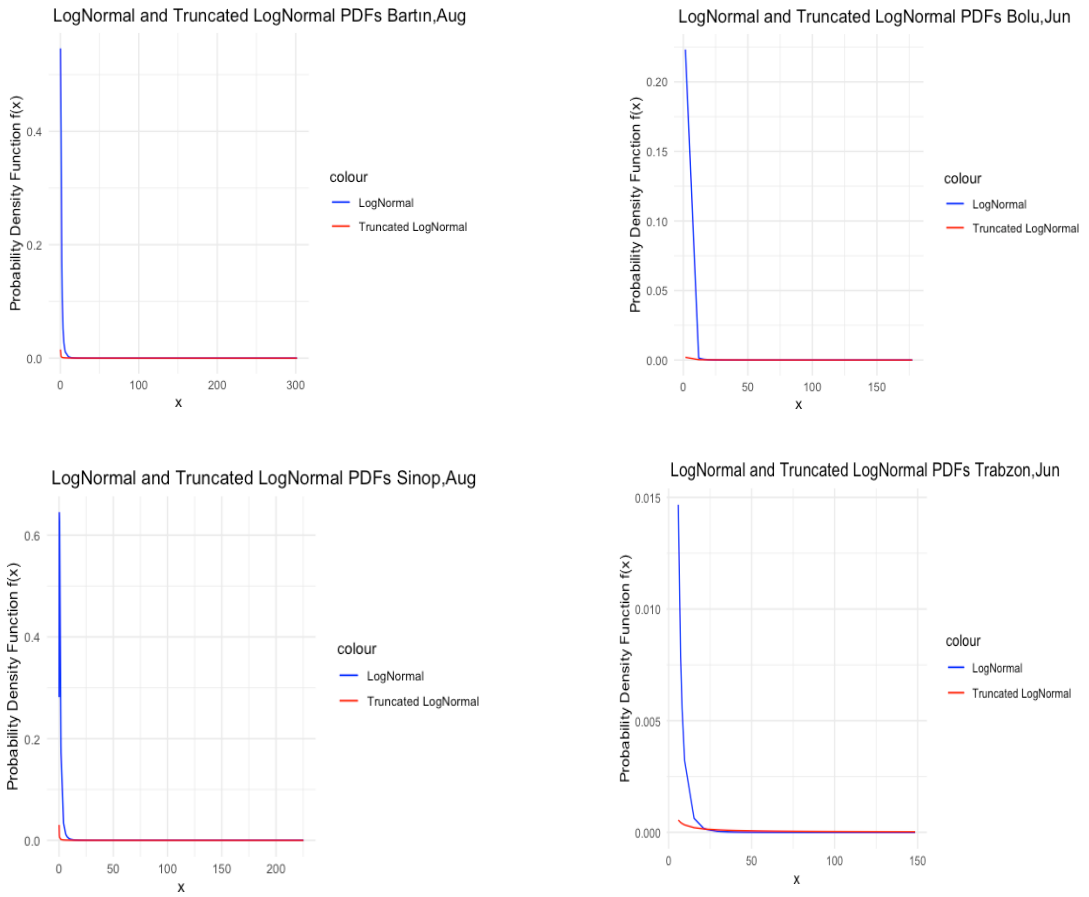

Figure 9. Comparison plots of Lognormal and Truncated Lognormal probability density functions.

DISCUSSION AND CONCLUSION

Rainfal data typically contain outliers because of their inherent variability and potential extreme weather events. Outliers in rainfal data can occur for multiple reasons, including extreme weather events, natural variability and spatial variatons. MDPDE approach has been applied statistical rainfall modeling by Hazra and Ghosh (2019). We found that the rainfall dataset of black sea region in Turkey follow lognormal distribution in most cases by applying similar method in our study. Finally, we visualized the comparison of lognormal and truncated lognormal pdfs on city-month paris with the highest outlier rates. Eventhough rainfall data has a lower bound of zero, in the case of truncated distributions, the distribution is still affected by extreme values that exist. Therefore, the possibility of applying robust methods to the truncated case arises. Truncated distributions are worth considering for the MDPDE approach in rainfall data modeling.

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Changing The Risk Measures In Risk Parity Models

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Abstract

The uncertainty of the financial markets after the 2008 crisis has pushed in the interest of finding new way of diversification. With the Risk Parity or Equally weighted Risk Contribution strategy, Maillard, Roncalli and Teiletche (2008) suggested a method that maximize the diversification. These authors have applied this strategy to the volatility (standard deviation). In this work, we change the Risk measure by using Conditional Value at Risk. Passing to CVaR, a coherent measure, the model can benefit from its properties with the needed assumptions. We have applied this method to stock portfolios, bond,commodities, mixed and the later cryptocurrency, compared the Risk Parity strategies with each other and with the Mean Variance and Conditional Value at Risk. An important part is the analysis of the riskiness, the diversification and the turnover. We compare not only between the Risk Parity models but also with other models like the traditional Mean Variance, CVaR, the naïve 1/n and some particular cases. Also we change number of possible selection for the possible choices.

Key words: *Risk Parity, CVaR, Portfolio optimization, Asset allocation*

INTRODUCTION

In the past years, the financial markets high volatility, has pushed the need on finding better ways to diversify the financial portfolios, specially in the cryptocurrency market. The evolution of modern portfolio theory, the after Markowitz (1952), have been in a large number of other portfolio optimization models created to target certain investors. (Sharpe,1964) tried to linearize the portfolio optimization model. The Mean-Variance model is too sensitive to the input parameters, specially to the expected returns (Merton,1980). Thus, a significant variation of the input parameters can significantly change the composition of the portfolio, like in the Mean Variance portfolio. Models that rely on expected returns tend to be very concentrated on few assets and perform poorly out of sample (Merton,1980).

The Black&Litterman model can be obtained using a Bayesian approach to change the estimated returns (Black, Litterman, 1990). With the passing of time, more sophisticated and advanced models were developed for the market forecasting, introducing different techniques and simulations. Thus, investors continue to use such simple allocation rules for allocating their capital across assets.

(Konno and Yamazaki 1991) introduced the Mean-Absolute Deviation (MAD), a different risk measure using linear programming model instead of a quadratic programming model.

The MiniMax approach, introduced by Young (1998), minimizes the worst-case scenario, which is used as risk measure. Risk Metrics introduced methods to quantify market risks, such as $VaR_\alpha(x)$ which is defined as the maximum potential change in value of a portfolio with a given probability over a certain horizon. Risk Management has used this instrument for many years, in order to evaluate the performance and regulatory requirements, and to develop methodologies to provide accurate estimates.

$VaR_\alpha(x)$ does not allow diversification. There are many works on the alternative risk measure $CVaR_\alpha(x)$ from the authors such as Andersson, Mausser and Uryasev (2000) that show why this is more preferred to $VaR_\alpha(x)$. The most important properties are that $CVaR_\alpha(x)$ is a coherent and a convex measure shown in the model presented by (Artzner,1999), a model that allows diversification. All these models have one problem in

common: they need as an input the estimation of expected return for the assets. Models that need to estimate expected returns, produce extreme weights and have significant fluctuation over time.

The models of portfolio selection using the Risk Parity criteria are the main topic of this paper. Following the 2008 financial crisis, these models' methods for allocating risk among the assets that make up a financial portfolio attracted more attention. In order to capture the long-term risk premium built into different assets, Qian (2005) proposed the concept and it resulted in the development of Risk Parity Portfolios, where we allocate the same level of risk to stocks and bonds. Risk Parity portfolios are more effective than conventional 60/40 portfolios and offer true risk allocation balance. Maillard, Roncalli, and Teiletche (2009) were the first authors to present and discuss this viewpoint. The risk of a portfolio is typically distributed using risk parity methodologies, which divide the entire risk of the portfolio into the risk contributions of each component in the same proportion. The Risk Parity approach's ability to avoid requiring the estimation of expected returns is one of its main advantages. The decomposition of risks is s feasible by applying the Euler decomposition for first order homogeneous functions by using the characteristics of the coherent and convex measures as specified by Artzner (1999).

In the Risk Parity models used in the literature, the measure of risk is the standard deviation of the financial portfolio. In this paper, we apply the Risk Parity approach to a different risk measure, the Conditional Value at Risk ($CVaR_\alpha(x)$), which is a coherent and convex risk measure, that allows to apply the Euler decomposition for first order homogeneous functions. The decomposition requires the calculation of the derivatives of risk measure. In the literature this model is used under the hypothesis that the returns are distributed like a multivariate normal for the calculation of the optimal weights with historical simulation. This hypothesis is less credible due to the lack of reality. Another author, Stefanovits (2009) in his master thesis, applies the equally risk contribution to the expected shortfall in case of standardized multivariate distribution, using a Gaussian kernel estimation. He implemented Risk Parity approach to Expected Shortfall assuming normally or t-student data in a parametric approach. In this paper the Risk Parity model with $CVaR_\alpha(x)$ as a risk measure can be applied any (real) return distribution. This is possible with approximation methods in the calculation of the partial derivatives of the Conditional Value at Risk (Tasche, 2000). The author compares the Risk Parity strategies with different risk measures (standard deviation and Conditional Value at Risk). The results are very similar but the time of computation of Risk Parity with Conditional Value at Risk is significantly shorter. Starting from the studies of Colucci (2013), the author creates a Risk Parity with Conditional Value at Risk which has no true diversification, in order to compare it with Risk Parity with $CVaR_\alpha(x)$.

The models have been applied to daily and weekly frequencies in order to have a good approximation of Risk Parity with $CVaR_\alpha(x)$. Since the last year the cryptocurrencies market had been afflicted from high volatility and a negative trend, the focus will be on how the portfolio created will perform in these cases. The algorithms for the calculation of the weights of the optimal portfolios are developed in Matlab 2022a©, running in a Windows 10 operating system, in a computer with processor Intel (R) Core(TM) i7-7500U CPU @ 2.70-2.90 GHz , and 12 GB of RAM that compute the algorithm in a very short time. The algorithm uses an interior point solution using limited number of iterations in the case of the Risk Parity model with $CVaR_\alpha(x)$.

MATERIAL AND METHODS

In the literature, the most common use of Risk Parity is the case with the standard deviation as risk measure. For a portfolio with n assets and weights $x = (x_1, x_2,, x_n)$, the standard deviation is:

$$\sigma_P(x) = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j \sigma_{ij}} = \sqrt{x'\Omega x}$$

where Ω is the covariance matrix.

The marginal risk contribution of the i asset:

$$MRC_i(x) = \frac{\partial \sigma_P(x)}{\partial x_i} = \frac{\partial \sigma_i^2 + \sum_{j=1}^{n} x_i \sigma_{ij}}{\sigma_P(x)} = \frac{(\Omega x)_i}{\sqrt{x'\Omega x}}$$

And the total risk contribution:

$$TRC_i(x) = x_i \frac{\partial \sigma_P(x)}{\partial x_i} = x_i \frac{\partial \sigma_i^2 + \sum_{j=1}^{n} x_i \sigma_{ij}}{\sigma_P(x)} = x_i \frac{(\Omega x)_i}{\sqrt{x'\Omega x}}$$

It is easy to show that:

$$\sum_{i=1}^{n} TRC_i(x) = \sum_{i=1}^{n} x_i \frac{(\Omega x)_i}{\sqrt{x'\Omega x}} = \sqrt{x'\Omega x} = \sigma_P(x)$$

Recall that the solutions Mean-Variance model enjoys the following problem:

$$\frac{\partial \sigma_P(x)}{\partial x_i} = \frac{\partial \sigma_P(x)}{\partial x_j}$$

In other words, it to equalizes the marginal risk contributions, instead of the total risk contributions as in case of the Risk Parity:

$$TRC_i(x) = TRC_j(x) \; \forall \; i, j$$

The Risk Parity model can be formulated as the following optimization problem:

$$x^* = \arg\min \sum_{i=1}^{n} \sum_{j=1}^{n} \left(TRC_i(x) - TRC_j(x)\right)^2$$

$$\sum_{i=1}^{n} x_i = 1$$

$$x \geq 0$$

Since $TRC_i(x) = x_i \frac{\partial \sigma_P(x)}{\partial x_i}$ and $TRC_i(x) = \frac{\sigma_P(x)}{n}$, the problem can be written as follow:

$$x^* = \arg\min \sum_{i=1}^{n} \sum_{j=1}^{n} \left(TRC_i(x) = TRC_j(x)\right)^2$$

$$\sum_{i=1}^{n} x_i = 1$$

$$x \geq 0$$

An important point is proving the existence and, after the uniqueness of the Risk Parity portfolio, that Maillard S., Roncalli T., Teiletche J (2012) had proved in their working paper. This is possible, by using the properties of the covariance matrix Ω which is positive-definite. Thus, this becomes a problem which requies the minimization of a convex quadratic function with convex constraints, where can be applied the first order Khun-Tucker conditions for the Lagrangian. An important conclusion of their work is the mathematical proof where they showed that the standard of the Risk Parity portfolio is in between the Mean- Variance Model and the naive portfolio (the portfolio that take equal weights 1/n).

$$\sigma_{MV} \leq \sigma_{RP} \leq \sigma_{\frac{1}{n}}$$

For the numerical approximation in the existence of the partial derivatives of $CVaR_\alpha(x)$ we need to put some assumptions on the distribution of the return vector $R = (r_1, r_2, .\, ,r_n)$.

The portfolio return $X = R'x = \sum_{i=1}^{n} x_i r_i$ to must be differentiable respect to the weights x_i to apply the Euler decomposition.

The return r_i from t to time $t+1$ is measured as follow:

$$r_{i,t+1} = \frac{P_{i,t+1} - P_{i,t}}{P_{i,t}}$$

Starting from the definition of $CVaR_\alpha(x)$ (Rockfellar R.T., Uryasevs, 2000) we have

$$CVaR_\alpha(x) = \frac{1}{\alpha}\int_0^\alpha VaR_v(x)\mathrm{d}v$$

With the needed assumption for the partial derivatives respect to the weights.

$$\frac{\partial CVaR_\alpha(x)}{\partial x_i} = \frac{1}{\alpha}\int_0^\alpha \frac{\partial CVaR_\alpha(x)}{\partial x_i}\mathrm{d}v = -\frac{1}{\alpha}\int_0^\alpha E[r_i|-R'x = VaR_\alpha(x)]\mathrm{d}v =$$

$$\frac{1}{\alpha}\int_0^\alpha E[r_i|X = q_\alpha(X)]\mathrm{d}v = -E[r_i|X \le -VaR_\alpha(x)]$$

After finding of the partial derivatives for the Value at Risk, we can use them to compute the partial derivatives of the Conditional Value at Risk.

The Total Risk contribution for each asset i of a portfolio is given from the following expression:

$$TRC_i^{CVaR^\alpha(x)}(x) = x_i \frac{\partial CVaR_\alpha(x)}{\partial x_i}$$

The expression in case of continuous returns distribution is the following:

$$TRC_i^{CVaR^\alpha(x)}(x) = -x_i E[r_i|X_i \le -VaR_\alpha(x)]$$

$$CVaR_\alpha(x) = \sum_{i=1}^{n} TRC_i^{CVaR^\alpha(x)}(x) = -\sum_{i=1}^{n} x_i E[r_i|X_i \le -VaR_\alpha(x)]$$

For the discrete variables in the numerical finding for $\boldsymbol{VaR_\alpha(x)}$ and $\boldsymbol{CVaR_\alpha(x)}$ Risk Parity using times series observations we have to do the following assumption. Suppose that the i-th asset return r_i consist of T number outcomes r_{ji} with i=1,.....,n and j=1,...,T. For each portfolio $x \in \mathbb{R}^n$ where n is the number of assets considered at our portfolio, the vector of the observed portfolio returns is $R_P = (r_{p1}, \dots\dots, r_{pT})$ where:

$r_{pj} = x'r^j$ with j=1,....,T where $r^j = (r_{j1}, \dots\dots, r_{jT})$.

By apply the Law of Large Numbers for the number of observation large engouh, The approximation of the empirical distribution of the observed portfolio return:

$$P(R_P \le y) \approx \frac{\#(j = 1, \dots\dots, T|r_{p1} \le y)}{T}$$

Therefore we compute the $VaR_\alpha(x)$ and $CVaR_\alpha(x)$ of portfolio returns as follows:

$$VaR_\alpha(x) \approx -r^{\text{sorted}}_{\text{p}\lfloor\alpha\text{T}\rfloor}$$

$$CVaR_\alpha(x) \approx -\frac{1}{\alpha\text{T}}\sum_{\text{j}=1}^{\lfloor\alpha\text{T}\rfloor} r^{\text{sorted}}_{\text{p j}}$$

where α is the significance level and $r^{\text{sorted}}_{\text{p j}}$are the sorted portfolio returns that must satisfy

$$r^{sorted}_{p\,1} \le r^{sorted}_{p\,2} \le \cdots r^{sorted}_{p\,j} \le \cdots \le r^{sorted}_{p\,j}$$

For more see Veliu D. PhD Thesis 2015

Using times series obervations, the approximation of the partial derivatives $CVaR_\alpha(x)$ for each asst i becomes:

$$\frac{\partial CVaR_\alpha(x)}{\partial x_i} \approx -\frac{1}{\alpha T}\sum_{k=1}^{\lfloor \alpha T \rfloor} r_{k\,i}^{\text{sorted}} \;\forall\; i=1,\ldots,n$$

and then the total risk contribution of asset i is

$$TRC_i^{CVaR^\alpha(x)}(x) = x_i \frac{\partial CVaR_\alpha(x)}{\partial x_i} \approx -\frac{1}{\lfloor \alpha T \rfloor} x_i \sum_{k=1}^{\lfloor \alpha T \rfloor} r_{k\,i}^{\text{sorted}}$$

where $r_{k\,i}^{\text{sorted}}$ are the related returns of asset i to the ordered portfolio returns from the smallest to the biggest. To use this, we have to have highly frequency data, at least weekly or better with daily data.

In this way we switched from standard deviation to CVaR as risk measures in the Risk Parity models.

An important phase of the paper is comparing the performance, and to see if there is a significative difference between these Risk Parity models with different risk measures.

For each portfolio We will try different rolling windows to see how do they perform by measuring the cumulated return of the portfolio.

$$\mu_k^c(R_P) = \prod_{j=1}^{k}(1 + r_{pj}) - 1$$

so that $\mu^c_T(R_P)$ is the compounded return from the beginning till the end.

For the diversification we have shown the bera park index. This diversification measure can be interpreted as the probability of each weight measure in terms of entropy:

$$D_{BP} = -\sum_{i=1}^{n} x_i \log(x_i) = \sum_{i=1}^{n} x_i \log\left(\frac{1}{x_i}\right)$$

The D_{BP} takes value between 0 (fully concentrated in one asset) and log(n) for the naive portfolio.
Also we have shown how many assets have been selected in each optimization.

RESULTS

For the group of the assets without interruption of the series(i.e. instead of 30 of DAX30 index we use only 26), in order to see the subset selected using the Mean Variance and the Conditional Value at Risk (Rockefellas 200) without the expected return constrain, and acheiving the minimum risk with the respective measure of risk. The period of observation weekly frequencies of data (finance.yahoo.com), is from 1/1/2000 to 4/7/2014 consisting of 756 weeks or 174 months (14.5 years). To compare the performance, the building of the rolling time window is extended within sample period of 4 past years (L= 4 years or 208 weeks) and out of sample period of one month (4 weeks). (We use this for DAX30/CAC40/Eurostoxx50, FTSE100, NIKKEI225)

Table 1. The concentration of Conditional Value at risk and Mean-Variance models

Average number of assets	**Concentration/Number of possible assets**				
Portfolio Model	**DAX30**	**CAC40**	**Eurostoxx50**	**FTSE100**	**NIKKEI225**
CVAR	8/26	11/32	12/44	20/77	18/188
Mean-Varianc	11/26	9/32	8/44	12/77	20/188

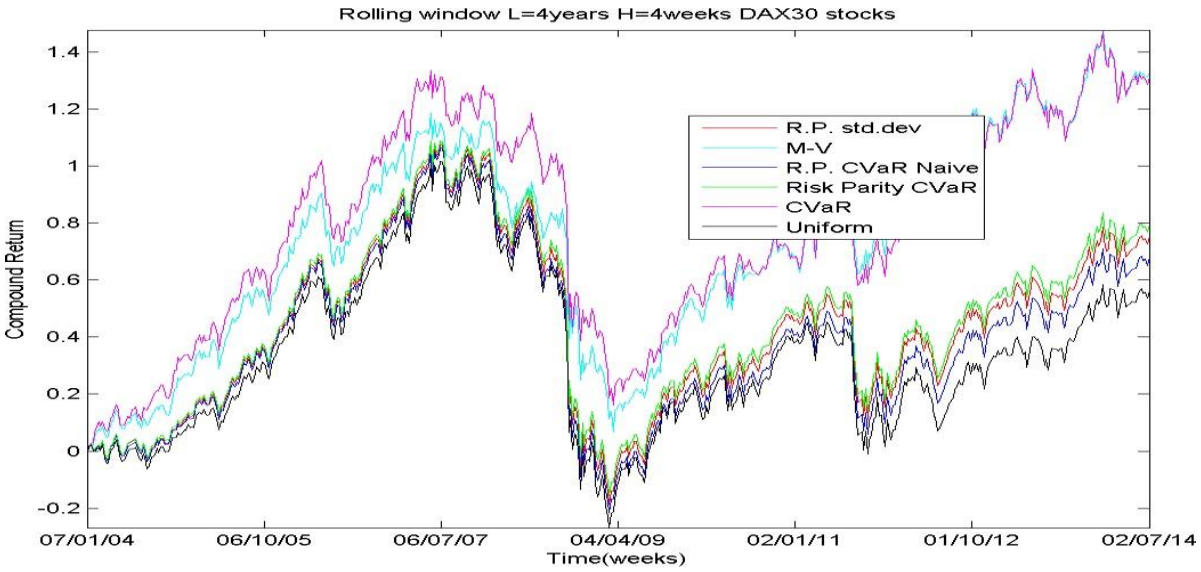
The Risk Parity strategies take in calculation all the assets of the portfolio in a significant way (more than 0.1%), they will have better diversification.

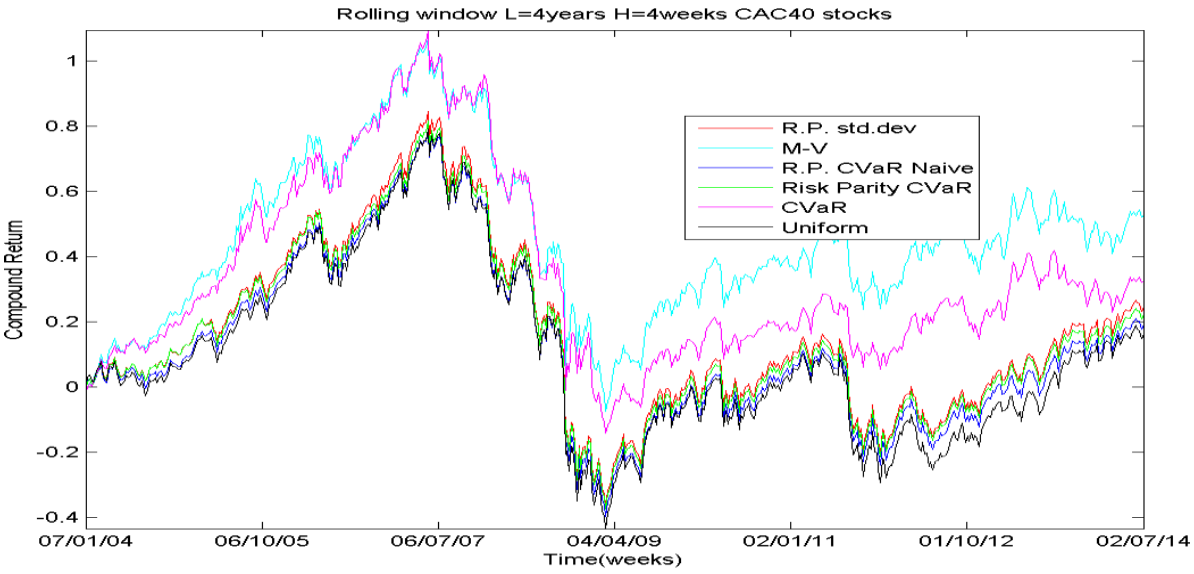
If the investor tends to select a smaller number of assets, he can use different strategies but can not apply the cardinality constraints for the optimization model. Table 1

Passing the data to monthly time series the concentration will be higher. The Risk Parity strategies take in consideration all the assets in a significant way. From the other side we have a higher turnover.

In the beginning, it may look a small number, but this is the average for the (756-208)/4=137 iterations.

The graphs of the compound return of the models can be described in two parts: The first is before the subprime crisis of 2008 and second after the crisis. We notice that Mean-Variance and CVaR, that are highly focused, in the first part have the same trajectory and after the crisis the Mean Variance dominates all the model in the performance.





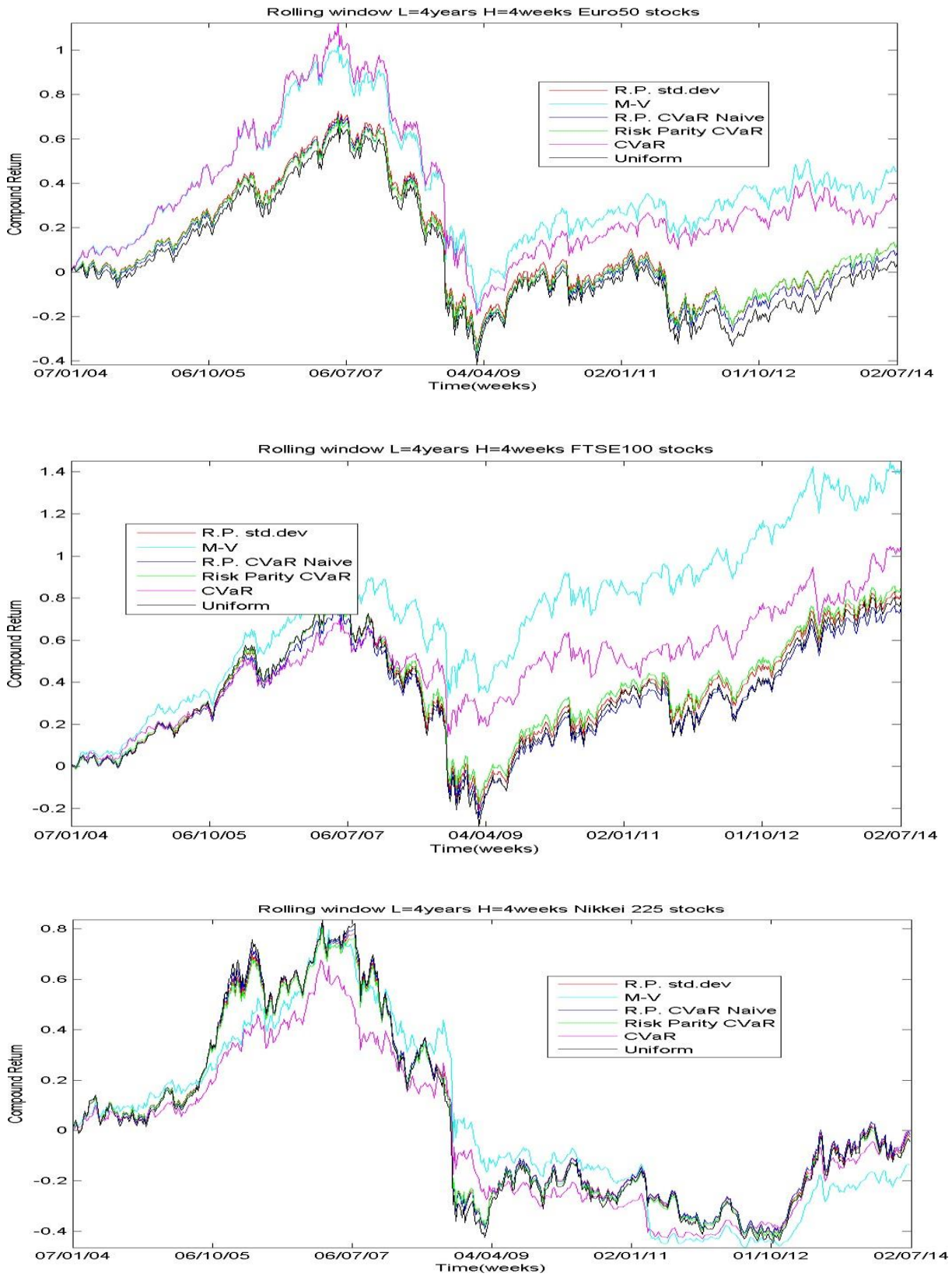


Fig.1 The compound returns for the DAX30/CAC40/ EURO50/FTSE100/Nikkei 225 stock selection

As we see from figure 1 there is no significative difference between Risk Parity with CVaR or standard deviation. Wıth increaseing the number of assets in the portfolio, the difference between the Risk Parity models with get closer to each other. The Mean Variance and CvaR are at minimum risk, but the performance in terms of compound returns is better than the other models.

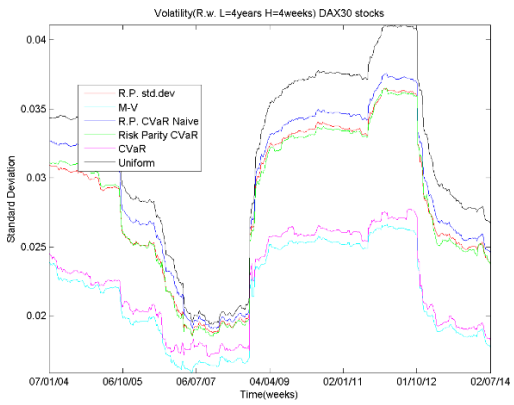
In another sample of cryptocurrency portfolio, we create the a rolling window using the daily frequency data of the past 2 years (from 1/1/2018 to 1/1/2020 so L=365*2=730 observation) for the estimation of the weights of the each of the portfolio models and move the rolling window in the period from 1/1/2020 to 31/1/2021 to measure the out of sample for the next 7 days (Holding period). Remind that the cryptocurrency is opened 24/7, so the holding period is one week. (data finance.yahoo.com)

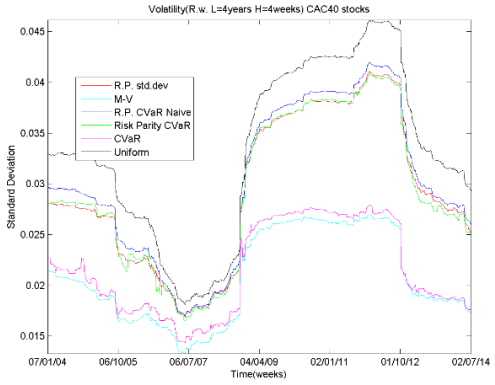
The Cryptocurrencies are: Binance Coin USD (BNB-USD), Bitcoin USD (BTC-USD), Cardano USD (ADA-USD), Chainlink USD (LINK-USD), Dogecoin USD (DOGE-USD), Ethereum Classic USD (ETC-USD) Litecoin USD (LTC-USD), Monero USD (XMR-USD), Stellar USD (XLM-USD), Tether USD (USDT-USD)

Fig.2 The compound return for the Cryptocurrencies

The uniform portfolio (naïve portfolio in blue color) and the Risk Parity with CVaR Naïve, which do not consider the risk in the first place, outperform compared to the other risk measures but on the ongoing have also a higher drawdown (April 2020). The uniform at the end of the observation have doubled his compound return rate.

The riskiness of each portfolio is measured in terms of mean Variace (in case of CVaR we will have same result with CVaR change the role of the standart deviation.





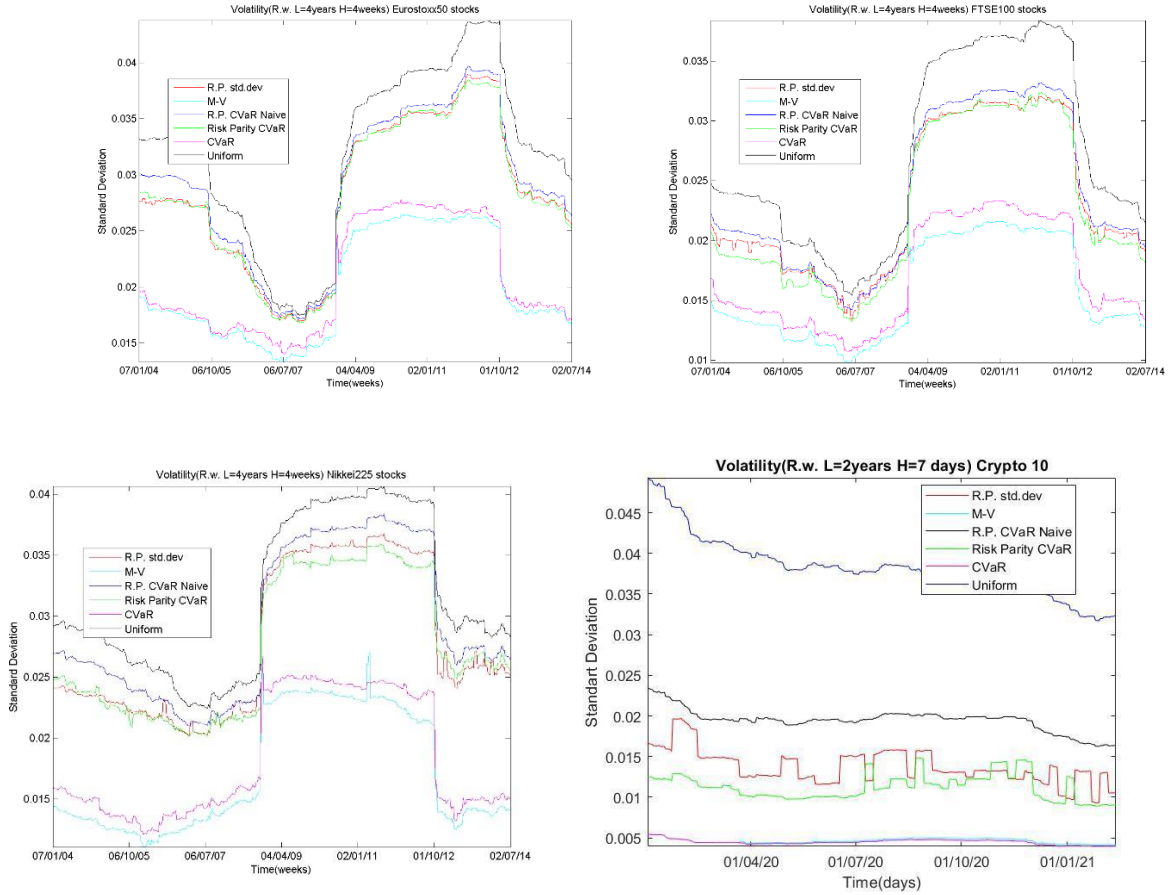
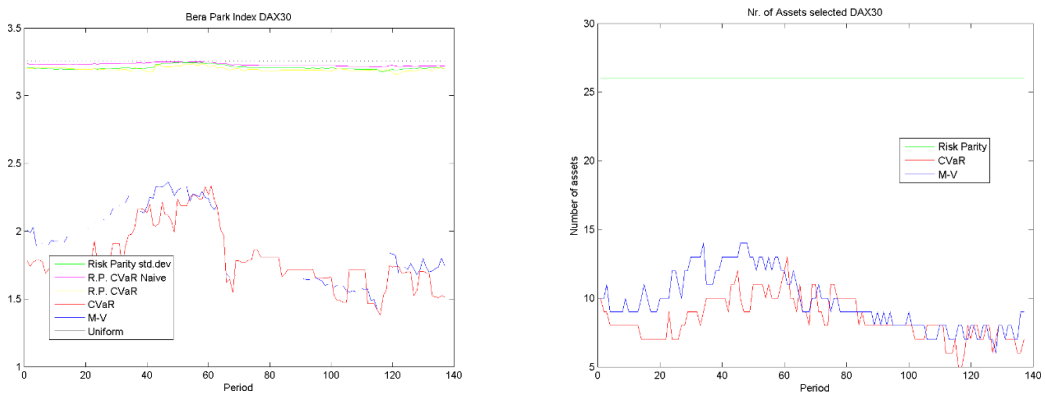


Fig 3. Volatilities of the DAX30/CAC40/ EURO50/FTSE100/Nikketi 225 and the crypto portfolio.

İn fig. 3 we see a common trend between the riksyness expressed with the standart deviation in all stock portfolios; the less riskiness in the Mean Variance with the minimum risk, the more risky is the naive or uniform and the risk parity are in between with not a signifant difference.

Another point in comparing the change of the risk measure to CVaR to the risk Parity models is to see the diversification and the turn over of the financial portfolio.



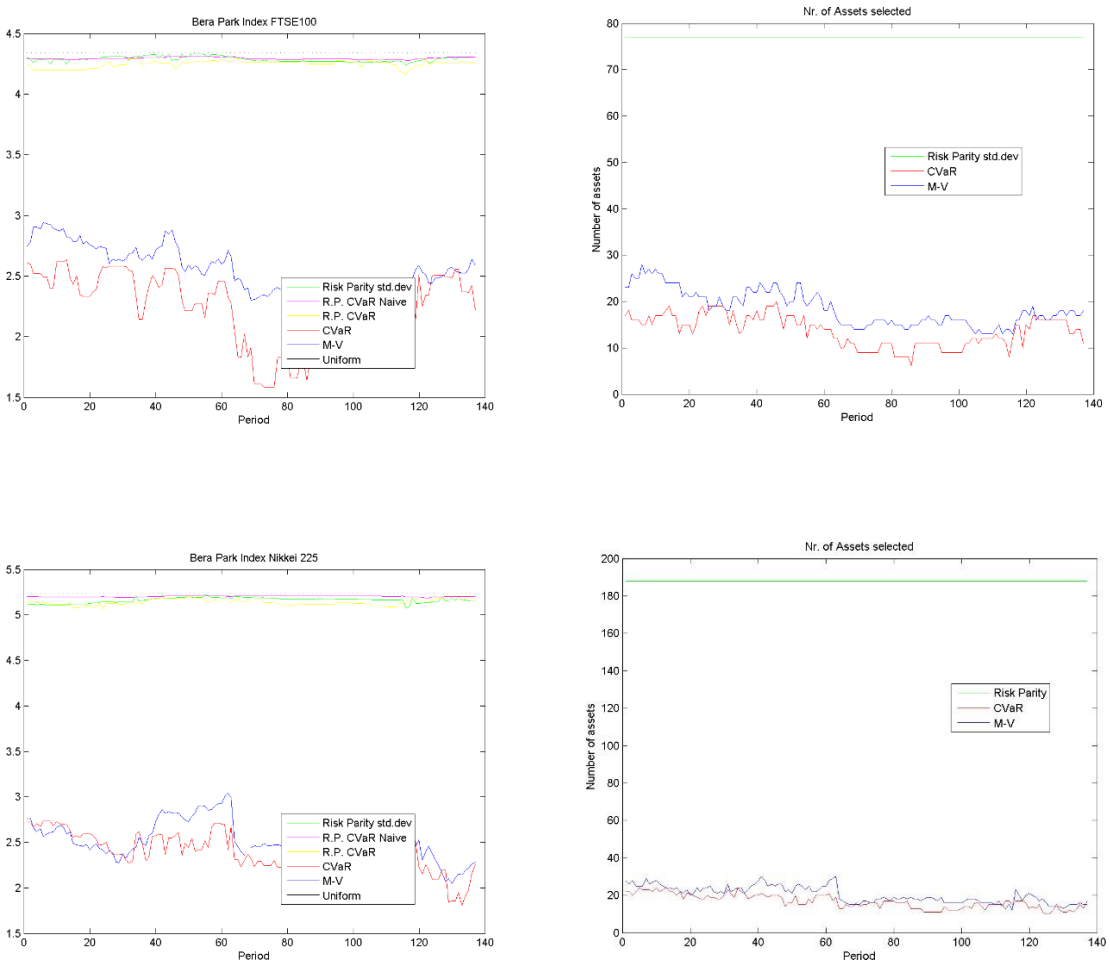


Fig.4 The Bera Park Index and the number of assets selected in each optimization

(DAX30/FTSE100/NIKKEI 225)

The Bera Park is used to measure diversification; keep in mind that the greater the value, the more well-diversified the portfolios are.

As the last point we consider the number of assets that each model selected with a reasonable quantity (we do not consider the weights smaller than 10^{-6} 6) . Since Risk Parity models and the naive portfolio, consider all the assets we will show just one of them.

Table 2. The average turnover (%) of the portfolios

Portfolio Model	**DAX30**	**CAC40**	**Eurostoxx50**
CVAR	0.2356	0.546	0.4568
Mean-Variance	0.1893	1.065	1.546
Risk Parity with St.d.	0.0526	0.053	0.0392
Risk Parity with CVaR	0.0847	0.105	0.0530
Risk Parity with CVaR-Naive	0.0438	0.052	0.0267

We notice that by increasing the number of the possible selections, the transaction cost will increase in the more concentrated portfolios. For the risk parity models there is no significance in the change of the risk measure from standart deviation to the Conditional Value at Risk.

The portfolio turnover will be larger since Mean Variance and CVaR are concentrated in a smaller number of cryptocurrencies due to the small number of cryptocurrencies (ten). Despite the fact that numerous sites are offering easy access to cryptocurrencies, we might still have to pay subscription fees and modest commissions.

DISCUSSION AND CONCLUSION

The conventional approaches, like the Markowitz model, exclusively concentrate on the assets thathave the absolute minimal amount of risk. Therefore, if the investor tries to rebalance the portfolio, this high concentration will likewise have significant transaction costs. Additionally, relying on excpected returns during a downturn in the economy would result in an unrealistic and pessimistic asset allocation.

For all of this, we constructed the numerical aproxiamtion to switch to Risk Parity to Conditional Value at Risk after describing the characteristics and constraints of the risk parity techniques. We have developed a rolling window for weekly frequencies 5 main stocks (DAX30/CAC40/ EURO50/FTSE100/Nikkei 225) portfolio, with samples of one year (252 days) and one week (5 days).

Although there is not a significant variance in performance(compound return) across Risk Parity strategies using different risk measures, by converting to CVaR, the investor can gain from the advantages of a coherent risk measure (Artzner, 1999). Additionally, the riskiness of the Risk Parity strategies (which are almost in the same level measured with the volatility of the portfolio), is allocated between the CVaR (or Mean Variance) and the naive portfolio.

The portfolio created using the Risk Parity criteria demonstrated improved diversification (as judged by Bera Park indices and the numer of assets involved) and less concentration in high weights when compared to Conditional Value at Risk and Mean Variance. The cost of recalibrating the portfolio will be lower if the costs are variable. An investor can cover the exposed quantity by retaining the same amount of risk-free assets (for example, the same number of bonds in the case of CVaR) and maintaining different and considerable amounts of each agricultural product. From the perspectives of performance and riskiness, the Risk Parity techniques are a good accommodation between the traditional CVaR, Mean-Variance, and the Nave (uniform selection).

In the case of crytocurrency portofolio, we used a higher frequence of data, by passing to daily data. This maket is known to have higher volatity and very sensitive to the input information. Due to the limited number of cryptocurrencies, the Risk Parity strategy will produce stable portfolios with little drawdown and good diversification.

In conclusion, if we change the risk measure in the risk parity models, to use the CvaR as risk measure, we will have less computational time, and also will have the same perfomance and riskyness as with the previus risk measure.

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Examination Of Eu 2020 Sustainable Growth Goals With Genetic Algorithms

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Abstract

Worldwide globalization, climate change, and the economic and financial crisis in the EU economy have deeply affected Europe. On March 3, 2010, the "Europe 2020 Strategy: European Strategy for Smart, Sustainable and Inclusive Growth" report was announced to make Europe stronger than before. The Europe 2020 strategy has identified 5 mutually supporting targets on employment, education, social inclusion, R&D and climate and energy, with the priority of smart, sustainable and inclusive growth targets. Sustainable growth is defined as the efficient use of resources and energy and sustainable economic growth. Within the scope of sustainable growth , it is aimed to protect EU countries in terms of biodiversity , prevent waste of resources and support efficient energy use. This issue is very important as it is expected that these targets will be effective in creating economic growth and new employment opportunities for EU countries. In this direction, with this study, the sustainable development of EU countries It is aimed to examine growth performances with genetic algorithm, which is one of the popular methods. Within the scope of the study, sustainable growth and indicators of sustainable growth were examined with a genetic algorithm and the situations of the countries were examined. Genetic algorithm is a multi-purpose optimization method which is one of the most effective methods in structures that are complex and require multiple goals to be achieved at the same time, and simultaneously. It has not been found in the literature to examine EU countries with this method according to their sustainable growth indicators. Therefore, it is thought that this study will contribute to the literature.

Key words: *EU 2020 Strategy, Sustainable Growth, Genetic Algorithm*

MCDM and Normalization Methods: Which Is More Critical In Decision Making Processes?

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Abstract

Multi-Criteria Decision Making (MCDM) methods refer to a decision-making methodology structured for the purpose of selecting the most appropriate alternative and ranking it with others, accompanied by criteria of different importance or weight. Criterion values in different units must be converted to unitless dimensions in order to be processed in the calculation. Normalization techniques are used to obtain a homogeneous decision matrix and start the MCDM process. Although these transformative techniques appear to be equivalent to each other, their performance is different and therefore they may affect the final rankings of MCDM differently. Some authors even argue that normalization is the usual suspect in the rank reversal phenomenon. Although there are exceptions depending on the data sets, we can obtain interesting insights when we keep an MCDM method constant and change the normalization techniques and check the results. First of all, it is clear that the normalization technique suggested and adopted by the inventors of MCDM methods and their successors (such as vector normalization for TOPSIS) is an issue that should be questioned. Second, the choice of an appropriate normalization technique is critical, and once this has been achieved, sometimes the choice of MCDM can be a much less important consideration. Thirdly, unit converters such as Vector, Sum, Max, Min-Max are widely adopted in MCDM methodology, whereas for artificial intelligence algorithms, this mostly applies to Min-Max and Z-Score. This unquestioned, rigid attitude is not objective and is a choice that is open to debate. Finally, the rank based converter, which is not used much by either discipline, can be recommended as a good alternative.

Key words: *Normalization, MCDM / Normalizasyon, ÇKKV*

Remote Sensing Applications In Agriculture

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Abstract

Remote sensing not only provides the opportunity to obtain data about dangerous, hard-to-reach and fast-moving objects, but also allows observation over large areas. Examples of remote sensing applications include monitoring deforestation, the condition of glaciers in the Arctic and Antarctic, and measuring ocean depth using lots. Remote sensing also replaces expensive and relatively slow methods of gathering information from the Earth's surface, while also ensuring that there is no human intervention in the natural processes in the areas or objects being observed. Remote sensing has also gained importance in the use and protection of natural resources in agriculture. Common threats faced by farmers are pests and weeds infesting crops. Remote sensing in agriculture can help detect these at an early stage and alert farmers to take necessary countermeasures to ensure crop health. Models prepared with the help of historical information and modern information collected from various sensors help agriculture in making future predictions.

Key words: *Sensors, Predictions, Modeling, Big data, GIS*

Bayesian Parameter Estimation Under Different Loss Functions For Geometric Process With Exponential Distribution

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Abstract

The aim of this study is to discuss the parameter estimation problem for the geometric process under the assumption that has an exponential distribution with parameter . The maximum likelihood (ML) and Bayesian methods are used in the parameter estimation problem. The Bayesian estimators are obtained under squared error loss function (SELF), LINEX, and general entropy loss functions (GELF) using uniform and gamma priors on the ratio a and parameters. Furthermore, the asymptotic confidence intervals (ACIs) are obtained by using the ML method. The Bayesian credible intervals of the parameters are also constructed by using the Gibbs sampling method. Moreover, the efficiencies of the Bayesian estimators under different loss functions are compared with the ML estimators through an extensive simulation study. It is seen that the Bayes estimators under the GELF and LINEX better than the ML estimators.

Key words: *Geometric process, Maximum likelihood, Bayesian estimators, Loss functions*

Comparison Of Quantile Regression And Bayesian Quantile Regression And Application Study

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Abstract

Regression analysis is one of the most widely used statistical analysis methods. It is widely used in the engineering field, as it is in many areas. If the conditions of linear regression are not met, such as linearity, homoscedasticity, independence, or normality, quantile regression is used as an extension of linear regression. Quantile regression models allow modeling in the presence of extreme values and in cases where the distribution is not normal. Quantile regression has advantages that linear regression does not have; it is robust against outliers and can model heteroscedasticity data. The parameters of quantile regression can be estimated using the Bayesian method. In Bayesian methods, parameters are considered random variables and have their own distribution. The posterior distribution of the parameters is obtained by using this distribution information and sample information. Any results related to the parameter are made by using this posterior distribution.This study aims to compare the estimation results obtained by quantile regression and Bayesian quantile regression. For this purpose, first, the data are obtained for the considering model by the simulation and the results of both methods are compared. Then, a similar comparison is made for the real dataset given in the literature. The R program is used to obtain simulations and real data results.

Key words: *MCMC (Markov Chain Monte Carlo), Bayesian Approach, Regression Analysis, Winbugs*

Learning With Subset Stacking (less)& nbsp; with Feature Selection Method: A Comparative Analysis

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Abstract

This study used the Cleveland, Hungarian, Switzerland, and VA Long Beach databases of the UCI repository of heart disease patients. In order to reduce the number of independent variables used for prediction, three different feature selection techniques were first applied: LASSO, Elastic Net and Adaptive LASSO. Then, four different classification techniques were implemented to predict heart disease: LESS, Support Vector Machine (SVM), Decision Tree (DT), Random Forest (RF). The performances of these methods were measured with different metrics such as accuracy, sensitivity, specificity and Matthew correlation coefficient, and the effects of the number of variables on the performance were compared.

Key words: *Classification Algorithms, LASSO, LESS*

A Research On Customer Relationship Management In The Retail Industry

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Abstract

Improving customer relations in the marketing sector is very important for the sustainable growth of the company. Customer relationship management provides strategies to better understand customers and predict how they will interact in the future. For this reason, the methods used in managing customer relations are very important for businesses. In this study, customer data of a developing market is discussed. It is aimed to provide strategic solutions to the market by analyzing the habits of market customers using statistical methods. For this purpose, customer segments were determined by RFM analysis by measuring customers' purchasing habits. The products that customers purchased together were examined through association analysis, and suggestions were made to the market about organizing campaigns for the products purchased together. Data visualization techniques were used to describe the analyzed big data and interpret statistical results. All statistical analyses were carried out using Python programming.

Key words: *Customer relationship management, RFM analysis, Association analysis, Big data*

Examining Turkey's PISA Success With Cluster Analysis

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Abstract

It is only possible for people to keep up with the universe they live in and live open to innovations with quality education. Various applications have been developed to determine the quality of education, and thanks to these applications, it is aimed to increase the quality of education and maintain a prosperous life. For this purpose, the PISA application, a research initiative by the Organization for Economic Co-operation and Development (OECD) in 1997, aims to measure the literacy of 15-year-old students in mathematics, science and reading, taking into account environmental factors such as motivation, socio-economic level and opportunities. In this study, our country's PISA mathematics achievement among OECD countries was examined using cluster analysis methods. For this purpose, some factors that are thought to affect success were discussed and it was investigated which countries our country is together with and which factors are more effective in determining the cluster in which our country is located.

Key words: *PISA, OECD, Clustering analysis, K-means, K-nearest neighbor*

GİRİŞ

Gün geçtikçe hızla değişen bir dünyada, bu değişikliklere uyum sağlayabilen, araştırabilen, eleştirebilen, özveri ve özgüven sahibi bireyler yetiştirmek ancak iyi bir eğitimle mümkündür. İstikbali parlak bir toplum için bireylere yapılacak en güçlü yatırım kaliteli bir eğitim ile mümkün olabilir. Özellikle akıl yürütme becerilerini geliştirmek, bireylerin sahip oldukları bilgileri, yaşantılarına uyarlayabilmeleri ve etkin iletişim becerilerine sahip olmaları evrene ayak uydurabilmek için şart hale gelmiştir.

Ülkelerin kalkınması için eğitime yapmış oldukları yatırımın da artması gerekir. Doğru alanlara yapılan sarfiyatlar sayesinde gelişmekte olan ülkelerin evrimleri de aynı oranda ilerleyecektir. Bu sebeplerden ötürü ülkeler yatırımlarının ne denli faydalı olduğunu görebilmek adına belli başlı ölçüm araçları geliştirmişlerdir.

Eğitim kalitesini daha iyi bir noktaya getirmek ve verilen eğitimi daha kullanışlı bir hale getirmek için, Türkiye'nin de kurucu üyelerinden biri olduğu Ekonomik İşbirliği ve Kalkınma Örgütü (OECD)'nün öğrenci değerlendirme programı olan PISA uygulanmaya başlamıştır.

PISA ve OECD

Uluslararası Öğrenci Değerlendirme Programı adıyla PISA, Ekonomik İşbirliği ve Kalkınma Örgütü tarafından, üçer yıl dönemler halinde planlanmış olan, ilköğretim zorunlu eğitimini tamamlayıp ortaöğretime geçmiş veya geçecek olan 15 yaş grubundaki öğrencilerin eğitim durumlarını ölçmeyi amaçlayan bir programdır (MEB, 2019). Bu programda öğrencilerin üç temel becerisi ölçülmek amaçlanır: Matematik okuryazarlığı, Fen Bilimleri okuryazarlığı ve Okuma becerileri. PISA testlerinde ölçülmek istenen durum, okul müfredatlarında işlenen konuları öğrencilerin hangi düzeyde öğrendiklerini belirlemekten ziyade, bu bilgileri hayatın içinde karşılaşabilecekleri sorunlar ve durumlar üzerinde uygulayabilme kabiliyetlerini ölçmek ve analiz yeteneklerini değerlendirmektir.

PISA araştırmalarından elde edilen sonuçlara göre ülkeler, eğitimde karşılaştıkları sorunları giderebilmek için çözüm yolları arama, eğitim-öğretim stratejilerini geliştirme ve dünya çapında eğitimdeki konumlarını görebilme

fırsatına sahip olmaktadırlar. Bu yönüyle PISA programı evrensel anlamda eşsiz bir konumda yer almaktadır (Çelen vd., 2011).

Açılımı Organisation for Economic Co-Operation and Development, Türkçe açılımı ile de Ekonomik İşbirliği ve Kalkınma Örgütü olarak bilinen OECD, 16 Nisan 1948 tarihinde Fransa merkezli olarak kurulmuştur. İkinci Dünya Savaşından sonra özellikle ekonominin sürdürülmesi ve iyileştirilmesi amacıyla birtakım faaliyetlerde bulunması hedeflenmiştir. 14 Aralık 1960 yılında Paris'te imzalanan "Convention on the Organisation for Economic Co-operation and Development", OECD'nin kurucu Anlaşmasını oluşturmaktadır. OECD'nin 20 tane kurucu üyesi vardır. Bunlar: ABD, Almanya, Avusturya, Belçika, Danimarka, Fransa, Hollanda, İngiltere, İsveç, İsviçre, İrlanda, İspanya, İtalya, İzlanda, Kanada, Lüksemburg, Norveç, Portekiz, Türkiye, Yunanistan'dır. İlerleyen yıllarda, kurucu ülkelere, 17 ülke daha eklenerek üye sayısı 37'ye çıkarılmıştır. Böylece günümüzde, Türkiye, ABD, Almanya, Avustralya, Avusturya, Belçika, Çekya, Danimarka, Estonya, Finlandiya, Fransa, Kore Cumhuriyeti, Hollanda, İngiltere, İrlanda, İspanya, İsrail, İsveç, İsviçre, İtalya, Japonya, İzlanda, Kanada, Kolombiya, Letonya, Litvanya, Lüksemburg, Macaristan, Meksika, Norveç, Polonya, Portekiz, Slovakya, Slovenya, Şili, Yeni Zelanda ve Yunanistan üye ülkeler konumuna gelmişlerdir (mfa.gov.tr).

OECD'nin eğitim alanında yapmış olduğu en etkili çalışmalardan biri ise PISA'dır. Bugün eğitimdeki en etkili uluslararası kuruluşlardan biri, Ekonomik İş birliği ve Kalkınma Örgütü'dür. Bu etkinliğini de özellikle performansı ölçen Uluslararası Öğrenci Değerlendirme Programı (PISA) aracılığıyla kazanmıştır. 2000 yılından bu yana PISA, tüm OECD ülkelerinde ve ötesinde her üç yılda bir uygulamasını sürdürmektedir.

1997 yılında geliştirilmeye başlanan ve ilk kez 2000 yılında dünya genelinde uygulanma fırsatı bulan PISA uygulamasına Türkiye katılım sağlayamamıştır. Ülkemizin bu uygulamaya ilk katılımı ise 2003 yılında gerçekleşmiştir.

OECD tarafından uygulamaya koyulan bu testler aşağıda verilen yönleri ile de ülkelere kılavuzluk etmektedir.

-Eğitimde fırsat eşitliği ilkesinin benimsenip benimsenmediğini ortaya koymak,

-Cinsiyet faktörlerinin eğitim üzerindeki etkilerini görmek,

-Okul çevresi, okul imkanları ve okul türü gibi özelliklerin eğitime katkısını ölçmek,

-Yapılandırmacı yaklaşımların eğitim üzerindeki katkılarını ölçmek,

-Eğiticilerin akademik yeterliliklerini ölçmek.

PISA, bu özellikleri sayesinde ülkelerin, eğitim sistemlerini elverişli hale getirmek için ulaşmaları gereken temel amaçları belirler. Böylece ülkeler en iyi verimi alabilmek ve eğitim sistemlerindeki başarıyı artırmak amacıyla bu önerileri dikkate alarak rekabet etmektedirler.

Matematik, Fen ve Okuma alanı becerilerini değerlendiren PISA, her periyotta farklı bir alana daha fazla ağırlık vermektedir. 2000 yılında Okuma becerileri ile başlayan bu döngü, 2003 yılında Matematik okuryazarlığı, 2006 yılında Fen okuryazarlığı, 2009 yılında, yine, Okuma becerileri, 2012 yılında Matematik okuryazarlığı, 2015 yılında Fen okuryazarlığı, 2018 yılında Okuma becerileri ve son olarak 2021 yılında Matematik okuryazarlığı şeklinde ilerlemektedir.

En son 2021 yılında uygulanması planlanan PISA uygulaması ise dünya genelinde etki eden bir salgın hastalık olan Covid-19 sebebiyle uygulanamamıştır. Bu nedenle son uygulama 2018 yılında gerçekleşmiştir.

Değişkenler

Ülkelerin PISA başarılarını etkileyen faktörleri incelemek amacıyla gerçekleştirilen bu çalışmada başarıyı etkileyebilecek nitelikler seçilmiş bu seçimdeki değişkenlere ait veriler uygulama aşamasında kullanılmıştır.

Matematik Okuryazarlığı Alanında Yeterlik Düzey Performansları

Matematik okuryazarlığı alanına ait 6 tane yeterlik düzeyi bulunmaktadır. Bu düzeyler hangi puan aralığına sahip olan bireylerin neleri yapabildiklerini gösterir. Tablo 1.'de matematik okuryazarlığı alanına ait yeterlik düzeylerinin ayrıntıları verilmiştir.

Tablo 1. Matematik okuryazarlığına ait yeterlik düzeylerine ait puan ve nitelikler

Düzey	Alt Puan	Yeterlik düzeyinde sahip olunan nitelikler
6	669	Bu düzeydeki öğrenciler, elde ettiği bilgileri kullanabilir ve genelleyebilir. Değişik bilgi kaynaklarından elde ettiği bilgiler ile bulduğu sonuçlar arasında bağ kurabilir. Sonuçlarına ait formüller oluşturabilir. Karşılaştığı problemleri çözebilmek için farklı stratejiler geliştirebilir.
5	607	Bu düzeydeki öğrenciler, problem içerisinden gerekli bilgileri eleyerek soru için modeller geliştirebilir. Gelişmiş akıl yürütme becerilerine sahiptir ve kendi bilgileri ile formülleri ilişkilendirebilir. Akıl yürütme sonucunda elde ettiği çıkarımlara ve yorumları arasında ilişki kurabilir.
4	545	Bu düzeydeki öğrenciler, karmaşık durumlarda ve hipotezlerin sağlanması gereken durumlarda çalışmalar yapabilirler. Basit anlamda akıl yürütme becerilerini kullanabilir. Akıl yürütme sonucu elde ettiği çıkarımlar ile yaptığı işlemleri açıklayabilir.
3	482	Bu düzeydeki öğrenciler, basit problem çözme stratejilerini kullanarak problem çözebilirler. Kişisel yorumları ile problemin sonuçları arasında ilişki kurabilir. Yüzdeler, kesinler, ondalık gösterimleri kullanarak çözüm yapabilir ve oran-orantı ilişkisi kurabilir.
2	420	Bu düzeydeki öğrenciler, problemde görülenden fazlasının ihtiyaç olmadığı durumları yorumlayabilir. Tam sayılar ile ilgili soruları çözebilir.
1	358	Bu düzeyde yer alan öğrenciler, soruya ait tüm veri ve bilgiler açık ve net şekilde verildiğinde, soru içerisinde yer alan yönergeleri kullanarak soruyu çözebilir. Grafik, tablo ve soru metinlerinden yararlanarak işlemleri gerçekleştirebilir.

Öğretmen Başına Düşen Öğrenci Sayısı

İstenilen bir eğitim kurumundaki İstatistiki Bölge Birimleri Sınıflamasına (İBBS) göre belirlenmiş olan toplam öğrenci sayısının bu kurumda görev yapmakta olan toplam öğretmen sayısına bölünmesi ile elde edilen oran sonucuna öğretmen başına düşen öğrenci sayısı denir. Örneğin mevcudu 250 olan bir okuldaki görev yapmakta olan öğretmen sayısı 10 ise, bu okulda bir öğretmen başına düşen öğrenci miktarı 250:10=25 olarak bulunur. Bu durumda her bir öğretmen ortalama 25 tane öğrenci ile ilgilenmek durumundadır (MEB, 2018). Tablo 2.'de OECD ülkelerine ait öğretmenlerin ilgilenmek durumunda oldukları ortalama öğrenci sayısı verilmiştir.

Tablo 2. OECD Ülkelerinde öğretmen başına düşen öğrenci sayısı

Avustralya	15	Kore	17
Avusturya	12	Letonya	12
Belçika	13	Litvanya	14
Kanada	16	Lüksemburg	9
Şili	19	Meksika	24
Kolombiya	23	Hollanda	16
Çekya	19	Yeni Zelanda	16
Danimarka	12	Norveç	10
Estonya	13	Polonya	10
Finlandiya	14	Portekiz	12
Fransa	19	Slovakya	17
Almanya	15	Slovenya	11
Yunanistan	9	İspanya	14
Macaristan	10	İsveç	13
İzlanda	11	Türkiye	18
İrlanda	15	Birleşik Krallık	20

İsrail	15	ABD	15
İtalya	11	Japonya	16

Öğrenci Başına Düşen Eğitim Kurumu Harcamaları

Eğitim, bir toplumun sahip olabileceği en değerli sermayedir. Bu sermayeye sahip olabilmek için yapılabilecek en mühim yol ise eğitime yapılacak olan yatırımlardır. Bir ülkenin sahip olduğu gayri safi yurt içi hasıladan (GSYH) eğitime ayırdığı bütçe içerisinden eğitim kurumlarına verilen ödeneklerin bu kurumlarda eğitim görmekte olan öğrenci sayısına bölünmesi ile elde edilen orana öğrenci başına düşen eğitim harcaması denir. Verilen eğitimin kalitesini artırmak, gelecekte sahip olunacak değerlerin yüceltilmesi, yeni teknolojik gelişmeleri yakından takip edebilmek, imalat ve sahip olunan işgücünde artış sağlamak kısaca gelişmişlik düzeyini artırarak refah seviyesine ulaşabilmiş bir ülke düzeyine gelebilmek, bir ülkenin eğitim alanında yaptığı ve yapacağı harcamalar ile doğru orantılıdır. Tablo 3.'te 2018 yılına ait, OECD ülkelerindeki öğrenci başına düşen eğitim kurumu harcamaları verilmiştir.

Tablo 3. Öğrenci başına düşen yıllık eğitim harcaması

Avustralya	11.340	Japonya	9.379
Avusturya	13.299	Kore	13.341
Belçika	11.720	Letonya	6.865
Kanada	10.570	Litvanya	7.095
Şili	6.018	Lüksemburg	22.203
Kolombiya	3.729	Meksika	2.977
Çekya	7.520	Yeni Zelanda	7.578
Danimarka	12.273	Norveç	15.334
Estonya	9.384	Polonya	8.949
Finlandiya	10.576	Portekiz	8.992
Fransa	9.312	Slovakya	7.972
Almanya	10.622	Slovenya	9.562
Yunanistan	7.279	İspanya	8.580
Macaristan	8.262	İsveç	13.234
İzlanda	14.304	Türkiye	4.400
İrlanda	8.687	Birleşik Krallık	11.936
İsrail	9.452	ABD	13.780
İtalya	10.570	Hollanda	10.150

Kişi Başına Düşen Gayri Safi Yurt İçi Hasıla

Gayri safi yurt içi hasıla (GSYİH), bir ülkenin veya ekonominin belirli dönemler dahilinde sınırları içerisinde gerçekleşen veya üretilen hizmet ve malların tümünün toplam değerine verilen addır. Tarım, sanayi ve hizmet sektörlerinde belirlenmiş olan dönem içerisinde üretilen tüm değerlerin fiyatları toplamı ile ülkenin ürünlerin üretimine karşılık yapmış olduğu ödenekleri toplamı ile gayrisafi yurt içi hasıla elde edilir. Kısaca, yerli ekonominin ülkeye olan katkısını incelerken kullanılan faktör olarak tanımlanabilir. Kişi başına düşen gayri safi yurt içi hasıla ise, gayri safi yurt içi hasılanın ülke nüfusuna bölünerek elde edilir. Tablo 4.'te OECD ülkelerinin kişi başına düşen gayri safi yurt içi hasıla değerleri ABD doları ile gösterilmiştir.

Tablo 4. Ülkelere göre kişi başına düşen gayrisafi yurt içi hasıla miktarı

OECD Ülkeleri	ABD Doları	OECD Ülkeleri	ABD Doları
Avustralya	60.443	Japonya	39.312
Avusturya	53.637	Kore	34.997
Belçika	51.247	Letonya	21.148
Kanada	51.987	Litvanya	23.723
Şili	16.265	Lüksemburg	133.590
Kolombiya	6.104	Meksika	10.045

Çekya	26.821	Hollanda	57.767
Danimarka	68.007	Yeni Zelanda	48.781
Estonya	27.943	Norveç	89.154
Finlandiya	53.654	Polonya	17.999
Fransa	43.659	Portekiz	24.567
Almanya	51.203	Slovakya	21.391
Yunanistan	20.192	Slovenya	29.291
Macaristan	18.728	İspanya	30.103
İzlanda	68.727	İsveç	61.028
İrlanda	100.172	Türkiye	9.661
İsrail	52.170	Birleşik Krallık	46.510
İtalya	35.657	ABD	70.248

Ülkelerin Gelişmişlik Endeksi

İnsani gelişmişlik endeksi, ülkelerin insani gelişimin yaşam koşulları, eğitim imkanları ve yaşam standartları olmak üzere üç temel boyuttaki başarılarının bir ortalama ölçüsü olarak tanımlanabilir. İnsani gelişim endeksinin hesaplanmasında bu farklı üç niteliğin 0 ile 1 arasındaki endekslere dönüştürülebilmesi için öncelikle bu niteliklerin minimum ve maksimum olan uç değerleri belirlenir. Bu uç değerlerden minimum değere sahip olanlar ‘’doğal sıfır’’ ve maksimum değere sahip olanlar ‘’beklenen hedefler’’ olarak adlandırılır. Tablo 5.’te insani gelişim endeksinin hesaplanmasında kullanılacak olan uç değerler verilmiştir.

Tablo 5. İnsani gelişim endeksi bileşenleri

Boyut	Gösterge	Minimum	Maksimum
Sağlık	Yaşam Süresi	20	85
Eğitim	Eğitim yılı (ortalama)	0	15
	Beklenen eğitim yılı	0	18
Yaşam Standardı	Kişi başına düşen GSYİH	100	75,000

Tablo 5.’te sağlık boyutu ile verilen yaşam süresinde minimum değerin sıfır yerine 20 olarak kabul edilmesinin nedeni 20. yüzyılda hiçbir ülke veya ekonominin 20 yıldan daha az sürecek bir yaşam beklentisinin olmaması ile ilgilidir.

Maksimum ve minimum olarak uç değerlen tanımlandıktan sonra boyut endeksleri şu şekilde hesaplanır:

$$\text{Boyut endeksi: } \frac{\text{Gerçek değer} - \text{Minimum değer}}{\text{Maksimum değer} - \text{Minimum değer}}$$

Eğitim boyutu için endeks hesaplanırken önce ortalama eğitim yılı ve beklenen eğitim yılı için ayrı ayrı boyut endeksi hesaplanır ve ardından bu iki soncun aritmetik ortalaması alınır.

İnsani gelişmişlik endeksi ise bu üç boyuttaki endekslerin geometrik ortalaması alınarak hesaplanır.

$$\text{IGE} = (I_{Sağlık} . I_{Eğitim} . I_{Gelir})^{1/3}$$

Bu endeks sonuçlarına göre ülkeler dört kategoride ayrıştırılmıştır. Tablo 6.’da ise bu ayrıma ait endeksler ve kategoriler verilmiştir.

Tablo 6. İnsani gelişim endeksi kategorileri

Çok yüksek insani gelişim endeksi	>0,800
Yüksek insani gelişim endeksi	0,700-0,799
Orta düzey insani gelişim endeksi	0,550-0,699
Düşük insani gelişim endeksi	<0,550

Bu bilgiler kapsamında OECD ülkelerinin 2018 yılına ait insani gelişim endeksleri Tablo 7.’de verilmiştir.

Tablo 7. OECD ülkeleri insani gelişim endeksi

OECD Ülkeleri	İnsani Gelişim Endeksi	OECD Ülkeleri	İnsani Gelişim Endeksi
Kolombiya	0,763	Kore	0,919
Meksika	0,777	Lüksemburg	0,922
Türkiye	0,839	Japonya	0,923
Macaristan	0,849	ABD	0,927
Şili	0,856	Birleşik Krallık	0,929
Slovakya	0,859	Belçika	0,933
Portekiz	0,860	Kanada	0,933
Letonya	0,866	Finlandiya	0,936
Litvanya	0,880	Yeni Zelanda	0,936
Yunanistan	0,886	İrlanda	0,937
Polonya	0,886	Hollanda	0,939
Estonya	0,891	Avustralya	0,941
İtalya	0,893	Danimarka	0,942
Çekya	0,894	İsveç	0,942
Fransa	0,901	Almanya	0,945
İspanya	0,901	İzlanda	0,959
Avusturya	0,917	Norveç	0,962
Slovenya	0,917	İsviçre	0,959
İsrail	0,919		

MATERYAL VE METOTLAR

Materyaller

2020 yılında meydana gelen dünya geneli bir salgın olan Covid 19 sebebiyle gerçekleştirilemeyen PISA 2021 uygulaması nedeniyle bu çalışmada, erişilebilen en son veriler olan 2018 yılına ait PISA verileri kullanılmıştır. Veriler OECD ve MEB resmî web sitelerinden alınan veriler ile Birleşmiş Milletler tarafından yayımlanan insani gelişim endeksleri ve göstergelerine ait veriler kullanılarak gerçekleştirilmiştir. Çalışma esnasında veriler MATLAB adlı paket programa işlenip, veri analizi için gerekli olan kodlamalar işlenerek kümeleme analizi yapılmıştır.

Metotlar

Bir veri grubundaki elemanlar, herhangi bir araştırma sonucunda elde edilen veriler veya bir olaya konu olan nesneler pek çok değişken tarafından etkilenebilirler. Bu değişkenlerin belirlenmesi sırasında değişkenlerin ayrı ayrı ele alınması, değişkenler arasındaki ilişkiyi gerçek anlamda açıklayamayacağından verilerin ayrı ayrı analizi yerine kullanılabilecek Çok Değişkenli Analiz Yöntemleri geliştirilmiştir. Bu yöntemlerden biri Kümeleme Analizi'dir. Kümeleme analizi gruplanmamış verileri benzerlik özelliklerine göre gruplamak için kullanılan çok değişkenli istatiksel bir analiz tekniğidir. Kümeleme analizi ilk defa Tyron tarafından 1939'da kullanılmıştır.

Tatlıdil (2002)'e göre 'Küme, birbirine yakın (benzer) nesnelerin çok boyutlu uzayda oluşturdukları bulutlar benzetmesi' şeklinde tanımlanabilir. Kümeleme analizi de bu benzer özelliklere sahip elemanların oluşturduğu kümeleri elde etme yöntemidir. Pek çok sayıda gruplanmamış veriyi anlamlı gruplara ayırarak aralarındaki benzerlik durumlarına göre veri indirgemesi yapan kümeleme analizi bu yönüyle bir tür veri azaltma tekniği olarak da düşünülebilir.

Kümeleme teknikleri aralarındaki uzaklığın esas alındığı bir matris kullanılarak, nesneleri kendi grupları arasında homojen, gruplar arasında heterojen olarak ayırmaya olanak sağlar. Kümeleme yöntemleri izledikleri yaklaşımlara göre iki temel gruba ayrılırlar. Bunlar, hiyerarşik kümeleme yöntemleri ve hiyerarşik olmayan kümeleme yöntemleridir. Bu çalışmada hiyerarşik ve hiyerarşik olmayan kümeleme yöntemlerinin veriler

üzerindeki etkisinin ayrı ayrı incelenmesi amacıyla her iki yöntemden de uygun olan birer tane yöntem seçilerek veriler üzerinde uygulanmıştır.

Hiyerarşik Kümeleme Yöntemleri

Hiyerarşik kümeleme yöntemleri nesneleri birbirleri ile değişik aşamalarda bir araya getirerek ardışık biçimde kümeler belirlemeyi ve bu kümelere girecek elemanların hangi uzaklık (ya da benzerlik) seviyesinde o kümenin elemanı olduğunu belirleyen bir teknik analizdir (Karaoğlan, 2018). Hiyerarşik kümeleme yöntemlerinden bazıları; k-en yakın komşuluk, k-en uzak komşuluk, ortalama bağlantı, Ward's ve Centroid yöntemidir.

Çalışmada kullanılacak olan yöntem olan en yakın komşuluk yöntemi, ilk olarak Florek ve arkadaşları tarafından 1951 yılında uygulanmıştır. Hiyerarşik kümeleme yöntemleri içerisindeki en basit algoritmaya sahip yöntemdir. Yöntemin mantığı birbirine en yakın nesneleri ya da kümeleri birleştirme işleminin tekrarlanmasıdır. Yöntemin uygulanması için önce birbirine en yakın iki nokta bulunur. Bulunan bu iki nokta bir adet küme oluşturur. Kümedeki diğer herhangi üçüncü bir noktanın, küme belirten iki noktadan herhangi birine olan uzaklığı, kümelenmemiş olan diğer noktalara olan uzaklıklarından daha küçükse bu kümeye atanır (Yalçın, 2013).

Hiyerarşik Olmayan Kümeleme Yöntemleri

Hiyerarşik olmayan yöntemler küme sayısı hakkında daha önceden bilgi edinildiği durumlarda ya da araştırmacının küme sayısı hakkında karar verebildiği durumlarda kullanılan bir yöntemdir. Nesneleri kendi içinde homojen, kümeler arasında heterojen bir yapı oluşturmayı amaçlar. Hiyerarşik olmayan kümeleme yöntemlerinden bazıları şöyledir; k-ortalamalar, bulanık yöntem, k-medoid.

Çalışmada kullanılacak olan k-ortalamalar yöntemi, 1960'lı yıllarda ortaya atılan hata kareler ortalamasından sonra 1970'lı yıllarda Hartigan tarafından bulunmuştur. İlk aşamada n adet nesneden oluşan bir kümeden k adet nesne seçilir ve seçilen k adet nesne kümelerin merkezini gösterir. Bu n adet nesneden geriye kalan n-k adet nesnenin her biri ile belirlenen küme merkezleri arasındaki uzaklık hesaplanarak hangi kümenin merkezine yakın ise o kümeye dahil edilir. Diğer adımda yeni oluşan kümelerin her biri için ortalamalar hesaplanır elde edilen sonuç kümenin yeni merkezi olur. Her nesne bir kümeye yerleşene kadar teknik uygulanır.

BULGULAR

K-Ortalamalar Yöntemi ile Ülkelerin PISA Matematik Başarılarına Göre Kümelenmesi

PISA matematik okur yazarlığı başarı puanına etkisinin, yapılan literatür incelemeleri sonrasında diğerlerine göre daha fazla olduğu kabul edilen 5 değişkene ait verilerden gayri safi yurt içi hasıla değişkeni sayısal olarak çok büyük ve ülkelerin sahip olduğu insani gelişim endeksi değişkeni çok küçük verilerden oluşmaktadır. Veriler arasındaki bu büyük fark, yapılacak olan analizlerde doğru olmayan sonuçlar oluşmasına sebep olmaktadır. Çok büyük veya çok küçük veriler kümeleme işlemlerinde analizin doğruluğunu uç yönlere doğru değiştirebilir. Bu nedenle kullanılacak verilerin aynı sayı değeri aralığında olması önem arz etmektedir. Sonuçların doğruluğu için tüm veriler üzerinde ''veri standartlaştırılması'' uygulanmıştır. Burada amaç, farklı ölçekleme yöntemleri ile elde edilmiş olan verileri tek bir sistem üzerinde toplayarak kıyaslanabilir duruma ulaştırmaktır. Ardından OECD ülkelerine ait normalleştirilmiş veriler, k-ortalamalar yöntemi ile analiz edilmiştir.

PISA puanları dikkate alınarak k-ortalamalar yöntemi ile kümeleme analizi yapılmıştır. Bu yöntem ile oluşturulacak kümeler için k=3 olarak kabul edilmiş ve bunun sonucunda 3 adet küme elde edilmiştir. Ardından puan değişkeni üzerine öğretmen başına düşen öğrenci sayısı eklenerek ve puan değişkeni ile öğretmen başına düşen öğrenci sayısı değişkeni üzerine yeterlik düzeyi 4'te bulunan öğrenci yüzdeleri eklenerek kümeleme analizi iki farklı şekilde tekrar edilmiştir. Tablo 8.'de OECD ülkelerinin puan değişkeni baz alınarak k-ortalamalar yöntemi ile kümelenmesi sonucunda elde edilen kümeler verilmiştir. Bu değişkenin üzerine sırasıyla önce öğretmen başına düşen öğrenci sayısı ve matematik okur yazarlığı alanında 4. yeterlik düzeyinde bulunan öğrenci yüzdesi eklenerek kümeleme analizi gerçekleştirilmiştir. Bu iki kümeleme analizi sonucunda oluşan kümeler için 1. ve 3. kümelerde bulunan ülkeler İspanya ve Litvanya hariç olmak üzere aynı kalmıştır. Türkiye ise iki küme analizi sonucunda da aynı ülkelerle birlikte aynı kümede yer almış, yalnızca Yunanistan üçüncü kümeleme analizi sonucunda yer değiştirmiş ve 3. kümeye geçmiştir. Tablo 9.'da k-ortalamalar yöntemi ile k=3 için 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan ve öğretmen başına düşen öğrenci sayısı değişkenine göre

kümelenmesi yer alırken Tablo 10.'da ise k-ortalamalar yöntemi ile k=3 için 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı ve Yeterlik Düzeyi 4'te Bulunan Öğrenci Yüzdesi değişkenine göre kümelenmesi sonucunda elde edilen kümeler yer almaktadır.

Tablo 8. 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
ABD	Kolombiya	Belçika
Almanya	Meksika	Danimarka
Avustralya	Şili	Estonya
Avusturya	Türkiye	Finlandiya
Birleşik Krallık	Yunanistan	Hollanda
Çekya		İsviçre
Fransa		Japonya
İrlanda		Kanada
İspanya		Kore
İsrail		Polonya
İsveç		Slovenya
İtalya		
İzlanda		
Letonya		
Litvanya		
Lüksemburg		
Macaristan		
Norveç		
Portekiz		
Slovakya		
Yeni Zelanda		

Tablo 9. 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan ve öğretmen başına düşen öğrenci sayısı değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
ABD	Kolombiya	Avusturya
Almanya	Meksika	Belçika
Avustralya	Şili	Danimarka
Birleşik Krallık	Türkiye	Estonya
Çekya		İspanya
Finlandiya		İsveç
Fransa		İtalya
Hollanda		İzlanda
İrlanda		Letonya
İsrail		Litvanya
İsviçre		Lüksemburg
Japonya		Macaristan
Kanada		Norveç
Kore		Polonya
Slovakya		Portekiz
Yeni Zelanda		Slovenya
		Yunanistan

Tablo 10. 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı ve yeterlik düzeyi 4'te bulunan öğrenci yüzdesi değişkenine göre kümelenmesi

KÜME	KÜME	KÜME
ABD Almanya Avustralya Birleşik Krallık Çekya Finlandiya Fransa Hollanda İrlanda İspanya İsrail İsviçre Japonya Kanada Kore Litvanya Slovakya Yeni Zelanda	Kolombiya Meksika Şili Türkiye	Avusturya Belçika Danimarka Estonya İsveç İtalya İzlanda Letonya Lüksemburg Macaristan Norveç Polonya Portekiz Slovenya Yunanistan

Uygulanan dördüncü kümeleme analizinde, puan, öğretmen başına düşen öğrenci sayısı ve 4. yeterlik düzeyinde bulunan öğrenci yüzdesi değişkenlerinin üzerine kişi başına düşen eğitim kurumları harcamaları eklenmiştir. Bunun sonucunda ise 3 küme oluşmuştur. Elde edilen kümelerdeki ülkeler, ilk 3 kümeleme analizi sonucunda oluşan kümelerden oldukça değişkenlik göstermiştir. 2. kümede yer alan Türkiye dahil 4 ülke, yine, aynı kümede yer alırken 1. ve 3. kümede yer alan ülkeler farklılaşmıştır.

Beşinci kümeleme analizi, dördüncü kümeleme analizinde kullanılan puan, öğretmen başına düşen öğrenci sayısı, 4. yeterlik düzeyinde yer alan öğrenci yüzdesi ve öğrenci başına düşen eğitim kurumları harcamaları değişkenleri üzerine ülkelerin sahip olduğu gayri safi yurt içi hasıla değişkeni eklenerek gerçekleştirilmiştir. Burada 1. kümede yer alan 5 ülke (ABD, Avusturya, İsveç, İzlanda ve Kore), 3. kümeye geçmiştir. Bunun sonucunda Lüksemburg ve Norveç diğer kümelerden ayrışmışlardır. İkinci kümede Türkiye'nin de içlerinde bulunduğu dört ülke ise herhangi bir değişiklik göstermemiştir.

k-Ortalamalar yöntemi kullanılarak uygulanan son kümeleme analizinde bir önceki analizde kullanılan beş değişkenin üzerine ülkelerin insani gelişim endeksleri değişkeni eklenmiştir. Bunun neticesinde üç adet küme oluşmuştur. Beşinci kümeleme analizinde elde edilen ilk kümede yer alan Norveç, üçüncü kümeye geçmiş ve Lüksemburg yalnız başına bir küme oluşturmuştur. İkinci kümede yer alan dört ülke yine bir değişiklik göstermemiştir. Tablo 11., Tablo 12 ve Tablo 13.'te ise tüm verilerin üzerinde sırasıyla, eğitim kurumu harcamaları, GSYİH ve insani gelişim endeksi verileri eklenerek elde edilen kümeler gösterilmiştir.

Tablo 11. 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı, yeterlik düzeyi 4'te bulunan öğrenci yüzdesi, öğrenci başına düşen eğitim kurumu harcamaları değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
ABD Avusturya İsveç İzlanda Kore Lüksemburg Norveç	Kolombiya Meksika Şili Türkiye	Almanya Avustralya Belçika Birleşik Krallık Çekya Danimarka Estonya Finlandiya

		Fransa Hollanda İrlanda İspanya İsrail İsviçre İtalya Japonya Kanada Letonya Litvanya Macaristan Polonya Portekiz Slovakya Slovenya Yeni Zelanda Yunanistan

Tablo 12. 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı, yeterlik düzeyi 4'te bulunan öğrenci yüzdesi, öğrenci başına düşen eğitim kurumu harcamaları, gayrisafi yurt içi hasıla değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
Lüksemburg Norveç	Kolombiya Meksika Şili Türkiye	ABD Almanya Avustralya Avusturya Belçika Birleşik Krallık Çekya Danimarka Estonya Finlandiya Fransa Hollanda İrlanda İspanya İsrail İsveç İsviçre İtalya İzlanda Japonya Kanada Kore Letonya Litvanya Macaristan Polonya Portekiz Slovakya Slovenya Yeni Zelanda Yunanistan

Tablo 13. 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı, yeterlik düzeyi 4'te bulunan öğrenci yüzdesi, öğrenci başına düşen eğitim kurumu harcamaları, gayrisafi yurt içi hasıla değişkeni ve insani gelişim endeksi değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
Lüksemburg	Kolombiya Meksika Şili Türkiye	ABD Almanya Avustralya Avusturya Belçika Birleşik Krallık Çekya Danimarka Estonya Finlandiya Fransa Hollanda İrlanda İspanya İsrail İsveç İsviçre İtalya İzlanda Japonya Kanada Kore Letonya Litvanya Macaristan Norveç Polonya Portekiz Slovakya Slovenya Yeni Zelanda Yunanistan

OECD ülkeleri içerisinde yer alan Lüksemburg'un gayri safi yurt içi hasıla değişkeni bakımından diğer ülkelerden önemli bir farka sahip olması ve k-ortalamalar yöntemi kullanılarak oluşturulan son iki kümede diğer elemanlardan ayrılması nedeniyle OECD ülkeleri içerisinden Lüksemburg'un verileri ayrıştırılarak yeniden kümeleme analizi uygulanmıştır. Bu uygulama sonucunda 6 küme oluşmuştur.

OECD ülkeleri içerisinde yer alan Lüksemburg'un gayri safi yurt içi hasıla değişkeni bakımından diğer ülkelerden önemli bir farka sahip olması ve k-ortalamalar yöntemi kullanılarak oluşturulan son iki kümede diğer elemanlardan ayrılması nedeniyle OECD ülkeleri içerisinden Lüksemburg'un verileri ayrıştırılarak yeniden kümeleme analizi uygulanmıştır. Bu uygulama sonucunda 6 küme oluşmuştur. Tablo 14., Tablo 15., Tablo 16., Tablo 17, Tablo 18. ve Tablo 19. ile verilen tablolarda ise Lüksemburg hariç tutularak, geriye kalan verilere k-ortalamalar yönteminin uygulanması sonucunda elde edilen kümeler verilmiştir.

Lüksemburg'un verileri dahil edilmediği için kümeleme sonucunda elde edilen kümelerde yer almamıştır. Bu sebeple Lüksemburg'un kümeleme analizleri sonucundaki yerini tahmin edebilmek amacıyla Lüksemburg'un verilerinin hangi ülkelerin verilerine daha yakın olduğu incelenmiştir ve hangi ülkeye daha yakın değerlere sahip ise o ülkenin bulunduğu kümeye dahil edilmiştir.

Tablo 14. Lüksemburg dışındaki 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
ABD	Kolombiya	Türkiye
Almanya	Meksika	Yunanistan
Avustralya	Şili	
Avusturya		
Belçika		
Birleşik Krallık		
Çekya		
Danimarka		
Estonya		
Finlandiya		
Fransa		
Hollanda		
İrlanda		
İspanya		
İsrail		
İsveç		
İsviçre		
İtalya		
İzlanda		
Japonya		
Kanada		
Kore		
Letonya		
Litvanya		
Macaristan		
Norveç		
Polonya		
Portekiz		
Slovakya		
Slovenya		
Yeni Zelanda		
Lüksemburg		

Puan değişkeni kullanılarak yapılan kümeleme analizi sonucunda Tablo 14.'te verilen kümeler oluşmuştur. Burada puan bakımından diğer ülkelere göre son sırada yer alan 3 ülke, Meksika, Şili, Kolombiya birlikte bir küme oluştururken, Türkiye ise Yunanistan ile aynı kümede yer almıştır.

Tablo 15. Lüksemburg dışındaki 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan ve öğretmen başına düşen öğrenci sayısı değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
ABD	Kolombiya	Avusturya
Almanya	Meksika	Belçika
Avustralya	Şili	Danimarka
Birleşik Krallık		Estonya
Çekya		Finlandiya
Fransa		İspanya
Hollanda		İsveç
İrlanda		İtalya
İsrail		İzlanda
İsviçre		Letonya
Japonya		Litvanya
Kanada		Macaristan
Kore		Norveç
Slovakya		Polonya
Türkiye		Portekiz
Yeni Zelanda		Slovenya
		Yunanistan
		Lüksemburg

Puan değişkeninin üzerine öğretmen başına düşen öğrenci sayısı değişkeni eklenerek yapılan kümeleme analizi sonucunda Tablo 15 elde edilmiştir. Burada ikinci kümede yer alan ülkeler değişmezken, Türkiye 1. kümeye yerleşmiştir.

Tablo 16. Lüksemburg dışındaki 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı ve yeterlik düzeyi 4'te bulunan öğrenci yüzdesi değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
ABD	Kolombiya	Avusturya
Almanya	Meksika	Belçika
Avustralya	Şili	Danimarka
Birleşik Krallık		Estonya
Çekya		Finlandiya
Fransa		İrlanda
Hollanda		İspanya
İsrail		İsveç
İsviçre		İtalya
Japonya		İzlanda
Kanada		Letonya
Kore		Litvanya
Slovakya		Macaristan
Türkiye		Norveç
Yeni Zelanda		Polonya
		Portekiz
		Slovenya
		Yunanistan
		Lüksemburg

Tablo 16'da verilen kümelerde puan ve öğretmen başına düşen öğrenci sayısı değişkenlerine yeterlik düzey 4'te bulunan öğrenci yüzdesi değişkeni eklenmiştir. Bunun sonucunda ise Tablo 15'e göre büyük bir değişim yaşanmamıştır. Yalnızca İrlanda 3. Kümeye kaymıştır. Diğer tüm ülkeler aynı ülkeler ile bir arada kalmıştır.

Tablo 17. Lüksemburg dışındaki 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı, yeterlik düzeyi 4'te bulunan öğrenci yüzdesi, öğrenci başına düşen eğitim kurumu harcamaları değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
Almanya Birleşik Krallık Çekya Fransa Hollanda İsrail İsviçre Japonya Kanada Kore Slovakya Yeni Zelanda	Kolombiya Meksika Şili Türkiye	ABD Avustralya Avusturya Belçika Danimarka Estonya Finlandiya İrlanda İspanya İsveç İtalya İzlanda Letonya Litvanya Macaristan Norveç Polonya Portekiz Slovenya Yunanistan Lüksemburg

Tablo 17'de puan, öğretmen başına düşen öğrenci sayısı ve yeterlik düzey 4'te bulunan öğrenci yüzdesi değişkenlerinin üzerine kişi başına düşen eğitim kurumu harcamaları değişkeni eklenerek yapılan kümeleme analizi sonrasında oluşan kümeler verilmiştir. Burada Türkiye başarı bakımından son sıralarda yer alan ülkeler ile aynı kümeye yerleşmiştir.

Tablo 18. Lüksemburg dışındaki 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı, yeterlik düzeyi 4'te bulunan öğrenci yüzdesi, öğrenci başına düşen eğitim kurumu harcamaları, gayrisafi yurt içi hasıla değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
Birleşik Krallık Çekya Estonya Finlandiya Fransa Hollanda İrlanda İspanya Japonya Kanada Kore Letonya Litvanya Polonya Slovakya Yeni Zelanda Lüksemburg	Kolombiya Meksika Şili Türkiye	ABD Almanya Avustralya Avusturya Belçika Danimarka İsrail İsveç İsviçre İtalya İzlanda Macaristan Norveç Portekiz Slovenya Yunanistan

Tablo 18'de puan, öğretmen başına düşen öğrenci sayısı, yeterlik düzey 4'te bulunan öğrenci yüzdesi ve kişi başına düşen eğitim kurumu harcamaları değişkenlerinin üzerine ülkelerin sahip oldukları gayri safi yurt içi hasıla değişkeni eklenerek yapılan kümeleme analizinin sonuçları verilmiştir. Burada Türkiye'nin konumu Tablo 16'daki değişkenler ile yapılan kümeleme analizine göre değişiklik göstermezken diğer ülkelerin konumlarında değişiklik gözlenmektedir.

Tablo 19. Lüksemburg dışındaki 2018 PISA uygulamasına katılım gösteren OECD ülkelerinin puan, öğretmen başına düşen öğrenci sayısı, yeterlik düzeyi 4'te bulunan öğrenci yüzdesi, öğrenci başına düşen eğitim kurumu harcamaları, gayrisafi yurt içi hasıla değişkeni ve insani gelişim endeksi değişkenine göre kümelenmesi

1. KÜME	2. KÜME	3. KÜME
Çekya Estonya İspanya İtalya Letonya Litvanya Macaristan Polonya Portekiz Slovakya Slovenya Türkiye Yunanistan	Kolombiya Meksika Şili	ABD Almanya Avustralya Avusturya Belçika Birleşik Krallık Danimarka Finlandiya Fransa Hollanda İrlanda İsrail İsveç İsviçre İzlanda Japonya Kanada Kore Norveç Yeni Zelanda Lüksemburg

Tablo 19'da puan, öğretmen başına düşen öğrenci sayısı, yeterlik düzey 4'te bulunan öğrenci yüzdesi, kişi başına düşen eğitim kurumu harcamaları, ülkelerin sahip oldukları gayrisafi yurt içi hasıla değişkenlerine ülkelerin insani gelişim endeksleri eklenerek kümeleme analizi gerçekleştirilmiştir. Bunun sonucunda Türkiye, yine, yer değiştirmezken diğer ülkelerin konumlarında gözle görülür değişiklikler olmuştur.

K-En Yakın Komşuluk Yöntemi ile Ülkelerin PISA Matematik Başarılarına Göre Sınıflandırılması

OECD ülkelerinin k-En Yakın Komşuluk yöntemi kullanılarak 3 kategoride sınıflandırılması amaçlanmıştır. Bu işlem için öncelikle OECD ülkelerinin PISA 2018 matematik okuryazarlığı başarı puanları üzerinden bir kategori kümesi oluşturulmuştur. Bu kategori kümesinin elemanları başarı puanları çoktan aza doğru sıralanarak belirlenmiştir. x, ülkelerin PISA 2018 başarı puanlarını belirtmek üzere;

$$\{\begin{array}{ll} x < 460, & \text{az başarılı} \\ 460 \leq x < 500, & \text{başarılı} \\ x \geq 500, & \text{çok başarılı} \end{array}$$

olarak kategori kümesi belirlenmiştir. Kategori kümesi Y olarak isimlendirilsin. Az başarılı olan ülkeler ''a'', başarılı olan ülkeler ''b'', çok başarılı olan ülkeler ''c'' olarak sembolize edilirse, Y kategori kümesi Tablo 20.'deki gibi oluşturulmuş olur.

Tablo 20. Y kategori kümesi

OECD ÜLKELERİ	BAŞARI KRİTERİ	PISA 2018 BAŞARI PUANI
ABD	b	478
Almanya	c	500
Avustralya	b	491
Avusturya	b	499
Belçika	c	508
Birleşik Krallık	c	502
Çekya	b	499
Danimarka	c	509
Estonya	c	523
Finlandiya	c	507
Fransa	b	495
Hollanda	c	519
İrlanda	c	500
İspanya	b	481
İsrail	b	483
İsveç	c	502
İsviçre	c	515
İtalya	b	487
İzlanda	b	495
Japonya	c	527
Kanada	c	512
Kolombiya	a	391
Kore	c	526
Letonya	b	496
Litvanya	b	481
Lüksemburg	b	483
Macaristan	b	481
Meksika	a	409
Norveç	c	501
Polonya	c	516
Portekiz	b	492
Slovakya	b	486
Slovenya	c	509
Şili	a	417
Türkiye	a	454
Yeni Zelanda	b	494
Yunanistan	a	451

MATLAB paket programı üzerinden yapılan çalışmada k değişkeni 2'den 10'a kadar denenmiş ve uygun değerler olarak iki sonuç elde edilmiştir. r, sınıflandırma hatasını belirtmek üzere, sınıflandırma hatası sıfıra ne kadar yakınsa sınıflandırmanın doğruluğu o kadar yüksektir. k=2 ve k=4 için r= 0,1081 olarak elde edilmiştir. Bu nedenle iki sonuca ait kümeler incelendiğinde k=4 için oluşturulan kümeler k-ortalamalar yöntemi ile oluşturulmuş kümelerin 2. kümeleri ile benzerlik gösterdiğinden k=4 olarak kabul edilmiştir. Tablo 21.'de farklı k değerleri için elde edilen r değerleri verilmiştir.

Tablo 21. K-en yakın komşuluk yöntemi için kabul edilen k ve r değerleri

k	r
2	0,1081
3	0,1351
4	0,1081
5	0,1622
6	0,1892
7	0,1351
8	0,1622
9	0,1892
10	0,1351

k değişkeni 4 olarak kabul edildikten sonra k-en yakın komşuluk yöntemi ile oluşan küme Tablo 22.'de verilmiştir.

Tablo 22. En yakın komşuluk yöntemi ile elde edilen küme

ÇOK BAŞARILI	BAŞARILI	AZ BAŞARILI
Almanya	ABD	Kolombiya
Avustralya	Avusturya	Meksika
Belçika	Çekya	Şili
Birleşik Krallık	Fransa	Türkiye
Danimarka	İspanya	
Estonya	İsrail	
Finlandiya	İsveç	
Hollanda	İtalya	
İrlanda	Letonya	
İsviçre	Litvanya	
İzlanda	Lüksemburg	
Japonya	Macaristan	
Kanada	Portekiz	
Kore	Slovakya	
Norveç	Yeni Zelanda	
Polonya	Yunanistan	
Slovenya		

Tablo 22 incelendiğinde k-en yakın komşuluk yöntemi ile sınıflandırılmış OECD ülkelerinden, PISA 2018 matematik okur yazarlığı puanları bakımından çok başarılı ülkeler 17, başarılı ülkeler 16 ve az başarılı ülkeler 4 adet olarak oluştuğu görülmektedir.

Kategori kümesinde başarılı kümeler içinde yer alan İsveç, kümeleme işlemi sonrasında çok başarılı kümelere yerleşmiştir.

Benzer şekilde, kategori kümesinde başarılı ülkelerden olarak adlandırılan Avustralya ve İzlanda, kümeleme sonrasında çok başarılı ülkeler arasında yerini almıştır. Kategori kümesinde az başarılı olarak görülen Yunanistan ise kümeleme işleminden sonra başarılı ülke kategorisine yerleşmiştir.

TARTIŞMA VE SONUÇ

Kümeleme analizi yöntemleri iki ana başlığa ayrılmaktadır: Hiyerarşik yöntemler ve hiyerarşik olmayan yöntemler. Bu çalışmada hiyerarşik olmayan yöntemlerken k-ortalamalar yöntemi ile hiyerarşik yöntemlerden k-en yakın komşuluk yöntemleri kullanılarak iki farklı kümeleme analizi gerçekleştirilmiştir. Kümeleme analizleri sonucunda OECD ülkeleri PISA 2018 matematik okuryazarlığı başarı puanlarına göre sınıflandırılmış ve bunun sonucunda iki farklı küme oluşmuştur.

Hiyerarşik olmayan kümeleme analizi yöntemlerinden biri olan k-ortalamalar yöntemi ile önce tüm değişkenler kullanılarak sınıflandırma yapılmıştır. Ancak Lüksemburg'un diğer ülkelere oranla sayısal bakımdan çok büyük gayri safi yurt içi hasıla değerine sahiptir. Uç değerlere sahip bir verinin olması, kümeleme analizinde o verinin diğerlerinden oldukça ayrışmasına sebep olmaktadır. Bu durumun oluşmaması için, k-ortalamalar yöntemi ile kümeleme analizi yapılırken Lüksemburg'a ait veriler çıkarılarak kalan veriler üzerinde tekrar k-ortalamalar yöntemi uygulanmıştır.

Hiyerarşik yöntemlerden, k-en yakın komşuluk yöntemi kullanılarak oluşan küme ile, Lüksemburg'un verilerinin çıkarılmasıyla k-ortalamalar yöntemi uygulanarak elde edilen kümelerden beşincisi olan, PISA 2018 matematik okuryazarlığı puanı, öğretmen başına düşen öğrenci sayısı, 4. yeterlik düzeyinde bulunan öğrenci yüzdesi ve ülkelerin sahip oldukları eğitim kurumu harcamaları değişkenleri kullanılarak elde edilen küme ile oldukça benzer özelliklere sahip olduğu görülmektedir. K-en yakın komşuluk yöntemiyle oluşan, içerisinde Türkiye'nin de bulunduğu az başarılı küme ile k-ortalamalar yöntemi ile oluşan beşinci kümenin 2. kümesi aynı elemanlara sahiptir. Çok başarılı küme ile 9 ülke ve başarılı ülke ile 8 ülke benzerlik göstermektedir.

k-Ortalamalar yöntemiyle elde edilen bu sonuçlar incelendiğinde, gayri safi yurt içi hasıla ile insani gelişim endeksi değişkenlerinin verileri kullanıldığında oluşan kümelerin diğer kümelerden bariz anlamda farklılaştığı göze çarpmaktadır. Dolayısıyla bu iki değişkenin kümelemedeki değişimde etkili oldukları söylenebilir.

K-ortalamalar yöntemi ve k-en yakın komşuluk yöntemleri kıyaslandığında, Türkiye'nin her iki analiz sonrasında da Meksika, Şili ve Kolombiya ülkeleri ile aynı kümede olduğu görülmektedir.

Bu durum Türkiye'nin başarı olarak 33 OECD ülkesinin gerisinde kaldığını göstermektedir.

Türkiye'nin yapılan tüm kümeleme analizleri sonucunda Norveç gibi gelişmişlik düzeyi bakımından yüksek ülkeler ile aynı kümede yer almadığı görülmüştür.

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Çemberleme Makinesi Seçim Kriterlerinin Fucom Yöntemi İle Ağirliklandirilmasi

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Özet

Çemberleme, PP veya metal şerit (çember) şeklindeki malzemenin, ambalajlanacak malzemenin dağılmadan durabilmesi veya taşıma esnasında dağılıp parçalanmaması için, ilgili malzemenin etrafında dolandırılarak malzemeyi sıkıca sarması ve sabitlemesi işlemidir. Çemberleme Makinesi, ambalajlama süreçlerinde kullanılan bir makine olup, en küçük ölçekte ambalaj kutularının, en büyük ölçekte ise palet vb. büyüklükteki malzemelerin paketlenmesi ve taşımaya uygun hale getirilmesi için kullanılmaktadır. Bu çalışmada PP malzeme ile çemberleme işlemi yapmak üzere, alınacak çemberleme makinesi için, seçimde kullanılacak kriterlerin ağırlıkları belirlenmiştir. Kriter ağırlıklarının belirlenmesinde Çok Kriterli Karar Verme tekniklerinden birisi olan ve ağırlık belirleme yöntemi olarak kullanılan FUCOM (Full Consistency Method-Tam Tutarlılık Metodu) yöntemi kullanılmıştır. FUCOM, 2018'de Pamucar, Stevic ve Sremac tarafından geliştirilmiş olup, yöntemin yapısına göre gerekli koşulların sağlanması amacıyla oluşturulan bir Matematiksel Programlama modeli ile ağırlık değerlerinin belirlenmesi esasına dayanan bir yöntemdir. Problemde Çember Makinesi seçimi için belirlenmiş kriterler, Fiyat (K1), Otomatiklik özelliği (Tam Otomatik, Yarı otomatik) (K2), Çember Genişliği (K3), Çember Kalınlığı (K4) ve Çember Gerginlik Ayarıdır (K5). FUCOM tekniği uygulama adımlarına göre, önce kriterler önem derecesine göre sıralanmış, daha sonra ikili karşılaştırmalar yapılarak kriterlerin birbirlerine göre önem dereceleri tespit edilmiştir. Son olarak oluşturulan Matematiksel model çözülerek kriterlerin ağırlıkları belirlenmiştir. Kriter ağırlıkları, Fiyat (K1) için %32,1; Çember Genişliği (K3) için %25; Otomatiklik özelliği (Tam Otomatik, Yarı otomatik) (K2) için %17,9; Çember Gerginlik Ayarı (K5) için %17,3 ve Çember Kalınlığı (K4) için %10,7 olarak bulunmuştur. Bu kriter ağırlıkları, belirlenecek alternatif listesi için oluşturulacak Çok Kriterli Seçim Problemi için bir girdi verisi olarak kullanılabilecektir.

Anahtar kelimeler: *Multi Criteria Decision Making, Weighting Methods, FUCOM, Strapping Machine Selection Criteria*

Dematel İle Lazer Sac Kesim Makinesi Seçim Kriterlerinin Değerlendirilmesi ve Ağirliklandirilmasi

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Özet

Lazer sac kesim makineleri, orta ve yüksek hacimde üretim yapan işletmelerde üretim hızının artırılması amacıyla, üretim sistemine entegre edilen makinelerdir. Bu makineler aynı zamanda yüksek hassasiyetli ölçülerde üretim yapma ve hatalı ürün üretiminin azaltılması özellikleriyle de önemli fonksiyonlara sahiptirler. Ancak makineler genelde yüksek fiyatlı oldukları için, makinelerin alım süreci, birçok kriterin dikkate alınması ve detaylı analizlerin yapılması gereken bir süreçtir. Bu amaçla bu çalışmada, makinelerin alım sürecinde değerlendirmeye alınacak kriterlerin çok kriterli karar verme yöntemlerinden olan DEMATEL (Decision Making Trial And Evaluation Laboratory) Metodu ile değerlendirilmesi yapılmıştır. Kriterlerin birbirleriyle etkileşim halinde olduğu değerlendirildiğinden, hem bu etkileşimlerin ortaya konulması hem de kriter ağırlıklarının belirlenmesi amacıyla; bu analizleri yapmaya imkân vermesi nedeniyle DEMATEL Yöntemi seçilmiştir. Çalışmada değerlendirilmek üzere belirlenen kriterler, Fiyat, en büyük çalışma eni (sac genişliği), en büyük çalışma boyu (sac uzunluğu), işlenebilen sac kalınlığı ve rezonatör gücüdür. DEMATEL ile yapılan değerlendirme sonucunda, diğer kriterleri en çok etkileyen kriter işlenebilen sac kalınlığı, diğer kriterlerden en çok etkilenen kriter ise fiyat kriteridir. Fiyat kriteri diğer kriterlerle en fazla etkileşim içerisinde olan kriterdir. Buna göre en yüksek kriter ağırlığı %23,3 ile fiyat kriterine ait olup, izleyen kriter ağırlıkları sırasıyla %21,9 ile işlenebilen sac kalınlığı, %20,5 ile Rezonatör gücü, %18 ile en büyük çalışma boyu (sac uzunluğu), %16,3 ile en büyük çalışma eni (sac genişliği) şeklindedir. Belirlenen bu ağırlıklar, makine seçim aşamasında karar vericinin yapacağı çok kriterli analiz için önemli bir girdi olarak kullanılabilecektir.

Anahtar kelimeler: *Multi Criteria Decision Making, Weighting Methods, DEMATEL, Laser Sheet Metal Cutting Machine Selection Criteria*

Data Envelopment Analysis For Measuring Tourism Efficiency Of European Countries

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Abstract

Tourism contributes to the country's economy and employment. For this reason, countries focus on increasing tourism income by making various expenditures in order to make a breakthrough in terms of tourism. Tourism was one of the industries negatively affected by the epidemic, which was declared a pandemic by the World Health Organization as of March 11, 2020. On March 13, 2020, it was reported that Europe had become the epicenter of the COVID-19 crisis. This study aims to measure the effectiveness of European countries in terms of tourism for the years 2020 and 2021, when the pandemic occurred, by using the Data Envelopment Analysis (DEA) method, which is one of the efficiency measurement methods. In the study, an output-oriented linear programming model is established and International Tourism Expenditure is considered as input variable and International Tourism Receipts, Employment in Tourism, Tourism as share of total Exports are considered as output variables. The established models have been solved with the LINDO computer program. The efficiency scores have been calculated and the tourism efficiency of the countries have been compared.

Key words: *Data Envelopment Analysis, European Countries, Tourism Efficiency*

Optimization Of Subassembly Station Location For Machine Manufacturing Plant By Using Assignment Model

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Abstract

Optimizing the workflow within a plant is crucial for efficiency and cost-effectiveness in the dynamic world of manufacturing. In Odaksan Mühendislik A.Ş. one of the most important part type of the machines is assembled and stored in different located stations. Some of the parts used in assembly of this main part are got from subassembly stations. We used mathematical model in order to reduce the distance between part assembly station and subassembly station locations. Assignment model is one of the valuable tool in the field of operations research. This type of models can be used to find the subassembly locations which will result in optimization of the flow of materials. This proposed model offers a systematic approach to streamline operations which will result in efficiency and cost-effectiveness in assemblying operations by using assignment model of operations research.

Key words: *Machine manufacturing, Assembly station location optimization, Assignment models, Optimization*

Machine Service Planning By Using Vehicle Routing Algorithms

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Abstract

Service planning is playing a crucial role in the industries that rely on machinery. Effectively managing the service operations for maintenane and repair is very important with respect to operational cost and customer satisfaction. There are many machines operating at the customer sites which are manufactured by ODAKSAN Mühendislik A.Ş. Our customers reports when they have breakdown. Our technicians service to the customers where the machine breakdown occurs. In addition to breakdowns we also service for the periodic and non-periodic maintenances. As ODAKSAN Mühendislik A.Ş. we used vehicle routing algorithm to optimize machine service operations. By doing so, we also accomplished machine prioritization and technician scheduling which result in customer satisfaction, cost reduction and operational effectiveness.

Key words: *Machine Service, Vehicle Routing Algorithms, Optimization*

Scientific Study Design and Statistical Applications in Ophthalmology

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Abstract

Abstract Most scientific studies in the field of ophthalmology employs eye examinations under various clinical conditions to obtain certain measurements. However, unlike other medical fields, the participating subjects have two eyes both of which are potential candidates to be included for evaluation in the studies. This particularity makes the analysis more complicated since there might be interaction effects between the right and left eyes of the same person. Adding more complexity is the fact that data from one eye may not be available for several reasons such as some participants refuse both of their eyes to be evaluated. Aforementioned difficulties result in the creation of mixed data sets containing information about only one eye for some patients and both eyes for others within the scope of the same study. Last but not least, it is possible that ophthalmic clinical manifestations show a unilateral or bilateral course. Hence, design considerations and choice of statistical methods in ophthalmology studies are of utmost importance in order to achieve the most accurate results.

***Key words**: Bias, Eyes and statistics, Ophthalmology, Ophthalmic study design, Statistics*

Türkiye Süper Ligindeki Şampiyonluklara Markov Zinciri Analizi ile Yaklaşim

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Özet

Bu çalışmada, Türkiye Süper Lig'inde 1959 – 2023 yılları arasında şampiyon olan takımlar iki farklı biçimde durumlara ayrılarak Markov zinciri analizi ile incelenmiştir. Birinci analizde Galatasaray, Fenerbahçe ve Beşiktaş kendi başlarına birer durum ve bu üç takım dışında kalan takımlar dördüncü bir durum olarak ele alınmıştır. İkinci analizde ise, ilk analizde ayrı takımlar olarak ele alınan Galatasaray, Fenerbahçe ve Beşiktaş takımları birlikte bir durum ve süper ligdeki diğer takımlar ikinci bir durum olarak ele alınmıştır. Bu analiz yaklaşımıyla sonraki yılda şampiyon olacak takım ve herhangi bir yıl şampiyon olan takımın ortalama kaç yıl sonra tekrar şampiyon olabileceği kestirilebilir. Analizde kullanılan veriler, Türkiye Futbol Federasyonu (TFF) resmî sitesinde yayınlanan tescillenmiş "Türkiye Ligi Şampiyonlukları" dosyasından alınmıştır.

Anahtar kelimeler: *Futbol, Türkiye Süper Ligi, Markov zinciri*

GİRİŞ

Futbol, tartışmasız en popüler spor dalıdır ve dünyada ve Türkiye'de popülerliğini her geçen gün arttırmaktadır. Popülerliğinin artmasının en önemli sebebleri futbola yapılan yatırımlar ve uluslararasıalanda tanınmada önemli rol oynadığı için devletlerin futbola verdiği desteklerdir.

Futbol birçok ülkenin geçmiş tarihinde yer almakla birlikte, bu konuda en fazla tartışılan konulardanbiri futbolun ilk kez İngiltere'de ortaya çıktığı iddiasıdır. Fransızların iddiasına göre futbol, Normanlar tarafından İngiltere'ye götürülmüştür. İtalyanların iddiasına göre ise, İtalya'dan İngiltere'ye gitmiştir.

Türklerde ise futbol Orta Asyada oynandığı belirtilen "tepük" adını verilen bir oyuna dayandırılmaktadır. Ülkemizde bugünkü anlamda futbolun gelişimi ve toplum hayatında yer alması, batılılaşma yönünde gelen yenilikler sonrasında Tanzimat Döneminde gerçekleşmeye başlamıştır. Daha sonra Türkiye Futbol Federasyonu'nun kurulması futbol sporunun yaygınlaşmasında bir aşama olarak görülebilir (bkz. Kahraman, 2019 ve orada verilen kaynaklar).

18. yüzyıla kadar dünya ülkelerinde kendi kurallarına göre oynanan futbol 19. yüzyılda belirli kurallara göre oynanmaya başlamış ve ülkelerin kendi futbol federasyonlarının kurulmaya başlamasıyla kurumsallaşmaya başlamıştır. Dünya Futbol Federasyonu (FIFA) 1904 yılında ve Avrupa Futbol Federasyonu (UEFA) 1954 yılında kurulmuştur. Bugün futbol toplumlarda birçok yönden ilgiyi üzerine çeken, ülkelerin tanınmasında önemli bir etkisi olan, ekonomik olarak da büyük bir öneme sahip bir faaliyettir (Kilci, 2022). Bu faaliyetlerin en üst düzeyde bir sonucu olan Dünya Futbol Şampiyonalarının İkinci Dünya Savaşı yüzünden 1942 ve 1946 yılları hariç 1930 yılından beri 4 yılda bir düzenlenmekte olduğunu görüyoruz. Bu şampiyonalarda Brezilya 5, Almanya ve İtalya 4'er, Arjantin 3, Uruguay ve Fransa 2'şer ve İngiltere ile İspanya 1'er defa şampiyon olmuşlardır (https//:goal.com/).

Türkiye Süper Liginde mücadele eden takımların birçok uluslarası karşılaması ve başarısı mevcuttur. Bu başarılardan en büyüğü Galatasaray Spor Kulubü'nün 2000 yılında UEFA Avrupa Ligi şampiyonluğudur. Bu şampiyonluktan iki yıl sonra da Türkiye Milli Futbol Takımı FIFA 2002 Dünya Kupası'nda üçüncü olmuştur (https://tr.wikipedia.org/wiki/T%C3%BCrkiye_mill%C3%AE_futbol_tak %C4%B1m%C4%B1).

Bu çalışmada, Türkiye Süper Lig'inde 1959 – 2023 yılları arasında şampiyon olan takımlar iki farklı biçimde

durumlara ayrılarak Markov zinciri analizi ile incelenmiştir. Birinci analizde Galatasaray, Fenerbahçe ve Beşiktaş kendi başlarına birer durum ve bu üç takım dışında kalan takımlar dördüncü birdurum olarak ele alınmıştır. İkinci analizde ise, Galatasaray Fenerbahçe ve Beşiktaş birlikte bir durum ve süper ligdeki diğer takımlar ikinci bir durum olarak ele alınmıştır.

VERİLER

Çalışmada, veriler Türkiye Süper Liginde (1. Ligde) 1959 – 2023 yılları arasında şampiyon olan takımların isimlerinden oluşmaktadır. Veriler Türkiye Futbol Fedarasyonu (TFF) Resmi sitesinde yayınlanan tescillenmiş "Türkiye Ligi Şampiyonlukları" dosyasından alınmıştır.

Bu dosyadaki verilere Süper Ligdeki takımlar açısından bireysel olarak bakıldığında, 65 yıl boyunca Galatasaray'ın toplam 23, Fenerbahçe'nin 19, Beşiktaş'ın 16, Trabzonspor'un 8 ve İstanbul Başakşehir ile Bursaspor'un da 1'er kez şampiyon oldukları gözlenmiştir. Bu şampiyonluklarda Galatasaray 1996- 1997, 1997-1998, 1998-1999, 1999-2000 sezonlarında 4 kez art arda, 1970-1971, 1971-1972, 1972- 1973 sezonlarında 3 kez art arda, 1961-1962, 1962-1963; 1986-1987, 1987-1988; 1992-1993, 1993- 1994; 2011-2012, 2012-2013; 2017-2018, 2018-2019 sezonlarında 2 kez art arda ve 1968-1969; 2001- 2002; 2005-2006; 2007-2008; 2014-2015 ve en son 2022-2023 sezonlarında ise 1 kez şampiyon olmuştur. Fenerbahçe takımı da 1963-1964, 1964-1965; 1973-1974, 1974-1975; 2003-2004, 2004-2005 sezonlarında 2 kez art arda ve 1959, 1960-1961, 1967-1968, 1969-1970, 1977-1978, 1982-1983, 1984-1985, 1988-1989, 1995-1996, 2000-2001, 2006-2007, 2010-2011 ve 2013-2014 sezonlarında da 1 kez şampiyon olmuştur. Beşiktaş takımı ise 1989-1990, 1990-1991, 1991-1992 sezonlarında 3 kez art arda, 1965-1966, 1966-1967; 2015-2016, 2016-2017 sezonlarında 2 kez art arda, 1959-1960, 1981- 1982, 1985-1986, 1994-1995, 2002-2003, 2008-2009 ve 2020-2021 sezonlarında ise 1 kez şampiyon olmuştur. Trabzonspor takımı da 1978-1979, 1979-1980, 1980-1981 sezonlarında 3 kez art arda ve 1975-1976, 1976-1977 ile 2021-2022 sezonlarında 2 kez art arda ve 1983-1984 sezonunda 1 kez şampiyon olmuştur. Bursaspor ise yalnızca 2009-2010 sezonunda ve İstanbul Başakşehir ise 2019-2020sezonunda 1'er kez şampiyon olmuştur.

MARKOV ZİNCİRLERİ: TANIM, TEMEL ÖZELLİKLER

Stokastik süreçler alanının duygusal ve tarihsel olarak çekirdeğini oluşturduğu söylenebilecek bir süreçvarsa, bu Markov zincirleridir. Ayrıca, bilimsel, mühendislik ve hattâ finans ve beşeri bilimler literatürü,değişen başarı dereceleriyle Markov zincirleri ile modellenmiş rastgele süreç örnekleriyle doludur (Anderson, 1991 CTMCs, s. vii).

Bu çalışmada Türkiye Süper Ligindeki şampiyonluklara kesikli parametreli Markov zincirleriyle yaklaşımda bulunulacağından, bu süreçlere ait tanım ve temel özellikler kısaca hatırlatılacaktır.

Tanım 1. $X = \{X_n : n \in \mathbb{N}\}$ sayılabilir bir E durum uzayına sahip bir stokastik süreç olsun. Her bir $j \in E$ ve $n \in \mathbb{N}$ için

$$P\{X_{n+1} = j | X_0, X_1, \dots, X_n\} = P\{X_{n+1} = j | X_n\}$$

sağlanıyorsa, $X = \{X_n : n \in \mathbb{N}\}$ stokastik sürecine parametre uzayı $\mathbb{N}$ ve durum uzayı E olan bir *Markov zinciri* denir (Çınlar, 1975).

$$P\{X_{n+1} = j | X_n = i\} = p_{ij}(n), n \in \mathbb{N}$$

olasılık değerlerine n. dönemde i durumunda bulunan Markov zincirinin $n + 1$. dönemde j durumuna *geçiş olasılığı* denir. Doğal olarak bu koşullu olasılık i ve j durumları ile n dönemine bağlı olabilir. Geçişolasılıkları özellikle dönem parametresi n'ye bağlı olduğunda ele alınan Markov zinciri *durağan olmayan* veya *homojen olmayan Markov zinciri* olarak adlandırılır. Bu durumun tersi, yani, geçiş olasılıklarının dönem parametresi n'ye bağlı olmaması durumunda Markov zincirleri *durağan* veya *homojen Markov zinciri* olarak isimlendirilir. Uygulamada durağan Markov zincirleri daha sıklıklakullanılmaktadır. Bu çalışmada durağan Markov zincirinin

bir uygulaması verilecektir.

Markov zincirinde geçiş olasılıkları 1 dönemlik veya 1 adımlık geçiş olasılıkları olarak da ifade edilir.

Geçiş olasılıklarında dönem sayısı veya adım sayısı artınca aşağıdaki tanım verilir.

Tanım 2. $X = \{X_n: n \in \mathbb{N}\}$, E durum uzayına sahip bir Markov zinciri olsun. Her $i, j \in E$ ve $m, n \in \mathbb{N}$ ve $m \geq 1$ için

$$P\{Xn+m = j|Xn = i\} = p(m)$$

olasılık değerine Markov zincirinin m *dönemde* veya m *adımda* i *durumundan* j *durumuna geçiş olasılığı* denir (Çınlar, 1975).

Markov zincirlerinde geçiş olasılıkları süreci tanımlayan en önemli araç olup hesaplamaları kolaylaştırması için bir matris biçiminde düzenlenir ve P ile gösterilir. Tanım 2'de verilen m dönemlik geçiş olasılıkları P geçiş matrisinin m. kuvveti ile bulunur. Süreci tanımlayan bir diğer araç sürecin başlangıç dağılımıdır. Sürecin başlangıç dağılımı

$$\{X_0 = i\} = \pi_0(i),\ i \in E$$

olarak tanımlanır. Sürecin başlangıç dağılımı ve m dönemlik geçiş olasılıkları matrisi P^m, birlikte sürecin m. dönem dağılımını verir: bu dağılım, $P\{X_m = i\} = \pi_m(i)$, $i \in E$ olmak üzere

$$\pi'_m = \pi'_0 P^m,\ m \geq 1$$

ile bulunur (Çınlar, 1975).

Markov zincirlerinde bir diğer önemli araç sürecin asimptotik davranışını gösteren limit dağılımdır. Markov zincirlerinde durumların sınıflandırılması ile yakından ilişkili olan bu kavram sınıflandırma ayrıntılarına girilmeden aşağıdaki tanımda verilmiştir.

Tanım 3. Bir Markov zincirinde bütün durumlardan birbirine geçiş mümkün olsun. Bu durumda

$$\begin{cases} \pi' = \pi' P \\ \pi' 1 = 1 \end{cases}$$

denklem sistemini sağlayan π' olasılık vektörüne Markov zincirinin limit dağılımı denir. Bu tanımda ikinci denklemin ilk tarafında yer alan 1, bütün bileşenleri 1 olan bir vektör ve eşitliğin sağ yanında yer alan 1 ise bir skalerdir. Limit dağılım ayrıca her $i, j \in E$ için

$$(j) = \lim_{n\to\infty} p_{ij}^{(n)}$$

özelliğini sağlar. π'ye limit dağılım denmesi bu özellikten gelmektedir.

Tanım 4. $X = \{Xn: n \in \mathbb{N}\}$ bütün durumlardan birbirine geçişin mümkün olduğu bir Markov zinciri ve π bu Markov zincirinin limit dağılımı olsun. Her $i \in E$ durumu için

$$r_i = \frac{1}{\pi_i}$$

değerine i durumuna ortalama ilk geri dönüş zamanı denir. ri değeri Markov zincirinin $i \in E$ durumuna iki girişi arasında geçen ortalama süreyi gösterir.

1. UYGULAMA

Giriş Kesimi'nde de belirtildiği gibi, bu çalışmada Türkiye Süper Lig'inde 1959 – 2023 yılları arasında şampiyon olan takımlar ilk analizde Galatasaray, Fenerbahçe ve Beşiktaş kendi başlarına birer durum ve bu üç takım dışında kalan takımlar dördüncü bir durum olarak ve ikinci analizde ise Galatasaray Fenerbahçe ve Beşiktaş birlikte bir durum ve süper ligdeki diğer takımlar ikinci bir durum olarak ele alınmıştır. Çalışmada Markov zincirinin geçiş matrisinin tahmini ile limit dağılım ve bazı kestirimlere yer verilecek ve bu araçlar aracılığıyla takımlar birbirleriyle karşılaştırılacaktır.

1.1 GEÇİŞ OLASILIKLARI MATRİSİNİN TAHMİNİ, LİMİT DAĞILIM, ORTALAMA İLK GERİ DÖNÜŞ ZAMANLARI

2. Kesim'de sözü edilen verilerden dört durumlu model için durumlar arası Geçiş Frekansları Matrisi

$$F_1 = \begin{array}{c} GS \\ FB \\ BJK \\ DT \end{array} \begin{bmatrix} 10 & 7 & 3 & 1 \\ 8 & 4 & 5 & 3 \\ 3 & 5 & 4 & 2 \\ 1 & 3 & 2 & 3 \end{bmatrix}$$

ve geçiş frekansları matrisinde her bir frekans bulunduğu satırın toplam frekansına bölünerek Geçiş Olasılıkları Matrisinin En Küçük Kareler tahmini

$$P_1 = \begin{array}{c} GS \\ FB \\ BJK \\ DT \end{array} \begin{bmatrix} 0{,}47619 & 0{,}33333 & 0{,}14286 & 0{,}04762 \\ 0{,}40000 & 0{,}20000 & 0{,}25000 & 0{,}15000 \\ 0{,}21429 & 0{,}35714 & 0{,}28571 & 0{,}14286 \\ 0{,}11111 & 0{,}33333 & 0{,}22222 & 0{,}33334 \end{bmatrix}$$

olarak bulunur. Bu Markov zinciri için durum uzayı $E = \{GS, FB, BJK, DT\}$ ve bu durum uzayında GS: Galatasaray, FB: Fenerbahçe, BJK: Beşiktaş ve DT: Diğer Takımlar olduğu açıktır.

Geçiş Olasılıkları Matrisinin tahmini incelendiğinde, Galatasaray'ın şampiyon olduğu herhangi bir sezon sonrasında en olası durumun %47,6 olasılıkla yine Galatasaray'ın şampiyon olması, Fenerbahçe'- nin şampiyon olduğu herhangi bir sezon sonrasında en olası durumun %40 olasılıkla Galatasaray'ın şampiyon olması, Beşiktaş'ın şampiyon olduğu herhangi bir yıl sonrasında en olası durumun %35,7 olasılıkla Fenerbahçe'nin şampiyon olması ve Diğer Takımlardan birinin şampiyon olduğu herhangi bir yıl sonrasında en olası durumların aynı %33,3 olasılıkla Diğer Takımlardan birinin veya Fenerbahçe'nin şampiyon olması olduğunu gözlüyoruz.

QSB (Quantitative Systems for Business) paket programı Markov Process modülünden yararlanılarak, dört durumlu Markov zincirinin limit dağılımı

$\pi 1$ = (0,3461; 0,2987; 0,2168; 0,1384)

olarak elde edilmiştir. Bu limit dağılımı tüm sezonların %34,6'sında Galatasaray'ın, %29,9'unda Fenerbahçe'nin, %21,7'sinde Beşiktaş'ın ve %13,8'inde Diğer Takımların şampiyonlukları ile karşılaşılmasını bekleriz, diye yorumlayabiliriz. Aynı paket programdan her bir durumun kendisine Ortalama İlk Geri Dönüş Zamanları

r = (2,89; 3,35; 4,61; 7,23)

olarak bulunur. Bu Geri Dönüş Zamanlarını da her sezon bir yılı ifade ettiğinden, ortalama olarak her 2,89 yılda bir Galatasaray'ın, her 3,35 yılda bir Fenerbahçe'nin, her 4,61 yılda bir Beşiktaş'ın ve her 7,32 yılda bir Diğer Takımlardan birinin şampiyon olması beklenir, şeklinde yorumlarız.

2. Kesim'de sözü edilen verilerden iki durumlu model (Galatasaray Fenerbahçe ve Beşiktaş birlikte bir durum ve diğer takımlar ikinci bir durum) için durumlar arası Geçiş Frekansları Matrisi

$$F_2 = \begin{bmatrix} 49 & 6 \\ 6 & 3 \end{bmatrix},$$

ve geçiş frekansları matrisinde her bir frekans bulunduğu satırın toplam frekansına bölünerek Geçiş Olasılıkları Matrisinin En Küçük Kareler tahmini

$$P_2 = \begin{vmatrix} 0{,}89091 & 0{,}10909 \\ 0{,}66667 & 0{,}33333 \end{vmatrix}$$

olarak bulunur. Bu Geçiş Olasılıkları Matrisinden, üç büyük takımdan birinin şampiyon olduğu herhangi bir sezon sonrasında %89'u biraz aşan bir olasılıkla yine üç büyük takımdan birinin şampiyon olması beklenirken, üç büyük takım dışındaki takımlardan birinin şampiyonluğu sonrasında üç büyük takımdan birinin şampiyon olması %66,7 (yani, 2/3) olduğunu gözlüyoruz.

QSB paket programından, bu ikinci modelin limit dağılımı ve Ortalama İlk Geri Dönüş Zamanları sırasıyla,

$\pi 2$ = (0,8594; 0,1406) ve r = (1,16; 7,11)

olarak elde edilir. Limit dağılımdan tüm sezonların %85,9'unda üç büyük takımdan birinin ve yaklaşık

%14,1'inde üç takım dışındaki takımlardan birinin şampiyon olması beklenir. Yine *h*er sezon bir yıl olduğundan, ortalama olarak her 1,16 yılda bir üç büyük takımdan birinin, her 7,11 yılda bir üç büyük takım dışında kalan birinin şampiyon olması beklenir.

1.2 KESTİRİMLER

Bu kesimde herhangi bir sezonda durumları oluşturan takımlardan birinin şampiyon olduğu varsayımı altında sonraki sezonlarda hangi olasılıklarla diğer takımların şampiyon olacağını ele alacağız. Markov

Tablo 1. $i = GS, FB, BJK, DT$ Durumlarından başlayan Markov Zincirinin Durumlarda Bulunma Olasılıkları.

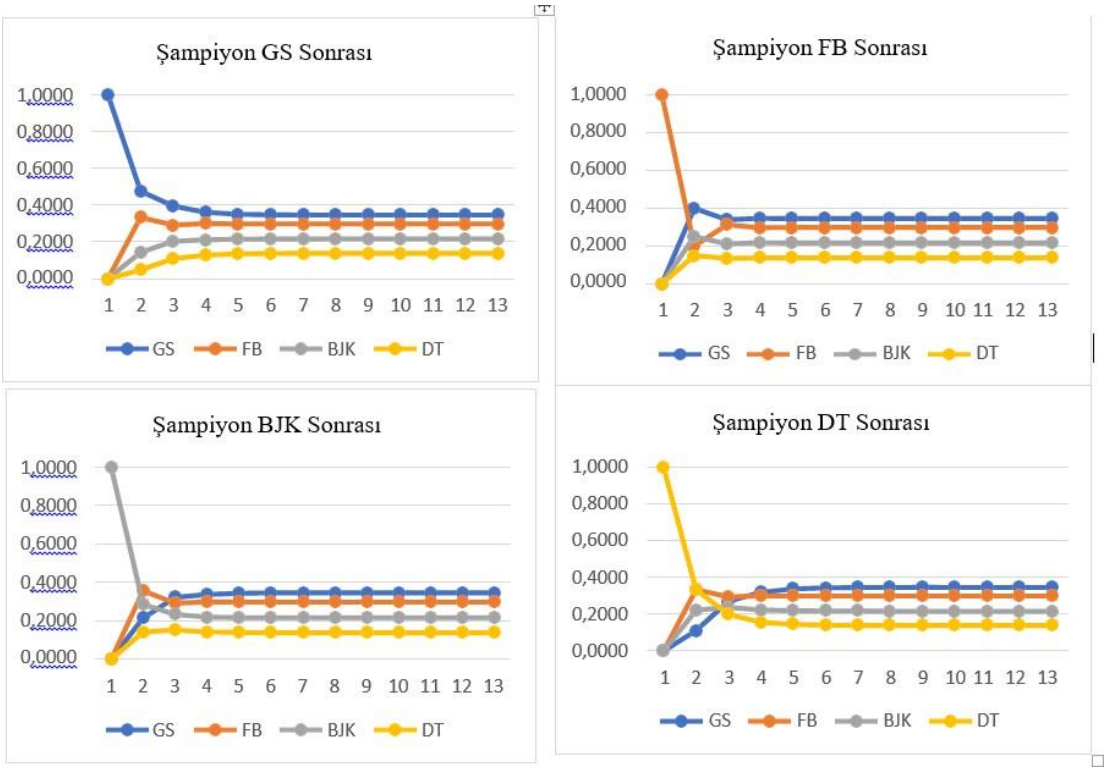
GS	FB	BJK	DT	GS	FB	BJK	DT
1,0000	0,0000	0,0000	0,0000	0,0000	1,0000	0,0000	0,0000
0,4762	0,3333	0,1429	0,0476	0,4000	0,2000	0,2500	0,1500
0,3960	0,2923	0,2028	0,1090	0,3407	0,3126	0,2119	0,1348
0,3610	0,2992	0,2118	0,1280	0,3477	0,2967	0,2173	0,1383
0,3512	0,2985	0,2153	0,1360	0,3462	0,2989	0,2167	0,1382
0,3478	0,2987	0,2163	0,1373	0,3461	0,2987	0,2168	0,1384
0,3467	0,2987	0,2167	0,1380	0,3461	0,2987	0,2168	0,1384
0,3463	0,2987	0,2168	0,1383	0,3461	0,2987	0,2168	0,1384
0,3462	0,2987	0,2168	0,1383	0,3461	0,2987	0,2168	0,1384
0,3461	0,2987	0,2168	0,1384	0,3461	0,2987	0,2168	0,1384
0,3461	0,2987	0,2168	0,1384	0,3461	0,2987	0,2168	0,1384
0,3461	0,2987	0,2168	0,1384	0,3461	0,2987	0,2168	0,1384
0,3461	0,2987	0,2168	0,1384	0,3461	0,2987	0,2168	0,1384
GS	FB	BJK	DT	GS	FB	BJK	DT
0,0000	0,0000	1,0000	0,0000	0,0000	0,0000	0,0000	1,0000
0,2143	0,3571	0,2857	0,1429	0,1111	0,3333	0,2222	0,3333
0,3220	0,2925	0,2333	0,1522	0,2709	0,2942	0,2368	0,1982
0,3372	0,2999	0,2196	0,1433	0,3194	0,2997	0,2239	0,1569
0,3435	0,2986	0,2177	0,1402	0,3374	0,2987	0,2194	0,1445
0,3452	0,2987	0,2171	0,1390	0,3432	0,2987	0,2177	0,1404
0,3458	0,2987	0,2169	0,1386	0,3452	0,2987	0,2171	0,1390
0,3460	0,2987	0,2168	0,1385	0,3458	0,2987	0,2169	0,1386
0,3461	0,2987	0,2168	0,1384	0,3460	0,2987	0,2168	0,1385
0,3461	0,2987	0,2168	0,1384	0,3461	0,2987	0,2168	0,1384
0,3461	0,2987	0,2168	0,1384	0,3461	0,2987	0,2168	0,1384

0,3461	0,2987	0,2168	0,1384	0,3461	0,2987	0,2168	0,1384
0,3461	0,2987	0,2168	0,1384	0,3461	0,2987	0,2168	0,1384

zincirlerinde m. dönem dağılımı bu hesaplamaları bize verir.

Tablo 1'deki olasılıklardan ve bu olasılıklara ilişkin Şekil 1'deki grafiklerden de görüldüğü gibi, bir şampiyonluğu sonrasında Galatasaray'ın sonraki sezonlarda tüm diğer takımlardan daha fazla şampiyon olma olasılığı göze çarpıyor. Hattâ bu olasılık Fenerbahçe'nin şampiyonluğu sonrasında ilk yıl %40 (1. Sırada) ve Beşiktaş'ın şampiyonluğu sonrasında ilk yıl %21,4 (3. Sırada) iken, Diğer Takımlardan birinin şampiyonluğu sonrasında ilk yıl %11,1 (4. Sırada)'dir. Galatasaray'ın sonraki sezonlarda şampiyon olma olasılığı (kendi şampiyon olduğu sezon sonrası hariç) Fenerbahçe'nin şampiyon olması sonrasında ilk sezonda, Beşiktaş'ın şampiyon olması sonrasında ikinci sezonda ve Diğer Takımlardan birinin şampiyon olması sonrasında üçüncü sezonda diğer takımlardan üste çıkıyor ve bu üstünlüğünü sonraki sezonlarda koruyor. Beşiktaş'ın ve Diğer Takımlardan birinin şampiyon olması sonrasında Fenerbahçe'nin ilk sezonda şampiyon olması olasılığı diğer takınlardan daha yüksek iken, bu üstünlüğün hemen bir sonraki sezonda korunamadığını gözlüyoruz. Diğer Takımlardan birinin şampiyon olması sonrasındaki sezonda Fenerbahçe ve Diğer Takımlardan birinin şampiyon olması olasılığı aynı %33,3 olasılık olup bu olasılık hemen bir sonraki sezonda Fenerbahçe'nin lehine değişmektedir.

Bu grafik ve olasılıklardan son bir gözlem olarak şu söylenebilir: Diğer Takımlardan birinin şampiyon olması sonrasında en geç iki yıl sonra yine bu Diğer Takımlardan birinin şampiyon olması olasılığı üç büyük takımın hepsinden daha düşük hâle geliyor. Dört durumlu Markov zincirinde bu tür olasılık kestirimleri üzerinden takımlar daha fazla karşılaştırılabilir.

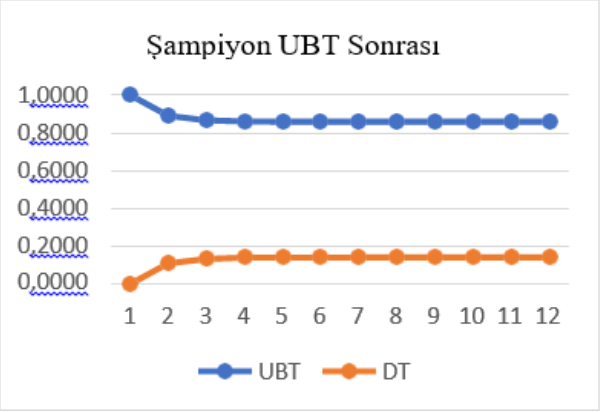


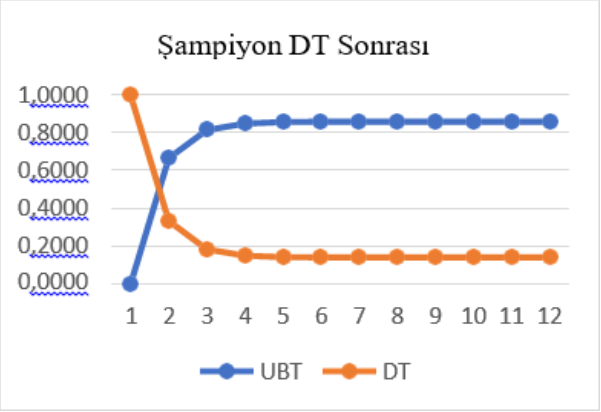
Şekil 1. $i = GS, FB, BJK, DT$ Takımlarının Şampiyonluğu Sonrasındaki Sezonlarda Takımların Şampiyon Olma Olasılıkları.

Dört durumlu Markov zincirindeki olasılık kestirimleri üzerine verilen yorumlar, benzer şekilde durum uzayı $E = \{UBT, DT\}$ ve UBT: Üç Büyük Takım, DT: Diğer Takımlar olmak üzere iki durumlu Markov zinciri için de verilebilir. Herhangi bir sezonda UBT ve DT takımlarından birinin şampiyon olduğu varsayımı altında, sonraki sezonlarda hangi olasılıklarla bu iki takımın şampiyon olacağını Markov zincirinin m. dönem dağılımı kestirimleriyle elde ederiz.

Tablo 2. $i = UBT, DT$ Durumlarından başlayan Markov Zincirinin Durumlarda Bulunma Olasılıkları.

UBT	DT	UBT	DT
1,0000	0,0000	0,0000	1,0000
0,8909	0,1091	0,6667	0,3333
0,8664	0,1336	0,8162	0,1838
0,8610	0,1390	0,8497	0,1503
0,8597	0,1403	0,8572	0,1428
0,8595	0,1405	0,8589	0,1411
0,8594	0,1406	0,8593	0,1407
0,8594	0,1406	0,8594	0,1406
0,8594	0,1406	0,8594	0,1406
0,8594	0,1406	0,8594	0,1406
0,8594	0,1406	0,8594	0,1406
0,8594	0,1406	0,8594	0,1406
		0,8594	0,1406





Şekil 2. $i = UBT, DT$ Takımlarının Şampiyonluğu Sonrasındaki Sezonlarda Takımların Şampiyon Olma Olasılıkları.

Tablo 2'deki olasılıklardan ve bu olasılıklara ilişkin Şekil 2'deki grafiklerden de görüldüğü gibi, bir UBT şampiyonluğu sonrasında UBT'nin sonraki sezonlarda Diğer Takımlardan daha fazla şampiyon olma olasılığı göze çarpıyor. UBT'nin üstünlüğü Diğer Takımlardan herhangi birinin şampiyonluğu sonrasındaki tüm diğer sezonlarda da aynen devam eder.

1.3 TAKIMLAR ARASINDA DİĞER KARŞILAŞTIRMALAR

Bu kesimde herhangi bir sezonda durumları oluşturan takımlardan birinin iki şampiyonluğu arasında diğer takımların ortalama kaç kez şampiyon olmasının beklendiğine ilişkin istatistikler bakımından karşılaştırmalara devam edilmiştir. Dolayısıyla π limit dağılımdan yararlanarak, durum uzayında

$j, k \in E$ herhangi iki durum olmak üzere, $\pi k/\pi j$ oranı aracılığıyla j'ye yapılan iki giriş arasında k'ya yapılan ortalama girişlerin sayısı elde edilmiş ve bu istatistik açısından takımlar birbiriyle karşılaştırılmıştır.

Dört durumlu Markov inciri için şunlar elde edilir:

$\frac{\pi_{GS}}{\pi_{FB}} = \frac{0,3461}{0,2987} = 1,16$: FB'nin iki şampiyonluğu arasında beklenen GS şampiyonluğu sayısı,

$\frac{\pi_{GS}}{\pi_{BJK}} = \frac{0,3461}{0,2168} = 1,60$: BJK'nın iki şampiyonluğu arasında beklenen GS şampiyonluğu sayısı,

$\frac{\pi_{GS}}{\pi_{DT}} = \frac{0,3461}{0,1384} = 2,50$: DT'ın iki şampiyonluğu arasında beklenen GS şampiyonluğu sayısı,

$\frac{\pi_{FB}}{\pi_{BJK}} = \frac{0,2987}{0,2168} = 1,38$: BJK'nın iki şampiyonluğu arasında beklenen FB şampiyonluğu sayısı,

$\frac{\pi_{FB}}{\pi_{DT}} = \frac{0,2987}{0,1384} = 2,16$: DT'ın iki şampiyonluğu arasında beklenen FB şampiyonluğu sayısı,

$\frac{\pi_{BJK}}{\pi_{DT}} = \frac{0,2168}{0,1384} = 1,57$: DT'ın iki şampiyonluğu arasında beklenen BJK şampiyonluğu sayısı.

Bu limit oranlardan da görüldüğü gibi, sabit tutulan takım arasında GS'ın FB ve BJK'ya göre daha yüksek olduğu, yani,

$$\frac{\pi_{GS}}{\pi_{BJK}} = 1,60 > \frac{\pi_{FB}}{\pi_{BJK}} = 1,38, \quad \frac{\pi_{GS}}{\pi_{DT}} = \frac{0,3461}{0,1384} = 2,50 > \frac{\pi_{FB}}{\pi_{DT}} = 2,16 > \frac{\pi_{BJK}}{\pi_{DT}} = 1,57$$

olduğu görülüyor. Doğal olarak bu oranlar GS, FB ve BJK'nın şampiyonluk frekansları ile paraleldir.

İki durumlu Markov inciri için de şu sonuç elde edilir:

$\frac{\pi_{UBT}}{\pi_{DT}} = \frac{0,8594}{0,1406} = 6,11$: DT'ların iki şampiyonluğu arasında UBT şampiyonluğu sayısı.

Yani, Diğer Takımlardan birinin iki şampiyonluğu arasında Üç Büyük Takımın oluşturduğu grubun oratalama 6,11 şampiyonluk yaşaması beklenir.

SONUÇ VE ÖNERİLER

Futbol liglerindeki olgular üzerine çeşitli istatistiksel tekniklerle birçok araştırma yapılmıştır ve yapılmaya devam etmektedir. Daha önce verdiğimiz iki referans dışında bu çalışmalar arasında (Aydın, 2019), (Gözcü, 2011), (Eryılmaz ve Er, 2016), (Güneş, 2022) ve daha birçok çalışma sayılabilir.

Bu çalışmada, Türkiye Süper Lig'inde 1959 – 2023 yılları arasında yalnızca şampiyon olan takım bilgisi kullanılarak oluşturulan dört ve iki durumlu Markov zincirleri ile tahmin edilen geçiş olasılıkları matrisi ve dolayısıyla Markov zinciri istatistiklerinden m dönemde geçiş olasılıkları, limit dağılım ve ortalama ilk geri dönüş zamanları aracılığıyla takımlar karşılaştırılmaktadır. Bu çalışma Emre İnce'nin Lisans Bitirme Tezi olarak Osmangazi Üniversitesi'ne sunduğu 1953 - 2021 yılları arasındaki Türkiye Süper Ligi şampiyonluklarından elde edilen sonuçlara son iki yıldaki şampiyonluklar eklenerek elde edilmiş güncellenmiş bir biçimidir. Aşağıda vereceğimiz elde edilen istatistiklerden de görüleceği gibi, kazanılan her bir şampiyonluk kazanan takım lehine istatistikleri değiştirmektedir. Ancak farklı takımlar tarafından kazanılan şampiyonluklarda tahmin edilen geçiş olasılıkları matrisinin bu lehindeliği değiştirebileceği de dikkatle izlenmelidir.

Burada Önceki Tahmin ile Emre İnce'nin tezindeki 1953 - 2021 yılları arasındaki şampiyonluklardan elde edilen (Ö) indisli sonuçları ve Sonraki Tahmin ile bu çalışmada kullanılan 1953 - 2023 yılları arasındaki şampiyonluklardan elde edilen (S) sonuçları kastediyoruz.

Dört durumlu Markov zinciri için limit dağılımları karşılaştırırsak,

πÖ = (0,3361; 0,3091; 0,2271; 0,1277) ↔ πS = (0,3461; 0,2987; 0,2168; 0,1384)

GS ve DT'lardan Trabzonspor'un her ikisinin birer şampiyonluk kazanmasıyla, bu takımların limit dağılım olasılıklarını sırasıyla %1 ve %1,07 arttırdıkları ve FB ve BJK'nın ise, azalttıkları görülüyor.

Benzer şekilde iki durumlu Markov zinciri için limit dağılımlar karşılaştırıldığında,

πÖ = (0,8710; 0,1290) ↔ πS = (0,8594; 0,1406)

GS ve DT'lardan Trabzonspor'un her ikisinin birer şampiyonluk kazanmasıyla, üç büyüklerin takımı

UBT'nin limit olasılığında %1,16 düşme halini gösterirken, DT'nin limit olasılığında aynı oranda artışa işaret ediyor.

Bir başka karşılaştırmayı Önceki ve Sonraki Tahmin değerlerinin verdiği şampiyona sonrası iki dönemde kestirilen Durumlarda Bulunma Olasılıklarını gözleyerek de yapabiliriz:

πÖ(GS, 1) = (0,4545; 0,3182; 0,1818; 0,0455) ↔ πS(GS, 1) = (0,4762; 0,3333; 0,1429; 0,0476)

πÖ(GS, 2) = (0,3993; 0,2818; 0,2169; 0,1019) ↔ πS(GS, 2) = (0,3960; 0,2923; 0,2028; 0,1090)

Burada πÖ(GS, 1), GS'ın şampiyon olduğu 1 dönem sonrası Önceki Tahmine Göre Durumlarda Bulunma Olasılıkları vektörünü temsil etmektedir. Kestirilen Durumlarda Bulunma Olasılıklarından GS'ın hemen şampiyonluk sonrası dönemde Önceki Tahmine göre %45,45 olan tekrar şampiyon olma olasılığını

%47,62'ye çıkardığını gözlüyoruz.

Benzer şekilde

πÖ(FB, 1) = (0,4737; 0,1579; 0,2105; 0,1579) ↔ πS(FB, 1) = (0,4000; 0,2000; 0,2500; 0,1500)

πÖ(FB, 2) = (0,3387; 0,3158; 0,2236; 0,1219) ↔ πS(FB, 2) = (0,3407; 0,3126; 0,2119; 0,1384)

Kestirilen Durumlarda Bulunma Olasılıklarından FB'nin hemen şampiyonluk sonrası dönemde Önceki Tahmine göre %15,79 olan tekrar şampiyon olma olasılığını %20'ye çıktığını gözlüyoruz.

πÖ(BJK, 1) = (0,2308; 0,3846; 0,3077; 0,0769) ↔ πS(BJK, 1) = (0,2143; 0,3571; 0,2857; 0,1429)

πÖ(BJK, 2) = (0,3581; 0,2813; 0,2368; 0,1237) ↔ πS(BJK, 2) = (0,3220; 0,2925; 0,2333; 0,1522)

Kestirilen Durumlarda Bulunma Olasılıklarından BJK'nün hemen şampiyonluk sonrası dönemde Önceki Tahmine göre %30,77 olan tekrar şampiyon olma olasılığının %28,57'ye düştüğünü gözlüyoruz.

πÖ(DT, 1) = (0,0000; 0,3750; 0,2500; 0,3750) ↔ πS(DT, 1) = (0,1111; 0,3333; 0,2222; 0,3333)

πÖ(DT, 2) = (0,2353; 0,2960; 0,2496; 0,2191) ↔ πS(DT, 2) = (0,2709; 0,2942; 0,2368; 0,1982)

Kestirilen Durumlarda Bulunma Olasılıklarından DT'ların hemen şampiyonluk sonrası dönemde Önceki Tahmine göre %37,5 olan tekrar şampiyon olma olasılığının geçen yıl GS'dan önce DT'lardan Trabzonspor'un şampiyon olmasına rağmen %33,33'e düştüğünü gözlüyoruz. Burada GS'a karşı gelen olasılığın %0 olasılığının %11,11'e artması ilginçtir. Bunun nedeni bu yıla kadar GS'ın DT'lardan sonra hiç şampiyon olmamasıdır. Bu bilgiyi Emre İnce'nin Geçiş Frekansları Matrisinden gözlüyoruz.

Burada yorumları uzatmamak için bu iki dönemlik karşılaştırmalarda hemen alt satırda yer alan olasılıkları yorumlamadığımızı kaydedelim.

Yukarıda dört durumlu Markov zinciri için verdiğimiz iki dönemlik Durumlarda Bulunma Olasılıklarına benzer yorumları iki durumlu Markov zinciri için de aşağıdaki gibi verebiliriz:

πÖ(UBT, 1) = (0,9273; 0,0727) ↔ πS(UBT, 1) = (0,8909; 0,1091)

πÖ(UBT, 2) = (0,9014; 0,0986) ↔ πS(UBT, 2) = (0,8664; 0,1336)

Buradaki kestirilen Durumda Bulunma Olasılıklarından DT'lardan Trabzonsporun şampiyon olmasının

UBT'da hemen bir sonraki dönemde şampiyon olma olasılığını %92,73'ten %89,09'a düşürdüğü gözleniyor.

πÖ(DT, 1) = (0,5714; 0,4286) ↔ πS(DT, 1) = (0,6667; 0,3333)

πÖ(DT, 2) = (0,7748; 0,2252) ↔ πS(DT, 2) = (0,8162; 0,1838)

Buradaki kestirilen Durumda Bulunma Olasılıklarından DT'lardan Trabzonsporun şampiyon olmasının

UBT'dan birinin hemen bir sonraki dönemde şampiyon olma olasılığını %42,86'dan %66,67'ye yükselttiği görülürken, aynı sezonda DT'lardan birinin şampiyon olma olasılığını %42,86'dan %33,33'e düşürdüğü gözleniyor.

Az önce Dört Durumlu Markov zincirinde GS'ın son şampiyonluğuna benzer etkileri Markov zincirinin her bir durumuna karşı gelen takımın veya takımların sonraki yılda şampiyon olacağı varsayımı altında verdiğimiz Markov zinciri istatistiklerine olan etkileri de araştırılabilir. Ancak çalışmayı daha fazla uzatmamak için burada noktayı koyuyoruz. Ayrıca her futbol sezonu sonunda şampiyon olan takım bilgisini verilere ilâve edip ondan sonra sonraki yıl veya yıllar için burada örneklendirdiğimiz tahminleri ve kestirimleri yapmanın daha tutarlı sonuçlara bizi ulaştıracağını söyleyebiliriz.

Çalışmada son söz ve öneri olarak şu durumu belirtmekte yarar görüyoruz. Doğal olarak, futbol ve benzeri spor karşılaşmalarında sonucu daha güvenilir bir şekilde tahmin etmek için ele alınan sportif faaliyette konuyu bilen uzmanlara danışarak veya onlarla birlikte teknik analizler yapmak yararlı olur. Bu anlamda özellikle spor eğitimi veren kurumlarda yapılan çalışmaların da son yıllarda yaygınlaşmakta olduğunu görüyoruz, bu bizi mutlu ediyor.

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Deprem Sonrası Psikolojik Dayanıklılığın İstatistiksel Yöntemlerle İncelenmesi

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Özet

Psikolojik sağlamlığın yüksek olması, kişilerin karşılaştıkları zorlayıcı ve travmaya yol açan durumlar karşısında etkin baş etme ve sorun çözme becerilerini kullanabilmelerini sağlamaktadır. Psikolojik sağlamlık düzeyinin düşük olması bireyde tükenmişlik duygusu, anksiyete, depresyon ve travma sonrası stres bozukluğu belirtilerinin artmasına yol açabilmektedir. Bu nedenle, depreme maruz kalan bireylerin psikolojik sağlamlıklarının incelenmesi önemli olacaktır. Bu çalışmada, afet bölgesinde yaşayan, depremi yaşayan ve/veya depremden etkilenen kişilere "Connor Davidson Psikolojik Dayanıklılık Ölçeği (CD-RISC)" uygulanmıştır. Deprem sonrasında kişilerin toparlanma yetisine etki eden değişkenler istatistiksel analizler araştırılmıştır. CD-RISC Ölçeğinin manevi eğilim alt faktörünün puan değerleri bakımından "bulunduğunuz çevre ile kıyaslandığınızda ekonomik düzey" ve "bireysel güvenliğin sağlanması" değişkenlerinin grupları arasında anlamlı farklılık olduğu görülmüştür. Bu risk faktörlerinin göz önüne alınmasının kişilerin dayanıklılıklarını artıracağı düşünülmektedir.

Anahtar Kelimeler: *Connor Davidson Psikolojik Dayanıklılık Ölçeği, Deprem, Psikolojik Durum, İstatistiksel Analiz.*

Abstract

In addition to the physical pain and destruction of the earthquake disaster that occurred in our country on 6/2/2023, the fact that it also had psychological effects increased the existing pain. It is of vital importance for our country to take steps to remove, heal and reduce the effects of this mental collapse. It is an important research for our country to be able to reveal emotional, conscious, behavioral and spiritual results about the emotional state that occurs as a result of the earthquake and the trauma experienced after it, to measure and evaluate variables that cannot be observed directly related to psychology, to analyze data with statistical methods and to offer various suggestions with established mathematical models. is the subject. It is known that physical tools and equipment are used to measure concrete variables in scientific studies. However, there are no physical tools and equipment to be used to measure some intangible variables such as psychological attitude. In such cases, unmeasurable (unobservable) variables can be explained based on measurable (observable) variables. In order to apply the survey form prepared for this study, the necessary ethics committee permission and permissions from official institutions were obtained. The collected data were analyzed using statistical methods. With the mathematical models established, important factors about the psychological states of people affected by the earthquake were tried to be revealed.

Key words: *Connor Davidson Psychological Resilience Scale, Earthquake, Psychological Situation, Statistical Analysis.*

GİRİŞ

Psikolojik sağlamlık (resilience), bir olumsuzluk durumu ile karşı karşıya kalındığında, risk faktörleri ve koruyucu faktörlerin etkileşimi sonucu oluşan süreçte, bireyin hayatındaki değişikliğe uyum göstermesini ifade etmektedir. Psikolojik sağlamlıkla ilgili yapılan çalışmalar ortaya çıkabilecek bir risk karşısında bireyin hayatına göstereceği uyumu değerlendirmek için yapılmaktadır. Stresli yaşam olaylarının neden olduğu risk faktörleri ve riskin olumsuz etkilerini hafifleten koruyucu faktörler, gelişimsel bir süreç olarak da tanımlanan psikolojik sağlamlık kavramına katkıda bulunmaktadırlar. Bu çalışmada, deprem bölgesinde depremi direk yaşayan ya da haberlerden takip eden kişilerin psikolojik sağlamlıklarının tanımlanması, risk faktörlerinin ortaya konması ve psikolojik sağlamlıktaki değişkenliği açıklayan faktörlerin belirlenmesi amaçlanmaktadır.

Sağlamlık kavramı, üretilen bir ürün strese maruz kaldıktan sonra tekrar eski şeklini kazanabilme yeteneği ve kullanıma uygunluğu olarak tanımlanırken psikoloji alanında ise bir kişinin stres sonrası kendini toparlama yeteneği ve çevresine uyum sağlama özelliği olarak kullanılmaktadır. Bu kavram İngilizce ’de “psychological resilience” veya ‘psychological hardiness” olarak kullanılmakla birlikte, Türkçe karşılığı olarak yılmazlık, psikolojik dayanıklılık, kendini toparlama gücü ve psikolojik sağlamlık gibi sözcüklerin kullanımına literatürde rastlanmaktadır. Bu çalışmada “psikolojik dayanıklılık” ifadesi kullanılacaktır.

Psikolojik dayanıklılık, bireyin belirsizlikler karşısında, engelleme ve olumsuz olarak kabul ettiği olaylar karşısında mücadele ederek başarılı bir şekilde olayları yönetebilme yeteneği olarak kabul edilmektedir (Basım-Çetin, 2011). Yaşam içerisinde karşılaşılan stresli olaylar veya hastalık gibi kişiyi direk etkileyecek olaylar ile yüz yüze gelindiğinde bir direnç kaynağı gibi kişinin gösterdiği kendine has iradesidir (Kobasa, 1979).

Ayrıca psikolojik dayanıklılık hakkında yapılan diğer tanımlar aşağıda verilmiştir.

- Bir bireyin yüksek riskli veya zorlu bir durumla karşı karşıya kalmasına rağmen, olumlu işleyiş yeterliliğini başarılı bir şekilde geri kazanma kapasitesi (Egeland, 1993).
- Bireylerin ciddi zorluk veya travma deneyimlerine rağmen pozitif uyum gösterdiği dinamik bir süreç (Luthar ve Cicchetti, 2000).
- Zorluklar karşısında bireyin gelişimini sağlayan kişisel özellik (Connor ve Davidson, 2003).
- Duygusal dayanıklılık ve stresle başa çıkma yetisini ölçmeye yarayan kavram (Connor, 2006).
- Çevresel risk deneyimlerine karşı kırılganlığın en aza indirilmesi, stres veya zorlukların aşılması veya riskli deneyimlere rağmen nispeten iyi bir sonuca ulaşma (Rutter, 2006) .
- Kişinin engel, belirsizlik ve benzeri birçok olumsuz durumla baş etme ve başarılı olma yeteneği (Terzi 2008).
- Stresli durumlar karşısında sağlıkla duygusal dengede kalabilme kişisel özelliği (Karaırmak, 2010).
- Sıra dışı ya da sıradan olabilecek akut veya kronik olumsuzluklara karşı esnek bir bilişsel, davranışsal ve duygusal tepkiler kümesi (Neenan, 2009).

Psikolojik sağlamlığın yüksek olması, kişilerin karşılaştıkları zorlayıcı ve travmaya yol açan durumlar karşısında etkin baş etme ve sorun çözme becerilerini kullanabilmelerini sağlamaktadır. Psikolojik sağlamlık düzeyinin düşük olması bireyde tükenmişlik duygusu, anksiyete, depresyon ve travma sonrası stres bozukluğu belirtilerinin artmasına yol açabilmektedir. Bu nedenle, depreme maruz kalan bireylerin psikolojik sağlamlıklarının incelenmesi önemli olacaktır. Bu çalışmada, afet bölgesinde yaşayan,

depremi yaşayan ve/veya depremden etkilenen kişilere "Connor Davidson Psikolojik Sağlamlık Ölçeği" uygulanmıştır. Deprem sonrasında kişilerin toparlanma yetisine etki eden değişkenler araştırılmış ve istatistiksel modelleme sonucunda çeşitli öneriler ortaya konulmuştur.

Connor - Davidson Psikolojik Sağlamlık Ölçeği (CD-RISC)

Connor ve Davidson Psikolojik Sağlamlık Ölçeği (CD-RISC), Connor ve Davidson (2003) tarafından geliştirilen 5'li Likert tipi ve 25 maddelik bir ölçektir. Connor Davidson Psikolojik Sağlamlık ölçeği, Karaırmak (2007, 2010) tarafından Türk kültürüne uyarlanmıştır. Ölçeğin toplam puanı 0-100 arasındadır. Ölçekten alınan yüksek puan, yüksek psikolojik sağlamlığı işaret etmektedir (Aydın, 2018).

Ölçek 25 madde ve 3 alt boyuttan oluşmakta; ölçekteki maddeler ise '0=Hiç doğru değil, 1= Nadiren doğru, 2= Bazen doğru, 3= Sıklıkla doğru, 4= Neredeyse her zaman doğru' şeklinde 5'li Likert tipi puanlanmaktadır. Bu alt boyutlar; azim ve kişisel yeterlik, olumsuz olaylara tolerans (hoşgörülü olmak) ve manevi eğilim olarak tanımlanmıştır.

Ölçekte yer alan 1, 5, 10, 11, 12, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25 numaralı maddelerden oluşan Azim ve Kişisel Yeterlilik boyutu, kişisel yeterlilik, yüksek standartlar, kararlılık, içgüdülerine güvenme, duygusal sıkıntıya tahammül edebilme, stresin güçlendirici etkisi ve değişimini olumlu kabul etme düzeyini ölçmektedir ve bu faktörün alacağı puan 60'dan küçüktür. Ölçekte yer alan 4, 6, 7, 8, 13, 14 numaralı maddelerden oluşan Olumsuz Duyguya Tolerans boyutu ile kriz durumlarına verilen tepkiyi ölçmektedir ve bu faktörün alacağı puan 24'den küçüktür. Manevi Eğilimi boyutunu oluşturan 2, 3, 9, 20 maddeleri ise maneviyatın etkisini ölçmektedir bu faktörün alacağı puan 16'dan küçüktür. Orijinal ölçeğin Cronbach alfa güvenilirlik katsayısı 0.89'dur. Karaırmak'ın (2010) çalışmasında ölçek bütünü için α=0.92, Azim ve Kişisel Yeterlilik, Olumsuz Duyguya Tolerans ve Maneviyat Eğilimi boyutları için ise, sırasıyla α=0.93, α=0.79 ve α=0.50'dir. Bu üç faktör ile açıklanan varyans oranı %52 olarak bulunmuştur (Karaırmak, 2010; Önel, 2021).

Deprem sonrası ortaya çıkan travma, stres ve çeşitli psikolojik problemler adı geçen ölçeklerden elde edilecek puanlarla ele alınıp ölçekler arasındaki ilişki istatistiksel modellerle incelenecektir.

MATERYAL VE METOT

Bilimsel çalışmalarda somut değişkenlerin ölçülmesinde fiziksel araç ve gereçler kullanılırken, psikolojik tutum gibi bazı soyut değişkenlerin ölçülmesinde kullanılacak fiziksel araç ve gereçler bulunmamaktadır. Bu tür durumlarda ölçülebilen (gözlenebilen) değişkenlerden yola çıkılarak, ölçülemeyen (gözlenemeyen) değişkenler açıklanabilmektedir. Bu çalışmada yüzyüze ve onlin-çerimiçi anket yaparak toplanan veriler ve ölçek puanları istatistiksel yöntemlerle analiz edilecektir. Araştırmada elde edilen veriler IBM SPSS-v20.0 ve R programı kullanılarak analiz edilmiştir.

Veri Kümesi

19.05.2023-03.09.2023 tarihlerinde Google anket platformu Google Formlar'da hazırlanan çevrimiçi anket formu ile toplam 518 gönüllü kişiye anket yapılmıştır. Anket verileri 18-65 yaş ve üstü yetişkinlerden toplanmıştır ve yaşadığı şehir, depremde bulunduğu şehir, depremde maddi zarar, depremde bir yakınını kaybetme, gelir, meslek, çalıştığı sektör, depremde bireysel güvenliğinin sağlandığına dair güven, cinsiyet ve medeni durumu kapsayan demografik değişkenler yer almaktadır. Çalışmaya katılım göstermeyi gönüllü olarak kabul eden bireylere sırasıyla "Kişisel bilgi Formu" ve "Connor- Davidson Psikolojik Sağlamlık Ölçeği (CD-RISC)" uygulanmıştır. Veri analizinde kullanılacak örneklemin büyüklüğü hakkında çeşitli görüşler vardır. Örneğin Bryman ve Cramer (2001), madde sayısının en az 5 katı derken Nunually (1978)'ın çalışmasında 10 katı, Gorush (1983) ise 15 katı olarak görüş bildirmiştir (Delice ve Ergene, 2015). Ankete katılan gönüllü sayısı 400 kişiyi analizler yapılmaya başlanmıştır. Bu çalışmanın yapılabilmesi için etik kurul onayı alınmıştır (Kırıkkale

Üniversitesi Sosyal ve Beşeri Bilimler Araştırmaları Etik Kurulu, 22.05.2023 tarihli 05 numaralı oturumunda alınan 25 numaralı karar). Kırıkkale Üniversitesi Rektörlüğü aracılığıyla gönderilen resmi yazı ile deprem bölgesi olarak ilan edilen illerden gerekli resmi izinler alınarak anket sayfası linki duyurulmuştur. Çevrimiçi anket sistemi yanıtları otomatik olarak topladığı için veri girişinde insandan kaynaklanabilecek hata potansiyelinin sınırlı olduğu düşünülmektedir.

Verinin Hazırlanması ve Analizi

İstatistiksel analizler öncesinde veriler Excel programından SPSS programına aktarılmış, değişkenlerin düzeyleri kodlanmıştır. Verilerin ön incelenmesinden sonra CD-RISC puanlarının değişimine etki eden önemli değişkenler istatistiksel yöntemlerle araştırılmıştır. Verilerin analizinde SPSS v19.0-lisanslı (https://www.ibm.com/products/spssstatistics) yazılımı ve R programlama dili (http://www.R-project.org) kullanılmıştır.

BULGULAR

Ankete 211 (%40.7) Kadın, 307 (%59.3) Erkek olmak üzere toplam 518 kişi katılım yapmıştır. Araştırmaya katılan kişilerin yaş ve CD-RISC puan ortalamaları ve standart sapma (SD) değerleri sırasıyla kadınlar için 36.081 (SD = 8.156), 64.9 (SD=17.617); erkekler için 41.866 (SD=9.818), 64.873 (SD=18.958) olarak hesaplanmıştır.

Diğer sosyodemografik değişkenler için de bulunan frekans ve göreli frekans ile bu değişkenlere CD-RISC puan ortalamaları ve standart sapması Tablo 1'de verilmiştir. Tablo 1'in KS Test sütununda her bir sosyodemografik değişkenin alt düzeyleri için Kolmogorov-Smirnov testinin p-değeri sonucu gösterilmiştir.

CD-RISC puanlarının normal dağılım varsayımını sağlamadığı tespit edildiği için değişkenlerin alt gruplarına göre CD-RISC puanlarının medyanları arasındaki farklılıklar Mann-Whitnry U (MWU) testi ve Kruskall-Wallis H (KWH) testi ile incelenmiştir ve tablonun son sütununda bu testlerin p-değeri sonucu verilmiştir. Elde edilen bu parametrik olmayan hipotez testi sonuçlarına p-değeri>0.05 olduğu için CD-RISC puanlarının bu tabloda yer alan değişkenlerin alt grupları arasında değişmediği gözlenmiştir. Örneğin, Kadın ver Erkeklerin CD-RISC puanlarının medyanları arasındaki farkın önemi Mann-Whitney U testi ile araştırıldığında 0.05 anlamlılık düzeyinde önemli bir farklılık olmadığı (Mann-Whitney U test istatistiği =33015, p=0.708) görülmüştür.

Bu nedenle Tablo 2'de CD-RISC puanlarının alt faktörlerinin aritmetik ortalama ve standart sapmaları verilmiştir. Tablo 3-5 'de CD-RISC puanlarının alt faktörlerinin puan değerlerinin kategorik değişkenlerin alt grupları arasındaki değişimi Mann-Whitnry U (MWU) testi ve Kruskall-Wallis H (KWH) testi ile incelenmiştir ve tablonun son sütununda bu testlerin p-değeri sonucu verilmiştir. Tablo 2'de ilk satırda CD-RISC puanlarının alt faktörlerinin puan değerlerinin alabileceği en büyük değerler "< işareti" ile yazılmıştır.

Tablo 1. CD-RISC Puanı için Betimsel İstatistikler

DEĞİŞKENLER		CD-RISC Puanı				KS test	KWH test/ MWU Test
		n	n %	Aritmetik Ortalama	SD	p-değeri	p-değeri
Cinsiyetiniz	Kadın	211	40,734	64,900	17,617	0.006	0.708*
	Erkek	307	59,266	64,873	18,958	<0.0001	
Eğitim_Durumu	İlk_Orta_Lise_Yuksekokul	111	21,429	62,928	21,260	0.004	0.087**
	Lisans	316	61,004	64,354	17,625	0.088	
	Lisansüstü/Doktora	91	17,568	69,110	16,814	0.062	
Medeni Durum	Ayrılmış	10	1,931	69,400	19,080	<0.0001	0.83**
	Bekar	110	21,236	62,282	17,358	<0.0001	
	Eşi Vefat Etmiş	4	,772	43,500	27,258	<0.0001	
	Evli	394	76,062	65,713	18,449	<0.0001	
İş Durumu	Çalışıyor	513	99,035	64,887	18,448	<0.0001	0.593**
	Çalışmıyor	3	,579	69,333	16,743	<0.0001	
	Öğrenci	2	,386	57,500	13,435	<0.0001	
Aylık Geliriniz	15000 TL ve altında	42	8,108	63,690	21,884	0.045	0.243**
	15001 TL -20000 TL	79	15,251	61,013	19,266	0.003	
	20001 TL - 25000 TL	149	28,764	63,711	18,145	0.038	
	25001 TL - 30000 TL	130	25,097	65,438	17,675	0.010	
	30001 TL - 35000 TL	75	14,479	68,453	16,921	0.2	
	35001TL - 40000 TL	17	3,282	70,706	13,190	0.127	
	40001 TL ve üzeri	26	5,019	68,423	20,221	0.2	
Bulunduğunuz Çevre İle Kıyasladığınızda Ekonomik Düzey	Cok_Kötü	21	4,054	66,810	21,734	0.2	0.360**
	Kötü	69,	13,320	62,551	19,496	0.2	
	Orta	326	62,934	64,242	18,597	<0.0001	
	İyi	92	17,761	67,902	15,778	0.2	
	Cok_İyi	10	1,931	70,100	18,604	0.2	
Aileden_Bir Yakını Kayıp	Hayır	454	87,645	64,850	18,319	<0.01	0.667*
	Evet	64,	12,355	65,125	19,164	<0.001	
Maddi_Zarar	Hayır	218	42,085	64,028	18,386	<0.001	0.273*
	Evet	300	57,915	65,507	18,427	<0.001	
Bireysel Güvenliğin Sağlanması	Kesinlikle_Düşünmüyorum	119	22,973	65,462	21,270	0.002	0.203**
	Düşünmüyorum	163	31,467	63,104	16,975	0.001	
	Bilmiyorum_Kararsızım	93	17,954	64,086	16,363	0.009	
	Düşünüyorum	118	22,780	67,534	17,514	0.005	
	Kesinlikle_Düşünüyorum	25	4,826	64,200	23,376	0.2	

** Kruskall Wallis H testi, * Mann-Whitney U testi

Tablo 2. CD-RISC Ölçeğinin Alt Faktörlerinin İstatistikleri

Değişkenler		Azim-Kişisel Yetkinlik <60		Negatif Olaylara Tolerans<24		Manevi Eğilim<16	
		Aritmetik Ortalama	SD	Aritmetik Ortalama	SD	Aritmetik Ortalama	SD
Cinsiyetiniz	Kadın	40,24	11,41	13,75	4,96	10,91	2,94
	Erkek	40,96	12,44	13,69	4,90	10,22	3,28
Eğitim Durumu	İlk Orta Lise_Yüksekokul	39,55	13,83	13,66	5,21	9,72	3,45
	Lisans	40,23	11,55	13,45	4,86	10,67	3,10
	Lisansüstü/Doktora	43,56	10,91	14,71	4,69	10,84	2,86
Medeni Durum	Ayrılmış	43,70	11,72	14,80	4,92	10,90	3,35
	Bekar	39,05	11,60	13,21	4,67	10,02	3,35
	Eşi Vefat Etmiş	27,75	16,01	8,50	7,14	7,25	4,65
	Evli	41,18	12,04	13,88	4,94	10,65	3,06
İş Durumu	Çalışıyor	40,68	12,05	13,70	4,93	10,50	3,16
	Çalışmıyor	42,00	11,53	15,67	4,73	11,67	2,52
	Öğrenci	35,50	6,36	14,50	2,12	7,50	4,95
Aylık Gelir	15000 TL ve Altında	39,74	14,27	13,83	5,38	10,12	3,62
	15001 TL -20000 TL	38,47	13,14	12,37	4,92	10,18	3,01
	20001 TL - 25000 TL	39,89	11,75	13,48	4,76	10,34	3,26
	25001 TL - 30000 TL	40,78	11,52	14,06	4,96	10,60	2,95
	30001 TL - 35000 TL	43,27	10,91	14,51	4,64	10,68	3,25
	35001TL - 40000 TL	45,53	9,51	14,24	4,24	10,94	2,86
	40001 TL ve Üzeri	42,15	12,12	14,62	5,61	11,65	3,16
Bulunduğunuz Çevre ile Kıyasladığınızda Ekonomik Düzey	Cok_Kötü	43,10	15,33	13,48	5,24	10,24	4,22
	Kötü	39,86	12,55	13,12	4,95	9,58	3,46
	Orta	40,35	12,18	13,52	4,97	10,37	3,05
	İyi	41,46	10,28	14,78	4,48	11,66	2,69
	Cok_İyi	44,30	11,19	14,90	5,57	10,90	3,67
Aileden_Bir Yakını Kayıp	Hayir	40,67	11,96	13,67	4,89	10,51	3,17
	Evet	40,66	12,60	14,03	5,14	10,44	3,13
Maddi_Zarar	Hayir	40,13	12,02	13,61	4,87	10,29	3,19
	Evet	41,06	12,03	13,80	4,96	10,65	3,13
Bireysel Güvenliğin Sağlanması	Kesinlikle_Düşünmüyorum	41,69	13,86	13,59	5,81	10,18	3,36
	Düşünmüyorum	39,67	11,24	13,39	4,50	10,04	3,12
	Bilmiyorum_Kararsizim	39,65	10,83	13,49	4,41	10,95	2,60
	Düşünüyorum	41,94	11,34	14,47	4,63	11,13	3,11
	Kesinlikle_Düsünüyorum	40,12	14,71	13,76	5,97	10,32	3,97

CD-RISC Ölçeğinin Azim ve Kişisel Yetkinlik alt faktörünün aldığı değerler çeşitli kategorik değişkenlerin alt gruplarına göre parametrik olmayan hipotez testleri ile incelendiğimde Tablo 3'de verilen sonuçlar elde edilmiştir. Bu tabloda Kruskall Wallis-H testi sonuçları ** ile, Mann-Whitney U Testi sonuçları * ile işaretlemiştir. Tablo 3'de yer alan p-değeri>0.05 olduğu için CD-RISC Ölçeğinin Azim ve Kişisel Yetkinlik alt faktörünün puan değerlerinin cinsiyet, eğitim durumu, medeni durum, iş durumu, aylık gelir, bulunduğunuz çevre ile kıyaslandığınızda ekonomik düzey, aileden bir yakını kayıp, maddi zarar ve bireysel güvenliğin sağlanması değişkenlerinin alt düzeylerine göre değişmediği görülmüştür.

Tablo 3. Azim ve Kişisel Yetkinlik Puanının kategorik değişkenlerinin analiz sonuçları

Değişken	İstatistik Değeri	Serbestlik Derecesi	p-değeri
Cinsiyet	1.317	1	0.251
Eğitim Durumu	5.527	2	0.063 **
Medeni Durum	6.502	3	0.090 **
İş Durumu	0.916	2	0.632
Aylık Gelir	7.588	6	0.270**
Bulunduğunuz Çevre ile Kıyaslandığınızda Ekonomik Düzey	2.935	4	0.569
Aileden Bir Yakını Kayıp	14908.500	1	0.734*
Maddi Zarar	34707.500	1	0.232
Bireysel Güvenliğin Sağlanması	6.516	4	0.164

** Kruskall Wallis-H testi, * Mann-Whitney U testi

CD-RISC Ölçeğinin Negatif Olaylara Tolerans alt faktörünün aldığı değerler çeşitli kategorik değişkenlerin alt gruplarına göre parametrik olmayan hipotez testleri ile incelendiğimde Tablo 4'de verilen sonuçlar elde edilmiştir. Bu tabloda Kruskall Wallis-H testi sonuçları ** ile, Mann-Whitney U Testi sonuçları * ile işaretlemiştir. Tablo 4'de yer alan p-değeri>0.05 olduğu için CD-RISC Ölçeğinin Negatif Olaylara Tolerans alt faktörünün puan değerlerinin cinsiyet, eğitim durumu, medeni durum, iş durumu, aylık gelir, bulunduğunuz çevre ile kıyaslandığınızda ekonomik düzey, aileden bir yakını kayıp, maddi zarar ve bireysel güvenliğin sağlanması değişkenlerinin alt düzeylerine göre değişmediği görülmüştür.

Tablo 4. Negatif Olaylara Tolerans Puanının bazı kategorik değişkenlerinin analiz sonuçları

Değişken	İstatistik Değeri	Serbestlik Derecesi	p-değeri
Cinsiyet	0.008	-	0.927*
Eğitim Durumu	4.739	2	0.094**
Medeni Durum	3.622	3	0.305 **
İş Durumu	0.378	2	0.828**
Aylık Gelir	8.139	6	0.228**
Bulunduğunuz Çevre ile Kıyaslandığınızda Ekonomik Düzey	6.409	4	0.171**
Aileden Bir Yakını Kayıp	15487.500	-	0.391*
Maddi Zarar	33571	-	0.604*
Bireysel Güvenliğin Sağlanması	4.170	4	0.383**

** Kruskall Wallis-H testi , * Mann-Whitney-U Testi

CD-RISC Ölçeğinin Manevi Eğilim alt faktörünün aldığı değerler çeşitli kategorik değişkenlerin alt gruplarına göre parametrik olmayan hipotez testleri ile incelendiğimde Tablo 5'de verilen sonuçlar elde edilmiştir. Bu tabloda Kruskall Wallis-H testi sonuçları ** ile, Mann-Whitney U Testi sonuçları * ile işaretlemiştir. Tablo 5'de verilen sonuçlara göre cinsiyet, eğitim durumu, bulunduğunuz çevre ile kıyaslandığınızda ekonomik düzey ve bireysel güvenliğin sağlanması değişkenlerinin alt düzeylerine göre CD-RISC Ölçeğinin Manevi Eğilim alt faktörünün puan değerlerinin medyanları arasında anlamlı bir farklılığın olduğu görülmüştür ($p<0.05$). CD-RISC Ölçeğinin Manevi Eğilim alt faktörünün puan

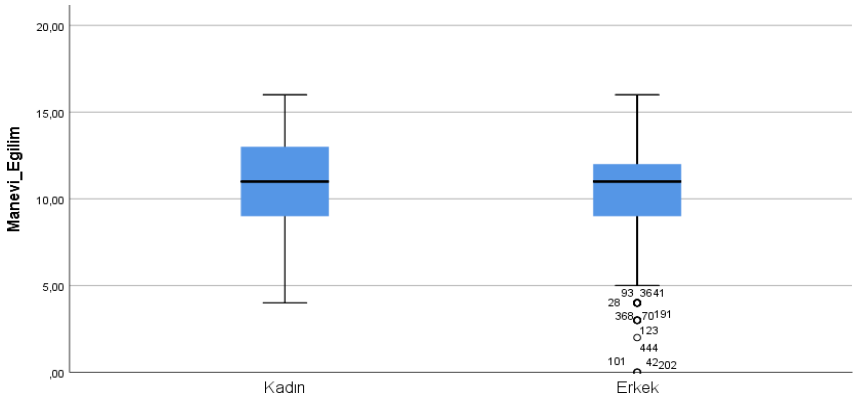
değerleri için medeni durum, iş durumu, aylık gelir, aileden bir yakını kayıp, maddi zarar kategorik değişkenlerinin alt düzeyleri arasında anlamlı bir farklılık bulunmamıştır (p>0.05).

Tablo 5. Manevi Eğilim Puanının bazı kategorik değişkenlerinin analiz sonuçları

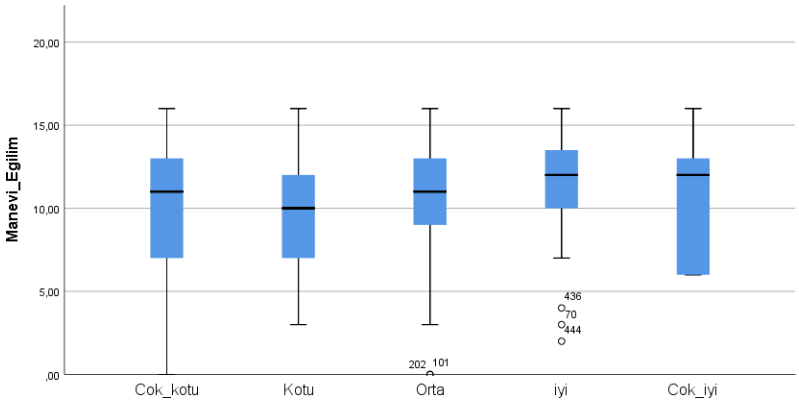
Değişken	İstatistik Değeri	Serbestlik Derecesi	p-değeri
Cinsiyet	4.735	-	**0.030***
Eğitim Durumu	7.500	2	**0.024****
Medeni Durum	5.635	3	0.131 **
İş Durumu	1.674	2	0.433**
Aylık Gelir	5.684	6	0.459**
Bulunduğunuz Çevre ile Kıyaslandığınızda Ekonomik Düzey	20.188	4	**0.000****
Aileden Bir Yakını Kayıp	1444.000	-	0.940*
Maddi Zarar	34973.000	-	0.174*
Bireysel Güvenliğin Sağlanması	12.833	4	**0.012****

** Kruskall Wallis testi , * Mann-Whitney U testi

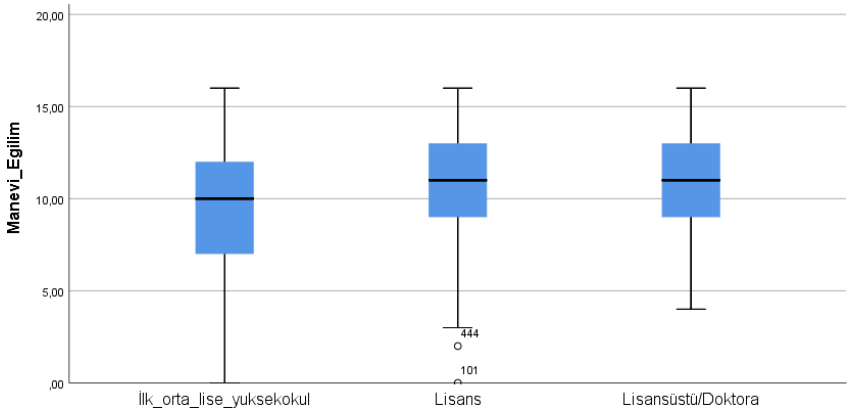
Cinsiyet, eğitim durumu, bulunduğunuz çevre ile kıyaslandığınızda ekonomik düzey ve bireysel güvenliğin sağlanması değişkenlerinin alt düzeylerine göre CD-RISC Ölçeğinin Manevi Eğilim alt faktörünün puan değerlerinin kutu grafikleri aşağıda Şekil 1-4 ile verilmiştir.



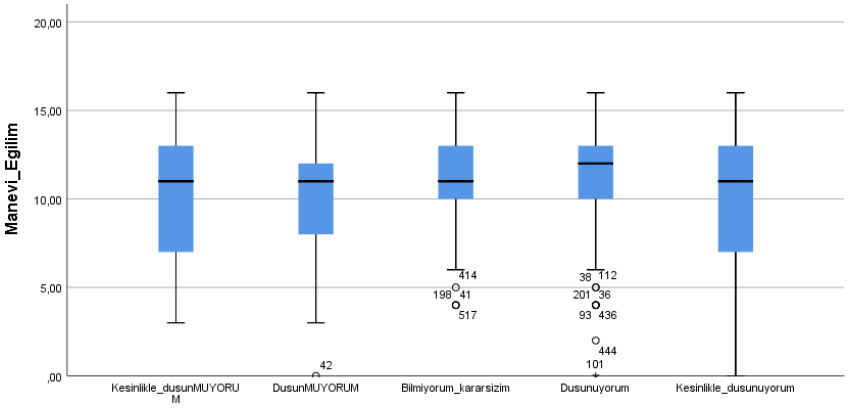
Şekil 1. Cinsiyete Göre Manevi Eğilim Puanlarının Kutu Grafiği



Şekil 2. Bulunduğunuz çevre ile kıyaslandığınızda ekonomik düzey Göre Manevi Eğilim Puanlarının Kutu Grafiği



Şekil 3. Eğitime Göre Manevi Eğilim Puanlarının Kutu Grafiği



Şekil 4. Bireysel Güvenliğin Sağlanasına Göre Manevi Eğilim Puanlarının Kutu Grafiği

SONUÇ VE ÖNERİLER

6/2/2023 tarihinde ülkemizde meydana gelen deprem felaketinin yarattığı fiziksel acı ve yıkımın yanı sıra psikolojik etkilerinin de olması mevcut acıları arttırmıştır. Bu ruhsal çöküntünün ortadan kaldırılması, iyileştirilmesi ve etkilerinin azaltılmasına yönelik adımların atılması ülkemiz açısından hayati önem taşımaktadır.

Deprem ve sonrasında yaşanan travma sonucu oluşan duygu durumu ile ilgili duygusal, bilinçli, davranışsal ve ruhsal sonuçların ortaya konabilmesi, doğrudan gözlemlenemeyen değişkenlerin ölçülüp değerlendirilebilmesi ülkemiz açısından önemli bir araştırmadır. Psikoloji ile ilgili verileri istatistiksel yöntemlerle analiz etmek ve oluşturulan matematiksel modeller ile çeşitli öneriler sunmak önemli bir problemdir.

Bilimsel çalışmalarda somut değişkenleri ölçmek için fiziksel araç ve gereçlerin kullanıldığı bilinmektedir. Ancak psikolojik tutum gibi bazı soyut değişkenleri ölçmek için kullanılabilecek fiziksel araç ve gereçler bulunmamaktadır. Bu gibi durumlarda ölçülemeyen (gözlemlenemeyen) değişkenler, ölçülebilir (gözlemlenebilir) değişkenlere dayalı olarak açıklanabilir. Bu çalışma için hazırlanan anket formunun uygulanabilmesi için gerekli etik kurul izni ve resmi kurumlardan izinler alınmıştır. Toplanan veriler istatistiksel yöntemler kullanılarak analiz edilmiştir. Yapılan istatistiksel analizler sonucunda

cinsiyet, eğitim durumu, bulunduğunuz çevre ile kıyaslandığınızda ekonomik düzey ve bireysel güvenliğin sağlanması değişkenlerinin alt düzeylerine göre CD-RISC Ölçeğinin Manevi Eğilim alt faktörünün puan değerlerinin değiştiği görülmüştür. Bu risk faktörlerinin göz önüne alınmasının kişilerin dayanıklılıklarını artıracağı düşünülmektedir.

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Lag Sequential Analysis for Analyzing Communicative Collaborative Interactions

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Abstract

In our observational-experimental study aimed to explore the impact of diversity and affective states on team cognition, through recorded online sessions, 50 teams, each composed of 3 members, engaged in collaborative efforts to accomplish assigned tasks within the realms of social policy or business development. Their goal was to cultivate innovative, diverse, and impactful ideas. Relationships between the independent variables of cognitive style diversity (Aggarwal et al., 2019) and team affect (Daniel & Jordan, 2015), (Jehn and Mannix, 2001) with the dependent variables of team cognition (Lewis, 2003) and team performance is explored, respectively. For this purpose, video recordings of online team meetings were annotated and every interaction between members are coded and categorized according to Act4teams Behavioral Codes (Klonek et al., 2016) standard coding scheme, into categories like, problem focused (PF_pos), positive or negative procedural (P_pos, P_neg), positive or negative socio-emotional (SE_pos), positive or negative action-oriented statements. These categories of conversational units and their sequential relations are analyzed by conducting lag sequential analysis (LSA). Joint frequencies of consecutive conservation units are analyzed among around 7000 conservation units across the activity of the participated teams. These conservation units are also considered to be the thought units as they were the building blocks of the eventual outcome of the mental collaboration of the team and team cognition. LSA aims to detect the instances of transition from one conversation (interaction) category to another more or less likely than by chance. This provides an insight for the researcher to have sense of what kind of interaction is more prone to trigger a similar or different kind of interaction and then further theatrically explain this statistically sound sequentially. In this presentation, in addition to the results based on joint and transitional frequencies, adjusted residuals and significance levels, the overall findings and insight based of LSA will be demonstrated.

Key words: *Interaction Analysis, Team Cognition, Lag Sequential Analysis, LSA, Collective Intelligence*

Gompertz Büyüme Modelinden Türetilen Farklı Model Formlarının Bazı Eğrisellik Ve Yanlılık Ölçütleri Ile Değerlendirilmesi

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Özet

Tek ağaç ve meşcere gelişimlerinin modellenmesinde doğrusal olmayan regresyon modelleri (Ör. Gompertz, Lojistik ve Richards fonksiyonları) ve bu modellerin çeşitli formları yaygın bir şekilde kullanılmaktadır. Farklı model formları uyum istatistikleri açısından benzer/kabul edilebilir sonuçlar üretirken, bu modeller içerisinde asimetrik davranış gösteren yapılar bulunabilmektedir. Bu durumda uyum istatistiklerinin, model tahminlerinin ve model sonuçlarına dayalı çıkarımların geçerliliği sorgulanabilir duruma gelmektedir. Bu çalışmada, Gompertz büyüme modeline ilişkin üç model formunun istatistiki özellikleri Kızılçam ağaçlarının yaş (t)-göğüs çapı (d1.3) ilişkisi üzerinden incelenmiştir. Çalışmada kullanılan modeller; Model 1 (M1): $d1.3=\beta1\times exp(-exp(\beta3\times(\beta2-t))$, Model 2 (M2): $d1.3=\beta1\times exp(-exp(\beta2-\beta3\times t))$ ve Model 3 (M3): $d1.3=\beta1\times exp(-\beta2\times exp(\beta3\times 3t))$ olarak belirlenmiştir. Modellerin geliştirilmesinde kullanılan veriler (n=365), Isparta-Sütçüler Orman İşletme Müdürlüğü'nde gerçekleştirilen Orman Amenajman çalışmalarından elde edilmiştir. Dikkate alınan üç modelin uyum istatistikileri açısından karşılaştırılmasında ortalama hata ve Akaike Bilgi Kriteri kullanılırken, model davranışlarının değerlendirilmesinde parametre etkili eğrisellik ölçütü ve parametre yanlılık ölçütü kullanılmıştır. Ayrıca, yeniden örneklem verisi ile oluşturulan simülasyon veri seti kullanılarak söz konusu modellerdeki parametrelerin normal dağılıma uygunluğu analiz edilmiştir. Model sonuçlarına göre, üç model aynı uyum istatistiklerine sahip olup, ortalama hata -0,0066 cm ve Akaike Bilgi Kriteri 2063,5 olarak elde edilmiştir. Üç modelin hepsinde β2 parametresi için yanlılık değeri>%1,0'den büyük elde edilmiştir. Modellerin diğer parametrelerinde yanlılık değerleri yaklaşık %0,5 olarak bulunmuştur. Buna karşın, simülasyon veri setindeki örneklem sayısı artışına paralel olarak, M1'in β1 ve β2 parametresi ile M2 ve M3'ün β1 parametresi normal dağılımdan uzaklaşmıştır. Tüm bulgular göz önüne alındığında, en belirgin asimetrik davranış M1'de gözlemlenmiştir. M2 en başarılı model formu olarak belirlenmiştir. Ağaçların çap-yaş ilişkinin modellenmesinde M2 model formunun kullanılması önerilmektedir.

Anahtar kelimeler: *Doğrusal davranış, simetrik dağılım, Pinus brutia, Yeniden parametrelendirme*

GİRİŞ

Ormancılıkta artım ve büyümenin geleceğe yönelik tahmininde [Ör. Meşcere hacmi = f (bonitet endeksi, meşcere sıklığı, meşcere yaşı)] ve çeşitli tek ağaç özellikleri arasındaki ilişkilerin modellenmesinde [Ör. ağaç boyu=f(d)] regresyon analizi yaygın bir şekilde kullanılmaktadır (Bolat et al., 2022; Burkhart and Tomé, 2012). Modellerin değerlendirilmesi ve denetlemesi aşamasında hem istatistiki ölçütler hem de artım ve büyüme kanuniyetleri dikkate alınmaktadır (Vanclay and Skovsgaard, 1997; Von Gadow and Hui, 1998). İstatistiki bakış açısıyla yapılan değerlendirmelerde, regresyon katsayılarının işareti ve anlamlılığı, veriler arasındaki zamansal/konumsal bağımlılık, açıklayıcı değişkenler arasındaki ilişkiler,

uyum iyiliği istatistikleri ve hataların trendi gibi pek çok konu ele alınmaktadır. Büyüme kanuniyetlerine uygunluğun değerlendirilmesinde ise büyüme eğrilerinin meşcere özellikleri ve yetişme ortamı koşulları dikkate alındığında beklenen trendle (büyüme kanuniyetleri) ne derece örtüştüğü incelenmektedir. Seki and Sakıcı (2017), Cieszewski (2004) tarafından geliştirilen model ile bonitet endeks gelişimini modelledikleri çalışmalarında gözlem sayısı ile model hataları arasındaki ilişkiyi, veriler arasındaki zamansal bağımlılığı, hataların dağılımını ve bonitet endeks eğrilerinin büyüme kanuniyetlerine uygun olup olmadığını analiz etmişlerdir. Bolat et al. (2023), Gompertz (1825) tarafından geliştirilen büyüme modelini yeniden parametrelendirerek asli meşcere elemanlarını bonitet endeksi, meşcere sıklığı ve meşcere yaşının fonksiyonu olarak tahmin etmişlerdir. İlgili çalışmada, regresyon katsayılarının işareti ve anlamlılığını, hataların dağılımını ve meşcere elemanlarına ilişkin büyüme eğrilerinin beklenen büyüme kanuniyetleri ile ne derece uyumlu olduğunu araştırmışlardır.

Model değerlendirme sürecinde ele alınması gereken önemli bir diğer konu ise, özellikle doğrusal olmayan modellerde, model tahmin davranışının bazı eğrisellik ve yanlılık ölçütleri ile analiz edilmesidir. Diel et al. (2019) bu analizin istatistiki değerlendirme süreci içerisindeki en önemli konu olduğunu ifade etmişlerdir. Fischer and Schönfelder (2017) ise doğrusal olmayan regresyon modellerine ilişkin parametrelerin asimptotik özelliklere sahip olması diğer bir ifade ile farklı büyüklükteki veri kümelerinde parametre güven aralıklarının benzer değerler alması gerektiğini ifade etmişlerdir (Bates and Watts, 1980; Ratkowsky, 1986). Asimetrik davranış hem uyum iyiliği ölçütlerinin hem de model parametrelerine dayalı yapılacak çıkarımların (Ör., maksimum büyümenin gerçekleştiği zamanın/yaşın belirlenmesi) güvenirliliğini sorgulanır duruma getirmektedir. Mevcut literatür incelendiğinde, ormancılık çalışmalarında bu konuda henüz bir değerlendirmenin yapılmadığı görülmüştür. Bu bağlamda mevcut çalışma ile alandaki bilgi boşluğuna katkı sağlanması amaçlanmıştır. Bu gerekçe ile, Gompertz büyüme modelinden türetilen üç farklı model formunun istatistiki özellikleri bazı eğrisellik ve yanlılık ölçütleri ile değerlendirilmiştir.

MATERYAL VE METOT

Bu çalışmada kullanılan veriler, Isparta-Sütçüler Orman İşletme Müdürlüğü'nde gerçekleştirilen Orman Amenajman çalışmalarından elde edilmiştir. Çap ve yaş değişkenine ilişkin bilgiler Tablo 1'de özetlenmiştir.

Tablo 1. Çap ve yaş değişkenine ilişkin tanımlayıcı istatistikler (n=365)

Değişken	En küçük	En büyük	Ortalama	Standart sapma
Çap (cm)	9,0	83,5	35,9	14,4
Yaş (yıl)	18	150	68	36

Çalışma kapsamında, Gompertz büyüme modeline ilişkin üç farklı model formu dikkate alınmıştır. Bu modellerin matematiksel eşitliği Denklem 1-3'te verilmiştir.

M1 $$d_{1.3}=\beta_1\times\exp(-\exp(\beta_3\times(\beta_2-t)) \quad (1)$$

M2 $$d_{1.3}=\beta_1\times\exp(-\exp(\beta_2-\beta_3\times t)) \quad (2)$$

M3 $$d_{1.3}=\beta_1\times\exp(-\beta_2\times\exp(\beta_3\times 3t)) \quad (3)$$

Bu eşitliklerde, $d_{1.3}$: yerden 1.3 m yüksekliğindeki ağaçların göğüs çapını, t: ağaç yaşını ve $\beta_{1\text{-}2\text{-}3}$: tahmin edilecek regresyon katsayılarını ifade etmektedir.

Söz konusu modellerin parametrelerine ilişkin başlangıç değerleri, Bolat et al. (2023) tarafından GenSA paketi (*R* programı) esas alınarak geliştirilen bir çözücü aracı ile elde edilmiştir (Xiang et al., 2013).

Elde edilen parametre başlangıç değerleri, SAS programında tanımlanmış ve modellerin sonuçları üretilmiştir. Modeller öncellikle ortalama hata ve Akaike Bilgi Kriterleri bakımından kıyaslanmış, daha sonra Bates and Watts (1980) tarafından önerilen parametre etkili eğrisellik ölçütü ve Box (1971) tarafından geliştirilen parametre yanlılık ölçütü kullanılarak değerlendirilmiştir. Bu ölçütlere göre model parametrelerine ilişkin yanlılık (hata) değerinin %1,0'den ve parametre etkili eğrisellik ölçütü değerinin 1,0'den küçük olması beklenmektedir (Ratkowsky, 1986). Söz konusu yöntemlere ilişkin denklem yapıları oldukça karmaşık olup ilgili makalelerde çözüm yolları detaylıca açıklanmıştır. Bu çalışmada söz konusu ölçütler SAS programı kullanılarak elde edilmiştir. Daha sonra, MATLAB programında *bootci* fonksiyonu kullanılarak 1,000, 5,000 ve 10,000 yeniden örneklem verisi üretilmiş ve bu örneklerle model parametrelerinin normal dağılıma uygunluğu belirlenmiştir. Model sonuçlarının görselleştirilmesinde MATLAB programı kullanmıştır.

BULGULAR

Model parametre tahminleri ile bunların standart hataları ve uyum iyiliği ölçütlerine ilişkin bulgular Tablo 2'de verilmiştir. Dikkate alınan üç model formunun ortalama hata ve Akaike Bilgi Kriteri değerleri aynı bulunmuştur.

Tablo 2. Model parametre tahminleri ve uyum iyiliği ölçüt değerleri

Parametreler	M1	M2	M3
β_1	55,9560 (2,3683)	55.9560 (2.3683)	55.9557 (2.3683)
β_2	28,3692 (1,7041)	0.7558 (0.0837)	2.1294 (0.1783)
β_3	0,0266 (0,00347)	0.0266 (0.00347)	-0.00888 (0.00116)
Ort. Hata	-0,0066	-0,0066	-0,0066
Akaike Bilgi Kriteri	2063,5	2063,5	2063,5

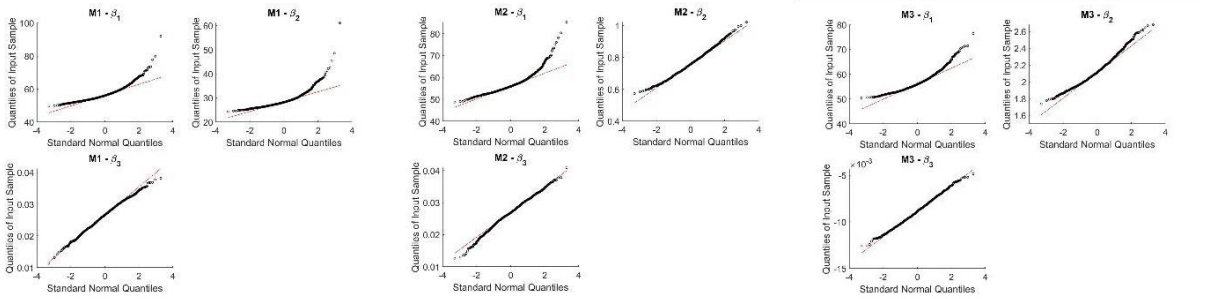
⁑Parametre tahminlerinin standart hataları parantez içerisinde verilmiştir.

Parametre etkili eğrisellik ölçütü ve parametre yanlılık değeri bakımından en uygun sonuçlar M1 için elde edilmiştir. Bunu sırasıyla M3 ve M2 takip etmiştir (Tablo 3). Tüm model formlarının β_2 parametresi yanlı elde edilmiştir (>%1,0).

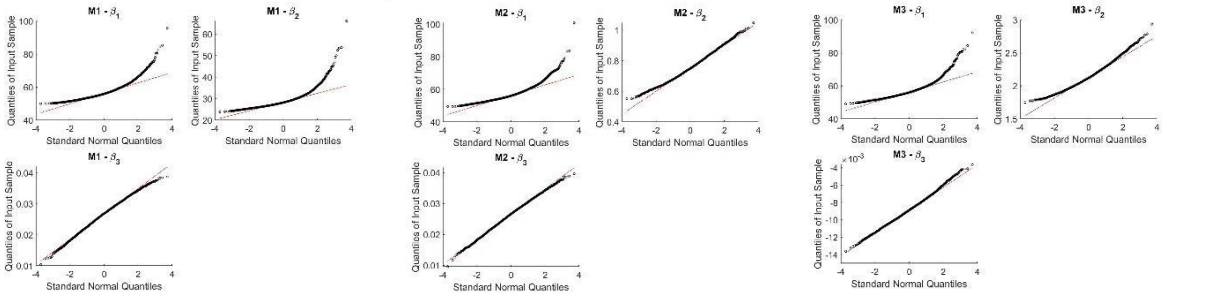
Tablo 3. Model yapılarına ilişkin eğrisellik ve model parametrelerine ait yanlılık değerleri (%)

Modeller	M1	M2	M3
β_1	0,57	0,57	0,57
β_2	1,03	1,03	1,13
β_3	0,42	0,42	0,42
Parametre etkili Eğrisellik Ölçütü	0,7413	0,8186	0,7729

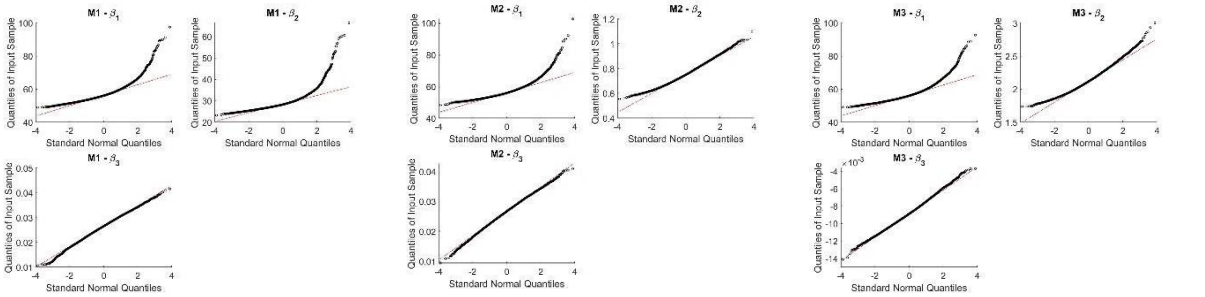
Model değerlendirme süreci farklı büyüklükteki yeniden örneklem verileri kullanılarak detaylandırılmıştır. Bu analiz ile model parametrelerinin normal dağılıma uygunluğu ortaya konulmuştur. Yeniden örneklem verilerine göre model parametre davranışları Şekil 1-2-3'te verilmiştir.



Şekil 1. Modellerin 1,000 yeniden örneklem verisine göre normal Q-Q grafikleri



Şekil 2. Modellerin 5,000 yeniden örneklem verisine göre normal Q-Q grafikleri



Şekil 3. Modellerin 10,000 yeniden örneklem verisine göre normal Q-Q grafikleri

Grafiksel analiz sonuçlarına göre, çalışma kapsamındaki çap-yaş verileri için en uygun model M2 olarak belirlenirken, veri setini temsil etme kabiliyeti en düşük olan model ise M1 olarak belirlenmiştir. Diğer modellerin aksine, M1'in iki parametresi önemli asimetrik davranış göstermiştir. Dolayısıyla M1'in istatistiki açıdan güvenilirliğinin zayıf olduğu ortaya çıkmıştır.

TARTIŞMA VE SONUÇ

Bu çalışma doğrusal olmayan modellerin değerlendirme süreçlerine odaklanmaktadır. Ormancılık alanındaki mevcut literatür incelendiğinde, model değerlendirme sürecinde uyum iyiliği ölçütleri, veri yapılarının analizi, hata trend analizi ve büyüme kanuniyetlerine uygunluklar değerlendirilmektedir (Fox et al. 2001; Huang and Titus, 1995). Bu değerlendirmelerin eğrisellik ve yanlılık ölçütleri ile desteklenmesi model yapısının daha iyi analiz edilmesine, böylece daha güvenilir sonuçlar elde edilmesine katkı sağlayacaktır. Çünkü model yapısının sağlamlığı/esnekliği bu kriterler ile gerçekçi bir şekilde ortaya konulabilmektedir (Diel et al., 2019; Fischer and Schönfelder, 2017). Bu çalışma kapsamında elde edilen bulgular, eğrisellik ve yanlılık ölçütlerinin dikkate alınması gerekliliğini doğrular niteliktedir. Farklı model yapıları uyum iyiliği ölçütleri bakımından birebir aynı değerlerle sonuçlanmıştır. Bu değerlendirme ile veri setine uygun model yapısının seçilmesi mümkün olmamıştır. Bununla birlikte, eğrisellik ve yanlılık ölçütlerinin sadece istatistiki sonuçları da uygun model yapısının

belirlenmesinde yeterince etkili olmamıştır. En ayırt edici sonuçlara, yeniden örneklem verilerinin kullanılmasıyla ulaşılmıştır. Bu sonuçlar, doğrusal olmayan modellerin simülasyon veri setleri kullanılarak daha kapsamlı değerlendirilmesi gerekliliğini öne çıkarmıştır (Ratkowsky, 1986). Sonuç olarak, Gompertz modelinin farklı formları eğrisellik ve yanlılık ölçütlerine göre kabul edilebilir davranışlar göstermiştir. Ancak, simülasyon veri setlerindeki model parametre davranışları çap-yaş verileri için M1 modelinin kullanışsız olduğunu göstermiştir. Bu tip bir veri seti için M2 model formunun kullanılması önerilmektedir.

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Teşekkür

Orman Genel Müdürlüğü'ne veri paylaşımından dolayı teşekkür ederim.

Comparison Of Chain Ladder Methods In Estimation Of Reserves

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Abstract

The reserve estimates for unpaid losses are great importance of insurance companies. Many methods are used to calculate reserve estimates in the literature. The most used one of these methods is chain ladder method. In this study, reserve estimates are calculated by Chain Ladder, Chain Ladder Arithmetic Mean, Chain Ladder Geometric Mean and Weighted Chain Ladder methods. The results of the methods examined are compared.

Key words: *Loss Reserve, Chain Ladder Method, Chain Ladder Arithmetic Mean, Chain Ladder Geometric Mean, Weighted Chain Ladder*

Fuzzy Clustering Approach To Missing Value Imputation

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Abstract

The situation where the values in the cell cannot be observed in the data sets is called missing data, incomplete observation or incomplete data in the literature. It is aimed to find missing values and reach more accurate results by completing the missing data in the data sets. There are various missing data estimation methods to complete missing data. In this study, the fuzzy c-means method was used as an alternative method to estimate missing data. The suitability of the method in completing missing data was examined. "Depression Anxiety and Stress Scales-21" (DASS-21) data set was used in this study. Random data was lost with the rates of 1%, 5%, 10% and 20% from the DASS-21 data set. In this study, RMSE, MAE and Cronbach's alpha values were calculated according to number of clusters. The resulting values were compared with the frequently used mean assignment, median assignment and mode assignment methods.

Key words: *Fuzzy C-Means, Missing Values*

Examination Of The Provinces In The Marmara Region According To Some Health İndicators With Correspondence Analysis

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Abstract

This study aims to examine the distribution of some health indicators according to the provinces in the Marmara region through correspondence analysis. Correspondence analysis is a multivariate statistical method in which the relationships between variables are examined with two or more dimensional cross-tables, which display the variables as points in two-dimensional space and provide graphical information about the relationship between variables. The correspondence analysis used in examining two-variable cross-tabulations is called simple correspondence analysis. The data used in this study were taken from the official website of the Turkish Statistical Institute and analyzed with the IBM SPSS Statistics 22 program using the simple correspondence analysis method. As a result of the study, the analyzed health indicators were examined and interpreted with graphs and tables in which provinces they were seen more intensely. According to the results obtained for the number of beds, one of the health indicators examined, the singular values of the first and second dimensions were 0.224 and 0.192, respectively. According to the row profiles, the highest rate for the number of beds indicator belongs to Istanbul (62.4%). When we look at the indicator of the number of hospitals by province, it is determined that the highest province according to the row profiles is Istanbul (56%), followed by Bursa (10%) and Kocaeli (6.9%). The analysis results for the health personnel indicator showed that nurses were concentrated in the provinces of Bursa and Istanbul, pharmacists were concentrated in the provinces of Bursa, Kocaeli, and Sakarya, and other health personnel were focused on the provinces of Kocaeli, Tekirdağ, and Bursa. The results show the current situation of provinces in a region regarding three health indicators using the correspondence analysis method. The study can also include other regions and other health indicators for a more detailed analysis.

Key words: *Correspondence Analysis, Health Indicators, Inertia*

Diagnosis Of Acute Appendicitis In Paediatric Patients Via Machine Learning Algorithms

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Abstract

Acute appendicitis is one of the most common types of abdominal emergencies, especially in children. Accurately distinguishing of acute appendicitis from other diseases with similar symptoms will help physicians to treat more quickly and reduce potential loss. The aim of this study is to detect appendicitis in paediatric patients whether it is acute or subacute using machine learning (ML) algorithms and to compare the diagnostic performance of these algorithms in discriminating acute appendicitis from non-acute appendicitis. The dataset, which is acquired from 1050 children and adolescents aged from 0 to 18 years, has been collected from Faculty of Medicine at Selcuk University between 2011 and 2022 years. The predictive performance of the models obtained by various ML algorithms, including Random Forest: RF, XG Boosting: XGB, k-Nearest Neighbour: k-NN, Linear Discriminant Analysis: LDA, Classification and Regression Tree: CART, Logistic Regression: LR, Neural Network: NN, Naïve Bayes: NB) are compared. The diagnostic performance of the model is evaluated with accuracy, precision, recall/sensitivity, specificity and F1-score statistics. The Boruta variable selection method is used to decide the most important features associated with acute appendicitis. According to the results of the Boruta method, neutrophile count, white blood cell (WBC), lymphocyte count, monocyte count, age of the patients, vomiting, platelet count, nausea, right left quadrant (RLQ) tenderness and gender of the patients were the most important features. The predictive analysis revealed that the Random Forest algorithm obtains the optimal result with an accurately predicted result of 82.44%, precision of 84.19%, recall of 95.63%, specificity of 33.93% and the F1-score of 89.55%. This study showed that machine learning algorithms are highly successful in the diagnosis of acute appendicitis. This study using machine learning techniques can help diagnose acute appendicitis in children, identify the most important parameters for its diagnosis and management, and make more appropriate medical decisions.

Key words: *Acute appendicitis, Machine Learning Algorithms, Classification, Predictive Performance, Children*

Sporting Goods Awareness Scale: Validity and Reliability Study

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Abstract

The aim of this study is to develop a valid and reliable scale that can be used to evaluate the awareness of athletes and coaches about sports materials, equipment or sports-related products. In line with this purpose, the study was conducted using quantitative research methods with a descriptive survey design. The draft scale, consisting of 19 items, which was given its final form with expert recommendations, was applied to a total of 140 randomly selected individuals among the athletes and coaches, for the pilot study. In the analysis of the data obtained from the preliminary study, item-total item correlation, item analysis, test-retest technique, exploratory factor analysis (EFA), and reliability analyses were utilized. In line with the internal consistency analysis and test-retest analysis conducted to test the reliability of Sporting Goods Awareness Scale (SGAS, it was determined that the scale has a highly reliable and time-stable structure. Within the scope of item analysis, 27% lower-upper group score differences were found to be significant. As a result of statistical analysis, the SGAS, consisting of 18 items and two sub-dimensions, was applied to a large sample group of 350 people. As a result of the EFA, it was seen that SGAS explained 69.23 of the total variance, the scale items were collected in two factors (knowledge and media follow-up) and that the scale was composed of 13 items. The total Cronbach's alpha reliability coefficient of the SGAS was found to be 0.935. Finally, SGAS was re-applied to a different group of 509 athletes and coaches and took its final form with confirmatory factor analysis (CFA). The conformity of the structure determined with EFA to the sample data was tested with CFA and it was determined that the fit indices resulting from EFA confirm the two-factor structure obtained in EFA. Based on these findings, it has been concluded that the SGAS is a valid and reliable data collection tool that can be used to evaluate the awareness of athletes and coaches about sports materials, equipment or sports-related products.

Keywords: *Awareness, Sports equipment, Athletes, Coaches*

Clustering Heatmap and an Application

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Abstract

In this study, the clustering of provinces in the Black Sea Region based on variables used in the healthcare sector is aimed. Cluster heat maps, which can be used to visualize and define clusters of rows with similar values in large amounts of multidimensional data, were used for this purpose. Data for the provinces in the Black Sea Region in the year 2020 were obtained from the healthcare statistics database of the Turkish Statistical Institute (TUIK) for clustering the provinces and variables. Various clustering methods were used for calculations, including Single Linkage, Complete Linkage, Simple Average, Group Average, Median, Centroid, Ward's Minimum Variance, and Flexible Strategy methods. Euclidean distance was used for calculating distance matrices in cluster heat maps, and Cophenetic Correlation Coefficient and delta values were determined to compare the classification performance of the methods. Data analysis was performed using the NCSS software package. According to the analysis results, the most suitable methods were found to be Simple Average and Group Average. For the provinces, the provinces of Amasya, Bolu, Düzce, Karabük, Kastamonu, Rize, and Sinop formed a cluster, while Artvin, Bartın, Bayburt, and Gümüşhane formed another cluster. Giresun, Ordu, Tokat, Zonguldak, and Çorum each formed their own clusters. Samsun and Trabzon remained outside any cluster and formed their own clusters. For the variables, the variables "total number of physicians and total number of hospitals per thousand people" formed one cluster, "number of nurses and number of other healthcare personnel" formed another cluster, "number of specialist physicians, number of general practitioners, and number of midwives" formed another cluster, "number of assistant physicians, number of occupational physicians, number of pharmacists, and total number of hospital beds per hundred thousand people" formed another cluster, and the variable "number of hospital beds" remained outside any cluster and formed its own cluster. Based on this, it was determined that Samsun province in the Black Sea Region is in a good condition in terms of the number of hospitals, number of nurses, and other healthcare personnel compared to other provinces. It was also determined that Artvin, Bartın, Bayburt, and Gümüşhane provinces have similar situations in terms of the number of hospitals, number of nurses, and other healthcare personnel.

Key words: *Black Sea region, Double dendogram, Health, Panel data*

Towards Reproducıble Research Era: Automating Statistical Analysis And Wrıting Scientific Papers

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Abstract

R Markdown is a file format for making dynamic documents with R. An R Markdown document is written in markdown and contains chunks of embedded R codes. Markdown is a simple and easy-to-write plain text format for authoring technical and computing books. A markdown document is converted to HTML, PDF, MS Word document, ePub and many others including interactive books by adding a couple of codes to it. It is especially a good and rapid authoring tool for updating the figures and examples in a technical book without rewriting or reformatting the content again and again when required. Just imagine that you have added dozens of figures and tables on a sample data set into your book or journal article. And then decide if the data set is wrong and you need to change it. You have to review hundreds of pages in the book you are writing and reproduce and reformat all of your figures and tables. How many hours, how many days do you need? With R markdown, you just need to change the name of a data set and only in a single document. In a few minutes your book will be updated in HTML, PDF and in other file formats what you want. Thus, we can so-call this task as reproducibility in research. In this study, a very short introduction to R Markdown is given, and its advantages are presented to generate the technical documents.

Key words: *Reproducible research, Technical writing, Markdown, Bookdown*

Comparing Quantiles Of Two Independent Groups In Agricultural Experiments

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Abstract

In agricultural experiments, the well-known parametric t-test is used to compare the means of two experimental groups. The Wilcoxon signed-rank test is the non-parametric equivalent of this test for comparing sample medians for non-normal distributed data. On the other hand a null hyphtohesis test based on the quantiles can indicate a difference in scattering of data. In this study, the test for difference in quantiles and IQR is compared on the simulated and real datasets.

Key words: *Quantiles, Robust statistics, Bootstrapping, Permutation tests, Hypothesis test*

Genomic Prediction Using Deep Learning With Illustrative Examples

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Abstract

Many prediction methods including GBLUP, penalized regression methods such as ridge regression and Lasso in addition to a dozen of Bayesian regression methods have been used for genomic selection in animal and plant breeding for a long time. In recent years, the machine learning and deep neural network models have also started to run as the new players. In this study, the use of deep learning models such as multilayer perceptron (MLP) and convolutional neural networks (CNN) are presented with some illustrative R code examples. For genomic prediction, the findings on a real wheat traits data set showed that CNN models promise as an alternative to classical methods requiring many parametric assumptions.

Key words: *Genomic Prediction, Deep Learning, Convolutional Neural Network, Multi-Layer Perceptron, GBLUP, Genomic Selection*

Introduction

Increasing the food supply to feed people is among our most important goals today, as in the past. Moreover, today, due to global warming and climate change, food supply stands ahead us as a problem that is more talked about, a priority and even awaiting an international solution. Of course, there are many factors that will contribute to the solution of this problem. However, one of the most important contributions will be provided by biotechnology and bioinformatics.

It can be said that environmental resources for increasing production have come to an end and have even begun to decrease. What remains is to increase the genetic capacities of plants and animals. Gene editing has shown promise in recent years. But for the last 40 years, genomic selection based on the marker data have been the most important tools we have. Developments in artificial intelligence and especially deep learning networks over the last 5 years also have the potential to contribute to this field. This paper briefly explains genomic prediction with deep learning on some illustrative examples.

Genomic Selection and Prediction

Phenotype (P) is a measure of a trait of animal or plant. It is biologically an outcome of expression fo the genotype (G) and environmental effects (E), and a sum of these two components with a mathematical notation as shown in Equation 1.

$$P = G + E \qquad \text{(Eq.1)}$$

Actually, G consists of additive gene effects (A), dominance effects (D) and epistatic effects while E consists of permanent and temporial environmental effects such as herd, location, gender, season etc. in additon to unmeasured random effect (e). However, the majority of the environmental effects is fixed effects (E1), some of them may be random effects (E2). So we can model a phenotypic outcome as in Equation 2.

$$P = A + D + I + E1 + E2 + e \qquad \text{(Eq.2)}$$

Using Equation 2, statistically a predictive model in matrix notation as shown in Equation 3.

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Zu} + \mathbf{e} \qquad \text{(Eq. 3)}$$

Where **y** is the phenotype vector, **X** and **Z** are respectively the design matrices for fixed and random effects, and **e** stands for the random errors or residuals of model. Almost all the predictive models are built as in Equation 3. In general, a process to calculate an outcome using some predictors is called prediction, and in genomics it is applied in three ways:

- phenotype to genotype
- genotype to phenotype
- sequence to consequence

In genomic selection, the best individuals or lines are selected based on their estimated breeding values (EBVs) running a trained prediction model on genotypic data of a breeding population (BP). But the genotypic data of a reference population (RP) is used to build or train various models to predict phenotypes and genomic breeding values. Here, the reference population is the population genotyped for whole genome. Recently the single polymorphism loci (SNPs) is used in genotyping. And also a replicated/non-replicated phenotypic recording is applied in breeding environment. The breeding population is only genotyped for the same SNPs in reference population.

Prediction Methods

The success in genomic selection mainly depends on following factors:

- Types and densities of markers
- Heritability and number of QTLs for the interested traits
- Reference and breeding population size
- Polygenic effect provided with kinship (A, D, A+D effects)

Additionally, the success is also highly depends to use an apropriate prediction methods for estimation of marker effects even. Different models gives performs well or bad on the same data. There are many

methods that can be used depending on the prediction purpose listed above and the traits being studied. These methods can be simply classified as follows:

- Pedigree based methods
  - BLUP and its derivatives
- Genomic prediction methods
  - GBLUP
  - SSGBLUP (HBLUP)
- Penalized regression methods
  - RR-BLUP
  - LASSO-BLUP
  - Elastic Net
- Bayesian regression methods
  - Bayesian Alphabet Methods (Bayes A, Bayes B, Bayes C, Bayes D)
  - Bayesian Ridge Regression (Bayes RR)
  - Bayesian Lasso (Bayes L)
- AI-based methods
  - Machine learning methods
    - CART, RF, SVR, GBM, XGBM, MARS,…
  - Artificial neural networks
    - MLP, CNN, RNN, AC, GAN,…

The Best Linear Unbiased Prediction (BLUP) uses the matrix *A*, numerator relationships between samples which is calculated from pedigree (Henderson, 1975). The method Genomic BLUP (GBLUP) originally proposed by Meuwissen et al (2001). It is based on the use of a *G* matrix providing the genomic relationships between samples usually applying Van Raden method (Van Raden, 2008) on marker data. GWS uses all genome-wide markers whether they are significantly associates with utilized traits or not contrary to Marker Assisted Selection (MAS) which Works on Quantitaive Trait Loci (QTLs) with large effects but not minor QTLs. GBLUP contributed to much to genomic selection. For instance, according to an USDA report, milk yield prediction accuracy has been increased 0.51 to 0.86 by using GBLUP instead BLUP. Currently, ssBLUP or HBLUP, based on a *H* matrix mixing *A* and *G* is being applied as a combination of BLUP and GBLUP. RR BLUP and Lasso BLUP fix the $n<p$ problems occurs due to less number samples but many more SNPs in genotypic data. Bayesian regression methods use the prior information about the distributions and frequency on non-zero effect of markers. Finally the methods under the umbrella of Artificial Intelligence (AI) can be applied for every kind of problems including textual data, images, sounds etc. AI is a field of computer sciences that combines data science and statistic in order to enable problem-solving. It mainly focuses machine learning (ML) and deep neural networks (DNN). However, DNNs are intensively applied in computer vision, natural language processing, reinforcement learning, etc. the number of research is also increasing for genomic prediction in recent years.

A fully connected multi-layer neural network is called Multilayer Perceptron (MLP). MLP is a fully connected multi-layer neural network. It has one input, one output and several hidden layers. An MLP is a typical example of a feedforward artificial neural network with backpropagation. If a feed forward network has more than one hidden layer, it is called a deep ANN.

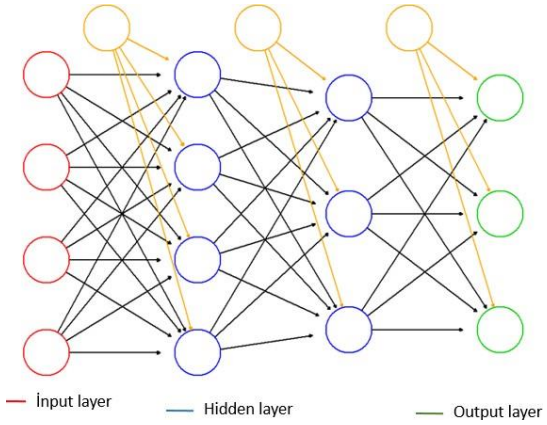

Figure 1. An example of MLP architecture

CNN is a regularized type of feed-forward neural network that learns feature engineering by itself via filters optimization. Convolutional Neural Network consists of multiple layers like the input layer, convolutional layer, pooling layer, and fully connected layers and output layer. Every CNN has at least one convolution layer and pooling layer. A convolutional layer is the first in a CNN model architecture as shown in Figure 2.

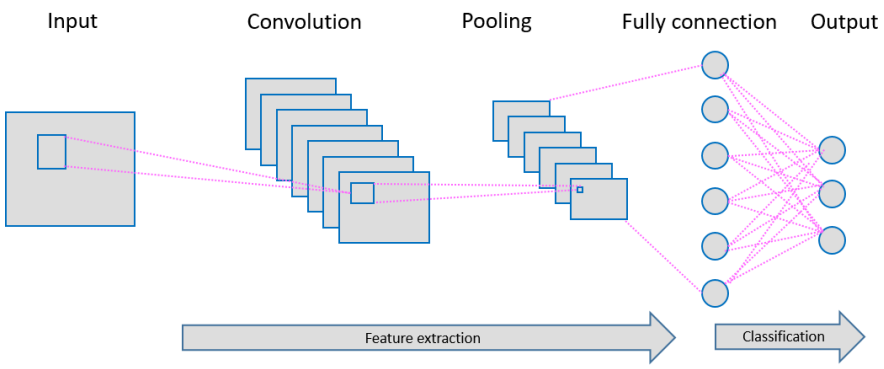

Figure 2. An example of CNN architecture

Illustrative Examples Genomic Prediction Methods

Here, we give some illustrative running examples to apply in R environment (R Core Team, 2023).

Genomic and phenotypic data and computing tools

The genotypic and phenotypic data used in this study was borrowed from the wheat dataset in BGLR package. As the phenotypic trait in this dataset we used the first grain yield of the 599 wheat lines evaluated in each of four mega-environments in CIMMYT's Global Wheat Program. The genotypic data is DArT markers with a minor allele frequency greater than 0.05, and missing genotypes were imputed with samples from the marginal distribution of marker genotypes. In Example 1, the wheat dataset is loaded into R, and then standardized using scale function of R. Afterward the whole data is randomly splitted as the training dataset and testing dataset with the rates of 70% and 30% respectively. Finally a function called calcMetrics is coded for calculating the performance metrics COR, MAE and RMSE.

```
# Example 1. Data for genomic prediction
library(BGLR)
data(wheat)
X <- wheat.X
Y <- wheat.Y[,1]
X[1:5, 1:5]
Y[1:5]

# Standardize data
X <- scale(X)
   wPt.0538 wPt.8463 wPt.6348 wPt.9992 wPt.2838
[1,]        0        1        1        1        1
[2,]        1        1        1        1        1
[3,]        1        1        1        1        1
[4,]        0        1        1        1        1
[5,]        0        1        1        1        1

Y <- wheat.Y[,1]
      775       2166       2167       2465       3881
 1.6716295 -0.2527028 0.3418151 0.7854395 0.9983176

# Combined data
XY <- cbind(Y=Y, X=X)
XY[1:5, 1:5]
             Y wPt.0538 wPt.8463 wPt.6348  wPt.9992
 775 1.6716295 -1.3598855 0.2672768 0.772228 0.4419075
2166 -0.2527028  0.7341284 0.2672768 0.772228 0.4419075
2167  0.3418151  0.7341284 0.2672768 0.772228 0.4419075
2465  0.7854395 -1.3598855 0.2672768 0.772228 0.4419075
3881  0.9983176 -1.3598855 0.2672768 0.772228 0.4419075

# Training and test data partitions
# Random selection of the indexes for training data
set.seed(123)
trainIdx <- sample(1:nrow(XY), round(0.7 * nrow(X)))
# Training data
trainY <- XY[trainIdx,1]
trainX <- XY[trainIdx,-1]
# Test data
testY <- XY[-trainIdx,1]
testX <- XY[-trainIdx,-1]

# Performance metric calculation
calcMetrics <- function(y, yhat){
corp <- cor(y, yhat)
  mae     <-     mean(abs(y-yhat))
  rmse <- sqrt(mean((y-yhat)^2))
  perf <- data.frame(COR=corp, MAE=mae, RMSE=rmse)
  return(perf)
}
```

Genomic Prediction Using GBLUP

Although there are many packages in R that can be used in Bayesian genomic prediction applications, the BGLR (Bayesian Generalized Linear Regression) package (Perez & de los Campos, 2014) is an R package that comes first compared to others due to its scope, flexibility in modeling, and fast operation since it is coded in Fortran language. In the BGLR package, it is possible to work with binary and ordinal variables as well as continuous variables. In Example 2, we run BGLR function of the package for building and predicting with GBLUP model. For this purpose, G, the genomic relationship matrix is passed to X argument of model deifinition (ETA) and GBLUP is performed using BRR method. Then we show the calculation of heritability (h2) and calculate the test metrics of the model.

```
# Example 2. GBLUP with BGLR
# Genomic relationship matrix
G <- tcrossprod(X)/ncol(X)

library(BGLR)
modelGBLUP <- BGLR(y=Y, ETA=list(mrk=list(X=G, model='BRR')),
   nIter=1000, burnIn=100, saveAt='BRR_')

varE <- scan('BRR_varE.dat')
varU <- scan('BRR_ETA_mrk_varB.dat')
h2 <- mean(varU/(varU+varE))
h2
testY <- Y[-trainIdx]
testYhat <- modelGBLUP$yHat[-trainIdx]
head(testYhat,3)
calcMetrics(testY, testYhat)
```

Genomic Prediction Using Deep Learning

In this section we train MLP and CNN models using Keras and Tensorflow. TensorFlow is a flexible and open source ecosystem that makes it easy to produce end-to-end solutions with the tools and libraries it provides to create machine learning models for desktop, mobile, web and cloud. Keras is an open source library that provides a Python interface for artificial neural networks. Since Keras and TensorFlow are coded in Python, to use them in R, the reticulate package (Ushey et al., 2023) must be installed. After this package is installed, it is also necessary to install the tensorflow (Allaire and Tang, 2023) and keras (Allaire and Chollet, 2023) R packages to install Pyhton libraries of Keras and TensorFlow (See details at https://tensorflow.rstudio.com/reference)

In Example 3 we defined an MLP model with three layers. First the input layer has 64 neurons, and uses the shape of training X set and activates the output with the rectified Linear Unit (relu) function. The second layer has 32 neurons and uses relu activation function. Finally the last layer has one neuron as the ouput produced a linear activation function. After definition, the model should be compiled with compile function of Keras. Then, the model is trained with fit function using training X and training Y dataset. Here, epochs shows the number of tours to complete all of the training data, because in every pass of algorithm the data is processes as the batches. So, batch_size declares the size of these batthes.

```
# Example 3. MLP using Keras + TensorFlow
if(!require(keras)){
  install.packages("devtools", repo="https://cloud.r-project.org");
  devtools::install_github("rstudio/keras");
  require(keras) }
```

```
# Build model
modelMLP <- keras_model_sequential()
modelMLP %>%
  layer_dense(units=64, input_shape=dim(trainX)[2], activation="relu") %>%
  layer_dense(units=32, activation="relu") %>%
  layer_dense(units= 1, activation="linear")
# Compile model
modelMLP %>% compile(
    loss = "mse",
    optimizer = optimizer_adam(learning_rate=0.001), ,
    metrics = c('mean_absolute_error','mean_squared_error')
)
summary(modelMLP)

# Fit model
modelMLPFit <- modelMLP %>% fit(
   x = trainX,
   y = trainY,
   epochs = 100,
   validation_split = 0.2,
   shuffle = TRUE,
   batch_size = 32,
   verbose=2
)

# Training performance
modelMLPFit

# Plot the training history
plot(modelMLPFit)

# Prediction on test data
evaluate(modelMLP, testX, testY)
testYhat <- predict(modelMLP, testX)
head(testYhat)
calcMetrics(testY, testYhat)
```

In the last part of Example 3, the trained model is tested on test data, and the first rows of the predicted values are listed. Then the model metrics are calculated and displayed. Here, testY contains the observed values and testyHat is the vector containing the predicted values.

Below, in Example 4, we build a CNN model called modelCNN. But, first we reshape data using array_reshape function of reticulate. In the model architecture, the first layer is a 1D convolution layer because the reshaped data is 1D tensor. Secondly we add a maximum pooling layer for reducing the dimensions of the output from previous convolution layer. Here, pool_size show the dimensions of pool, which it is 2x2 matrix for calculating the maximum of them. After pooling we add a flatten layer to produce a flat output for the remaining layers of the model. The remaining part in the example is the same with MLP as shown in Example 3. Finally, the trained CNN model predicts test data, and then the model metrics are calculated and displayed.

```
# Example 4. CNN using Keras + TensorFlow
if(!require(keras)){
  install.packages("devtools", repo="https://cloud.r-project.org");
```

```
  devtools::install_github("rstudio/keras");
  require(keras) }

# Yeniden şekillendirilmiş eğitim ve test verisi
trainXa <- array_reshape(trainX, dim=c(dim(trainX)[1], dim(trainX)[2], 1))
testXa <- array_reshape(testX, dim=c(dim(testX)[1], dim(testX)[2], 1))
trainYa <- array_reshape(trainY, dim=c(length(trainY), 1, 1))
testYa <- array_reshape(testY, dim=c(length(testY), 1, 1))

# Parameters of the model
nFeatures <- dim(trainX)[2] # Number of the predictors
nStrides <- 3 # Number of sliding steps for filtering
nFilters <- 32 # Filter size
nKernels <- 3 # Kernel size

modelCNN <- keras_model_sequential()
modelCNN %>%
 layer_conv_1d(filters=nFilters, kernel_size=nKernels,
 strides=nStrides, input_shape=c(nFeatures, 1))%>%
 layer_max_pooling_1d(pool_size=2) %>%
 layer_flatten() %>%
 layer_dense(units=64, activation="relu") %>%
 layer_dense(units=32, activation="softplus") %>%
 layer_dense(units=1)

# Compile the model
modelCNN %>% compile(
loss = "mse",
  optimizer = optimizer_adam(learning_rate=0.001),
  metrics = c('mean_absolute_error','mean_squared_error')
)
modelCNN %>% summary()

# Train the model
modelCNNFit <- modelCNN %>% fit(
 x = trainXa, y = trainYa,
 epochs = 200,
 validation_split = 0.2,
 shuffle = FALSE,
 batch_size=32,
 verbose=2)

modelCNNFit %>% plot()

# Prediction on test data
evaluate(modelCNN, testXa, testYa)
testYhat <- predict(modelCNN, testXa)
head(testYhat,3)
calcMetrics(testY, testYhat)
```

Comparison of the model performances

The performances of the GBLUP, MLP and CNN models trained in the examples above on the test data is shown in Table 1. Generally, Pearson correlation coefficient (COR), Mean Absolute Error (MAE) and Root of Mean Squared Error (RMSE) metrics are used for comparison of ML models (Cebeci et al,

2022). According to all these criteria, GBLUP showed the highest performance, followed by CNN. Although it showed a remarkable performance, the MLP performed worse than the others. This may expected result because CNN models has a good feature extraction layers before its MLP part starts.

Table 1. Performance comparison of the models on test data

Model	COR	MAE	RMSE
GBLUP	0.69	0.636205	0.793119
MLP	0.54	0.700066	0.890137
CNN	0.62	0.668634	0.839159

The results in Table 1 were obtained with a simple CNN architecture shown in the example above. However, it is possible that it can perform at the GBLUP level or even higher. For this purpose, network capacity can be improved by adding a few more convolution and pooling layers, and dropout layers can be added. Different filters and kernel sizes and learning rates can be applied. Combinations of all the hyperparameters mentioned above that will give the lowest error can be sought, which is called hyperparameter tuning. In R, the packages caret (Khun, 2008) and/or tfruns (Allaire, 2022) can be used for hyperparameter tuning. When the model is recompiled and run with the network parameters that give the best results, it will be able to show better test performance.

Conclusion

In this article, the creation of MLP and CNN deep learning models in genomic prediction and the prediction process are demonstrated with some illustrative examples. Aat the same time, the performances obtained in the wheat data set were compared by using GBLUP's performance as the base. The results showed that deep learning models, especially CNN models can be used successfully in genomic prediction. Beyond their comparable performance to classical methods such as GBLUP, these models also do not rely on a number of assumptions, making them easy to create and potential candidates to simplify genomic selection.

Of course, there is no a single model forever applicable and fits for all the traits and the species. But there are some good practice architectures for special cases of data and problem. The marker effects and GEBVs estimates may change because of the changes in gene frequencies and epistatic interactions. So the models should be updated in every cycle of breeding. CNNs and even MLPs are in developmental stage in genomic and transcriptomics prediction. There are increasing research interest to develop the models for animal and plant breeding and drug discovering. In near future, the models taking dominance and epistatic effects are also be studied. The models should be developed to achieve the maximum prediction accuracies using higher precision marker data for higher number of population sizes. Thus, "Big Data" processing will be much more important player. Finally modelling AI with Quantum Computing will be one of popular research topics.

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Kamu Çalişanlarinin Bireysel Emeklilik Sistemi Hakkindaki Görüşleri: Tokat İli Örneği

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Özet

Sosyal güvenlik, fizyolojik ve sosyo-ekonomik tehlikelerin olumsuz sonuçlarına karşı tedbir alınması ile birlikte bir ülkenin ekonomik ve iktisadi kalkınma olarak en önemli refah göstergesidir. Günümüz koşulları göz önüne alındığında sosyal güvenlik sistemleri gelir-gider dengesi bakımından bütçe açığı vermesi finansman ihtiyacı artışına sebep olmaktadır. Dolaysıyla sosyal devlet anlayışının gerekliliğiyle sorunlara çözüm üretilebilmesi ve sistemin sürdürülebilmesi noktasında yetersiz kalması kapsamlı bir reform ihtiyacına sebep olmuştur. Bu bakımdan hem sosyal güvenlik sistemindeki yükü azaltmak hem de ekonomiye uzun vadeli bir gelir kaynağı yaratmak amacıyla ülkemiz de 2001 yılında Bireysel Emeklilik Sistemini (BES) yasal zeminde uygulamaya koymuştur. Ancak ülkemiz bu süre zarfında büyük bir mesafe katetse de birçok katılımcının emeklilik şartlarını tamamlamadan sistemden ayrıldığı görülmektedir. Bu çalışmada Tokat ili bölgesindeki sisteme dahil olanların ve sistemden ayrılan kamu çalışanlarının BES tercihlerini tasarruf ve yatırım perspektifinden görüşleri incelenmiştir. Araştırma istatiksel olarak betimsel bir araştırma niteliğimde olup, veri toplama yöntemlerinden olan anket kullanılmıştır. Anket kapsamındaki soru formları kamu sektöründeki çalışanlar olmak üzere 368 katılımcıya yöneltilmiştir. Verilerin analizi ve bulguların yorumlanması için istatistik programlarından olan SPSS.22 programı kullanılmıştır. Bulgular ise istatistik testlerinden Bağımsız Örneklem T testi ve Tek Yönlü Varyans (ANOVA) Analizi testler uygulanarak yorumlanmıştır. Analiz sonucunda ankete katılan çalışanlarının yaş, medeni durum, eğitim, meslek ve aylık gelir durumları ile BES tercihleri arasında anlamlı bir fark olmadığı sonucuna varılmıştır. Bununla birlikte yapılan analizde, cinsiyet faktörüne bakıldığında, kadınların BES'e yaklaşımının daha olumlu olduğu ve bunun istatistiki olarak anlamlı bulunduğu sonucuna ulaşılmıştır.

Anahtar kelimeler: *Sosyal Güvenlik, Emeklilik, Bireysel Emeklilik, Tasarruf, Erken Ayrılma*

Yeni Medyada Nefret Söylemi Olarak Mizojinizm: Ekşi Sözlük Örneği

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ÖZ

Toplumsal iletişim ve etkileşim sırasında ortaya çıkabilen nefret söylemi, belli bir topluluğa veya bireye yönelik ayrımcı ifadeler içeren sağlıksız bir davranış biçimi olarak nitelendirilmektedir. Bu tür söylemler; kişinin ırkı, dini inancı, cinsel yönelimi ve cinsiyeti gibi farklı özelliklere dayalı olarak gelişebilmektedir. Cinsiyete dayalı nefret söylemi olarak ele alınan mizojini kavramı da bu türün bir alt kategorisini oluşturmaktadır. Mizojini, kadınlara yönelik düşmanlık içeren bir tür nefret söylemi olarak tanımlanmakta ve bu tür nefret söylemi tarihsel olarak birçok farklı kültürde bulunmaktadır. Teknoloji çağında, nefret söylemi yüz yüze iletişimin yanı sıra dijital platformlarda da büyüyen bir sorun haline gelmiştir. Dijitalleşme, bireylerin kimliklerini gizleyerek anonim bir şekilde düşüncelerini ifade etmelerine imkan tanımaktadır. Ancak, bu özgürlük bazı kullanıcılar için nefret söylemi ve ayrımcılığı teşvik etmek için kullanılmaktadır. Bu nedenle, dijital dünyada nefret söylemiyle mücadele etmek ve çevrimiçi toplulukları daha güvenli hale getirmek her geçen gün daha fazla önem kazanmaktadır. Bu çalışma, dijital dünyadaki nefret söylemi konusunda farkındalık yaratmayı hedefleyen bir çerçevede tasarlanmıştır. Özellikle mizojini kavramına odaklanarak bu hedefi gerçekleştirmeyi amaçlayan çalışma kapsamında Türkiye merkezli olarak faaliyet gösteren ve kullanıcıların anonim bir şekilde içerik paylaşabildiği Ekşi Sözlük uygulaması örneklem olarak seçilmiştir. Çalışma, Ekşi Sözlük'te yer alan "mizojinizm" başlığı altında paylaşılan içerikleri, nitel araştırma yöntemlerinden içerik analizi ile anlamlı verilere dönüştürerek gerçekleştirilmiştir. Ekşi Sözlük uygulaması içerisinde "mizojinizm" başlığı altında paylaşılan metinler, 2005-2023 yılları arasında üretilen paylaşımları içermektedir. 18 yıl boyunca "mizojinizm" başlığı altında üretilen 97 paylaşım 2 araştırmacı tarafından analiz edilerek; destekleyen yorum, karşı çıkan yorum, nötr yorum ve diğer kategorilerine ayrılarak ayrıntılı bir incelemeye tabi tutulmuştur. Bu bağlamda, paylaşımların hangi yıllarda yoğunluk gösterdiği, ortalama kelime sayısı ve kullanılan dil gibi faktörler de detaylı bir inceleme ile tespit edilerek sayısal veri olarak sunulmuştur. Bu çalışmanın sonucunda, mizojini kavramı dahil olmak üzere dijital dünyada yayılan nefret söyleminin önemli bir sorun olduğu vurgulanmıştır. Mizojini gibi nefret söylemleriyle mücadele etmek, çevrimiçi platformları daha güvenli hale getirmek oldukça önem taşımaktadır.

Anahtar kelimeler: *Yeni medya, mizojinizm, ekşi sözlük, nefret söylemi*

GİRİŞ

İletişim teknolojilerinin gelişimi, kişiler arası etkileşimi şekillendirmiştir. Bu doğrultuda zamansal ve mekânsal olguların yıkıldığı bilinmekte kişilerin internet ortamlarında kolayca iletişim kurabildiği

gözlemlenmektedir. Bireylerin ve toplumların yaşantısını devam ettirebilmesi adına temel bir gereklilik olarak görülen iletişim kavramı, dijitalleşmeyle birlikte kendini sürekli yenilemektedir (Yengin & Çakar, 2023: 599). Bu dijitalleşme kişinin yaşantısına yeni argümanlar eklemektedir. Bugünün yaşantısını tanımlayan en önemli kavramlardan birisinin dijitalleşme olduğu söylenebilmektedir (Yengin, Çakar & Şahin, 2023: 11). Özellikle internet ortamların bireye birden fazla hesap açabilme imkanını tanıması, beraberinde bazı kötü unsurların yayılmasına da neden olmuştur. Ele alınan pek çok araştırma kapsamında, özellikle genç kuşağın sosyal medya platformlarını kullanmasının nedenleri belirlenmeye çalıştığında; kişilerin paylaşım yapma duygusu taşıdığı, duygu ve düşüncelerini kolayca aktarabilme isteği yaşadığı, eğlenceli vakit geçirmek istediği gibi etmenler olduğu gözlemlenmiştir (Çakar & Can, 2022: 386). İletişim ortamlarından bireyin özgürce hareket edebilmesi, yeni medya ortamlarında nefret söyleminin yayılmasına neden olmaktadır. Kişilerin fiziksel ya da ruhsal özelliklerine yönelik aşağılayıcı ifadeler ve davranışlar sergilemek nefret söylemi kavramının basit bir tanımı olarak gösterilebilmektedir. Nefret söylemi kavramının pek çok tanımı mevcuttur. Nefret söylemi kavramı, aynı dili konuşmayan, aynı ırka sahip olmayan, dini bir olmayan ya da fiziki görünümü benzemeyen kişileri ya da topluluklara yönelik ayrımcılık yapma olarak tanımlanmaktadır (Boyle, 2010: 65). Kitle iletişim araçlarının kullanımıyla birlikte nefret söylemine yönelik sergilenen davranışlar daha da belirginleşmiş ve görünürlük kazanmıştır. Sosyal ağların yapısı gereği kolayca kendini ifade eden bireyin hızlıca içerik üretmesi, durumun takip edilebilirliğini zorlaştırmıştır (Harranoğlu & Yengin, 2022: 233). Yaşadığımız dönem, enformasyon çağı olarak adlandırılmakta, bilgiye erişim diğer dönemlere göre daha kolay ve ekonomik bir hale geldiği bilinmektedir. İnternetin doğuşu ve iletişim teknolojilerinin gelişimi, hayatımıza birçok yeni kavramın girmesine yol açmıştır.

Marshall McLuhan'ın vurguladığına göre, teknolojik altyapının belirleyici bir güce sahip olduğu ve bu gücün, yeni toplumların ve yaşam koşullarının oluşmasına yol açtığı ifade edilmektedir (Yengin & Bayrak, 2022). Yeni medya, internet altyapısına dayalı platformlar aracılığıyla bireylere sunduğu iletişim ve bilgi paylaşımı fırsatlarıyla tanımlanabilmektedir. Bu yeni medya araçları, insanlara bilgiyi hızlı bir şekilde elde etme ve dünyayla bağlantı kurma olanağı sağlamıştır (Yengin, 2014: 49). Ancak, bu olumlu gelişmelerin yanı sıra, yeni medya ortamının sunduğu olanaklar, bazı olumsuz sonuçları da beraberinde getirmiştir. Nefret söylemi, dijital alanlarda yer bulan olumsuzluklardan biridir. Nefret söylemi, kişilerin doğuştan gelen özellikleri nedeniyle kendilerini diğerlerine üstün görmesi ve bu nedenle de ayrımcılık, düşmanlık ve şiddet içeren ifadeler kullanması biçiminde tanımlanabilmektedir (Weber, 2011: 03). İnternetin sunduğu denetimsizlik ve anonimlik özellikleri, bazı kişilerin nefret söylemi kullanma eğilimini artırmış ve bu tür söylemin daha görünür hale gelmesine katkı sağlamıştır. Bu nedenle, yeni medya platformlarında nefret söylemi ile mücadele etmek ve çevrimiçi toplulukları daha güvenli hale getirmek büyük bir önem taşımaktadır. Bu bağlamda, "sözlük" kültürü popülerleşmiştir. Sözlükler, her türlü kavram, kelime veya başlık hakkında tartışma ve bilgi paylaşımının yapıldığı platformlar haline gelmiştir. Türkiye'de bu tür platformlardan biri olan Ekşi Sözlük, 15 Şubat 1999 tarihinde Sedat Kapanoğlu tarafından geliştirilmiş ve en çok kullanılan platformlardan biri haline gelmiştir. Ekşi Sözlük, her türlü konunun rahatça tartışılabildiği ve farklı görüşlerin bir araya geldiği bir platform olarak öne çıkar. Bu platform, internet kullanıcılarının bilgi kaynağı haline gelmiştir. Bu nedenle, bu çalışma, dijital dünyadaki nefret söylemi konusunda farkındalık yaratmayı amaçlayan bir çerçevede tasarlanmıştır. Kadına yönelik nefreti temsil eden mizojinizm konusunda toplumsal farkındalık oluşturulması önem arz etmektedir (Ilgın & Kurtulmuş, 2023: 738). Özellikle, Türkiye merkezli olarak faaliyet gösteren ve kullanıcıların anonim bir şekilde içerik paylaşabildiği Ekşi Sözlük uygulamasını örneklem olarak seçmiştir. Çalışma, içerik analizi yöntemiyle Ekşi Sözlük'ün "mizojinizm" başlığı altında paylaşılan içerikleri incelemektedir. Bu başlık altında 2005-2023 yılları arasında üretilen 97 paylaşım, iki araştırmacı tarafından analiz edilerek destekleyen yorumlar, karşı çıkan yorumlar, nötr yorumlar ve diğer şeklinde dört kategorilere ayrılmıştır. Ayrıca,

paylaşımların hangi yıllarda yoğunluk gösterdiği, ortalama kelime sayısı gibi faktörler de ayrıntılı bir şekilde incelenmiştir. Bu çalışma, dijital dünyada anonimlik ve özgürlüğün, nefret söyleminin yayılmasına neden olabileceğini göstermektedir. Bu nedenle, çevrimiçi platformlarda nefret söylemi ile mücadele etmek ve çevrimiçi toplulukları daha güvenli hale getirmek büyük bir önem taşımaktadır.

Nefret Söylemi Bağlamında Mizojinizm

İnternet ortamında nefret söyleminin pek çok örneğine rastlanmaktadır. Bu örneklerden bazıları internet haberleri, sosyal medya platformları üzerinden paylaşılan içerikler, gönderiler altına yapılan yorumlar, yazılı ya da görsel içerikler şeklindedir (Sayımer & Derman, 2017:385). Bu bağlamda yeni medya teknolojileri aracılığıyla içerikler yeniden paylaşarak dolaşıma sokulmakta ve geleneksel iletişim yöntemlerine göre daha fazla kitleye ulaşmaktadır. Dünyanın en etkili ve güçlü teknolojik buluşu olarak görülen internet, insan yaşantısında çeşitli değişkenler yaratmıştır (Yengin & Bayrak, 2023: 103). Literatürde pek çok kez çalışılan nefret söylemi toplumun farklı gruplarına odaklanan çalışmaları kapsamaktadır. Bu bağlamda yaşlı bireylerin yeni medya ortamlarında maruz kaldığı nefret söylemine odaklanan çalışma kapsamında Ekşi Sözlük üzerinden incelemeler gerçekleştirilmiştir (Akgül, 2020: 61). Araştırmadan elde edilen bulgular irdelendiğinde Türkiye'de Covid-19 pandemisine bağlı vakaların henüz görülmeye başlandığı dönemde alınan tedbirlerden biri olan 65 yaş üstü sokağa çıkma yasağı, yaşlılara yönelik nefret duygusunun dışa vurulduğu olay olarak tespit edilmiştir. Ekşi Sözlük yazarları tarafından "21 Mart 2020 yaş üstüne sokağa çıkma yasağı" başlığı altında daha ilk günden yapılan yüzlerce yorumda nefret içeren çok sayıda küfür, hakaret, aşağılama ve ötekileştirme mesajına rastlanmaktadır.

Ekşi Sözlük üzerinden nefret söylemini tespit etme amacıyla gerçekleştirilen bir başka araştırmaya göre çevre hareketi özelinde iklim aktivisti Greta Thunberg'e yönelik üretilen nefret söylemini incelenmektedir (Çetin, 2023). Ayrıca, bu çalışma, iklim krizi temelinde kadınlara yönelik ayrımcı söylemlerin kolayca oluşturulabileceğini göstermiştir. Greta Thunberg'in Asperger Sendromlu olması nedeniyle, fiziksel, zihinsel ve bedensel engellere sahip kişilerin damgalanabileceği ve nefretin hedefi olabileceği belirtilmiştir. Bu bağlamda yeni medya ortamlarında nefret söyleminin daha basit bir şekilde gerçekleştiği gözlemlenmiştir.

Yeni medya ve nefret söylemi üzerine kaleme alınan bir başka çalışmada geçmişten günümüze farklı konularda işlenen nefret suçlarını incelenerek gazetelerin internet sitelerinden derlenmiş ve sonuca bağlanmıştır (Taş, 2017). Çalışma, medyada nasıl nefret suçu oluşturulduğunu, nasıl yayıldığını ve okuyucuları nasıl etkilemeye çalıştığını göstermektedir. Araştırma kapsamında yazarların kendi düşünce ve kişisel nefretlerini okuyuculara aktarmak yerine objektif bir bakış açısı benimsemeleri gerektiği vurgulanmıştır. Nefret suçları, dünya genelinde geniş bir kategori yelpazesi sunmaktadır. Bu bağlamda her çeşit nefret söylemine odaklanmayı amaçlayan çalışma; siyasi nefret söylemi, kadınlara yönelik nefret söylemi, etnik köken temelli ırkçı nefret söylemi, cinsel kimlik temelli nefret söylemi, inanç ve mezhep temelli nefret söylemi ve engellilere veya çeşitli hastalıklara yönelik nefret söylemi gibi alt kategorilere dikkat çekmiştir. Katılımcı sözcükler üzerinde nefret söylemine odaklanan bir başka çalışmanın sonuçlarına göre çoğunlukla Türkiye kapsamında dijital katılımcı sözlüklerde özellikle kadın ve erkek ifadelerinde nefret söylemi görülmektedir (Akyazı, 2014). Çalışmanın sonuç kısmında kadın ve erkek aramalarında nefret söylemi içeren içeriklerin oranının düşük olması, bu sözlüklerin kurallarının etkin bir şekilde çalıştığını ve sözlük yöneticilerinin denetlemeleri yeterince gerçekleştirdiğini gösterdiği tespit edilmiştir.

YENİ MEDYADA NEFRET SÖYLEMİ OLARAK MİZOJİNİZM: EKŞİ SÖZLÜK ÖRNEĞİ

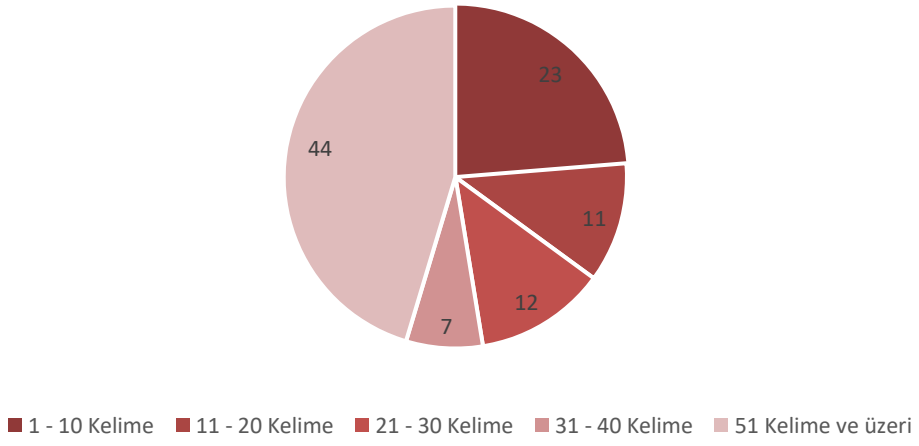
Kişilerin sosyal ağlar aracılığıyla bilgi, duygu ve düşüncelerini aktarabilmesi, kişisel resmi hesapların yanı sıra kullanıcısı belli olmayan anonim hesap oluşumunu da yaratmıştır. İletişim teknolojilerinin bireye sunduğu anonimlik ya da bilinmezlik özelliği, kişilerin düşünce paylaşımlarını daha kolay bir şekilde yapmasını sağlamıştır. Bu kapsamda her türlü kavram, kelime ya da başlığın tartışılabildiği 'sözlük' kültürü popülerleşmeye başlamıştır. 15 Şubat 1999 tarihinde, Sedat Kapanoğlu tarafından geliştirilen Ekşi Sözlük adlı internet sitesi de etkileşimli sözlük niteliği taşıyan ve Türkiye'de en çok kullanılan platformlardan biri haline gelmiştir (Gürel & Yakın, 2007: 204). Ekşi Sözlük bağlamında her türlü konu başlığının rahatça tartışılabilmesi, her görüşten kişinin bulunması, internet sitesini bir veri kaynağı haline getirmektedir. Bu doğrultuda çalışma, dijital dünyadaki nefret söylemi konusunda farkındalık yaratmayı hedefleyen bir çerçevede tasarlanmış, Türkiye merkezli olarak faaliyet gösteren ve kullanıcıların anonim bir şekilde içerik paylaşabildiği Ekşi Sözlük uygulaması örneklem olarak seçilmiştir. Çalışma, Ekşi Sözlük'te yer alan "mizojinizm" başlığı altında paylaşılan içerikleri, nitel araştırma yöntemlerinden içerik analizi ile anlamlı verilere dönüştürerek gerçekleştirilmiştir.

Sosyal bilimlerde araştırma yöntemleri kapsamında sıkça kullanılan veri analizi yöntemi, çalışma kapsamında tablolar ve şekillerden yararlanılarak bir sonuca ulaşma durumu olarak tanımlanabilmektedir. Creswell'e göre veri analizi kavramı, nitel bir araştırma kapsamında toplanan verilerin görselleştirilmesi, tablolaştırılarak bulguların sadeleştirilmesiyle birlikte bir tartışma ortamı yaratacak argümanları kapsamaktadır (2021: 182). Verilerin daha anlaşılır bir biçimde kaleme alınmasıyla anlamlı verilerin ön plana çıkmasını sağlayan analiz yöntemi, sorunu veya problemi anlamayı kolaylaştırmaktadır. Veri analizi kapsamında gerçekleştirilen analiz yöntemleri, elde edilen bulguları sadeleştirerek konuya boyut kazandırmaktadır (Sandelowski, Docherty & Emden 1997: 371). Ekşi Sözlük uygulaması içerisinde "mizojinizm" başlığı altında paylaşılan gönderiler, 2005-2023 yılları arasında üretilen metinleri içermektedir. 18 yıl boyunca "mizojinizm" başlığı altında üretilen 97 paylaşım 2 araştırmacı tarafından analiz edilerek; destekleyen yorum, karşı çıkan yorum, nötr yorum ve diğer kategorilerine ayrılarak ayrıntılı bir incelemeye tabi tutulmuştur. Bu bağlamda, paylaşımların hangi yıllarda yoğunluk gösterdiği, ortalama kelime sayısı ve kullanılan dil gibi faktörler de detaylı bir inceleme ile tespit edilerek sayısal veri olarak sunulmuştur. Çalışmanın Ekşi Sözlük uygulaması üzerinden gerçekleştirilmesi, bu tür sorunların çevrimiçi platformlarda ne sıklıkla karşılaşıldığının göstergesidir. Dijital dünyada anonimlik, insanların daha cesurca nefret söylemi kullanmalarına neden olabilmektedir. Bu nedenle örneklem olarak seçilen Ekşi Sözlük üzerinden içerik analizi gerçekleştirilmiştir.

Tablo 1. 'Mizojinizm' konu başlığına ilişkin içerik analizi

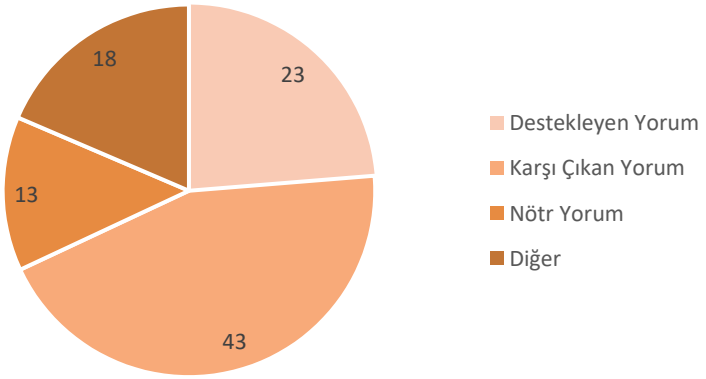
	Kategoriler				
Yıllar	**Destekleyen Yorum**	**Karşı Çıkan Yorum**	**Nötr Yorum**	**Diğer**	**Toplam**
2005			+		**1**
2006	+				**1**
2007					**0**
2008		+ +			**2**
2009		+			**1**
2010	+	+ +	+	+	**5**
2011	+ +	+	+ +	+ +	**7**
2012					**0**
2013	+	+ +		+ +	**5**
2014	+	+	+		**3**
2015	+	+ + +	+ + +		**7**
2016	+	+ + + +		+ +	**7**
2017	+ +	+		+ +	**5**
2018		+ +		+	**3**
2019	+	+ + + +		+	**6**
2020	+ + +	+ + + + + + + +	+ +	+ +	**15**
2021	+ +	+ + + +	+ +	+ +	**10**
2022	+ + + + + +	+ + + +	+	+ +	**13**
2023	+	+ + + +		+	**6**
Toplam	**23**	**43**	**13**	**18**	**97**

Yeni medya araçları bağlamında nefret söyleminin varlığını tespit etme amacıyla oluşturulan çalışma kapsamında 2005-2023 yılları arasında Ekşi Sözlük üzerinde üretilen 'mizojinizm' konu başlığı altındaki 97 paylaşım incelenmiştir. İncelemeler sonuncunda elde edilen verilere göre oluşturulan Tablo 1'de Ekşi Sözlük uygulaması içerisinde 'mizojinizm' başlığı adı altında yer alan gönderilerin analizi yer detaylı bir şekilde yer almaktadır. 4 farklı kategoride incelenen içeriklerin, kadın nefreti şeklinde basitçe tanımlanabilecek mizojini yaklaşımına karşı çıkan yorumların çoğunluğu dikkat çekmektedir. Yıllara göre toplam içerik sayılarının gösterildiği tabloda 2007 ve 2012 yıllarında içerik paylaşımı yapılmadığı, en fazla paylaşımın ise 2020 yılında üretildiği tespit edilmiştir. Araştırma kapsamında elde edilen tüm veriler konu başlıklarına göre grafik şeklinde sunulmuştur.



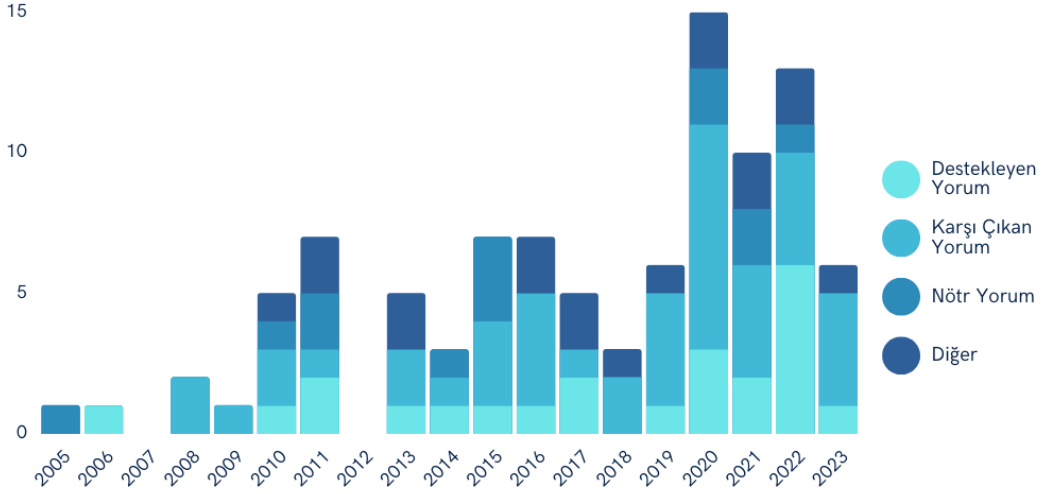
Grafik 1. Paylaşımların kelime sayılarına ilişkin pasta grafiği

Ekşi Sözlük uygulaması kapsamında 2005-2023 yılları arasında paylaşılan 97 içeriğin kelime oranları Grafik 1'de verilmiştir. Elde edilen veriler neticesinde içeriklerin büyük çoğunluğunun 51 kelime ve daha fazla bir şekilde paylaşıldığı gözlemlenmiştir. Bu kapsamda 1-10 kelime arasında olan paylaşım sayısı 23, 11-20 kelime arasında olan paylaşım sayısı 11, 21-30 kelime arasında olan paylaşım sayısı 12, 31-40 kelime arasında olan paylaşım sayısı 7, 51 ve üzeri kelime sayısına sahip paylaşım sayısı 44 olarak hesaplanmıştır.



Grafik 2. 'Mizojinizm' konu başlığı yorum dağılımları

Araştırma kapsamında 2005-2023 yılları arasında 'mizojinizm' başlığı altında üretilen gönderiler kategorize edildiğinde; mizojinizm düşüncesine karşı çıkan yorumların oranı Grafik 2'de yer alan verilerin yüzdelik dilimleri kapsamında incelenmiş ve %44,32 olarak hesaplanmıştır. Bu bağlamda paylaşımların çoğunun nefret söylemine karşı çıktığı tespit edilmektedir. Aynı başlık altında mizojinizm düşüncesini destekleyen ve nefret söylemini gerçekleştiren yorumların sayısı %23,71 olarak hesaplanmıştır. İçerikler incelendiğinde herhangi bir yorum içermeyen, bilgi verici paylaşımları kapsayan nötr yorumlar ise %18,55'lik bir orana sahiptir. Herhangi bir kategoriye dahil olmayan, konuyla ilgisi bulunmayan içeriklerin oranı ise %13,40 olarak tespit edilmiştir.



Grafik 3. 'Mizojinizm' konu başlığı yıllara göre paylaşım konuları

Örneklem olarak belirlenen Ekşi Sözlük bünyesinde 'mizojinizm' başlığı altında üretilen 2005-2023 yılları arasında yer alan içeriklerin yıllara göre kategorisel paylaşımları Grafik 3'te verilmiştir.

Araştırma kapsamında elde edilen bulgulara göre; mizojinizm başlığı altında 2005 yılı boyunca 1 paylaşım yapılmış, yorum kategorisi nötr olarak belirlenmiştir. 2006 yılı boyunca 1 paylaşım yapılmış, kategorisi ise destekleyen yorum olarak tespit edilmiştir. Ekşi Sözlük platformu bünyesinde 'mizojinizm' başlığı altında 2007 yılında hiçbir gönderi üretilmediği gözlemlenmiştir. 2008 yılında yapılan 2 paylaşımın karşı çıkan yorum kategorisine dahil olduğu 2009 yılında ise toplam bir paylaşım üretildiği ve karşı çıkan yorum kategorisine dahil olduğu gözlemlenmiştir. Konuya ilişkin yorumların artış göstermeye başladığı 2010 yılında ise; 1 paylaşım destekleyen yorum, 2 paylaşım karşı çıkan yorum, 1 paylaşım nötr yorum ve 1 paylaşım diğer kategorisine aittir. 2011 yılında ise 2 paylaşım destekleyen yorum, 1 karşı çıkan yorum, 2 nötr yorum, 2 diğer yorum tespit edilmiştir. 2012 yılında konu başlığı altında herhangi bir içerik üretimi yapılmamıştır. 2013 yılında 1 destekleyen yorum, 2 karşı çıkan yorum, 2 diğer yorum; 2014 yılında ise 1 destekleyen yorum, 1 karşı çıkan yorum, 1 nötr yorum kategorisine ilişkin paylaşımlar tespit edilmiştir. 2015 yılında yapılan paylaşımlar incelendiğinde 1 destekleyen yorum, 3 karşı çıkan yorum, 3 nötr yorum; 2016 yılında 1 destekleyen yorum, 4 karşı çıkan yorum ve 2 diğer yorum bulunmaktadır. 2017 yılında, 2 destekleyen yorum, 1 karşı çıkan yorum, 2 diğer yorum; 2018 yılında 2 karşı çıkan yorum, 1 diğer yorum; 2019 yılında ise 1 desteklenen yorum, 4 karşı çıkan yorum ve 1 diğer yorum bulunmaktadır. Yıllar bazında en fazla içerik üretiminin gerçekleştirildiği 2020 yılında ise mizojinist yaklaşımı destekleyen 3 yorum, fikre karşı çıkan 8 yorum, nötr özellik taşıyan 2 yorum ve herhangi bir kategoriye dahil edilemeyen 2 içerik bulunmaktadır. 2021 yılında paylaşılan içerikler incelendiğinde 2 destekleyen yorum, 4 karşı çıkan yorum, 2 nötr yorum, 2 diğer yorum; 2022 yılı verileri incelendiğinde 6 destekleyen yorum, 4 karşı çıkan yorum, 1 nötr yorum 2 diğer yorum; 2023 yılı veri incelendiğinde 1 destekleyen yorum, 4 karşı çıkan yorum ve 1 diğer yorum bulunmaktadır.

Elde edilen bulgular neticesinde 'mizojinizm' başlığı altında üretilen içeriklerin son yıllarda daha fazla olduğu tespit edilmiştir. En fazla içeriğin üretildiği 2020 yılı verilerinde içeriklerin en fazla mizojinizme karşı çıkma amacıyla paylaşıldığı gözlemlenmektedir. En fazla paylaşım yapıllan yıllar sıralamasında ikinci sırada olan 2022 yılı verilerine göre ise bir nefret söylemi olarak ele alınabilecek mizojinizm başlığına destek veren yorumların fazlalığı dikkat çekmektedir. Elde dilen bulgular incelendiğinde 2013 yılı ve sonrasında konuya ilişkin paylaşım sayılarının artmaya başladığı tespit edilmiştir.

SONUÇ

Toplumsal iletişim ve etkileşim sırasında ortaya çıkan nefret söylemi, belli bir topluluğa veya bireye yönelik ayrımcı ifadeler içeren olumsuz bir davranış biçimi olarak kabul edilmektedir. Bu tür söylemler, kişinin ırkı, dini inancı, cinsel yönelimi ve cinsiyeti gibi farklı özelliklere dayalı olarak ortaya çıkabilmektedir. Cinsiyete dayalı nefret söylemi içeren mizojini terimi, bu türün alt bir kategorisini oluşturmakta ve kadınlara yönelik düşmanlık içeren bir tür nefret söylemi olarak tanımlanmaktadır. Teknoloji çağında, nefret söylemi sadece yüz yüze iletişimde değil, aynı zamanda dijital platformlarda da büyük bir sorun haline gelmiştir. Dijitalleşme, bireylere kimliklerini gizleyerek anonim bir şekilde düşüncelerini ifade etme fırsatı sunmakta, bu özgürlük bazı kullanıcılar tarafından nefret söylemi ve ayrımcılığı teşvik etmek için istismar edilebilmektedir. Bu nedenle, dijital dünyada nefret söylemiyle mücadele etmek ve çevrimiçi toplulukları daha güvenli hale getirmek giderek daha fazla önem taşımaktadır. Nefret söylemi ve mizojini arasındaki ilişki, mizojinin özel bir türü olarak kabul edilen cinsiyete dayalı nefret söylemiyle ilgilidir. Mizojini, cinsiyete dayalı bir nefret söylemi türüdür. Bu, kadınlara yönelik düşmanlık içeren ifadeler, cinsiyet ayrımcılığı ve cinsiyet temelli şiddet içeren bir tür nefreti ifade etmektedir. Mizojini, toplumsal cinsiyet eşitsizliğinin bir yansıması olarak kabul edilmektedir. Nefret söylemi, genel olarak belli bir topluluğa veya bireye yönelik düşmanlık içeren ifadeleri kapsamakta mizojini ise cinsiyete dayalı nefret söyleminin özel bir alt türü olarak ele alınmaktadır. Hem nefret söylemi hem de mizojini, hem toplumsal hem de küresel bir tehlikeyi temsil etmektedir. Bu tür söylemler, toplum içinde ayrımcılığı, düşmanlığı ve şiddeti teşvik etmekte dolayısıyla, bu tür söylemlerin yayılmasına karşı mücadele etmek her geçen gün önemini arttırmaktadır.

Bu çalışma, dijital dünyadaki nefret söylemi sorununa dikkat çekmeyi amaçlayan bir çerçevede tasarlanmıştır. Özellikle mizojini konusuna odaklanarak, Türkiye merkezli faaliyet gösteren ve kullanıcıların anonim bir şekilde içerik paylaşabildiği Ekşi Sözlük uygulamasını örneklem olarak kullanmıştır. Ele alınan çalışma kapsamında, 2005-2023 yılları arasında Ekşi Sözlük üzerinde 'mizojinizm' konu başlığı altında üretilen 97 paylaşımı inceleyerek yeni medya araçları bağlamında nefret söyleminin varlığını tespit etmeye yönelik bir araştırma yürütülmüştür. 4 farklı kategoride incelenen içerikler, mizojini yaklaşımını destekleyen, karşı çıkan, herhangi bir görüş bildirmeyen (nötr) ve diğer şeklinde ayrıştırılmıştır. Bu bağlamda 18 yıllık içerik üretimi incelendiğinde 'mizojinizm' düşüncesine karşı çıkan yorumların oranı %44,32 olarak belirlenmiştir. Bu bulgu, çoğu paylaşımın nefret söylemine karşı çıktığını göstermektedir. Aynı başlık altında mizojinizm düşüncesini destekleyen ve nefret söylemini teşvik eden yorumların oranı ise %23,71 olarak hesaplanmıştır. İçerikler daha detaylı bir şekilde incelendiğinde, herhangi bir yorum içermeyen, bilgi verici paylaşımları kapsayan nötr yorumların oranı %18,55'tir. Konuyla ilgisi bulunmayan içeriklerin herhangi bir kategoriye dahil olmayan oranı ise %13,40 olarak tespit edilmiştir.

Nefret söyleminin önlenmesi, toplumun daha adil ve eşit bir yer olmasına katkıda bulunan önemli bir noktaya temas etmektedir. Nefret söyleminin önüne geçebilmek, dijital ortamda bu gibi paylaşımları en aza indirebilmek, küresel çapta huzuru sağlayabilmenin en temel yapı taşlarından biri olarak değerlendirilmelidir. Bu bağlamda nefret söylemi kavramının gelişimini engelleyebilmek adına çeşitli eğitim ve farkındalık programlarının her yaşa uygun bir şekilde hazırlanması gerektiği düşünülmektedir. Bu tarz eğitimler bireylere zorunlu olarak verilmeli ve nefret söyleminin bir suç unsuru teşkil ettiği anlatılmalıdır. Çalışma kapsamında yeni medyada yayılan mizojini kavramına odaklanılmasının nedeni nefret söyleminin dijital platformlarda hızla yayılabilir olmasıdır. Bu nedenle, sosyal medya ve çevrimiçi platformlar nefret söylemini önlemek için politika ve filtreleme önlemleri geliştirilmelidir. Nefret söyleminin önlenebilmesi, insan haklarının korunması, eşitlik ve adaletin güçlendirilmesi, toplumsal uyum ve barışın teşvik edilmesi, duygusal ve psikolojik sağlığın korunması, toplumsal dayanışma ve iş birliğinin artırılması, çoğulculuk ve çeşitliliğin teşvik edilmesi, demokratik değerlerin desteklenmesi ve toplumun daha güvenli hale gelmesi gibi pek çok konuda iyileştirmeler gerçekleştirme gücüne sahiptir. Bu nedenle, nefret söyleminin azaltılması önlenmesi, ya da farkındalığı arttıracak eğitimlerin düzenlenmesi toplumun daha sağlıklı ve barışçıl bir şekilde işleyişine katkıda bulunmaktadır.

Nefret söylemiyle mücadele, elbette eğitimle başlamaktadır. Toplumu, nefret söyleminin neden yanlış olduğu, insanları nasıl olumsuz etkilediği ve toplumsal birliği nasıl bozduğu konusunda bilinçlendirmek oldukça önemlidir. Okullarda, üniversitelerde ve sivil toplum kuruluşları tarafından düzenlenen atölye çalışmaları, seminerler ve kampanyalar bu bilinçlendirmeyi sağlamaya yardımcı olabilmektedir. Medya, toplumu etkileyen en güçlü araçlar arasında yer almaktadır. Bu bağlamda medya kuruluşları, nefret söylemini teşvik etmeyen ve toplumu ayrıştırmayan yayın politikalarını benimsemeli ve uygulamalıdır. Ayrıca, medyanın çeşitliliği teşvik edilmeli, böylece farklı bakış açıları topluma kazandırılabilmelidir. İnternet ve sosyal medya platformları, nefret söylemini yaymada sıkça kullanılan ortamlar arasında yer almaktadır. Bu platformlar, nefret içeriklerini tanımlamak ve kaldırmak için daha etkili denetimler uygulamalıdır. Kullanıcıları, nefret içeren içeriklere karşı bilinçlendirmek ve şikayet mekanizmalarını iyileştirmek de önem arz etmektedir. Empatiyi teşvik etmek ve insan haklarına saygıyı artırmak için her yaşa uygun farklı eğitimler düzenlenmelidir. İnsanların farklı kültürler, inançlar ve yaşam tarzları hakkında daha fazla bilgi sahibi olmaları ve bu çeşitliliği değerli bulmaları teşvik edilmelidir. Nefret söylemi ve ayrımcılık, sadece ulusal düzeyde değil, aynı zamanda uluslararası düzeyde de ele alınmalıdır. Ülkeler arası iş birliği, nefret söylemi ve ayrımcılığın sınırları aşmasına yardımcı olacağı düşünülmektedir. Nefret söylemiyle mücadele, uzun vadeli bir çaba gerektirmektedir. Toplumun her kesiminden bireylerin bu mücadeleye katılım sağlaması gerekmektedir. Eğitimle başlayan nefret

söylemine yönelik mücadele çalışmaları, uzun vadeli bir performans gerektirse de daha adil, hoşgörülü ve saygılı bir toplumun inşasına katkı sunacak en önemli değerler arasında yer almaktadır.

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The Relationships Between Raw Score And Weighted Score By Item Difficulty Index In The Timss 2019 Mathematics Test

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Abstract

Trends in International Mathematics and Science Study (TIMSS) is an international research conducted by the International Association for the Evaluation of Educational Achievement (IEA). TIMSS examines trends in mathematics and science achievement of 4th and 8th grade students, various descriptive variables and affective structures in participating countries. In this way, it allows countries to compare their education processes with each other and develop their education policies. Due to the importance of TIMSS at the international level, how scores for mathematics and science achievements are calculated is important. It was aimed to examine the relationships between raw scores in the TIMSS 2019 Mathematics test, the scores obtained by weighting with the TIMSS 2019 Percent Correct Statistics-International Average (PCS-IA), and the scores weighted with the item difficulty index specific to Türkiye, and to examine the effect on reliability in this study. Accordingly, these scores will be obtained by using the dichotomous multiple-choice items in a randomly selected booklet in the TIMSS 2019 Mathematics test. In obtaining the raw scores, the correct responses in the multiple-choice items will be scored with 1, and the incorrect and missing or blank responses will be scored with 0, and a total score will be obtained. To obtain weighted scores with PCS-IA, the items in the booklet will be used by subtracting the international averages published in the TIMSS International Database from 1 for each item (1-PCS-IA). Thus, for each item, correct answers will be scored as 1-PCS-IA and incorrect answers will be scored as 0. In calculating the scores weighted with the item difficulty index (p), the value of p for Türkiye data will be calculated for the multiple-choice items in the relevant booklet and the answers will be weighted with (1-p). Thus, correct responses will be scored (1-p) and incorrect responses will be scored 0. Finally, total scores will be obtained for each student. To examine the relationship between the total scores obtained by these methods, the assumptions will first be examined and the correlation method will be decided accordingly. In addition, Cronbach's α internal consistency coefficients will be calculated for the reliability of the measures obtained from the test within the scope of the research. Weighting methods will be interpreted in the context of the correlation coefficients and reliability values found as a result of the research.

Key words: *Weighted scoring, Reliability, 1-0 scoring, Achievement test, Item difficulty index*

Actuarial Calculations ın Life Insurance by Multiple Decrement Models for Turkey's Population and Demography Statistics

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Abstract

In the insurance sector, which has a significant contribution to the country's economy in terms of premium production, good determination of premiums affects our country economically. At the same time, ensuring that life insurance holders' death policies are covered on time and in the correct amount affects the policyholders' confidence. On the other hand, it is known that pandemic events and fatal diseases such as cancer, which are on the agenda of our country and the whole world lately, cause severe population decreases. In this sense, in insurance and actuarial science, multiple decrement methods are used to calculate death probabilities and, therefore net premiums and reserves according to the reason for entering or leaving the insurance system. The study aims to prepare multiple decrement mortality tables according to selected causes of death, perform actuarial calculations, and compare these results with those obtained using the mortality table independent of the causes of death. For this purpose, firstly, tables (https://data.tuik.gov.tr/) containing population information for 2018-2022 obtained from Turkish Statistical Institute (TÜİK), the number of deaths due to causes of death separated by age and gender, and the census information of our country were edited. Secondly, multiple decrement mortality tables were created by calculating death probabilities according to age groups and gender. Then, with the help of multiple decrement models, net premium and net annual premium calculations for some annuity and insurance products were obtained according to the causes of death. These results were compared with actuarial calculations obtained using standard mortality tables, regardless of the cause of death. At the end of the study, it is shown with tables and graphs that the actuarial calculations made considering the decreases according to the causes of death are different. *"This work was supported by TUBİTAK 2209 A (2022/2). Project number: 1919B012222334"*

Key words: *Multiple decrement models, Mortality tables, Actuarial Premium, Insurance, Death-Survival probabilities.*

Employing Gaussian Mixture Model Clustering And Gray Relational Analysis For Assessing Economic Indicators In The Context Of European Union Countries And Türkiye

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Abstract

The globalized world economy demands a comprehensive analysis, considering all its components. Evaluating countries based on economic indicators and positioning them relative to others is of paramount importance in this evolving landscape. This research aims to categorize Turkey and European Union (EU) member countries using selected economic indicators and employing Multi Criteria Decision-Making (MCDM) techniques for ranking. To achieve this, a decision matrix was constructed using various macroeconomic indicators for Türkiye and 27 EU member countries in 2022, including Gross Domestic Product, National Income per Capita, gross minimum wage, exports, imports, inflation, and unemployment data. Initially, countries were ranked using Gray Relational Analysis (GRA), and subsequently, the Gaussian Mixture Model (GMM) was applied to cluster them. This study allows for a comparison between the outcomes of MCDM and clustering, highlighting their similarities. The results reveal that Türkiye, due to its high inflation, unemployment rate, and import rate, coupled with low gross minimum wage values in 2022, exhibited the weakest economic performance among the analyzed indicators. Conversely, Luxembourg and Germany emerged as the top-performing countries based on the discussed data

Anahtar kelimeler: *European Union (EU) Member Countries, Gaussian Mixture Model (GMM), Gray Relational Analysis (GRA), Multi Criteria Decision-Making (MCDM)*

Evaluating the Performance of RealESRGAN for Super-Resolution Upscaling on the Urban100 Dataset

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Abstract

In recent years, deep learning-based Super-Resolution (SR) techniques have emerged as powerful tools for enhancing the resolution of low-resolution images. Among these techniques, RealESRGAN has garnered attention due to its ability to upscale images significantly while maintaining a high level of detail. This study explores the performance of the pre-trained RealESRGAN model on the Urban100 dataset, which contains a diverse range of urban images. Through quantitative analysis utilizing PSNR and SSIM metrics and qualitative evaluations based on visual inspections, we assess the model's proficiency in enhancing image resolutions. Moreover, we delve into a critical analysis of the model's ability to handle intricate details present in urban images, such as textures, edges, and text. The findings of this study shed light on the strengths and areas for improvement in the RealESRGAN model, paving the way for future developments in SR techniques.

Key words: *Super-Resolution, RealESRGAN, Urban100 Dataset, PSNR, SSIM.*

INTRODUCTION

Super-Resolution (SR) techniques have evolved substantially over the past decade, with deep learning-based methods marking a significant milestone in this trajectory. These methods, leveraging Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs), have showcased remarkable proficiency in enhancing the resolution of images while preserving intricate details.

RealESRGAN, a variant of the ESRGAN model, stands as a notable contribution in this domain, demonstrating impressive performance in upscaling images with a considerable maintenance of details. This research aims to scrutinize the performance of the pre-trained RealESRGAN model on the Urban100 dataset, a collection of 100 high-resolution images depicting various urban scenes. The choice of this dataset stems from its rich diversity in textures, structures, and elements commonly found in urban environments.

In this study, we embark on a journey to explore the following aspects:

- Quantitative Analysis: A comprehensive evaluation of the upscaled images using two widely accepted metrics - PSNR and SSIM. The distributions of these metrics across the dataset offer insights into the model's performance.
- Qualitative Analysis: Beyond numbers, a visual inspection of the upscaled images against the ground truth high-resolution images furnishes a detailed understanding of how well the model handles various details present in the images.

- Comparative Analysis: Positioning RealESRGAN against other state-of-the-art SR methods to unravel its standing in the current landscape of SR techniques.
- Future Prospects: Identifying the potential avenues for further enhancing the RealESRGAN model, thereby contributing to the ongoing advancements in SR techniques.

The subsequent sections of this paper will delve deeper into the methodology adopted for this research, followed by a detailed analysis of the results derived from the evaluations.

Literature Review

Super-resolution techniques have garnered considerable attention due to their ability to enhance image quality, a necessity in numerous applications including medical imaging, satellite imagery, and entertainment. The literature outlines a series of evolutionary developments in this field, with deep learning techniques, especially Generative Adversarial Networks (GANs), marking a revolutionary phase.

Development and Features of RealESRGAN: RealESRGAN is grounded in the foundations laid by Goodfellow et al. (2014) through the introduction of GANs. The model builds upon the Enhanced Deep Super-Resolution (EDSR) and Residual in Residual Dense Block (RRDB) architectures, delivering high-fidelity images with a remarkable preservation of details (Wang et al., 2021). Its architecture leverages a two-stage strategy, encompassing pre-enhancement and super-resolution phases, to optimize image quality. Further, the model introduces innovations such as the integration of a Blur and Downsample Module and the SwinIR transformer to enhance performance.

Urban100 Dataset: The Urban100 dataset, curated by Huang et al. (2015), is a rich repository of high-resolution urban images. It encapsulates a wide variety of urban scenarios, including diverse architectural styles, urban landscapes, and populated areas, providing a robust ground for evaluating super-resolution algorithms.

Previous Studies: The existing literature showcases extensive work in the field of super-resolution. Ledig et al. (2017) demonstrated the viability of deep learning approaches in super-resolution, setting a precedent for further research. Zhang et al. (2018) introduced a residual learning approach, enhancing the learning efficiency and performance of super-resolution networks.

This research seeks to contribute to this growing body of literature by offering a detailed evaluation of the RealESRGAN model, employing both quantitative metrics and qualitative assessments to gauge its performance on the Urban100 dataset.

MATERIAL AND METHOD

The methodology delineated for this research pivots on a structured approach involving the utilization of the Urban100 dataset and a series of analytical techniques to evaluate the performance of the RealESRGAN model. The methodology compasses the following components:

Material

The Urban100 dataset plays a pivotal role, serving as the benchmark for this study. It encompasses 100 high-resolution images portraying various urban scenarios, thus offering a diversified ground for the evaluation process.

Methods

The research leveraged Python, a versatile programming language, equipped with libraries such as OpenCV for image processing and Skimage for computing essential metrics. The pre-trained

RealESRGAN model, hosted on a Python environment, was utilized to upscale the low-resolution images derived from the Urban100 dataset.

Evaluation Metrics: A dual approach was adopted for the evaluation:

- **PSNR (Peak Signal-to-Noise Ratio):** Employed to quantify the quality of the reconstructed images, PSNR offers insights into the noise level in the reconstructed images, with a higher PSNR value indicative of superior image quality.
- **SSIM (Structural Similarity Index Measure):** Leveraged to assess the structural similarity between the ground truth and the upscaled images, SSIM provides a perception-based model that correlates with human image quality assessments.

Visual Inspection: Beyond numerical metrics, a qualitative visual assessment was conducted to scrutinize the visual appeal, texture preservation, and detail retention in the upscaled images. This involved a systematic comparison of the ground truth images with their upscaled counterparts to identify strengths and potential shortcomings of the RealESRGAN model.

RESULTS

The results section presents a detailed exposition of the findings, derived from both quantitative and qualitative analyses undertaken using the pre-trained RealESRGAN model on the Urban100 dataset.

Quantitative Analysis:

To provide a meticulous understanding of the model's performance, the PSNR and SSIM metrics were meticulously calculated for each upscaled image. The PSNR values exhibited a considerable range, indicating varied levels of noise reduction efficiency across different images.

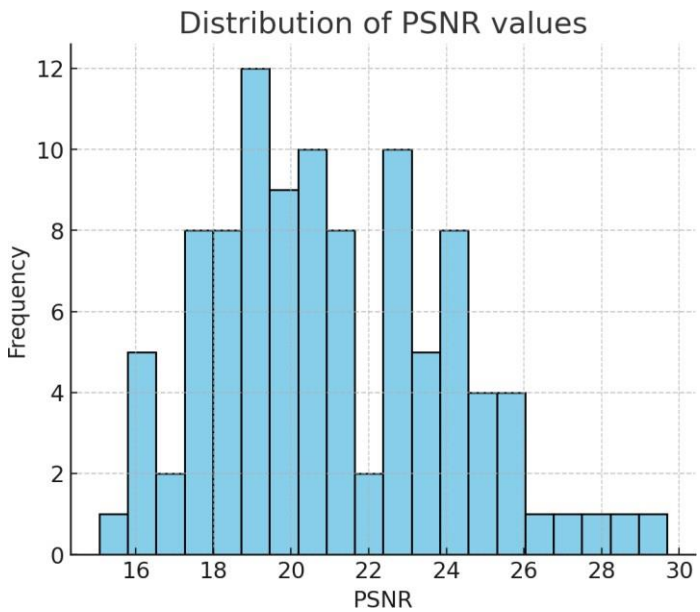

Figure 1. *Distribution of PSNR values across the dataset*

The SSIM index, on the other hand, elucidated the structural similarities between the ground truth and the upscaled outputs, offering insights into the perceptual differences experienced by viewers. A granular breakdown revealed certain patterns correlating higher SSIM values with specific image attributes.

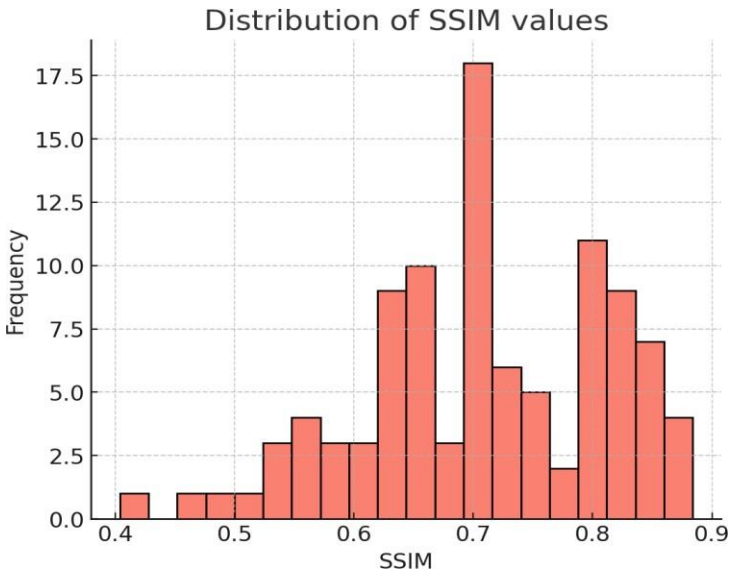

Figure 2. *Distribution of SSIM values across the dataset*

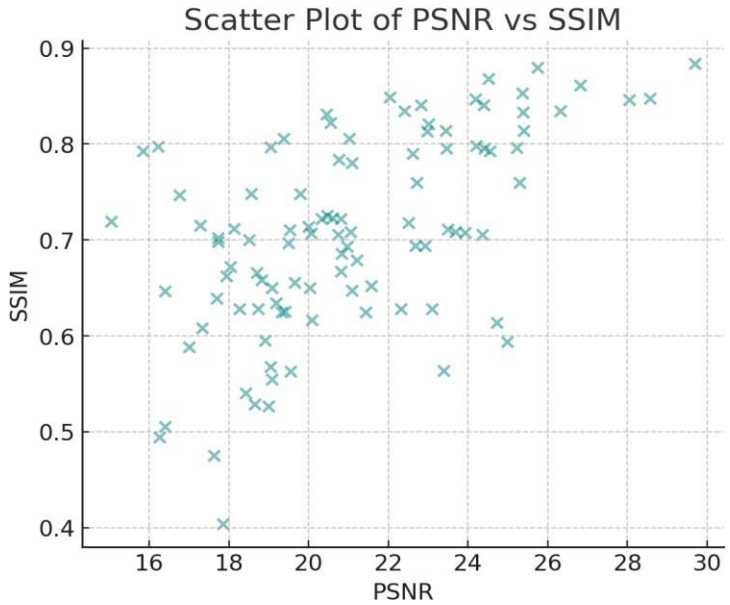

Figure 3. *Scatter Plot of PSNR vs SSIM*

Qualitative Analysis:

The qualitative analysis embarked on a deep exploration of the visual attributes of the upscaled images. A recurring pattern was the model's propensity to render images with a "cartoonish" aspect, marked by a pronounced smoothing of textures and a flattening effect that rendered the images in a style reminiscent of paintings. This was particularly noted in images with intricate details, where the model tended to simplify complex textures, sometimes at the expense of finer details.

Moreover, an examination of the color dynamics revealed that the model adeptly maintained color consistency, ensuring that the vibrant urban landscapes were rendered with rich and vivid hues, albeit with a slight tendency towards oversaturation in certain instances.

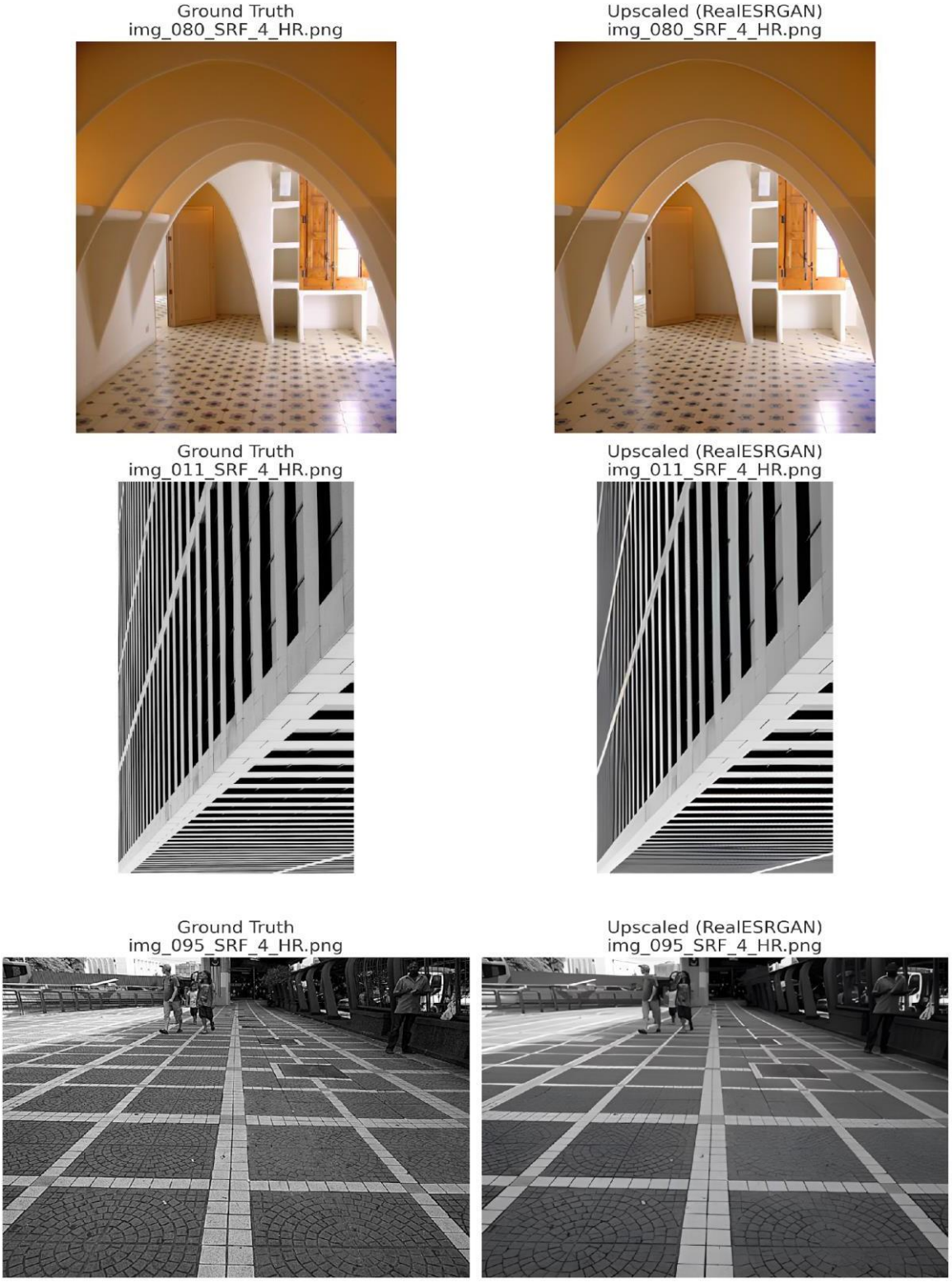

Figure 4. *Distribution of SSIM values across the dataset*

Comparative Analysis:

A side-by-side comparison of the ground truth and the upscaled outputs unearthed a series of observations. While the model effectively enhanced resolution, it occasionally imparted a stylized semblance to the outputs, slightly deviating from the natural textures present in the ground truth images.

In-depth analysis of individual cases highlighted areas where the model excelled, adeptly enhancing details and presenting sharper images, alongside instances where the results were less satisfactory, with a loss of detail and a deviation from the original textures.

	Image_Name	PSNR	SSIM	
0	img_001_SRF_4_HR.png	23.675	0.708617	—
1	img_002_SRF_4_HR.png	20.46	0.725773	—
2	img_003_SRF_4_HR.png	20.0888	0.61666	—
3	img_004_SRF_4_HR.png	18.5642	0.747939	—
4	img_005_SRF_4_HR.png	20.5579	0.822181	—
5	img_006_SRF_4_HR.png	19.0747	0.555096	—
6	img_007_SRF_4_HR.png	23.4559	0.795784	—
7	img_008_SRF_4_HR.png	17.0005	0.588468	—
8	img_009_SRF_4_HR.png	28.5585	0.847685	—
9	img_010_SRF_4_HR.png	23.4353	0.813707	—
10	img_011_SRF_4_HR.png	15.0554	0.719132	—
11	img_012_SRF_4_HR.png	19.1779	0.634248	—
12	img_013_SRF_4_HR.png	23.9232	0.707583	—
13	img_014_SRF_4_HR.png	18.829	0.658608	—
14	img_015_SRF_4_HR.png	21.5651	0.651844	—
15	img_016_SRF_4_HR.png	24.5207	0.86786	—
16	img_017_SRF_4_HR.png	19.7912	0.747893	—
17	img_018_SRF_4_HR.png	22.3231	0.627845	—
18	img_019_SRF_4_HR.png	17.7341	0.697854	—
19	img_020_SRF_4_HR.png	17.9355	0.662796	—
20	img_021_SRF_4_HR.png	24.3578	0.705574	—
21	img_022_SRF_4_HR.png	22.5085	0.718283	—
22	img_023_SRF_4_HR.png	20.7514	0.783585	—
23	img_024_SRF_4_HR.png	17.3251	0.608278	—
24	img_025_SRF_4_HR.png	25.3812	0.833088	—
25	img_026_SRF_4_HR.png	24.7246	0.613512	—
26	img_027_SRF_4_HR.png	25.294	0.759949	—
27	img_028_SRF_4_HR.png	28.04	0.846019	—
28	img_029_SRF_4_HR.png	22.7164	0.759771	—
29	img_030_SRF_4_HR.png	18.1363	0.711544	—
30	img_031_SRF_4_HR.png	20.6098	0.722816	—
31	img_032_SRF_4_HR.png	24.5524	0.792749	—
32	img_033_SRF_4_HR.png	22.9162	0.694139	—
33	img_034_SRF_4_HR.png	18.9906	0.526702	—
34	img_035_SRF_4_HR.png	21.0931	0.780189	—
35	img_036_SRF_4_HR.png	24.3878	0.840489	—
36	img_037_SRF_4_HR.png	20.7365	0.705347	—
37	img_038_SRF_4_HR.png	23.3963	0.563929	—
38	img_039_SRF_4_HR.png	18.0393	0.672262	—
39	img_040_SRF_4_HR.png	19.0381	0.796996	—
40	img_041_SRF_4_HR.png	20.4548	0.831465	—
41	img_042_SRF_4_HR.png	22.3975	0.834862	—
42	img_043_SRF_4_HR.png	25.7349	0.879642	—
43	img_044_SRF_4_HR.png	20.8197	0.721876	—

	Image_Name	PSNR	SSIM	
44	img_045_SRF_4_HR.png	18.2593	0.628458	—
45	img_046_SRF_4_HR.png	20.3317	0.722458	—
46	img_047_SRF_4_HR.png	17.2867	0.715247	—
47	img_048_SRF_4_HR.png	16.7668	0.746543	—
48	img_049_SRF_4_HR.png	19.4921	0.696421	—
49	img_050_SRF_4_HR.png	20.9746	0.69304	—
50	img_051_SRF_4_HR.png	22.6028	0.789776	—

	Image_Name	PSNR	SSIM	
51	img_052_SRF_4_HR.png	23.0011	0.820898	—
52	img_053_SRF_4_HR.png	18.5096	0.700482	—
53	img_054_SRF_4_HR.png	17.6999	0.63911	—
54	img_055_SRF_4_HR.png	25.3574	0.852961	—
55	img_056_SRF_4_HR.png	19.9994	0.714091	—
56	img_057_SRF_4_HR.png	25.229	0.796442	—
57	img_058_SRF_4_HR.png	21.0228	0.805501	—
58	img_059_SRF_4_HR.png	19.5272	0.710422	—
59	img_060_SRF_4_HR.png	18.654	0.528968	—
60	img_061_SRF_4_HR.png	18.7007	0.666165	—
61	img_062_SRF_4_HR.png	17.7273	0.702076	—
62	img_063_SRF_4_HR.png	19.0474	0.567715	—
63	img_064_SRF_4_HR.png	21.2104	0.679086	—
64	img_065_SRF_4_HR.png	20.0242	0.649904	—
65	img_066_SRF_4_HR.png	19.3229	0.62501	—
66	img_067_SRF_4_HR.png	16.2281	0.797879	—
67	img_068_SRF_4_HR.png	24.4168	0.795602	—
68	img_069_SRF_4_HR.png	20.8291	0.686006	—
69	img_070_SRF_4_HR.png	19.547	0.563076	—
70	img_071_SRF_4_HR.png	24.9849	0.593807	—
71	img_072_SRF_4_HR.png	15.8472	0.792495	—
72	img_073_SRF_4_HR.png	16.263	0.494672	—
73	img_074_SRF_4_HR.png	18.7288	0.628449	—
74	img_075_SRF_4_HR.png	25.3972	0.813782	—
75	img_076_SRF_4_HR.png	19.4153	0.625177	—
76	img_077_SRF_4_HR.png	18.9014	0.595341	—
77	img_078_SRF_4_HR.png	23.0917	0.628485	—
78	img_079_SRF_4_HR.png	21.0827	0.647458	—
79	img_080_SRF_4_HR.png	29.6847	0.883857	—
80	img_081_SRF_4_HR.png	26.317	0.834506	—
81	img_082_SRF_4_HR.png	24.182	0.847088	—
82	img_083_SRF_4_HR.png	19.086	0.650389	—
83	img_084_SRF_4_HR.png	22.6815	0.693984	—
84	img_085_SRF_4_HR.png	22.8267	0.840933	—
85	img_086_SRF_4_HR.png	24.1949	0.798258	—
86	img_087_SRF_4_HR.png	22.9666	0.813635	—
87	img_088_SRF_4_HR.png	16.3996	0.505402	—
88	img_089_SRF_4_HR.png	21.4388	0.624725	—
89	img_090_SRF_4_HR.png	26.8161	0.861104	—
90	img_091_SRF_4_HR.png	18.4298	0.540688	—
91	img_092_SRF_4_HR.png	16.4007	0.64695	—
92	img_093_SRF_4_HR.png	22.0472	0.848931	—
93	img_094_SRF_4_HR.png	23.4945	0.711364	—
94	img_095_SRF_4_HR.png	17.8445	0.403815	—
95	img_096_SRF_4_HR.png	19.3696	0.806044	—

	Image_Name	PSNR	SSIM	
96	img_097_SRF_4_HR.png	20.071	0.706707	—
97	img_098_SRF_4_HR.png	17.6336	0.475505	—
98	img_099_SRF_4_HR.png	19.6557	0.65586	—
99	img_100_SRF_4_HR.png	20.8186	0.667342	—
100	Average	21.0597	0.708307	—

DISCUSSION AND CONCLUSION

Discussion

The analysis of the pre-trained RealESRGAN model in upscaling images from the Urban100 dataset has unfolded a spectrum of insights regarding its performance, both quantitatively and qualitatively.

Performance Insights

From a quantitative standpoint, the model demonstrated a noteworthy performance, achieving substantial PSNR and SSIM values. The scatter plot illustrating the correlation between PSNR and SSIM values (Figure 3) elucidated a generally positive trend, highlighting the model's proficiency in balancing reconstruction accuracy and structural preservation. However, it was observed that there is a variability in the performance across different images, pointing to the model's varying efficacy in handling diverse urban scenarios presented in the dataset.

On the qualitative front, the visual inspection of the upscaled images presented a mixed bag of outcomes. While the model managed to upscale images to a higher resolution successfully, it exhibited a tendency to render images with a slightly cartoonish hue. This not only altered the natural textures in some instances but also, at times, resulted in a flattening effect, thereby compromising the depth perception in the images.

Comparison with Other SR Techniques

A comparative analysis with other state-of-the-art SR techniques revealed that RealESRGAN holds a promising position in the current landscape. Despite its limitations, the model stands competitive, showcasing a robust performance in handling a wide array of urban scenarios with intricate details. This comparative standing of RealESRGAN encourages further exploration and optimization to enhance its performance.

Potential Areas for Improvement

Delving deeper, our analysis identified certain areas where the model could see further improvements. A critical observation was the model's handling of faces and people in the images, where it often failed to retain the necessary details, rendering faces almost unrecognizable. This highlights a potential avenue for further research, focusing on enhancing the model's capability in preserving intricate details, especially in scenarios involving faces and human figures.

Future Directions

Looking forward, it is imperative to explore strategies to mitigate the identified limitations. One potential direction could be the integration of additional training datasets with a rich representation of urban scenarios to further train the model, aiming to enhance its proficiency in handling diverse urban scenarios.

Moreover, leveraging advancements in deep learning and artificial intelligence could pave the way for the development of more sophisticated models capable of better handling intricate details and preserving natural textures, thereby achieving a more natural and realistic upscaling of images.

In conclusion, this research has laid a foundation for a deeper understanding of the RealESRGAN model's capabilities and limitations. It opens up avenues for further research, steering towards the development of more refined and optimized SR techniques in the future.

Conclusion

In this study, we embarked on an analytical journey to scrutinize the performance of the pre-trained RealESRGAN model in super-resolution upscaling using the Urban100 dataset. Through a meticulous quantitative and qualitative analysis, we have unearthed a panorama of insights regarding the model's capabilities and areas that necessitate further refinement.

Key Findings

Our quantitative analysis, grounded on PSNR and SSIM metrics, showcased that while the RealESRGAN model is capable of delivering commendable results, it exhibits a variability in performance across different urban scenarios presented in the Urban100 dataset. The qualitative analysis further affirmed this, illustrating the model's tendency to sometimes impart a cartoonish hue to the images, which, although enhancing certain textures, occasionally resulted in a compromise on the natural depth perception in the images.

Implications and Future Directions

The findings from this study have several implications. Firstly, it underscores the potential of RealESRGAN in the realm of super-resolution upscaling, especially in enhancing images with intricate details. However, it also illuminates the areas where the model falls short, primarily in preserving the natural textures and handling faces and human figures in the images effectively.

Looking forward, it opens up a vast landscape for further research, where strategies to enhance the model's performance could be explored. This could encompass leveraging more diverse training datasets and integrating advancements in deep learning and AI to develop more sophisticated SR techniques capable of achieving more natural and realistic upscaling of images.

Furthermore, future studies could delve into a comparative analysis with a broader spectrum of SR techniques to fathom the RealESRGAN model's standing more comprehensively in the current landscape of super-resolution methods.

Closing Remarks

In conclusion, this research stands as a testimony to the RealESRGAN model's potential, albeit with identified areas for improvement. It lays a robust foundation for further explorations in this domain, steering towards a future where the boundaries of super-resolution upscaling are continually pushed, paving the way for more refined and optimized techniques that bring us ever closer to achieving a perfect upscaling of low-resolution images to high-definition counterparts.

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Fractional Order Mathematical Modeling Of Diabetes Disease With Memory Effect

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Abstract

In this study, we propose a new illustrative and effective model to point out the behaviors of diabetes. Not only do we consider the mathematical modeling, equilibria, their stabilities, and existence-uniqueness analysis of the model, but also, we also make numerical simulations by using the Adams-Bashforth numerical scheme that is commonly preferred by analysts to solve and simulate both fractional and integer order nonlinear systems. Also, in this study, we propose the fractional-order system (FOS) of diabetes instead of the integer-order to be able to make an analysis in detail and to take into account the memory property which is one of the most important advantages of FOS. The unique non-negative solution is contained inside the region that is biologically possible, and the paper discusses both the presence and uniqueness of its solution. In the paper, the stability analysis of the aforementioned model is taken into account, and the biological applicability of the equilibria is also carried out. The results point out that the order of the fractional derivative has an essential effect on the dynamical process of the constructed model for diabetes [1,2,3].

Key words: *Fractional order differential equations, Diabetes disease, Positivity and boundedness.*

Using Network Analysis To Examine The Connectivity Between The Brain Regions In Rs-fmri Data Of Fnd Patient And Healthy Participant : A Single Subject Study

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Abstract

Introduction: Functional neurological disorders is one of the most common causes of neuropathy of unclear neuropathy. Unraveling the fundamental mechanisms of that is imperative to formulate effective treatment approaches. This study was conducted on R-fMRI scans taken from two volunteers (FND patient and healthy subject) who had the same characteristics. Method: Gaussian graphical models were fitted on these data using a network approach and the results were shown graphically. Results: The networks associated with both the healthy individual and the patient exhibited a notable level of density. the findings revealed a higher presence of positive connections among the regions, with the majority demonstrating a robust relationship. there were also instances of negative associations. The networks of the healthy participant with almost symmetrical structures and the patient with FND showed different characteristics, including asymmetry between the hemispheres. Conclusion: This study is the first of showcasing that the brain regions of both individuals with FND and healthy participants can be perceived as networks. the results of this research can help in future studies. It gives an insight that the brain regions of FND patients can be investigated using network analysis.

Key words: *Keywords: R-fMRI ,FND disease, Network analysis, GGM*

Exploring The Impact Of Stage And Tumor Site On Colorectal Cancer Survival: Bayesian Survival Modeling

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Abstract

Introduction: Colorectal cancer is a widespread malignant condition of significant worldwide importance. The objective of this retrospective analysis was to explore how the stage of cancer and the location of the tumor affect the survival rates of 284 patients diagnosed with CRC between 2001 and 2017. Method: The patients were divided into four categories depending on both the location of the tumor (colon or rectum) and the stage of the disease (early stage or advanced stage). We conducted Bayesian survival modeling with R 4.1 software using semi-competing risks illness-death models, utilizing an Accelerated Failure Time approach. Results: Results demonstrated significantly higher time ratios for disease recurrence (TR = 1.712, 95% CI = 1.489-2.197), mortality without recurrence (TR = 1.933, 1.480-2.510), and mortality after recurrence (TR = 1.847, 1.147-2.178) in early-stage colon cancer (Cc - early stage) compared to early-stage rectal cancer (RC).Patients with advanced-stage rectal cancer, had shorter survival times for disease recurrence compared to patients with early-stage colon cancer.the interaction effect between disease site and cancer stage was not significant. Conclusion: These results, obtained for both terminal and non-terminal events, emphasize the importance of early detection and effective management strategies for colon cancer. In comparison to other stages, early-stage colon cancer exhibited enhanced survival rates in terms of disease recurrence, mortality without recurrence, and mortality after recurrence. therefore, care and early intervention play a pivotal role in improving the prognosis and reducing adverse events in individuals with colon cancer.

Key words: *Disease stage, Cancer site, Bayesian log-normal model, Semi-competing risks, Illness-death*

Anti–biofilm And Anti–quorum Sensing Activities Of Prunella Vulgaris L. Extracts

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Abstract

Diseases caused by biofilm-forming bacteria require long-term treatment and can lead to antibiotic resistance. Biofilm formation is controlled by cell-to-cell communication commonly known as quorum sensing. Inhibition of quorum sensing is one of the methods applied to control biofilm-forming microorganisms without causing drug resistance. Prunella vulgaris L. is a perennial herbaceous plant with proven effectiveness in the treatment of various diseases. In this study, the effect of Prunella vulgaris L. extracts prepared with methanol, ethyl acetate, water and hexane on acyl-homoserine lactone (AHL), the communication molecule of gram negative bacteria, was investigated. We found that plant extracts prepared with methanol inhibited the quorum sensing system, which is a bacterial auto control system. Our results show that Prunella vulgaris L. methanol extracts can possibly be an important agent in the treatment process of certain infections that cause diseases; however, further research is required.

Key words: *Biofilm, Quorum Sensing, Plant Extracts, Prunella Vulgaris L., Bacteria*

INTRODUCTION

It has been demonstrated that the vital activities of bacteria do not consist of reproduction, but that the cells of the same or different bacteria communicate with each other. The system that provides this communication is called quorum sensing. Quorum sensing (QS) is a system that enables bacteria reaching the maximum population size to recognize the signal molecules they produce (Boşgelmez-Tınaz, 2003). Thanks to quorum sensing, an auto-control system, bacteria can be aware of the microbial density and cell numbers in their environment, and they can perform many virulence features (biofilm, anti-microbial resistance, pathogenesis, etc.) as well as antibiotic biosynthesis or new protein production. By manipulating this communication system, a significant success can be achieved in the treatment of infections, and the number of bacteria can be reduced. The biofilm protects the bacterium against the immune system, and these protected bacteria are resistant to antibiotics and antimicrobial agents. Most bacteria can form a biofilm on living or non-living surfaces. The biofilm pathogens form allows them to escape from antimicrobial agents and the host's immune response (Towner, 2009).

Prunella vulgaris L. is a herbaceous perennial and edible plant known as "self-healing" or "healing all", belonging to the Labiatae family (Zhao et al., 2018). *Prunella vulgaris* L. extract has a broad range of biological properties including antibacterial, anti-inflammatory, anticancer, antiallergic, antioxidant and antiviral activities (Kim, 2012; Haarberg et al., 2015; Fazal et al., 2016). In this study, anti-biofilm and

anti- quorum sensing activities of methanol, ethyl acetate, water and hexane extracts of *Prunella vulgaris* L. plant were investigated

MATERIAL AND METHODS

Preparation of *Prunella vulgaris* L. extracts

The *Prunella vulgaris* L. were obtained from Kütahya Municipality Hekim Sinan Medicinal and Aromatic Plants Garden, Turkey. 10 g dried *Prunella vulgaris* L. plant was mixed with 90 mL methanol, (Sigma Aldrich) hexane and ethyl acetate solutions (Sigma Aldrich) separately after grinding, and stirred for 48h with a magnetic stirrer. Then, plant particles in solvents were filtered, solvents were evaporated and extracts were obtained in a viscous form (Özbek et al., 2020).

Antibiofilm activity

Anti-biofilm activities of *Prunella vulgaris* L. plant extracts were determined using *Listeria monocytogenes, Salmonella typhimurium, Vibrio parahaemolyticus, Salmonella enterica, Staphylococcus aureus, Pseudomonas aeruginosa, Enterococcus faecalis, Bacillus subtilis, Bacillus cereus, Acinetobacter baumannii, Escherichia coli* (ATCC 25922), *Shigella sonnei, Escherichia coli 0157:H7, Klebsiella pneumoniae, Klebsiella oxytoca* and *Moraxella catarrhalis* bacteria. The microorganisms used in the study were reproduced from the microbial culture collection kept in microbiology laboratory of Scientific and Technological Research Center of Aksaray University. Biofilm formation was confirmed with the crystal violet method. Brain Heart Infusion Broth (BHI) medium was used in the study. 10^6 cfu/mL of the microorganism suspension to be tested was added to BHI media and incubated at 37 °C for 24 hours. Following the incubation, polystyrene microplates with 24 wells were filled with 800 µl BHI medium + 100 µl plant extract (100 mg/ml) + 100 µl test bacteria, and left at 37°C for 48h. After incubation, the plates were washed with 1x PBS (phosphate buffer) and dried at 65°C, and then were left to be dyed with 1% crystal violet for 2 minutes. After staining, the plates were washed three times with distilled water and dried at room temperature, and then dissolved with 30% acetic acid solution. The crystal violet solutions in solved microplates were read in the spectrophotometer (Thermo Scientific Genesys 10S Uv-Vis spectrophotometer) at 595 nm against the control group. Thus, the biofilm forming ability of the test bacteria determined (Stepanović et al., 2000; Hoffman et al., 2005; O'Toole, 2011).

Antiquorum Sensing Activity

The bacterial culture of *Chromobacterium violaceum* CV026 biosensor strain, which was grown at 30°C for 18 hours, was adjusted to a McFarland standard 0.5 (10^6 cfu/ml). *C. violaceum* CV026 and the extract of 50 µl N-(ß-ketocaproyl)-L-homoserine lactone (3-oxo-C6-HSL) on 10 ml soft Luria Bertani (LB) agar medium was added for agar diffusion test. Discs impregnated with *Prunella vulgaris* L. extracts were placed on solidified soft LB agar medium and incubated at 30 ˚C for 48 hours. LB agar medium was prepared with 0.9% agar, 100 µl *C. violaceum* CV026, and 50 µl 3-oxo-C6-HSL extract, and after solidification, 4 mm diameter wells were scooped out from the LB agar medium. The wells were filled with the *Prunella vulgaris* L. extracts (50 mg/ml) in different solvents. The agar plates were incubated at 30 °C for 48h. Antiquorum sensing activity assay tests were also conducted in triplicate. Violasin pigment amount of *Prunella vulgaris* L. extracts prepared in different solvents was measured at 585 nm in spectrophotometer and anti-quorum sensing activity was determined (Bezek et al., 2016; Oliveira et al., 2016).

Violacein pigment isolation

Violacein pigment isolation was performed using the method reported in our previous study (Erdönmez et al., 2018).

RESULTS

Effect of *Prunella vulgaris* L. extracts on bacterial biofilm formation

The activities of *Prunella vulgaris* L. plant extracts on microbial biofilm formation were determined by measuring at 595 nm wavelength in a spectrophotometer. The obtained results were evaluated against the adhesion to the nitrocellulose membrane, which was used as a positive control and gave the highest absorbance value for the bacteria to adhere to the surface. The obtained absorbance measurement results are given in Table 1. Although the effect of *Prunella vulgaris* L. extracts on the biofilm formed by food pathogens such as *Listeria monocytogenes*, *Salmonella typhimurium*, *Vibrio parahaemolyticus*, *Salmonella enterica* was found to be significant, its effectiveness was not observed in *Escherichia coli* 0157:H7, an important food pathogen. Table 1 shows that the extract prepared with hexane has the lowest effect on *Listeria monocytogenes*. The water extract of *Prunella vulgaris* L. has the highest effect against *Vibrio parahaemolyticus*, while the extract prepared with methanol has the lowest effect. We found that the extract prepared with hexane has the lowest effect on *Salmonella enterica*, while the extract prepared with methanol had the highest effect. All prepared extracts affect the biofilm formed by *Shigella sonnei*, which affects public health and causes death. *Escherichia coli* 0157:H7 can survive for a long time in products with low water activity and acidic foods that are frozen and stored in the cold. The effectiveness of the extracts has not been determined in these bacteria, which have high biofilm forming abilities and high potential to adhere to various surfaces, such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Acinetobacter baumannii*, *Klebsiella pneumoniae* and *Enterococcus faecalis*, which are hospital-acquired infectious agents. Only *Prunella vulgaris* L. methanol extract affected the biofilm formed by *Moraxella catarrhalis*. It was observed that the water and methanol extracts of *Prunella vulgaris* L. have a high effect on the biofilm formed by *Klebsiella oxytoca*. We determined that *Bacillus cereus* and *Bacillus subtilis* bacteria were not affected by these treatments in terms of their biofilm forming abilities.

Table 1. Biofilm forming abilities of *Prunella vulgaris* L. plant extracts.

Bacteria	Plant extracts				Control
	Methanol	Ethyl acetate	Water	Hexane	
Listeria monocytogenes	3.105	3.048	2.870	3.290	2.960
Salmonella typhimurium	3.162	3.031	1.821	2.742	3.501
Vibrio parahaemolyticus	3.100	2.96	2.801	2.921	3.010
Salmonella enterica	3.106	3.405	3.162	3.425	3.106
Staphylococcus aureus	2.354	2.354	2.354	2.354	2.354
Pseudomonas aeruginosa	1.879	1.879	1.879	1.879	1.879
Enterococcus faecalis	1.765	1.765	1.765	1.765	1.765
Bacillus subtilis	2.734	2.734	2.734	2.618	2.734
Bacillus cereus	2.784	2.784	2.784	2.784	2.784
Acinetobacter baumannii	2.319	2.319	2.319	2.319	2.319
Shigella sonnei	1.319	1.109	1.462	1.265	1.467
Escherichia coli 0157:H7	2.673	2.673	2.673	2.673	2.673
Escherichia coli	1.593	1.593	1.593	1.593	1.593
Klebsiella pneumoniae	1.672	1.672	1.672	1.672	1.672
Klebsiella oxytoca	1.253	1.453	1.153	1.453	1.453
Moraxella catarrhalis	1.742	1.842	1.842	1.842	1.842

Anti-quorum Sensing Activity

In this study, *Chromobacterium violaceum CV026 (biosensor strain), Chromobacterium violaceum 12472* (wild type) and *Chromobacterium violaceum 31532* (positive control) bacterial strains were used. In order to determine the anti-quorum sensing activity of Prunella vulgaris extracts, the amount of violacin pigment formed was also measured in addition to the Disk Diffusion and Agar Diffusion Test. It was determined that only methanol extract from *Prunella vulgaris* L. extracts had a negative effect on the bacterial communication molecule AHL. This shows that only methanol extract of *Prunella vulgaris* L. plant has anti-quorum sensing activity. The extracts obtained using ethyl acetate, water and hexane did not have any activity on AHL.

The effect of *Prunella vulgaris* L. extracts on violacin pigment production is given in Figure 1. As seen, the effectiveness of *Prunella vulgaris* L. methanol extracts on violacin pigment production, which is known as virulence feature, is quite good in determining the anti-quorum sensing activity. This shows that methanol extracts can be potentially used in the treatment of certain infections. However, further *in vivo* data is required.

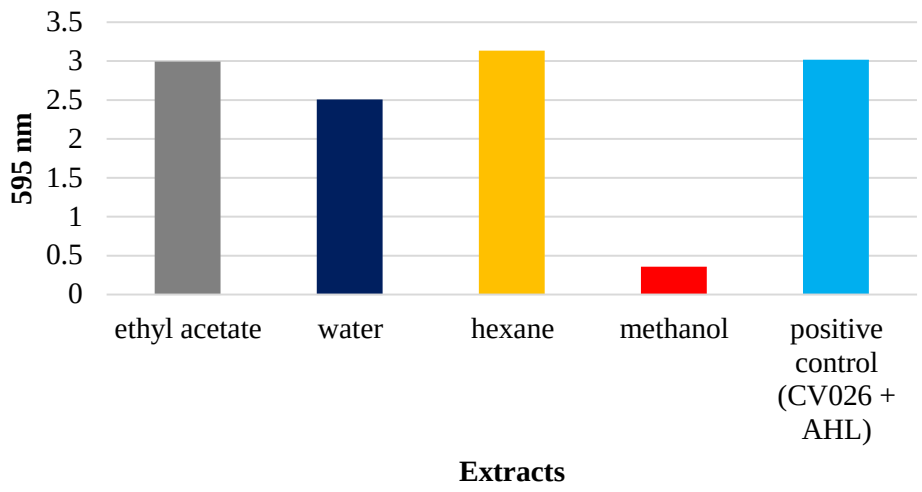

Figure 1. Effect of *Prunella vulgaris* L. extracts on violacin pigment production.

CONCLUSION

Inhibition of the quorum sensing system, the effectiveness of which has been determined by changes in the virulence, brings a new perspective to the treatment of many diseases caused by bacteria. The fact that the *Prunella vulgaris* L. plant has been used in traditional medicine since ancient times has shown that it can also be potentially used in the treatment of some other diseases. In this study, it was determined that the extract prepared with ethyl acetate, water, hexane and methanol of *Prunella vulgaris* L. plant only inhibited the quorum sensing system, which is a bacterial auto control system. As a result, we showed that the methanol extract of *Prunella vulgaris* L. inhibits this bacterial communication system and can make an important contribution to the treatment of certain infections that cause diseases. In this way, significant reductions in the population of bacteria that cause diseases in organisms can be achieved and the transmission of diseases can be prevented at least to a certain extent. However, preliminary data presented in the current study should be supported by *in vivo* data; therefore, further research is needed to better understand the efficacy of these extracts, active molecules and modes of action.

Conflict of Interest

The authors have declared that there is no conflict of interest.

Author Contributions

All the authors equally contributed to this work.

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Sosyal Medya Ve Ebeveynlik: Lisansüstü Tezler Üzerine Bir Analiz

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Özet

Teknolojide yaşanan gelişim ve dönüşümler sosyal medya platformlarının yaygınlaşmasını sağlamıştır. Hayatımızın önemli bir parçası haline gelen sosyal medya platformları tüm kitleleri etkisi altına aldığı gibi ebeveynler tarafından da bilinçli veya bilinçsiz bir şekilde kullanılmaktadır. Bu çalışma, isminde sosyal medya ve ebeveyn kelimeleri bulunan lisansüstü tezlerin doküman analizi yöntemiyle analiz edilerek araştırmaların yapıldığı alanları saptamak ve çalışılacak alanları tespit etmek amacıyla yapılmıştır. Araştırmanın evrenini Yükseköğretim Kurumu Dokümantasyon (YÖK) Daire Başkanlığı Ulusal Tez Merkezi sisteminde kayıtlı olan tezler örneklemini ise sosyal medya ve ebeveyn kelimelerinin yer aldığı 2018-2023 yılları arasında hazırlanan 25 lisansüstü tez oluşturmaktadır. Çalışmaya dahil edilen 25 tez 2 araştırmacı tarafından 8 kategori altında incelenmiştir. Bu kategoriler yıl, üniversite, anabilim dalı, cinsiyet, danışman ünvanı, tez türü, veri toplama yöntemi, yöntem şeklinde yer almaktadır. Analiz edilen tezler türüne göre incelendiğinde yer alan 25 tezin tamamı yüksek lisans tezinden oluşmaktadır. Tezler yıllara göre incelendiğinde en çok tez 8 frekans %32 oran ile 2022 yılında yazılmıştır. Yazılan tezlerin yöntemleri incelendiğinde nicel yöntemler 19 frekans %79 oran, nitel yöntemler 6 frekans %24 oran ile yer aldığı saptanmıştır. Veri toplama araçları incelendiğinde 19 frekans %76 oran ile en fazla anket yöntemi kullanılarak verilerin toplandığı görülmüştür. İncelenen bulgular sonucunda sosyal medya ve ebeveynlik kavramının son 5 yılda çalışılmış olduğu ve bu alanda daha çok çalışma yapılmasına gerek duyulduğu düşünülmektedir.

Anahtar Kelimeler: *Sosyal Medya, Yeni Medya, Ebeveyn, YÖK Tez*

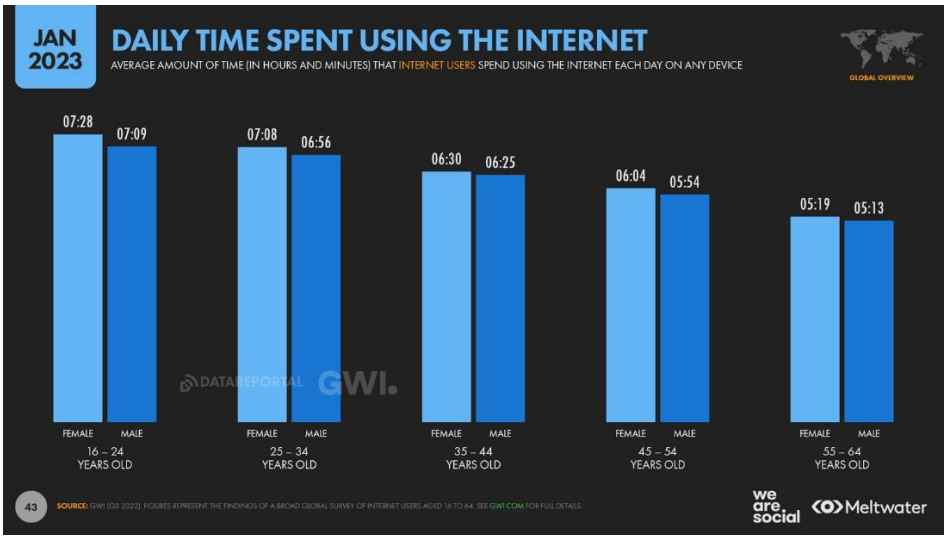
GİRİŞ

Gelişen ve sürekli dönüşüm halinde olan internet ve web uygulamaları çağımızda bireylerin tamamının gündelik hayatlarını etkileyen faktörlerin başında gelmektedir. Dijitalleşme, bilgi ve iletişim teknolojilerinin gelişmesiyle birlikte yaşamın pek çok yönünü etkileyen ve dönüştüren önemli bir olgudur (Yengin, Çakar & Şahin, 2023: 11). Bireylerin ve toplumların yaşamlarını sürdürebilmesi için temel bir gereklilik olan iletişim kavramı, dijitalleşme ile sürekli olarak dönüşmektedir (Yengin & Çakar, 2023: 599). Hızla gelişen, iletişim ve bilgi paylaşımının merkezini oluşturan sosyal medya hesaplarının kullanımı giderek artmakta ve her kuşaktan bireylerin bu uygulamaları kullandığı görülmektedir. Kullanıcılarına kolaylık sağlayan bu platformlar kişilerin hızlı bilgi paylaşmalarına, görsel ve video paylaşımlarına, reklam ve sanal çevre oluşturmalarına olanak sağlamaktadır (Yüksel, 2021: 51). Bu dijital uygulamalarda kullanıcılar yüksek beğeni alma, yüksek takipçi sayısı, kendini kabullendirme veya fenomen olma adına mahremiyet kültürünü kaybetmekte ve kişisel bilgilerini, aile

yaşantısını paylaşmaktadırlar (Esgin vd., 2020: 2081). Hayatımıza yerleşen yeni medya uygulamaları anne ve çocuklara yönelik değişimler ortaya çıkarmış ve yaşantımıza instamom, blogger annelik, sharenting gibi kavramlar dahil olmuştur (Ergül ve Yıldız, 2021: 612; Yüksel, 2021: 52). Bu kavramlar ile birlikte yaşantımızda yeni alışkanlıklar meydana gelmiştir. Çocuklarının yaşamının her anının bu uygulamalarda paylaşılması, ebeveynlerin bu paylaşımlardan ticari kazanç sağlaması ve çocuklarının mahremiyet alanlarını işgal etmeleri büyük bir problem teşkil etmektedir (Güngör, 2021: 2). Ebeveynlerin sosyal medya uygulamalarında yaptıkları bu paylaşımlar içeriklerin toplum tarafından yorumlanma biçimine göre farklılık gösterebilir ve çocukların ilerleyen yaşam sürecini etkileyebilir ve siber zorbalığa neden olabilir (Ömür ve Uyar, 2022: 24). Sosyal medya uygulamalarının kullanımının artması ve doğru şekilde kullanılmayan uygulamalar ebeveynler ve çocuklar için tehdit haline gelmektedir. Dezavantajlı gruplar arasında yer alan çocuklara ve ebeveynlere yönelik yapılan çalışmalar bu bağlamda önem arz etmektedir. Bu sebeple yapılan bu araştırma isminde sosyal medya ve ebeveyn kelimeleri bulunan lisansüstü tezlerin doküman analizi yöntemiyle incelenerek ve içerik analizi yöntemi kullanılarak araştırmaların yapıldığı alanları belirlemek ve çalışılacak alanları tespit etme hedefiyle yapılmıştır. Yapılan çalışmadan elde edilen sonuçlarla çalışılması gereken alanlar tespit edilecek ve yapacağımız çalışmalar o alanlara yönlenecektir.

1. SOSYAL MEDYA VE EBEVEYNLİK

Teknolojinin değişen ve gelişen serüveninde sosyal medya platformları hayatımızın bir parçası haline gelmiştir. Sosyal medya platformları, kullanıcıların kendi kişi listelerini oluşturmalarına, birbirleriyle iletişim kurmalarına, bilgilerini içeren profiller oluşturmalarına olanak tanıyan, fotoğraf ve video paylaşılabilen, çeşitli iletişim ve bilgi teknolojilerinden oluşan web tabanlı platformlardır (Uluç ve Yarcı, 2017). Bu platformlarda insanlar kendilerine yeni bir alan oluşturarak sosyalleşmektedir. Sosyal medya, kullanıcıları için gündelik hayattan kaçış, bilgi, eğlence, iletişim, topluluklar tarafından takdir edilme, sosyal etkileşimden kaçıp yalnız kalabildiği bir uygulamadır (Çalışkan ve Mencik, 2015). We Are Social 2023 raporuna göre dünyada 5.16 milyar internet kullanıcısı bulunmakta ve bu sayı dünya nüfusunun %64,4'ünü oluşturmakta, 4.76 milyar aktif sosyal medya kullanıcısı bulunmakta ve bu sayı dünya nüfusunun %60'ının biraz altına denk gelmektedir. Bu oranlar her yıl giderek artış göstermektedir (We Are Social, 2023a). Kitle iletişim araçlarının kullanımının yaygınlaşması ve internet teknolojisinin gelişmesiyle birlikte gündelik hayatın tüm anları sosyal medya platformları aracılığı ile kamuya açık hale gelmektedir. Kamuya açık hale gelen kişisel alan güvenli ve denetlenebilirliği sağlanan yapıya kavuşturulmalıdır. Sosyal medyanın çekim gücü yetişkinlikler kadar çocuklar içinde geçerli olmakta ve kişisel alan ihlali sıklıkla yapılmaktadır (Dursun,2019, 202). Sosyal medya, günümüzün dijital çağında oldukça yaygın bir şekilde kullanılan bir iletişim aracı haline gelmiştir. Ancak, çocukların sosyal medyayı kullanmaya başlamasıyla birlikte, ebeveynler için yeni sorumluluklar ve endişeler ortaya çıkmıştır. Ortaya çıkan bu endişeler sanal ebeveynlik kavramının uygulanması ile çözüme kavuşabilmektedir. Bu kavram ile sanal dünya üzerinde ebeveynlerin kontrolleri ve gözetim gerekliliğinin önemi vurgulanmaktadır (Çalapkulu ve Alp, 2020, 136). Sanal ebeveynlik kavramı ile ebeveynlerin çocuklarının internet üzerindeki etkileşimlerini ve deneyimlerini yönetmelerini ifade eder. Günümüzde çocuklar daha küçük yaşlardan itibaren internetle etkileşime geçiyorlar ve bu da ebeveynler için internet güvenliği ve çocukların çevrimiçi deneyimlerini yönetme gerekliliğini ortaya çıkarıyor



Şekil 1: Yaş Gruplarına Göre İnternet Kulanım Süreleri

Kaynak: https://datareportal.com/reports/digital-2023-deep-dive-time-spent-online?utm_source=Global_Digital_Reports&utm_medium=Partner_Article&utm_campaign=Digital_2023

Şekil 1'de yer alan grafikte yaş ve cinsiyete göre internet kullanım oranları verilmiştir. Bu grafik kapsamında kullanıcıların gündelik hayatlarının büyük birçoğunu dijital dünyada geçirdikleri saptanmıştır (We Are Social, 2023b). Bu noktada ailelere Sanal ebeveynlik kapsamında farklı misyonların yüklenmesini gerektirmektedir. Çocukların interneti güvenli ve bilinçli bir şekilde kullanmalarını sağlama konusunda önemlidir. Ebeveynler, çocuklarını internetin potansiyel tehlikelerine karşı koruma ve onları çevrimiçi dünyada yönlendirme sorumluluğuna sahiptirler.

2. ARAŞTIRMANIN METODOLOJİSİ

Bu çalışma, isminde sosyal medya ve ebeveyn kelimeleri bulunan lisansüstü tezlerin doküman analizi yöntemiyle analiz edilerek araştırmaların yapıldığı alanları saptamak ve çalışılacak alanları tespit etmek amacıyla yapılmıştır. Araştırmada nitel araştırma yöntemleri arasında yer alan doküman analizi yöntemi kullanılmıştır. Sak ve arkadaşları tarafından doküman analizi "Belgesel tarama olarak da bilinen doküman analizinde, var olan kayıt ve belgeler incelenerek veri elde edilmektedir. Doküman analizi, belli bir amaca dönük olarak kaynakları bulma, okuma, not alma ve değerlendirme" şeklinde açıklanmıştır (Sak vd., 2021: 230). Dokümanlar incelenirken yıl, üniversite, anabilim dalı, cinsiyet, danışman ünvanı, tez türü, veri toplama yöntemi ve yöntem olmak üzere 8 kategori altında incelenmiştir. Kategoriler oluşturulurken Ilgın ve Kurtulmuş tarafından 2022 yılında yapılan "Göç ve Kadın Ekseninde Sağlık Bilimleri Alanında Yazılan Lisansüstü Tezler Üzerine Bir İnceleme" adlı çalışmada kullanılan kategorilerden yararlanılmıştır (Ilgın ve Kurtulmuş, 2022).

2.1. Araştırmanın Evren ve Örneklemi

Araştırmanın evrenini Yükseköğretim Kurumu Dokümantasyon (YÖK) Daire Başkanlığı Ulusal Tez Merkezi bünyesinde bulunan lisansüstü tezler oluşturmaktadır. Araştırmanın örneklemini ise Ulusal Tez Merkezi bünyesinde kayıtlı isminde "Sosyal Medya" ve "Ebeveyn" kelimeleri bulunan 25 adet tez oluşturmaktadır.

2.2. Veri Toplama Yöntemi

Veriler toplanırken tezleri incelemeye yönelik bir form oluşturulmuştur. Tezler incelenirken yıl, üniversite, anabilim dalı, cinsiyet, danışman ünvanı, tez türü, veri toplama yöntemi ve yöntem olmak üzere 8 kategori altında incelenmiştir. İncelenen tezler Microsoft Excel programına kaydedilmiştir.

2.3. Veri Analizi

Elde edilen veriler içerik analizi yöntemi kullanılarak analiz edilmiştir. Çalışmanın analiz süreci dört aşamadan oluşmaktadır. İlk aşamada anahtar kelimeler belirlenmiş ve alanyazın incelenerek kavramsal çerçeve oluşturulmuştur. İkinci aşamada incelenecek olan tezler belirlenmiş ve bir klasörde kayıt altına alınmıştır. Üçüncü aşamada belirlenen tezler incelenerek Excel dosyasına kaydedilerek veriler analiz edilerek tablolaştırılmıştır. Elde edilen verilerin güvenirliğini sağlamak amacıyla tezler iki araştırmacı tarafından farklı Excel dosyalarına kaydedilmiştir. Son aşamada elde edilen bulgular yorumlanarak sonuç elde edilmiştir.

3. BULGULAR

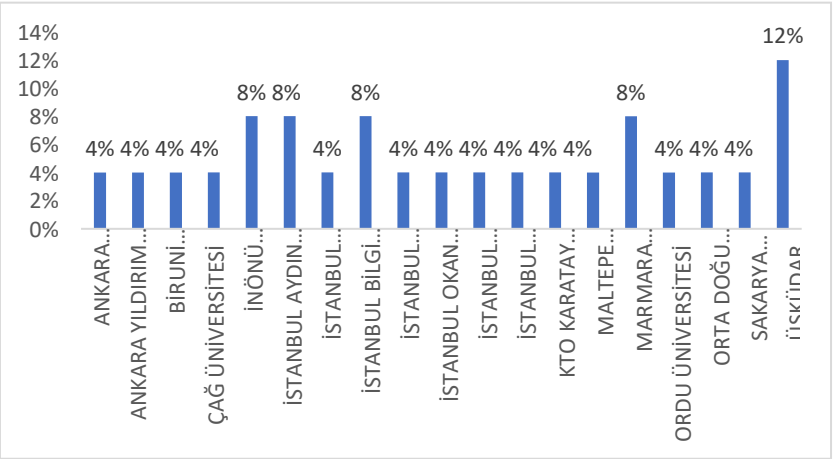
İncelenen veriler doğrultusunda aşağıda yer alan bulgulara ulaşılmıştır.

Tablo 1: Lisansüstü Tezlerin Yıllara Göre Dağılımı

YIL	FREKANS	YÜZDE
2023	4	%16
2022	8	%32
2021	6	%24
2020	3	%12
2019	2	%8
2018	2	%8
TOPLAM	25	%100

İsminde sosyal medya ve ebeveyn kelimeleri geçen lisansüstü tezler yıllara göre incelendiğinde 2023 yılında 4 frekans %16 oran, 2022 yılında 8 frekans %32 oran, 2021 yılında 6 frekans %24 oran, 2020 yılında 3 frekans %12 oran, 2019 yılında 2 frekans %8 oran, 2018 yılında 2 frekans %8 oran şeklinde dağılım göstermektedir.

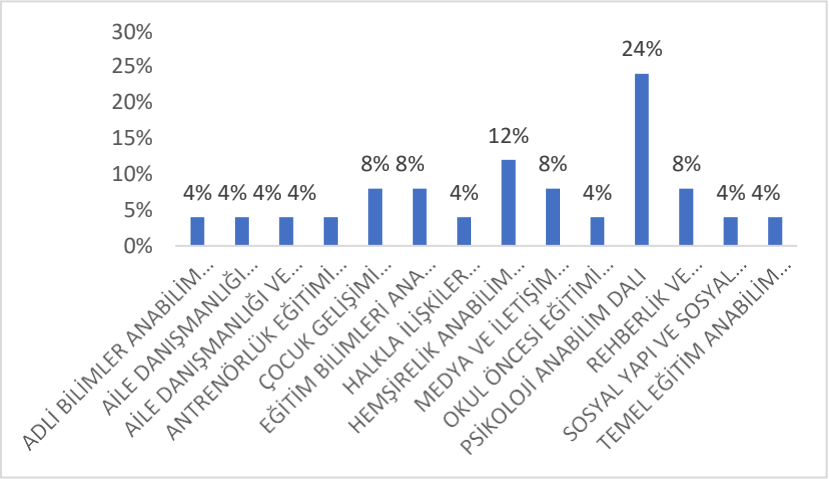
Grafik 1: Lisansüstü Tezlerin Üniversitelere Göre Dağılımı



İsminde sosyal medya ve ebeveyn kelimeleri geçen lisansüstü tezler üniversitelere göre incelendiğinde Ankara Üniversitesi 1 frekans %4 oran, Ankara Yıldırım Beyazıt Üniversitesi 1 frekans %4 oran, Biruni

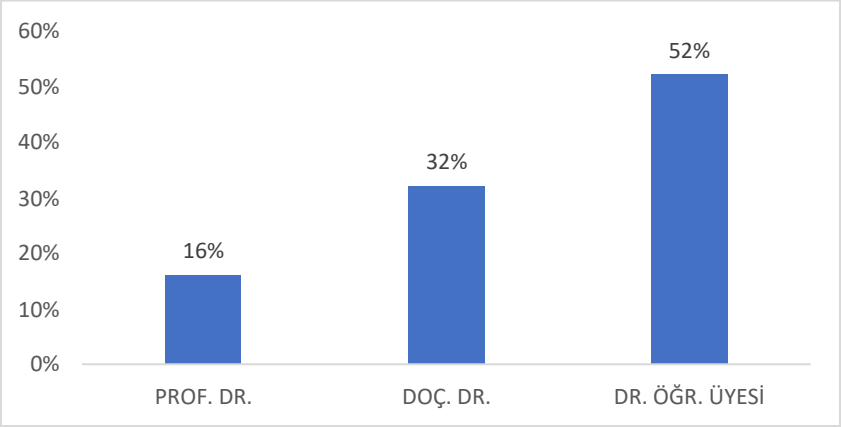
Üniversitesi 1 frekans %4 oran, Çağ Üniversitesi 1 frekans %4 oran, İstanbul Ayvansaray Üniversitesi 1 frekans %4 oran, İstanbul Gelişim Üniversitesi 1 frekans %4 oran, İstanbul Okan Üniversitesi 1 frekans %4 oran, İstanbul Ticaret Üniversitesi 1 frekans %4 oran, İstanbul Üniversitesi 1 frekans %4 oran, KTO Karatay Üniversitesi 1 frekans %4 oran, Maltepe Üniversitesi 1 frekans %4 oran, Ordu Üniversitesi 1 frekans %4 oran, Orta Doğu Teknik Üniversitesi 1 frekans %4 oran, Sakarya Uygulamalı Bilimler Üniversitesi 1 frekans %4 oran, İnönü Üniversitesi 2 frekans %8 oran, İstanbul Aydın Üniversitesi 2 frekans %8 oran, İstanbul Bilgi Üniversitesi 2 frekans %8 oran, Marmara Üniversitesi 2 frekans %8 oran, Üsküdar Üniversitesi 3 frekans %12 oran şeklinde dağılım göstermektedir.

Grafik 2: Lisansüstü Tezlerin Anabilim Dalına Göre Dağılımı



İsminde sosyal medya ve ebeveyn kelimeleri geçen lisansüstü tezler anabilim dalına göre incelendiğinde adli bilimler anabilim dalı 1 frekans %4 oran, aile danışmanlığı anabilim dalı 1 frekans %4 oran, aile danışmanlığı ve eğitimi anabilim dalı 1 frekans %4 oran, antrenörlük eğitimi anabilim dalı 1 frekans %4 oran, halkla ilişkiler anabilim dalı 1 frekans %4 oran, okul öncesi eğitimi anabilim dalı 1 frekans %4 oran, sosyal yapı ve sosyal değişme anabilim dalı 1 frekans %4 oran, temel eğitim anabilim dalı 1 frekans %4 oran, çocuk gelişimi anabilim dalı 2 frekans %8 oran, eğitim bilimleri ana bilim dalı 2 frekans %8 oran, medya ve iletişim sistemleri anabilim dalı 2 frekans %8 oran, rehberlik ve psikolojik danışmanlık anabilim dalı 2 frekans %8 oran, hemşirelik anabilim dalı 3 frekans %12 oran, psikoloji anabilim dalı 6 frekans %24 oran şeklinde dağılım göstermektedir.

Grafik 3: İncelenen Tezlerin Danışman Ünvanına Göre Dağılımı



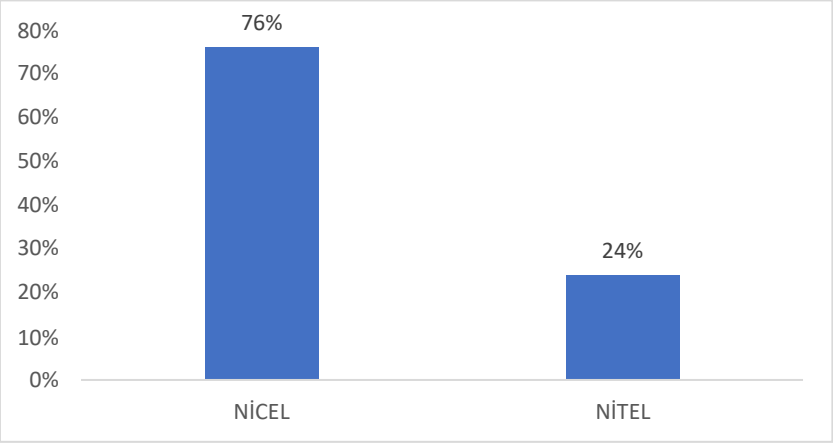
İsminde sosyal medya ve ebeveyn kelimeleri geçen lisansüstü tezler danışman ünvanına göre incelendiğinde Prof. Dr. 4 frekans %16 oran, Doç. Dr. 8 frekans %32 oran, Dr. Öğr. Üyesi 13 frekans %52 oran şeklinde dağılım göstermektedir.

Tablo 2: İncelenen Tezlerin Danışman Tez Türüne Göre Dağılımı

Tez Türü	Frekans	Yüzde
YÜKSEK LİSANS	25	%100
DOKTORA	0	0
TOPLAM	25	%100

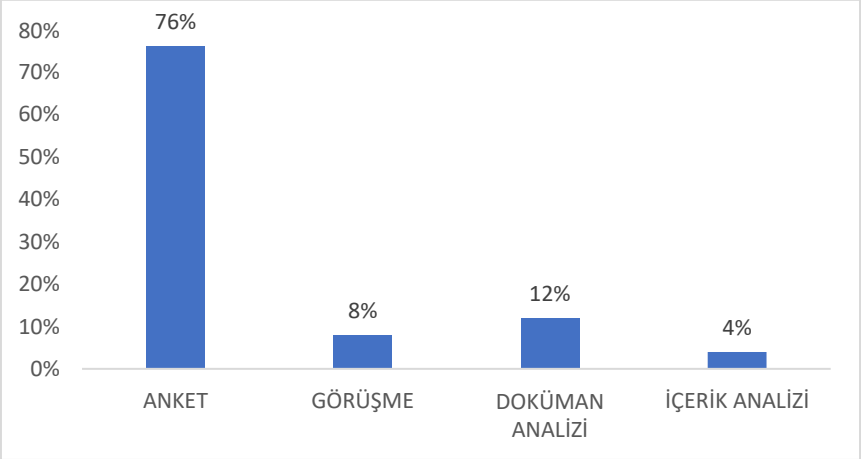
İsminde sosyal medya ve ebeveyn kelimeleri geçen lisansüstü tezler tez türüne göre incelendiğinde yüksek lisans tezleri 25 frekans %100 oran şeklinde dağılım göstermektedir. Doktora düzeyinde tez çalışması yapılmamıştır.

Grafik 4: İncelenen Tezlerin Yönteme Göre Dağılımı



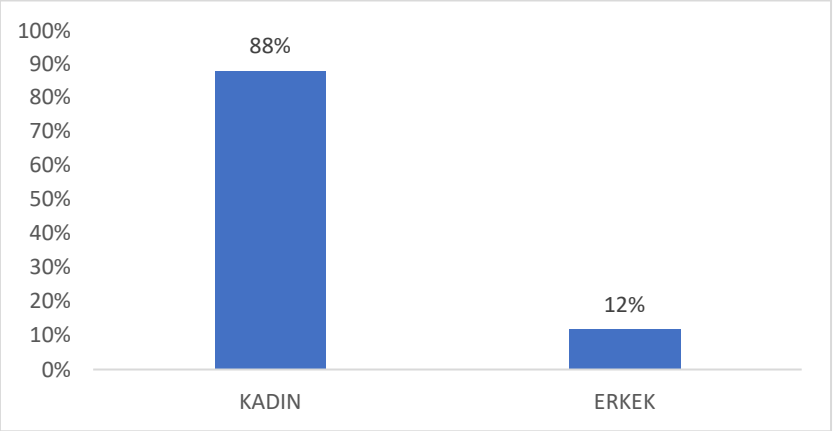
İsminde sosyal medya ve ebeveyn kelimeleri geçen lisansüstü tezler yönteme göre incelendiğinde nicel araştırma yöntemleri 19 frekans %76 oran, nitel araştırma yöntemleri 6 frekans %24 oran şeklinde dağılım göstermektedir.

Grafik 5: İncelenen Tezlerin Veri Toplama Yöntemine Göre Dağılımı



İsminde sosyal medya ve ebeveyn kelimeleri geçen lisansüstü tezler veri toplama yöntemine göre incelendiğinde anket 19 frekans %76 oran, doküman analizi 3 frekans %12 oran, görüşme 2 frekans %8 oran, içerik analizi 1 frekans %4 oran şeklinde dağılım göstermektedir.

Grafik 6: İncelenen Tezlerin Yazar Cinsiyetine Göre Dağılımı



İsminde sosyal medya ve ebeveyn kelimeleri geçen lisansüstü tezler yazar cinsiyetine göre incelendiğinde kasın yazarlar 22 frekans %88 oran erkek yazarlar 3 frekans %12 oran şeklinde dağılım göstermektedir.

SONUÇ

Günümüz koşullarının dijitalleşmesi ile sosyal medya uygulamalarının kullanımı artmış ve yaşantımızda büyük rol oynamaya başlamıştır. Her yaş grubundan insan bu uygulamaları kullanmakta ve günlük zamanının birçoğunu bu uygulamalara ayırmaktadır. Ebeveynlerde bu uygulamaları çok sık kullanmakta ve çocuklarına ait video ve görselleri bu uygulamalarda paylaşmaktadır. Ayrıca gebelik sürecinde olan kadınlarda bu uygulamaları kullanarak baby shower, cinsiyet partisi gibi aktiviteler düzenleyerek paylaşmaktadırlar. Bu araştırma isminde sosyal medya ve ebeveyn kelimeleri bulunan lisansüstü tezlerin doküman analizi yöntemiyle incelenerek ve içerik analizi yöntemi kullanılarak araştırmaların yapıldığı alanları belirlemek ve çalışılacak alanları tespit etme hedefiyle yapılmıştır. Araştırmaya dahil edilen tezler yıllara göre incelendiğinde sosyal medya ve ebeveyn kelimelerine yönelik ilk lisansüstü tezin 2018 yılında yazıldığı, en çok tezin ise 8 frekans %32 oran ile 2022 yılında yazıldığı görülmüştür. Bu durum ele alınan konunun güncel ve çalışılması gereken bir konu olduğunu düşündürmektedir. Ele alınan tezler üniversitelere göre incelendiğinde en çok Üsküdar Üniversitesi ve anabilim dalına göre incelendiğinde ise en çok psikoloji anabilim dalında yazıldığı görülmüştür. Tezler danışman ünvanına göre analiz edildiğinde en fazla 13 frekans %52 oran ile Dr. Öğr. Üyesi danışmanlık verdiği saptanmıştır. Yayınlanan tezlerin tez türü incelendiğinde örneklemi oluşturan 25 tezin tamamının yüksek lisans derecesinde olduğu görülmüştür. Sosyal medya ve ebeveyn konularına yönelik doktora seviyesinde araştırmalar yapılmasının alanyazına katkı sağlayacağı düşünülmektedir. Tezler yönteme göre incelendiğinde en çok nicel araştırma yöntemlerinin kullanıldığı ve veri toplama aracı olarak ise anket yönteminin kullanıldığı görülmüştür. Tezler yazar cinsiyetine göre incelendiğinde ise 22 frekans %88 oran ile kadın, 3 frekans %12 oran ile erkek yazarlar olduğu saptanmıştır.

Sosyal medya bünyesinde birçok bilgi bulunduran fakat yer alan bilgilerin doğruluğunun tespit edilemediği bir ortamdır. Bu ortamlardan elde edilen bilgiler kişilerin sağlık durumlarını tehlikeye atabildiği gibi ebeveynlere çocuk gelişimi konusunda yanıltıcı bilgiler vererek halk sağlığını da tehlikeye atmaktadır. Bu nedenle ebeveynler sosyal medyada yer alan tehlikelere karşı bilgilendirilmesine yönelik dijital medya okuryazarlığı eğitimleri düzenlenebilir. Sosyal medyayı

çocukları üzerinden ticari kazanç sağlamak için kullanan ebeveynlere yönelik politikalar geliştirilebilir. Alanyazın için yapılacak geniş kapsamlı çalışmalar sorunların tespit edilmesine olanak sağlayacak ve çözüm önerileri üretecektir.

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Stronger estimations of Csiszar f-divergences

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Abstract

In many problems in statistics, closeness/similarity between two probability distributions needs to be measured. To solve such problems, various statistical divergences are introduced as essential and general tool for comparison of two distributions. A statistical divergence D(p,q), as mapping of two probability distributions p and q to ***R****, satisfies conditions D(p,q)≥0 and D(p,q)=iff p=q. Two distributions p and q are very similar if D(p,q) is very close to zero. One important class of statistical divergence is defined by means of convex functions and is known as Csiszár f-divergence. In our work, we establish stronger estimations of Csiszar f-divergences between two distributions by using the class of strongly convex functions, a subclass of convex functions with stronger versions of analogous properties. As outcome we derive stronger estimates for some well known divergences as the Kullback-Leibler divergence, χ-divergence, Hellinger divergence, Bhattacharya distance and Jeffreys distance.*

Key words: *Strongly convex functions, Csizar f-divergences, Kullback-Leibler divergence, Hellinger divergence*

Sharper bounds on the expectation of a strongly convex function of a random variable

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Abstract

Jensen's inequality is the most important inequality for convex functions. In the context of probability theory, Jensen's inequality gives the lower bound on the expectation of a convex function of a random variable. On the other side, the upper bound is consequence of Converse Jensen's inequality, and is known as the Edmundson-Madansky inequality. In this work, using the class of strongly convex functions, which is subclass of convex functions with stronger versions of analogous properties, we get improvement and generalization of Jensen's inequality and its converse by means of the positive linear functionals acting on a space of real functions. As direct consequences we get sharper lower and upper bound on the expectation of a strongly convex function of a random variable.

Key words: *Strongly convex functions, Jensen inequality, Jessen inequality, Converse Jensen inequality, Edmundson-Madansky inequality*

Applıcatıon of Renewable Energy In Aromatherapy

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Abstract

Albania lies in the Western part of Balkan Peninsula. Its geographical position allows the application and wide use of renewable energy, since it has about 308 sunny days per year. At the same time, the Mediterranean climatic conditions enable the growth and development of many medicinal plants (cultivated and non-cultivated) like Lavender. For this reasons, combining the implementation of renewable energy (from sunlight) with aromatherapy treatment by Lavender plant was very challenging. The scope of this research is determination of the way of combination and application of renewable energy in aromatherapy. This therapy was used for distribution of medicinal plants aroma in environments with areas until 40m^2, also and for curing the respiratory tract and mental state of the people. The whole experimental system was set up in laboratory of company "Salvia Nord" Shpk, Koplik-Malesi e Madhe, Albania, which combined application of equipments with electrical energy, direct current, taken from Photovoltaic Solar Panel. The equipment (diffuser) served as a distributor of aroma, by using a ratio distilled water – oil distilled from Lavender plant, 80 ml ÷ 3 to 5 points of oil. The process of covering the space or volume with aroma is achieved in a time of 5-8 minutes.

Key words: *Lavender plant, Diffuser, Aromatherapy, "Salvia Nord" Shpk, Solarmont 5000L 2-3H2,*

The Time-Varying Beta Risk Of Agriculture, Forestry, Fishing And Hunting Sector: The Case Of Turkey

Merve PAKER[1*]

Abstract

In this study, Time-varying Linear Market Model (Tv-LMM) is used which is consistent with the Conditional Capital Asset Pricing Model (C-CAPM) and enables the beta risk as the benchmark model for the purposes of perform the modeling and estimating for the agriculture, forestry, fishing, and hunting sector investors in Turkey. For the modeling of Tv-LMM, GARCH, EGARCH, and GJR-GARCH that are univariate GARCH-type models are used. The prices of the daily of the period of last 10 years which 18.11.2011-18.11.2021 at BIST National All index (BIST) based on these prices are used as the research data. According to the findings, it was concluded that the GARCH-type model that best models time-varying beta risk differs according to companies. For this reason, the GARCH-type models that modeling beta risks used are not superior to each other, it has been concluded that the companies have opposed relationship with the market and if the risk measure is beta, which is an unavoidable risk, the riskiest investment in this portfolio is TACTR.

Keywords: *Beta Risk, Agriculture, Forestry, Fishing and Hunting, Univariate GARCH-type Models, Conditional Capital Asset Pricing Model (C-CAPM), Time-varying Linear Market Model (Tv-LMM)*

Introduction

The theory modeling the risk-return relationship between financial assets was first developed by Markowitz (1952). The modern portfolio theory (MPT) includes the variance-covariance model, which suggests that the risk will decrease with the diversification of financial assets in the portfolio. Based on this theory is the Capital Asset Pricing Model (CAPM), which is frequently preferred by investors due to its ease of implementation and flexibility of parameters put forward by Sharpe (1964), Lintner (1965) and Mossin (1966).

The CAPM includes the beta risk parameter and gives how the financial asset changes according to the market and whether the risk is high. The Linear Market Model (LMM), which is consistent with this model, summarizes beta risk with a stationary or fixed beta parameter. One of the most important assumptions of the model is the linearity between the variables in the model. It has been proven in many studies that this assumption cannot be met (Malliaropulos, 1997; Mark, 1988; Engel & Rodrigues, 1989; Tai, 2001). Therefore, The Conditional Capital Asset Pricing Model (C-CAPM) was in which the time-varying beta parameter is used instead of the stationary or fixed beta parameter created by Jagannathan and Wang (1996). That is, the Time-varying Linear Market model (Tv-LMM), which is consistent with this model, summarizes the beta risk with the dynamic or time-varying beta parameter. In the studies given in the literature, it has been observed that GARCH-type models are frequently preferred for the time-varying beta parameter (Brooks et al., 1998; Faff et al., 2000; Brooks et al., 2002; Mergner and Bulla, 2008; Altinsoy, 2009; Köseoğlu and Gökbulut, 2011; Neslihanoglu, 2014; Aksoy, 2020; Paker, 2021; Agarwal and Mangla, 2014; Nugraha and Susanti, 2019; Benbob, Chikhi and Bennaceur, 2017; Varga and Rappai, 2002; Hall, Miles and Taylor, 1988; Canegrati, 2008; Choudhry and Wu, 2008). In addition, these studies were carried out for different sectors Aksoy, 2020; Paker, 2021; Agarwal and Mangla, 2014; Nugraha and Susanti, 2019; Benbob, Chikhi and Bennaceur, 2017; Varga and Rappai, 2002; Hall, Miles and Taylor, 1988; Canegrati, 2008; Choudhry and Wu, 2008).

In this paper, the first to address the systematic risk or also known as beta risk of the agriculture, forestry, fishing, and hunting industry. The beta risk or systematic risk measurement of the quarrying and mining sector in Turkey, which is missing in the literature, is discussed. For this purpose, a portfolio was created by taking the daily frequency data of all quarrying and mining companies in the BIST National All index covering the period 18.11.2011-18.11.2021. The Conditional Capital Asset Pricing Model (C-CAPM), which allows time-varying beta parameter, was used as the basic model. The time-varying beta parameter is modeled with GARCH, EGARCH, and GJR-GARCH that are univariate GARCH-type models. Additionally, features and effects on these models are described. First of all, it is aimed to guide the investors who want to invest in this sector and to summarize the different features and effects of the models at the date of research in this sector. in addition, the garch models, which are the volatility models that have become more famous in recent years, and the beta risk, which is systematic risk, have been examined for this sector, which has not been investigated before, researchers have been provided with an idea, and contribute to the literature.

2. Materials and Methods

2.1. Financial Models

2.1.1. Capital Asset Pricing Model (CAPM)

In the finance literature, CAPM or Two-Moment CAPM is the most generally prefered model to investigate the systematic risk measure beta risk, in other words, systematic covariance risk or systematic beta, put forward by Sharpe (1964), Lintner (1965) and Mossin (1966). This model is defined as equation (3). The Linear Market Model (LMM) is consistent with CAPM and is the data generation process of CAPM, is defined as equation (1). This model is based on the MPT developed by Markowitz (1952). LMM is the model that allows stable beta risk (β_{im}). It is based on the assumption that the asset returns are normally distributed and the investor's utility function is of second order, that is, the utility can only be expressed with the mean and variance measures (Neslihanoğlu, 2014). That is why it is called a two-moment model. In the model, the mean criterion expresses the expected return, and the variance criterion expresses the risk.

$$R_{it} - R_{ft} = a_i + \beta_{im}(R_{mt} - R_{ft}) + \varepsilon_{it} \qquad i = 1, \dots, n, \quad t = 1, \dots, T \qquad (1)$$

The slope of the model (β_{im}) is the beta coefficient that is defined as the beta risk of the financial asset i.. R_{it} is return on financial asset i. at time t.. R_{ft} is risk-free rate return at time t. and R_{mt} is the return on portfolio at time t.. Here, $R_{mt} - R_{ft}$ *is* excess return on portfolio (R_{mt}) relative to the risk-free return over time t. and $R_{it} - R_{ft}$ *is* excess return on financial asset i. (R_{it}) relative to the risk-free return over time t.. The a_i coefficient is becomes zero when the market is active, the prices in the period of interest are not affected by past prices, and the price change is assumed to be random (random walk theory). In this case, the error terms (ε_{it}) are independent, with constant variance and same distribution, and the coefficient of a_i is assumed to be zero according to the Sharpe-Lintner-Mossin version of CAPM. In this case ε_{it}, financial asset i. are the residuals of $i \neq k$ for $\varepsilon_{it} \sim N(0, \sigma^2_i)$ and $j > 0$ for $E(\varepsilon_{it}\varepsilon_{i\,t+j}) = 0$ in time of t..

Estimation of β_{im} is, under the assumption $\varepsilon_{it} \sim N(0, \sigma^2)$, defined in equation (2).

$$\beta_{im} = \frac{\sum_{t=1}^{T}[(R^*_{it} - \bar{R}^*_i)(R^*_{mt} - \bar{R}^*_m)]}{\sum_{t=1}^{T}[(R^*_{mt} - \bar{R}^*_m)^2]} = \frac{Cov(R_i, R_m)}{Var(R_m)} \qquad (2)$$

$$R^*_{mt} = R_{mt} - R_{ft}, \qquad R^*_{it} = R_{it} - R_{ft}, \qquad \bar{R}^*_i = \frac{1}{T}\sum_{t=1}^{T} R^*_{it}, \qquad \bar{R}^*_m = \frac{1}{T}\sum_{t=1}^{T} R^*_{mt}$$

Here, R^*_{it} is the excess return on financial asset i. at time t., R^*_{mt} is the excess return on portfolio at time t., $\bar{R}_i$ is the average excess return on financial asset i. on the total time., $\bar{R}_m$ is average excess return on portfolio on the total time. $Cov(R_i,\ R_m)$ is the covariance between the return on financial asset i. and on portfolio, $Var(R_m)$ is variance on the portfolio.
CAPM is defined in equation (3).

$$E(R_i) - R_f = \quad \beta_{im}[E(R_m) - R_f] \qquad i = 1, \ldots, n \tag{3}$$

Here, R_i, R_m, R_f are return on financial asset i., portfolio and risk-free rate, recpectively. $E(R_i)$ and $E(R_m)$ are expective return on financial asset i. and portfolio, respectively. $E(R_i) - R_f$ is expected excess return on financial asset i. relative to the risk-free return. $E(R_m) - R_f$ is expected excess return on portfolio relative to the risk-free return. β_{im} is investment risk and market risk of financial asset i..

2.1.2. Conditional Capital Asset Pricing Model (C- CAPM)

While including the constant or stable beta risk parameter (β_{im}) into the model that the CAPM, including the time-varying or dynamic beta risk parameter (β_{imt}) into the model that the Conditional Capital Asset Pricing Model (C-CAPM) (Paker, 2021). The Time-varying Linear Market Model (Tv-LMM) is is consistent with C-CAPM and allows time-varying beta risk (β_{imt}).

Tv-LMM is defined in equation (4).

$$R_{it} - R_{ft} = a_i + \beta_{imt}(R_{mt} - R_{ft}) + \varepsilon_{it}, \qquad i = 1, \ldots, n, \quad t = 1, \ldots, T \tag{4}$$

In this model, beta risk (β_{imt}) is calculated based on time. β_{imt} is beta risk of financial asset i.. at time t. and defined in equation (3.6). C-CAPM is defined in equation (5).

$$E(R_{it}) - R_{ft} = \quad \beta_{imt}[E(R_{mt}) - R_{ft}] \qquad i = 1, \ldots, n, \quad t = 1, \ldots, T \tag{5}$$

$$\beta_{imt} = \frac{Cov(R_{it}, R_{mt})}{Var(R_{mt})} \tag{6}$$

Here, $Cov(R_{it}\ ,\ R_{mt})$ is the covariance among the return on financial asset i. and on portfolio at time t., $Var(R_{mt})$ is variance on the portfolio at time t. So, the variance in this model should be calculated as time varying. Where, autoregressive conditional variance is used for the time-varying variance.

2.2. Statistical Models

2.2.1. Autoregressive Conditional Variance (ARCH)

The first of these models is ARCH model, which includes the dynamic feature and changing variance of a single financial asset created by Engle (1982). In its most general form, ARCH (p) model is defined in equation (7).

$$\boldsymbol{\sigma_t^2 = \quad w + \sum_{i=1}^{p} \psi_i Y_{t-i}^2\ , \qquad t = \min(p) + 1, \ldots, n} \tag{7}$$

Here, σ_t^2 gives the conditional variance, ω constant term, Y_{t-i}^2 gives the square of the errors of the model, and ψ_i gives the coefficients of the errors. For the stationarity constraint, the condition $\sum_{i=1}^{p} \psi_i < 1$ must be met.

2.2.2. Generalized Autoregressive Conditional Variance (GARCH)

GARCH model which was created in the future was created by Bollerslev (1986) as an extending of the ARCH model duration to express more complex volatility, volatility and structure, by transforming the autoregressive conditional variable variance model into an autoregressive moving average model. In the GARCH model, as in the ARCH model, the conditional variance in the t period is not only modeled on the square of the past values of the error terms, but also on the conditional variances in the past. GARCH (p, q) model is defined in equation (8).

$$\sigma_t^2 = w + \sum_{i=1}^{p} \psi_i Y_{t-i}^2 + \sum_{j=1}^{q} \theta_j \sigma_{t-j}^2 \quad , \quad \mathrm{t} = \min(\mathrm{p}, \mathrm{q}) + 1, \dots, \mathrm{n} \tag{8}$$

Here, $\omega > 0$, $\psi_i \geq 0$ and $\theta_j \geq 0$ constraints were defined by Nelson and Cao (1992) so that the conditional variance model parameters are positive at every t. Another constraint in the model is the constraint of stationarity of covariance. For this, the condition $\sum_{i=1}^{p} \psi_i + \sum_{j=1}^{q} \theta_j < 1$ must be met (Aksoy, 2020). The coefficient sums in the GARCH model give the persistence of volatility in the face of a shock/news. If the sum is equal to 1, the GARCH model transforms into IGARCH (the integrated generalized autoregressive conditional variance) model.
Owing to the features of financial time series like extreme kurtosis, volatility clustering, leverage effect, studies on GARCH-type models have been carried out and developed in the past and today.

2.2.3. Exponential Generalized Autoregressive Conditional Variance (EGARCH)

One of these models is EGARCH model created by Nelson (1991), which models the leverage effect logarithmically. Volatility is modeled based on both the magnitude and sign of the lagged error terms. In other words, EGARCH model parameters estimation is a model that does not require positive parameter estimates of the GARCH model and performs volatility modeling regardless of the sign. The GARCH model cannot differentiate between positive and negative shocks/news affecting volatility; however, considering the leverage effect, it can be said that there are situations where volatility does not give the same response to shocks and may react asymmetrically (Aksoy, 2020). EGARCH (p, q) model is defined in equation (9).

$$\ln(\sigma_t^2) = \omega + \sum_{i=1}^{q} \psi_i \frac{|Y_{t-i}|}{\sqrt{\sigma_{t-i}^2}} + \sum_{i=1}^{q} \zeta_i \frac{Y_{t-i}}{\sqrt{\sigma_{t-i}^2}} + \sum_{j=1}^{p} \theta_j \ln(\sigma^2)_{t-j} \tag{9}$$

In this model, the standardized version of the $\frac{Y^{t-i}}{\sqrt{\sigma_{t-i}^2}}$ expression is used instead of the Y_{t-i}^2 expression used in the GARCH model. Therefore, standardization ensures that the permanence and dimensions of shocks/news are clearly revealed.

2.2.4. Glosten-Jagannathan-Runkle GARCH (GJR-GARCH)

One of these models is GJR-GARCH model created by Glosten-Jagannathan-Runkle (1993), which models the leverage effect. The leverage effect here was defined by Black (1976) and it is defined as the asymmetric reaction of volatility to positive and negative shocks in series. GJR-GARCH (p, q) model is defined in equation (10).

$$\sigma_t^2 = w + \sum_{i=1}^{p} (\psi_i Y_{t-i}^2 - \zeta_i I_{t-i} Y_{t-i}^2) + \sum_{j=1}^{q} \theta_j \sigma_{t-j}^2 \tag{10}$$

Here, ζi is the leverage term that t. value 1 if the value is negative or zero while t. value 0 if the value is positive an indicator variable $It{-}i$ is defined.

3. Results

The research data of this paper covers the dates of 18 November 2011 to 18 November 2021. In this date range, a portfolio was created by taking daily frequency data of the agriculture, forestry, fishing and hunting companies in the BIST National All index. The 3-month Turkish Lira Reference Interest Rate (TRLIBOR) is preferred used and risk-free rate data from http://www.trlibor.org/veriler.aspx.
The abbreviations of the research data are given in Table 1 and Figure 1 gives the time series plots of close price of the companies on the XUTUM.

Table 1. Names and Codes of the Country's Stocks Exchange and Agriculture, Forestry, Fishing & Hunting Companies

Codes	Explain of Codes
XUTUM	BIST National All
IZTAR	Iz Livestock, Agriculture and Food Industry Trade Inc.
TACTR	Tac Agricultural Products, Livestock, Food Industry and Trade Inc.
YAPRK	Yaprak Milk and Livestock Farms Industry and Trade Inc.

The daily returns for the companies in the BIST National All index and the BIST National All market portfolio were obtained by the first difference of the logarithm of closing price of Turkish lira.

$$R_{it} = \log(P_{it}) - \log(P_{it-1}) \tag{11}$$

The three-month Turkish Interbank Offered Rate (TRLIBOR) interest rate served in percentage per annum ($TRLIBOR_t$), they can be converted to a daily rate of return as follows (Neslihanoğlu, 2014).

$$R_{ft} = (1 + \frac{TRLIBOR_t}{100})^{\frac{1}{252}} - 1 \tag{12}$$

Table 2. Descriptives Statistics of Daily Return

	Mean	Std. Dev.	Skewness	Kurtosis	SW	LB	LM
XUTUM	0,000204	0,005785	-0,82613	5,105722	0.94955* ($p < 0.05$)	0.052459 ($p > 0.05$)	1.3736 (p=0.2412)
IZTAR	0,000522	0,02106	0,089893	6,102272	0.8948* ($p < 0.05$)	16.758* ($p < 0.05$)	437.59* ($p < 0.05$)
TACTR	0,000386	0,020205	0,02584	4,858317	0.88422* ($p < 0.05$)	78.856* ($p < 0.05$)	632.06* ($p < 0.05$)
YAPRK	0,000695	0,016069	0,314333	4,024181	0.89798* ($p < 0.05$)	50.711* ($p < 0.05$)	445.94* ($p < 0.05$)
TRLIBOR	0,000495	0,000172	1,094714	0,100348	0.85848* ($p < 0.05$)	2000.8* ($p < 0.05$)	1996.4* ($p < 0.05$)

[1] Notes: Shapiro-Wilk (SW) statistic shows that the Shapiro-Wilk test of normality statistics; where the null hypothesis (H_0) is defined as there is no difference between the distribution of the series and the normal distribution. Ljung-Box (LB) statistic shows that the Ljung-Box (LB) test of autocorrelation statistics; where the null hypothesis (H_0) is defined as there is no autocorrelation in the series. ARCH-LM (LM) statistic shows that the ARCH-LM test of ARCH effects statistics; where the null hypothesis (H_0) is defined as there is no ARCH effects in the series. '*' means that null hypothesis (H_0) is rejected at 95% confidence level.

Table 2 gives descriptive statistics for the daily returns on the XUTUM market portfolio and the 3 global markets of agriculture, forestry, fishing and hunting in the XUTUM. And this portfolio has 2007 observations. This table that the mean return on the daily XUTUM is 0.000204, with a standard deviation of about 0.0005785. A positive XUTUM average indicates that investors who will invest in XUTUM during the research period will make a profit financially. The range of mean from 0.0002 for XUTUM to 0.000695 for YPRK, meaning that YPRK generated greater financial profit on investment than XUTUM on this period. The mean return on 3 out of 2 the companies is more than the mean risk-free rate (TRLIBOR), which stand for the minimum return an investor theoretically expects for any investment, recomming that investors would prefer to invest in these sector on this period. The highest standard deviation is that for IZTAR (0.02106), while the lowest one is that of XUTUM (0.005785). For this reason, when the standart deviation is accepted as a risk measure, it can be said that the riskiest company is the IZTAR. The return distributions of all 3 company and risk-free rate (TRLIBOR), except for XUTUM, show positive skewness that there are frequent small drops and a few excessive increases in returns, while negative skewness means that there are frequent small increases and a few excessive drops in returns. The range of skewness between -0.82613 (XUTUM) and 1.094714 (TRLIBOR). This shows that investment experiences increases and a few excessive drops in terms of investment, while XUTUM reports frequent small drops and a few excessive increases returns. The return distributions of all the companies and XUTUM are leptokurtic, meaning that the market has fatter tails than the normal distribution (which has kurtosis ≥ 3) and more chance of excessive outcomes. The range of kurtosis between 6.102272 (IZTAR) and 0.100348 (TRLIBOR). This shows that IZTAR has more chance of excessive financial losses or profits than the other investments. The normality of each investment, XUTUM and risk-free rate (TRLIBOR) is also rejected at the 5% significance level using the Shapiro-Wilk (SW) test which is probable to be owing to skewness and kurtosis observed in Table 2. To test the autocorrelation for the squared returns (proxies for volatilities) of the investment, the XUTUM and the risk-free rate, the Ljung-Box (LB) test is used in this study. According to the LjungBox (LB) test, the null hypothesis of no autocorrelation for the squared returns is rejected at the 5% significance level for all companies and the XUTUM, and the risk-free rate meaning that there have a statistically significant autocorrelation for the squared returns. The ARCH effect of each investment is also rejected at the 5% significance level using the ARCH-LM (LM) test. This result show that all companies can modeling of GARCH-type models. As results supply mightly evidence for the estimability of the volatility for the companies, the XUTUM and the risk-free rate (Christoffersen, 2003). Achieved results provide effects such as the principal features of these data are the asymmetry (left-skew and right-skew), positive mean, relatively high volatility, and leptokurtosis (fat tails) over the performance of all models while estimating the time-varying volatility. And these features match the most common features of market studies (Harvey, 1995).

Figure 1 shows the time series graphs of returns on the XUTUM and all these companies, respectively. When the graphs here are examined, it is observed that the trends in the companies and the movements of the companies over time are consistent with the comments given in Table 2. the date 2020 was defined as the COVID-19 global epidemic by the WHO was March 11, 2020, the date of the 59th presidential election in the USA was December 12, 2020, the economic crisis observed in the Turkish economy in 2018, and the effects on the markets consequently of the global economic crisis experienced in 2008-2012 effect, that is extreme fluctuations, was clearly observed.

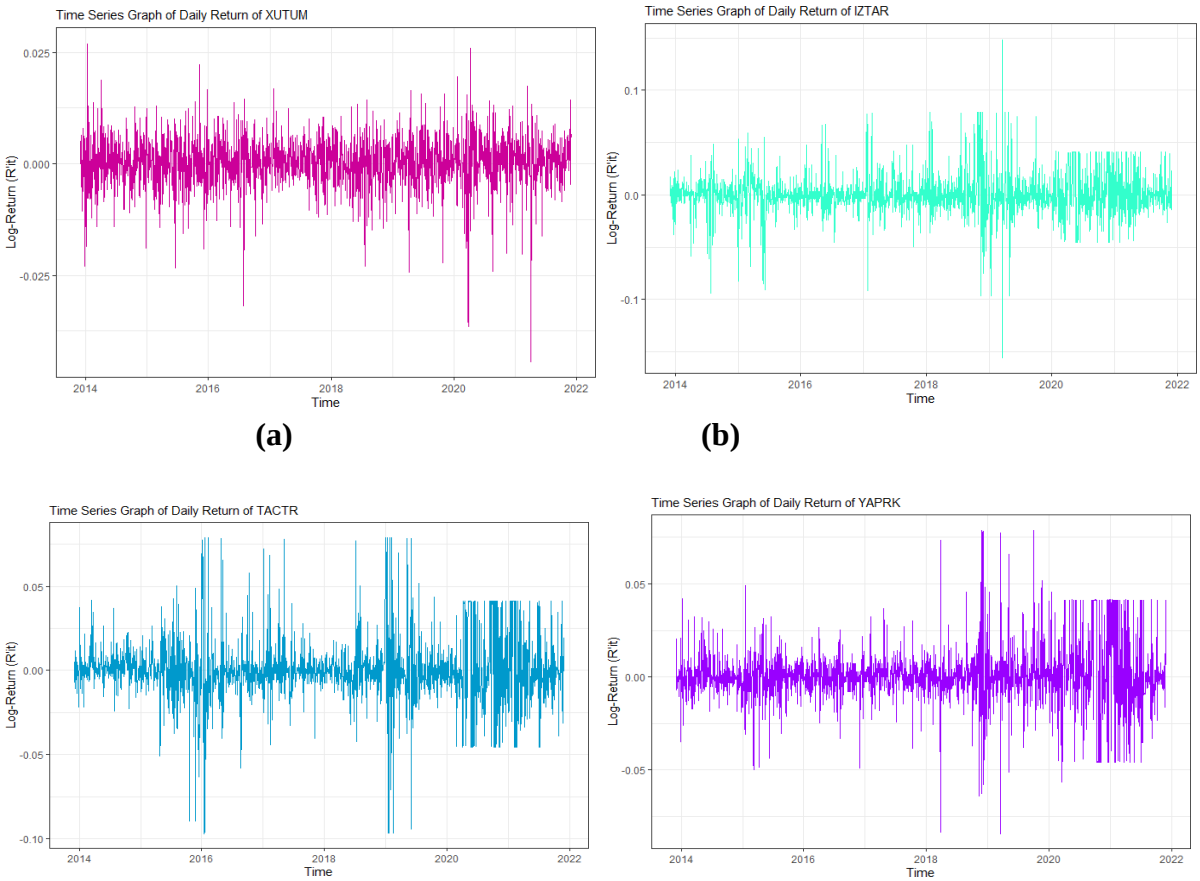


Figure 1. Time Series Plots of Returns: (a) XUTUM; (b) IZTAR; (c) TACTR; (d) YPRK

Table 3 shows parameter estimates of the GARCH-type models. The constant term of parameter ω, the $\psi 1$ parameter the effect of shocks/new news on the market on volatility, that is, the short-term conditional variance (ARCH term), the $\theta 1$ parameter represents the effect of the volatility of the previous period on the volatility of the next period, that is, the long-term conditional variance (GARCH term), the $\zeta 1$ parameter indicates the effect of leverage on volatility, the δ parameter shows the power parameter, that is, the dependence of volatility on that period in the conditional variance equations of GARCH-type models. The constant term (ω) of the models is statistically significant at the 95% confidence level, except TACTR for EGARCH model, and the conditions of the models belonging to each company are met. If the model coefficients are to be examined in more detail, the ARCH effect parameter $\psi 1$, which expresses the past shocks, is 0.23 in IZTAR, while the GARCH effect parameter $\theta 1$, which expresses the effect of the shocks in the previous period from the current period on the volatility of the next period, is 0.62 in IZTAR. This indicates that approximately 23% of the IZTAR company's return consists of shocks from the past period, and approximately 62% from the shocks of the immediately previous period. Thus, it can be said that the volatility of IZTAR company is heavily affected by the shocks of the previous period. ARCH effect parameter $\psi 1$ is 0.47 in TACTR, while the GARCH effect parameter $\theta 1$ is 0.47 in TACTR. This indicates that approximately 47% of the TACTR company's return consists of shocks from the past period, and approximately 47% from the shocks of the immediately previous period. Thus, it can be said that the volatility of TACTR company is affected by the shocks both of the previous and the past period. And ARCH effect parameter $\psi 1$ is approximately 0.27 in YAPRK, while the GARCH effect parameter $\theta 1$ is 0.58 in YAPRK. This indicates that approximately 27% of the YAPRK company's return consists of shocks from the past period, and approximately 58% from the shocks of the immediate previous period. Thus, it can be said that the volatility of YAPRK company is heavily affected by the shocks of the previous period. According to these result, it is concluted that volatilitiy of all the companies are heavily affected by the shocks of the

previous period. The $\zeta 1$ parameter in the EGARCH and GJR-GARCH models is positive, except IZTAR and YPRK for GJR-GARCH model. This parameter is positive shows that negative shocks affect volatility more than positive shocks. According to this result, this companies has a leverage effect of this period.

Table 3. Model Parameters

Models	Parameters	The Agriculture, Forestry, Fishing & Hunting Companies		
		IZTAR	TACTR	YAPRK
GARCH	ω	0.000061*	0.000045*	0.000035*
	p-value	0.0009	*0.0000*	*0.0000*
	ψ_1	0.232463*	0.471208*	0.269644*
	p-value	*0.0000*	*0.0000*	*0.0000*
	θ_1	0.621131*	0.467268*	0.585180*
	p-value	*0.0000*	*0.0000*	*0.0000*
	AIC	**-5.1953***	-5.5164	-5.7919
	BIC	**-5.1841***	**-5.5052***	**-5.7807***
	LogL	5212.31	**5534.21***	5810.383
EGARCH	ω	-1.108204*	-1.417009	-1.551319*
	p-value	*0.0000*	*0.0000*	*0.0000*
	ψ_1	0.033387	-0.027927	0.050981*
	p-value	*0.06414*	*0.2376*	*0.0118*
	θ_1	0.856583*	0.821755	0.813610*
	p-value	*0.0000*	*0.0000*	*0.0000*
	ζ_1	0.349710*	0.613155	0.416237*
	p-value	*0.0000*	*0.0000*	*0.0000*
	AIC	-5.1837	**-5.5190***	-5.7803
	BIC	-5.1697	-5.5050	-5.7663
	LogL	**5201.64***	5537.815	**5799.744***
GJR-GARCH	ω	0.000058*	0.000044*	0.000035*
	p-value	0.0039	*0.0000*	*0.0000*
	ψ_1	0.234447*	0.419151*	0.294537*
	p-value	*0.0000*	*0.0000*	*0.0000*
	θ_1	0.636548*	0.472146*	0.592353*
	p-value	*0.0000*	*0.0000*	*0.0000*
	ζ_1	-0.023356	0.108417	-0.066676
	p-value	*0.5389*	*0.1137*	*0.1312*
	AIC	-5.1945	-5.5167	**-5.7920***
	BIC	-5.1805	-5.5027	-5.7781
	LogL	5212.48	5535.486	5811.517

[2] Note: Parameters marked with '*' indicate parameters that are significant at the 95% confidence level. Both '*' and **bold** shows the best model for each companies with regard to lowest information criteria.

Table 4 gives descriptive statistics of time-varying beta risks of agriculture, forestry, fishing and hunting companies. When the beta parameter is accepted as a risk measure, it can be said that the model with the highest volatility belongs to the TACTR company, which varies in the range of [0.007; 0.130]. It can be said that investments with beta risk less than 1 that have lower risk than XUTUM investment while investments with beta risk more than that have higher risk than XUTUM investment. The negative

beta risks indicate that the companies are in the opposed direction with the market. The average beta risk of less than 1 indicates that companies are less sensitive to the market while the average beta risk of greater than 1 indicates that companies are highly sensitive to the market. Thus, it is concluded that the sensitivity of the sector to the market is low.

Table 4. Descriptive Statistics of Time-varying Beta Risk

Companies	Models	Time-varying Beta Risk of the Agriculture, Forestry, Fishing & Hunting Companies						
		Min.	Max.	Median	Mean	Std. Dev.	Skewness	Kurtosis
IZTAR	β^{GARCH}	-0.024	-0.002	-0.016	-0.016	0.004	0.661	3.200
	β^{EGARCH}	-0.035	-0.002	-0.016	-0.017	0.005	-0.174	2.650
	$\beta^{GJR-GARCH}$	-0.023	-0.001	-0.017	-0.016	0.004	0.818	3.046
TACTR	β^{GARCH}	0.008	0.088	0.061	0.059	0.014	-0.661	3.200
	β^{EGARCH}	0.007	0.130	0.062	0.063	0.021	0.174	2.650
	$\beta^{GJR-GARCH}$	0.004	0.087	0.066	0.062	0.018	-0.818	3.046
YAPRK	β^{GARCH}	-0.029	-0.002	-0.020	-0.019	0.004	0.661	3.200
	β^{EGARCH}	-0.043	-0.002	-0.020	-0.020	0.006	-0.174	2.650
	$\beta^{GJR-GARCH}$	-0.029	-0.001	-0.021	-0.020	0.005	0.818	3.046

Table 3,5 and 6 shows values of information criteria of models of agriculture, forestry, fishing and hunting companies. This information criterias that Akaike's information criterion (AIC), Bayesian information criterion (BIC), Log-Likelihood (LogL), Mean Absolute Error (MAE) and Mean Squared Error (MSE) as follows:

$$AIC = -2\log L + 2k \tag{13}$$

$$BIC = -2\log L + k\log(N) \tag{14}$$

$$MAE = \frac{1}{N}\sum_{i=1}^{N}\left|\hat{Y}_i - Y_i\right| \tag{15}$$

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(\hat{Y}_i - Y_i)^2 \tag{16}$$

Here, L, N and k are the values of likelihood function evaluated at the parameter estimates, observations (N=2509), and estimated parameters, respectively [10, 18].
According to the values given in Table 3,5 and 6, the best modeling is EGARCH for IZTAR, GARCH for TACTR and GJR-GARCH for YAPRK. So, it was concluded that the GARCH-type model that best models time-varying beta risk differs according to companies.

Table 5. Estimation performance with MAE criteria of Time-varying Beta Risk with GARCH-type models

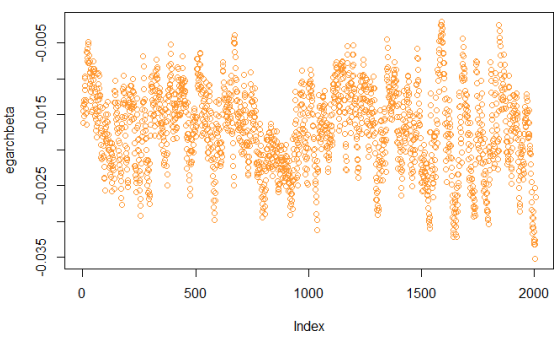
MAE ($x10^2$) criteria to determine the estimation performance of the model's comparisons			
	Models		
Companies	GARCH	EGARCH	GJR-GARCH
IZTAR	0.04774	0.04751*	0.04768
TACTR	0.03816*	0.03950	0.03847
YAPRK	0.02686	0.02718	0.02671*
[3]Note: '*' means that the model with the smallest value fits the data better.			

Table 6. Estimation performance with MSE criteria of Time-varying Beta Risk with GARCH-type models

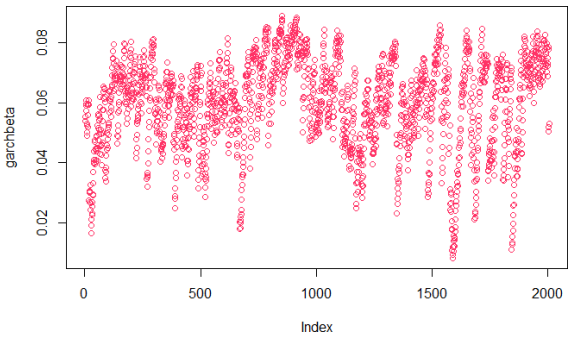
MSE ($x10^4$) criteria to determine the estimation performance of the model's comparisons

Companies	Models		
	GARCH	EGARCH	GJR-GARCH
IZTAR	0.01298	0.01232*	0.01292
TACTR	0.00767*	0.00816	0.00781
YAPRK	0.00311	0.00314	0.00310*
[4]Note: '*' means that the model with the smallest value fits the data better.			

Figure 2 shows the time series graphs of time-varying beta risks of the model that best models of these companies.



(a)



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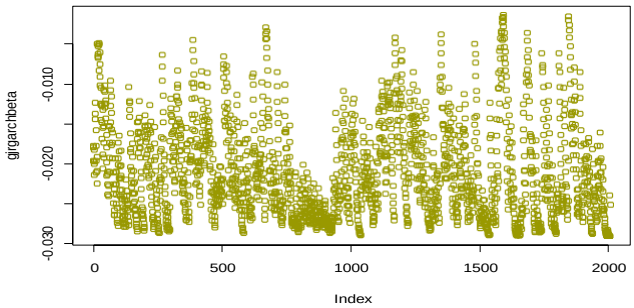


(c)

Figure 2. Time Series Plots of Beta Risk: (a) IZTAR; (b) TACTR; (c) YPRK

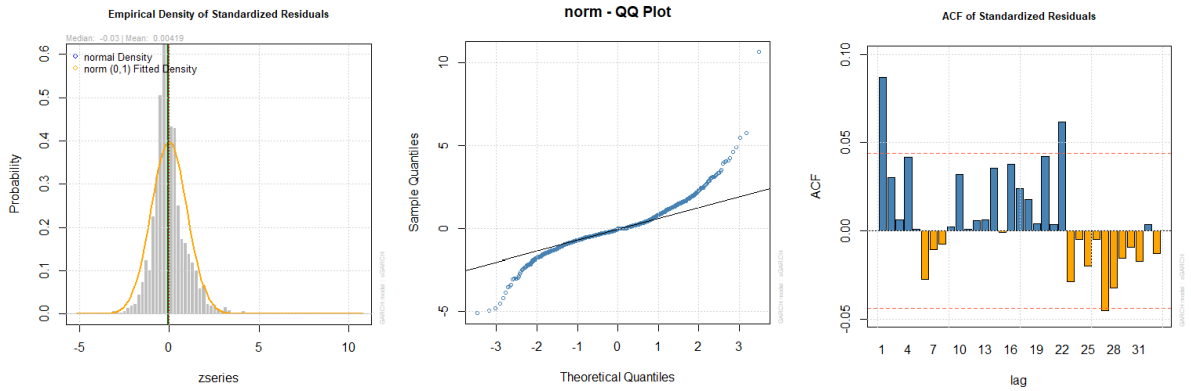
Table 7 and Figure 3, 4, 5 shows residuals test of GARCH-type models of the companies. The test normality and autocorrelation of each investment's residuals is also rejected at the 5% significance level using the Jarque-Bera (JB) and Ljung-Box (LB) test, while the test heteroscedasticity of each investment's residuals is also rejected at the 5% significance level using the Heteroscedasticity (Het) test. According to these test, residual series aren't normally distributed, there is an autocorrelation problem between the residuals, but there is no problem of heteroscedasticity. Result of these test that residual series are insufficient in normality and autocorrelation, but sufficient in heteroscedasticity.

Table 7. Residuals Test of GARCH-type Models

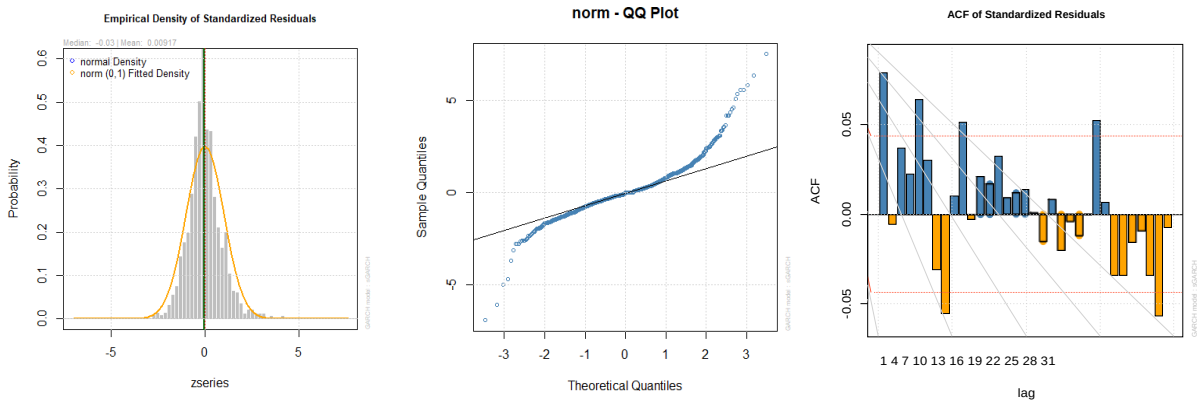
Models	Residuals Tests	The Agriculture, Forestry, Fishing & Hunting Companies		
		IZTAR	TACTR	YAPRK
GARCH	JB	1167974*	96461*	111778*
	p-value	0.000	0.000	< 0.000
	LB (45)	1240.9*	3771.8*	2705.3*

	p-value	0.000	0.000	< 0.000
	Het (669)	552.4	717.33	632.95
	p-value	0.999	0.095	0.838
EGARCH	JB	1173815*	92352*	111690*
	p-value	< 0.000	< 0.000	< 0.000
	LB (45)	1239.4*	3767.6*	2705.8*
	p-value	< 0.000	< 0.000	< 0.000
	Het (669)	550.38	720.27	633.11
	p-value	0.999	0.083	0.837
GJR-GARCH	JB	1170527*	95369*	112105*
	p-value	< 0.000	< 0.000	< 0.000
	LB (45)	1240.3*	3771*	2703.4*
	p-value	< 0.000	< 0.000	< 0.000
	Het (669)	551.52	718.12	632.31
	p-value	0.999	0.092	0.842

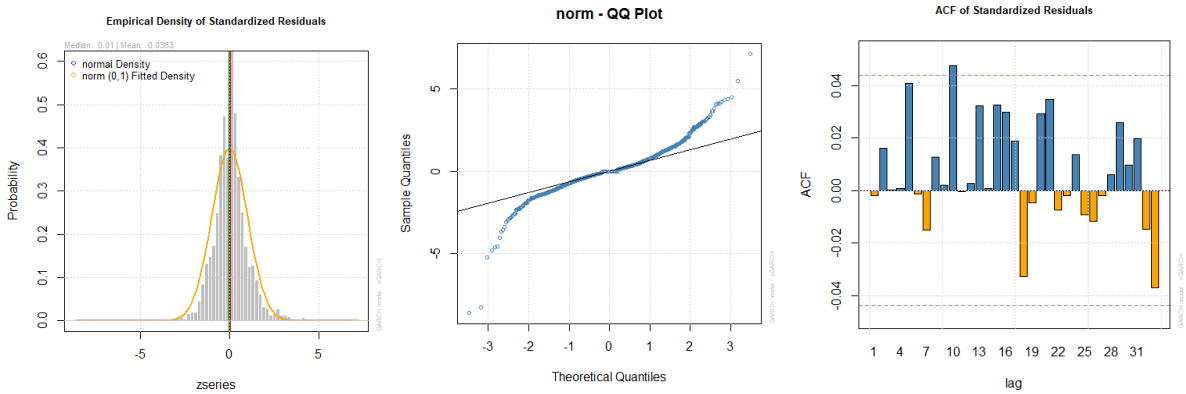
[5]Notes: Jarque-Bera (JB) statistic shows that the Jarque-Bera test of normality statistics; where the null hypothesis (H0) is defined as there is no differentiation among the distribution of the residuals series and the normal distribution. Ljung-Box (LB) statistic shows that the Ljung-Box (LB) test of autocorrelation statistics; where the null hypothesis (H_0) is defined as there is no autocorrelation in the residuals series. Heteroscedasticity (Het) statistic shows that the Heteroscedasticity test of heteroscedastic statistics; where the null hypothesis (H_0) is defined as there is the residuals are homoscedastic. '*' means that null hypothesis (H_0) is rejected at 95% confidence level.



(a) **(b)** **(c)**

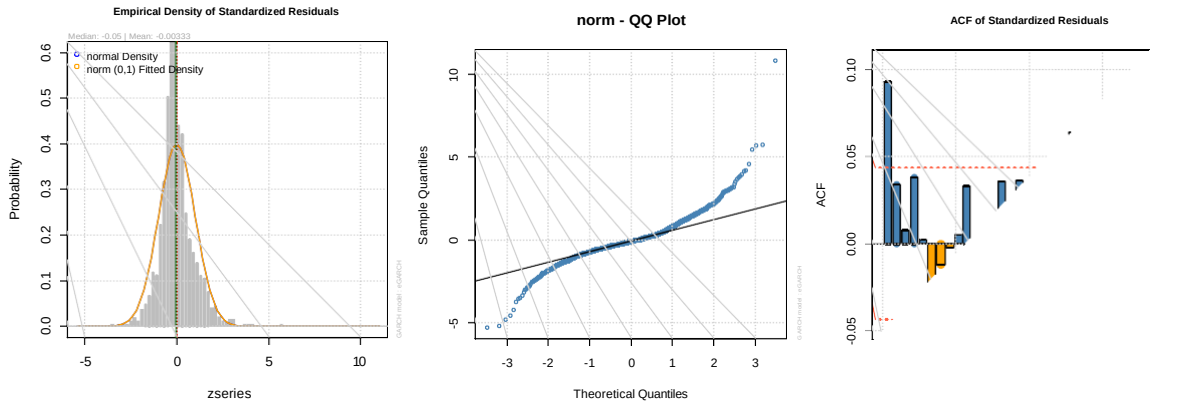


(d) **(e)** **(f)**

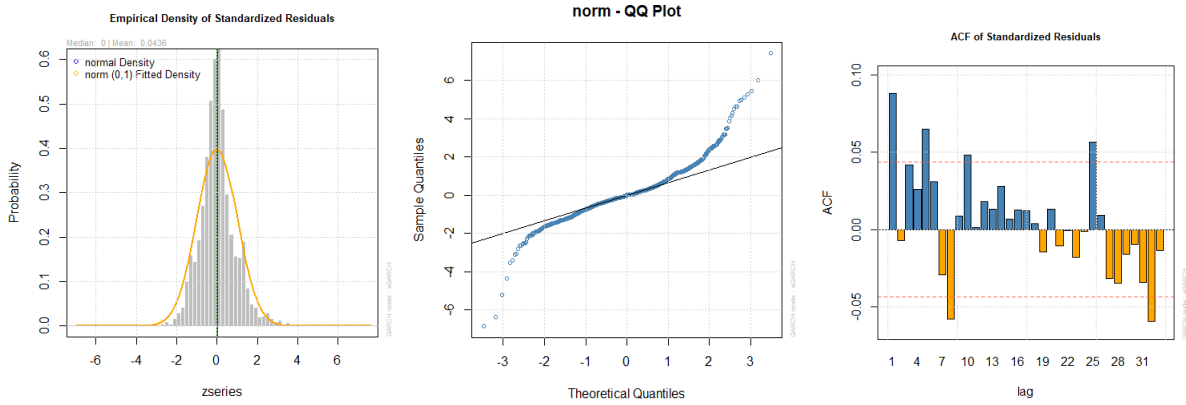


(g) **(h)** **(ı)**

Figure 3. Plots of Residuals of GARCH model: (a) Standartized Residuals of IZTAR; (b) QQ Plot of IZTAR; (c) ACF of IZTAR; (d) Standartized Residuals of TACTR; (e) QQ Plot of TACTR; (f) ACF of TACTR; (g) Standartized Residuals of YPRK; (h) QQ Plot of YPRK; (ı) ACF of YPRK



(a) **(b)** **(c)**



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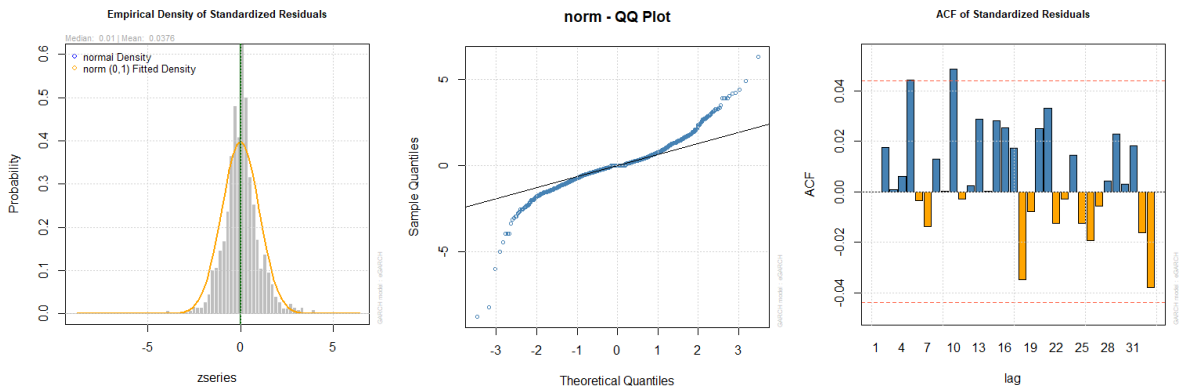
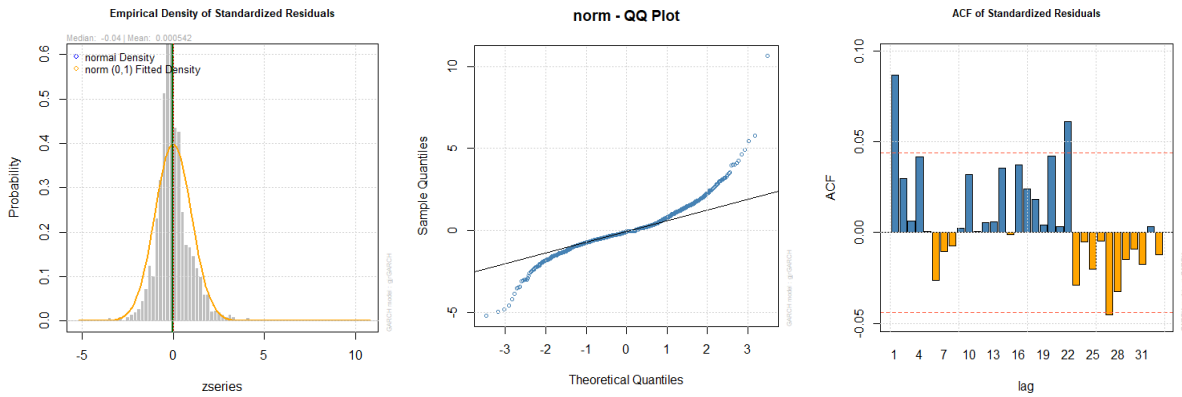
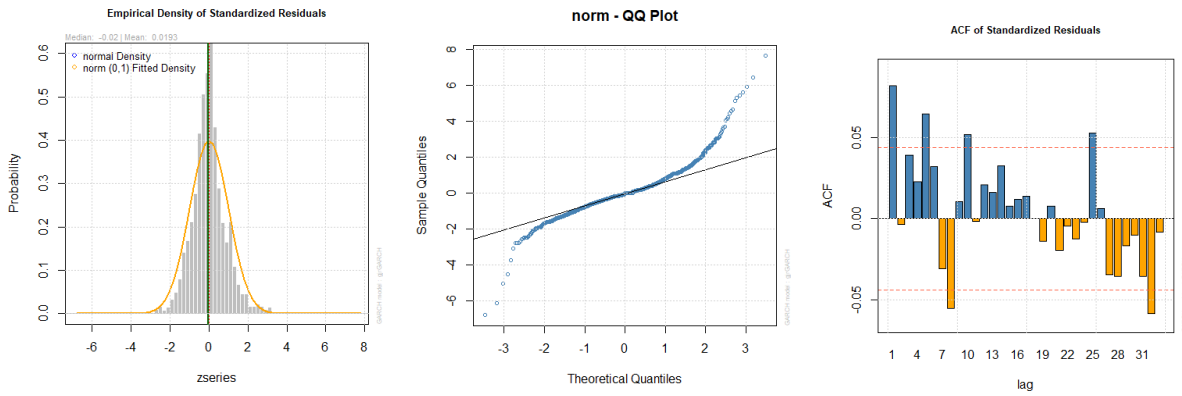


(g) **(h)** **(ı)**

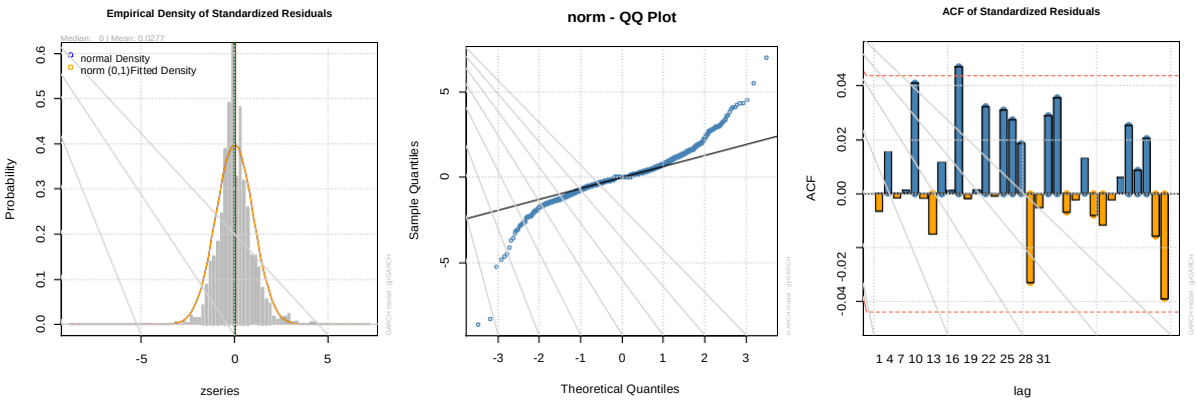
Figure 4. Plots of Residuals of EGARCH model: (a) Standartized Residuals of IZTAR; (b) QQ Plot of IZTAR; (c) ACF of IZTAR; (d) Standartized Residuals of TACTR; (e) QQ Plot of TACTR; (f) ACF of TACTR; (g) Standartized Residuals of YPRK; (h) QQ Plot of YPRK; (ı) ACF of YPRK



(a) **(b)** **(c)**



(d) **(e)** **(f)**



(g) (h) (ı)

Figure 5. Plots of Residuals of GJR-GARCH model: (a) Standartized Residuals of IZTAR; (b) QQ Plot of IZTAR; (c) ACF of IZTAR; (d) Standartized Residuals of TACTR; (e) QQ Plot of TACTR; (f) ACF of TACTR; (g) Standartized Residuals of YPRK; (h) QQ Plot of YPRK; (ı) ACF of YPRK

4. Discussion and Conclusions

The research data of this paper covers the dates of November 18, 2011 to November 18, 2021. In this date range, a portfolio was created by taking daily frequency data of all agriculture, forestry, fishing and hunting companies in the BIST National All index. This paper was conducted for the beta risk or systematic risk, that is the investors who create the risk cannot avoid, for the first time BIST National All index and all companies belonging to agriculture, forestry, fishing and hunting are used the daily frequency data on the date of last ten years which 18 November 2011 to 18 November 2021. For the time-varying beta risk parameters, the Conditional Capital Asset Pricing Model (C-CAPM) is used. Time-varying Linear Market Model (Tv-LMM) that is a data production model consistent with C-CAPM is modeled with GARCH, EGARCH and GJR-GARCH that are univariate GARCH-type models. In this paper, three main conclusions were reached and contributed to the practice literature. Firstly, according to the model benchmarking criterias for GARCH-type model which best models the time-varying beta risk; It was found that EGARCH for IZTAR, GARCH for TACTR and GJR-GARCH for YAPRK. So, it has been found that GARCH-type models are not superior to each other. Secondly, the date 2020 was defined as the COVID-19 global epidemic by the WHO was March 11, 2020, the date of the 59th presidential election in the USA was December 12, 2020, the economic crisis observed in the Turkish economy in 2018, and the effects on the markets consequently of the global economic crisis experienced in 2008-2012 effect, that is extreme fluctuations, was clearly observed and there is a leverage effect in all companies on this period. Finally, when standard deviation is considered as risk measures, it has been found that IZTAR is the riskiest company while beta risk is considered as risk measures, it has been found that TACTR is the riskiest company in all the companies in the BIST National All Index. In addition, it has been determined that the companies are in the opposed direction with the market and there is a leverage effect in several companies on this period. In future studies, it is recommended to compare the performance of models in different financial markets, periods and frequencies and to create investment portfolios.

Statement of Support and Appreciation

No external support has been received during the conduct of this study.

Research and Publication Ethics Statement

All the rules stated in the “Higher Education Institutions Scientific Research and Publication Ethics Directive” were strictly considered at every stage of this research. None of the actions specified under the heading "Actions Against Scientific Research and Publication Ethics" of the directive has not been carried out. During the writing process of this study, the

citations were made in accordance with the ethical rules and a bibliography was created. The study was subjected to plagiarism control.

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Psychological inflexibility and its connection to levels of depression in Albanian youth

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Abstract

This study aims to analyze the relationship between psychological inflexibility and levels of depression in young Albanian people of ages between 21 to 24 years old. In recent years, the topic of psychological flexibility and inflexibility have been discussed more than any other time in the area of psychological research, thanks to the work of Steven C.Hayes among many others, combined with the rising initiative to understand the deep changes in forms of thinking during early adulthood. At the same time, a contextualization of this connection between psychological inflexibility and levels of depression within the psychosocial stage of development during early adulthood, along with the intellectual and ethical development as laid out by the Perry Scheme, are included in this study. Using half-structured interviews with 8 participants and a data analysis carried out by focusing on recurring themes and subjects with each participant, the end goal of this study was to help consolidate the importance that maintaining good psychological flexibility has when it comes to managing levels of depression. The interviews consisted in the application of two questionnaires, Beck's Depression Inventory and The Acceptance and Answer Questionnaire II, all for the purpose of establishing a base level of both variables, followed by several open questions with the objective being to elaborate as much as possible on the subjective experience of each participant. This study found that there does indeed exist a positive correlation between levels of depression and psychological inflexibility, adding onto this the possible link with the ways of thinking that is characteristic of the age group. Further studies are needed to investigate further on the possible "bridge" (form of thinking) between psychological inflexibility and levels of depression.

***Key words**: psychological flexibility/inflexibility, levels of depression, psychosocial development, intellectual development, early adulthood, BDI, AAQ-II*

INTRODUCTION

Psychological flexibility is known as the ability to stay in touch with the present moment despite negative internal experiences (unpleasant thoughts, feelings, and bodily sensations), while choosing to act based on the situation and in coherence with your personal values (Stein, 2016). Psychological inflexibility in this way will be the opposite, i.e. a general construct that describes the dominance of continuous internal experiences over chosen values and an indecisiveness in action (Bond, Hayes, Baer, Carpenter, Guenole, Orcutt, Waltz & Zettle , 2011).

Psychological inflexibility has often been associated with a higher level of depression, among other negative psychological experiences and states (Vidal & Odriozola-González, 2016). The work with this construct began around the same time when a new behavioral therapeutic approach was being developed called Acceptance and Commitment Therapy/ACT, which aims to increase the level of psychological flexibility.

What is known from existing research on psychological flexibility and inflexibility is that links can be established between these constructs and mental health problems. However, all these studies are of a quantitative nature and therefore often fail to specifically identify the related aspects of psychological flexibility that affect these mental health problems, specifically the level of depression. This fact has created a gap in knowledge and understanding regarding the relationship between psychological inflexibility and the level of depression experienced. Naturally, this also means that our approach to solving these problems is somewhat lacking.

Following the recommendation from Kashdan and Rottenberg's (2010) meta-analysis to conduct studies of a qualitative nature, this study aims to help fill the existing gap of information concerning personal experience and insight into the experience of the people involved in the study, in addition to interpretation and not just the simple measurement of psychological flexibility and the level of depression. This study also discusses the impact that the level of psychological flexibility has on the level of depression experienced by young Albanians, specifically aged 21 to 24.

The purpose of this study is to analyze the role that psychological inflexibility plays in the level of depression among young Albanians.

The research question raised in this study is: is there a correlation between psychological inflexibility and levels of depression among young Albanians?

Psychological flexibility refers to an individual's ability to manage, accept and adapt to difficult situations (Tindle & Moustafa, 2021). Psychological Flexibility Theory (PFT) was created to expand existing knowledge on the underlying processes that lead to the development of psychopathology (Levin, MacLane, Daflos, Seeley, Hayes, Biglan & Pistorello, 2014). Psychological flexibility, especially in recent years, has been defined as one of the essential aspects of the health and total well-being of an individual (Kashdan & Rottenberg, 2010). It has been shown, through a series of studies, that our ways of acting in line or not with what is defined as "psychopathology" are deeply influenced by our level of psychological flexibility (Fledderus, Bohlmeijer, Smit & Westerhof, 2021). This model of psychological inflexibility has also proven to be a dimensional approach to psychopathology and health (Hayes, Villatte, Levin & Hildebrandt, 2011).

A scientific approach was deemed necessary to assess whether mindfulness-based practices with the aim of reducing suffering have a place in modern psychology, so PFT was also developed to serve as a more functional explanation of mindfulness processes (Fletcher & Hayes, 2005). The distinction between mindfulness itself and mindfulness-based practices is important to make, as the practice itself is not the component of awareness, but simply serves as an opportunity to be in touch with feelings and thoughts. (Upton, 2020).

PFT has its roots in Relational Frame Theory (RFT), a modern behavioral approach that aims to explain human language and cognition (Fletcher & Hayes, 2005). In RFT, a well-known concept called "derived relational responding" is an essential component in the development of language and cognition, which means that we first learn to associate different stimuli together and then combine them with other stimuli (Upton, 2020). Psychological flexibility includes six main processes closely related to each other, which are: cognitive diffusion, acceptance, being in touch with your values, being present, self-as-context and acting committed (Fletcher & Hayes , 2005). These processes are conceptualized as positive psychological skills and not simply as methods of avoiding psychopathology.

Cognitive diffusion is defined as the ability to detach from the thoughts and feelings of the moment, giving the individual the opportunity to examine the latter within the context without changing their content (Fletcher & Hayes, 2005). In the absence of cognitive diffusion, people often follow a pattern of behavior that is largely controlled by thoughts, feelings, and other internal experiences or by the desire to avoid such experiences (Hayes et al., 2014). The opposite of cognitive diffusion is cognitive fusion, which means that the individual acts mostly based on their thoughts and feelings. Individuals who experience difficulties with cognitive fusion often experience high levels of psychological distress, such as depression, anxiety, and post-traumatic stress (Bardeen & Fergus, 2016).

Acceptance is defined as the ability and willingness to experience (without changing the form, frequency or sensitivity to) unwanted internal experiences (Bond, Hayes, Baer, Carpenter, Guenole, Orcutt, Waltz & Zettle, 2011). In other words, acceptance is also seen as the moment-by-moment process of observing and accepting the feelings, thoughts and sensations that arise at a given moment without trying to change them (Fletcher & Hayes, 2005). For example, anxious patients are taught to feel anxiety as a feeling, fully and without defense, rather than struggle with it (The Six Core Processes of ACT, Association for Contextual Behavioral Science/ACBS).

Being present consists of focusing on sensations within the body, thoughts, feelings, and everything that is happening outside the individual (Fletcher & Hayes, 2005). The goal is to encourage the person to experience the world in a more direct way making their behavior more flexible and therefore more in line with their values (ACBS, n.d). Being present gives the possibility of seeing oneself as a process of a series of awareness's about psychological experiences, giving the idea of "self as a process" (Fletcher & Hayes, 2005).

Being in touch with your values helps in the process of setting goals because of their function as life directions (Fletcher & Hayes, 2005). Values can be different, such as honesty, being ambitious and successful, etc. An individual may set goals that are in line with their values but values themselves do not contain action steps (Upton, 2020). The purpose of psychological interventions with a focus on psychological flexibility is precisely to strengthen or change the individual's behavior depending on the context, which is achieved through acceptance, diffusion and being present, which in themselves become meaningful because of being in contact with your values (Hayes, Levin, Plumb-Vilardaga, Villatte & Pistorello, 2013).

Self-as-context, the least studied component of psychological flexibility, consists of seeing the self as the context for all internal events (eg, thoughts, feelings) rather than seeing these events as the context itself (Fletcher & Hayes 2005). Seeing oneself as the context for internal events gives individuals the opportunity to understand themselves separate from their thoughts and feelings, a perspective shift that facilitates psychological flexibility (Upton, 2020). Interventions that focus on cultivating the self-as-context help individuals to see their internal experiences as separate from their consciousness and from themselves and thus not see these experiences as threatening, which increases the level of psychological flexibility. (Hayes et al., 2013). A heightened sense of self encourages individuals to experience their own thoughts and feelings, while at the same time disassociating from identification with the conceptualized self ("I'm a bad person," "I'm depressed," etc.) (Fletcher & Hayes 2005).

Committed actions involve an individual's behavior that is in line with their values (Fletcher & Hayes, 2005), whether these behaviors are in the short or long term. For example, being a good parent may exemplify a value, but behaving more caringly with your children is a clear, concrete, and achievable goal. The purpose of improving the skills is precisely to reduce barriers to and enable dedicated actions (Upton, 2020). Interventions that work with psychological flexibility always include a strong focus on expanding behavioral patterns that are in line with the person's values, that discourage inaction and impulsivity (Hayes et al., 2013).

Each of these components of psychological flexibility have an opposite side that enables psychological inflexibility, i.e. a behavioral pattern directed by feelings, thoughts or the desire to avoid these internal experiences, instead of more effective and meaningful actions (Levin et al., 2013).

To expand further on the difference between the level of depression and a depressive disorder we can also look at the definition of "low mood" and what it means. Low mood is something that everyone experiences, often after a disappointing or bitter event for example, but this condition passes after a few days or after the cause of the low mood is no longer present (WHO, 2023). Signs of a generally low mood, as outlined by the National Health Service UK (2022), may include feelings of sadness, anxiety or panic, being more tired than usual, problems sleeping, anger or frustration and low self-esteem. Low mood can certainly have many causes, ranging from problems at work or school to more personal and intimate problems such as those with family, social and romantic relationships (NHS, 2022).

On average, 1 in 15 adults will be affected by a depressive disorder each year (6.7%), and 1 in 6 people will experience a significant increase in their level of depression at least once in their lifetime (16.6%), typically during adolescence and young adulthood (APA, What Is Depression? 2020). Different levels of depression are experienced differently by each individual at certain times of their lives and it has been seen that young adults typically show signs of a higher level of depression in the form of irritability, changes in appetite and weight, sleep disturbances (hypersomnia and insomnia) and a predominantly negative or pessimistic view of life and the future (National Institute of Mental Health, Depression, 2021). More than any other age, young adults report other accompanying psychosocial concerns, such as anxiety problems, substance addiction, etc. (NIMH, 2021). In the descriptions of individuals who experience a high level of depression, elements of psychological inflexibility are often seen, mainly cognitive fusion and the view of the world around us as "flat", empty, and undifferentiated (Kashdan & Rottenberg, 2010). This means that despite the absence of a diagnosable depressive disorder, elements of depression level and psychological inflexibility are seen to have a mutual relationship (Masuda & Tully, 2012).

The work of Hayes and his colleagues on psychological flexibility, first discussed in 2005 (Fletcher & Hayes, 2005), raised questions about the relationship of this concept to negative psychological experiences. Early work on this topic was done with psychological distress in general (Masuda, Mandalia & Tully, 2013; Masuda, Muto, Tully, Morgan & Hill, 2014; Mendoza, Goodnight, Caporino & Masuda, 2016; Tavakoli, Broyles, Reid, Sandoval & Correa-Fernández, 2018; Makriyianis, Adams, Lozano, Mooney, Morton & Liss, 2019), allowing then space to explore the relationship between psychological inflexibility (or the lack of psychological flexibility) with certain mood levels, anxiety states of various, sleep disturbances among others.

It has been noted that in studies conducted with specific populations, such as Asian American individuals, psychological inflexibility has been identified as a very useful concept in understanding a wide range of psychological problems (such as somatization, depression, and anxiety).) (Masuda et al., 2013). Following on from studies conducted in populations where there is little or no frequency of genuine mental disorders and where individuals are mostly in their twenties, another study suggests that psychological inflexibility is an important transdiagnostic process for a variety of psychological disorders, but also for comorbid disorders (Levin et al., 2014). Further, in a population of Japanese university students, psychological inflexibility was found to be associated with higher levels of depressive symptoms and sleep problems (Kato, 2016).

According to the study by Gilbert, Tonge, and Thompson (2018), only three of the correlated aspects of psychological inflexibility had a significant relationship with the level of depression, but also theorized that in samples with higher levels of depression they would show more than three of those aspects. So, as expected, also in their study the construct of psychological inflexibility was associated with depression and to some extent with anxious excitement (Gilbert et al., 2018). Furthermore, in a study conducted in Taiyuan with 500 university students it was found that students with higher psychological inflexibility had a higher risk of higher levels of depression, suicidal tendencies and internet addiction (Chou, Yen & Liu , 2018).

The link between Adverse Childhood Experiences (ACEs), depression, anxiety and psychological inflexibility was brought into focus in a study where it was seen that psychological inflexibility (because of these difficult experiences) was the construct that then facilitated depression and anxiety (Makriyianis, Adams, Lozano, Mooney, Morton & Liss, 2019). Specifically, the study concluded that it was the lack of self-as-context and the lack of committed actions that created this link with depression and anxiety, while for anxiety it was seen that the lack of cognitive defusion was the main aspect that facilitated this link (Makrivianis et al ., 2019).

Although somewhat outside the age range considered in the present study, a 2019 study on the relationship between psychological inflexibility and levels of postpartum depression in new mothers (given that the average age of the 360 mothers in the study was 26.7) was noted that psychological inflexibility was a major determining factor in the level of depression these new mothers would experience after discharge from the hospital (Stotts, Villarreal, Klawans, Suchting, Dindo, Dempsey,

Spellman, Green & Northrup, 2019). In 2020, a study looked at the relationship between caregiving stressors and psychological inflexibility with depression and anxiety in individuals who cared for their relatives with dementia (Kishita, Contreras, West & Mioshi, 2020). The findings of this study clearly demonstrate that psychological inflexibility was a frequent factor explaining mental health problems in the population under consideration, even when they controlled for other variables that have been shown to have an impact (Kishia et al., 2020).

Sleep disturbances and higher level of depression are common problems in a university student population and through the study conducted by Peltz, Rogge, Bodenlos, Kingery and Pigeon (2020) it was seen that sleep disturbances predicted depressive symptoms and suicidal tendencies such as result of changes in the level of psychological inflexibility in these young people. Psychological inflexibility has also been found to be an important factor in the level of depression and sleep disturbances experienced by people with chronic pain (Kato, 2020). Kato's study (2020) clearly shows that strategies centered on reducing psychological inflexibility in these individuals should be implemented.

Finally, a study conducted with 1769 Chinese students in 2023 clearly showed that the group of students with low psychological flexibility also reported higher levels of negative feelings such as depression, anxiety, and stress (Wang, Fang, Yang, Tang, Zhu & Nie, 2023).

METHOD

The purpose of this qualitative study is to analyze the role that psychological inflexibility plays in the level of depression. This study aims to determine the relationship between psychological inflexibility and the level of depression.

The participants for this study were all young adults, specifically aged 21-24, with an average age of 22.8 years. All study participants were randomly selected. A total of 8 participants completed two questionnaires and a semi-structured interview lasting 40-50 minutes and were included in the data analysis. 5 of the participants were female and 3 were male.

Study participants were first informed about the rules about anonymity and confidentiality of the entire data collection process and the purpose for which these data would be used. Verbal consent was sought from each participant to be part of the study. After completing the questionnaires (AAQ-II and BDI) each participant was asked a series of questions according to the structure of a semi-structured interview. As the interview contained a few personal and potentially difficult questions to answer, it was made clear to each participant that they could choose not to answer any question they did not agree to answer and that they could to stop the interview at any moment.

Instrument I: To measure psychological flexibility, I used a questionnaire called Acceptance and Action Questionnaire-II (Acceptance and Commitment Questionnaire-II) or AAQ-II as I will refer to below. The AAQ-II was designed by Steven C. Hayes et al., to create a measuring tool of psychological flexibility and the skills that this concept includes (Bond et al., 2011). The questionnaire consists of 7 statements (i.e: "My painful memories prevent me from living a happy life"), which the person must rate according to the Likert scale from 1 (never true), 2 (very rarely true), 3 (rarely true), 4 (sometimes true), 5 (often true), 6 (almost always true) to 7 (always true).

Total points are derived by adding the points of each statement. The interpretation of the total score of this questionnaire is not static and is not determined by intervals, unlike the Beck Depression Inventory. As a result, this total should be seen within the context in which the questionnaire was used, as proposed by Kashdan & Rottenberg (2010), which is somewhat more possible thanks to the qualitative nature of this study. However, a high total score indicates lower psychological flexibility and a low total score indicates higher psychological flexibility. The AAQ-II has been proven through a series of studies to be an important psychometric tool, with consistent validity and accuracy (Fledderus et al., 2012).

Instrument II: To measure the level of depression I used the questionnaire called Beck's Depression Inventory (Beck's Depression Inventory) or BDI for short. The BDI was originally developed in 1961 with the primary purpose of serving as a measure of behavioral manifestations of depression (Beck, Ward, Mendelson, Mock & Erbaugh, 1961). The BDI is a 21-item questionnaire, where each item contains 4 statements corresponding to 0, 1, 2 or 3 points (i.e: 0 - I do not feel sad, 1 - I feel sad, 2 - I feel /sad all the time and I can't get out of this state, 3 - I feel so sad and not happy that I can't stand it anymore). The DUI has been frequently scrutinized by various studies aimed at evaluating the safety and accuracy of this test.

This questionnaire is interpreted based on the defined intervals, namely 1-10 "These ups and downs are considered normal", 11-16 "Mild mood disturbances", 17-20 "On the border of clinical depression", 21-30 "Depression average", 31-40 "severe depression" and over 40 "extreme depression". Among the main advantages of the BDI are its sensitivity to change, its item accuracy, high convergent validity with other depression scales, accurate discrimination between depressed and non-depressed persons, and consistent reliability. internal when administered to both psychiatric and non-psychiatric samples (Richter, Werner, Heerlein, Kraus & Sauer, 1998).

RESULTS

Case Study 1. Age 23, higher education, female, software developer.

Case 1 scored a total of 14 points on the Beck Depression Inventory, which places him in the second range that includes scores 11-16 and is classified as "mild mood disturbances." In the psychological flexibility questionnaire, she scored a total of 31 points, which indicates that she does not have a very high level of psychological flexibility. Case 1 did not express specific problems regarding the level of mood and its management, except for problems with decision-making and self-criticism. In terms of psychological flexibility, he emphasized that he had problems with the intensity of emotions, their control and management, in addition to constant worries about these issues.

Case 1 expressed that the transition was a crucial period for her in terms of her approach to emotions and their expression. She claimed that the transition from late adolescence to young adulthood has brought a series of difficulties and extra responsibilities which have made it more difficult for her to manage her emotional state. Among the main strategies for managing difficult emotions and levels of depression, she repeatedly mentioned her tendency to ignore and avoid these inner experiences. She also added that when she had free time, she used it to practice her hobby, such as playing the guitar. Her way of thinking and the approach she expressed to emotions and inner experiences places her in the Multiplicity stage, in positions 3 and 4.

Case Study 2. Age 21, higher education, male, software developer.

Case 2 scored a total of 7 points on the Beck Depression Inventory, which places him in the first range that includes points 1-10 and is qualified as "these ups and downs are considered normal". In the psychological flexibility questionnaire, it resulted in a total of 10 points, which means that case 2 has a high level of psychological flexibility. Regarding the level of humor, he did not identify any difficulties except for a slight feeling of guilt. Regarding psychological flexibility, he did not identify any difficulties in any of the areas of psychological flexibility.

Case 2 stated that the transition from late adolescence to young adulthood had not actually had a substantial impact on either his approach to emotions or his management of low mood. Regarding techniques and strategies for managing difficult emotions, he said that he tried to reflect on them and process them internally, in addition to distracting himself at times through his hobbies. His way of thinking and approaching emotions, himself and others places him in the intellectual developmental stage of Relativism, in position 6.

Case Study 3. Age 24, higher education, female, student/assistant architect.

Case 3 scored a total of 16 points, which places her in the range that coincides with scores 11-16 and is classified as "mild mood disturbances." In the psychological flexibility questionnaire, she scored a total of 30 points, which means that she has a low level of psychological flexibility. In the context of managing the level of depression, she singled out feelings such as sadness and especially guilt with which she had more difficulties. In terms of psychological flexibility, she expressed that she had difficulties with experiencing negative emotions, a pessimistic view of herself in relation to others and a constant feeling of concern that she will fail.

Case 3 claimed that the transition played a very large role in her path to becoming aware of her feelings and complexes, specifically those around processing negative emotions. Among the main techniques and strategies, she mentioned rationalization and reflection, alongside daily activities such as reading. The form of thinking and its approach to self, emotions and others places the case 3 in the stage of Relativism, specifically in position 5.

Case Study 4. Age 23, higher education, female, actress.

Case 4 scored a total of 29 points on the Beck Depression Inventory, which places him in the range of 21-30 and is defined as "moderate level of depression". In the psychological flexibility questionnaire, she scored a total of 39 points, which means that she has a low level of psychological flexibility. Regarding the management of the level of depression, she stated that she has experienced many difficulties with maladjustment to the environment, with feelings of guilt and control. In terms of psychological flexibility, she stated that she encountered special difficulties in terms of her relationship with negative feelings, with the concern that they will get out of control and destroy her life.

Case 4 expressed that the transition from late adolescence to young adulthood had had a very big impact on her, with the main element being the depression she felt because of the need to adapt to an environment and way of living fully clouds for him. She also expressed that her experience at the university was very influential, stating that the way the university encouraged her to think helped her through this difficult period in her life. Among the main techniques and strategies, she mentioned returning to oneself, one's own values and reflecting on situations that cause suffering or stress. The form of thinking about self, emotions, and other places case 4 in the intellectual and ethical developmental stage of Relativism, specifically in position 6.

Case Study 5. Age 24, higher education, female, student.

Case 5 scored a total of 33 points on the Beck Depression Inventory, which places him in the range that includes scores of 31-40 and is defined as "severe depression level". In the psychological flexibility questionnaire, she scored a total of 33 points, which means that she does not have a high level of psychological flexibility. Regarding the management of the level of depression, she expressed special difficulties with feelings of guilt, sadness, feeling that she is being punished, low self-esteem, problems with decision-making, fatigue, and suicidal thoughts. In terms of psychological flexibility, she expressed difficulties with the intensity of emotions, concern about their control and difficulties about her painful memories and experiences.

Case 5 stated that her transition period from late adolescence to young adulthood had a major impact on her although she also stated that she did not follow the “traditional” path of attending university after high school. She claims that this experience has helped that transition period to be easier for her. She also adds that the university, the academic preoccupation, and the evaluation by the lecturers have helped her with issues of self-confidence and distraction from her problems and negative emotions. Among her main techniques and strategies, she mentions activities that distract her from difficult experiences, such as music, reading, food, etc. Case 5's way of thinking about self, emotions, and others places it in the intellectual and ethical developmental stage of Relativism, specifically position 5.

Case Study 6. Age 23, higher education, male, student.

Case 6 scored a total of 10 on the Beck Depression Inventory, which places her in the 1-10 range and is defined as "these ups and downs are considered normal." In the psychological flexibility questionnaire,

he came out with a total of 21 points, which means that he does not have a particularly high level of psychological flexibility. Case 6 did not specify any difficulties with mood when filling out the first questionnaire or during our conversation although throughout the interview he seemed to actively try to avoid questions about emotions. In terms of psychological flexibility, it was seen that there was moderate difficulty with worries, feelings, and the idea that other people around him were coping with life better than him.

Case 6 explained that the transition from adolescence to young adulthood had a huge impact on him, often highlighting during the interview aspects of the increased responsibility because of being older and now also working. Also, he added that a few years ago, around the age of late adolescence, he was characterized by a very high emotionality, but that he had passed this period of his life thanks to reflection and taking more responsibility due to age. Case 6 also named reflection as his main strategy for managing negative emotions and mood disturbances, without mentioning any other technique or strategy. His way of thinking about himself, his emotions, and his approach to the world and others seemed to fit the way of thinking seen in the Multiplicity stage, specifically that of position 3.

Case Study 7. Age 24, higher education, male, student.

Case 7 scored a total of 26 points on the Beck Depression Inventory, which places him in the range of 21-30 and is defined as "moderate level of depression". In the psychological flexibility questionnaire, it came out with a total of 48 points, which means that it has an extremely low level of psychological flexibility. It was very clearly noted that case 7 had trouble with feelings of guilt, specifically in the context of interpersonal relationships on which he placed great emphasis. In terms of psychological flexibility, or more precisely in this case psychological inflexibility, case 7 showed difficulties with every aspect of psychological flexibility.

Furthermore, Case 7 explained that the transition from adolescence to young adulthood had a considerable but not drastic level of impact, as he explained that his experience at university had been largely "unengaged". When asked about techniques or strategies for managing negative emotions, depression, and low mood, he gave a series of activities from listening to music, cooking to physical activity, but among them also food as a not very healthy management technique. Case 7's way of thinking about self, emotions, and others seemed to fit the way of thinking in the Multiplicity stage, specifically position 3.

Case Study 8. Age 21, higher education, female, student.

Case 8 scored a total of 20 on the Beck Depression Inventory, which places him in the range of 17-20 and is considered "borderline clinically depressed." In the psychological flexibility questionnaire, she scored a total of 21 points, which means that she does not have a particularly high level of psychological flexibility. Regarding the management of the level of depression, she stated that she did not encounter any difficulties with issues of emotions and affect, apart from constant fatigue from work and school, sadness, mild anhedonia, and almost complete loss of interest in others. In terms of psychological flexibility, she expressed that she experienced difficulties with inconsistencies in the way she felt, making it more difficult to balance her emotions. She also added that regardless of the nature of the emotions, it was their intensity that dictated the negative consequences in her life, also combined with constant worries about her relationship with others.

Case 8 stated that the transition from late adolescence to young adulthood had played a very important role, as it had greatly helped her process of self-discovery. Among the main techniques and strategies, she mentioned optimism, crying and positive self-reinforcement. The way of thinking of case 8 places it in the stage of intellectual and ethical development of Relativism, specifically in position 6.

CONCLUSIONS

The purpose of this qualitative study is to analyze the role that psychological inflexibility plays in the level of depression. This goal was achieved through an analysis of recurring themes and patterns in the

cases considered. The research question of this study was: is there a relationship between psychological inflexibility and the level of depression among young Albanians?

Studies show that a high level of psychological inflexibility is associated with a higher level of depression, starting from Masuda and Tully (2012), Levin et al. (2014), Bardeen and Fergus (2016) to the most recent one conducted by Wang et al. (2023), of course among others. A study that is very similar to the present study is the one conducted by Vidal and Odriozola-González (2016) where the relationship between psychological inflexibility and Beck's cognitive model of depression was seen. It happens while this study uses the BDI to measure the level of depression, creating even more parallel lines. It is concluded that the role of psychological inflexibility in the cognitive model of depression has not been sufficiently explored at all (Vidal and Odriozola-González, 2016).

The hypothesis of this study has been proven thanks to the 8 cases taken into consideration and is in line with the studies conducted before, since there is a consistent continuity between the result in the DUI and the AAQ-II. Specifically, the principle is clearly reflected that the higher the level of psychological inflexibility, the higher the level of depression tends to be, thus giving a positive relationship between them. However, this study reflects more nuance than that.

First, the most repeated topic from every interviewee is the one about emotions, and therefore it is worth discussing the approach to these internal experiences and the connection that this approach has (which reflects the level of psychological flexibility) with the level of depression. The cases can be divided into two groups if we look at them from this aspect, together with the level of depression and that of the corresponding psychological inflexibility. The first group consists of those cases that express a higher level of depression and psychological inflexibility, as illustrated by case 1, 4, 5, 7 and 8. The second group meanwhile is characterized by a lower level of depression and psychological inflexibility, as illustrated by cases 2, 3 and 6.

Higher level of depression and higher psychological inflexibility: Case 1, 4, 5, 7 and 8

What is impressive is that any case that belongs to the first group is also characterized by a higher level of cognitive fusion, which means that they experience difficulties in separating themselves from the emotions they feel (Masuda & Tully, 2012). In this way, it can be theorized that it is precisely this complete "melting" with their feelings of the moment that makes that feeling so intense or at least that it plays an important role in this finding (Levin et al., 2014). Moreover, it is also seen that every case, apart from case 8, reports a high level of psychological inflexibility, ranging from 31 to 48 total points on the AAQ-II.

Another element of psychological flexibility that is missing in these individuals is the self-as-context. This means that it supports the statement made above, i.e. that these cases tend to identify with the current situation and circumstance in which they are and not with themselves specifically (Levin et al., 2014). As a result of the deep connection that these skills have with each other, the ability of these cases to be in contact with their values and consequently also their ability for dedicated actions is also affected. The aspect of psychological flexibility that keeps these individuals somewhat further from the highest level of psychological inflexibility is acceptance. Despite the great value that acceptance has as a positive psychological ability and as an element of psychological flexibility, it clearly does not necessarily translate into a more positive relationship with internal experiences, specifically with negative emotions and worries (Wang et al., 2023).

Regarding the level of depression experienced, this group can be further divided into two subgroups: the group consisting of cases 1 and 8 reporting a lower level of depression and the group consisting of cases 4, 5 and 7 experiencing levels of depression above what is considered average. This finding is of interest for the study since it can indicate the influence of other circumstances that have an impact on the level of depression. It seems clear that case 4, 5 and 7 are similar in terms of a phenomenon defined as "depression of maladjustment", which means that this higher level of their depression comes as a result of their maladjustment to the situation they are in for this period of time. However, one could argue that maladjustment itself is a sign of high psychological inflexibility, which these cases also have

(Bardeen & Fergus, 2016). Therefore, it can be hypothesized that the construct of psychological inflexibility may play a greater role than previously thought in maladjustment, but it remains for future research to look at this issue specifically.

On the other hand, case 1 was expected to report a higher level of depression because of a higher level of psychological inflexibility. According to the statements of case 1, it can be assumed that there may be a lack of being present, which makes the issue of negative emotions easier to manage in the moment (Fletcher & Hayes, 2005). Case 8, on the other hand, was an interesting exception to the rule that this group has a high level of psychological inflexibility, while for this case it seems that psychological inflexibility is not pronounced. This is also in line with the low level of depression that case 8 reported. However, feelings and emotions remained a difficult aspect for him to navigate due to the cognitive fusion he possessed.

Finally, it is worth mentioning the importance that the transition from late adolescence to young adulthood has had in this group along with their experience at university, which certainly has also influenced their position in the stages of the Perry Scheme (Moore, 2002). Specifically, cases 1 and 7 can be positioned in the stage of Multiplication, while cases 4, 5 and 8 can be positioned in that of Relativism. These two stages stand next to each other and therefore do not constitute profound changes in the form of thought (Perry, 1970). Still, it is worth noting that cases that are in Relativism express a broader understanding of their inner world and emotions, accepting every side of them.

Lower depression level and lower psychological inflexibility: Case 2, 3, and 6

The second group consisted of individuals who expressed that emotions were not as important to them as being rational and thus found themselves more disconnected from these inner experiences. Specifically, case 2 results with a high level of psychological flexibility, case 3 with a low level of psychological flexibility and case 6 between them but leaning more towards psychological flexibility. It is also worth noting that case 3 was the only one of this group that emphasized her perception of emotions as "anger", emerging from the expectation created by the other two cases to be indifferent and uninvolved with her emotions. This may provide an explanation for the low level of psychological flexibility that case 3 reports.

At the same time, the two groups are almost the opposite of each other in the psychological flexibility skills they possess and do not possess. Specifically, the second group experiences special difficulties with acceptance and being present, while they clearly demonstrate that they are in touch with their values, act according to them and have a respectable level of cognitive diffusion (Levin et al., 2014). The problem is that these skills show up in almost every other aspect of their lives except the intrapersonal one.

Regarding the level of depression, these three cases are seen to experience ups and downs in mood that are considered normal and mild. This comes because of their generally higher psychological flexibility, but it can also be suspected that in line with the reports of these three cases, this lower level of depression is not necessarily a reflection of their inner reality. If an individual is not present and receptive to his own emotions and thoughts, then this can lead to the exercise of some repression (Vidal & Odriozola-González, 2016). As a result, these emotions and thoughts are not fully experienced by the individual and in this way, I can feel that as a result of this non-coping they do not feel after or at all a low mood level (Vidal & Odriozola-González, 2016).

Within their position in the phases of Perry's Scheme, case 6 can be positioned in the Multiplication phase, while cases 2 and 3 in that of Relativism. This difference between their thinking style, however small, raises questions about the influence of this specific schema thinking style on the level of psychological flexibility, although this level varied somewhat from case to case within this group. What can be said with certainty is that the difference in the level of flexibility did not produce a further significant difference in the form of thinking. It should also be said that individuals may be at different stages within the schema for different issues and thus this relationship between the level of psychological

flexibility and the form of thinking or intellectual development remains to be interpreted, considering the many other influencing factors (Moore, 2002).

Recommendations

The purpose of this study was to analyze the role that psychological inflexibility plays in the level of depression. The results of this study proved the hypothesis: There is a positive relationship between psychological inflexibility and the level of depression among young Albanians.

Despite the finding of this study, these results remain non-generalizable. As a result, quantitative studies for the age considered could produce such results. This study was also somewhat limited in influencing factors on the level of depression, since it can be hypothesized that gender could be another important factor to be considered in further studies. In fact, even in this study, it was clearly seen that the men included in this study reported different problems and ways of managing the level of depression, but as mentioned above, the limited number of participants and the disparity in the number of men and women in this study makes this nothing more than a finding of this particular study, which however is recommended to carry out further studies to investigate this matter more deeply.

In addition, further studies are recommended to see the effectiveness of various psychotherapeutic interventions in reducing the level of psychological inflexibility in this age group. Finally, special attention should be paid to the experience of young adults at university and how the education system can support these individuals for a smoother transition from adolescence to adulthood.

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Impact of Macroeconomic Factors on UEFA Club Performances: Dynamic Panel Data Analysis

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Abstract

UEFA leagues are one of the important sports activities in which countries in competition. The UEFA coefficient is important parameter of rankings system show the football performances of the countries. Macroeconomic parameters, which have an impact on the competition of countries in many areas, may be positively or negatively effective on football clubs and therefore their football performances. In this study, it was investigated whether economic factors as well as UEFA points, which are a combination of the football performances of sports clubs, affect the UEFA performances of the eight countries. These countries are active associations which have all their teams competing in 2002-2022 time period's UEFA club competitions were taken into consideration. In this context, the relationship between macroeconomic variables that may affect the UEFA Coefficients of England, Spain, Germany, Italy, Netherlands, France, Belgium and Turkey and their UEFA points was tested by the dynamic panel data analysis method. In this study, the dynamic panel model was estimated via Arellano and Bond (1991) two-stage generalized moment method (GMM). Followed by model estimation, Sargan (1958) test of overidentifying restrictions, Arellano and Bond test for autocorrelation were apllied. As a result of the analysis, a valid dynamic panel model estimation with no overfitting and no 1st degree (AR1) and 2nd degree (AR2) autocorrelation was obtained. According to the results of the Sargan test, the validity of the instrumental variables was accepted. According to the findings obtained from the model estimation results, since the UEFA performance in the previous period increases UEFA success, the coefficient of the lagged UEFA points variable was obtained positive. The Sovereign debt and Ratio of current account balance in gross domestic product have positive effect, and Inflation rate, Population density and Unemployment rate variables have negative effect on the UEFA points. Additionally, it has been determined that Gross domestic product per capita has a u-shaped effect on UEFA points.

Key words: *Dynamic Panel Data, Two stage-GMM, UEFA Coefficients*

Statistical Process and Quality Control in Business: Enhancing Performance and Decision-Making

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Abstract

This paper explores the significance of statistical process and quality control in improving performance and decision-making within business organizations. It emphasizes the role of statistical methods and quality control techniques in ensuring consistent product or service quality, reducing defects, and enhancing overall operational efficiency. The paper discusses key concepts and principles related to statistical process control (SPC), highlighting its application in various industries. Additionally, it examines the integration of statistical process and quality control with data analysis tools and methodologies to drive continuous improvement and informed decision-making. The study presents case studies and empirical evidence to demonstrate the benefits of implementing statistical process and quality control practices, such as reducing waste, improving customer satisfaction, and increasing profitability. Furthermore, it discusses the challenges and considerations involved in implementing and sustaining effective quality control systems. The findings suggest that a systematic and data-driven approach to quality control can significantly enhance business performance and provide a competitive advantage. The paper concludes with recommendations for businesses to implement and optimize statistical process and quality control practices in their operations.

Keywords*: Statistical Process Control, Quality Control, Business Performance, Decision-Making, Continuous Improvement, Operational Efficiency.*

INTRODUCTION

Statistical process and quality control are crucial components in business operations, aimed at ensuring consistent and reliable performance while meeting customer expectations. These disciplines employ statistical techniques to monitor, analyze, and improve processes, products, and services, ultimately enhancing business performance and decision-making. The importance of statistical process and quality control in business cannot be overstated, as they contribute to increased efficiency, reduced waste, improved customer satisfaction, and competitive advantage (Montgomery, 2017; Pyzdek & Keller, 2019).

In today's dynamic and competitive business environment, organizations face various challenges such as globalization, changing customer preferences, and market volatility. In such a context, effective quality control becomes essential for businesses to maintain a competitive edge and meet the ever-increasing demands of customers. By implementing statistical process and quality control techniques, businesses can identify and address process variations, minimize defects, optimize resources, and continuously improve their operations (Oakland, 2019; Besterfield-Sacre et al., 2016).

The purpose of this paper is to explore the significance of statistical process and quality control in business and highlight their role in enhancing performance and decision-making. The paper aims to provide a comprehensive overview of the theoretical foundations, practical applications, and benefits of statistical process and quality control in various business contexts. By examining real-world examples and case studies, the paper will demonstrate how organizations can leverage statistical process and quality control techniques to achieve operational excellence, customer satisfaction, and strategic goals.

The objectives of this paper include:

1. To provide a clear understanding of statistical process and quality control concepts, methodologies, and their relevance to business operations.
2. To explore the application of statistical process and quality control in different industries and identify best practices for implementation.
3. To highlight the impact of statistical process and quality control on business performance, including factors such as operational efficiency, cost reduction, customer satisfaction, and decision-making.
4. To offer recommendations for businesses to effectively implement and sustain statistical process and quality control practices, considering challenges and considerations in the process.

By addressing these objectives, this paper aims to contribute to the existing body of knowledge on statistical process and quality control in the business context, and provide insights for practitioners and researchers seeking to enhance business performance through effective quality management practices.

THEORETICAL FRAMEWORK

Statistical Process Control (SPC) and quality control are essential components of ensuring consistent and reliable business performance. This section provides a theoretical framework by defining key concepts, exploring principles and methodologies, and highlighting the relationship between statistical process and quality control and business performance.

Definition and Key Concepts

Statistical Process Control (SPC) involves the application of statistical methods to monitor and control processes, ensuring they operate within predefined specifications. It focuses on identifying and minimizing process variations that can lead to defects or deviations from desired outcomes. Quality control, on the other hand, encompasses activities aimed at ensuring the final output meets or exceeds customer expectations in terms of quality, reliability, and performance.

Key concepts in SPC and quality control include:

a) Control Charts: Control charts are graphical tools used in SPC to monitor process performance over time. They plot process data points against control limits, providing a visual representation of process stability and detecting any unusual variations or patterns.

b) Variation: Variation refers to the natural variability that exists in any process. It can be categorized as common cause variation (inherent to the process) or special cause variation (resulting from external factors). SPC aims to identify and distinguish between these types of variations to take appropriate corrective actions.

c) Process Capability: Process capability measures the ability of a process to consistently produce output that meets customer specifications. It is assessed using various statistical indices such as Cp, Cpk, and Pp.

Principles and Methodologies

The principles and methodologies of statistical process and quality control provide a systematic approach to achieving process stability, identifying areas for improvement, and enhancing overall quality. Some common techniques include:

a) Statistical Tools: Statistical tools such as hypothesis testing, analysis of variance (ANOVA), regression analysis, and design of experiments (DOE) are employed to analyze process data, identify significant factors, and make data-driven decisions.

b) Six Sigma: Six Sigma is a disciplined approach that combines statistical techniques with process improvement methodologies. It aims to minimize process variations and defects, achieving a level of performance where the probability of a defect is extremely low.

c) Lean Manufacturing: Lean manufacturing focuses on eliminating waste and streamlining processes to enhance efficiency and reduce costs. It emphasizes continuous improvement, just-in-time production, and value stream mapping.

Relationship between Statistical Process and Quality Control and Business Performance

Statistical process and quality control play a vital role in influencing business performance. Effective implementation of these practices can lead to several benefits, including:

a) Improved Product and Service Quality: By identifying and addressing process variations, SPC and quality control contribute to enhanced product and service quality. This, in turn, leads to increased customer satisfaction, loyalty, and retention.

b) Cost Reduction: Statistical process and quality control help in identifying areas of waste, inefficiency, and defects, leading to cost savings. By optimizing processes and minimizing rework, businesses can reduce operational costs and improve their bottom line.

c) Enhanced Operational Efficiency: SPC and quality control enable businesses to monitor and control their processes, ensuring they operate at optimal levels. This results in increased productivity, reduced cycle times, and improved resource utilization.

d) Data-Driven Decision-Making: By analyzing process data and performance metrics, SPC and quality control provide valuable insights for decision-making. Businesses can make informed decisions regarding process improvements, resource allocation, and risk management.

The relationship between statistical process and quality control and business performance is a symbiotic one. Effective implementation of SPC and quality control practices leads to enhanced business performance, while a focus on performance improvement drives the adoption and utilization of these practices.

In conclusion, this section has provided a theoretical framework for understanding statistical process and quality control in the context of business performance. By defining key concepts, exploring principles and methodologies, and highlighting the relationship with business performance, businesses

can gain a deeper understanding of the importance of statistical process and quality control in achieving operational excellence and meeting customer expectations.

APPLICATION OF STATISTICAL PROCESS AND QUALITY CONTROL IN BUSINESS

Statistical process and quality control have wide-ranging applications across various industries. This section explores case studies and examples that highlight the implementation of these practices, the benefits they bring in enhancing business performance, and their integration with data analysis tools and methodologies.

Case Studies and Examples

Case studies and examples show how statistical process and quality control have been successfully implemented in different industries:

a) Manufacturing Industry: A manufacturing company implemented statistical process control techniques to monitor and control key manufacturing processes. By analyzing process data using control charts and statistical tools, they were able to identify and eliminate sources of variation, leading to improved product quality, reduced defects, and increased customer satisfaction.

b) Healthcare Industry: A hospital implemented quality control practices in its laboratory operations. By using statistical methods to monitor the accuracy and precision of medical tests, they reduced errors, improved diagnostic accuracy, and ensured patient safety. This resulted in enhanced healthcare outcomes and increased trust among patients and healthcare providers.

c) Service Industry: A customer service call center implemented statistical quality control techniques to monitor and improve service delivery. By analyzing customer feedback, call resolution times, and other performance metrics, they identified areas for improvement, implemented process changes, and achieved higher customer satisfaction ratings.

Benefits and Outcomes of Effective Quality Control Practices

Effective implementation of statistical process and quality control practices brings numerous benefits and outcomes to businesses:

a) Enhanced Product and Service Quality: By implementing quality control practices, businesses can identify and address issues that affect product and service quality. This leads to reduced defects, improved consistency, and increased customer satisfaction.

b) Increased Efficiency and Cost Reduction: Statistical process and quality control help identify areas of waste, inefficiency, and non-value-added activities. By streamlining processes, businesses can reduce costs, increase productivity, and improve overall operational efficiency.

c) Better Decision-Making: Integration of statistical process and quality control with data analysis tools and methodologies enables businesses to make data-driven decisions. By analyzing process data, businesses gain insights into process performance, identify improvement opportunities, and prioritize actions based on objective evidence.

d) Continuous Improvement: Statistical process and quality control promote a culture of continuous improvement within organizations. By monitoring processes, analyzing data, and implementing corrective actions, businesses can achieve incremental improvements over time, leading to long-term success and sustainability.

Integration with Data Analysis Tools and Methodologies

The integration of statistical process and quality control with data analysis tools and methodologies further enhances their effectiveness:

a) Data Collection and Management: Businesses utilize data collection methods and software systems to capture process data efficiently. This includes the use of data logging devices, automated data capture, and robust data management systems to ensure data integrity and accessibility.

b) Statistical Software: Businesses employ statistical software packages such as Minitab, JMP, or R to perform data analysis, generate control charts, conduct hypothesis testing, and perform advanced statistical analyses. These tools provide the capability to analyze large datasets and extract meaningful insights for quality control purposes.

c) Six Sigma Methodology: Six Sigma methodology, which integrates statistical process control with process improvement methodologies, provides a structured approach to problem-solving and process optimization. It incorporates data analysis tools, such as DMAIC (Define, Measure, Analyze, Improve, Control) and DFSS (Design for Six Sigma), to drive continuous improvement and achieve performance excellence.

d) Lean Principles: Integration with lean principles, such as value stream mapping and waste reduction techniques, helps streamline processes, eliminate non-value-added activities, and optimize resource utilization. This, in turn, enhances the effectiveness of statistical process and quality control efforts.

In conclusion, this section has discussed the application of statistical process and quality control in business. Through case studies, examples, and the integration with data analysis tools and methodologies, businesses can harness the benefits of these practices to enhance their performance, improve decision-making, and achieve operational excellence.

CHALLENGES AND CONSIDERATIONS IN IMPLEMENTING QUALITY CONTROL SYSTEMS

Implementing quality control systems in businesses can present various challenges and obstacles. This section discusses the common barriers encountered during implementation, strategies for overcoming them, and considerations for sustaining quality control systems in the long term.

Barriers and Obstacles

a) Resistance to Change: Resistance from employees and management can hinder the successful implementation of quality control systems. Employees may be reluctant to adopt new processes or fear job insecurity due to process changes. Management may resist the allocation of resources or may not fully understand the benefits of quality control practices.

b) Lack of Awareness and Knowledge: A lack of awareness about the importance and benefits of quality control can impede implementation. Employees may not be familiar with statistical process control techniques or may not possess the necessary skills to analyze and interpret data.

c) Inadequate Resources: Insufficient resources, including funding, equipment, and trained personnel, can limit the effective implementation of quality control systems. Without adequate resources, organizations may struggle to collect and analyze data, implement corrective actions, and sustain quality improvement efforts.

d) Organizational Culture: A culture that does not prioritize quality or continuous improvement can pose a significant barrier. If the organizational culture does not support quality control practices, it may be challenging to obtain buy-in from employees and achieve lasting change.

Strategies for Overcoming Challenges

a) Leadership Support and Engagement: Strong leadership support is crucial for overcoming resistance to change. Leaders should actively communicate the importance of quality control, allocate necessary resources, and lead by example. Engaging employees through training, workshops, and continuous communication can help address their concerns and build support for quality control initiatives.

b) Education and Training: Providing comprehensive education and training on quality control principles, statistical tools, and data analysis techniques is vital. By enhancing employees' knowledge and skills, organizations can empower them to actively participate in quality control efforts.

c) Resource Allocation: Organizations need to allocate sufficient resources, including finances, equipment, and personnel, to support the implementation of quality control systems. Adequate resources enable effective data collection, analysis, and implementation of improvement measures.

d) Cultural Transformation: Organizations should work towards developing a culture of quality and continuous improvement. This involves fostering open communication, recognizing and rewarding quality achievements, and integrating quality control practices into performance evaluations and organizational goals.

Considerations for Sustaining Quality Control Systems

a) Management Commitment: Sustaining quality control systems requires ongoing commitment from top management. Management should continuously promote and reinforce the importance of quality control, provide necessary resources, and actively monitor and evaluate the effectiveness of quality control practices.

b) Continuous Improvement: Quality control systems should be viewed as dynamic processes that require continuous improvement. Regularly reviewing and updating quality control practices, incorporating feedback from employees and customers, and staying updated on advancements in statistical techniques contribute to long-term success.

c) Employee Engagement: Engaging employees in quality control efforts fosters a sense of ownership and accountability. Encouraging employee involvement in problem-solving, process improvement, and decision-making empowers them and strengthens the sustainability of quality control systems.

d) Monitoring and Evaluation: Establishing metrics and performance indicators to monitor the effectiveness of quality control systems is crucial. Regular data analysis, measurement of key performance indicators, and periodic audits help identify areas for improvement and ensure compliance with quality standards.

In conclusion, implementing quality control systems in business can face challenges, but with effective strategies and considerations for sustainability, organizations can overcome these obstacles and reap the benefits of improved quality, performance, and customer satisfaction.

ENHANCING PERFORMANCE AND DECISION-MAKING THROUGH STATISTICAL PROCESS AND QUALITY CONTROL

Statistical process and quality control play a crucial role in enhancing business performance and enabling informed decision-making. This section explores the various ways in which statistical process and quality control contribute to operational efficiency, cost reduction, customer satisfaction, and strategic planning.

Improving Operational Efficiency

Operational efficiency is a critical aspect of business performance and competitiveness. Organizations strive to optimize their processes and minimize inefficiencies to enhance productivity, reduce costs, and deliver high-quality products and services. Statistical process and quality control techniques play a crucial role in this pursuit by enabling organizations to identify and eliminate operational inefficiencies effectively.

One of the key contributions of statistical process and quality control techniques is their ability to continuously monitor and analyze process data. Through the use of control charts, organizations can visualize process performance over time, detect variations, and identify potential sources of inefficiencies. Control charts provide a graphical representation of process data, allowing businesses to distinguish between common cause and special cause variations. This helps in identifying areas of improvement and taking targeted actions to eliminate process variations that negatively impact efficiency.

In addition to control charts, process capability analysis is another valuable technique employed in statistical process and quality control. It assesses the inherent capability of a process to meet customer requirements and specifications. By evaluating process performance against predefined tolerances, organizations can identify areas where improvements are necessary to enhance operational efficiency. Process capability analysis provides a quantitative measure of a process's ability to consistently produce output within specified limits, guiding organizations in setting realistic goals for improvement.

Furthermore, the application of Six Sigma methodologies, which integrate statistical process and quality control techniques, can significantly contribute to improving operational efficiency. Six Sigma is a data-driven approach that focuses on reducing process variations and defects to achieve near-perfect performance. By employing the DMAIC (Define, Measure, Analyze, Improve, Control) framework, organizations can identify process inefficiencies, measure their impact, analyze root causes, implement improvements, and establish control mechanisms to sustain gains. Through the rigorous application of statistical tools and techniques, Six Sigma helps organizations streamline operations, reduce cycle times, and improve overall efficiency.

By leveraging statistical process and quality control techniques, organizations can identify and address operational inefficiencies proactively. The continuous monitoring and analysis of process data enable businesses to detect deviations, identify improvement opportunities, and implement targeted actions to enhance operational efficiency. The use of control charts, process capability analysis, and Six Sigma methodologies provide organizations with valuable insights and tools to measure, analyze, and improve process performance. Ultimately, by improving operational efficiency, organizations can achieve cost savings, increase customer satisfaction, and gain a competitive edge in the marketplace.

Reducing Defects, Waste, and Costs

Effective quality control practices play a pivotal role in minimizing defects, waste, and the associated costs within business operations. By implementing rigorous quality control measures, organizations can significantly reduce the occurrence of defects and non-conformities, leading to improved product and service quality. This, in turn, results in a wide range of benefits, including cost savings, enhanced customer satisfaction, and increased operational efficiency.

One of the key advantages of implementing effective quality control practices is the early identification and addressing of potential sources of defects and non-conformities. Through the use of quality control tools and techniques, such as failure mode and effects analysis (FMEA), organizations can systematically assess potential failure modes, their causes, and their potential impact on product or process performance. By proactively identifying and addressing these risks, organizations can take preventive actions to mitigate or eliminate them before they impact the final product or service. This proactive approach helps minimize the occurrence of defects and reduces the need for costly rework or product recalls.

Root cause analysis is another important tool in effective quality control practices. It enables organizations to investigate and identify the underlying causes of defects or non-conformities. By understanding the root causes, organizations can implement targeted corrective actions to address the issues at their source, rather than merely treating the symptoms. This not only helps in resolving the immediate problem but also prevents the recurrence of similar issues in the future, resulting in long-term cost savings.

Mistake-proofing techniques, also known as poka-yoke, are employed to design processes and systems in a way that prevents or detects errors before they occur or reach the customer. These techniques involve the implementation of mechanisms or controls that make it difficult for errors to happen or immediately alert operators if an error is made. By incorporating mistake-proofing techniques into the production or service delivery processes, organizations can significantly reduce the likelihood of defects and associated costs. This can include methods such as visual cues, checklists, error-proof fixtures, or automated error detection systems.

The effective implementation of quality control practices not only minimizes defects but also leads to substantial cost savings. By reducing scrap, rework, and customer complaints, organizations can save on material costs, labor costs, and resources required to rectify defects. Moreover, the prevention of defects through proactive quality control measures helps in avoiding the costs associated with warranty claims, product recalls, or customer dissatisfaction. Additionally, organizations can achieve cost savings through improved operational efficiency, as quality control practices streamline processes, eliminate bottlenecks, and reduce cycle times.

Enhancing Customer Satisfaction, Loyalty, and Retention

Quality control plays a crucial role in directly impacting customer satisfaction and loyalty. When organizations consistently deliver products and services that meet or exceed customer expectations, they can build a strong reputation for quality and reliability. This, in turn, fosters trust and loyalty among customers, leading to increased customer satisfaction, repeat purchases, and improved customer retention.

Statistical process control techniques are instrumental in ensuring product quality throughout the production process. By monitoring and controlling various parameters and variables during production, organizations can detect and address any deviations or issues that may affect the quality of the final

product. This proactive approach allows businesses to make real-time adjustments and maintain consistent performance and adherence to specifications.

When customers receive products or services that consistently meet their expectations, they experience a higher level of satisfaction. They have confidence in the organization's ability to deliver reliable and high-quality offerings. This positive experience not only leads to a higher likelihood of repeat purchases but also increases the likelihood of positive word-of-mouth recommendations to others. Satisfied customers may become brand advocates, promoting the organization's products or services to their network, which can contribute to business growth and success.

Moreover, quality control helps in minimizing the occurrence of defects, errors, or issues that can lead to customer dissatisfaction. By addressing potential quality issues at an early stage and ensuring that only products or services that meet the desired standards are delivered to customers, organizations can prevent customer complaints, returns, or negative experiences. This not only preserves the organization's reputation but also saves valuable resources that would otherwise be spent on rectifying quality-related issues or addressing customer complaints.

Customer satisfaction and loyalty are critical factors for the long-term success of businesses. By consistently meeting customer expectations through effective quality control practices, organizations can cultivate a loyal customer base. Satisfied customers are more likely to continue doing business with the organization, provide positive feedback, and refer others to the company's products or services. This not only contributes to revenue growth but also helps in maintaining a competitive edge in the market.

Contributing to Informed Decision-Making and Strategic Planning

Statistical process and quality control provide businesses with data-driven insights for informed decision-making and strategic planning. By collecting and analyzing process data, organizations can identify patterns, trends, and areas for improvement. Quality control tools such as Pareto analysis, cause-and-effect diagrams, and statistical hypothesis testing assist in identifying root causes, evaluating process changes, and making evidence-based decisions. Quality control data also provides valuable inputs for strategic planning, enabling businesses to set quality objectives, allocate resources, and prioritize improvement initiatives based on identified areas of improvement and customer requirements.

In conclusion, statistical process and quality control are instrumental in enhancing business performance and facilitating informed decision-making. By improving operational efficiency, reducing defects and costs, enhancing customer satisfaction, and providing data-driven insights, organizations can achieve sustainable growth, competitive advantage, and long-term success.

RECOMMENDATIONS FOR IMPLEMENTING STATISTICAL PROCESS AND QUALITY CONTROL

Implementing statistical process and quality control requires a systematic approach and a commitment to continuous improvement. This section provides recommendations for businesses to adopt and optimize statistical process and quality control practices, build a culture of quality, and engage employees in quality control initiatives.

Guidelines and Steps for Adoption

To successfully implement statistical process and quality control, businesses should follow these guidelines and steps:

a) Define Quality Objectives: Clearly articulate the quality objectives that align with the organization's overall goals and customer expectations.

b) Identify Key Processes: Identify the critical processes within the organization that directly impact product or service quality. Prioritize these processes for quality control implementation.

c) Collect Process Data: Establish a system for collecting and analyzing process data. This includes defining appropriate metrics and indicators to measure process performance and quality.

d) Apply Statistical Tools and Techniques: Utilize statistical tools and techniques such as control charts, Pareto analysis, and process capability analysis to monitor, analyze, and improve process performance.

e) Establish Control Limits: Set appropriate control limits based on process capability and specifications to identify out-of-control conditions and take corrective actions.

f) Implement Corrective and Preventive Actions: Develop a robust system for addressing non-conformities, identifying root causes, and implementing corrective and preventive actions to prevent quality issues from recurring.

g) Continuously Monitor and Improve: Implement a culture of continuous improvement by regularly reviewing process data, identifying areas for improvement, and implementing appropriate changes to enhance process performance and quality.

Building a Culture of Quality and Continuous Improvement

Building a culture of quality and continuous improvement is essential for the successful implementation of statistical process and quality control. Here are some strategies to foster such a culture:

a) Leadership Commitment: Ensure that senior management demonstrates a strong commitment to quality and leads by example. Establish quality as a core value of the organization.

b) Employee Engagement: Involve employees at all levels in quality control initiatives. Encourage their active participation, provide opportunities for suggestions and feedback, and recognize and reward their contributions to quality improvement.

c) Communication and Training: Communicate the importance of quality control to all employees. Provide training programs to enhance their understanding of statistical process and quality control methodologies and their application in daily work.

d) Continuous Learning: Encourage a culture of continuous learning by promoting knowledge sharing, conducting regular training sessions, and providing access to resources and best practices in quality control.

Importance of Employee Training and Engagement

Employee training and engagement are vital for the successful implementation of statistical process and quality control. Businesses should:

a) Provide Comprehensive Training: Offer training programs on statistical process and quality control methodologies, tools, and techniques. This ensures that employees have the necessary skills and knowledge to contribute effectively to quality improvement efforts.

b) Foster Employee Ownership: Encourage employees to take ownership of quality control by involving them in problem-solving, decision-making, and process improvement activities. This fosters a sense of responsibility and accountability for maintaining and enhancing quality.

c) Recognize and Reward Quality Contributions: Acknowledge and reward employees for their contributions to quality control initiatives. This can be done through performance evaluations, incentives, or recognition programs, which further motivate employees to actively participate in quality improvement.

d) Promote Cross-Functional Collaboration: Encourage collaboration and knowledge sharing across different departments and teams to leverage diverse perspectives and experiences in identifying and resolving quality issues.

In conclusion, businesses can optimize the implementation of statistical process and quality control by following guidelines, building a culture of quality and continuous improvement, and prioritizing employee training and engagement. By adopting these recommendations, organizations can achieve sustained quality improvements, enhance customer satisfaction, and drive business success.

CONCLUSION

In this paper, we have explored the importance and application of statistical process and quality control in business. We have discussed the theoretical framework, the application of statistical process and quality control in different industries, the challenges and considerations in implementing quality control systems, and the role of statistical process and quality control in enhancing business performance and decision-making.

Key findings from this paper indicate that statistical process and quality control plays a crucial role in improving operational efficiency, reducing defects and costs, and enhancing customer satisfaction and loyalty. By implementing effective quality control practices, businesses can make informed decisions, improve their overall performance, and gain a competitive edge in the market.

The significance of statistical process and quality control in business cannot be overstated. It provides organizations with the tools and methodologies to monitor and improve processes, identify areas for improvement, and make data-driven decisions. This ultimately leads to improved product and service quality, increased customer satisfaction, and greater operational efficiency.

While this paper has provided a comprehensive overview of statistical process and quality control in business, there are still potential areas for further research. Future studies could explore the application of advanced statistical techniques and artificial intelligence in quality control, the integration of quality control with supply chain management, and the impact of quality control on sustainability and environmental performance.

In conclusion, statistical process and quality control are essential components of successful business management. By adopting and optimizing these practices, organizations can enhance their performance, make informed decisions, and achieve long-term success in today's competitive business landscape.

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New Characterizations Of Spinor Equations In 3-Dimensional Euclidean Space

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Abstract

One of the most studied subjects of differential geometry in different dimensions and spaces is the theory of curves. The first studies on this theory were made by Newton and Leibniz. Later, these works were followed by the works of Euler and Monge. Spinor representation is one of the most studied topics in the theory of curves. In this study, therefore, spinor representation of pythagorean hodograph curve in Euclidean 3-space is studied. The geometric properties of this representation will be examined. Finally, examples of the results obtained from the theory will be given.

Key words: *Spinor, Euclidean Space, Pythagorean Hodograph Curve*

Special Polynomial Curves in $\mathbb{R}^3_1$

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Abstract

One of the most important fields of study of computational geometry is geometric modeling. The first step in geometric modeling is the parametrization of curves and surfaces. In this study, therefore, a subclass of a special polynomial curve called the Minkowski Pythagorean Hodograph curve in 3D Minkowski space is studied. The geometric properties of this curve will be examined. Finally, examplesof the results obtained from the theory will be given.

Key words: *Polynomial Curve, Pythagorean Hodograph, Minkowski Space.*

A new c-k estimator for the poison regression model

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Abstract

The Poisson regression model (PRM) is usually applied in the situations when the response variable is in the form of count data. For estimating the unknown parameters of the PRM, maximum likelihood estimation (MLE) is commonly used. However, its performance is suspected when the regressors are multicollinear. This study introduces the c-k class estimator to address the issue of multicollinearity in the PRM. The proposed estimator is obtained by mixing the two existing estimators namely Stein and ridge estimators. The proposed estimator is the robust solution to tackle with the linearly correlated explanatory variables. For evaluation purpose, we perform a theoretical comparison with other existing competitive estimators. The Monte Carlo simulation study has also been conducted to verify the supremacy of the c-k estimator under different evaluated conditions where mean square error (MSE) is considered as a performance criterion. Based on the results of simulation study and real- life applications, it is observed that the proposed estimation method is the more efficient estimation method as compared to the MLE method and other competitive estimations.

Keywords *Multicollinearity. c-k estimator. Ridge estimator. James Stein estimator. Shrinkage parameter. MLE.*

Twitter Analysis of Kahramanmaraş Earthquakes in Türkiye

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Abstract

Two devastating earthquakes with magnitudes of 7.8 and 7.5 hit southeast Türkiye on February 6, 2023, claiming the lives of over 50,000 individuals, and leaving thousands more injured. Social media, primarily Twitter, can be used by those affected by a natural catastrophe to request immediate help with debris removal, supply delivery, or emergency search and rescue. This descriptive study investigates Twitter usage during the Kahramanmaraş Earthquakes to determine the amount and content of communication on Twitter by extracting the information and mapping aid requests. 721,783 tweets were included in the raw dataset. Because some of the hashtags were provincial names (for example, #Hatay, #Gaziantep), some of the tweets featured advertisements, city promotion efforts, photographs, and noisy Twitter streams. After removing duplicated retweets, the sample contained 697,313 publicly available and usable tweets from February 6 to February 14, 2023. From the first hours of the earthquake, assistance was requested via Twitter to rescue those trapped under the rubble; for example, 229.1 thousand tweets between 8.00 am and 9.00 am. During the third and fourth days, tweets increasingly addressed necessities such as shelter/housing, drinking water, medication, cranes, and mobile toilets. The number of retweets and likes for the tweets posted by various institutions with propaganda and social campaign content is low. Tweets with hashtags on some geologists and pioneering volunteer leaders are the most retweeted and liked by the community. Using Twitter, governments and organizations can promptly respond and implement necessary measures to effectively manage emergency situations, thereby minimizing loss and damage.

Key words: *Big Data Analysis, Twitter, Earthquake, Kahramanmaraş, Türkiye,*

Singular Optimal Control Problem for Stochastic Switching System with Delays

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Abstract

Necessary conditions of optimality give a tool for studying of optimization problems. In partucalar, first-order necessary conditions provide a basis for solving of optimal control problems in general. But sometimes this information may be trivial and cannot provide enough information to find the desired optimal controls.
This paper is devoted to stochastic singular optimal control problem of switching systems. The behavior of switching systems are governed by the collection of stochastic differential equations whose initial positions depend on its previous state. We study switching control systems whose dynamics is described by stochastic differential equations, whose drift and diffusion coefficients contain time delays. Second order necessary condition of optimality for above mentioned stochastic optimal control systems is established.

Key words: *Differential equations with delay, Switching control systems; Optimality conditions, Singular controls; Switching law*

INTRODUCTION

Uncertainty and time delay are important properties of many real phenomena. Systems with uncertainties have provided a lot of interest for problems of nuclear fission, communication systems, self-oscillating systems and etc. (Ayyub et.al.,2006; Benjamin et.al., 1970; Schweppe,1973). Stochastic differential equations find much exhibits in description of the real systems, which in one or another degree are subjected to the influence of the random noises (Gikhman et al.,1972; Mao, 1997). Withal differential equations with time delay can be used in modeling of processes with a memory; that is, the behaviour of the system is dependent of the past (Malek-Zavarei et.al.1987, Kolmanovsky et.al,1992).

Many problems in physics, engineering, biological and economical sciences are expressed in terms of optimality principles, which provide the compact description of the laws governing dynamics and design of a systems (Arnold, 1974; Annunziata et.al., 2007; Pham, 2005). Stochastic models and stochastic control problems have many practical applications. Modern presentations of stochastic optimal control principles are considered in (Elsanosi et.al, 2002; Larssen, 2002; El-Bakry et.al.,2010; Federico et.al,2011).

A switching systems have the benefit of modeling dynamic phenomena with the continuous law of movement. Recently, optimization problems for switching systems with delay have attracted a lot of theoretical and practical interest in modelling and investigation of power systems, manufacturing systems, communication systems, aerospace space and a lot of problems of mathematical finance [Bengea et.al.,2005; Capuzzo et.al., 1984; Xu et.al,2003).

Deterministic and stochastic optimal control problems of switching systems, described by differential equations with delay, are actual at present (Aghayeva, 2015a; Avalishvili, 1985; Kharatatishvili et.al, 1997; Shen et.al., 2009).

The first-order necessary conditions provide a basic tools to study the properties of stochastic optimal controls. However, in some cases the first-order necessary condition for stochastic optimal controls may be trivial and therefore it cannot provide enough information to find the desired optimal controls. In such cases arise the problems associated with singular controls. First-order necessary conditions of optimality for stochastic switching systems with uncontrolled diffusion coeffcients have been studied by the author in Aghayeva, 2015a, Aghayeva, 2015b, stochastic singular case of optimal control problem for switching systems have been investigated in Aghayeva, 2016.

In this paper, the singular optimal control problem of stochastic switching systems with delay is considered. We obtain second-order necessary condition of optimality and transversality conditions for such systems.

MATERIAL AND METHODS

Let (Ω, F^l, P), $l = 1, \dots, r$ be a probability spaces with filtration $\{F^l_t, t \in [t_{l-1}, t_l],\ l = 1, \dots, r\}$, $0 = t_0 < t_1 < \dots < t_r = T$. Assume that $w^1, w^2, \dots, w^r$ are independent Wiener processes, which generate $F^l_t = \sigma(w^l_t, t_{l-1} \le t \le t_l)$, $l = 1, \dots, r$. Let R^n denotes the n - dimensional real vector space and $|.|$ denotes the Euclidean norm in R^n. E represents the expectation. $L^2_{F^l}(a, b; R^n)$ denotes the space of all predictable processes $x_t(\omega)$ such that: $E\int_a^b |x_t(\omega)|^2 dt < +\infty$. $R^{m\times n}$ is the space of linear transformations from R^m to R^n. Let $O_l \subset R^{n_l}, Q_l \subset R^{m_l}, l = \overline{1,r}$, be open sets.

Consider the following stochastic control system:

$$dx^l_t = g^l\left(x^l_t, x^l_{t-h}, u^l_t, t\right)dt + f^l\left(x^l_t, x^l_{t-h}, t\right)dw_t \quad t \in \left(t_{l-1}, t_l\right],\ l = 1,\dots, r, \quad (1)$$

$$x^1_t = \mathrm{K}^l(t), t \in \left[t_{l-1} - h, t_{l-1}\right), l = 1,\dots r, \quad (2)$$

$$x^l_{t_{l-1}} = \Phi^{l-1}\left(x^{l-1}_{t_{l-1}}, t^{l-1}\right) \quad l = 2,\dots, r; \quad x^1_{t_0} = x_0, \quad (3)$$

$$u^l_t \in U^l \equiv \left\{u^l(\cdot,\cdot) \in L^2_{F^l}\left(t_{l-1}, t_l; R^{m_l}\right) \mid u^l(t,\cdot) \in U^l \subset R^{m_l}, l = 1,\dots, r \quad a.c.\right\} \quad (4)$$

where U^l, $l = 1,\dots, r$ are non-empty bounded sets.

In optimal control problem of stochastic switching systems, one needs to find both optimal inputs $\left(x^1, x^2, \dots, x^r, u^1, u^2, \dots, u^r\right)$ and switching sequences $t_1, t_2, \dots, t_r$, which minimize the cost functional:

$$J(u) = \sum_{l=1}^{r} E\left[\varphi^l\left(x^l_{t_l}\right) + \int_{t_{l-1}}^{t_l} p^l\left(x_t, u_t, t\right) dt\right] \quad (5)$$

which is determined on the decisions of the system (1)-(3), which are generated by all admissible controls $U = U^1 \times U^2 \times \dots \times U^r$.

Consider the sets: $A_i = \mathrm{T}^{i+1} \times \prod_{j=1}^{i} O_j \times \prod_{j=1}^{i} O_j \times \prod_{j=1}^{i} \Lambda_j \times \prod_{j=1}^{i} Q_j$, $i = 1,\dots, r$, with the elements $\pi^i = (t_0, t_1, t_i, x^1_{t_0}, x^2_{t_2}, \dots, x^i_{t_i}, K^1, K^2, \dots, K^i, u^1, u^2, \dots, u^i)$.

Definition 1: The set of functions $\left\{x^l_t = x^l\left(t, \pi^l\right), t \in \left[t_{l-1} - h, t_l\right], l = 1,\dots, r\right\}$ is said to be a solution of the equation with variable structure which corresponds to an element $\pi^r \in A_r$, if the function $x^l_t \in O_l$

on the interval $[t_l - h, t_l]$ satisfies the conditions (2),(3), while on the interval $[t_l, t_{l+1}]$ it is absolutely continuous with probability 1 and satisfies the equation (1) almost everywhere.

Definition2: The element $\pi^r \in A_r$ is said to be admissible if the pairs $(x_t^l, u_t^l), t \in [t_{l-1} - h, t_l], l = 1,...,r$ are the solutions of system (1)-(4) .

A_r^0 denotes the set of admissible elements.

Definition 3: The element $\tilde{\pi}^r \in A_r^0$, is said to be an optimal solution of problem (1)-(5) if there exist admissible controls $\tilde{u}_t^l, t \in [t_{l-1}, t_l], l = 1,...,r$ and corresponding solutions of system (1)-(3) $\{\tilde{x}_t^l, t \in [t_{l-1} - h, t_l], l = \cancel{1,r}\}$, and these pairs $(\tilde{x}_t^l, \tilde{u}_t^l), l = \cancel{1,r}$ minimize the functional (5).

Finally, to state the main result of this paper, we need to introduce the following definition of stochastic singular switching systems in sense of maximum principle.

Definition 4. An admissible controls $u_t^l, t \in [t_{l-1}, t_l], l = 1,...,r$ are said to be singular on control regions V^l, if each $V^l \subset U^l$ is nonempty and for a.e. $t \in [t_{l-1}, t_l]$, we have
$H_x^l(\psi_t^l, x_t^l, y_t^l, u_t^l, t) = H_x^l(\psi_t^l, x_t^l, y_t^l, v_t^l, t), v_t^l \in V^l$.

RESULTS

Next first order necessary condition of stochastic switchig systems with delay is important to investigate the optimal control problem for considering systems (Aghayeva, 2015b).

Theorem (Maximum Principle). Suppose that, $\pi^r = (t_0, t_1, t_r, x_t^1, x_t^2, ..., x_t^r, u_t^1, u_t^2, ..., u_t^r)$ is a optimal solution of problem (1)-(5) and $(\psi_t^l, \beta_t^l) \in L^2_{F^l}(t_{l-1}, t_l; R^{n_l}) \times L^2_{F^l}(t_{l-1}, t_l; R^{n_l x n_l})$ are the solutions of the following adjoint equations:

$$\begin{cases} d\psi_t^l = -\left[H_x^l(\psi_t^l, x_t^l, u_t^l, t) + H_y^l(\psi_{t+h}^l, x_{t+h}^l, u_t^l, t)\right]dt + \beta_t^l dw_t^l, \ t_{l-1} \le t < t_l - h, \\ d\psi_t^l = -H_x^l(\psi_t^l, x_t^l, u_t^l, t)dt + \beta_t^l dw_t^l, \ t_l - h \le t < t_l, \ l = 1,..., r, \\ \psi_{t_l}^l = -\varphi_x^l(x_{t_l}^l) + \psi_{t_{l+1}}^l \Phi_x^l(x_{t_l}^l, t_l), \ l = 1,..., r-1, \\ \psi_{t_r}^l = -\varphi_x^l(x_{t_r}^l), \ 1,..., r. \end{cases} \quad (6)$$

Then,

a) For $\forall \tilde{u}^l \in U^l, l = 1,...,r,$ a.c the maximum principal hold:

$$H^l(\psi_\theta^l, x_\theta^l, y_\theta^l, \tilde{u}^l, \theta) - H^l(\psi_\theta^l, x_\theta^l, y_\theta^l, u_\theta^l, \theta) \le 0, \ \text{a.e.} \theta \in [t_{l-1}, t_l] \quad (7)$$

b) Following transversality conditions hold:

$$\psi_{t_l}^{l+1} \Phi_t^l(x_{t_l}^l, t_l) = 0, \ l = 1,...,r-1, \quad (8)(8)$$

Here $H^l(\psi_t, x_t, y_t, u_t, t) = \psi_t^l g^l(x_t, y_t, u_t, t) + \beta_t^l f^l(x_t, y_t, t) - p^l(x_t, u_t, t), \ t \in [t_{l-1}, t_l],$

and $y_t^l = x_{t-h}^l, \ l = 1,...,r.$

Theorem (Second Order Necessary Condition). Let $\pi^r = (t_0, t_1, t_r, x_t^1, x_t^2, \ldots, x_t^r, u_t^1, u_t^2, \ldots, u_t^r)$ is a optimal solution of problem (1)-(5) and $u = (u^1, u^2, \ldots, u^r)$ be singular on the control region $V = (V^1, V^2, \ldots, V^r)$. Random processes $(\psi_t^l, \beta_t^l) \in L^2_{F^l}(t_{l-1}, t_l; R^{n_l}) \times L^2_{F^l}(t_{l-1}, t_l; R^{n_l \times n_l})$ are the solutions of the adjoint system (6). Then, a.e. in $\tau \in [t_{l-1}, t_l)$ for $\forall v^l \in V^l$, a.c. the second order maximum principle in form

$$E\Delta_{v^l} g^{l*}(x_\tau^l, y_\tau^l, u_\tau^l, \tau) K^l(\tau, \tau) \Delta_{v^l} g^l(x_\tau^l, y_\tau^l, u_\tau^l, \tau) +$$
$$+ E\Delta_{v^l} H_x^{l*}(\psi_\tau^l, x_\tau^l, y_\tau^l, u_\tau^l, \tau) \Delta_{v^l} g^l(x_\tau^l, y_\tau^l, u_\tau^l, \tau) \le 0,$$

hold for each $l = 1, \ldots, r$. Here

$$K^l(\tau, \theta) = \int_{\max(\tau,\theta)}^{t_l} \Big[Q_{t\tau}^{l*} H_{xx}^l(\psi_t^l, x_t^l, y_t^l, \mu_t^0, t) Q_{t\theta}^l +$$
$$+ Q_{t-h,\tau}^{l*} H_{xy}^l(\psi_t^l, x_t^l, y_t^l, u_t^l, t) Q_{t\theta}^l + Q_{t\tau}^{l*} H_{yx}^l(\psi_t^l, x_t^l, y_t^0, u_t^l, t) Q_{t-h,\theta}^l +$$
$$+ Q_{t-h,\tau}^{l*} H_{yy}^l(\psi_t^l, x_t^l, y_t^l, u_t^l, t) Q_{t-h,\theta}^l \Big] dt - Q_{t_l\tau}^{l*} p_{xx}^l(x_T^l) Q_{t_l\theta}^l$$

and $Q_{t\tau}^l$ are the solutions of following homogenous equatios:

$$dQ_{t\tau}^l = \left(g_x^l(x_t^l, y_t^l, u_t^l, t) Q_{t\tau}^l + g_y^l(x_t^l, y_t^l, u_t^l, t) Q_{t-h,\tau}^l \right) dt +$$
$$+ \left(f_x^l(x_t^l, y_t^l, t) Q_{t\tau}^l + f_y^l(x_t^l, y_t^l, t) Q_{t-h,\tau}^l \right) dw_t, \qquad t > \tau;$$
$$Q_{\tau\tau} = I;$$
$$Q_{t\tau} = 0, \qquad t < \tau.$$

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The Impact of Poverty on Educational Achievement

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Abstract

Poverty is a growing and massive problem for the whole world. The growing income inequality is demonstrated by the differences between counties of North Carolina. People from different counties are living in poor conditions such as poor educational facilities; additionally, poor communities cannot afford good services, such as sufficient teaching facilities, and the high costs of basic services. Because of the lack of access to education resources, students do not graduate from high school, or they do not earn high enough scores to enter universities. Educational achievements facilitate the most important opportunities to get a job and earn money. Thus, there is a need for government funding programs address poverty. Because of these needs, government should expand its programs that target spending at low- income communities, and provide increasing awareness of poverty and its consequences.

Poverty is a huge problem for North Carolina's educational outcomes; educational achievement gaps have increased in families with low-income levels. The specific research objective isto examine how poverty in different regions impacts student educational achievements. The purpose ofthis study is to explore the impact of poverty in North Carolina counties, focusing on the relationship between students' poverty and students' achievement. There is a connection between economic advantages and educational achievements; this study focuses on describing how the disadvantages of living in certain North Carolina counties affect educational success, and how poverty in different regions affects student educational achievements.

Key Words: *Poverty, Educational Achievement, North Carolina*

THEORY AND HYPOTHESIS

The purpose of this study is to explore the impact of poverty in North Carolina counties, focusing on the relationship between students' poverty and students' achievement. There is a connection between economic advantages and educational achievements; this paper describes how Percent Persons in Poverty in 100 counties of North Carolina affects educational success. This study will hypothesize that as poverty rates increase, educational achievement will decrease; this leads to the research hypothesis:

H1: In a comparison of North Carolina counties, those counties with lower income levels will be less likely to have high SAT scores than those who live in similar counties with higher income levels.

DATA

This hypothesis was tested by the North Carolina counties through the United States Census Bureau and the Log into North Carolina (LINC) database system. The Census Bureau provides the leading source of quality data about North Carolina's population; the LINC offers services including historical information for each geographical area in the state of North Carolina. LINC's statistical scope is broad and includes elements such as population, housing, health, social, and human services. The data used for this qualitative study is secondary, and the samples of data were composed for 100 North Carolina counties (O'Sullivan, Rassel, & Berner, 2008a).

The interval- level independent variable used in this study is the Percent Persons in Poverty in North Carolina counties. The data was received from the United States Census Bureau and the source of this data was derived from Federal Agency Data within the Census of Population and Housing. This independent variable measured the persons for whom poverty status was determined. The 1970 data were from the General Social and Economic Characteristics; the 1980, 1990, and 2000 data were derived from total poverty as a percentage of total poverty status by sample data.

The interval- level dependent variable was the SAT total average scores in North Carolina counties, and was derived from the Department of Public Instruction. Scores of students from the North Carolina School of Science and Mathematics were excluded from SAT averages for the counties. The state of North Carolina SAT quantitate and verbal part scores included both public school and private school students. This dependent variable was represented by 2001 for the 2000-2001 school years.

The interval- level control variable used in this study is Public School Expenditures. The state agency data were originated from the Department of Public Instruction. The Public School Expenditure measured by the ending year of the fiscal year, i.e.2003 represents the 2002- 03 school year. The financial report of 100 counties contains all current expenditures for public kindergarten, elementary, and secondary schools and special schools for exceptional children. Public School Expenditures are directly related to student enrollment numbers. Per pupil expenditures were computed by using average daily membership, which is greater than average daily attendance. Funding sources were derived from state, federal, and local governments' budgets. This control variable will help this study demonstrate that public school expenditures impact educational outcome. We assume that Public School Expenditure has a weak effect on poverty level; We expect that this study will examine a stronger correlation between poverty and educational outcomes than between expenditures and educational outcomes.

METHODS

In this study, the independent, dependent, and control variables are interval level variables; therefore, first, we selected bivariate correlation analysis as the method of analysis. This analysis will allow me to examine the relationship between the variables, and show the correlation between poverty and educational outcomes. Because correlation is completed as a preliminary analysis to regression, the next step is regression analysis, which helps this study estimate the relationships among variables. This analysis also helps this study show how dependent variable, Average SAT Total, changes when independent variable, Pct. Persons in Poverty, is varied. Thus, in this study, regression analysis is used to understand which independent variable is related to the dependent variable, and to explore the results of these relationships.

FINDINGS

Table 2 shows the results of this study's correlation analysis. According to the results, the internal level variables used in this correlation analysis include: the Public School Expenditures, Average SAT Total, and Percent Person in Poverty. These variables derive from ORB Dataset of the 100 North Carolina counties. In this bivariate correlation, these variables are examined and significant results were found.

First, the Pearson Product Moment Correlation Coefficient r for Public School Expenditures and Average SAT Total is .244. The correlation indicates that these two variables are statistically significant. The relationship is weak. However, the correlation indicates that these variables are positively correlated. P-value for the correlation is .015, which means p< 0.01. r is lower than .05; therefore, the null hypothesis is rejected.

Second, the Pearson correlation for Average SAT total and percentage person in poverty is -. 673, which indicates that the relationship is strong. There is a statistically significant relationship between the two variables, so the null hypothesis is rejected. The negative sign in the correlation indicates that two variables are negatively correlated: the higher average SAT total, the lower perceived percentage person in poverty. P-value for the correlation is .000, which shows p<.001.

Finally, the Pearson correlation for Public School Expenditures and Pct. Person in Poverty is -.339, so the relationship between the two variables is weak. Therefore, there is a statistically significant relationship between two variables, and the null hypothesis is rejected. The two variables are negatively correlated. P-value for the correlation is .001.

The table labelled Model Summary (Table 3) includes information about R, R2, and adjusted R2. In the multiple regression analysis for this study, the result of .673 indicates that linear combination of two independent variables, Public School Expenditures, and Pct. Persons in Poverty, strongly predict the actual dependent variable, Average SAT Total. This regression analysis shows that the linear combination of Pct. Persons in Poverty and Public School Expenditures explains 45.3% the variance in Average SAT Total. The adjusted R2 is .442, and the difference between R2 and adjusted R2 is very small; therefore, it is different enough from unadjusted R2 to be worth reporting.

The table labelled ANOVA (Table 4) in the SPSS output provides the results of a test of significance for R and R2 using the F- statistic. In this analysis, the p-value is below .05: thus, R, R2, and adjusted R2 for the multiple regression conducted Average SAT Total based on the linear combination of Public School Expenditures and Pct. Persons in Poverty is statistically significant.

The table labelled Coefficients (Table 5) in the SPSS output provides:

Y (Average SAT Total) = 1111.17-9.60X1 (Pct. Persons in Poverty) + 8.39X2 (Public School Expenditures)

This result indicates that the intercept is 1111.17 Average SAT Total when all independent variables have a value of zero. Holding Public School Expenditure constant, the Average SAT Total increases by 9.604 for each additional decrease in the Pct. Persons in Poverty. The p- value for this coefficient is statistically significant (p<.001), meaning that Pct. Persons in Poverty is a significant predictor of Average SAT Total. Holding Pct. Persons in Poverty constant, the Average SAT Total increase by 8.39, for this coefficient is not a significant predictor of the Average SAT Total. With the Beta values in this analysis, Pct. Persons in Poverty .667 has the strongest relationship with Average SAT Total, compared to Public School Expenditures (.017). In this analysis, all VIF is lower than 5; therefore, there is no multicollinearity problem in this analysis.

CONCLUSION

Even though the USA is one of the richest nations in the world, more than 30 million children live in poverty which is more than one in five. In low- income communities, there was only one book for every 300 children. The lack of federal and state educational programs is likely to strengthen the link between economic disadvantages and educational outcomes. According to the Annie Casey Foundations Annual Kids Count report, after comparing poverty rates of almost 1.3 million children living in low-income families, North Carolina is the fourteenth worst state for kids. Poverty is a huge problem for North

Carolina's educational outcomes; educational achievement gaps have increased in counties with low level incomes.

This relevant literature provides support for my hypothesis for the relationship between poverty and educational success in North Carolina counties. When conducting both bivariate correlation and regression analysis, findings supported a correlation between poverty and educational achievements. The findings of this study show a statistically significant relationship between poverty and educational outcome (Table 2, and Table 5). Furthermore, Public School Expenditures as a controllable variable had a small effect on poverty and educational achievement. The expected result of this study shows that as poverty levels decrease, educational success will increase. The visual of this result shows scatterplot that is negatively strong relationship between poverty and SAT scores (Graph 1).

This study's results, hopefully, provide a discussion about policy for reducing poverty. The evidence of this study shows administrators take into account educational and economic gap, and public administrator should reduce this gap properly addressing this study.

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APPENDIX

Table 1: Descriptive Statistics

Descriptive Statistics

	Mean	Std. Deviation	N
PublicSchoolExpenditurein1000s	91861.90	126039.315	100
Ave SAT Total	974.19	61.898	100
Pct. Persons in Poverty	14.342	4.3009	100

Table 2: Data Outcome

Correlations

		Public School Expenditure in1000s	Ave SAT Total	Pct. Persons in Poverty
PublicSchoolExpenditurein1000s	Pearson Correlation	1	.244*	-.339**
	Sig. (2-tailed)		.015	.001
	N	100	100	100

Ave SAT Total	Pearson Correlation	.244*	1	-.673**
	Sig. (2-tailed)	.015		.000
	N	100	100	100
Pct. Persons in Poverty	Pearson Correlation	-.339**	-.673**	1
	Sig. (2-tailed)	.001	.000	
	N	100	100	100

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.673a	.453	.442	46.232	.453	40.230	2	97	.000

a. Predictors: (Constant), PublicSchoolExpenditurein1000s, Pct. Persons In Poverty

Table 4: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	171974.046	2	85987.023	40.230	.000b
	Residual	207327.344	97	2137.395		
	Total	379301.390	99			

a. Dependent Variable: Ave SAT Total
b. Predictors: (Constant), PublicSchoolExpenditurein1000s, Pct. Persons in Poverty

Table 5: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	1111.165	18.599		59.744	.000	1074.252	1148.079		
Pct.Personsin Poverty	-9.604	1.149	-.667	8.362	.000	-11.884	-7.325	.885	1.130
PublicSchoolExpenditurein1000s	8.395E-6	.000	.017	.214	.831	.000	.000	.885	1.130

a. Dependent Variable: Ave SAT Total

Graph 1 : Visual presentation of bivariate correlation analysis

Investigating Factors Influencing the Usage Intentions of Mobile Banking Users for Chatbot Applications: An Extended meta-UTAUT Approach

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Abstract

With the advancement of technology, the use of the Internet and mobile phones has increased. People utilize mobile applications on their phones to fulfill various needs such as entertainment, education, and healthcare. One of these needs includes banking transactions. Users now have the convenience to conduct many banking transactions through mobile applications. Recently, many banks have been managing their customer relationships through applications known as chatbots. Chatbots are artificial intelligence-based applications with which users interact through text or voice communication. The utilization of chatbots in banking operations enables banks to enhance communication with customers and reduce costs. This study examines the impact of perceived trust in chatbots on users' intention to reuse them. A survey was conducted involving 413 users who had experienced banking operations through chatbot applications. The data was analyzed using Structural Equation Modeling in the R programming language. The findings reveal that performance expectancy, hedonic motivation, habit, anthropomorphic traits, and automation factors have a significant and positive impact on trust. However, factors like effort expectancy, social influence, discomfort, perceived innovativeness, and perceived privacy risk do not significantly affect the trust variable. Additionally, it was observed that the trust variable significantly and positively influences the intention to reuse. The outcomes provide novel insights for professionals, academics, bank top management, product development teams, design teams, and customer satisfaction units, offering new perspectives on banking service distribution channels.

Keywords: *Mobile banking, Chatbot, Structural Equation Modeling, R programming, UTAUT*

Cognitive Resource Allocation in Project Administration: An Exploration through Game Theory

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Abstract

Effective resource allocation is a critical aspect of project management, influencing project timelines, costs, and overall success. This study delves into the intricate realm of resource allocation within project administration, adopting a unique perspective through the lens of game theory. By leveraging concepts from game theory, this research offers a novel exploration of cognitive resource allocation strategies that account for the dynamic and often competitive nature of project environments. Through the application of game-theoretic models, this study aims to provide insights into decision-making processes for resource allocation, where multiple stakeholders with differing objectives engage in a strategic interplay. The investigation considers the complex interdependencies among resources, tasks, and project objectives, acknowledging the inherent uncertainties that project managers face. The outcomes of this research are anticipated to contribute to the development of more robust and adaptable resource allocation methodologies, enabling project managers to make informed decisions in dynamic and challenging project scenarios.

Key words*: Resource Allocation, Project Administration, Game Theory, Decision-making, Strategic Interplay, Cognitive Strategies.*

INTRODUCTION

Effective resource allocation is a pivotal element in the realm of project management, with far-reaching implications for project outcomes, timelines, and costs (Smith & Johnson, 2022; Anderson & Chen, 2021). The intricate task of allocating resources optimally becomes even more challenging in dynamic and competitive project environments. Traditional resource allocation methods often struggle to address the complexities arising from interdependent tasks, multiple stakeholders, and evolving project objectives (Lee & Jackson, 2022). As projects increasingly demand efficient and adaptive resource distribution, a fresh perspective is essential.

This study embarks on a unique exploration of resource allocation strategies within project administration, drawing insights from the field of game theory. Game theory provides a theoretical framework to analyze situations where multiple decision-makers, each pursuing their own objectives, interact and influence each other's outcomes (Smith & Johnson, 2022; Anderson & Chen, 2021). By applying game-theoretic models to resource allocation, we aim to address the strategic and cognitive dimensions of decision-making in project environments.

In the classical project management context, resources are allocated based on predefined plans or heuristics, often overlooking the strategic interactions between stakeholders. However, projects involve diverse stakeholders, each with their objectives and preferences. The allocation of resources in such scenarios resembles a game where stakeholders make decisions considering the actions of others (Brown

& Garcia, 2023). Game theory enables us to capture these interactions, incorporating the dynamic and competitive nature of project environments.

The complex interplay of resource allocation decisions becomes particularly evident in scenarios with uncertain task durations, changing priorities, and fluctuating resource availability (Williams & Martinez, 2023). Traditional methods may falter in these circumstances, as they tend to overlook the strategic responses of stakeholders to changing conditions. Game theory, with its ability to model the strategic behaviors of decision-makers, offers a promising avenue to enhance resource allocation strategies in the face of uncertainty.

Objectives of the Study:

The primary objectives of this study are as follows:

1. To explore the application of game theory in optimizing resource allocation decisions within project administration.
2. To examine the influence of strategic interactions and cognitive factors on resource allocation strategies.
3. To propose enhanced resource allocation methods that consider the dynamic and competitive nature of project environments.

Research Question:

This study seeks to address the following research question: "How can game theory be leveraged to develop cognitive resource allocation strategies that effectively address the dynamic and competitive nature of project administration?"

LITERATURE REVIEW

Resource allocation within project administration has been a subject of significant interest in recent literature, driven by the growing complexity of projects and the need for efficient utilization of resources. Traditional approaches often rely on static allocation plans that may not adequately address the challenges posed by uncertainty, dynamic project environments, and strategic interactions among stakeholders.

In their study, Smith and Johnson (2022) emphasized the importance of integrating game theory into project resource allocation. They demonstrated that game-theoretic models offer a robust framework for considering the diverse objectives of stakeholders and capturing the competitive dynamics inherent in project environments. This aligns with our study's aim to explore cognitive resource allocation strategies through a game theory lens.

Anderson and Chen (2021) extended the application of game theory to complex projects, highlighting its ability to incorporate strategic decision-making and uncertainties. They proposed that the consideration of competitive interactions through game-theoretic modeling can lead to more optimal resource allocation strategies, which echoes our goal of addressing the dynamic and competitive nature of project administration.

Williams and Martinez (2023) delved into the role of uncertainty and competition in project resource allocation. They demonstrated that traditional deterministic approaches can be inadequate in capturing the variability and unpredictability that characterize project environments. By introducing a game-

theoretic perspective, they offered a fresh outlook on handling uncertainty in resource allocation decisions, aligning with our study's emphasis on addressing uncertainty through cognitive strategies.

Lee and Jackson (2022) explored dynamic resource allocation strategies within multi-stakeholder projects. They emphasized that considering the interdependencies and interactions among stakeholders is crucial for effective resource allocation. Their findings resonate with our study's objective to examine the influence of strategic interactions and cognitive factors on resource allocation strategies.

Brown and Garcia (2023) approached the integration of cognitive factors into project resource allocation using game theory. They argued that cognitive considerations, such as bounded rationality and cognitive biases, can significantly impact decision-making processes. Their work aligns with our study's focus on cognitive strategies and underscores the need to incorporate human cognitive aspects in resource allocation models.

In summary, recent literature highlights the potential benefits of incorporating game theory into resource allocation strategies within project administration. The dynamic and competitive nature of project environments, coupled with uncertainties and strategic interactions, make game-theoretic models an appealing avenue for developing effective cognitive resource allocation strategies.

3. METHODOLOGY

This chapter outlines the methodology employed in the study to explore cognitive resource allocation strategies in project administration using game theory. The research design, data collection process, and analytical approach are detailed to provide a comprehensive understanding of the study's methodology.

3.1 Research Design

The study adopts a mixed-methods research design that combines qualitative and quantitative approaches. Qualitative analysis will involve in-depth interviews with experienced project managers to gain insights into their cognitive decision-making processes during resource allocation. Quantitative analysis will utilize game-theoretic models to simulate and optimize resource allocation strategies in various project scenarios.

3.2 Data Collection

3.2.1 Qualitative Data

Semi-structured interviews will be conducted with a purposive sample of project managers who have experience in resource allocation. The interviews will explore their decision-making considerations, cognitive factors, and challenges encountered during resource allocation. Audio recordings and transcriptions of the interviews will be analyzed using thematic analysis to identify recurring themes and patterns.

3.2.2 Quantitative Data

Data for quantitative analysis will be sourced from project management case studies and scenarios. Project parameters such as task durations, resource availability, stakeholder objectives, and uncertainties will be collected and structured for input into game-theoretic models. These models will be used to simulate various resource allocation strategies and their outcomes.

3.3 Analytical Approach

3.3.1 Qualitative Analysis

Thematic analysis will be applied to the interview transcripts to identify key themes related to cognitive decision-making factors and resource allocation strategies. The identified themes will be compared with existing literature to establish alignment or divergence and to develop a comprehensive understanding of the cognitive aspects of resource allocation.

3.3.2 Quantitative Analysis

Game-theoretic models will be formulated to simulate resource allocation decisions in scenarios characterized by uncertainty and strategic interactions among stakeholders. The models will consider different cognitive strategies, incorporating factors such as risk preferences, bounded rationality, and cognitive biases. The outcomes of different strategies will be compared to assess their effectiveness in achieving project objectives.

3.4 Ethical Considerations

The study will adhere to ethical guidelines for research involving human participants. Informed consent will be obtained from all interview participants, and their identities will be anonymized in the research findings to ensure confidentiality.

3.5 Limitations

It is acknowledged that the scope of the study may be limited by the sample size of interview participants and the specific scenarios used in the quantitative analysis. However, efforts will be made to ensure the findings are valid and provide valuable insights into cognitive resource allocation strategies in project administration.

4. RESULTS AND ANALYSES

This part presents the results obtained from both the qualitative interviews and the quantitative analysis using game-theoretic models. The findings are presented and analyzed to address the research objectives and research question outlined earlier.

4.1 Qualitative Findings

The qualitative analysis of interviews with experienced project managers revealed several key themes related to cognitive resource allocation strategies:

- **Cognitive Biases Impact Decision-Making**: Interviewees consistently highlighted the influence of cognitive biases, such as overconfidence and anchoring, on their resource allocation decisions. These biases often led to suboptimal resource allocation outcomes.
- **Risk Preferences Vary Among Stakeholders**: The qualitative data indicated that stakeholders' risk preferences significantly impact their resource allocation decisions. Some stakeholders exhibited risk-averse behaviors, while others were more risk-tolerant, leading to varying allocation strategies.
- **Strategic Interactions Shape Decisions**: Stakeholders' strategic interactions were acknowledged as crucial factors in resource allocation. The interviews revealed instances of competition for resources, collaborative negotiations, and the influence of power dynamics on allocation decisions.

4.2 Quantitative Findings

The quantitative analysis employed game-theoretic models to simulate resource allocation strategies in diverse project scenarios. Different cognitive strategies were incorporated into the models, and their outcomes were compared.

- **Cognitive Strategies Influence Outcomes**: The quantitative simulations demonstrated that resource allocation outcomes were significantly influenced by the cognitive strategies adopted. Strategies that accounted for cognitive biases and stakeholder risk preferences often led to more balanced and efficient resource allocations.
- **Strategic Interactions Impact Results**: Game-theoretic simulations highlighted the impact of strategic interactions among stakeholders on resource allocation outcomes. Scenarios with competitive interactions tended to result in suboptimal allocations, while collaborative strategies led to improved outcomes.

4.3 Comparison with Literature

The findings from both the qualitative and quantitative analyses align with existing literature. The qualitative themes of cognitive biases, risk preferences, and strategic interactions correspond to insights documented by Smith and Johnson (2022), Anderson and Chen (2021), and Brown and Garcia (2023).

4.4 Implications and Discussion

The results underscore the importance of considering cognitive factors and strategic interactions in resource allocation decision-making. The integration of cognitive strategies, along with a deeper understanding of stakeholders' risk preferences and strategic behaviors, can enhance the efficiency and effectiveness of resource allocation in project administration.

4.5 Limitations

It is important to acknowledge that the results are based on simulated scenarios, and real-world project dynamics may vary. Additionally, the qualitative findings are limited to the perspectives of a specific group of project managers, which may not capture the full spectrum of cognitive strategies.

5. DISCUSSIONS

The discussion part interprets and contextualizes the results presented in the previous part within the broader landscape of project management, game theory, and decision-making. The findings from both qualitative interviews and quantitative game-theoretic simulations are examined in relation to existing literature and their implications for practice and research.

5.1 Cognitive Biases and Decision-Making

The qualitative findings confirmed that cognitive biases play a significant role in project managers' resource allocation decisions. Overconfidence, anchoring, and other cognitive biases identified in the interviews align with the observations of Smith and Johnson (2022) and Brown and Garcia (2023). These biases can lead to suboptimal resource allocation outcomes by distorting the assessment of task priorities and resource requirements.

5.2 Risk Preferences and Strategic Interactions

The consideration of risk preferences and strategic interactions highlighted the complex nature of resource allocation decisions. Quantitative simulations demonstrated that different stakeholder risk preferences can lead to diverse allocation strategies, influencing project outcomes. This resonates with the insights of Anderson and Chen (2021) and Lee and Jackson (2022) who emphasized the importance of addressing stakeholder heterogeneity.

5.3 Implications for Practice

The study's findings suggest that cognitive strategies, such as recognizing and mitigating cognitive biases, can enhance the rationality of resource allocation decisions. Acknowledging the varying risk preferences of stakeholders and considering strategic interactions can lead to more informed and effective allocation outcomes. Project managers can benefit from integrating these insights into their decision-making processes.

5.4 Research Contributions and Future Directions

This study contributes to the existing literature by shedding light on the cognitive aspects of resource allocation decisions through the lens of game theory. The qualitative-quantitative approach adopted provides a comprehensive understanding of the challenges and opportunities in project resource allocation. Future research could delve deeper into specific cognitive biases, explore additional strategic interaction models, and validate findings through real-world project case studies.

5.5 Limitations and Recommendations

The study acknowledges several limitations, including the reliance on simulated scenarios and the limited scope of interview participants. To enhance the study's external validity, future research could involve larger and more diverse samples of project managers from various industries. Additionally, extending the game-theoretic analysis to incorporate more complex scenarios and real project data could yield more robust insights.

5.6 Conclusion

In conclusion, this study has illuminated the intricate dynamics of cognitive resource allocation strategies in project administration. The integration of cognitive considerations, stakeholder risk preferences, and strategic interactions can significantly impact allocation outcomes. By recognizing these factors and adopting a game-theoretic perspective, project managers can make more informed decisions in the face of uncertainty and competition.

6. CONCLUSION

This study aimed to explore cognitive resource allocation strategies within project administration through the application of game theory. By integrating qualitative insights from interviews with experienced project managers and quantitative analysis using game-theoretic models, the study gained a comprehensive understanding of the complex dynamics that influence resource allocation decisions.

The qualitative findings illuminated the impact of cognitive biases, risk preferences, and strategic interactions on project managers' decision-making processes. These insights align with existing literature, showcasing the relevance of cognitive factors in resource allocation (Smith & Johnson, 2022; Brown & Garcia, 2023). Quantitative simulations demonstrated that incorporating these cognitive considerations into game-theoretic models significantly influences allocation outcomes and strategic interactions (Anderson & Chen, 2021; Lee & Jackson, 2022).

The implications of this study are twofold. First, project managers can enhance resource allocation decisions by recognizing and addressing cognitive biases, considering varying risk preferences, and strategically interacting with stakeholders. Second, the study contributes to the field by providing a comprehensive framework for integrating cognitive strategies into resource allocation models.

While this study sheds light on the cognitive dimensions of resource allocation, it is not without limitations. The reliance on simulated scenarios and a specific group of interview participants may limit the generalizability of the findings. Future research can expand the scope by involving a broader range of industries and real-world project data.

In conclusion, the integration of cognitive considerations and game-theoretic approaches presents a promising avenue for enhancing resource allocation strategies in project administration. This study underscores the importance of acknowledging cognitive biases, understanding stakeholder risk preferences, and accounting for strategic interactions in making informed and effective resource allocation decisions.

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Econometrıc Approach of The Impact of Clımate Change on Economıc Gorwth: Evidence From Western Balkan

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Abstract

There is no doubt about the high emission of the carbon dioxide in the atmosphere, causing the global warming of our planet to increase constantly, thus resulting with the latest emerging concerns about global warming and climate changes. Having into consideration the latest trends about the climate changes and global warming, no consensus has been reached by policymakers and scholars, as an instrument for gradual decrease of the carbon dioxide emissions worldwide, yet there has been lots of attempts in trying to its decline worldwide.

Having into mind the attention given to the climate change concerns and the attempts in finding effective solution in dealing with the carbon emission and its impact on the economic growth, the main objective of this study is to analyze the effects of climate change on the growth in Western Balkan countries. Thus, the following panel techniques have been used in determining the effects of the carbon emissions on the economic growth of these countries: OLS, Fixed effect and Random effect model, mainly for comparison results, while Hausman Taylor test is used to determine the appropriate model among them. Finally, empirical results reveal existence of a negative and statistically significant relationship between carbon emission and economic growth in Western Balkan economies, suggesting the need for policy strengthen of the adoption and effective use of the carbon tax on these countries, in order to reduce the carbon dioxide emissions and to indirectly help boosting the economic growth in this region.

Keywords: *carbon emission, economic growth, panel, Western Balkans.*

Investigating the spatial pattern of relative risk of hyperlipidemia in Iran: An exploration using hierarchical Bayesian modelling

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Abstract

The prevalence of hyperlipidemia in Iran is steadily increasing, thus potentially playing a significant role in amplifying the vulnerability to cardiovascular diseases and other health complications associated with elevated blood lipid levels. To evaluate the elevated lipid risk at a higher level across the provinces of Iran, this study utilized hierarchical Bayesian models, which hold a crucial position in spatial modeling and effectively addressing uncertainties stemming from diverse spatial data sources.

This study included individuals diagnosed with hyperlipidemia from all provinces of Iran in 2019. The main variables of interest in this study were the average age, gender distribution, and the reported number of hyperlipidemia cases in each province. Population data for each province and age group, disaggregated by gender and year, were obtained from the Iranian Statistics Center database and used to calculate disease prevalence and expected case numbers using a direct approach. Data analysis was conducted using the Besag-York-Mollié (BYM) and BYM2 models, with parameter estimation performed using the Hamiltonian Monte Carlo method. The relative risk of hyperlipidemia was greater than 1 in 16% (95% CI: (0.304, 0.879)) of Iranian provinces (posterior probability > 0.8). The BYM2 model was used to fit the hyperlipidemia data, with the model successfully converging. It was found that an increase of 1% in the population would lead to a 2.38% increase in the number of individuals with hyperlipidemia. The study also found a significant variation in hyperlipidemia across different provinces, with the highest relative risk (RR) observed in Tehran (RR= 1.701; 95% CrI: (1.69, 1.713). The Prevalence of hyperlipidemia was found to be higher in women than in men. However, the Prevalence of hyperlipidemia in men and women over 50 years old was lower than the national average. The employment of hierarchical Bayesian models has proven to be an effective and successful method in examining the spatial distribution of hyperlipidemia in Iran. Our study has unveiled notable variations in the prevalence of hyperlipidemia among various provinces, with Tehran displaying the highest relative risk. Furthermore, the research has demonstrated a higher occurrence of hyperlipidemia in women compared to men. Nevertheless, the average prevalence among individuals aged 50 and above, both male and female, was found to be lower than the national average. These findings possess valuable implications for policymakers in devising targeted interventions to mitigate the burden of hyperlipidemia in Iran.

Keywords*: Random effect model, hierarchical Model, Clustering, epidemiology, Hyperlipidemi*

Detection of Cotton Disease Using Deep Learning Methods

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Abstract

Cotton is one of the most grown agricultural products in the world and has significant economic impacts in many areas, such as food and textiles. However, cotton plants are susceptible to infectious diseases caused by microorganisms such as viruses, bacteria, and fungi. These diseases cause a decrease in yield by damaging the cotton crop. Early detection of diseases can reduce losses by taking necessary precautions. This process is quite time-consuming and very tiring for farmers. Deep learning methods have been successfully applied in agriculture in analyzing images and detecting diseases recently. In this study, diseases of the cotton crops were determined using a technique based on CNN and encoder-decoder architecture, a deep learning method. Experimental studies show that this proposed method is quite successful in detecting disease in the leaves of cotton plants.

Keywords: *deep learning, convolutional neural networks, cotton disease, precision agriculture*

Survival Prediction and Prognostic Factors in Colorectal Cancer after curative surgery: Insights from Cox Regression and Neural Networks

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Abstract

Medical research frequently relies on Cox regression to analyze the survival distribution of cancer patients. Nonetheless, in specific scenarios, neural networks hold the potential to serve as a robust alternative. In this study, we aim to scrutinize the effectiveness of Cox regression and neural network models in assessing the survival outcomes of patients who have undergone treatment for colorectal cancer. We conducted a retrospective study on 284 colorectal cancer patients who underwent surgery at Imam Khomeini clinic in Hamadan between 2001 and 2017. The data was used to train both Cox regression and neural network models, and their predictive accuracy was compared using diagnostic measures such as sensitivity, specificity, positive predictive value, accuracy, negative predictive value, and area under the receiver operating characteristic curve (ROC). The analyses were performed using STATA 17 and R4.0.4 software.

The study revealed that the best neural network model had a sensitivity of 74.5% (95% CI: 61.0-85.0), specificity of 83.3% (65.3-94.4), positive predictive value of 89.1% (76.4-96.4), negative predictive value of 64.1% (47.2-78.8), AUC of 0.79 (0.70-0.88), and accuracy of 0.776 for death prediction. For recurrence, the best neural network model had a sensitivity of 88.1% (74.4%-96.0%), specificity of 83.7% (69.3%-93.2%), positive predictive value of 84.1% (69.9%-93.4%), negative predictive value of 87.8% (73.8%-95.9%), AUC of 0.86 (0.78-0.93), and accuracy of 0.859. The Cox model had comparable results, with a sensitivity of 73.6% (64.8-81.2) and 85.5% (78.3-91.0), specificity of 89.6% (83.8-93.8) and 98.0% (94.4-99.6), positive predictive value of 84.0% (75.6-90.4) and 97.4% (92.6-99.5), negative predictive value of 82.0% (75.6-90.4) and 88.8% (0.83-93.1), AUC of 0.82 (0.77-0.86) and 0.92 (0.89-0.95), and accuracy of 0.88 and 0.92 for death and recurrence prediction, respectively. In conclusion, the study found that both Cox regression and neural network models are effective in predicting early recurrence and death in patients with colorectal cancer after curative surgery. The neural network model showed slightly better sensitivity and negative predictive value for death, while the Cox model had better specificity and positive predictive value for recurrence. Overall, both models demonstrated high accuracy and AUC, indicating their usefulness in predicting these outcomes.

Keywords: *Cox regression, neural network, machine learning, survival analysis, colorectal cancer, Curative surgery, early recurrence*

Predicting Mortality and Recurrence in Colorectal Cancer: Comparative Assessment of Predictive Models

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Abstract

Colorectal cancer (CRC), also known as colorectal carcinoma, poses a significant health challenge due to its substantial mortality rates, ranking as the third most common cause of global mortality. This research aimed to evaluate the effectiveness of predictive models in forecasting both mortality and disease recurrence in individuals diagnosed with colorectal cancer. A retrospective analysis was conducted on a dataset comprising 284 patients diagnosed with colorectal cancer between 2001 and 2017. Demographic and clinical information, including gender, disease stage, age at diagnosis, recurrence status, and treatment details, were meticulously documented. A range of predictive models, including Decision Trees, Random Forests, Random Survival Forests (RSF), Gradient Boosting, mboost, Deep Learning Neural Network (DLNN), and Cox regression, underwent rigorous evaluation. Various performance metrics, including sensitivity, specificity, positive predictive value (ppv), overall accuracy, and area under the receiver operating characteristic curve (ROC area), were calculated for each model to predict both mortality and disease recurrence. The analyses were performed using the R4.1.3 software and the Python programming language. In terms of predicting mortality, the mboost model exhibited the highest sensitivity at 96.9% (95%CI: 0.83 - 0.99) and an impressive ROC area of 0.88. It also demonstrated strong specificity at 80% (95%CI: 0.59 - 0.93), a positive predictive value of 86.1% (95%CI: 0.70 - 0.95), and an overall accuracy of 89% (95%CI: 0.78 - 0.96). On the contrary, Random Forests achieved perfect sensitivity of 100% (95%CI: 0.85 - 1) but displayed low specificity of 0% (95%CI: 0 - 0.52) and subpar overall accuracy (50%). Conversely, DLNN yielded the least favorable performance metrics for mortality prediction, with a sensitivity of 24% (95%CI: 0.222 - 0.268), specificity of 75% (95%CI: 0.73 - 0.77), and a lower positive predictive value of 42% (95%CI: 0.38 - 0.45). For recurrence prediction, the Gradient Boosting model excelled, achieving a flawless sensitivity of 100% (95%CI: 0.87 - 1) and high specificity of 92.9% (95%CI: 0.76 - 0.99). It also boasted a substantial positive predictive value of 93.3% (95%CI: 0.77 - 0.99) and an ROC area of 96.4%. Notably, mboost, with an ROC area of 75%, also delivered commendable performance in recurrence prediction. In contrast, DLNN underperformed for recurrence prediction, with a sensitivity of 1.75% (95%CI: 0.01 - 0.02), specificity of 98% (95%CI: 0.97 - 0.98), and a lower positive predictive value of 52.6% (95%CI: 0.39 - 0.65). In summary, the mboost model demonstrated outstanding performance in predicting mortality, excelling in sensitivity, specificity, positive predictive value, and overall accuracy. Although Random Forests exhibited perfect sensitivity, its specificity and overall accuracy were lacking. DLNN displayed the weakest performance metrics for mortality prediction. In the context of recurrence prediction, the Gradient Boosting model outperformed its counterparts, achieving impeccable sensitivity, high specificity, and positive predictive value. Conversely, DLNN yielded the poorest performance metrics for recurrence prediction. Overall, these findings underscore the efficacy of the mboost and Gradient Boosting models in prognosticating mortality and disease recurrence in colorectal cancer patients.

Keywords: *Cox regression, Deep Learning Neural Network (DLNN), machine learning, survival analysis, colorectal cancer, Curative surgery, early recurrence*

Küresel İklim Değişikliğinin Türkiye Denizlerindeki Balık Popülasyonu Üzerine Etkisinin İstatistiksel Analizi

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Abstract

Global climate change is a concept that refers to the long-term transformations of climate systems worldwide. These changes are caused by the accumulation of greenhouse gases in the atmosphere and the influence of natural processes. Global climate change has accelerated under the influence of human activities, especially in the last century. The emissions produced by countries are transported from one place to another without limits in the atmosphere of our world and contribute to climate change on a global scale outside the place where they are produced. Accordingly, this situation causes the sea water temperature to rise, affecting the migration movements and distribution of fish. Thus, it causes changes between fish populations in the seas and shifts in species composition. This study aims to determine the effect of the increase in air temperature on sea water temperature based on the factors leading to global climate change and the effect on the change in fish populations. In the study, correlation, multiple linear regression analyses and cross tables were used. The results from the findings show that increasing sea water temperatures have negative effects on fish species and the marine ecosystem.

Keywords: *Global Climate Change, Fish Population, Sea Water Temperature, Statistical Analysis*

GİRİŞ

İklim, yavaş gelişen süreçler sonucunda zaman içinde değişebilen bir yapıya sahiptir. Bu dinamik yapının doğal süreçlerden kaynaklanan sonuçları, iklim değişikliği olarak adlandırılır. Ancak iklim değişikliği, doğal değişkenliğe ek olarak insan faaliyetlerinin doğrudan veya dolaylı etkileri sonucunda ortaya çıkan değişimleri ifade eder. İnsan etkileşimleri, fosil yakıt kullanımı, sanayi faaliyetleri, ormansızlaşma, tarım uygulamaları gibi faktörler atmosferde sera gazı birikimine neden olur (Başoğlu,2014). Sera gazları, yerküre yüzeyinden yayılan kızılötesi radyasyonu hapseder ve bu şekilde atmosferde tutarak, gezegenin enerji dengesini değiştirir. Böylece bu gazlar, bu ışınların uzaya çıkmasını engeller ve yüzey ısısının artmasına neden olur. Sera gazlarının bu etkisine "sera etkisi" denir ve bu süreç sonucunda ortaya çıkan ısınma olayına da "küresel ısınma" denir (Doğan, 2005). Küresel ısınma, dünya üzerindeki yaşamı tehdit eden bir durumdur. Denizlerin ısınmasına ve sucul türlerin olumsuz etkilenmesine neden olmaktadır (Kayhan,2007). İnsan faaliyetleri sonucu açığa çıkan karbon dioksit (CO_2), metan (CH_4), kloroflorokarbon (CFC), ozon (O_3) gibi sera gazlarının emisyonlarında görülen aşırı artış, küresel ısınmanın kaynağıdır. Yeryüzündeki sıcak yüzeyden yayılan uzun dalga ışınımının bir kısmı, atmosferin üst seviyelerinde bulunan doğal sera gazları tarafından emilir ve daha sonra tekrar yayılır (Demir, 2009). Küresel ısınmanın deniz seviyesi üzerindeki etkilerini araştıran bilim insanları, deniz seviyesinin her yüzyılda 1 metre yükseleceği konusunda uyarmaktadırlar (Erman, 2009). Hindistan'daki iki küçük mercan adasında deniz seviyesinin sadece 0,1 metre yükselmesi sonucunda

tatlı su kaynaklarının seviyeleri sırasıyla 36 metreden 28 metreye ve 25 metreden 10 metreye düşmüştür (IPCC, 2008).

Küresel iklim değişikliği, ekosistemler ve biyolojik çeşitlilik üzerinde olumsuz etkilere neden olmaktadır. Bu etkiler, su ve kara ekosistemlerini farklı şekillerde etkilemekle birlikte, su ekosistemlerinde olumsuz etkilerin kara ekosistemlerine göre daha hızlı ortaya çıkması öngörülmektedir (Demir,2009). Özellikle deniz canlıları için ideal sıcaklık aralığı değiştiğinde türlerin dağılımı ve popülasyonlar üzerinde değişiklikler meydana getirebilir. Bu duruma bağlı olarak deniz suyu ve sıcaklığının yükselmesi asitleşme etkisiyle birleşerek mercanların yaşamsal faaliyetlerini azaltmaktadır. Tabiatın önemli parçalarından biri olan denizlerde, tropik mercan kayalıkları ve mercan resifleri, mercan poliplerinin kalsiyum karbonat iskeletinin oluşmasına yardımcı olan mikroskobik alg içeren mercanlardan oluşur. Bu alanlar, mercanlar, yumuşakçalar ve balıklar gibi birçok türün yaşam bulduğu hayvan ve bitki çeşitliliği açısından kritik habitatlardır. Bu nedenle, denizlerdeki faunal ve floral zenginlik açısından büyük öneme sahiptirler (Sağlam vd,2008). İklim değişikliği, deniz kaplumbağalarını da olumsuz yönde etkileyen önemli bir faktördür. Su sıcaklığındaki değişiklikler, bu canlıların büyüme hızlarını ve embriyolarındaki cinsiyet oluşumunu etkilemektedir. Ayrıca, dalga enerjisindeki ve fırtına sayı ve şiddetindeki artışlar, kaplumbağaların yuvalandıkları kumsalları tahrip eder ve yumurtaların hayatta kalma oranlarını azaltır. Bu durum, deniz kaplumbağalarının popülasyonlarının azalmasına ve hayatta kalma şanslarının tehlikeye girmesine neden olmaktadır. Bu nedenle, deniz ekosistemlerinin korunması ve iklim değişikliğine karşı önlemler alınması, deniz kaplumbağaları gibi önemli canlı gruplarının korunmasında kritik bir rol oynamaktadır (Sağlam vd,2008).

Türkiye, küresel ısınmanın etkilerini hisseden ülkelerden biridir ve yapılan çalışmalar özellikle sıcaklıkların artış eğiliminde olduğunu göstermektedir (Demircan vd,2013). Türkiye'nin balıkçılığı için büyük öneme sahip olan hamsi balıkları, Kuzey Karadeniz sularının ısınması ve besin üretiminin artmasıyla birlikte daha ılıman olan Güney Karadeniz yerine kuzey sularında kalmayı tercih edecekler ve ülkemiz kıyı sularına gelmeyeceklerdir. Bu durum, ülkemizin balık üretiminin %80'ini sağlayan kaynağın ortadan kalkacağı anlamına gelir ve bu da ülke ekonomisi ve balıkçılarımız için çok ciddi bir sorun teşkil edecektir. (Sağlam vd,2008).

MATERYAL VE METOD

Çalışmada Çevre Şehircilik İklim Değişikliği Bakanlığı Meteoroloji Genel Müdürlüğü (MGM,2022) hava ve deniz suyu sıcaklığı verileri ve balık popülasyonu (TÜİK,2022) veri setleri kullanılmıştır. Çalışmanın veri analizleri MS Excel ve SPSS 25 programları kullanılarak elde edilmiştir. Türkiye'de meydana gelen küresel iklim değişikliğinin yaşanmasından dolayı oluşan hava sıcaklığı, deniz suyu sıcaklığının seçilen balık popülasyonlarını nasıl etkilediğine dair ilişki İstatistiksel yöntemlerden Korelasyon ve Regresyon analizleri ile SPSS 25 paket programı kullanılarak yapılmıştır.

Korelasyon Analizi

İki değişken arasındaki ilişkiyi veya bir değişkenin diğer tüm değişkenler ile aralarında olan ilişkileri incelemek için kullanılan istatistiksel yönteme korelasyon analizi denir (Gülmez, Huseynli,2019). Bu analiz yöntemi, değişkenler arasındaki ilişkinin ne kadar güçlü ve yönlü olduğunu değerlendirir. Korelasyon analizi, değişkenler arasındaki ilişkiyi incelemek ve bu ilişkinin gücünü ölçmek için kullanışlı bir araçtır. Ancak, korelasyon, nedensellik ilişkisini doğrulamaz. Yani, iki değişken arasında güçlü bir korelasyon olsa bile, bu değişkenler arasında bir nedensellik ilişkisi olmayabilir.

Korelasyon analizi ile ilgili hipotezler;

H0: Hava ve deniz suyu sıcaklığı ile balık popülasyon sayısı arasında ilişki yoktur.
H1: Hava ve deniz suyu sıcaklığı ile balık popülasyon sayısı arasında ilişki vardır olacak şekilde ifade edilmektedir.
İki değişken arasındaki korelasyon modeli,

$$r = \frac{\sum(X_t - \bar{X})(Y_t - \bar{Y})}{\sqrt{[\sum(X_t - \bar{X})^2][\sum(Y_t - \bar{Y})^2]}} \quad (1)$$

Denklemi ile gösterilir (Gülmez, Huseynli,2019). Burada, r korelasyon katsayısını gösterirken, X_t ve Y_t; t zamanında değişkenlerdeki değişimi göstermektedir. $\bar{X} ve \bar{Y}$ Değişkenlerdeki örneklem ortalamasını ifade etmektedir.

Çoklu Doğrusal Regresyon Analizi

Çoklu doğrusal regresyon analizi, bir bağımlı değişkenin bir veya daha fazla bağımsız değişkenle ilişkisini incelemek için kullanılan bir analiz yöntemidir. Bu analiz yöntemi, bağımsız değişkenlerin bağımlı değişkendeki, değişkenliği açıklama yeteneğini değerlendirir. Regresyon analizi tekniğini kullanarak güvenilir tahminler yapabilmek için modelde yer alan değişkenler arasındaki ilişkinin durumunu bilmek gerekmektedir (Erilli, Alakuş,2016).

Çoklu doğrusal regresyon analizi ile ilgili hipotezler aşağıda verilmiştir:
H0: Hava ve deniz suyu sıcaklığı hamsi balığı popülasyonunu etkilemez.
H1: Hava ve deniz suyu sıcaklığı hamsi balığı popülasyonunu etkiler.

Bir bağımlı ve birden çok bağımsız değişken olduğu durumlarda değişkenler arasındaki ilişkiyi inceleyen çoklu doğrusal regresyon modeli aşağıdaki gibi ifade edilir (Hoş,2020).

$$\gamma = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon \quad (2)$$

Burada, γ ;bağımlı değişken, β_0; regresyon eğrisinin y eksinini kesim noktasını, β_1 ; ilk tahmin değişkeninin X_1 katsayısını ve β_n ler X_n değişkenlerinin tahmin katsayısını, ε ; ise veri setindeki γ 'nin tahmin edilen değeri ile gözlenen değeri arasındaki farkı ifade etmektedir.

VERİ SETİ

Tablo1. Türkiye'deki 2000-2020 Yılları Arasındaki Hava ve Deniz Suyu Sıcaklık Ortalamaları (SO) °C

Yıllar	Türkiye SO	Marmara SO	Ege SO	Akdeniz SO	Karadeniz SO
2000	13,1	15,6	18,3	22	15,5
2001	14,2	16,2	18,8	21,8	15,9
2002	13,2	15,9	19,2	21,9	15,7
2003	13,2	14,9	18,6	21,8	14,8
2004	13,2	15,6	18,9	22	15,1
2005	13,3	15,6	19,2	22,2	15,4
2006	13,8	15,4	19,2	21,7	15,6
2007	13,6	16,4	19,2	21,6	15,9
2008	13,7	16,2	19,3	21,9	15,4
2009	15,1	15,8	18,5	21,9	15,8
2010	12,8	16,3	19,4	22	16,2
2011	13,8	15,2	18,6	22	15,5
2012	13,8	16	18,8	21,8	16
2013	14,5	15,9	18,9	21,9	15,7
2014	13,8	16,7	19,4	21,8	16,2
2015	14	16,7	19	22	16,2
2016	13,7	17,2	18,9	22,2	16,4
2017	15,1	16,4	18,8	22,3	15,6

2018	14,4	17,4	19,8	22,4	16,5
2019	14,6	18,6	20,9	23,8	18,5
2020	14,5	18	19,5	22,2	16,3

* Çevre Şehircilik İklim Değişikliği Bakanlığı Meteoroloji Genel Müdürlüğü 2022

Tablo2. Türkiye Denizlerindeki 2000-2020 Yılları Arasındaki Balık Popülasyonları (Ton)

Yıllar	Hamsi	Sardalya	İstavrit	Palamut	Lüfer
2000	280000	16500	22200	12000	4250
2001	320000	10000	26180	13460	13060
2002	373000	8684	26482	6286	25000
2003	295000	12000	28000	6000	22000
2004	340000	12883	27405	5701	19901
2005	183569	20666	27518	70797	18357
2006	270000	15586	25927	29690	8399
2007	385000	20941	32021	5865	6858
2008	251675	17531	32177	6448	4048
2009	204699	30091	28268	7036	5999
2010	229023	27639	20447	9401	4744
2011	228491	34709	25010	10019	3122
2012	163982	28248	30946	35764	7390
2013	179615	23913	28424	13158	5225
2014	96440	18077	16324	19032	8386
2015	193492	16883	16664	4573	4136
2016	102595	18162	11148	39460	9574
2017	158094	23426	12985	7578	1936
2018	96452	18854	20678	30920	5767
2019	262544	19119	19505	1578	1214
2020	171253	21265	12349	22743	3722

* TÜİK 2022 İstatistikleri

BULGULAR

Korelasyon Analizi Sonuçları

Analizde 2000-2020 yılları arasında Türkiye'deki ortalama hava sıcaklığı ile Marmara, Ege, Akdeniz ve Karadeniz'in su sıcaklıkları arasındaki ilişki balık popülasyonu üzerinde incelenmiştir.

Tablo3. Türkiye, Marmara, Ege, Akdeniz ve Karadeniz'in Sıcaklık Ortalamaları (SO) °C ile Hamsi, İstavrit, Palamut, Sardalya ve Lüfer Balık Türlerinin Korelasyon Analizi

	Türkiye SO °C	**Marmara SO°C**	**Ege SO °C**	**Akdeniz SO °C**	**Karadeniz SO °C**	**Hamsi**	**İstavrit**	**Palamut**	**Sardalya**	**Lüfer**
Türkiye SO°C Pearson korelasyon	1	,446*	,187	,349	,378	-,411	-,272	-,137	,293	-,528*
sig (2-tailed)	22	,038	,404	,112	,083	,057	,221	,543	,186	,012
N		22	22	22	22	22	22	22	22	22
Marmara SO°C Pearson korelasyon	,446*	1	,766**	,695**	,864**	-,378	-,598**	-,037	-,031	-,467*
sig (2-tailed)	,038	22	,000	,000	,000	,083	,003	,870	,891	,029
N	22		22	22	22	22	22	22	22	22

Ege SO°C Pearson korelasyon	,187	,766**	1	,728**	,776**	-,142	-,216	-,040	-,137	-,229
sig (2-tailed)	,404	,000		,000	,000	,530	,334	,861	,542	,305
N	22	22	22	22	22	22	22	22	22	22
Akdeniz SO°C Pearson korelasyon	,349	,695**	,728**	1	,795**	-,186	-,393	-,051	,034	-,305
sig (2-tailed)	,112	,000	,000		,000	,408	,071	,820	,882	,167
N	22	22	22	22	22	22	22	22	22	22
Karadeniz SO°C Pearson korelasyon	,378	,864**	,776**	,795**	1	-,244	-,432*	-,058	,102	-,471*
sig (2-tailed)	,083	,000	,000	,000		,273	,045	,798	,652	,027
N	22	22	22	22	22	22	22	22	22	22
Hamsi Pearson korelasyon	-,411	-,378	-,142	-,186	-,244	1	,554**	-,423*	-,383	,442*
sig (2-tailed)	,057	,083	,530	,408	,273		,008	,050	,079	,039
N	22	22	22	22	22	22	22	22	22	22
İstavrit Pearson korelasyon	-,272	-,598**	-,216	-,393	-,432*	,554**	1	-,064	-,001	,335
sig (2-tailed)	,221	,003	,334	,071	,045	,008		,778	,996	,128
N	22	22	22	22	22	22	22	22	22	22
Palamut Pearson korelasyon	-,137	-,037	-,040	-,051	-,058	-,423*	-,064	1	,106	,195
sig (2-tailed)	,543	,870	,861	,820	,798	,050	,778		,637	,385
N	22	22	22	22	22	22	22	22	22	22
Sardalya Pearson korelasyon	,293	-,031	-,137	,034	,102	-,383	-,001	,106	1	-,585**
sig (2-tailed)	,186	,891	,542	,882	,652	,079	,996	,637		,004
N	22	22	22	22	22	22	22	22	22	22
Lüfer Pearson korelasyon	-,528*	-,467*	-,229	-,305	-,471*	,442*	,335	,195	-,585**	1
sig (2-tailed)	,012	,029	,305	,167	,027	,039	,128	,385	,004	
N	22	22	22	22	22	22	22	22	22	22

*Korelasyon 0.05 düzeyinde anlamlıdır. (2-tailed)

**Korelasyon 0.01 düzeyinde anlamlıdır. (2-tailed)

Analiz sonuçlarına göre, bu çalışmada deniz suyu sıcaklığı ile balık popülasyonu arasında doğrusal bir ilişki olduğu ve deniz suyu sıcaklığı arttıkça bazı balık türlerinin yüzdesinin azaldığı gözlenmiştir. Marmara Denizi'nde su sıcaklığı arttıkça hamsi, istavrit, sardalya, palamut ve lüfer gibi balık türlerinin yüzdesi negatif yönde bir eğilim göstermiştir. İstavrit, -0.598** değeri ile %0.05 düzeyinde anlamlılık gösterirken, lüfer ise -0.467* değeri ile %0.01 düzeyinde anlamlı bulunmuştur. Ege Denizi'nde su sıcaklığı arttıkça hamsi, istavrit, palamut ve lüfer gibi balık türlerinin yüzdesi negatif yönde bir eğilim göstermektedir. Bu durumda, incelenen tüm balık popülasyonlarının Ege Denizi'ndeki su sıcaklığı artışından olumsuz etkilendiği tespit edilmiştir. Akdeniz'de su sıcaklığı arttıkça hamsi, istavrit, palamut ve lüfer gibi balık türlerinin yüzdesi negatif yönde bir eğilim göstermektedir, ancak sardalya balığı pozitif yönde etkilendiği tespit edilmiştir. Karadeniz'de su sıcaklığı arttıkça istavrit (% -0.432*) ve lüfer (% -0.471*) gibi balık türlerinin yüzdesi negatif yönde bir eğilim göstermiştir ve bu ilişki %0.01 düzeyinde anlamlılık göstermiştir. Türkiye'deki 2000-2020 yılları arasında ölçülen hava sıcaklığı

ortalamalarındaki artış, deniz suyu sıcaklığındaki artışı olumlu yönde etkilemektedir. Bu durumda, hava sıcaklığı ile deniz suyu sıcaklığı arasında bir pozitif ilişki olduğu ve bu ilişkinin istatistiksel olarak anlamlı olduğu belirlenmiştir. Ayrıca, yapılan analiz sonuçlarına göre, en yüksek anlamlı ilişki Marmara Denizi ile Karadeniz arasında (,0.864**) gözlenmiştir. Sardalya (Sardina pilchardus), Kupes (Boops boops), Salpa (Sarpa salpa), Mığrı (Conger conger) ve Dülger balığı (Zeus faber) gibi özellikle güney Akdeniz'de yaygın olarak bulunan bazı balık türlerinin, Karadeniz ve Marmara Denizi gibi daha kuzey bölgelerde de görülmesi, sıcaklık artışının biyolojik çeşitlilik üzerindeki etkilerini açıkça ortaya koymaktadır. Bu türlerin yayılması, su sıcaklıklarının kuzey bölgelere doğru değişmesinin ve deniz ekosistemlerinin dönüşmesinin bir göstergesidir (Miroğlu,2011).

Çoklu Doğrusal Regresyon Analizi Sonuçları

Analizde, 2000-2020 yılları arasında Türkiye'deki sıcaklık ortalamalarının Marmara, Ege, Akdeniz ve Karadeniz üzerindeki etkisi incelenerek hamsi balığı popülasyonuna olan etkisi araştırılmıştır.

Tablo4. Türkiye, Marmara, Ege, Akdeniz ve Karadeniz'in Sıcaklık Ortalamaları (SO) ℃ ile Hamsi Tanımlayıcı İstatistik Tablosu

Analiz sonuçlarında Türkiye ve denizlerindeki ortalama sıcaklık değerleri ile hamsi balığı popülasyonunun ortalama değerleri ve standart sapmaları hesaplanmıştır.

Tablo5. Türkiye, Marmara, Ege, Akdeniz ve Karadeniz'in Sıcaklık Ortalamaları (SO) ℃ ile Hamsi Korelasyon Analizi Tablosu

	Ortalama Değer	**Standart Sapma**	**Örneklem Sayısı (N)**
Hamsi	224387,3	84947,5	22
Türkiye SO	13,8	,63117	22
Marmara SO	16,3	,89757	22
Ege SO	19,1	,55682	22
Akdeniz SO	22,0	,43703	22
Karadeniz SO	15,9	,71534	22

	Hamsi	**Türkiye SO℃**	**Marmara SO℃**	**Ege SO℃**	**Akdeniz SO℃**	**Karadeniz SO℃**
Pearson Korelasyon Hamsi	1,000	-,411	-,378	-,142	-,186	-,244
Türkiye SO℃	-,411	1,000	,446	,187	,349	,378
Marmara SO℃	-,378	,446	1,000	,766	,695	,864
Ege SO℃	-,142	,187	,766	1,000	,728	,776
Akdeniz SO℃	-,186	,349	,695	,728	1,000	,795

Karadeniz SO°C	-,244	,378	,864	,776	,795	1,000
Sig (1-Tailed)						
Hamsi	.	,029	,041	,265	,204	,136
Türkiye SO°C	,029	.	,019	,202	,056	,041
Marmara SO°C	,041	,019	.	,000	,000	,000
Ege SO°C	,265	,202	,000	.	,000	,000
Akdeniz SO°C	,204	,056	,000	,000	.	,000
Karadeniz SO°C	,136	,041	,000	,000	,000	.
N						
Hamsi	22	22	22	22	22	22
Türkiye SO°C	22	22	22	22	22	22
Marmara SO°C	22	22	22	22	22	22
Ege SO°C	22	22	22	22	22	22
Akdeniz SO°C	22	22	22	22	22	22
Karadeniz SO°C	22	22	22	22	22	22

Karadeniz ve Marmara denizlerinin sıcaklık ortalamaları arasında gözlenen değerin ,864 biriminde olması, bu iki bağımsız değişkenin güçlü bir ilişki içerisinde olduğunu ve çoklu doğrusallık sorunuyla karşı karşıya kalındığını göstermektedir. Ayrıca, Karadeniz ve Marmara denizi sıcaklık ortalamalarının Sig(1-tailed) değerlerinin kesişim noktasında anlamlılığın tespit edildiği belirlenmiştir. Deniz suyu sıcaklıklarının artması ile hamsi balığı popülasyonunun negatif yönde eğilim gösterdiği test edilmiştir. Su sıcaklığının artması, hamsi göç davranışı ve hareket yollarında değişikliklerle sonuçlanabilir. Hamsi sürüleri, besin arayışı için kıyılara gelirler ve bu nedenle kuzey Karadeniz sularını tercih edebilirler. Ancak, kuzey Karadeniz'in ısınması ve besin üretiminin artması ile birlikte, hamsi sürüleri daha sıcak sulara doğru yönelmeye başlayabilirler. Bu da onların güney Karadeniz sularında daha uzun süre kalabilecekleri anlamına gelir (Sağlam vd,2008).

Tablo6. Türkiye, Marmara, Ege, Akdeniz ve Karadeniz'in Sıcaklık Ortalamaları (SO) °C Katsayı Tablosu

Model		ndart Hata	a		.	Sınır	Sınır	r	mi	ça	ta Payı	F
me imi	619497,2	145014,8		,541	596	1807825,9	46820,3					
Türkiye SO°C	-35624,6	34376,6	265	1,036	315	-108499,8	7250,5	-,411	-,251	-,224	,714	,400
Marmara SO°C	-57346,9	45435,3	606	1,262	225	-153665,4	3971,5	-,378	-,301	-,272	,202	,947
Ege SO°C	29370,7	60500,5	193	,485	634	-98884,8	7626,2	-,142	,120	,105	,296	,375
Akdeniz SO°C	2700,3	73653,7	014	,037	971	-153438,5	8839,2	-,186	,009	,008	,324	,082
Karadeniz SO°C	25967,4	61160,6	219	,425	677	-103687,4	5622,2	-,244	,106	,092	,176	,693

Yapılan analiz sonuçlarına göre, p değeri > 0.05 olduğu için HO hipotezi reddedilemez. Bağımsız değişkenlerin etkisi olmasa bile (B değeri sıfır olsa dahi), hamsi balığı popülasyonunun hala 619497.2 oranında var olduğunu söylemek mümkündür. Marmara Denizi'ndeki ortalama sıcaklıklarda her bir birimlik artış, hamsi balığı popülasyonunda -57346.9 birimlik bir azalışa neden olmaktadır. Ancak sig. değeri anlamlı olmadığı için deniz suyu sıcaklığının artması popülasyonu düşürse de anlamlı bir ölçüde etkiye sahip değildir. Beta katsayılarına bakılacak olursa Marmara denizindeki ortalama sıcaklıklardaki bir birimlik artış hamsi balığı popülasyonunda %60'lık bir düşüşe neden olmaktadır. Karadeniz'in sıcaklık ortalamasının 5'in üzerinde olması, çoklu doğrusallık probleminin varlığını gösteren bir işarettir. Bu durum, Karadeniz sıcaklık ortalamasının diğer bağımsız değişkenlerle güçlü bir ilişki içinde olduğunu işaret etmektedir. Analiz sonuçlarına göre bir birimlik değişim, bağımlı değişken üzerinde ne kadar bir değişime neden olduğunu gösterir. Ege Denizi sıcaklık ortalamalarındaki bir birimlik değişim, hamsi popülasyonunda 0.193 birimlik bir artışa sebep olurken, Akdeniz'de bu değer 0.014 birim ve Karadeniz'de ise 0.219 birimdir.

Tablo7. Türkiye, Marmara, Ege, Akdeniz ve Karadeniz'in Sıcaklık Ortalama (SO) °C Modelinin Özeti Tablosu

del		quare	Kare	ınminin Standart Hatası
1	,504	,255	,022	84027,07

2000-2020 yılları arasındaki hamsi balığı popülasyonunun sayısal değeri, Türkiye'nin hava sıcaklığı ortalamaları ile Marmara, Ege, Akdeniz ve Karadeniz'in deniz suyu sıcaklık ortalamalarının %2'si tarafından açıklanmaktadır. Bu ilişkiyi test etmektedir.

Tablo8. Türkiye, Marmara, Ege, Akdeniz ve Karadeniz'in Sıcaklık Ortalamaları (SO) °C ile Hamsi ANOVA Tablosu

Model	Kareler Toplamı	Serbestlik Derecesi	Ortalama Değeri	F	Sig.
Gerileme	38569081896,2	5	7713816379,2	1,093	,402
Kalan	112968799514,8	16	7060549969,6		
Toplam	151537881411,0	21			

Analiz sonuçlarına göre, sig değeri p>0.05 olduğu için elde edilen sonuçlar istatistiksel olarak anlamlı kabul edilemez. Bu durumda, hamsi balığı popülasyonu ile Türkiye'deki ortalama hava sıcaklığı ile Marmara, Ege, Akdeniz ve Karadeniz deniz suyu sıcaklıkları arasında anlamlı bir etkinin olmadığı tespit edilmiştir.

SONUÇ

Küresel ısınma ve iklim değişikliği, günümüzde dünya genelinde en ciddi sorunlardan biridir ve acil önlemler almayı gerektiren bir durumdur. Sanayi devrimiyle birlikte artan sera gazları atmosferde birikmeye başlamıştır ve bu durum doğal iklim sisteminin ve ekosistemin dengesini bozarak çeşitli olumsuz etkiler doğurmuştur. Türkiye, küresel iklim değişikliğinin etkilerini yoğun şekilde yaşayan ülkelerden biridir. Özellikle denizlerimizdeki su sıcaklıklarındaki artış, hamsi, palamut, sardalya, istavrit ve lüfer gibi pelajik deniz canlıları üzerinde popülasyon değişikliklerine neden olmaktadır. Bu nedenle, bu balık türlerinin küresel iklim değişikliğinden etkilenme düzeylerini incelemek çalışmanın odağı haline gelmiştir. Yapılan değerlendirme sayesinde, balık popülasyonlarındaki değişikliklerin boyutlarını ve etkilerini anlamamıza yardımcı olarak gelecekte alınacak önlemler için önemli bir kaynak olacaktır.

Çalışmada, deniz suyu sıcaklığı, hava sıcaklığı ve balık popülasyonları arasındaki ilişkiyi anlamak amacıyla korelasyon analizi kullanılmıştır. Yapılan analizler, hava sıcaklığındaki artışın deniz suyu sıcaklığını olumlu yönde etkilediğini ve bu ilişkinin istatistiksel olarak anlamlı olduğunu göstermiştir. Ayrıca, yapılan analiz sonuçlarına göre, en yüksek anlamlı ilişki Marmara Denizi ile Karadeniz arasında (,0.864**) oranıyla gözlenmiştir. Ancak, bazı balık türleri için negatif ve güçlü bir ilişkinin varlığı tespit edilmiştir. Marmara denizindeki ortalama sıcaklıklardaki bir birimlik artış hamsi balığı popülasyonunda %60'lık, Karadeniz'de ise istavrit (%-0.432*) ve lüfer (%-0.471*) gibi balık popülasyonlarında düşüşe neden olmaktadır. Bu durum, belirli balık türlerinin deniz suyu sıcaklığındaki artışa karşı olumsuz bir tepki verdiğini, bu balık türlerinin popülasyonları hava sıcaklığı arttıkça azalma eğilimi gösterdiği görülmektedir. Ayrıca, çalışmada seçilen deniz gruplarında çoklu doğrusallık sorunuyla karşılaşıldığı, özellikle Karadeniz ve Marmara denizlerinin sıcaklık ortalamaları arasında gözlenen değerin ,864 biriminde olması, bu iki bağımsız değişkenin güçlü bir ilişki içerisinde olduğunu göstermektedir. Bu durum, bağımsız değişkenler arasında yüksek bir ilişki olduğu anlamına gelmektedir. Hava sıcaklığı ve deniz suyu sıcaklığı arasındaki yüksek pozitif ilişki dikkat çekicidir, ancak bazı balık türlerinin bu artışa negatif yönlü korelasyon ile tepki verdiği görülmüştür. Çalışmanın sonuçları, deniz ekosistemlerinin korunması ve sürdürülebilirliği için gelecekteki yönetim stratejilerinin belirlenmesinde önemli bir rol oynayabilir.

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An application of Uniform Manifold Approximation and Projection (UMAP) dimensionality reduction technique with Decision Tree algorithm in ecological studies – a case study of *Alburnoides bipunctatus* (Bloch, 1782) populations

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Abstract

A key challenge in long-term and spatial ecology is to deploy an adequate technique to capture nonlinear relationships in complex and high-dimensional data while simultaneously retaining both global structure (relationships among distinct clusters) and local structure (relationships within a cluster). Therefore, we applied a manifold learning Uniform Manifold Approximation and Projection (UMAP) as a nonlinear dimensionality reduction technique with a supervised Decision Tree algorithm to unveil and visually present which environmental parameters shape the abundance and distribution of spirlin Alburnoides bipunctatus (Bloch, 1782). The dataset consisted of 3041 specimens, collected from 2010 to 2021, comprising 62 rivers within 132 sampling sites in Serbia. The results showed that the highest values of production, abundance, and biomass were estimated in sites with low temperature, optimal pH, and well-oxygenated water, even though we found them in heavily polluted waters with extremely high values of conductivity. The obtained ordination pattern was ecologically meaningful following the autecology of spirlin. Additionally, UMAP and Decision Tree pointed out a pattern of migratory behavior, in which spirlin migrate upstream to sites at a higher altitude in early summer and autumn. Combined unsupervised UMAP and supervised Decision Tree have improved as a powerful, highly predictive performance for exploring complex ecological datasets with visually accessible interpretation of presentative variables within clusters and among distinct clusters.

Keywords: *Manifold learning, Machine learning, Fish ecology, Dimensionality reduction technique, Data visualization*

INTRODUCTION

In the era of Big Data, new technologies enable ecologists to improve their understanding of complex problems (Todman et al., 2023). Ecological data is usually composed of a complex mix of data in different dimensions (high dimensional data) (Younas, 2019), necessary to improve interest research area. Even though, many leading data scientists and trend analysts predict Small Data as a potentially better solution for understanding the ecological rarity in cost-effective ecological studies with previously established purposes in mind (mission-oriented studies) (Todman et al., 2023), a long-term spatial ecology still needs complex insight into the problem. For example, the fish populations are synergistically driven by multiple biotic and environmental parameters (Gebremedhin et al., 2021), whose influence can considerably vary across temporal and spatial scales. So, one ecologist needs to investigate the autecology of different fish species, the fish structure assemblage, habitats, environmental parameters, as well as all potentially negative impacts on the fish populations (Hossain et al., 2019). All of these aspects are crucial to provide unique insight into fish biology and ecology

preferences. In addition, ecological datasets can be very difficult to present visually (Milošević et al., 2022).

Therefore, a key challenge is to deploy an adequate technique to capture nonlinear relationships in complex and high-dimensional data while simultaneously retaining both global structure (relationships among distinct clusters) and local structure (relationships within a cluster). Here, we wanted to apply a manifold learning Uniform Manifold Approximation and Projection (UMAP) with a Decision Tree algorithm to unveil which environmental parameters influence the population parameters and occurrence of spirlin *Alburnoides bipunctatus* (Bloch, 1782).

MATERIAL AND METHODS

Material

During intensive fieldwork, a total of 3041 specimens were collected from 2010 to 2021 comprising 62 rivers within 132 sampling sites in Serbia. Fish were sampled using electrofishing equipment "AquaTech" GI 1300 (2.6 kW; 80–470 V, 70 Hz; AquaTech, Kitzbuehel, Austria), then measured for standard (SL in cm) and total length (TL in cm) as well as weighted (W, total wet weight in g) to the nearest 1 mm and 0.01 g. After measurement, the fish were carefully released. The fish identification was performed according to Kottelat and Freyhof (2007) and Simonović (2001).

In addition, environmental parameters were simultaneously measured during the fieldwork. Water temperature T (°C), conductivity EC (µs/cm3), pH (0–14), the concentration of dissolved oxygen DO (mg/L), saturation DO% (%), and hardness H (CaCO3) were measured by HANNA set instruments, and altitude ALT (m, height above mean sea level) was measured with GPS (eTrex® Legend, GarminInc, Kansas, USA). Detailed sampling design is presented in Jakovljević et al. (2023).

Methods

Population parameters

The working database consisted of fish population parameters and environmental parameters measured at 132 sampling sites. The fish population parameters (production P, abundance Ab, fish biomass B, mean length L, mean weight W, age A, and condition factor CF) were estimated according to established methods presented in Jakovljević et al. (2023).

Statistical Analysis

The input matrix contained 132 rows (one row represented one sampling site) and 14 columns. Each column referred to one estimated parameter. Seven quantitative fish population parameters (production, abundance, fish biomass, mean length, mean weight, age, and condition factor) were considered in the analysis within seven environmental parameters (water temperature, conductivity, pH, concentration of dissolved oxygen, saturation, hardness, and altitude). Prior to manifold learning, the data were Hellinger-transformed, considering that the UMAP model is based on Euclidian distances (Legendre and Gallagher, 2010; Milošević et al., 2022). We tested the number of neighbors (n_neighbors) from 5 to 50 and set n_neighbors = 15 as the most appropriate value for retaining a balance between global and local structure during the embedding of data points (virtual sampling sites). Additionally, we set the min_dust to 0.1 and spread to 1.0, which controls how dense UMAP is allowed to pack data points together. Finally, we applied a versatile supervised machine learning algorithm Decision Tree for classification. An analysis of the most presentative variable for clustering was carried out through algorithms that iteratively create all possible subsets from the feature vector and then use a classification algorithm to assess which subset performs the best (Arrighi and Castelli, 2023).

Descriptive statistics were performed using Microsoft Office 365 Excel software, in MS Addinsoft XLSTAT version 2022.5.1.1395. UMAP model with Decision Tree was carried out using BioVinci software (BioTuring Inc., San Diego, CA, USA) version 3.0.9.

RESULTS

Parameters	**Abbreviation**	**Measuring Unit**	**Minimum**	**Maximum**	**Mean**	**±SD**
Production	P	kg/km^2	0.02	32.88	1.39	3.19
Abundance	Ab	N/km	28.00	2240.00	419.87	430.93
Biomass	B	kg/km	0.08	23.90	2.72	3.38
Mean length	L	cm	3.51	13.7	8.44	1.55
Mean weight	W	g	1.00	29.20	6.73	3.78
Age	A	/	1.00	5.00	2.34	0.60
Condition factor	CF	/	0.74	1.15	0.94	0.16
Temperature	T	°C	8.40	27.10	17.79	4.33
Conductivity	EC	$\mu s/cm^3$	60.00	1300.00	364.27	149.29
pH	pH	0–14	6.70	10.33	8.15	0.66
Dissolved oxygen	DO	mg/L	4.75	13.70	9.32	5.51
Saturation	DO%	%	52.50	173.70	103.58	9.71
Hardness	H	($CaCO_3$) (mg/L)	80.00	650.00	186.85	77.51
Altitude	ALT	m	34.00	970.00	341.44	176.84

The main descriptive statistics of the seven fish population parameters and seven environmental parameters for the total sample are reported in Table 1. The virtual sampling sites were ordinated with a UMAP model in two-dimensional space (Figure 1) and classified with the Decision Tree algorithm into seven clusters (Figure 2). The ordination mainly reflected both population parameters and environmental parameters gradients, except for altitude (ALT). A primary gradient for ordination reflected the conductivity (EC) of the sampling sites, where a gradient is shown from left (sampling sites with a lower value of EC as well as hardness H and pH, contrary to the high concentrations of dissolved oxygen DO) to right (sampling sites with a higher value of EC, H, and pH, opposite to the low value of DO) side of UMAP space (Figure 1). Moreover, the altitude (ALT) was pointed to as one of the parameters that shape the distribution of the species, clearly separate from cluster 0 (sampling sites at a high altitude) (Figure 2).

Table 1. Descriptive statistics with standard deviations of seven fish population parameters and seven environmental parameters.

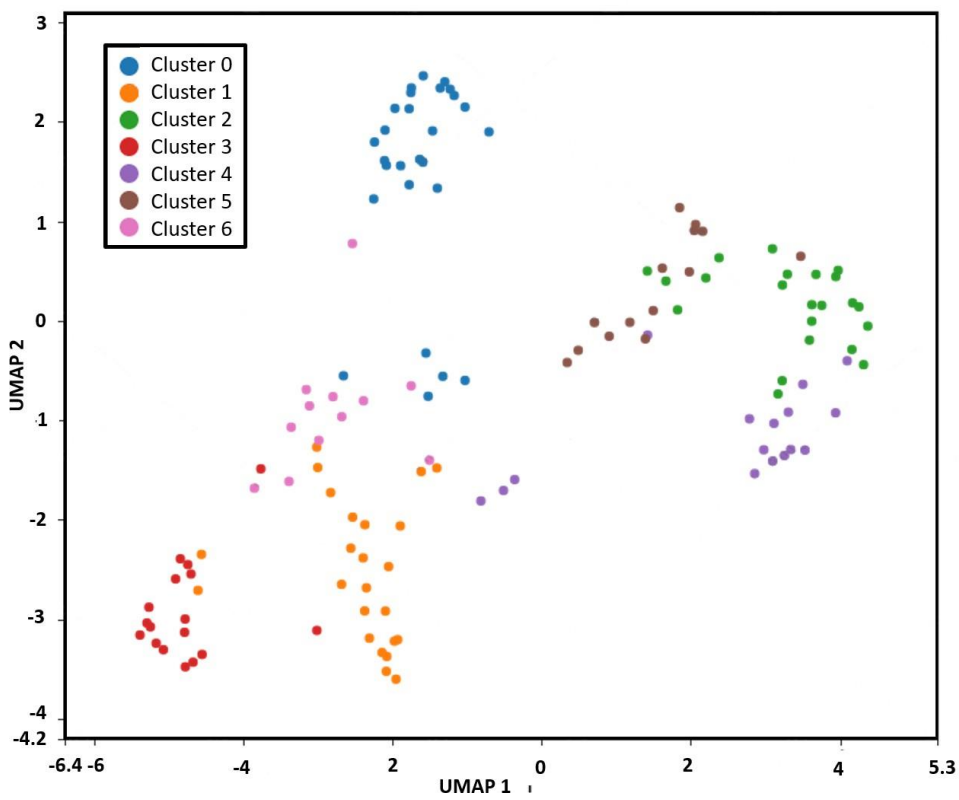

Figure 1. Ordination of sampling sites using the UMAP model. Colors stand for different seven clusters of sites identified by the Decision Tree algorithm. Each point on the 2D UMAP space presents different sampling sites.

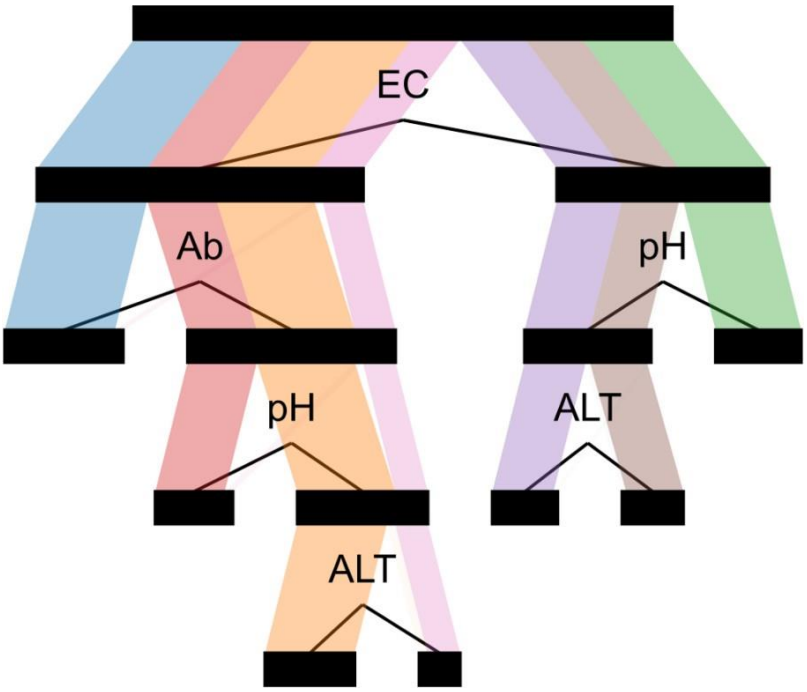

Figure 2. The Decision Tree algorithm was used to detect the most significant parameters for clustering.

DISCUSSION AND CONCLUSION

The commonly used dimensional reduction technique in ecological studies is Principal Components Analysis (PCA) (Legendre and Gallagher, 2010). Meanwhile, the UMAP has been widely used in genomic studies since 2018 (Diaz-Papkovich et al., 2021). Considering that PCA is a linear projection tending to obscure final patterns (Diaz-Papkovich et al., 2021) and lose important dependencies, we propose the UMAP for exploring complex ecological datasets to retain as many variations as possible from the data.

This study is the first attempt to link the fish population parameters to environmental parameters using the unsupervised manifold learning (dimensionality reduction technique) with a supervised Decision Tree algorithm for classification. Milošević et al. (2022) used the UMAP but with Louvain algorithm in ecological studies. The results showed that the highest values of production, abundance, and biomass were estimated in sites with low temperature, optimal pH, and well-oxygenated water, even though we found them in heavily polluted waters with extremely high values of conductivity. Additionally, UMAP and Decision Tree pointed out a pattern of migratory behavior, in which spirlin migrate upstream to sites at a higher altitude in early summer and autumn. The obtained ordination pattern was ecologically meaningful following the autecology of spirlin according to previous scientific studies (Breitenstein and Kirchofer, 2000; Treer et al., 2006; Patimar and Dowlati, 2007; Ruchin et al., 2009; Marszał et al., 2015).

Combined unsupervised UMAP and supervised Decision Tree have been improved as a powerful, highly predictive performance for exploring complex ecological datasets. Beyond its capacity to visualize high-dimensional data, UMAP is also easily accessible to interpret presentative variables within clusters and among distinct clusters.

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Numerical Simulation of a Stochastic Model in Tumor Growth

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Abstract

In this paper we consider a stochastic model for the behaviour of parathyroid cancer tumours in the human body, described by a stochastic differential equation. We discuss estimating the parameters of the stochastic model. Some numerical results are obtained for the parathyroid cancer and the order of convergence of our numerical scheme is investigated. We study the convergence of the solution process as well as its exact solution. Finally, computer simulations are also given.

Key words: *Gompertzian stochastic model, Numerical Schemes, Parameter estimation*

From Equations to Predictions: Understanding the Mathematics and Machine Learning of Multiple Linear Regression

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Abstract

In this paper, the core concepts of multiple linear regression are explored, with a focus on its mathematical foundations and integration with machine learning principles. The objective is to bridge the gap between theory and practical application, providing readers with a comprehensive understanding of this versatile method and highlighting its synergy with traditional statistical approaches and modern computational methods.

The paper begins by applying multiple linear regression to predict wine quality based on physicochemical attributes, using a comprehensive dataset. The least squares method is used to estimate regression coefficients, facilitating the construction of a predictive model. The study also encompasses the testing of assumptions such as homoscedasticity and normality of residuals, along with the assessment of autocorrelation to ensure model robustness.

To illustrate the practical implementation of multiple linear regression, a demonstration using PyTorch, a popular deep learning framework, is provided. A linear model is defined, and the significance of gradient descent in optimizing model parameters is elucidated. Additionally, the paper covers topics such as data preprocessing, model evaluation, and insights into interpreting regression results.

Furthermore, the performance of linear regression is evaluated in comparison to decision trees, random forests, and support vector regression, showcasing the versatility of this classic technique. By presenting a holistic view of multiple linear regression, emphasizing its mathematical foundations, practical implementation, and integration with machine learning, researchers and practitioners are empowered to leverage the potential of linear regression across various domains.

Keywords*: Multiple Linear Regression, Machine Learning, Mathematical Foundations, Model Implementation, Predictive Modeling.*

INTRODUCTION

Multiple linear regression, a foundational statistical technique, plays a pivotal role in modeling the intricate relationships that exist between a dependent variable (response) and one or more independent variables (predictors) (Montgomery, Peck, & Vining, 2012). This method involves fitting a linear equation to observed data, enabling us to comprehend, quantify, and predict associations among variables. Its versatility extends across a multitude of domains, including economics (Gujarati & Porter, 2009), marketing, and scientific research, where it serves as an invaluable tool for making predictions and unraveling intricate variable connections.

At its core, multiple linear regression is a supervised learning algorithm. It's particularly adept at handling continuous real-numbered target variables (James et al., 2013). This method establishes relationships between the dependent variable, denoted as 'y,' and one or more independent variables, collectively represented as 'x,' through the creation of a best-fit line. This process operates under the fundamental principle of ordinary least squares (OLS) or mean square error (MSE) (Hastie, Tibshirani, & Friedman, 2009). OLS serves as a method to estimate the unknown parameters of the linear regression function, with its primary objective being the minimization of the sum of squared differences between the observed dependent variable and the values predicted by the linear regression function (Hastie, Tibshirani, & Friedman, 2009).

This paper embarks on an exploration of the intricate world of multiple linear regression, aiming to bridge the chasm between theoretical understanding and practical application. The following sections delve into the mathematical foundations of this method, in alignment with the insights presented by Kutner, Nachtsheim, Neter, and Li (2004). The discussion extends further, encompassing the synergistic relationship between traditional statistical approaches and contemporary computational methods. Our journey begins with the practical application of multiple linear regression to predict wine quality based on physicochemical attributes, employing an extensive dataset (Cortez et al., 2009). Leveraging the least squares method, we estimate regression coefficients, paving the way for the construction of a predictive model. Assumptions, such as homoscedasticity and normality of residuals, are rigorously tested. Additionally, we assess autocorrelation, ensuring the robustness of our model.

On the practical implementation of multiple linear regression, this paper provides a hands-on demonstration using PyTorch, a well-regarded deep learning framework (PyTorch, 2023; Chen et al., 2018). Within this context, a linear model is defined, emphasizing the critical role of gradient descent in optimizing model parameters (Chen et al., 2018). Subsequent sections of the paper delve into essential topics such as data preprocessing, model evaluation, and insightful approaches for interpreting regression results (Ribeiro et al., 2016).

Furthermore, this study broadens its scope by evaluating the performance of linear regression against other contemporary machine learning techniques, including decision trees, random forests, and support vector regression. This comparative analysis underscores the enduring adaptability of this time-honored method within the domain of predictive modeling. By offering a comprehensive perspective on multiple linear regression, emphasizing its mathematical foundations, practical applications, and integration with modern machine learning, this work aims to empower researchers and practitioners, equipping them to leverage the substantial potential of linear regression across various fields (Knights et al., 2022).

MATERIAL AND METHODS

Material

For the purpose of this study, a database from Cortez et al. (2009) was utilized. The dataset includes the following attribute information:

Input variables (based on physicochemical tests):
Input variables (based on physicochemical tests)
1 - fixed acidity (tartaric acid - g / dm^3)
2 - volatile acidity (acetic acid - g / dm^3)
3 - citric acid (g / dm^3)
4 - residual sugar (g / dm^3)
5 - chlorides (sodium chloride - g / dm^3
6 - free sulfur dioxide (mg / dm^3)
7 - total sulfur dioxide (mg / dm^3)
8 - density (g / cm^3)

9 - pH
10 - sulphates (potassium sulphate - g / dm3)
11 - alcohol (% by volume)
Output variable (based on sensory data):
12 - quality (score between 0 and 10)

Methods

The Collection of the Data

The data for this study were obtained from the dataset provided by Cortez et al. in 2009 [Cortez, P., Cerdeira, A., Almeida, F., Matos, T., & Reis, J. (2009). Modeling wine preferences by data mining from physicochemical properties. Decision Support Systems, 47(4), 547-553]. The dataset contains information on physicochemical attributes of wine, making it suitable for the analysis and implementation of multiple linear regression.

Statistical Analysis

The statistical analysis in this study primarily involves the implementation of Multiple Linear Regression.

Implementation of Multiple Linear Regression

Objective: The objective of Multiple Linear Regression is to find the estimates of the regression coefficients ($\beta 0$, $\beta 1$, $\beta 2$, ..., βp) that minimize the sum of the squared differences between the observed values (y) and the values predicted by the linear regression model.

Loss Function: Multiple Linear Regression employs a loss function that measures the squared differences between the observed and predicted values. The ultimate goal is to minimize the sum of squared residuals.

Assumptions: Multiple Linear Regression assumes that the errors (residuals) are normally distributed with constant variance (homoscedasticity) and does not require a specific probabilistic model for the errors.

Linear Regression Model:

In simple linear regression, with one independent variable (X) and one dependent variable (Y), the model is defined as:

$Y = \beta 0 + \beta iX$

For Multiple Linear Regression, where there are multiple independent variables (x1, x2, ..., xp), the model is represented as:

$Y(yi) = \beta 0 + \beta 1x1 + \beta 2x2 + ... + \beta pxp$
where Y(yi) presents the observed value

İn order to make predictions, the model is expressed as:

$Y` = \beta 0 + \beta 1X1 + \beta 2X2 + ... + \beta pXp + \varepsilon$

Y` represents the predicted value of the dependent variable Y for a given set of independent variables.

$\beta 0$ is the y-intercept, representing the expected value of Y when all independent variables are 0.

$\beta 1$, $\beta 2$, ..., βp are the coefficients (slopes) for the independent variables.

ε (Error or Residual) is the difference between the actual observed value (Y(yi)) and the predicted value (Y'). Matematically:

$$\varepsilon = yi - \hat{y}i$$

The primary objective of linear regression is to determine the coefficients that minimize the sum of squared errors (SSE) and provide an accurate model for predicting the target variable based on the input features. This is achieved through methods like the least squares approach, optimizing the coefficients to create a predictive model.

In the context of machine learning, this approach allows us to find the best-fitting linear model that captures the relationship between the independent variables and the dependent variable, facilitating accurate predictions on new, unseen data.

RESULTS

The dataset comprises m = 1599 examples and n = 11 independent variables (Table 1). The target variable, 'quality,' falls within a range of 0 to 10, while the remaining eleven variables represent various physicochemical attributes. Given the presence of multiple independent variables, we are tasked with fitting a multiple linear regression model.

The equation for multiple linear regression can be expressed as:

(Y(yi)) = β0 + β1 * fixed acidity + β2 * volatile acidity + β3 * citric acid + β4 * residual sugar + β5 * chlorides + β6 * free sulfur dioxide + β7 * total sulfur dioxide + β8 * density + β9 * pH + β10 * sulphates + β11 * alcohol

(1)

Table 1. The dataset of wine

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	Y(yi)
	fixed_ acidity	volatile_ acidity	citric_acid	Residual _sugar	chlorides	free_sulfur_ dioxide	total_sulfur_ dioxide	density	pH	sulphates	alco-hol	quality
y0	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	5
y1	7.8	0.880	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8	5
y2	7.8	0.760	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8	6
…	…	…		…	…	…	…	…	…	…	…	…
y1599	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	6

Before making predictions with linear regression, it's essential to estimate the coefficients β0 and βi from the available data. The estimation of βj, representing the coefficients, can be calculated using the following formula:

$$\beta j = \sum_{i=1}^{n} (x_{ij} - \bar{x}j)(yi - \bar{y}) \,/\, \sum_{i=1}^{n} (x_{ij} - \bar{x}j)^2 \qquad (2)$$

Where, xij is the value of the j-th feature for the i-th data point (e.g., fixed acidity, volatile acidity, citric acid, etc.).

$\bar{x}j$ is the mean of the j-th feature across all data points.

$\bar{Y}$ is the mean of the dependent variable (quality) across all data points.

The intercept term (β0) can be computed as:

Intercept

$$\beta_0 = \bar{y} - \sum^{n}{}_{i=1} \beta_j \bar{x}j \quad (3)$$

Instead of performing complex calculations manually using the given formulas to estimate the coefficients, (β0, β1, β2, β3, ..., β11) we leveraged machine learning techniques and libraries to automate this process. The coefficients were computed using the following code:

Table 2. Code for computed coefficients

Code
import statsmodels.formula.api as smf
# Update the formula to encompass the relevant variables
formula = "quality ~ fixed_acidity + volatile_acidity + citric_acid + residual_sugar + chlorides + free_sulfur_dioxide + total_sulfur_dioxide + density + pH + sulphates + alcohol"
# Fit the regression model
est = smf.ols(formula=formula, data=data).fit()
# Display the summary of the regression analysis
print(est.summary())

By utilizing this approach, we achieved a more efficient and automated means of estimating the coefficients, allowing us to focus on the interpretation and insights drawn from the results

The results of the multiple linear regression analysis are summarized in the following table:

Table 3. The results of the multiple linear regression analysis

Variable	**Coefficient**	**P-value**
Intercept	21.9652	0.300
Fixed Acidity	0.0250	0.336
Volatile Acidity	-1.0836	0.000
Citric Acid	-0.1826	0.215
Residual Sugar	0.0163	0.276
Chlorides	-1.8742	0.000
Free Sulfur Dioxide	0.0044	0.045
Total Sulfur Dioxide	-0.0033	0.000
Density	-17.8812	0.409
pH	-0.4137	0.031
Sulphates	0.9163	0.000
Alcohol	0.2762	0.000

These coefficients represent the estimated associations between each independent variable and the dependent variable, quality. For instance, the coefficient for volatile acidity (-1.0836) indicates that an increase in volatile acidity is correlated with a decrease in wine quality. Conversely, the coefficient for alcohol (0.2762) suggests that a higher alcohol content tends to be associated with higher wine quality.

This comprehensive analysis contributes valuable insights into the collective impact of these physicochemical attributes on wine

The next step is preparing data for a machine-learning model by performing:

- Separating the features (X) and the target variable (y- quality).
- Standardizing the features using `**StandardScaler**`, by performing the following

transformations on each feature: It calculates the mean (μ) and standard deviation (σ) of each feature in the training data.

- For each feature, it subtracts the mean (μ) and then divides by the standard deviation (σ):

$X_{standardized} = (X-\mu)/\sigma$

Where: X is the original feature value, $X_{standardized}$ is the standardized feature value.
Splitting the data into training and testing sets using train_test_split (X, y,random_state = 0,test_size=0.25).

Once these coefficients have been calculated, they can be used to make predictions for new data points by plugging in the values of the independent variables into the linear regression equation.

ŷi - Predicted values based on the linear model

$$\hat{y}i = \beta 0 + \beta jX + ei \quad (4)$$

The error term (*e*) is known as a residual, represents the difference between the actual observed values (*yi*) and the predicted values (ŷi) for each data point (*i*).

Table 4. Code for calculated residuals

Code
residuals = y_train.values-y_pred mean_residuals = np.mean(residuals) print("Mean of Residuals {}".format(mean_residuals)) Mean of Residuals 1.2741174994864182e-16

Residuals are calculated by subtracting the predicted values (y_pred) from the actual values (y_train). These residuals represent the differences between the observed (actual) values and the values predicted by linear regression model for each data point in your training dataset.

mean_residuals calculates the mean (average) of the residuals.

The output you provided, "Mean of Residuals 1.2741174994864182e-16," indicates that the mean of the residuals is extremely close to zero but not exactly zero. The value is approximately , which is a very small number.

In theory, the mean of residuals should ideally be exactly zero for a well-fitted linear regression model. Indicating that the linear regression model is reasonably well-calibrated on the training data, and, on average, it does not exhibit systematic bias in its predictions.

In the context of regression analysis, homoscedasticity,indicates that the residuals exhibit consistent or nearly consistent variance along the regression line. To assess this, we can create a scatter plot of the error terms against the predicted values, ensuring that there is no discernible pattern in the residuals

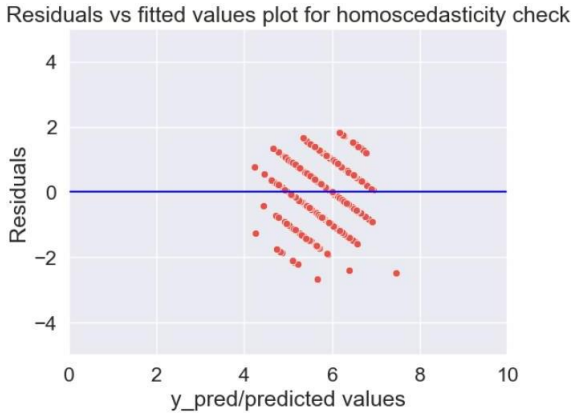

Figure 1. Presence of heteroscedasticity in the regression analysis

The graphical method involves visualizing the relationship between the error terms and predicted values to identify any patterns that may indicate the presence of heteroscedasticity in the regression analysis.

By Using Goldfeld-Quandt test, heteroscedasticity is tested.

Table 5. Code for testing heteroscedasticity

Code
import statsmodels.stats.api as sms from statsmodels.compat import lzip name = ['F statistic', 'p-value'] test = sms.het_goldfeldquandt(residuals, X_train) lzip(name, test) [('F statistic', 0.8906577345903255), ('p-value', 0.9197664304253765)]

In statistical analysis, the Goldfeld-Quandt test is commonly employed to assess homoscedasticity, a concept denoting the assumption that the variance of errors (residuals) in a regression model remains consistent irrespective of the levels of independent variables. Homoscedasticity holds significance in regression analysis as it signifies that the model's errors exhibit uniform variability, thereby contributing to the reliability of the model's performance.

When interpreting the Goldfeld-Quandt test results, the pivotal element is the p-value. In the context of the obtained p-value in wine analysis (0.9197664304253765), it signifies the following hypotheses:

Null Hypothesis (H0): The error terms exhibit homoscedasticity, implying they possess a constant variance.

Alternative Hypothesis (Ha): The error terms display heteroscedasticity, indicating varying variance.

In our specific case, the calculated p-value (0.9197664304253765) significantly exceeds the conventional significance level of 0.05. When the p-value surpasses the significance level, it implies that there is insufficient evidence to support the conclusion that the error terms exhibit heteroscedasticity. The null hypothesis implies that the error terms maintain homoscedasticity.

Homoscedasticity is a fundamental assumption in linear regression models. When this assumption is met, it signifies that the errors in the model consistently vary across different levels of the independent

variables. This uniformity ensures that the model's predictions maintain reliability across the entire spectrum of predictor values. This uniformity facilitates a clearer interpretation of the relationship between the dependent and independent variables.

The Goldfeld-Quandt test's outcome [('F statistic', 0.8906577345903255), ('p-value', 0.9197664304253765)] is considered favorable as it supports the fundamental assumption of homoscedasticity in linear regression. This assumption is crucial for ensuring the model's reliability, interpretability, and validity of statistical inferences derived from the model.

Checking for the normality of error terms (residuals) is an important step in regression analysis to assess whether the residuals follow a normal distribution, which is one of the assumptions of linear regression. The normality of residuals implies that the errors are normally distributed around zero, indicating that the model is appropriate for the data.

Check for Normality of error terms/residuals

```
p = sns.distplot(residuals,kde=True)
p = plt.title('Normality of error terms/residuals')
```

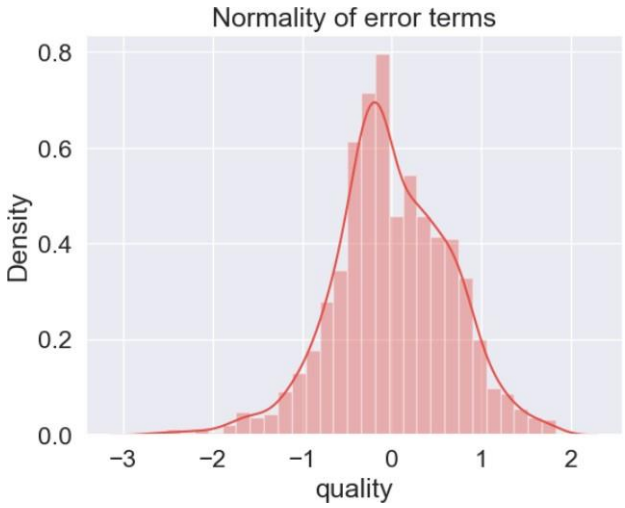

Figure 2. KDE histogram of normality of error terms(residuals)

The unit on the x-axis of the histogram and KDE (Kernel Density Estimation) plot for the normality of error terms/residuals depends on the values of the residuals themselves. The x-axis represents the range of values that the residuals are taken.

In the context of your specific analysis, the x-axis likely represents the range of residual values. These residual values are the differences between the actual observed values (yi) and the predicted values (ŷi) for each data point in your dataset.

For example, our regression problem where the dependent variable (quality) has values ranging from 0 to 10, and the model predictions (ŷi) also fall within this range, then the residuals on the x-axis would typically be centered around zero (representing the cases where the model predictions are close to the actual values), and the range would extend to both positive and negative values, depending on how much the predictions deviate from the actual values.

Autocorrelation is another statistical concept used to analyze and understand patterns in data. It is a statistical measure that assesses the linear relationship between a time series and its lagged values

(previous observations). It is often used to detect patterns or correlations within a time series data. Autocorrelation can help identify periodicity, trends, or seasonality in time series data.

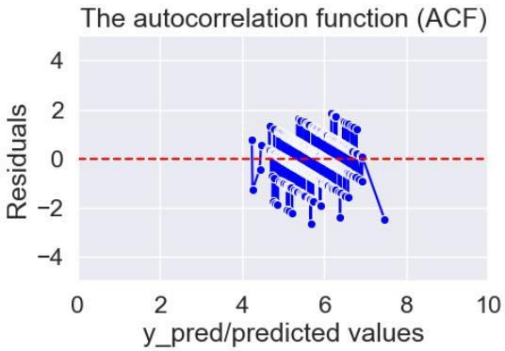

Figure 3. Autocorrelation function

The autocorrelation function (ACF) is used to plot the correlation between a time series and its lagged values at various lags.

The Ljung-Box test is a statistical test used to check for the presence of autocorrelation in time series data or in the residuals of a regression model. It assesses whether the past values of a series (lags) are correlated with the current values.

The null hypothesis of the Ljung-Box test is that there is no autocorrelation in the data, meaning that the values at different lags are not significantly correlated.
The alternative hypothesis is that there is autocorrelation present, meaning that the values at different lags are correlated.
Minimum lb_stat is value, 2.091432890259537, of the Ljung-Box statistic calculated for a specific lag or set of lags. It indicates the magnitude of autocorrelation in the residuals at those lags.

lb_pvalue is greater than chosen significance level, as it is in the results (0.07947300165019978 > 0.05), it suggests that the Ljung-Box statistic is not statistically significant. This means that there is no strong evidence to conclude that autocorrelation is present in the residuals at the specified lags.

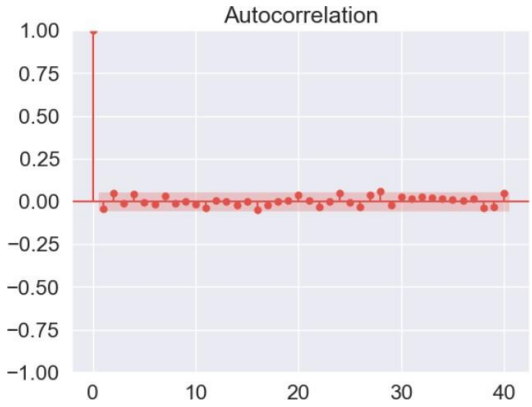

Figure 4. Autocorrelation

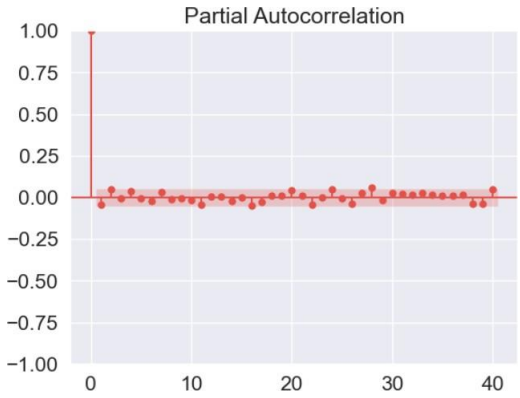

Figure 5. Partial Autocorrelation

Autocorrelation function (ACF) plot and partial autocorrelation function (PACF) plot are commonly used in time series analysis to understand the autocorrelation structure of a time series or the residuals of a time series model. The plots help identify the presence of autocorrelation at different lags and can guide the selection of appropriate models for time series data.

The observed pattern in the plot indicates the presence of autocorrelation because there is a spike that extends beyond the red confidence interval region. This suggests that there may be underlying dependencies or patterns in the data, possibly related to seasonality or other factors. It's important to further investigate and consider these autocorrelations when analyzing the time series data.

In the domain of linear regression analysis, a paramount component is the Loss Function. This integral element plays a pivotal role in evaluating the model's performance in terms of its ability to capture the underlying relationship between the independent variable (often denoted as X) and the dependent variable (Y).

The Sum of Squared Errors (SSE) is employed as an essential indicator of the overall goodness of fit of the linear regression model. It quantifies the collective magnitude of squared residuals, offering valuable insights into the model's ability to accurately represent the observed data.

Least squares method, which minimizes the sum of squared differences between the observed Y values and the predicted $\hat{Y}$ values:

The relationship between ε and SSE is expressed by the formula for SSE:
$\mathrm{ESS} = \sum_{i=1}^{N} (\mathrm{yi} - \hat{\mathrm{y}}\mathrm{i})^2$
Here's how ε and SSE are related:

$$\mathrm{SSE} = \sum_{i=1}^{N} (\mathrm{Y} - \hat{Y}_i)^2 = e_1^2 + e_2^2 + e_3^2 + e_4^2 \ldots + e_{11}^2 = \sum_{i=1}^{N} e_i^2 \tag{5}$$

And SST is diference differences betweean the observed values yi, and $\bar{y}$main of tte valye of yi

$$\mathrm{SST} = \sum_{i=1}^{N} (\mathrm{Y} - \bar{Y}_i)^2 = e_1^2 + e_2^2 + e_3^2 + e_4^2 \ldots + e_{11}^2 = \sum_{i=1}^{N} e_i^2 \tag{6}$$

Mean Absolute Error (MAE), measures the average absolute difference between the actual (observed) values and the predicted values.

$$MAE = \frac{1}{N} \sum_{i=1}^{N} |Y - \hat{Y}_i| \tag{7}$$

The central objective of the Loss Function is to quantify the error inherent in the model's predictions. In practice, it measures the extent of disparity between the observed values of the dependent variable (Y) and the corresponding predicted values ($\hat{Y}$) for each data point (i). A widely adopted metric within this context is the Mean Squared Error (MSE), defined as follows:

$$MSE = \frac{1}{N} \sum_{i=1}^{N} (Y - \hat{Y}_i)^2 \tag{8}$$

Според *Multiple Linear Regression* за даденото dataset за вино направени пресметки за mean_absolute_error, mean_squared_error и Root Mean Squared Error, за модел тренираното множество но и за тестираното множество. резулатите претставено се во Table 1.

For model evaluation is used R^2, statistical measure of how close data are to the fitted regression line.

$$R^2 = 1 - \frac{SSE}{SST} \tag{9}$$

Where SSE is **Sum of Square Error** and SST is **Sum of Square Total**

Table 6. Multiple Linear Regression Model

Loss Function	Multiple Linear Regression	
	y_train	y_test
MAE	0.48949	0.53303
MSE	0.38888	0.490888
RMSE	0.62360	0.700634
R^2	0.38123	0.303635
VIF	1.6161	1.43602

A lower MAE, MSE and RMSE, indicates a very good fit of the model to the data because it the predicted values are closer to the actual values.

The Variance Inflation Factor (VIF) is a measure that helps us understand how much the variance of an estimated regression coefficient is inflated due to the presence of multicollinearity in the dataset. Multicollinearity occurs when predictor variables in a regression model are highly correlated with each other.

$$VIF = \frac{1}{1-R^2} \tag{10}$$

R-squared (R2) values are statistical measures that indicate how well the regression model explains the variability in the data. A higher R2 value, closer to 1, suggests that the model is better at explaining the variability. In the results, R2 values of 0.38123 and 0.303635. A VIF value greater than 1 and less than 5 indicates moderate correlation. These values indicate that the explains some of the variability in the data, but there is still a substantial amount of unexplained variability.

VIF (Variance Inflation Factor) is a metric used to assess multicollinearity in a regression model. Multicollinearity occurs when predictor variables in the model are highly correlated with each other, which can lead to unstable coefficient estimates. A high VIF value (typically greater than 1) suggests that a predictor variable is highly correlated with other predictors in the model, indicating multicollinearity. In the results, VIF values of 1.6161 and 1.43602, which are relatively low. Lower VIF values are generally better because they indicate lower levels of multicollinearity.

In summary, R2 values suggest that regression models explain some but not all of the variability in the data. Additionally, your VIF values are relatively low, indicating lower levels of multicollinearity, which is generally a positive outcome in regression analysis.

In the realm of machine learning, choosing the right algorithm is paramount for achieving accurate and reliable predictions. In this analysis, we have evaluated the performance of three distinct regression models: the DecisionTreeRegressor, RandomForestRegressor, and Support Vector Machine (SVM). Each of these models brings its own strengths and characteristics to the table.

The DecisionTreeRegressor is known for its ability to capture complex relationships within the data, potentially leading to a high level of accuracy on the training set. However, it may also be prone to overfitting, where it performs exceptionally well on the training data but struggles to generalize to new, unseen data.

The RandomForestRegressor, on the other hand, employs an ensemble approach, combining multiple decision trees to enhance prediction accuracy. This model often strikes a balance between complexity and generalization, making it a popular choice for various regression tasks.

Lastly, the Support Vector Machine, or SVM, is a powerful algorithm that excels in capturing intricate patterns within data. While it may exhibit a lower accuracy on the training set compared to other models, it can provide robust predictions and is particularly adept at handling non-linear relationships.

In this comparative analysis, we present the results of these models based on metrics such as accuracy, R-squared, and various error measures. By understanding the strengths and limitations of each model, we aim to guide the selection process towards the algorithm best suited for the specific nuances of our dataset and objectives.

Table7. Comparising Linerar regression problem solwing with diferent type of machine learning models **for wine dataset**

Model	**Performance Comparison of Regression Models**				
	Accuracy	**R^2**	**MAE**	**MSE**	**RMSE**
DecisionTreeRegressor	1.0	1.0	0.000	0.000	0.00
RandomForestRegressor	0.929	0.929	0.158	0.047	0.217
SVM	0.556	0.556	0.380	0.295	0.543

To illustrate the practical implementation of multiple linear regression, a demonstration using PyTorch, as a popular deep learning framework, is provided in purpose to see the primary similarity and differences between traditional linear regression analysis and a linear regression model using the PyTorch deep learning framework.

*Initialization of Variables***:** Initially, random values are assigned to the coefficients (β0, β1, ..., β11) that will be learned during training. These coefficients are declared as PyTorch tensors with `requires_grad=True` to enable gradient computation.

*Linear Model Function***:** The linear model function `mylnmodel` is defined, which takes in the independent variables (e.g., fixed acidity, volatile acidity, etc.) as tensors and computes the predicted value for `quality` using the learned coefficients. It is a simple linear equation with coefficients and variables.
The Mean Squared Error function (MSE) is implemented to calculate the loss between the predicted values and the actual "quality" values in the dataset.
*Gradient Calculation***:** After predicting the values and computing the loss, the gradients of the loss function with respect to the coefficients are calculated using `loss.backward()`. This step enables the model to update the coefficients in the direction that minimizes the loss.
Gradient Descent is used for optimization. The code runs for 5,000 iterations, updating the coefficients with small steps in the direction of gradient descent. This process iteratively refines the coefficients to improve the model's accuracy.

DISCUSSION AND CONCLUSION

This paper has provided a comprehensive exploration of multiple linear regression, shedding light on its foundational principles and seamless integration with contemporary machine learning techniques. By bridging the theoretical underpinnings with practical applications, we have aimed to equip readers with a holistic understanding of this versatile statistical method.
Three key outcomes emerge from this study. Firstly, we demonstrate the formulation of independent and dependent variables in linear regression, providing a structured framework for modeling. Secondly, analyze model performance using essential metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and the Coefficient of Determination (R^2). These metrics offer insights into model accuracy and its explanatory power. Also validate a linear regression model, it is essential to assess several key assumptions to ensure the model's reliability and suitability for the data. These common assumptions for Linear Regression are as follows:

Normality of Residuals: The first assumption involves examining whether the residual errors follow a normal distribution.
Mean of Residuals Close to Zero: The second assumption requires that the mean of the residual errors should ideally be close to zero or approach zero. (A non-zero mean may indicate a systematic bias in the model which is not the case in our study).
Multivariate Normality: Linear regression assumes that all variables are multivariate normally distributed.
Homoscedasticity: which means that the variance of the residuals should remain constant across the regression line. To assess homoscedasticity, a scatter plot of residuals against fitted values can be examined. If the plot exhibits a consistent spread of points, homoscedasticity is met; otherwise, a funnel-shaped pattern may indicate heteroscedasticity.
Multicollinearity Check: The last assumption pertains to multicollinearity refers to high correlations among independent variables. To detect multicollinearity, the Variance Inflation Factor (VIF) is often used. VIF measures the correlation and strength of correlation between independent variables. A VIF value greater than 1 and less than 5 indicates moderate correlation, while a VIF less than 5 is considered a critical level of multicollinearity.
These assumptions collectively help ensure that a multiple linear regression model is appropriate for the given data and that the model's predictions are reliable. Violations of these assumptions may require further analysis or potential model adjustments.
Lastly, we conduct comparative assessments with alternative regression models, including decision trees, random forests, and support vector regression. Also illustrate the practical implementation of multiple linear regression, a demonstration using PyTorch, as a popular deep learning framework

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Ankara Şehir Hastanesi Acil Servisinde Çalışan Hemşirelerin Afetlere Hazırlık Durumunun Değerlendirilmesi

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Abstract

Amaç: *Bu çalışmanın amacı, Ankara Şehir hastanesinde çalışan hemşirelerin afetlere hazırlık algılarını ve psikolojik sağlamlıklarını belirlemektir. Hemşirelerin afete hazırlık algısı ile psikolojik sağlamlıkları arasında nasıl bir ilişki vardır? Sorusuna cevap aramaktır.*
Gereç ve Yöntem: *Bu araştırma, Ankara şehir hastanesi acil servisinde görev yapan toplamda 286 hemşirenin oluşturduğu evreni temel almıştır. Örneklem ise olasılıklı örnekleme yöntemi kullanılarak belirlenmiş ve araştırmaya katılmayı kabul eden gönüllü 260 hemşireyi içermektedir. Araştırma verileri, 23 soruluk anket formu, afetlere hazırlıklı olma durum skalası, Hemşirelerde Afete Hazırlık Algısı Ölçeği (HAHAÖ) ve Connor Davidson Psikolojik Sağlamlık Ölçeği (CD-RISC) kullanılarak toplanmıştır. Bu ölçüm araçları, araştırma sürecinde kullanılan temel veri toplama araçlarıdır ve katılımcıların bireysel özelliklerini, afetlere hazırlıklı olma algılarını ve psikolojik sağlamlık düzeylerini değerlendirmek amacıyla kullanılmıştır. Veriler; sayı, yüzde, ortalama, Kruskal-Wallis H Testi, Mann-Whitney U testi, Dunn testi ve Spearman Korelasyon Katsayısı kullanılarak değerlendirilmiştir.*
Bulgular: *Araştırmaya katılan hemşirelerin %74.3'ü kadın, çoğunluğu 21-30 yaş aralığında, bekâr, lisans mezunu ve 0-5 yıl arası deneyime sahiptir. Katılımcıların %82.9 afet öncesi dönemde hemşirelerin rolünün olduğunu düşünmektedir. Katılımcıların çoğunluğu tüm afet türleri için endişelendiklerini, bunun yanında mesleki yeterlilikleri açısından yeterli olduklarını ifade etmiştir. Hemşirelerin HAHAÖ puan ortalamaları 3,85 (min-max:1-5 puan), CD-RISC puan ortalaması 2,89 (min-max:0-4 puan) dır.*
Sonuç: *Hemşirelerin afetlere ait endişe düzeyleri yüksektir. Bunun yanında mesleki olarak kendilerini yeterli görmektedirler. Hemşireler afet öncesinde hazırlıklı olma konusunda oldukça isteklidir, aynı zamanda stresle başa çıkma yeteneklerine güvenmektedirler. Hemşirelerin afete hazırlıklı olma durumu ile HAHAÖ ve CD-RISC ölçeği arasında pozitif yönlü anlamlı ilişki bulunmaktadır.*

Anahtar Kelimeler: *Afete Hazırlık Algısı, Afet Yönetimi, Afet Hemşireliği, Psikolojik Sağlamlık, Hemşire.*

Essay On The Relationship Between Income Inequality And Inclusive Growth: The Case Of Morocco

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Abstract

This study aims to determine the nature of links between income inequality and inclusive growth in the Moroccan context. To do so, we started by literature review with the most recent studies, then we conducted an empirical analysis on Morocco over the period 1990-2020, then we established the link between the two variables in subperiods which are: 1990 to 2006 and 2007 to 2020. To establish the link between the variables in the overall period, stationarity and cointegration tests were used, Johansen cointegration test shows that there is evidence on the long-run relationship between the variables. Using Vector Error Correction Model (VECM), the analysis results show that there is a negative relationship between income inequality and economic growth. Granger Causality test shows that there is no causality between the two variables. In the sub-periods, we used a multiple linear regression model to establish the link between the variables.

Key words: *Inclusive growth, Inequality, Income distribution, VECM.*

Artificial Intelligence for 3D Printing to Optimum Surface Quality, Time and Material

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Abstract

3D printing is still new technology and is developing and need improvement in different aspect especially in production routine. The topic deals with Fused Decomposition Molding (FDM) technique which is find everywhere in research and industry for prototype production. However there are a lot of research work on optimization the surface quality of printed part and to reduce the print time also the material consumed in printing. Artificial Intelligence methods have an advantage to overcome the difficulties in 3D printing mentioned above. For example the print orientation and the slice number could be optimized by choosing proper optimization function and Appling the Genetic algorithm. The various part geometry and part mass are examined to solve the issue of better surface quality in minimum print time and less supporting. The solutions are printed by FDM and verified the results experimentally. The research results show that AI should induced in the slicing software with careful cautions.

Key words: *Additive Manufacturing , Artificial Intelligence, Layer Orientation, Surface Smoothness, Support Structures,*

Management functions- Support of the tobacco industry in the Republic of North Macedonia

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Abstract

The purpose of this research is to explore the management functions involved in supporting the tobacco industry in the Republic of North Macedonia. The study aims to analyze the role of management functions, including planning, organizing, leading, and controlling, in the development and sustenance of the tobacco industry within the context of North Macedonia. By examining the management practices and strategies employed by key stakeholders, this research seeks to shed light on the complexities and challenges faced by the tobacco industry and highlight the implications for sustainable growth and competitive advantage.

This study adopts a mixed-methods approach to provide a comprehensive understanding of the management functions supporting the tobacco industry in North Macedonia. The research begins with an extensive literature review to establish the theoretical framework and identify key concepts related to management functions and the tobacco industry.

The preliminary findings of this research indicate that effective management functions play a crucial role in supporting the tobacco industry in the Republic of North Macedonia. The planning function is essential for setting goals, formulating strategies, and allocating resources to ensure the industry's growth and competitiveness. Organizational structures and processes, as part of the organizing function, contribute to streamlining operations, optimizing efficiencies, and facilitating coordination among different stakeholders in the industry. The leadership function is vital in shaping the industry's vision, fostering innovation, and managing relationships with key stakeholders. Lastly, the controlling function enables monitoring and evaluation of performance, ensuring compliance with regulations, and addressing emerging challenges.

The study also reveals several challenges faced by the tobacco industry in North Macedonia, including changing consumer preferences, increasing health concerns, and evolving regulatory frameworks. These challenges require proactive management strategies, such as diversification, product innovation, and stakeholder engagement, to adapt and sustain growth in a rapidly changing environment.

This research contributes to the understanding of the management functions supporting the tobacco industry in the Republic of North Macedonia. The findings offer valuable insights for industry practitioners, policymakers, and scholars interested in the management of the tobacco industry, providing a basis for informed decision-making, strategic planning, and policy formulation aimed at promoting sustainable growth and addressing public health challenges associated with tobacco consumption.

Key words: *Tobacco, Tobacco industry, Management functions, Management practices, Economic significance.*

INTRODUCTION

The tobacco industry has long been a significant player in the global economy, with its products consumed by millions of individuals worldwide. In the Republic of North Macedonia, the tobacco industry holds a crucial position in the country's economy, contributing to employment, exports, and tax revenue. The purpose of this research is to examine the role of management functions in supporting the tobacco industry in North Macedonia and shed light on the complexities and challenges faced by the industry within the country's unique context.

The tobacco industry in North Macedonia has a rich history, with tobacco cultivation and production dating back several centuries. The favorable climate and soil conditions in the country have made it an ideal location for tobacco farming, attracting both domestic and international companies. The industry has experienced significant growth, becoming a vital sector in the Macedonian economy. As a result, understanding the management functions that underpin the industry's success and sustainability is of paramount importance.

The management functions of planning, organizing, leading, and controlling serve as the foundation for effective and efficient operations within any industry. In the context of the tobacco industry in North Macedonia, these functions play a crucial role in addressing various challenges, such as evolving consumer preferences, changing regulations, and health concerns. By examining how these management functions are implemented and executed within the industry, we can gain insights into the strategies employed by key stakeholders to support growth, navigate complexities, and maintain a competitive edge.

This research aims to provide a comprehensive understanding of the management functions supporting the tobacco industry in North Macedonia. It will explore the various aspects of each function and their implications for the industry's development, profitability, and sustainability.

By identifying successful management practices and strategies, this study can inform decision-making processes, aid in the development of effective policies, and guide industry practitioners in their pursuit of sustainable growth and responsible practices. Furthermore, understanding the management functions that support the tobacco industry in North Macedonia can provide insights into balancing economic development with public health concerns, which have become increasingly significant in the context of tobacco consumption.

This research aims to explore the management functions involved in supporting the tobacco industry in the Republic of North Macedonia. By analyzing the planning, organizing, leading, and controlling functions within the industry, the study seeks to uncover the strategies employed by stakeholders to navigate challenges and support sustainable growth. The findings will contribute to both academic knowledge and practical insights for industry practitioners and policymakers in North Macedonia and beyond.

MATERIAL AND METHODS

Analyzing the industry's management practices, this study seeks to contribute to the existing body of knowledge on the tobacco industry and its management, while also providing practical insights for industry practitioners, policymakers, and stakeholders.

The research will adopt a mixed-methods approach, combining qualitative and quantitative data to gain a holistic perspective on the management functions supporting the tobacco industry. Primary data will be collected through interviews with industry experts, government officials, and representatives from tobacco companies. These interviews will provide valuable insights into the industry's management strategies, challenges faced, and approaches to addressing them. Additionally, quantitative data, such as financial reports, industry statistics, and market research findings, will be analyzed to complement the

qualitative data. Taking into account the problems that this paper deals with, data obtained from regular statistical surveys conducted by the State Statistical Office, annual accounts from the Central Registry, and data from the Ministry of Agriculture, Forestry and Water Management, for the period from 2015 to 2021 have been used.

The studies will mainly be based on secondary sources of data, and the set goal is dictated by several methods: method of indices, comparative inductive, deductive and other mathematical-statistical methods characteristic of agro-economic research.

The findings of this research will not only contribute to the scholarly understanding of management functions within the tobacco industry but also have practical implications for policymakers and industry leaders.

Industry structure and market players in the tobacco industry in North Macedonia

The tobacco industry in North Macedonia shows a well-defined structure with key market players involved in different stages of the production and distribution process. Understanding the structure of the industry and the major players in the market provides insight into the dynamics and competitiveness in the tobacco sector.

Tobacco farming:

The industry begins with tobacco growing, which takes place primarily in the regions of Prilep, Kavadarci and Bitola. Tobacco farmers, often small producers, grow different varieties of tobacco, including oriental tobacco. These farmers play a key role in ensuring a stable supply of high-quality tobacco leaves for the next stages of processing and production.

Tobacco processing:

After being harvested, the tobacco leaves undergo processing to remove unwanted materials and improve their quality. Processing involves drying, curing and fermenting the leaves to achieve the desired flavors and aromas. Several processing facilities, both independent and owned by tobacco companies, are involved in this phase. These facilities often use advanced technologies to ensure the quality and consistency of processed tobacco.

Tobacco production:

Processed tobacco leaves are used by tobacco companies to produce a range of tobacco products, including cigarettes, cigars and smoking tobacco. Some prominent international tobacco companies have established production facilities in North Macedonia, and there are also domestic tobacco producers. These companies invest in state-of-the-art equipment and employ skilled workers to produce high-quality tobacco products.

Distribution and sales:

The distribution and sale of tobacco products includes a network of wholesalers, retailers and distributors. Wholesalers purchase tobacco products from manufacturers and distribute them to retailers, who sell them to consumers. These distribution networks are vital to ensure availability and affordability of tobacco products across the country. In recent years, there has been a growing trend of online sales platforms and e-commerce channels being used to distribute tobacco products.

Main market players:

Several key market players contribute to the growth and competitiveness of the tobacco industry in North Macedonia. These players include both international and domestic companies. The most significant market player in the country's tobacco industry is Philip Morris International- Prilep Tobacco Factory (TKP): Another prominent multinational tobacco company that has invested in North Macedonia. Philip Morris International has a manufacturing facility in the country and manufactures popular cigarette brands.

TKP is a domestic tobacco company and one of the largest employers in North Macedonia. It operates a tobacco processing plant and a cigarette manufacturing plant. TKP is known for its iconic Macedonian tobacco brands.
The banking sector in North Macedonia also plays a role in the tobacco industry. Certain banks provide banking services to tobacco companies and support their operations.
These market players contribute to the competitiveness of the industry through their investments in production facilities, research and development, marketing and distribution networks. They play a key role in driving innovation, introducing new products and meeting consumer demand in the tobacco market.
The tobacco industry in North Macedonia consists of a structured value chain that includes the cultivation, processing, production and distribution of tobacco. The industry includes both international and domestic market players that contribute to the country's economy through employment, exports and tax revenue. Understanding the industry structure and key market players is essential for analyzing market dynamics, competition and trends in the tobacco sector.

RESULTS AND DISCUSSION

AREAS UNDER INDUSTRIAL PLANTS FOR THE PERIOD 2015-2021

Starting from the data representing the areas under tobacco and sunflower, and for the period from 2015-2021, shown in Table 1, we will note that a total of 144.478 ha were planted, or an average of 20.639 ha. It can be seen from the table that during the period tobacco was planted on an average of 16.260 ha, and sunflower on 4.380 ha. So, almost 79% of the total areas are planted with tobacco. The remaining 21% is accounted for by sunflower.

Table 1 Areas under industrial plants

Areas under industrial plants in ha.	2015	2016	2017	2018	2019	2020	2021	Total	Average	%
tobacco	16.128	16.379	15.961	16.582	16.719	16.592	15.457	113.818	16.260	78,78
sunflower	5.562	3.974	4.073	2.386	4.677	4.859	5.129	30.660	4.380	21,22
Total	21.690	20.353	20.034	18.968	21.396	21.451	20.586	144.478	20.640	100

Source: Statistical Yearbook of the Republic of North Macedonia,2015-2021

ACREAGE AND TOBACCO GROWERS

Analyzing the planted areas with tobacco and the number of producers for the mentioned period (2015-2021), the first thing that is noticeable is that there are visible oscillations in the planted areas and that they have been decreasing in the last three years. At the same time, it is noticed that the number of producers is also decreasing. In the analyzed period, the average planted area is 16.260 ha, which is the closest to the area planted in 2016.
On average, 21.989 producers were engaged in tobacco production, regardless of the fact that the continuous decrease in the number of producers from year to year is visible.
If we look at the producers, the average planted area per producer is 0.75 ha, which is approximately to the average area per producer in 2018.

Table 2. Areas and producers of tobacco

Harvest	planted area in ha	Number of manufacturers	Average area per producer, ha
2015	16.128	24.234	0,67
2016	16.379	23.438	0,70
2017	15.961	23.373	0,68
2018	16.582	23.426	0,71
2019	16.719	20.997	0,80
2020	16.592	19.702	0,84
2021	15.457	18.752	0,82
Average	16.260	21.989	0,75

Source: Statistical Yearbook of the Republic of North Macedonia,2015-2021

Table 3. Exports of unprocessed tobacco (in tons) of tariff number 2401

Exporting country	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	Average
World	2.460.676	2.467.530	2.436.108	2.381.875	2.233.022	2.314.982	2.382.366
Brazil	466.286	442.921	440.755	527.394	485.115	434.184	466.109
Belgium**	161.035	186.767	228.184	226.396	217.324	206.108	204.302
China	172.324	205.979	186.599	194.015	185.649	191.767	189.389
India	217.859	191.006	194.280	185.946	176.700	190.184	192.663
Zimbabwe	155.227	157.337	185.281	173.559	177.606	177.171	171.030
Malawi	150.104	150.533	139.844	136.411	112.439	124.670	135.667
USA	173.883	158.723	150.976	105.033	97.764	105.472	131.975
Italy	66.909	68.059	74.136	67.214	58.860	59.813	65.832
Germany**	57.716	69.546	56.924	53.075	41.902	52.404	55.261
Argentina	90.948	85.264	57.922	48.492	54.723	51.954	64.884
Turkey	50.735	48.899	60.625	46.665	48.243	51.679	51.141
Mozambique	52.786	68.001	64.701	80.288	61.198	48.880	62.642
Philippines	26.250	59.455	39.603	44.419	36.162	45.219	41.851
Greece**	48.250	36.905	34.957	28.509	32.043	42.102	37.128
Tanzania	74.341	49.203	73.103	42.581	42.558	37.705	53.249
N.Macedonia	27.692	27.622	23.327	24.898	22.511	30.915	26.161
Indonesia	28.005	29.134	32.310	33.267	31.132	27.411	30.210
Poland	26.197	32.499	29.916	30.607	24.489	25.299	28.168
Bulgaria**	41.170	29.816	27.260	25.708	22.933	22.745	28.272
Spain	26.928	25.191	28.293	23.772	n.d	21.451	25.127

Source: ITC http://trademap.org/Country

The table attached above shows the export of unprocessed tobacco at the national level and the 20 exporting countries for the period from 2016-2021, including our country. Initially, what is noticeable is that exports at the world level also vary, but mostly decrease. If the national export in 2016 amounted to 2.460.676 tons of tobacco, then in 2021 it decreased by 6% and amounted to 2.314.982 tons. As previously mentioned, Brazil is not only among the three largest tobacco producing countries, but is also

the largest exporter. If we make a comparison between the average world export and the average Brazilian export, we will see that Brazil participates on average with a little more than 19% (19.56%). Although the USA also appears as an exporting country, there is a noticeable decline in exports, as it is in most other countries. In the analyzed period in 2016, they exported 173.883 tons, but in 2021, the export decreased by as much as 39.3% and amounted to 105.472 tons. The USA with the average export in the analyzed period participates with 5.5% in the world's average export.

And in Italy there is a visible decline in exports. If in 2016 the export amounted to 66.909 tons, in 2021 it will decrease by more than 10% and amount to 59.813 tons. The average Italian export, which is 65.832 tons, represents 2.8% of the world's average export. Spain is the smallest exporter at the world level, with an average export of 25.127 tons, which represents only 1% of the world average export of unprocessed tobacco.

Our country is one of the few (Belgium, China, Philippines...) that has increased its exports. Although Macedonia participates in world exports with only 1.1% since 2016, when the export was 27.692 tons, it increased by 11.6% in 2021, when it was 30.915 tons.

Tobacco has been an important export crop for Macedonia for many years. According to the World Bank, in 2019 tobacco accounted for approximately 9% of Macedonia's total exports. The country has a long history of growing tobacco, and tobacco production is an important source of income for many farmers and workers.

The tobacco industry in Macedonia is largely focused on the production of high-quality tobacco for export to other countries, especially Europe. The country has a reputation for producing premium tobacco with a distinctive flavor and is known for its high-quality oriental tobacco.

Planning in the Tobacco Industry

Planning is a crucial management function that plays a significant role in the success and growth of the tobacco industry. Effective planning allows industry stakeholders to set goals, define strategies, allocate resources, and anticipate future challenges and opportunities. Within the tobacco industry in the Republic of North Macedonia, planning serves as a foundation for decision-making and guides the industry's direction. Here are key aspects of planning in the tobacco industry:

- Setting Goals and Objectives: Planning begins with identifying and setting clear goals and objectives for the industry. These goals may include increasing market share, expanding into new markets, improving product quality, or enhancing sustainability practices.
- Formulating Strategies: Once goals are established, planning involves developing strategies to achieve those objectives. Strategies in the tobacco industry may include product diversification, brand positioning, market segmentation, pricing strategies, or investments in research and development.

- Resource Allocation: Planning in the tobacco industry entails allocating resources effectively and efficiently. This includes financial resources, human capital, technology, and infrastructure.
- Market Analysis and Forecasting: Planning in the tobacco industry involves conducting thorough market analysis and forecasting. This includes studying consumer behavior, market trends, competitor analysis, and regulatory changes. Market analysis helps identify opportunities and threats, enabling industry stakeholders to make informed decisions and adapt their strategies accordingly.
- Risk Assessment and Mitigation: Planning includes assessing risks and developing mitigation strategies. The tobacco industry faces various risks, such as changing regulations, health concerns, declining smoking rates, and competition.
- Long-Term Planning: Planning in the tobacco industry also involves long-term perspectives. This includes developing strategies that consider industry sustainability, environmental impact, and social responsibility.
- Monitoring and Evaluation: Planning is an iterative process that requires ongoing monitoring and evaluation. Industry stakeholders need to track the progress of their plans, measure performance against set goals, and make adjustments as needed.

Planning is a fundamental management function in the tobacco industry, providing a roadmap for industry stakeholders to navigate challenges, seize opportunities, and achieve sustainable growth. It involves goal-setting, strategy formulation, resource allocation, market analysis, risk assessment, and long-term perspectives. By embracing effective planning practices, the tobacco industry can adapt to changing market dynamics, comply with regulations, and address public health concerns while driving economic growth and maintaining a competitive edge.

Organizing in the Tobacco Industry

Organizing is a critical management function that plays a vital role in the effective and efficient operations of the tobacco industry. Organizing involves structuring the industry's resources, establishing relationships, and coordinating activities to achieve desired goals and objectives. In the Republic of North Macedonia's tobacco industry, organizing ensures the efficient allocation of resources, the establishment of clear roles and responsibilities, and the creation of a productive work environment. Here are key aspects of organizing in the tobacco industry:

- Organizational Structure: Organizing involves designing the organizational structure of the tobacco industry. This includes defining the hierarchy, departments, and reporting relationships within tobacco companies, processing facilities, manufacturing units, and distribution networks.

- Division of Labor: Organizing includes determining the division of labor within the tobacco industry. This involves assigning specific tasks and responsibilities to individuals or groups based on their skills, expertise, and roles.
- Workforce Management: Organizing involves managing the workforce within the tobacco industry. This includes recruitment, selection, training, and development of employees at all levels.
- Coordination and Collaboration: Organizing involves establishing coordination mechanisms and promoting collaboration among different stakeholders in the tobacco industry.
- Resource Allocation: Organizing entails allocating resources effectively within the tobacco industry. This includes financial resources, raw materials, machinery, technology, and infrastructure.
- Standardization and Procedures: Organizing involves establishing standardized processes, procedures, and guidelines within the tobacco industry. Standardization ensures consistency, quality control, and compliance with industry standards and regulations. It also facilitates efficient workflow, reduces errors, and enables effective performance measurement.
- Technology and Automation: Organizing in the tobacco industry involves leveraging technology and automation to streamline processes and improve efficiency. This includes adopting advanced machinery, automated production systems, inventory management software, and data analytics tools.
- Supply Chain Management: Organizing encompasses managing the supply chain within the tobacco industry. Effective supply chain management ensures timely availability of inputs, reduces bottlenecks, and enhances customer satisfaction.
- Regulatory Compliance: Organizing includes ensuring compliance with regulatory requirements and industry standards within the tobacco industry. This involves establishing processes and procedures to adhere to health and safety regulations, quality standards, labeling requirements, and marketing restrictions.

Organizing is a fundamental management function in the tobacco industry, enabling efficient resource allocation, clear role definition, coordination, collaboration, and adherence to regulations. By embracing effective organizing practices, the tobacco industry can optimize its operations, improve productivity, enhance customer satisfaction, and maintain a competitive advantage in the market.

Leading in the Tobacco Industry

Leading is a crucial management function in the tobacco industry that involves influencing, motivating, and guiding employees and stakeholders to achieve the industry's goals and objectives. Effective leadership within the tobacco industry is essential for driving innovation, managing change, fostering a

positive work culture, and ensuring the industry's long-term sustainability. Here are key aspects of leading in the tobacco industry:

- Vision and Strategy: Leaders in the tobacco industry provide a clear vision and strategy for the industry's growth and development. They articulate a compelling vision that inspires and motivates employees, stakeholders, and industry practitioners
- Decision-Making: Leaders play a critical role in decision-making within the tobacco industry. They analyze market data, industry trends, and stakeholder input to make informed decisions that drive the industry forward.
- Communication: Effective leaders in the tobacco industry prioritize communication. They ensure clear and transparent communication channels at all levels, facilitating the exchange of information, ideas, and feedback.
- Motivation and Engagement: Leaders in the tobacco industry motivate and engage employees to achieve high performance. They create a positive work environment, foster a culture of innovation and continuous improvement, and recognize and reward achievements.
- Change Management: Leading in the tobacco industry involves effectively managing change. Leaders navigate industry disruptions, regulatory changes, and evolving consumer preferences by embracing innovation and leading organizational transformation.
- Ethical Leadership: Leaders in the tobacco industry uphold ethical standards and promote responsible practices. They ensure compliance with industry regulations, environmental sustainability, and responsible marketing.
- Talent Development: Leading in the tobacco industry includes developing and nurturing talent. Leaders identify and develop potential leaders, provide training and development opportunities, and create succession plans.
- Stakeholder Management: Effective leaders in the tobacco industry engage and manage relationships with various stakeholders, including farmers, employees, government agencies, community organizations, and public health advocates.
- Industry Advocacy: Leaders in the tobacco industry advocate for the industry's interests while considering public health concerns and regulatory requirements. They actively participate in industry associations, engage in dialogue with policymakers, and contribute to policy development processes.

Leading in the tobacco industry requires visionary leadership, effective decision-making, clear communication, motivation, ethical practices, and stakeholder engagement. Strong leadership fosters a positive industry culture, drives innovation, navigates challenges, and ensures the industry's long-term sustainability and success.

Controlling in the Tobacco Industry

Controlling is a vital management function in the tobacco industry that involves monitoring, evaluating, and regulating various aspects of the industry's operations to ensure adherence to established goals, standards, and regulations. Controlling enables industry stakeholders to track performance, identify deviations, and take corrective actions when necessary. Within the tobacco industry, controlling plays a crucial role in maintaining product quality, complying with regulations, managing costs, and ensuring sustainable growth. Here are key aspects of controlling in the tobacco industry:

- Performance Measurement: Controlling in the tobacco industry involves measuring and assessing performance against predetermined goals, targets, and benchmarks. Key performance indicators (KPIs) are established to monitor various aspects of the industry, such as production volume, market share, revenue, profitability, quality standards, and customer satisfaction.
- Quality Control: Controlling includes implementing quality control measures throughout the tobacco industry's value chain. Quality control ensures that tobacco products meet established standards and regulatory requirements. This involves rigorous testing and inspections at various stages, such as farming, processing, manufacturing, and packaging. Controlling quality helps maintain product consistency, customer satisfaction, and compliance with industry regulations.
- Compliance Monitoring: Controlling in the tobacco industry involves monitoring and ensuring compliance with regulatory requirements and industry standards.
- Cost Control: Controlling encompasses managing costs within the tobacco industry. This involves monitoring expenses related to raw materials, production, distribution, marketing, and administrative functions.
- Inventory Management: Controlling includes effective management of tobacco inventories throughout the supply chain. This involves monitoring stock levels, tracking inventory turnover, and implementing inventory control systems to minimize waste, spoilage, and obsolescence.
- Risk Management: Controlling involves identifying and managing risks within the tobacco industry. Risk management focuses on areas such as regulatory changes, market volatility, supply chain disruptions, public health concerns, and legal liabilities.
- Feedback and Corrective Actions: Controlling includes establishing feedback mechanisms and implementing corrective actions when deviations from established goals or standards occur. This involves analyzing performance data, identifying areas of improvement or non-compliance, and taking timely corrective measures.
- Information Systems and Reporting: Controlling in the tobacco industry involves implementing robust information systems and reporting mechanisms. This includes collecting, analyzing, and reporting relevant data and information to support decision-making and control processes.

- Continuous Evaluation and Improvement: Controlling is an ongoing process of continuous evaluation and improvement within the tobacco industry. It involves periodically reviewing control mechanisms, performance indicators, and processes to identify areas for enhancement.

Controlling is a critical management function in the tobacco industry that ensures performance monitoring, quality control, compliance, cost management, risk mitigation, and continuous improvement. Effective controlling practices enable industry stakeholders to maintain product quality.

CONCLUSION

Effective management functions play a critical role in supporting the tobacco industry in the Republic of North Macedonia. Through planning, organizing, leading, and controlling, industry stakeholders can navigate challenges, capitalize on opportunities, and drive sustainable growth. The management functions discussed in this context provide a framework for the industry to achieve its goals while ensuring compliance with regulations, maintaining product quality, and addressing public health concerns.

Planning serves as the foundation for strategic decision-making in the tobacco industry. It involves setting goals, formulating strategies, and establishing action plans to guide the industry's direction. By engaging in comprehensive market analysis, anticipating regulatory changes, and embracing product diversification and sustainability initiatives, companies can adapt to changing consumer preferences and market dynamics.

Organizing in the tobacco industry focuses on structuring resources and processes to optimize efficiency and effectiveness. This includes managing the industry's supply chain, coordinating manufacturing operations, and establishing robust distribution networks.

Leading in the tobacco industry involves inspiring and motivating employees, fostering a culture of innovation, and driving strategic initiatives. By embracing research and development, promoting responsible practices, and engaging in collaborations, leaders can guide the industry toward sustainable growth and responsible practices.

Controlling is crucial for monitoring performance, ensuring compliance, and mitigating risks within the tobacco industry. It involves measuring key performance indicators, implementing quality control measures, and monitoring costs and inventory levels. Controlling also includes regulatory compliance monitoring, risk management, and implementing corrective actions. Through robust control mechanisms, industry stakeholders can maintain product quality, minimize waste, and respond proactively to deviations from established goals and standards.

While the tobacco industry faces challenges such as regulatory pressures, declining smoking rates, and public health concerns, it also presents opportunities for growth and innovation.

Effective management functions in the tobacco industry are essential for navigating challenges, capitalizing on opportunities, and achieving sustainable growth. By employing strategic planning, efficient organizing, inspirational leadership, and rigorous control mechanisms, industry stakeholders

can ensure responsible practices, drive innovation, and contribute to the long-term success of the industry. Embracing these management functions enables the tobacco industry to balance profitability with regulatory compliance, public health considerations, and evolving societal expectations.

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Automating Appropriate University Processes with Robotic Process Automation

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Abstract

Robotic Process Automation (RPA) is a machine learning process that deals with rule–based and repeatable tasks, making it possible to use technology quickly and efficiently. Digital robots programmed with Robotic Process Automation can perform operations such as data entry, data control, integration between systems, taking over repetitive work and processing simple business rules quickly and accurately by following the rules. There are many tasks involved in the daily routines of enterprises and universities that actually do not need manpower and intelligence. In this study, it is aimed to identify the processes of Erzincan Binali Yıldırım University that are suitable for automation and to digitalize these processes with Robotic Process Automation. The objectives and requirements of the selected processes were determined and integration was ensured by coding through a rule-based desktop and cloud-based system. The processes to be digitized were coded through the UiPath software platform offered free of charge for the academy. Thanks to the digital robots that will be created to work from start to finish, it is aimed to enable the efficient use of public resources by providing significant time and cost savings. In addition, since the processes to be automated are similar in universities, it will be possible to disseminate them to other universities. This study is expected to make significant contributions to the spread of digital robots and institutional development, especially in universities with personnel shortages.

Keywords: *Digital Transformation, Process Automation, Digital Robots, Artificial Intelligence, Machine Learning*

Examining the Factors Affecting the Problem-Solving Skill Levels of Medical and Dentistry Students

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Abstract

In this study, we focused on revealing some psychometric properties (such as self-esteem, state anxiety and trait anxiety), which influence the problem-solving skills of health sciences students who were in the School of Medicine and Dentistry at Ordu University with Structural Equation Modeling (SEM) method. A questionnaire consisting of Rosenberg Self-Esteem Inventory, State and Trait Anxiety Inventory, Problem Solving Inventory was prepared to measure the demographic variables and personality traits of a total of 292 students; 150 students were from medical and the other 142 students were from the dental schools. We implemented SEM statistics as a measurement tool to investigate the effects of personality characteristics of these students on resolving some issues that they tackle and come out with some feasible solutions.

Consequently, it showed that as the self-esteem increased, the problem-solving skills went up proportionally, and there was an inversed relationship between state anxiety and problem-solving skills. Parents' educational aspiration of students, which gives significant contribution for their academic achievements in education. This, in fact, boosts their confidence levels and help them to deal with any problems as they face. That results in a way that there will be new strategies developed in educational achievements.

Keywords*: Problem Solving, Self-esteem, State Anxiety, Trait Anxiety, Structural Equation Model, Faculty of Medicine and Dentistry Students*

Biclustering and an Application

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Abstract

Biclustering method is one of the most important methods of the data mining techniques. Biclustering can be used to discover similar patterns in datasets especially gene expression datasets or any datasets that can be presented as a matrix. Starting with Block clustering algorithm in 1972 until now a good number of the biclustering algorithms have been introduced. In biclustering methods, similar rows and columns in the data matrix are grouped simultaneously according to their subsets. The parameters used in biclustering algorithms are very important in determining the biclusters to be obtained. Because biclustering algorithms obtain different biclusters according to parameter values. There are many evaluation measures in the literature to obtain meaningful and effective biclusters.
Biclustering methods, which are popular recently, are used in the clustering analysis for this data. The performance of these algorithms needs to be examined in order to measure the effectiveness of the biclusters obtained for the purpose of the study. In this study, the performances of the most commonly used CC, Bimax algorithms are compared. Calculation of evaluation measures was made with Python, R functions and analyzes were applied to these codes. Artificial and real data are used to compare different data structures. As a result of the analysis, it was determined which algorithm obtained more meaningful biclusters in which data set.

Key words: *Biclustering, Bimax, CC*

Küresel Spor Bilimlerinde Özel ve Engelli Sporunda Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirme

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Abstract

Araştırmada; Spor Bilimlerinde Özel ve Engelli Sporunda Bireysel Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirmede Yenilikçi Bakışta Ulusal ve Küresel Değerlendirme Çalışmaları; Türkiye; Avustralya; Avrupa Birliği; Unesco Asya ve Pasifik Ülkeleri Modelinin açıklanması amaçlandı. Türkiye; İstanbul'da Küresel Terapi Akademisi; Özel ve Engelli Sporunda Bireysel Çok Amaçlı Eğitim Destek Terapisi Araştırma ve uygulama Merkezlerinde; ilgili konudaki çalışma palanları ve Çalışma Programları yapılmaktadır. Genelde; Dünya; Spor Bilimlerinde Özel ve Engelli Sporunda Bireysel Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirmede Yenilikçi Bakışta Ulusal ve Küresel Değerlendirme Çalışmaları Model Uygulamalarından yararlanılmaktadır. Dünyadaki; Spor Bilimlerinde Özel ve Engelli Sporun da Bireysel Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirmede Yenilikçi Bakışta Ulusal ve Küresel Çalışmaların Türkiye'de de yapılması önemli bulunmaktadır. Spor Bilimlerinde Özel ve Engelli Sporun da Bireysel Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirmede Küresel Çalışmalar takibedilmektedir. Geneldeki; Spor Bilimlerinde Özel ve Engelli Sporun da Bireysel Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirmede Küresel Çalışmalarına Türkiye'de de yer verilmesi istenmektedir. Genel Sonuçta; Spor Bilimlerinde Özel ve Engelli Sporunda Bireysel Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirmede Küresel Örgütlü ve Kurumsal Çalışmaların önü açılmaktadır. Spor Bilimlerinde Özel ve Engelli Sporunda Bireysel Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirmede Küresel Örgütlü ve Kurumsal Çalışmaların önü Türkiye'de de yapılması istenmektedir. Araştırmalarda; Spor Bilimlerinde Özel ve Engelli Sporunda Bireysel Çok Amaçlı Eğitim Destek Terapisinde İstatistiksel Değerlendirmede Yenilikçi Bakışta Ulusal ve Küresel Değerlendirme Çalışmaları; Türkiye; Avustralya; Avrupa Birliği; Unesco Asya ve Pasifik Ülkeleri Modelinin ön planda tutulmalıdır ve Türkiye'de uygulamaya konulmalıdır.

Keywords: *İstanbul Küresel Terapi Akademisi, Özel Destek Terapisi, Özel Spor Eğitimi Terapisi*

Küresel Spor Bilimlerinde Deha ve Mucidlerde İstatistiksel Yorumlama

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Abstract

In the research; National and Global Evaluation Studies with an Innovative Perspective in Statistical Evaluation in Sports Sciences, Special and Disabled Sports, Individual Multi-Purpose Training Support Therapy; Türkiye; Australia; European Union; It was aimed to explain the Unesco Asian and Pacific Countries Model. Türkiye; Australia; European Union; Retrieved from some of the Unesco Asian and Pacific Countries. Türkiye; Global Therapy Academy in Istanbul; In Individual Multi-Purpose Education Support Therapy Research and Application Centers in Special and Disabled Sports; Work plans and work programs on the relevant subject are prepared. In general; World; Innovative National and Global Evaluation Studies Model Applications are used in Statistical Evaluation in Sports Sciences, Special and Disabled Sports, Individual Multi-Purpose Education Support Therapy. In the world; It is important to carry out national and global studies in sports sciences, special and disabled sports, individual multi-purpose training support therapy, statistical evaluation, and national and global studies in Turkey. Global Studies are being followed in Statistical Evaluation in Special and Disabled Sports in Sports Sciences and in Individual Multi-Purpose Training Support Therapy. It is desired that global studies in general; in sports sciences, in special and disabled sports, in individual multi-purpose education support therapy and in statistical evaluation should also be included in Turkey. General Conclusion; The way is paved for Global Organized and Institutional Studies in Sports Sciences, Special and Disabled Sports, Individual Multi-Purpose Training Support Therapy and Statistical Evaluation. IIn general; Global Organized and Institutional Studies in Sports Sciences, Special and Disabled Sports, Individual Multi-Purpose Training Support Therapy, Statistical Evaluation are also desired to be carried out in Turkey. National and Global Evaluation Studies with an Innovative Perspective in Statistical Evaluation in Sports Sciences, Special and Disabled Sports, Individual Multi-Purpose Training Support Therapy; Türkiye; Australia; European Union; The Unesco Asian and Pacific Countries Model should be prioritized and ıt should be put into practice in Turkey.

Keywords: *Istanbul Global Therapy Academy, Individual Special Education, Individual Education Support Therapy*

Impact of trade openness and FDI on economic growth: evidence from North Macedonia

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Abstract

Whether the trade openness and Foreign Direct Investment really contribute to the economic growth are questions that have been strongly debated in the history of economic thoughts and as such have taken the attention of many scholars. Yet, mix empirical findings have been contributed even more to increase this attention, since no consensus has been reached among the scholars and policymakers regarding the effect and its significance for enhancing economic growth in both developed and developing countries. In this regard, this study tries to empirically analyze the impact of trade openness and FDI on the economic growth of the Republic of North Macedonia. Moreover, time series data has been checked for their stationarity by using two-unit root test: Augmented Dickey Fuller and Philips Perron test, while co-integration technique has been used in order to determine the short run and long run effects of trade openness and FDI on the economic growth of North Macedonia for the time spin 2000q1 – 2021q4. Furthermore, empirical findings suggest positive and significant long run nexus among trade openness and economic growth, while a negative effect of FDI on the economic growth.

Furthermore, such results will just contribute to the existing empirical findings and not to solve the long existing debate about the level of significance and direction of the impact of trade openness and FDI on the economic growth in developing countries.

Key words: *Trade openness, FDI, economic growth, co-integration, VECM*

Forecasting wheat production in Turkey using ARIMA model

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Abstract

This study conducted a time series analysis using wheat production data recorded in Turkey between 1961 and 2021. The aim was to forecast future production amounts based on historical data. Due to the annual frequency of the data and its long-term trend, the ARIMA (AutoRegressive Integrated Moving Average) model was chosen for the analysis. Since the data was non-stationary, a first-order differencing operation was applied, and the model parameters were determined through automatic selection. According to the AIC criterion, the most suitable model was found to be ARIMA(1,1,1). It was observed that the model parameters were statistically significant and successfully reflected the structural features of the series. Using the model, wheat production for the years 2022–2026 was forecasted, showing a moderate increasing trend. The results provide an important reference for agricultural policy planning, and it is recommended that future analyses include seasonal effects and external factors.

Key words: *Wheat, economic production, AIC, ARIMA*