

# BOOK OF FULL TEXT



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3th INTERNATIONAL APPLIED SCIENCES CONGRESS

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3th INTERNATIONAL APPLIED SCIENCES CONGRESS  
OCTOBER 16- 17, 2021  
İZMİR*

*Edited By*

*DR. GÜLTEKİN GÜRÇAY*

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## VISIONS FOR AN URBAN TRANSPORT SYSTEM FOCUSED METROPOLITAN VEHICLE FRAMEWORK

KENTSEL ULAŞIM SİSTEMİ ODAKLI BİR METROPOLİTEN ARAÇ ÇERÇEVESİ İÇİN  
VİZYONLAR

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### Abstract

Walking and cycling can make an extensive commitment to maintainable vehicle objectives, building better and more practical networks and adding to traffic and contamination decrease. There have been numerous public and nearby drives to advance strolling and cycling, however without a drawn out vision and reliable system it is hard to perceive how a critical change might be accomplished. This paper presents three elective dreams for the job of strolling and cycling in metropolitan regions for the year 2030: every vision represents a 'alluring' strolling and cycling-focused vehicle framework against an alternate 'exogenous social foundation'. These dreams have been created through a course of master conversation and audit and are planned to give a boost to banter on the potential for and attractiveness of such elective fates. Each depends on the Turkey and addresses a significant change to the current circumstance: specifically, every one of the dreams presents a perspective on a general public where strolling and cycling are extensively more significant than is right now the situation and where these modes provide food for a lot higher extent of metropolitan vehicle needs than as of now. The dreams show pictures of metropolitan conditions where reliance on engine vehicles has been diminished, in two of the dreams to extremely low levels. The methodological methodology for formulating dreams is educated by work on 'idealistic reasoning': a key idea basic this methodology is one of review the future in friendly constructivist terms (for example what's to come is the thing that 'we', as a general public, make it) instead of considering the future as something that can be 'deductively' anticipated by the extrapolation of latest things.

Keywords: Visioning, visualizations, Turkish cities, urban environments

### Özet

Yürüme ve bisiklete binme, sürdürülebilir ulaşım hedeflerine önemli katkılarda bulunabilir, daha sağlıklı ve daha sürdürülebilir topluluklar oluşturabilir ve trafik ve kirliliğin azaltılmasına katkıda bulunabilir. Yürümeyi ve bisiklete binmeyi teşvik etmek için birçok ulusal ve yerel girişim olmuştur, ancak uzun vadeli bir vizyon ve tutarlı bir strateji olmadan önemli bir değişikliğin nasıl elde edilebileceğini görmek zordur. Bu makale, 2030 yılı için kentsel alanlarda yürüme ve bisiklete binmenin rolü için üç alternatif vizyon sunmaktadır: her vizyon, farklı bir 'dışsal sosyal arka plana' karşı 'arzu edilen' yürüme ve bisiklete dayalı ulaşım sistemini

göstermektedir. Bu vizyonlar, bir uzman tartışması ve incelemesi süreciyle geliştirilmiştir. Bu tür alternatif geleceklerin potansiyeli ve arzu edilebilirliği üzerine tartışma için bir teşvik sağlamayı amaçlamaktadır. Her biri Türkiye'ye dayanmaktadır ve mevcut durumda önemli bir değişikliği temsil etmektedir: özellikle vizyonların her biri, yürüme ve bisiklete binmenin şu anda olduğundan çok daha önemli olduğu ve bu modların çok daha yüksek bir değere hitap ettiği bir toplum görünümü sunmaktadır. Vizyonlar, ikisinde çok düşük seviyelere kadar motorlu taşıtlara bağımlılığın azaltıldığı kentsel ortamların resimlerini göstermektedir. Vizyonlar tasarlamak için metodolojik yaklaşım, 'ütopik düşünce' üzerine yapılan çalışmalarla bilgilendirilir: bu yaklaşımın altında yatan anahtar kavram, geleceği sosyal inşacı terimlerle görmektir (yani gelecek, toplum olarak 'biz' ne yaparsak odur).

Anahtar Kelimeler: Vizyon, görselleştirme, Türkiye şehirleri, kentsel ortamlar

## 1. Introduction

Future investigations comprise the bit by bit study done on the conceivable, likely just as ideal future and they involve the perspectives and techniques that every future is related with Bell (1996) and Saul (2001). There is a probability that the future examinations will bring disturbances and challenge the current structure instead of work on the viability of the methodology. Future investigations involve a wide scope of studies and strategies, and the region is classified as an extremely fluffy multi-field (Marien, 2002). Futurists consider the interruption that strategies, for example, situation arranging and arising issues examination cause to work on the productivity of the methodology as futurists work on the flexibility and strength of the arrangement (Inayatullah 2000).

The fame of the single point determining was most elevated the period that what's to come was seen as comprehensible as futurists didn't believe vulnerability to be definitive. In any case, the quicker speed at which change is occurring and the continuous epistemological discussions in regards to the idea of information, it has become altogether more imperative to live with questionable fates in contrast with fostering a specific world (Schwartz, 1996).

Approximately three critical phases are notable in the evolution that the future modern studies. The first phase includes 1940s-1950s, the second includes 1960s-1970s while the third stretch from the 1980s to present. The initial phase is considered the golden phase of planning, positivism, quantitative methods, global financing and trade (Mannermaa, 1986). In this era, economic growth, industrialisation, urbanisation, the emergence of the potential of space travel and globalisation arose. This futures boom is characterised by a rising demand for organised trend-extrapolations, long-range planning and general technological foresight and assessment (Bell, 2005).

Figure 1 shows the periods of evaluation for future thinking based studies. Among the period from 1940's to the present day, it was seen that future thought-based studies consist of different disciplines and classified under different thinking categories (Kuosa, 2011). As seen from this figure, the first phase of futuristic studies is prediction thinking, which had involved control of life, oracle, seeing the future, magical arguments) until the beginning of the 1950s. Management



thinking is the next paradigm of future thinking approaches had been the cornerstone of the military, control of functions and physical arguments from 1960's to 2000's, while the final paradigm of future studies has begun after 1970's and classified into more different named thinking (systems, dialectic and futurology) and topics.

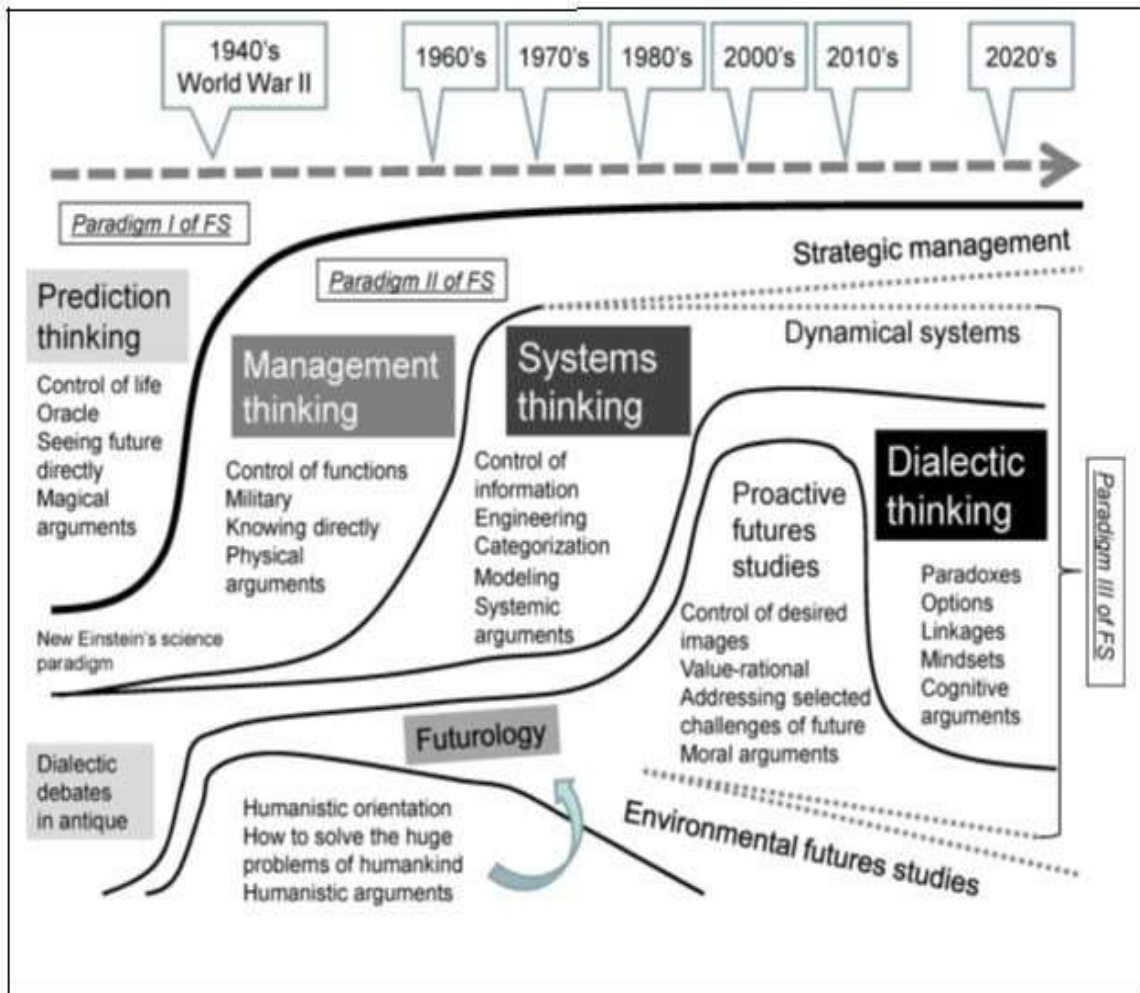


Image 1. Evolution of futures studies.

Source: Kuosa, 2011.

## 2. Overview of Approaches to Futures

It is workable for typologies to be valuable instruments when looking to convey, analyze, comprehend and foster techniques for future investigations. A scope of approaches differs relying upon which, ontological strategy is thought of. These modern methodologies are partitioned into three classes: Forecasting, Exploratory, and Normative (Tapio and Hietanen, 2002; Timms et al., 2014).

### 2.3.1. Estimating Scenarios

Estimates are characterized as exact future forecasts of a component by drawing upon past data of how the vital variables of the system have fluctuated throughout a particular timeframe

(Wada et al., 2011). Estimating techniques can be complicated numerical displaying suites which, are intermittently re-aligned to get which, components might have a changing measure of significance or they can basically be basic clarification based devices over the long haul (Makridakis et al., 2008).

Estimate situations recognize outrageous conditions and take into consideration a wide scope of potential figures to be made. For example, it is regular for a best, center and most dire outcome imaginable (with numerous other elective situations) to be introduced. Contrasting these various limits can lead with starting possibility arranging. Strategies are covered after the estimates are made, however don't drive interest (Coates, 2000).

### 2.3.2. Exploratory Scenarios

Exploratory techniques start from the present with an endeavor to see where occasions and patterns may be taken. They additionally check out how they push ahead while suggesting potential prospects. This implies that exploratory methodologies think about pre-conditions, convictions and social or mechanical potential outcomes which, as of now happen (Bock and Diday, 2012).

Exploratory situations ordinarily start with a primer evaluation of a potential (frequently an alluring) future that is of interest. Then, at that point, they work in reverse to take a gander at how these prospects may or probably won't occur in the present. They center around making conventional pictures of conceivable, attractive, bothersome or blended fates to work with key thought by associations (Timms et al., 2014).

### 2.3.3. Regularizing Scenarios

Regularizing strategies center just around theoretically advantageous fates and assist with giving pointers that can be utilized to configuration wanted fates. Standardizing situations focus on planning optimistic future situations and arranging objectives instead of foreseeing potential situations (Kuosa, 2014). It is entirely appropriate for participatory cycles and incorporates the uplifting potential for revolutionary changes, frequently in the medium and long haul. Visioning and backcasting are illustrative of this methodology. Visioning is a method that requires taking a gander at how unique positive dreams work. Backcasting thinks about what activities and strategies are required today that will associate the future to the present (Zimmermann et al., 2012).

## 3. Methodology

The poll overview means to empower the cooperation of people in general in the advancement of things to come fanciful situations. The related goals of this review are (I) to become familiar with the individual assumptions for the members about the maintainable vehicle dreams (the primary exploration objective); (ii) to look for the techniques which will guarantee

supportability in transport practices and ways of life (the second examination evenhanded) and; (iii) to investigate the components which will energize clients with unmistakable socioeconomics to utilize dynamic vehicle frameworks more (the third exploration objective). A similar web-based overview is used for the inquiries related with the main, second and third exploration questions. The overview results are accessible at <http://www.bisikletizm.com/bisikletli-ulasim-nasil-gelisebilir/>(by clicking Anket Sonuçları). The assent structure, member data sheet and online overview structure are given.

Open-finished overview questions offer members a chance to impart their insights unreservedly, and henceforth, it gives more productive information examination (Van Selm and Jankowski, 2000). Open-finished inquiries have various focuses in this review; the primary examination question is to comprehend members' necessities towards creating elective vehicle dreams for what's to come. The subsequent exploration question is to investigate viable vehicle rehearses that might assist with building a positive way of life and conduct change in Turkish metropolitan roads. All systems presented from the members are displayed.

The quantitative piece of the overview means to investigate transport rehearses that adequately advance distinctive financial gatherings to utilize non-mechanized vehicle frameworks for work ventures, thus kills disparity in the profile of dynamic vehicle clients. Hence, the third exploration question is intended to test transportation methodologies that might build the variety of people on foot and cyclists for the advancement of beneficial metropolitan conditions.

Likewise, members are asked a few inspiration inquiries. For instance, which of the accompanying changes (wellbeing, social, and natural) would rouse members to utilize dynamic vehicle frameworks more? The Statistical Package for Social Science (IBM SPSS Statistic 21) are utilized to test the contrast between the mean fluctuations (e.g., female and male) in view of different wellbeing, social-, and climate subordinate elements. Stretch scale questions are shaped to get some information about understanding strength, probability or fulfillment (for example totally fulfilled, fulfilled, unbiased, unsatisfied, totally unsatisfied).

The meetings are directed to evaluate (I) the influence of the elective dreams (the fourth examination evenhanded) and (ii) to develop adequate approach pathways that can be intended to accomplish a particular vision in Turkish urban areas (the fifth exploration objective). Semi-organized meetings are used in light of the fact that a little work had been recently done on the avocation of transport dreams, focussed on strolling and cycling (Richardson, 2007; Tight et al., 2011). A particularly methodological methodology is considered because of the intricacy of the difficulties that should have been tended to.

At first, the nonexclusive pictures are exhibited to willful members, and the critical changes of the situation accounts are momentarily clarified. Dreams and their representations are shown to the volunteer road and master members to assess the dependability of future substitute dreams. The overview questions are intended to resolve the fourth inquiry of the exploration.

In the meetings with general society, just the pictures of current and elective prospects at the applicable area is depicted and the photos of any pertinent area and its present condition are clarified in a more broad manner. For instance, the analysts don't expand on the critical factors of dreams for members in this piece of the work.

In the meetings with the specialists (metropolitan planners, transport engineers, non-legislative cycling gatherings, and scholastics), the indistinguishable inquiries are posed, all fanciful pictures are shown, and the clarifications are given in more detail. The explanation of utilizing two distinct methodologies for public and specialists is that the necessary time for every one of them are not quite the same as one another. One more distinction between the two methodologies is that the general population and the specialists are asked to respond to the inquiries as per every day transportation modes and working disciplines, individually. The normal occasions to finish the meetings with people in general and specialists were almost 5 and 35 minutes, individually.

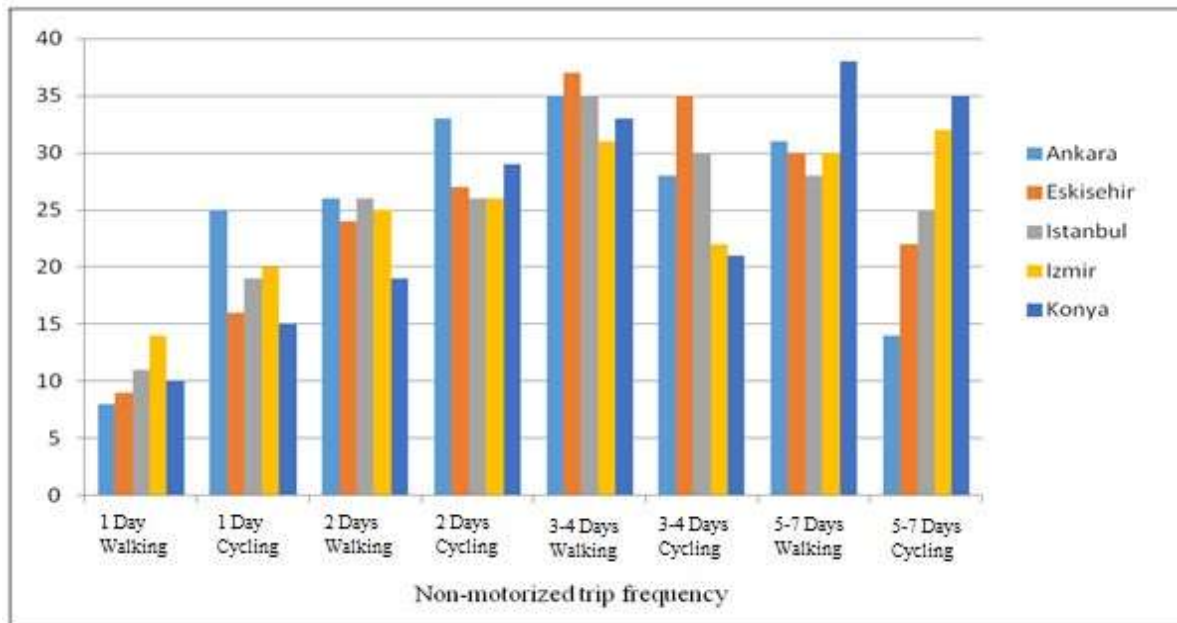
The fifth examination question is tended to through an educated conversation with the nearby and focal policymakers by the nonexistent photos of all dreams is clarified, however they are mentioned to clarify the inquiries just for the particular vision. They are requested to develop a timetable for the execution from measures that would help to accomplish the vision targets. Fanciful future travel situations are disclosed to those participating. Fully intent on getting the trademark information for each metropolitan region, the members are approached to evaluate the future nonexistent travel situations for their urban communities and offer their remarks and ideas to catch more normal and particular reactions. In the meetings with the focal strategy creators, the center is for the most part given to the vital portrayals of the situation stories. The inquiries of the meeting settled on with the nearby and focal chiefs are remembered.

#### 4. Results

Figure 1 demonstrates the extents of individuals are strolling and cycling to/from work on a given number of days in seven days. It is seen that cycling use rates for two days out of every week fluctuate between 26% and 33 percent and these rates are higher than strolling for similar recurrence in this load of urban areas.

The most extreme cycling utilization rates in Eskişehir and Istanbul are 3 and 4 days, individually; while, in Konya, it is more than four days out of each week. The cycle use rate diminishes just in Ankara. Then again, huge contrasts in cycling utilization recurrence between the metropolitan regions are not noticed ( $p < 0.05$  for the entire days).

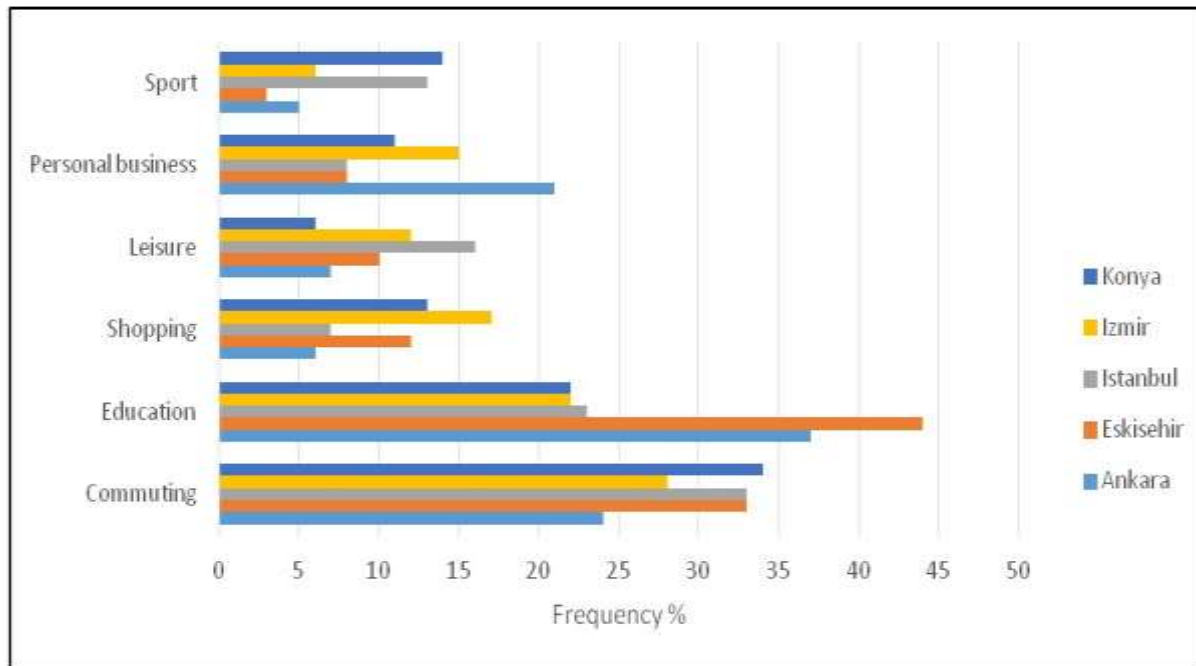




**Image 2.** The proportions of people are walking and cycling to work in a week.

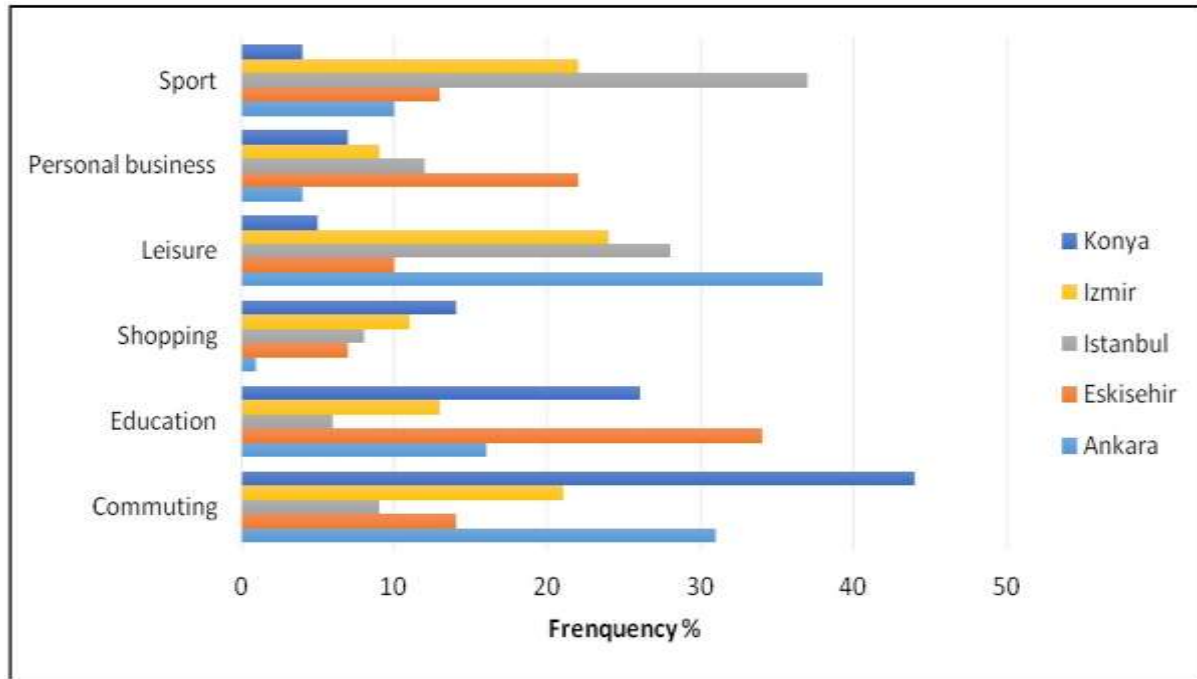
The successive utilization of the person on foot mode generally changes somewhere in the range of two and four days. As per the figure, the frequencies of passerby mode utilization in the model urban areas are comparable; nonetheless, the use more than four days is higher in Konya than in different urban communities. Nonetheless, there are no critical contrasts in the recurrence of walker mode utilization between the metropolitan regions ( $p < 0.05$  for the entire days). Of all excursions, 28-37% are walked somewhere around two days of the week, with the most minimal rate in İzmir and the least in Konya. Review information from five Turkish urban areas show that 31-37% of all strolling trips are made for three to four days, the most noteworthy figure being intended for Eskişehir and the least is İzmir. Excursions by walking happen most as often as possible in Konya with 35%, though strolling trips are less in Ankara with 13% for over five-roadtrips. Overview information from five Turkish urban areas show that 15-35% of cycling trips are made somewhere around five days out of each week, the most elevated figure being intended for Konya and the least is Ankara. For under three days on seven days, the portion of cycling use differs from 41% (Eskişehir) to 51% (Ankara). Figure 2 underscores that strolling is a method of voyaging utilized generally for two purposes: training and driving. Then again, there isn't a lot to convey, game and relaxation trips where the strolling is the central reason. Around 50-75% of all members strolled is intended for these two purposes, with Eskişehir at the top and Ankara at the base.





**Image 3.** The trip purpose of pedestrians in Turkey.

One example t-test was utilized to comprehend whether there is a huge connection between the recurrence of person on foot mode utilization in metropolitan regions and travel purposes or not. This test demonstrates that there is no measurable connection between the occurrence of walker mode utilization in five unique urban communities, aside from sports purposes ( $p > 0.22$ ). Figure 3 summed up that the bike is less utilized for excursions to shops, for the most part for recreation and sports purposes where bike visits perhaps are a point in itself. More individuals cycled for relaxation trips in Ankara (36%) and for sports trips in Istanbul (38%) than in some other chose Turkish urban areas. Notwithstanding, cycling is likewise a typical way for venturing out to work (and school). 65 % of members lived in Konya by bike is gone on home-work/school ventures. Eskişehir and Ankara followed, with 48% and 45%, separately on home-work strolling trips, though is the most minimal in Istanbul with 13%. One example t-test uncovers that there are factual contrasts between the recurrence and reason for cycling utilization. A critical distinction exists between the recurrence of cycling utilization for business or training purposes across different urban areas ( $p < 0.05$ ). Notwithstanding, there is no genuinely critical contrast between recurrence of cycling use for different purposes in various urban communities ( $p = 0.22$ , shopping;  $p = 0.06$ , relaxation;  $p = 0.14$ , private issue;  $p = 0.22$ , sport).



**Image 4.** The trip purpose of cyclists in the selected Turkish cities.

## 5. Findings

The motivation behind this review was to produce elective vehicle dreams that attention on walkers, cyclists, and public vehicle clients. The fanciful travel situations made for what's to come were created in accordance with thoughts from the general population, and full scale and miniature strategies which ought to be carried out to accomplish the objectives of a particular vision in metropolitan regions were looked for by the approach creators. To accomplish this examination point, the venture focussed on five fundamental exploration questions:

In this review, an exhaustive overview was embraced to learn the economical vehicle intercessions that members expected to find in the metropolitan spaces of Turkey inside the accompanying twenty years. In excess of 200 unique ideas towards creating future vehicle dreams in Turkey were considered for the motivations behind responding to the subsequent exploration question. Assessment of the members' assumptions for future Turkish metropolitan vehicle frameworks added to the making of a wide vision for future advancement that held public association to a greatest. Continuing to cycle courses separate from cars was observed to be the best future technique. Different needs were reduing vehicle speed and confining the utilization of private vehicles in some bustling pieces of the downtown area.

In this review, different methodologies that may change the transportation practices and ways of life of the members were looked for. Members indicated which potential systems may make positive or incompletely sure changes in their transportation practices. The outcomes show that the members will have different beneficial outcomes on their transportation conduct in every single future vision, yet explicit transportation methodologies that lead to any of these distinctive positive impacts couldn't be found.

The review researched whether the general significance of various security, social-, and natural arranged elements change essentially among various financial gatherings. A single direction ANOVA showed that the main measurably huge relationships were among sexual orientation and the normal scores of wellbeing, social, and natural elements. The discoveries of this investigation concurred with those of past examinations. Moreover, the factual outcomes uncovered methodologies that ought to be powerful in pushing sex gatherings to utilize more supportable vehicle frameworks. Nonetheless, the outcomes just gave restricted data about formulating potential procedures that may be designated at explicit financial gatherings (for example sexual orientation, age, pay, and instruction).

In this review, the proposed future travel dreams were assessed by thinking about open and master sees. A large portion of general society and master members believed every one of the dreams to be beneficial future metropolitan conditions for Turkish urban areas. Notwithstanding, the overall view from the members was that the vision that further develops public vehicle was more solid and surprisingly essential for metropolitan regions in Turkey, despite the fact that the aim of creating dreams for what's to come was an extreme expansion in non-mechanized vehicle frameworks.

This concentrate initially imagined future ways to deal with transport to investigate the fundamental public and nearby approaches in the chose case urban areas. The discoveries broaden scholarly information and comprehension of things to come jobs of different foundations in the advancement of positive metropolitan regions and effectively gave a valuable illustration of how unique Turkish nearby specialists could develop strategy pathways that would empower them to understand the Improve Vision focus constantly 2035.

## 6. Conclusion

This paper has set out various dreams for the year 2030 which achieve a stage change in the degree of strolling and cycling in Turkish metropolitan regions. The dreams are expected as a reason for conversation and to assist with advancing pondered what is associated with "person on foot and cyclist agreeable prospects" and regardless of whether such fates are attractive. Vision One expects to be a social setting "like the current day" and centers upon conditions which generally exist currently in various mainland European metropolitan regions and somewhere else. Dreams Two and Three accept profoundly unique social settings to the current day and the metropolitan regions depicted in these dreams are altogether different to what exactly exists in 2010. The advantages of the "strolling and cycling" parts of each of the three dreams are possibly broad – decreased nearby commotion and air contamination, decline in outflows of ozone depleting substances, further developed wellbeing, better wellness levels of the populace, just as changes which are more hard to evaluate such as more noteworthy friendliness of the metropolitan climate, expanded opportunities for youngsters to utilize the climate and a general improvement in metropolitan personal satisfaction. Considering that the dreams have been grown explicitly with regards to a medium measured city of 250,000 individuals, a significant inquiry identifies with their adaptability to metropolitan areas of various sizes in Turkey and to metropolitan regions outside Turkey. Indeed, even inside Turkey



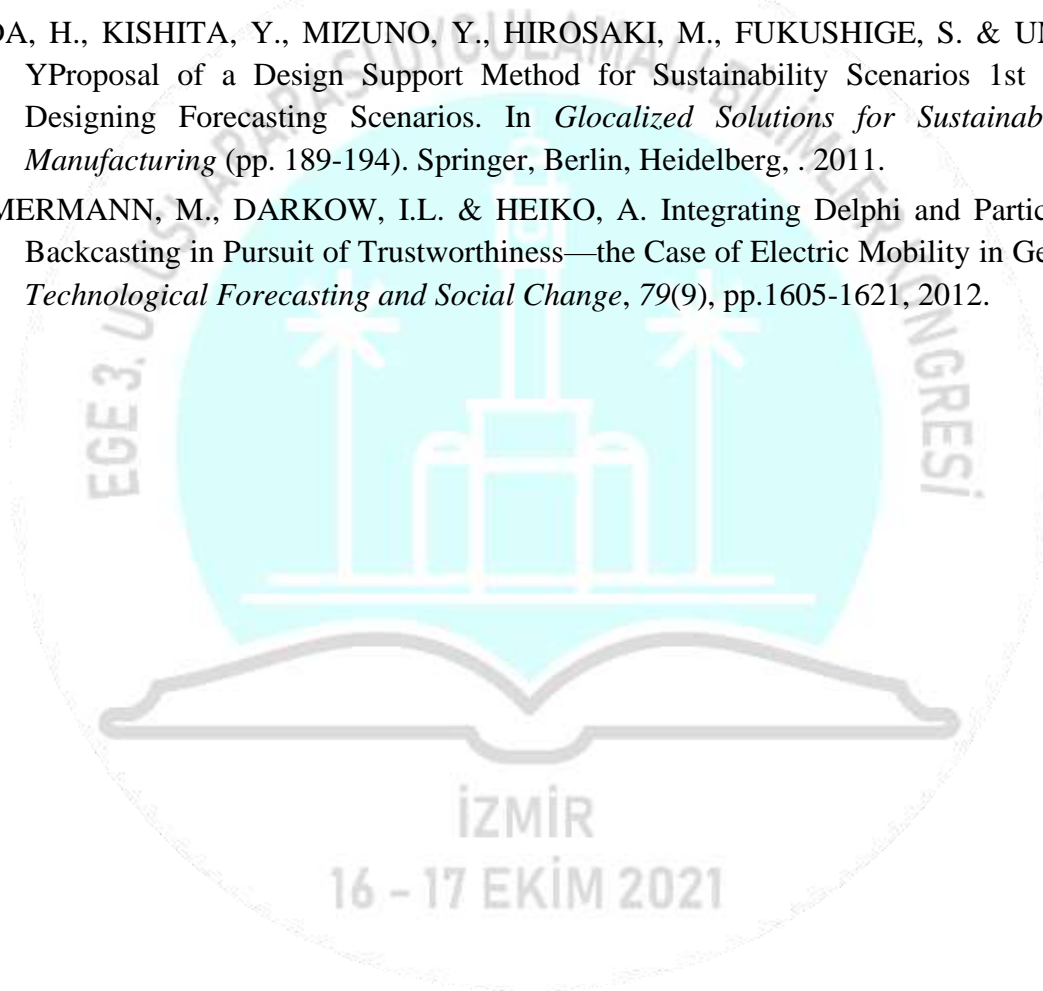
setting, it is hard to evaluate whether the progressions addressed in the dreams will be more troublesome or simpler to accomplish in more modest or bigger networks and this inquiry will be tended to in the rest of the exploration. Nonetheless, considering that large numbers of the actions which are available in the dreams are restricted to neighborhoods, it tends to be conjectured that it is far-fetched that there will be extra issues with these, paying little heed to the size of the in general metropolitan region. On the other hand, a portion of the cross metropolitan region provisions like organizations and generally network for strolling and cycling may possibly be more hard to accomplish in bigger urban areas. For super urban areas, for example, London it is conceivable that there might be issues with possibly long travel distances, however land-use change and localisation of exercises may go some approach to improving these. The following phases of the work will zero in on investigating pathways or storylines by which these dreams may be accomplished, that is to check out what sorts of things would need to occur and when to move from the current circumstance to every option 2030. It is expected to work through these storylines for both the theoretical city depicted here in this paper, and furthermore to endeavor to work with various nearby specialists and other vehicle partners in some Turkish metropolitan regions to investigate how the sorts of changes talked about here may be planned onto or adjusted to fit genuine areas.

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## FLOOD MANAGEMENT APPLICATIONS

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### ABSTRACT

The impact of floods and similar disasters on society is directly proportional to the economic power of the country and the magnitude of the disaster. This situation is most clearly seen in developing countries. Countries economies are weakened as a result of disasters. Therefore, it is very important for every country to reduce the negative effects of natural disasters and to predict the disaster early and to determine appropriate, costly and planned strategies.

Floods cause massive damage in different countries every year. It may not be possible to prevent and control the floods, but it is necessary to manage them. Turkey faces flooding risks due to climatic, ecologic and socio-economic changes. Nevertheless, mitigation efforts intended to reduce flood risks in Turkey, have been limited and not adequate. The negative effects of natural disasters such as floods on the country and society can be minimized when necessary precautions are taken on time and appropriate strategies are determined, especially by using technological methods. It is very important to take sustainable and appropriate measures against disasters especially floods.

This review presents effectiveness and sustainability of flood risk management strategies and related technologies.

**Keywords:** Flood; Natural disaster; Flood management.

### INTRODUCTION

Flooding is a major natural disaster that is becoming more severe for many human communities and governments. Floods accounted for about half of all persons affected by natural disasters in recent years, accounting for nearly one-third of all natural catastrophes worldwide (Adikari and Yoshitani, 2009). Due to climate change, environmental pollution and other factors around the world, natural calamities such as floods, tsunamis, droughts, bushfires, storms, epidemic diseases, landslides, earthquakes, hurricanes, cyclones, and tornadoes occur frequently (Samu and Kentel, 2018). Floods are one of the serious socio-natural disaster and causes significant damage to quality of lives and affecting the socio-economic living. Floods caused by the unintentional release of water storage, such as snow or tides, dams, or floods induced mostly by heavy rainfall (Samu and Kentel, 2018). Flood disaster events have affected the economic development of the country and socio-economic lives. The nature of flooding varies according to geography of region. The hydrology of floods is linked to both climate and physiographic characteristics (Shah and Gabriel, 2002).



Developing economies, such as Turkey's, are the most exposed to climate and flood dangers as a result of climate change. Floods and droughts in developing countries pose serious economic and social threats to humanity (Mohamed Shaluf, 2007). Flooding has been a frequent occurrence in Turkey, resulting in damage to crops, infrastructure, and human life. High rates of flood-prone urbanization, land use changes, many sub-customary constructions, increasing population density, and, most importantly, global warming associated with climate change have all contributed to an increase in flood-related losses (Luino et al., 2018). Most countries, including Turkey, are becoming increasingly urbanized, with the bulk of the population currently residing in urban areas; and some experts have noted that cities with rapid urban growth experience greater floods and flood damages (Hammond et al., 2015). Flood and other natural hazards are projected to be reduced in developing nations if proper and effective adaption measures are included in management plans and sustainability strategies (Thomalla et al., 2006). Levels of flood protection define how well a region is protected from flood damage (Samu and Kentel, 2018). Flood protection is provided through esplanades, dams, and other management techniques and technologies.

This review paper used various applications to identify the negative effects of floods on people and the environment in order to propose sustainable solutions for the future; to detect possible causes of floods, estimate future flood-related risks in the country, and review sustainable mitigation policies.

## **RESEARCH METHODOLOGY**

In this review study, the relevant literature was used.

## **RESULTS AND SUGGESTIONS**

In many parts of the world, stream flooding after excessive local precipitation or mass snowmelt is the most common example of flooding. Flood is a natural formation that develops depending on the climatic conditions, geotechnical and topographic characteristics of the region. However, the flood problem or disaster occurs mainly as a result of human activities. Uncontrolled urbanization activities in areas with flood risk without taking any precautionary measures are the most important cause of flood disasters in all parts of the world. Therefore, the damages we cause to the ecosystem appear in the form of floods and similar disasters. Riverine flooding, flash floods, coastal flooding, and lake flooding are the main types of flooding. Riverine flooding occurs when river flows exceed their capacity as a result of severe, sustained rains. Flash floods are fast and catastrophic, and they usually happen as a result of strong storms, landslides, a quick dam failure, or when runoff exceeds the drainage system's capacity. Rising seas, hurricanes/cyclones, sinking beaches, and tsunamis are all potential causes of coastal flooding. Following heavy storms and persistent wet years, water levels in lakes often shift gradually over numerous storms, causing overspill to the adjacent low-lying areas. Flood risk management tactics and technology have evolved over ages as civilizations in various regions of the world have developed. Structural engineering solutions have been increasingly important in flood risk management in recent years. Embankments, dykes, polders, diversion channels, and dams were the principal flood mitigation and control strategies used in the modern era. Nonstructural remedies have also been employed as a result of flooding to reduce exposure and



susceptibility (Richards et al., 2008). Depending on the local environment and planning processes, the effectiveness and long-term viability of all flood control methods varies substantially. The goal of long-term flood risk management can best be achieved if everyone contributes to flood risk management planning and implementation; additionally, flood risk management is a multidisciplinary issue that includes ecological, climatic, socioeconomic, institutional, and hydro-meteorological aspects.

Among the structural defense strategies are levees or dams, as well as broader ecosystemic interventions like renaturalization. The concept of risk can be illustrated using structural flood defenses such as dykes; dykes can give good protection against small to medium floods (Zbigniew et al., 2001). Flood risk management structural measures may result in changes to the natural environment and ecosystem. Embankments, spurs, dikes, floodwalls, gabion walls, dispersions, diversion structures, delay action dams, bypass-structures, and floodwater channelization are examples of structural measures. Non-structural flood mitigation strategies include the use of management planning systems to regulate human activities. Flood proofing, emergency response and recovery, floodplain mapping, land use restrictions, limiting new developments and storing dangerous chemicals or locating sewage treatment plants in high-risk locations, and implementing conservation methods are examples of nonstructural interventions. A river system is normally not tied to a single country, although an upstream country's actions might have a significant impact on those downstream. Non-structural measures, on the other hand, are difficult to deploy across borders. Instead of administrative or political borders, the optimum model for a single system of water management is based on river basins, which are natural geographical and hydrological units (EU, 2000). Water management should not be limited to a single country, but rather involve countries cooperating across borders to manage shared water, allowing for a more long-term sustainable approach.

Floods are prevented via flood warning systems and flood education. Residents in a region are better prepared for proper countermeasures when they are informed about flood coping tactics. As a result, in order to properly employ warning systems, residents must have adequate knowledge and take appropriate steps. Locals are given the opportunity to take their own measures by educating them and introducing a warning system. "Foreign borrowing to fund post-disaster rehabilitation presents a number of policy concerns. Since 1980, the World Bank has lent 7.5 billion dollars to 56 countries for post-disaster rehabilitation" (Roy and Kreimer, 1999). Funds are provided if necessary, and disaster effects are minimized. International help and borrowing from international lenders are prominent strategies for dealing with flood-related losses. One method to deal with disaster losses is to transfer risk management responsibility to property owners by enhancing underwriting chances. Insurance as a form of mitigation could assist the country in covering the costs of natural disasters (Amendola et al., 2000). Restoring streams to their natural state, restoring meanders, restoring vegetation, and afforestation, all with the goal of retaining the maximum amount of water, are major challenges in lowering peak discharge. Flooding management demands the integration of a dynamic planning approach that takes into account all aspects of flooding disasters (Dixit 2003). To achieve efficient flood risk management, organizations and individuals must play an effective role. The strategy a country takes to disaster management is mostly determined by policy, legislation, and institutional setup

(Mattingly 2002). Many federal and provincial agencies are participating in flood-prevention efforts. Effective rules and regulations, such as those governing air and water quality, rivers, property ownership, land use/zoning, and forest protection, as well as those governing human health, the environment, and natural resource conservation. There are some flaws in the current flood control system, such as incomplete flood control structures throughout the system; technical flaws in existing flood control works; a high number of casualties caused by storm events during flash floods and surges; inaccurate or insufficient flood forecasting and warning systems; information system problems; and dilemmas in land use adjustment.

Some recommendations for prevention of floods and reducing the adverse effects; preventing the construction of dams and raising facilities that change the flow regime that causes the water to swell in the river beds; predetermination of flood risk areas and preparation of disaster plans; making arrangements for infrastructure standards in areas with flood risk; ensuring the participation of local governments and residents of the settlements that will remain in the service area of the facility in the plans, projects, construction, maintenance and repairs of flood facilities; preventing all kinds of interventions to flood facilities; preventing the opening of sand and gravel pits and uncontrolled, excessive material intake, which will disrupt the basis of bed stability and cause coastal scours in stream beds; not giving the zoning plan to areas with flood risk; making arrangements regarding the distribution of duties between institutions; establishment of a ministry on disaster issues; preventing practices that will interfere with stream beds and flood facilities; training and information activities should be carried out periodically and continuously.

## CONCLUSIONS

All areas of flood control, including community, adaptation planning, research, trans-boundary water management, individual and institutional cooperation, should be considered if efficient and sustainable flood management is sought. This framework is intended to have a positive impact on the flood management system by ensuring individual safety, assuring the long-term viability of initiatives, and assessing the effectiveness of treatments within the region. There is a need for additional research into flood disasters.

Floods are inevitable, hard to predict and floods occur all over the world with devastating consequences. Floods are linked to increasing urbanization and industrialization, as well as extreme weather as a result of climate change and global warming. Engineered structural measures and nonstructural flood management methods are human responses. It is now widely acknowledged that no single technique is sufficient to minimize flood risk; however, in all floodplains and across countries, a combination of flood risk management measures is essential.

Due to climatic changes, rapid population increase, deforestation, altered indigenous ecosystem balance, and inadequate urban management elements, disasters and risks may become more common in Turkey. To minimize the damage to countries and society, necessary precautions should be done before disasters occur, and legal legislation on the subject should be updated and applied without compromise. As humans, we must cease damaging nature, take

long-term actions to reduce the damage caused by natural catastrophes, and constantly be prepared for natural disasters such as floods.

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## WATER QUALITY AND HUMAN HEALTH

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### ABSTRACT

Water is the most essential element of life. Because of chemical and physical pollution of water, it can be the source of many life-threatening diseases. Water quality is one of the most important environmental issues relating to sustainable development of many countries. In addition water resources and water quality are very important for humanity, especially in the water shortage regions. The world population is constantly increasing and world population is facing serious water security and water quality problems. Turkey and some other developing countries are facing severe water pollution. Providing healthy and sufficient drinking water has been an important engineering work throughout the history of humanity. Water quality issues are a major challenge that humanity is facing in the last century. Today, in addition to adequate water supply, the management of water quality process has great importance.

In this review, the importance of water quality and the importance of water quality in terms of human health has been emphasized.

**Keywords:** Water; Health; Water pollution; Water quality.

### INTRODUCTION

Water is essential for all living things. Water, which has long been a key ingredient in the growth of cultures and for which people have fought for centuries to get, has also been responsible for the collapse and extinction of many civilizations in the past. Many of humanity's challenges in the previous century have been tied to water supply or quality issues. Climate change, glacier melting, higher water temperatures, and an amplification of the water cycle, with perhaps more floods and droughts, will exacerbate these worldwide issues in the future. So governments must find an effective way to improve people's health and to improve using water quality.

Clean water supplies are dwindling, and the number of civilizations dealing with water issues and diseases linked to pollution is rising. Water quality is influenced by a number of elements, including hydrological circulation, treatment, and distribution. Drinking water quality is one of the most important variables affecting human health; nevertheless, in many countries, drinking water quality is poor, resulting in a slew of waterborne diseases. Everyone's right to safe drinking water is a core human right. Polluted drinking water and poor sanitation are linked to transmission of waterborne diseases such as diarrhea, cholera, dysentery, and polio (WHO, 2018). As a result, countries have set a significant public health aim of reducing waterborne infections and developing safe water supplies (Li and Qian, 2018).



There are numerous factors that influence and decide the quality of drinking water (physical and aesthetic, inorganic, radionuclides, organic, microbes, etc.). There should be no pathogenic microorganisms in the water; toxic or harmful substance concentrations should be below certain limits or not present in the water; water should be clear and colorless; it should not be salty; there should be no irritating odors and tastes in the water; it should not be so hard as to cause economic damage and should not be corrosive.

## RESEARCH METHODOLOGY

In this review study, the relevant literature was used.

## RESULTS AND SUGGESTIONS

Water color is an important feature in drinking water reservoirs because it affects the physical and biological aspects of the water (Hakanson, 1993). The following are some of the disadvantages of having a lot of color in the water: Water used in industries such as beverages, dairy products, food, paper, and textiles must be colorless and clear, even if it does not contain any harmful substances; some organic substances that give water color react with free chlorine and produce various by-products that are harmful to health; water used in industries such as beverages, dairy products, food, paper, and textiles must be colorless and clear, even if it does not contain any harmful substances; water used in industries such as beverages, dairy products, food, paper, and textile. One of the most important parameters related to drinking water quality is turbidity. Turbidity is caused by suspended solid particles and colloids. The amount of solids suspended in the water determines its turbidity; these solids in the water may include silt, clay, organic/inorganic debris, plankton, and other microscopic organisms. Suspended particles can provide food and protection from ultra-violet light for pathogen microbes, raising the risk of waterborne infections if not eliminated (Sinclair et al., 2012). (Tinker et al., 2008). Waterborne infections such as parasites, viruses, and bacteria, which can cause cramps, headaches, diarrhoea, and nausea, are becoming more common as turbidity levels rise (Sarai, 2006). Some pesticides and heavy metals may be retained on solid particles; some substances that cause turbidity prevent the water from being disinfected effectively; some substances that cause turbidity react with free chlorine during disinfection, resulting in the formation of by-products that are considered tainted; some substances that cause turbidity prevent the water from being disinfected effectively; some substances that cause turbidity react with free chlorine during disinfection, resulting in the formation of by-product Total dissolved solids is a measure that reflects the amount of all dissolved ions in water, and exceeding a specific level in water is undesirable. Among the physical parameters that determine the quality of drinking water, taste and smell are important in terms of "aesthetics". Undesirable tastes and odors in water can have many different causes. By definition, hardness is the sum of the concentrations of metal cations with a valence of  $+2$  or higher and hardness in practice is considered as the total concentration of calcium ( $\text{Ca}^{2+}$ ) and magnesium ( $\text{Mg}^{2+}$ ) ions. Some inorganic substances (arsenic, lead, cadmium, etc.) in water are thought to cause cancer. Other chemicals, such as copper, molybdenum, nickel, selenium, salt, and others, are useful or even necessary for human health in small levels, but high concentrations can be hazardous. While natural organic chemicals (such as humic acid) are generally not damaging to one's health, some may cause the water to change color or have unpleasant tastes and scents. When such compounds react with free

chlorine, hazardous by-products can result. Typhoid fever, paratyphoid, bacillus dysentery, cholera, amoebic dysentery, legionnaires' disease, jaundice, and infant paralysis are all diseases that can be transmitted through drinking water.

This review aims at highlighting the problem of water pollution with special emphasis on all kind of pollutants and their possible impacts on human health. Furthermore we summarized, emphasized the various water-linked health problems and the importance of water quality on human health.

## CONCLUSIONS

One of humanity's greatest issues is the increasing global contamination of natural water, which has negative consequences on aquatic life and human health. Drinking water should be continuously monitored in all locations; there is a need to transition from an intermittent to a continuous water supply system to avoid widespread contamination caused by intermittent water supply; and humans must educate the population about the importance of safe drinking water. Pollutants and micropollutants from many sources (agricultural, mining, landfills, industrial and urban effluent, etc.) must be avoided in order to avoid polluting the water. Reliable wastewater collection and treatment systems are important for human and ecosystem health.

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## SAKARYA İLİNİN SON 45 YILLIK METEOROLOJİK AFET ENVANTERİ

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### ÖZET

İlk çağdan günümüze insanoğlu afetlerle karşı karşıya gelmiştir ve gelecekte de gelmeye devam edecektir. Dünyanın hiçbir yerinde ve bölgesinde afetler engellenemez fakat afetlerin vereceği olası zararlar en az seviyeye indirilebilir. Bu araştırma ile bölgesel bir afet envanteri oluşturarak mevcut durumu ortaya koymak, küresel ısınmaya bağlı oluşan afetlerin hızla arttığı günümüzde ve gelecekte oluşabilecek zararların azaltılabilmesi konusunda alınması gereken tedbirler için veri tabanı oluşturabilmek ve bu tedbirler konusunda öneriler sunmak amaçlanmıştır. Çalışmada; Sakarya ilinin son 45 yıllık afet envanteri yıllık ve mevsimlik olarak ölüm ve hasar kriterleri bazında incelenmiştir. Oluşan hasar durumuna göre Sakarya ili hafif hasar, orta hasar ve ağır hasar olarak kategorize edilmiştir. Hasar sayısı bakımından en fazla orta hasar meydana gelirken, hafif hasar ikinci sırada yer almıştır. Ağır hasar ise en az gerçekleşen hasar çeşidi olmuştur. 1975-2020 yılları arasında meteorolojik afetlerden yağış/sel/su baskını kaynaklı 1 ölüm, heyelan kaynaklı 1 ölüm, yıldırım düşmesi kaynaklı 1, toplam 3 ölüm gerçekleşmiştir. Bu nicel araştırmada Tarım ve Orman Bakanlığı Meteoroloji Genel Müdürlüğü raporları kaynak olarak kullanılmıştır. Araştırma sonucunda, halkın afetler konusunda eğitilmesi gerekliliği, kamu kurumları ve sivil toplum kuruluşları arasında koordinasyonun ve iş birliğinin sağlanması zorunluluğu, özellikle yerel yönetimlerin afetlerin her an yaşanabileceğini göz önüne alarak imar planlarını yapması gerektiği gibi öneriler sunulmuştur.

**Anahtar Kelimeler:** Meteorolojik afet, Sakarya, envanter, zarar durumu, hasar azaltma.

### 1. GİRİŞ

Bu araştırmada Sakarya ilinin son 45 yıllık meteorolojik afet envanteri çıkarılmıştır. Son on yılda dünya çapında 1,7 milyar insan, iklim ve hava bağlantılı afetlerden etkilenmiştir. (Dünya

Afet Raporu 2020 Yönetici Özeti, 2020: 4). 2017 yılındaki insani ve ekonomik kayıpların neredeyse %90'ı klimatolojik, hidrolojik, veya meteorolojik afet kaynaklıdır. 2017 yılında afetlerden etkilenen insanların yaklaşık %60'ı sellerden etkilenirken, ekonomik zararların %85'i fırtınalar sebebiyle oluşmuştur. 2017 yılında en büyük üç kasırga Harvey 95 milyar ABD doları, Irma 66 milyar ABD doları ve Maria 69 milyar ABD doları zarara yol açmıştır. (<http://cred.be/sites/default/files/CredCrunch50.pdf>, 14.05.2021). Afet envanteri, afet durumunda hizmet verecek kuruluşların elinde bulunan malzeme, kaynak ve imkânların stok durumunu yönetmesini sağlamaya yarayan demirbaş listesi. (<https://www.afad.gov.tr/aciklamali-afet-yonetimi-terimleri-sozlugu>, 03.03.2021). Ülkemizde ise en sık görülen meteorolojik karakterli doğal afetler dolu, sel, taşkın, don, orman yangınları, kuraklık, şiddetli yağış, şiddetli rüzgâr, yıldırım, çığ, kar ve fırtınalardır. (<https://www.mgm.gov.tr/FILES/genel/kitaplar/dogalafet-2015.pdf>, 07.02.2021). Bu araştırma ile Sakarya ili için bölgesel bir afet envanteri oluşturarak mevcut durumu ortaya koymak, küresel ısınmaya bağlı oluşan afetlerin hızla arttığı günümüzde ve gelecekte oluşabilecek zararların azaltılabilmesi konusunda alınması gereken tedbirler için veri tabanı oluşturabilmek ve bu tedbirler konusunda öneriler sunmak amaçlanmıştır. Çalışmada, Sakarya illinde meydana gelen meteorolojik afetler mevsimlere göre gösterilmiştir. Afetlerden kaynaklı ölümler ve hasar durumu hafif hasar, orta hasar ve ağır hasar olarak ayrıca katagorize edilerek verilmiştir. Kadioğlu afeti “İnsanlar için fiziksel, ekonomik, sosyal, kültürel, doğal ve çevresel kayıplar doğuran, normal yaşamı ve insan faaliyetlerini durdurarak veya kesintiye uğratarak toplulukları etkileyen, etkilenen topluluğun yerel imkân ve kaynaklarını kullanarak baş edemeyeceği, kriz yönetimi gerektiren doğa veya insan kökenli olay ve/veya olayların sonuçlarına verilen genel bir ad” olarak tanımlar (öz, 2011:37). Türk Dil Kurumu afeti “Çeşitli doğa olaylarının sebep olduğu yıkım.” olarak tanımlar. (Türk Dil Kurumu (TDK), <https://sozluk.gov.tr>, 04/02/2021). Afet, birçok kurum ve kuruluşun koordineli bir biçimde görev almasını gerektiren ve insan hakları için fiziksel, ekonomik ve sosyal kayıplar meydana getiren, normal yaşamı ve insan aktivitelerini durdurarak veya kesintiye uğratarak toplumları veya insan topluluklarını etkileyen doğal, teknolojik ve insan kökenli olaylara denilmektedir. Bu olaylar içinde deprem, sel-taşkın, volkan püskürmeleri gibi doğanın normal bir işlevi olarak gerçekleşenler “doğal tehlike” olarak nitelendirilir ve “afet” niteliğini kazanması için insan can ve malının kaybına neden olması gerekir (Şahin ve Sipahioğlu, 2002: 15). Afet yönetim şekilleri yıllar geçtikçe değişmektedir. Günümüzde gelişmiş ülkeler bütünlükli afet yönetimi sistemi’ olarak adlandırılan bir yönetim anlayışını benimsemişlerdir. Bu model, afet ve acil durumların sebep olduğu zararların önlenmesi için tehlike ve risklerin önceden tespitini, afet olmadan önce



meydana gelebilecek zararları önleyecek veya en aza indirecek önlemlerin alınmasını, etkin müdahale ve koordinasyonun sağlanmasını ve afet sonrasında iyileştirme çalışmalarının bir bütünlük içerisinde yürütülmesini öngörmektedir. (Benli, 2018:29).

## 2. YÖNTEM

Bu nicel araştırmada veri, yazılı kaynaklardan elde edilmiştir. T.C. Tarım ve Orman Bakanlığı Meteoroloji Genel Müdürlüğü FEVK (Olağanüstü Olay) raporlarında yer alan;

- Meteorolojik afetlerin gerçekleştiği yıllar
- Meteorolojik afetlerin türü
- Meteorolojik afetlerin kayıtlara geçen zarar durumu
- Meteorolojik afet sonrası varsa ölü ve yaralı durumu
- Meteorolojik afetlerin sayısı
- Meteorolojik afetlerin yıllara göre dağılımı
- Meteorolojik afetlerin hangi ilde gerçekleştiği bilgileri bu kurum raporlarından yararlanılarak elde edilmiştir.

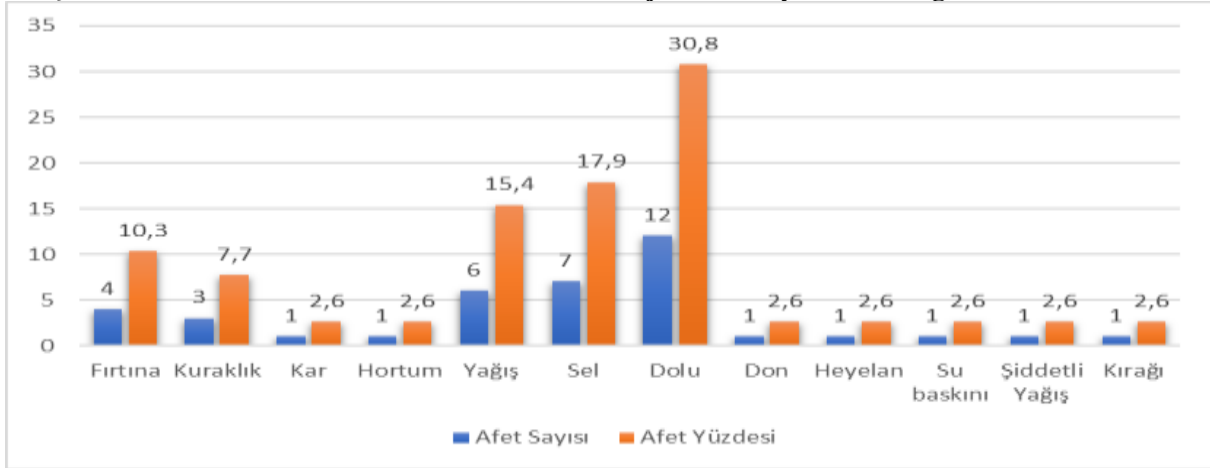
Verilerin analizinde SPSS 22.0 programı kullanılmıştır.

## 3. BULGULAR

Şekil 1. 1975-2020 Sakarya ilinin ilkbahar mevsimi meteorolojik afet sayılarının dağılımı ve yüzdeleri verilmiştir. Bu grafiğe göre en fazla görülen afet dolu olmuştur. Sakarya ilinde 1975-2020 yılları arasında ilkbahar mevsiminde 4 fırtına, 3 kuraklık, 1 kar, 1 hortum, 6 yağış, 7 sel, 12 dolu, 1 don, 1 heyelan, 1 su baskını, 1 şiddetli yağış, 1 kırağı görülmüştür. Oluşan toplam meteorolojik afet sayısı 39'dur.

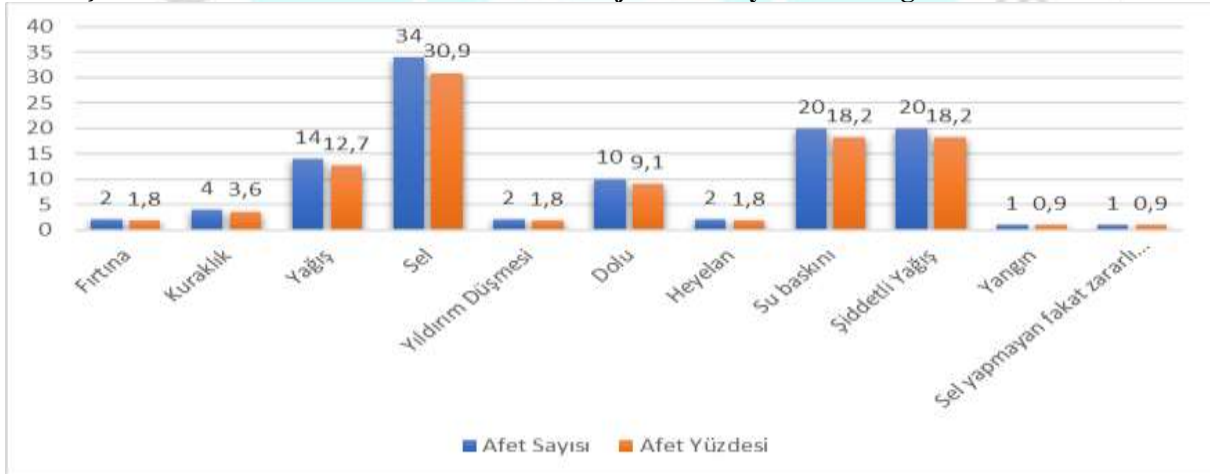


**Şekil 1. 1975-2020 İlkbahar Mevsimi Meteorolojik Afet Sayılarının Dağılımı ve Yüzdeleri**



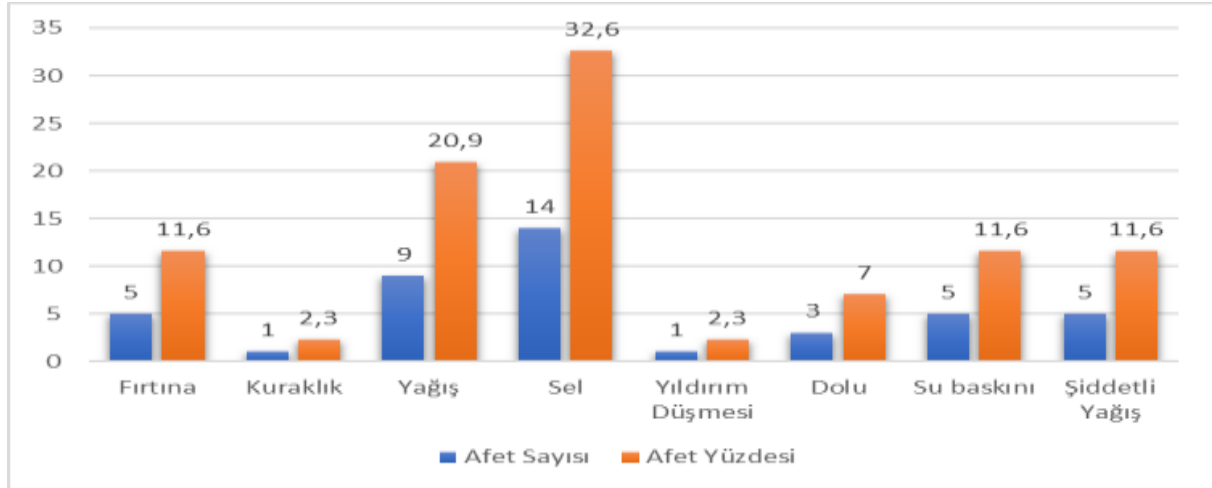
Şekil 2. 1975-2020 Sakarya ilinin yaz mevsimi meteorolojik afet sayılarının dağılımı ve yüzdeleri verilmiştir. Bu grafiğe göre en fazla görülen afet sel olmuştur. Sakarya ilinde 1975-2020 yılları arasında yaz mevsiminde 2 fırtına, 4 kuraklık, 14 yağış, 34 sel, 2 yıldırım düşmesi, 10 dolu, 2 heyelan, 20 su baskını, 20 şiddetli yağış, 1 yangın, 1 sel yapmayan fakat zararlı yağış görülmüştür. Oluşan toplam meteorolojik afet sayısı 110'dur.

**Şekil 2. 1975-2020 Yaz Mevsimi Meteorolojik Afet Sayılarının Dağılımı ve Yüzdeleri**



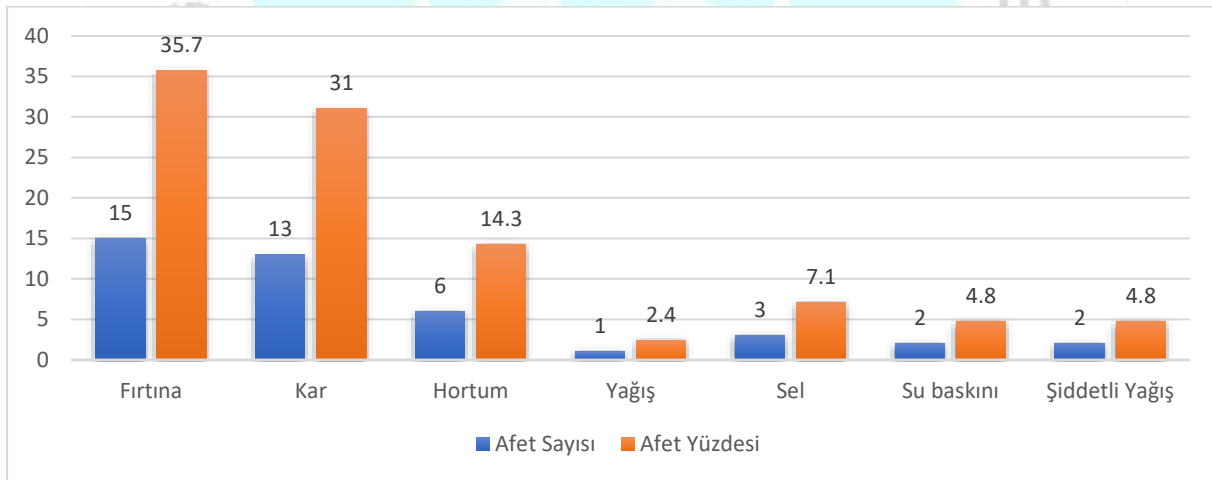
Şekil 3. 1975-2020 Sakarya ilinin sonbahar mevsimi meteorolojik afet sayılarının dağılımı ve yüzdeleri verilmiştir. Bu grafiğe göre en fazla görülen afet sel olmuştur. Sakarya ilinde 1975-2020 yılları arasında sonbahar mevsiminde 5 fırtına, 1 kuraklık, 9 yağış, 14 sel, 1 yıldırım düşmesi, 3 dolu, 5 su baskını, 5 şiddetli yağış görülmüştür. Oluşan toplam meteorolojik afet sayısı 43'tür.

**Şekil 3. 1975-2020 Sonbahar Mevsimi Meteorolojik Afet Sayılarının Dağılımı ve Yüzdeleri**



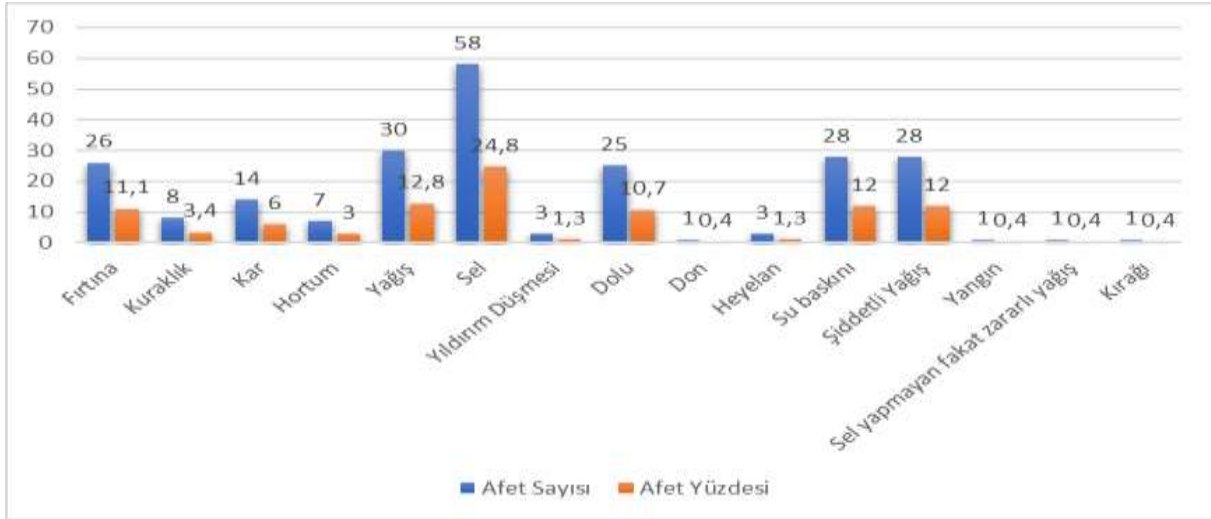
Şekil 4. 1975-2020 Sakarya ilinin kış mevsimi meteorolojik afet sayılarının dağılımı ve yüzdeleri verilmiştir. Bu grafiğe göre en fazla görülen afet fırtına olmuştur. Sakarya ilinde 1975-2020 yılları arasında sonbahar mevsiminde 15 fırtına, 13 kar, 6 hortum, 1 yağış, 3 sel, 2 su baskını, 2 şiddetli yağış görülmüştür. Oluşan toplam meteorolojik afet sayısı 42'dir.

**Şekil 4. 1975-2020 Kış Mevsimi Meteorolojik Afet Sayılarının Dağılımı ve Yüzdeleri**



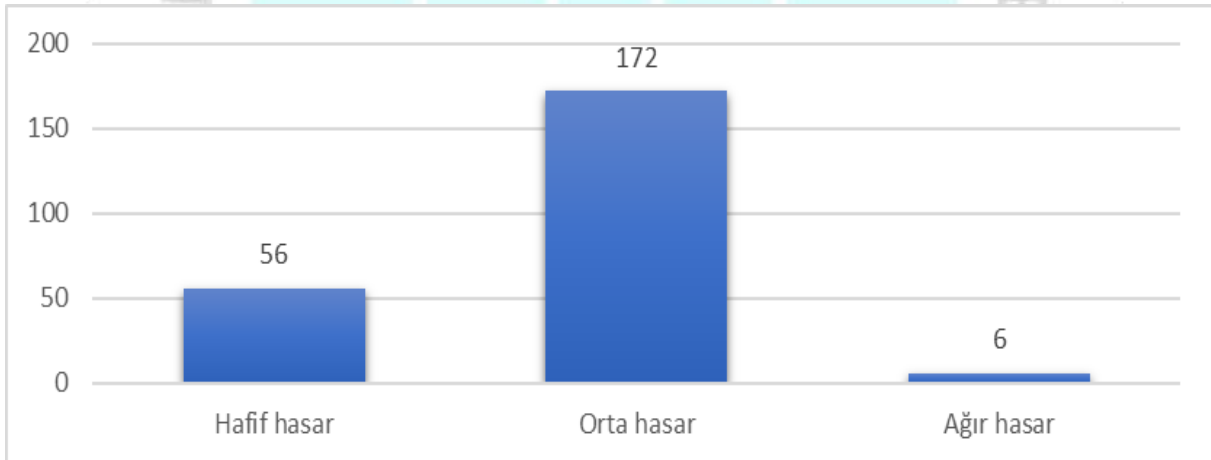
Şekil 5. 1975-2020 Sakarya ilinin genel meteorolojik afet sayılarının dağılımı ve yüzdeleri verilmiştir. Bu grafiğe göre en çok sel afeti görülmüştür. Sakarya ilinde 1975-2020 yılları arasında toplam 26 fırtına, 8 kuraklık, 14 kar, 7 hortum, 30 yağış, 58 sel, 3 yıldırım düşmesi, 25 dolu, 1 don, 3 heyelan, 28 su baskını, 28 şiddetli yağış, 1 yangın, 1 sel yapmayan fakat zararlı yağış, 1 kırağı görülmüştür. Oluşan toplam meteorolojik afet sayısı 234'tür.

Şekil 5. 1975-2020 Sakarya İlinin Genel Meteorolojik Afet Sayılarının Dağılımı ve Yüzdeleri



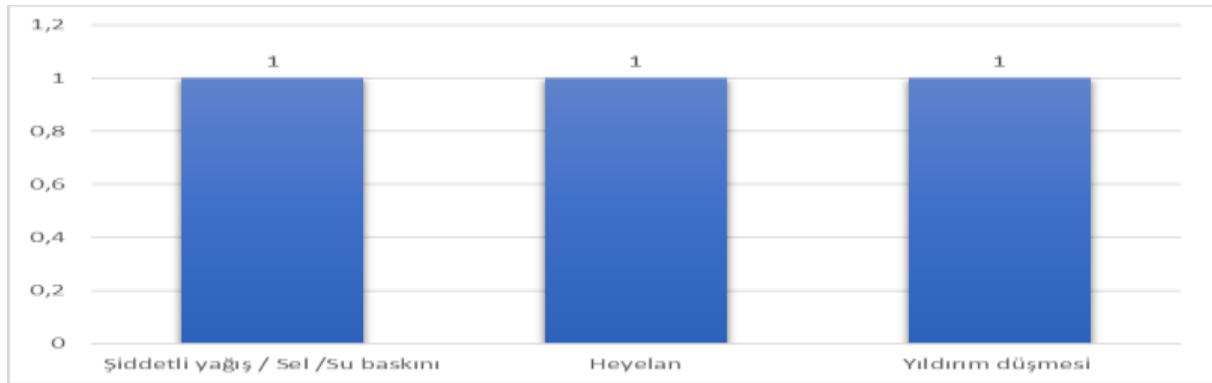
Şekil 6. Sakarya İli 1975-2020 meteorolojik afet kaynaklı hasar durumu gösterilmiştir. Grafiğe göre en fazla orta hasar oluşmuştur. 56 Hafif hasar, 172 orta hasar, 6 ağır hasar meydana gelmiştir.

Şekil 6. Sakarya İli 1975-2020 Meteorolojik Afet Kaynaklı Hasar Durumu



Şekil 7. Sakarya ili 1975-2020 meteorolojik afet kaynaklı ölüm sayıları dağılımını vermektedir. Sakarya ilinde 1975-2020 yılları arasında meteorolojik afet kaynaklı toplam 3 ölüm gerçekleşmiştir. Bu afetlerden şiddetli yağış/sel/su baskını kaynaklı 1 ölüm, heyelan kaynaklı 1 ölüm, yıldırım düşmesi kaynaklı 1 ölüm meydana gelmiştir.

Şekil 7. Sakarya İli 1975-2020 Meteorolojik Afet Kaynaklı Ölüm Sayıları Dağılımı



#### 4. SONUÇLAR VE ÖNERİLER

1975-2020 Yılları arasında en çok görülen meteorolojik afet çeşidi sel afeti olmuştur. Seller ile mücadelede, akarsu yatağını düzeltme ve düzenleme, sel kontrol setleri ve barajları, duvarları ve derivasyon kanalları, yağmur suyu drenaj sistemi, binaların taşınması, yükseltilmesi, vb. gibi sadece yapısal ve mühendislik yaklaşımlarını uygulamak yetmez. Bütün bunları yanı sıra sel, çığ yatağı, heyelan zonları/kamulaştırma/yasalar, rölekasyon, özel kullanım ve yapı izinleri, nehirlere ait sulak alanların geri verilmesi, afet yönetimi ve sigorta gibi yapısal olmayan yöntemlerin de gerektiği gibi kullanılması şarttır.(Kadıoğlu ve Özdamar, 2008: 263-264).

- Toplam 58 adet (%24,8) sel afeti görülmüştür. Sel sonucu 1 ölüm, heyelan sonucu 1 ölüm, yıldırım düşmesi sonucu 1 ölüm meydana gelmiştir. Maddi olarak en çok zarar veren sel afeti olmuştur. Belediye imar planlarında olası afet riskleri dikkate alınmalı, daha önce yaşanmış afetlerden yaşanabilecek olası afetlere karşı öngörü yapılabilir. Örneğin son 50 yıllık, 100 yıllık mümkünse daha fazla yılı kapsayan sel taşkın haritaları çıkarılarak buna göre bir yerleşim planı yapılmalı, dere yatağı alanına kesinlikle imar izni verilmemelidir.
- Yaşanan sel felaketlerinde ölüm vakalarının büyük çoğunluğu bodrum katlarda görülmektedir. Bu tip bodrum katlı binaların yapımına izin verilmemeli ve mevcut binaların teşvik edilerek kentsel dönüşümle yenilenmesi sağlanmalıdır.
- Tarım ve hayvancılıkla uğraşan halkımızın meteorolojik afetlere karşı sigorta yapturmaları daha fazla teşvik edilmelidir. Afetlerden ekonomik olarak zarar gören halkın üretim dışına çıkması ve köyden kente göçü önlenmelidir.
- Halk afetler konusunda bilinçlendirilmeli eğitimler anasınıfından başlayarak yaşam boyu öğrenme anlayışıyla hayat boyu sürmelidir. Okullarda ve işyerlerinde yapılan afet tatbikatları afetlere hazırlıklı olmanın önemine inanılarak yapılmalıdır.

- Afet yönetim sürecinde risk ve zarar azaltma ile hazırlık basamakları afet yönetim sürecinin en önemli aşamalarıdır. Bu basamaklar afet gerçekleşmeden alınacak tüm tedbir ve planlamalarını içerir. Bu süreç bir ülke tarafından tam olarak başarılı şekilde hayata geçirilebilirse afetlerden doğacak zararlarda minimum seviyede kalacaktır.
- Afet planları hazırlanırken gelişmiş ülkelerin birikiminden yararlanılmalı fakat bu yararlanma ‘kopyalama’ ile değil ülkemizin kendine özgü coğrafi ve sosyolojik yapısı dikkate alınmalıdır. Örneğin eyalet sistemiyle yönetilen Amerika Birleşik Devletleri’nin afetlere hazırlık süreci daha merkezîyetçi olan ülkemize uymayacaktır.
- Yerel yönetimler şehir planlamalarını şehir ve bölge planlama uzmanlarını istihdam ederek onların uzmanlığından faydalanmalı ve kaçak yapılaşmaya göz yummamalıdır.
- Olası bir afete karşı dezavantajlı bireyler (zihinsel ve bedensel engelliler ve aileleri, yaşlı bireyler vb.) afet yaşanmadan önce belirlenmeli ve afet sonrası müdahalelerde bu gruplara öncelik verilmelidir.
- Dere yataklarına kesinlikle imar izni verilmemelidir.





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## EFFECT OF ORAL ACETAZOLAMIDE TREATMENT ON URINE OUTPUT IN HEART FAILURE PATIENTS WITH DIURETIC RESISTANCE

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### ABSTRACT

**Background:** One of the most important causes of congestion in patients with heart failure (HF) is resistance to standard diuretic therapy. **Objective:** This study aimed to investigate the effect of oral acetazolamide on urine output in addition to standard diuretic treatment in patients with decompensated HF who developed diuretic resistance. **Methods:** A total of 57 patients with HF were included in the single-center retrospective study, including 26 consecutive HF patients who were started on acetazolamide therapy for diuretic resistance, and 31 HF patients whose age, sex, and comorbid conditions were not significantly different. Factors affecting urine output were evaluated with ANCOVA analysis. **Results:** Diuretic treatments, fluid intake and urine output of the two groups [26 HF patients receiving acetazolamide (age 67.12±9.92; male gender 14(53.8%)) and 31 HF patients not receiving acetazolamide (age 71.30±7.83; male gender 17(54.8 %))] were compared. The groups were similar in terms of medical treatment, but total furosemide, spironolactone, and dopamine intake doses were significantly higher in the acetazolamide group (all p values < 0.05). In terms of fluid intake-output monitoring, both fluid intake and urine output were significantly higher in the acetazolamide group (all p values < 0.05). In the investigation of the factors affecting urine output, only total fluid intake (p=0.004) and total furosemide dose (p=0.005) were found to have a significant effect. However, in our study, it was determined that the effect of acetazolamide dose on urine output was not significant (p=0.786). **Conclusion:** In our study, urine output that acetazolamide treatment did not increase urinary excretion was found to be associated with fluid intake and furosemide dose. However, these findings should be confirmed by large-population prospective studies with monotherapy.

**Keywords:** Acetazolamide, diuretic resistance, decompensated heart failure

## INTRODUCTION

Heart failure (HF) is a common clinical entity affecting 23 million people worldwide (1,2). The pathomechanics basis in HF is peripheral and pulmonary edema due to ventricular ejection or lack of ventricular filling. The undesirable impact of HF syndrome on the quality of life has brought heavy costs to the health system. Fluid overload is the main reason for hospitalization in intensive care units in HF patients, and diuretic resistance is the main reason for prolonged hospitalization (3). There are limited empirical treatment options in diuretic resistance that develops in the last stages of the disease. These treatments include furosemide, spironolactone, renal dose dopamine, hypertonic solution, tolvaptan and acetazolamide (3, 4).

Acetazolamide, a sulphamide-derived drug, is an agent used in the symptomatic therapy of congestive HF (5). Its mechanism blocks the enzyme carbonic anhydrase, which is expressed in the kidney proximal tubules. Bicarbonate and sodium excretion increases urinary alkalosis and blood acidosis (5). Theoretically, inhibition of proximal tubule sodium uptake would result in increased sodium in the distal tubule, thereby reducing renin levels and increasing the effectiveness of other diuretics in the Henle-loop and distal tubule (6). There are a limited number of studies with varying results that remain at the level of the evidence base (5,7).

Our aim in this study is to investigate the effect of oral acetazolamide treatment on urinary output in HF patients.

## METHOD

Patients admitted to the secondary coronary care unit with symptoms of HF between January 2015 and December 2018 were included in this retrospective cohort. In addition to the standard intensive diuretic strategy, 26 consecutive HF patients who were given acetazolamide for diuretic resistance and 31 HF patients who were not given acetazolamide were matched with no significant difference in terms of age, gender, and comorbidities, and a total of 57 patients were included in the study. Daily fluid intake, urine output values and HF treatment protocols were recorded. The left ventricular ejection fraction was calculated using Simpson's method modified in transthoracic echocardiography. Basic blood parameters were recorded on the first and last day of hospitalization. The estimated glomerular filtration rate (eGFR) of the participants was calculated using the Cockcroft-Gault method. Diabetes mellitus (DM) was defined as the use of an antidiabetic agent or fasting blood glucose > 126 mg/dL. Hypertension (HT) was defined as the presence of antihypertensive drugs or blood pressure > 140/90 mmHg. The conformity of the data to the normal distribution was evaluated with q-q plots and the Shapiro-Wilk test. Levene test was used for homogeneity of variance. Independent two-sample t-test and Man-Whitney U test were used for quantitative variables in comparisons between paired groups. Chi-square test was used to compare categorical data. ANCOVA analysis was used to evaluate the group effect by fixing the effect of other factors to investigate the effect of acetazolamide intake on the amount of urine. Analysis of the data was done in Turcosa Cloud (Turcosa Ltd Co) statistical software. Significance level was accepted as  $p < 0.05$ .

## RESULTS

The main clinical characteristics of the study population, laboratory parameters and medical treatment are presented in Table 1. Our study included a total of 57 HF patients, 26 patients receiving acetazolamide (age  $67.12 \pm 9.92$ ; male gender 14(53.8%)) and 31 patients not receiving acetazolamide (age  $71.30 \pm 7.83$ ; male gender 17 (54.8 %)). The groups were similar in terms of basic characteristics, biochemical and hematological blood parameters. Hospitalization day was significantly longer in the group receiving acetazolamide. The groups were similar in terms of medical treatment, but total furosemide, spironolactone, and dopamine intake doses were significantly higher in the acetazolamide group (all  $p$  values  $< 0.05$ ). In terms of fluid intake-output monitoring, both fluid intake and urine output were significantly higher in the acetazolamide group (all  $p$  values  $< 0.05$ ).

In the investigation of the factors affecting urine output, only total fluid intake ( $p=0.004$ ) and total furosemide dose ( $p=0.005$ ) were found to have a significant effect (Table 2). However, in our study, it was determined that the effect of acetazolamide dose on urine output was not significant ( $p=0.786$ ) (Table 2).

## DISCUSSION

In our study, the main findings were that total fluid intake and total furosemide dose were found to be effective on the urine output of patients hospitalized with the indication of HF, but it was found that acetazolamide was not effective on urine output.

Although the primary treatment of fluid retention in HF is diuretic therapy, its mortality-reducing effects have not been demonstrated, it only provides symptomatic improvement. Fluid expulsion due to diuretic resistance is the cause of many symptoms in chronic HF. It is also an indicator of the terminal period in HF (8).

Historically, one of the first diuretics used in the 1950s was carbonic anhydrase enzyme inhibitors (9). The basic mechanism of acetazolamide is blocking the carbonic anhydrase enzyme, which is expressed mainly in the proximal tubules in the kidney. In this way, it increases sodium and bicarbonate excretion, urinary alkalosis and blood acidosis (9). However, the discovery of loop diuretics has moved them away from carbonic anhydrase enzyme inhibitors. In HF patients receiving chronic loop diuretic therapy, the effect of loop diuretics is weakened by a mechanism of pathologically increased sodium reabsorption in the proximal tubules. This type of diuretic resistance can only be eliminated with the addition of thiazide and mineralocorticoid therapy, but these preparations that act on the distal tubule are thought to not have the full effect of acetazolamide, which has proximal tubule activity (10). In addition, acetazolamide can increase the effect of thiazide diuretics thanks to its urinary alkalization effect (11). In studies conducted in the last decade, it was determined that acetazolamide treatment has effects on natriuresis and provides an improvement in dyspnea symptoms (12). In a retrospective observational study conducted in 2018, it was found that adding it in the mid-term of treatment to patients presenting with acute HF was beneficial to recovery and caused a decline in functional class. However, in this study, acetazolamide was started as a routine



treatment, not reserved for patients with diuretic resistance. In addition, the effect of other diuretic agents has not been evaluated (13). In our study, unlike the literature, acetazolamide did not have an effect on urine output, but the difference from previous studies is that it was started on patients with diuretic resistance. The lack of effect of spironolactone treatment on urine output in our study may be explained by the fact that sequential nephron blockade was provided with loop diuretics in patients with diuretic resistance.

The limitations of our study are primarily retrospective, single-center and limited population. Types of HF were not evaluated separately. Acetazolamide treatment was not routinely started in all patients but was started in patients with diuretic resistance. Diuretic resistance was defined as decreased urine output but was not standardized and treatment with acetazolamide was at the discretion of the visiting physician.

## CONCLUSION

In this study, urine output, in which acetazolamide treatment did not increase urinary excretion, was related to the patient's fluid intake and furosemide dose. However, these findings should be confirmed by prospective randomized studies with monotherapy to be performed with acetazolamide.

**Table 1. Basic laboratory clinical characteristics of the groups<sup>a</sup>**

<i>Variables</i>	<b>Acetazolamide (-) (n=31)</b>	<b>Acetazolamide (+) (n=26)</b>	<i>p</i>
Age, years	71.30±7.83	67.12±9.92	0.084
Male gender, n(%)	17 (54.8)	14(53.8)	0.999
Hypertension, n(%)	21 (67.7)	13(50.0)	0.174
Diabetes mellitus, n(%)	12 (38.7)	11(42.3)	0.783
Left ventricular ejection fraction, %	40 (30-55)	40(30-55)	0.789
Right ventricular enlargement, n(%)	9 (29.0)	12(46.2)	0.404
Hospitalization, days	5 (4-7)	7(4-9)	<b>0.029</b>
Symptomatic hypotension during treatment, n(%)	2 (6.7)	3(11.5)	0.655
Fd Blood urea nitrogen, mg/dL	26 (19-33)	34 (23-43)	0.070
Ld Blood urea nitrogen, mg/dL	33 (26-42)	38 (30-54)	0.085
Fd Creatinine, mg/dL	1.22±0.48	1.34±0.54	0.367
Ld Creatinine, mg/dL	1.33±0.46	1.46±0.49	0.335
Fd eGFR mL/min	55 (41-77)	51 (34-74)	0.642
Ld eGFR mL/min	52 (36-62)	46 (31-62)	0.470
Fd Potassium, mEq/L	4.55±0.60	4.55±0.53	0.979
Ld Potassium, mEq/L	4.13±0.49	4.00±0.54	0.353
Fd Sodium, mEq/L	138.03±3.41	135.35±5.37	0.033
Ld Sodium, mEq/L	138.20±5.23	136.88±3.70	0.289
Fd Hemoglobin, g/dL	12.89±1.91	12.03±2.43	0.139





Ld Hemoglobin, g/dL	13.08±2.27	12.81±1.86	0.630
Fd Hematocrit, %	38.36±6.43	37.55±6.75	0.642
Ld Hematocrit, %	39.58±7.51	39.95±4.93	0.830
Angiotensin converting enzyme inhibitors / Angiotensin receptor blockers, n(%)	25 (81.6)	18 (69.2)	0.494
Beta Blocker, n(%)	27 (88.1)	22 (84.6)	0.312
Nitrate, n(%)	6 (19.4)	5 (19.2)	0.991
Acetazolamide treatment, days	0.0 (0.0-0.0)	3 (1-4)	<b>&lt;0.001</b>
Dopamine treatment, days	0 (0.0)	8(30.8)	<b>0.001</b>
Total Furosemide dose, mg	540 (400-760)	1350 (920-2480)	<b>&lt;0.001</b>
Total Spironolactone dose, mg	75 (0-150)	175 (75-300)	<b>0.012</b>
Total Acetazolamide dose, mg	0.0 (0.0-0.0)	1500 (500-2560)	<b>&lt;0.001</b>
Total Hydrochlorothiazide dose, mg	0.0(0.0-25.0)	0.0 (0.0-75.0)	0.248
Total fluid intake, L	7.9 (5.9-12.6)	12.7 (7.4-17.9)	<b>0.010</b>
Total urine output, L	12 (9.4-18)	20.4 (13.2-30)	<b>0.001</b>

**Abbreviations:** eGFR, estimated glomerular filtration rate; Fd, first day; Ld, last day. <sup>a</sup> Variables are expressed as median with interquartile range (25–75th percentiles) or mean ± standard deviation

**Table 2. Investigation of factors affecting urine output**

Source	DF	Sums of Squares	Mean Squares	F-value	<i>p</i>
Total Acetazolamide dose	1	2330727.7	2330727.7	0.074	0.786
Total Furosemide dose	1	275405257.9	275405257.9	8.795	<b>0.005</b>
Total Spironolactone dose	1	74840607.1	74840607.1	2.390	0.128
Total fluid intake	1	286731304.4	286731304.4	9.156	<b>0.004</b>
Hospitalization	1	6420975.6	6420975.6	0.205	0.653
Error	51	1597087832.5	31315447.7		
Total	57	27151508700.0			

R<sup>2</sup>=0.786 (adjusted R<sup>2</sup>=0.765)



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## EFFECT OF HEAT TREATMENT ON THE ELECTRIC CONDUCTIVITY OF THE CuAl5Zn5Sn1 NORDIC-GOLD ALLOY

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### ABSTRACT

This paper reports the result of investigations carried out on Nordic gold, a copper alloy containing 5 wt. % Zn, 5 wt. % Al and 1 wt. % Sn. Many European countries prefer Nordic gold alloy for their coin blanks since Nordic gold alloy has a golden-like appearance and high conductivity values. Even though the Nordic gold alloy has supreme electrical conductivity values, the coining process has a severe effect on electrical conductivity. In this study, the electrical conductivity values with different annealing temperatures of the Nordic gold alloy were investigated. Initially, the Nordic gold alloy was cast as ingot with the vertical semi-continuous casting technique. The samples were taken from the ingot as as-cast and pressed as the shape of the dog-bone tensile bar. Three of the samples were determined as reference samples (as-cast (AC)) and, the remaining samples were annealed four by four at different temperatures in equal heat treatment duration. The electrical conductivity measurements of the annealed samples were performed according to ASTM E1004 and were reported in conductivity rate compared to International Annealed Copper Standard (IACS) as well.

**Keywords:** CuAl5Zn5Sn1 alloy, Annealing, Electrical conductivity, Copper

### 1. INTRODUCTION

In general, copper-based alloys, due to copper's excellent electrical and thermal conductivity, are used for a wide range of applications. Thus, copper-based alloys can be used as coin blanks frequently. Nordic gold alloy is known for its good combination of physical and mechanical properties. Its electrical conductivity values are appropriate for the coin blank industry and its mechanical strength is efficient for the coining process. Moreover, its golden shape color and lowest tarnish rates among coin blank alloys (Horton et al. 2015) made nordic gold alloys more preferable than other alloys for use as coin blank.

Due to determine by scattering of electrons in the crystal structures including crystal defects, electrical conductivity mostly depends on the microstructure. Crystal structure defects lead to an increasing trend of tensile strength of metals; high electrical conductivity and high tensile strength are exclusive. For example, pure Cu has the most extraordinary electrical conductivity (%100 IACS) but relatively low tensile strength (100 MPa) (Islamgaliev et al. 2014).

The production of coin blanks has severe plastic deformation processes including cold working with high deformation ratios. Especially in alloys but not pure metals, during cold working, due to strain hardening hardness will increase and due to distortion of the lattice structure hinders the passage of electrons and the electrical conductivity will decrease (Çetinarslan 2009; Lu et al. 2006; Rontó et al. 2007).

To avoid that, and to continue cold work, re-crystallization annealing can solve many problems. Recrystallization annealing is a heat treatment method after cold forming. Like stress-relief annealing, normalizing or soft annealing, this method belongs to the annealing processes. During recrystallization annealing, grains can form anew, since the grain boundaries migrate due to diffusion processes. When the grains return to their original shape, the material regains its ductility and can be formable again. The main problem with recrystallization annealing is they are often carried out with high degrees (600 – 700 °C) for copper alloys.

In this paper to investigate the feasibility of relatively lower annealing degrees perform recrystallization and how affects electrical conductivity values and grain size, relatively low and relatively high annealing degrees are selected.

## 2. EXPERIMENTAL

The copper alloy of CuAl5Zn5Sn1 was used in the experimental studies. The chemical composition of this alloy was given in **Table 1**. CuAl5Zn5Sn1 ingot was cast in a vertical semi-continuous vertical mold. 11 samples were taken in the shape of dog-bone tensile rods using a 100-tonne press machine. Three of the samples were taken as as-cast with no annealing for reference samples. Half of the remaining samples are annealed at 450 °C for 7h and the remaining four samples are annealed at 750 °C for 7h. Due to microstructural analysis, firstly, all samples were ground and then polished with 1 µm diamond paste for microstructural investigations. The microstructural evolutions of the samples were determined and examined by optical microscopy with respect of the grain size of the alloys. The electrical conductivity measurements of the samples were performed using the FISCHER Sigmascope SM330 device based on Eddy's current principle. The measurements were reported in conductivity rate compared to International Annealed Copper Standard (IACS).

**Table 1.** Chemical composition of the CuAl5Zn5Sn1 alloy (wt. %).

Cu	Al	Ni	Zn	Sn
88.7	5.01	0.002	Rest	1.1
Fe	P	S	Si	As
0.025	0.005	0.005	0.004	0.001



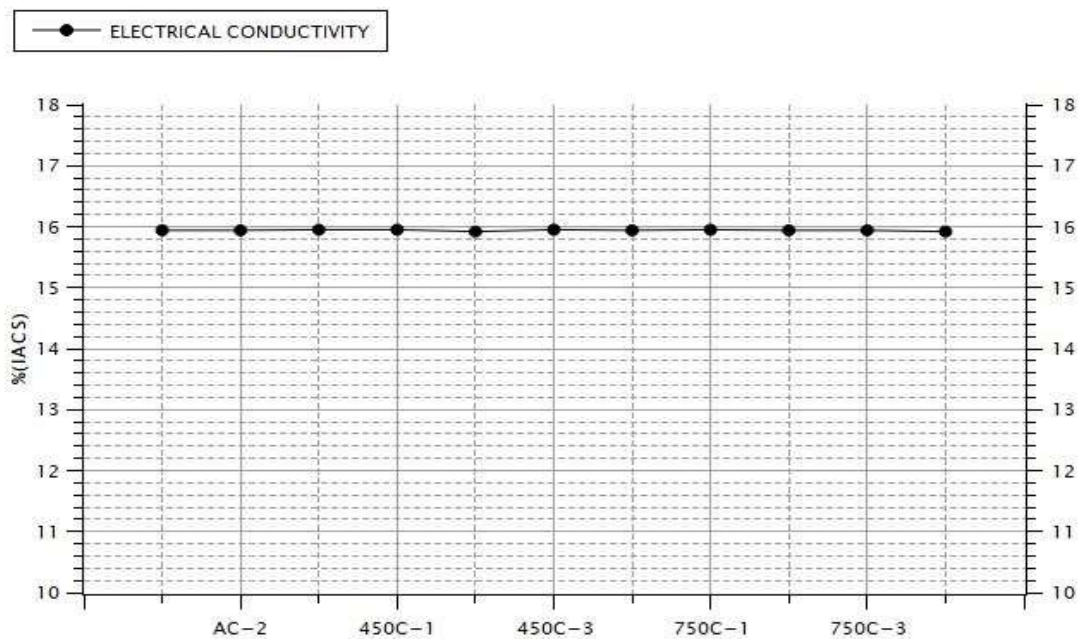
### 3. RESULTS

The test results of the electrical conductivity of the specimens were given in **Figure 1** and **Table 2**, and the microstructures of samples were given in **Figure 2**, **Figure 3**, **Figure 4**. As can be seen in **Figure 1**, the electrical conductivity values remained nearly constant with different annealing temperatures or without any annealing. The maximum electrical conductivity measured value was 15,95 %IACS which was almost the same as the electrical conductivity value of the as-cast sample, whereas the lowest value of electrical conductivity of all specimens was 15,92 %IACS.

**Table 2.** Average electrical conductivity values of the samples (%IACS).

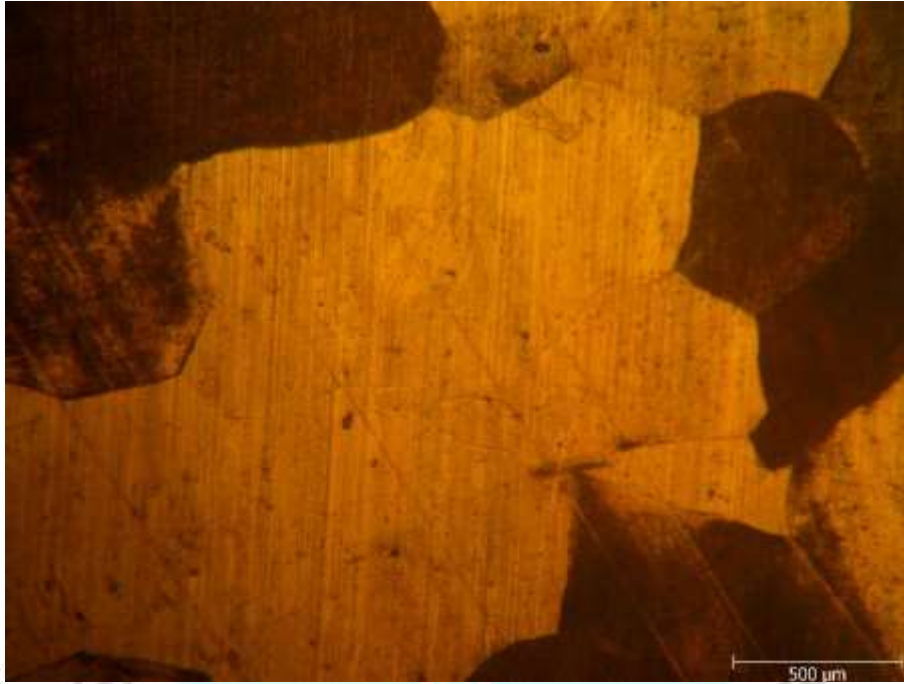
Name.	AC 1	AC 2	AC 3	450 °C 1	450 °C 2	450 °C 3	450 °C 4	750 °C 1	750 °C 2	750 °C 3	750 °C 4
No.	1	2	3	4	5	6	7	8	9	10	11
%IACS	15,94	15,94	15,95	15,95	15,92	15,95	15,94	15,95	15,94	15,94	15,92

In addition to this, from the micrographs of annealed samples respectively given in **Figure 2**, **Figure 3**, **Figure 4**, although the recrystallization has occurred on both low-temperature and the high-temperature annealing samples, and the grain sizes of the samples severely were decreased with both of them. There was a little difference with between them in terms of the values of electrical conductivity of the alloy.

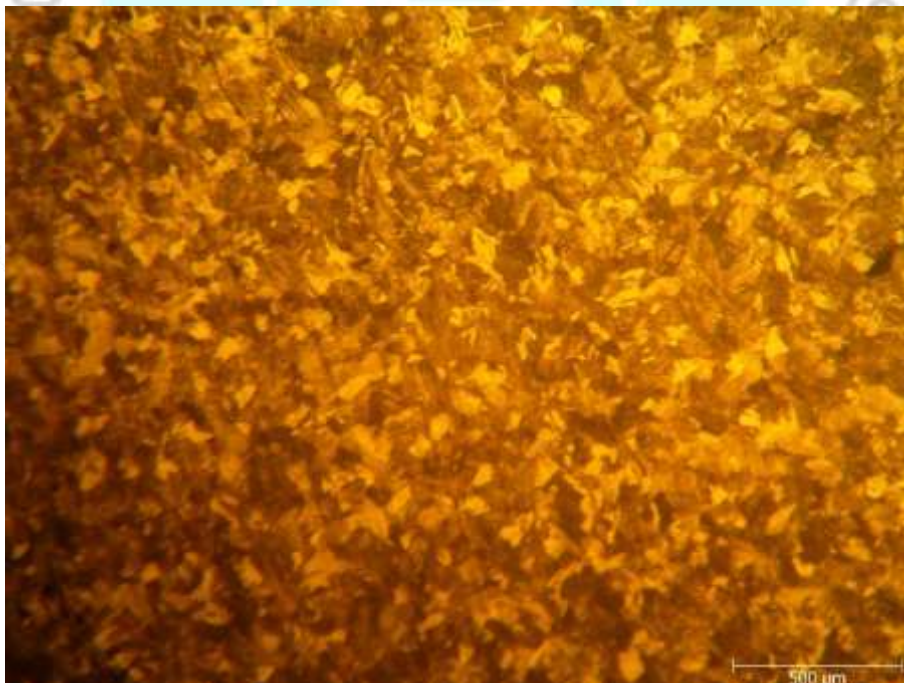


**Figure 1.** Electrical conductivity values of all samples

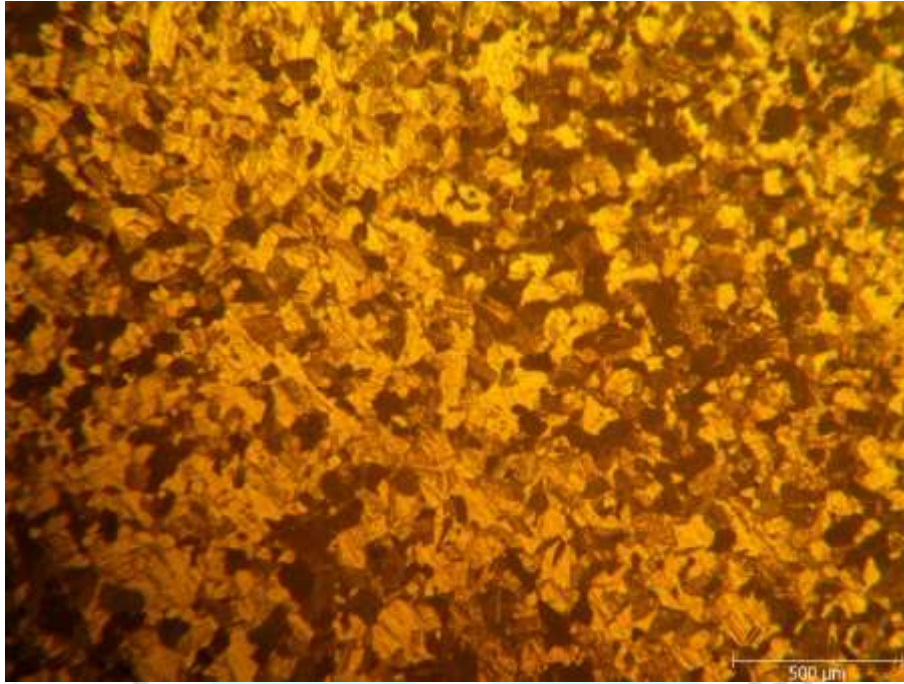




**Figure 2.** Microstructure of the as-cast sample (sample no.3)



**Figure 3.** Microstructure of the annealed (450 °C) sample (sample no.4)



**Figure 4.** Microstructure of the annealed (750 °C) sample (sample no.10)

Normally for pure copper, the electrical conductivity did not affect by crystal orientation and did not depend on grain size except for the losses due to dendritic microstructure. Raygan et al. reported that they increased the electrical conductivity by 32% by modifying the dendritic structure of pure and as-cast copper (Raygan et al. 2011). Exceptionally, the cold working process, one of the plastic deformation processes, of an annealed copper to about higher reduction rates can cause a small decrease in %IACS values of the alloys. The alloying of pure copper could reduce its electrical conductivity due to the occupation of the foreign atoms in the copper lattice, in addition, there is a cumulative effect of this scenario when more than one element is added into copper (Davis 2001).

#### 4. CONCLUSION

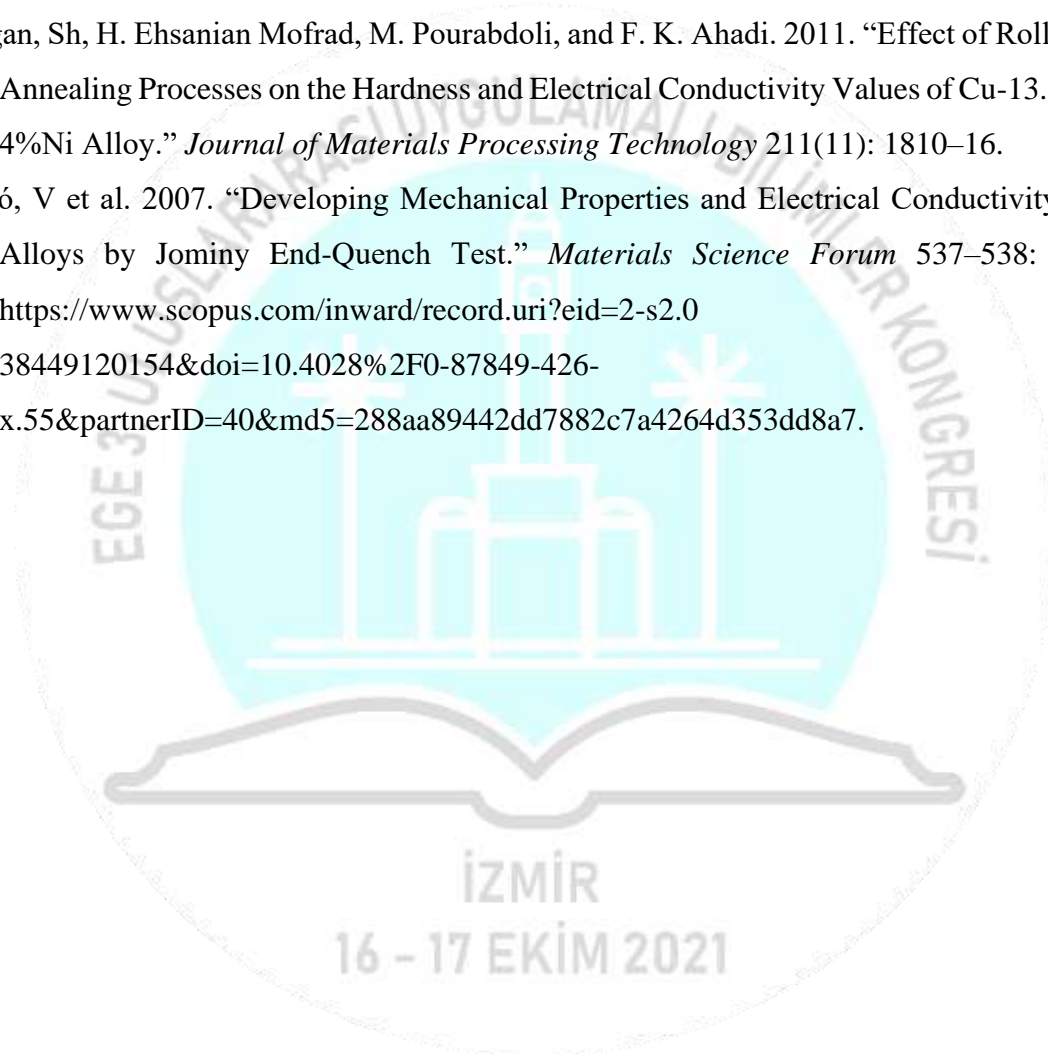
1. Recrystallization can occur on low-temperature annealing such as 450 °C for copper-nickel-zinc alloys.
2. Recrystallization has no significant effect on electrical conductivity values if the chemical compositions are the same.
3. The grain size values of the samples were almost the same between low-temperature annealing and high-temperature annealing for copper-nickel-zinc alloys.

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## SÜREKLİ VERİLERDE BAYESÇİ AĞLAR YAKLAŞIMI

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### ÖZET

Bayesçi Ağlar (Bayesian Network - BN) herhangi bir olayı incelemek amacıyla, bilinen bazı olası nedenler arasından herhangi birinin bu olaya katkıda bulunduğu faktör olma olasılığını tahmin ederek bu olasılıkları görsel olarak da araştırmacıya sunan grafiksel bir modeldir. Koşullu olasılık dağılımının niteliğine bağlı olarak bir BN modeli sürekli veya kesikli verilere sahip olabilmektedir. Kesikli verilerden oluşan bir veri seti ile bir BN modeli kurulmak istenildiğinde klasik BN yöntemine başvurulmaktadır. Sürekli veriler ile karşılaşıldığında ise başvurulabilecek iki yöntem vardır. Bunlardan birincisi verilerin kesikli hale getirilmesi ve klasik BN yönteminin kullanılmasıdır. Ancak, sürekli veriler kesikli hale dönüştürülerek yapılan çalışmalarda ciddi bilgi kayıpları ve hesaplama sorunları yaşanabileceğinden, doğrudan sürekli dağılımlar üzerine yoğunlaşmak tercih edilmelidir. İkincisi ise veriler üzerinde herhangi bir dönüşüm yapmadan Normal Dağılımlı Bayesçi Ağlar (Gaussian Bayesian Networks - GBN) yönteminin kullanılmasıdır. GBN yöntemi, modelde yer değişkenlerin sürekli ve koşullu olasılık dağılımları lineer normal olan bir BN türüdür. Tahmin ve çıkarım yapmak için çeşitli algoritmalar kullanılarak, karar destek sistemlerinin geliştirilmesinde etkili bir istatistiksel araç olarak görülmektedir. Bir GBN, tüm değişkenlerin bir Normal ön dağılımı veya ortalaması ana değişkenlerle doğrusal olarak ilişkili ve varyansı sabit olan bir Normal koşullu dağılımı ile tanımlanmasını gerektirir. Bu çalışmada, klasik BN ile GBN yöntemleri uygulamalı olarak ele alınacaktır. Yapılan uygulamalar sonucunda GBN yönteminin klasik BN yöntemine göre daha doğru sonuçlar verdiği sonucuna varılmıştır.

**Anahtar Kelimeler :** Bayesçi Ağlar, GBN, Kesikleştirme, Olasılıksal Grafik Modelleri, Parametre Öğrenme,

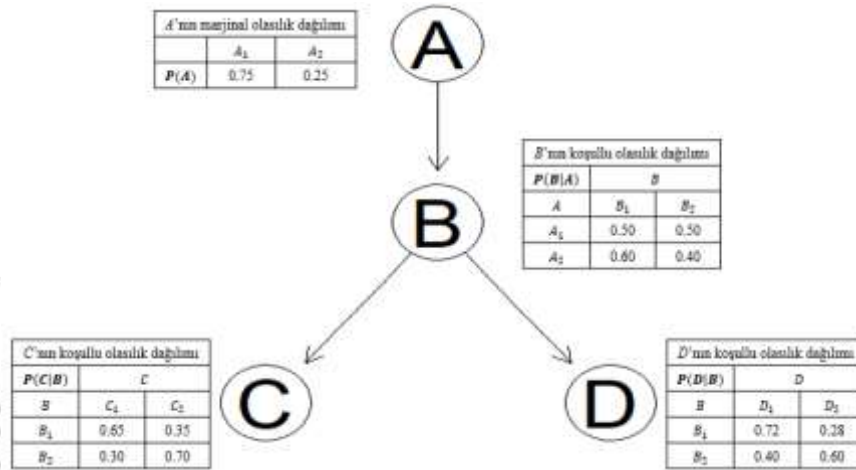
## 1. GİRİŞ

Bir varlığın herhangi bir özelliğinin o varlığın başka bir özelliği üzerinde doğrudan bir etkiye sahip olduğu durumu düşünüldüğünde, örneğin bir insanda bir hastalığın varlığı veya yokluğu o hastalığa yönelik bir testin pozitif mi yoksa negatif mi olduğunu doğrudan etkilemektedir. Yıllardır Bayes teoremi bu durumda olasılıksal çıkarım yapmak için kullanılmıştır. Mevcut örnekte bu teorem, bir hastalığa yönelik yapılan testin pozitif çıkması durumunda hastalığa sahip olan kişinin koşullu olasılığını hesaplamak için kullanılır. Bazı özelliklerin çıkarım zincirleriyle ilişkili olduğu durumu düşünüldüğünde, örneğin bir bireyin sigara içme öyküsünün olup olmadığı, hem o kişinin bronşit olup olmadığına hem de o kişinin akciğer kanseri olup olmadığına doğrudan etki etmektedir. Buna karşılık, bu hastalıkların her birinin varlığı ya da yokluğu, bireyin yorgunluk yaşayıp yaşamadığı üzerinde doğrudan bir etkiye sahiptir. Ayrıca, akciğer kanserinin varlığı ya da yokluğu, üzerinde doğrudan etkiye sahiptir. Çekilen bir göğüs röntgeninin pozitif olduğu varsayılması durumunda, doğrudan bir etkiye bağlı olmayan özellikleri içeren olasılıksal çıkarım yapmak istenir ise; örneğin, bireyin sigara içtiği, yorgun olduğu ve pozitif bir göğüs röntgeni sonuçlarına sahip olması halinde hem bronşit hem de akciğer kanserinin koşullu olasılıkları belirlenmek istenir. Ancak, bronşitin göğüs röntgeni pozitif olup olmaması üzerinde doğrudan bir etkisi yoktur (aslında hiçbir etkisi yoktur). Bu nedenle, bu koşullu olasılıklar basit bir Bayes teoremi uygulaması kullanılarak hesaplanamaz. Bunun sebebi, matematiksel işlem karmaşıklıklarına ve zamansal kayıplara neden olmasıdır. Bu zorlukların giderilebilmesi için de Bayesçi Ağlar geliştirilmiştir. Bayesçi Ağlar'ın grafiksel doğası insanoğluna değişkenler ya da özellikler arasındaki ilişkilerin daha iyi algılanmasına ve yorumlanmasına olanak sağlamaktadır. Yapay zekâ, uzman sistemler veya karar analizi, Bayesçi Ağlar'ın uygulanabilir olduğu alanlar arasında en sık rastlananlarıdır (Neapolitan, 2003).

BN, değişkenlerin düğümler olarak sergilendiği, değişkenler arasındaki bağımlılık ilişkilerinin de oklar kullanılarak ifade edildiği olasılıksal grafik modelleridir (Pearl,1988). BN, olasılıksal olaylarla başa çıkmak ve belirsizliği olan bir sorunu çözümlemek için kullanılan bir istatistiksel yöntemdir. BN, diğer istatistiksel modelleme yöntemlerinin aksine tek bir çıktı değişkenine bağlı kalmadan çıkarımların elde edilmesine imkân sağlamaktadır. Ayrıca, elde edilen çıkarımların gözlemler sonucunda yenilenebilir olma vb. gibi özelliği, son yıllarda BN'lerin öğrenilmesine yönelik algoritmaların çoğalmasına neden olmaktadır. BN, veri madenciliği, tıbbi teşhisler, nörogörüntüleme, siber güvenlik, güvenilirlik analizi vb. gibi birçok alanda modelleme yapabilmek için giderek daha popüler olarak kullanılan bir yöntemdir.



BN modelinde rastgele değişkenler düğümler, bu değişkenlerin aralarındaki koşullu bağımlılık ilişkilerinin ve nedensel etkileri ise oklar aracılığı ile ifade edildiği bir ağ yapısından oluşur. Ağda yer alan okların yönlerine göre değişkenler çocuk ve ebeveyn olarak adlandırılmaktadır. Bir düğümden bir diğer düğüme karşılık gelen yönlü kenarın başlangıç noktasını içeren düğüme ebeveyn, bitiş noktasını içeren düğüme ise çocuk denir. Bu ilişkilerin gösterildiği basit bir BN modeli Görsel 1’de verilmiştir.



**Görsel 1. Örnek BN modeli**

Görsel 1’de verilen örnek BN modeline göre her düğüme karşılık gelen ebeveyn ve çocuk düğümleri Çizelge 1’de verilmiştir.

**Çizelge 1. Ebeveyn ve çocuk ilişkisi**

Düğüm	Ebeveyn	Çocuk
A	-	B
B	A	C , D
C	B	-
D	B	-

Görsel 1 ve Çizelge 11’de verilmiş olan bilgiler, A düğümü B düğümünün, B düğümü ise C ve D düğümünün ebeveyni olduğunu belirtmektedir. Başka bir ifade ile, A düğümünün çocuğu B düğümüdür, B düğümünün çocukları ise C ve D düğümleridir.

BN’de yer alan düğümlerin koşullu olasılık dağılımlarının çarpımı mevcut ağın birleşik olasılık dağılımını oluşturmaktadır. N tane düğümün yer aldığı bir BN’de ortak olasılık dağılımı

$$P(X_1, \dots, X_N) = \prod_{i=1}^N P(X_i | Ebeveyn(X_i))$$

şeklinde ifade edilir (Nielsen ve Jensen, 2009). BN’nin temeli Bayes teoremine dayanmaktadır. BN’ye yeni bir gözlem eklendikçe Bayes teoremi art arda uygulanarak ağ yenilenir ve sonsal olasılıklar elde edilmektedir.

Bir BN modeli niceliksel ve niteliksel olarak iki bölümden oluşmaktadır. Düğümlerin ve bu düğümler arasındaki bağımlılık ilişkilerinin yer aldığı grafiksel kısım niteliksel kısım olarak

adlandırılmaktadır. Düğümlerin sahip oldukları olasılık dağılımlarının yer aldığı koşullu olasılık tabloları ise niceliksel kısım olarak adlandırılmaktadır.

BN modeli elde etme sürecinin tamamına öğrenme denir. BN'lerde öğrenme süresi iki kısımdan oluşur. Modelin öğrenimi için gerekli ilk aşama yapı öğrenmedir. Bu aşama, düğümler arası bağımlılık ve bağımsızlık ilişkilerinin ortaya çıkarılmasını ve BN'lerin grafiksel yapısının oluşturulmasını kapsamaktadır. Ağ yapısının öğrenimi için iki ana yaklaşım vardır. Birinci yaklaşım uzman görüşlerine dayanılarak, ikincisi ise çeşitli öğrenme algoritmaları ile veri setinden ağ yapısı belirlenmesidir. Elde edilen ağda okların yönleri herhangi bir nedensellik belirtmez iken yalnızca olasılıksal bağımlılık ilişkilerini belirtmektedir. Literatürde ağ yapılarının belirlenmesi amacıyla geliştirilmiş birçok algoritma bulunmaktadır. "arama ve skor bazlı algoritmalar" ve "kısıt bazlı algoritmalar" olmak üzere ikiye ayrılan bu algoritma çeşitleri arasından en çok, temelleri sezgisel optimizasyon algoritmalarına dayanan arama ve skor bazlı algoritmalar tercih edilmektedir. Hc, Tabu, rmax2 ve mmhc algoritmaları en sık kullanılanlarıdır. Bu ağlara ait skor puanlarının kıyaslanması için K2, Çapraz-Geçerlilik Kriteri, Bayeşçi Dirichlet Skoru, Akaike Bilgi Kriteri (AIC) ve Bayeşçi Bilgi Kriteri (BIC) ölçütleri kullanılabilir.

Ağın öğrenimi için gerekli ikinci aşama ise parametre öğrenimidir. Bu aşama koşullu olasılık değerlerinin hesaplanmasını kapsar (Neapolitan, 2003). Parametre öğrenme, ebeveynleri bilinen değişkenlerin koşullu olasılık değerlerinin tahmin edilmesi işlemidir. Kırca (2019), parametre öğreniminde Maksimum Olabilirlik (Maximum Likelihood-ML) ve Bayes Çıkarılması (Bayesian Inference) adı verilen iki yöntem bulunduğunu ifade etmektedir. Bu yöntemler aynı Markov zincirli Monte Carlo algoritmasını kullanmaktadır. Fakat önsel dağılımı ve olabilirlik fonksiyonunun maksimizasyonu alanlarında farklılık gösterirler (Kırca, 2019).

Günümüze kadar BN yöntemi daha çok kategorik değerler alabilen problemleri çözmeye yönelik çalışmalardır. Ancak, sürekli verilerin mevcut olduğu problemler ile de karşılaşılmaktadır. Bu çalışmada, değişkenler arasındaki koşullu olasılık ilişkilerini grafiksel bir model ile yansıtılabilmesini sağlayan BN modeli elde edilirken sürekli değişkenlerden oluşan veri setlerinin mevcut olması durumunda nasıl bir yol izlenmesi gerektiği ele alınmıştır. Sürekli değişkenler içeren veri setleri ile bir BN modeli kurulmak istenildiğinde başvurulabilecek yöntemlerden biri, sürekli verilerin kesikli hale getirilmesidir. Bu amaçla literatürde birçok kesikleştirme yöntemi bulunmaktadır. İstatistik alanında özellikle sınıflandırma problemlerinde kesikleştirme yöntemlerine sıklıkla başvurulmaktadır. BN modellerinde de mevcut öğrenme algoritmalarının kullanılabilmesi için sürekli verileri kesikli hale getirmek sıklıkla kullanılan bir yöntemdir. Bu yöntemler verileri azaltarak ve

basitleştirerek analizleri hızlandırmaktadır. Böylece, çıktılar daha hızlı ve kolay yorumlanabilmektedir. Literatürde yaygın olarak kullanılan kesiklileştirme yöntemleri Eşit Genişlik/Aralık ve Eşit Frekans yöntemleridir (Fernandez, 2012).

Sürekli değişkenler içeren veri setleri ile bir BN modeli kurulmak istenildiğinde başvurulabilecek alternatif bir yöntem ise lineer regresyonların ardılığı olarak bilinen GBN'dir (Masmoudi ve Masmoudi, 2019). GBN, her bir düğüm için ebeveynlerine göre doğrusal regresyonun art arda kullanılması şeklinde özetlenebilir. Bu yöntem, normal dağılım varsayımının avantajlarından yararlanarak sağlık bilimleri, biyoloji, ekonomi vb. gibi birçok farklı alanda başarıyla kullanılmaktadır.

## 2. DENEYSEL ÇALIŞMALAR

Çalışmada kullanılan veri seti UCI Machine Learning Repository<sup>1</sup> veri tabanından alınmıştır. "Forest Fires Data Set" isimli veri setinde yer alan değişkenler incelenerek 8 tanesi çalışmaya dahil edilmiştir. Sürekli verilerden oluşan nihai veri seti 517 gözlem değerine sahiptir. Kullanılan veri setine ait tanımlayıcı istatistikler Çizelge 2'de verilmiştir.

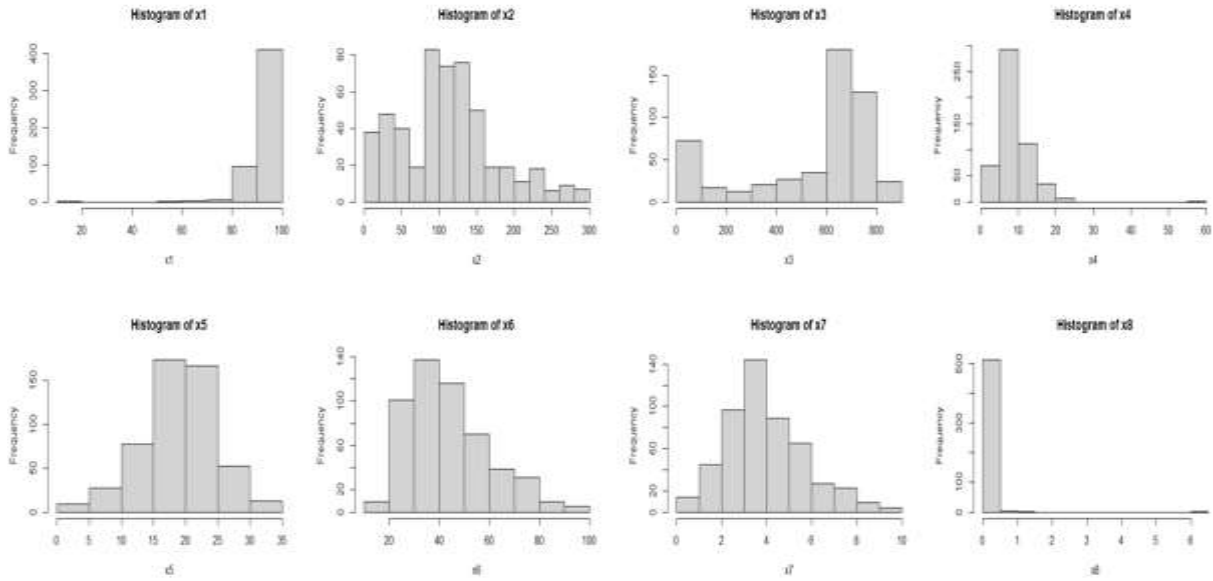
**Çizelge 2. Tanımlayıcı İstatistikler**

	Min	Maks	$\bar{X}$	Ss	<i>p</i>
<b>FFMC (x1)</b>	18,70	96,20	90,64	5,520	1.364098e-92
<b>DMC (x2)</b>	1,1	291,3	110,9	64,046	2.192121e-07
<b>DC (x3)</b>	7,9	680,6	547,9	248,067	1.015043e-77
<b>ISI (x4)</b>	0	56,100	9,022	4,560	3.040573e-24
<b>Temp (x5)</b>	2,20	33,30	18,89	5,807	2.873937e-03
<b>RH (x6)</b>	15	100	44,29	16,317	2.948304e-15
<b>Wind (x7)</b>	0,400	9,400	4,018	1,792	1.957064e-13
<b>Rain (x8)</b>	0	6,400	0,022	0,296	0.000000e+00

X: ortalama, Ss: Standart Sapma, *p*: olasılık değeri

Görsel 2'de ise çalışmada kullanılan her bir değişkenin dağılımlarına ait histogram grafikleri verilmiştir.

<sup>1</sup> <https://archive.ics.uci.edu/ml/datasets/Forest+Fires>



**Görsel 2. Değişkenlerin Dağılımları**

### 2.1. Kesikli Bayeşçi Ağlar

Çalışma kapsamında kullanılan verinin sürekli olması ve bir BN modeli elde edilmek istenmesi nedeni ile öncelikle veriler kesikli hale getirilmiştir. Bu aşamada literatürde yaygın olarak kullanılan eşit genişlik/aralık kesiklileştirme yöntemi kullanılmıştır. Bu yöntem uygulanırken kırılma noktası “2”, “3” ve “4” şeklinde seçilerek oluşturulan “d1”, “d2” ve “d3” isimli 3 farklı veri seti üzerinde daha sonra klasik BN yöntemi uygulanmıştır.

Kesikli hale dönüştürülmüş veri setleri üzerinde uygulanacak klasik BN için ağ yapısının belirlenmesi için yine literatürde yaygın olarak kullanılan puan tabanlı algoritmalarından hc, tabu, mmhc, rmax2 algoritmalarına başvurulmuştur. “d1”, “d2” ve “d3” isimli veri setleri üzerinde hc, tabu, mmhc, rmax2 algoritmalarının kullanılması sonucu öğrenilen ağ yapılarının birbirinden farklı olduğu görülmüştür.

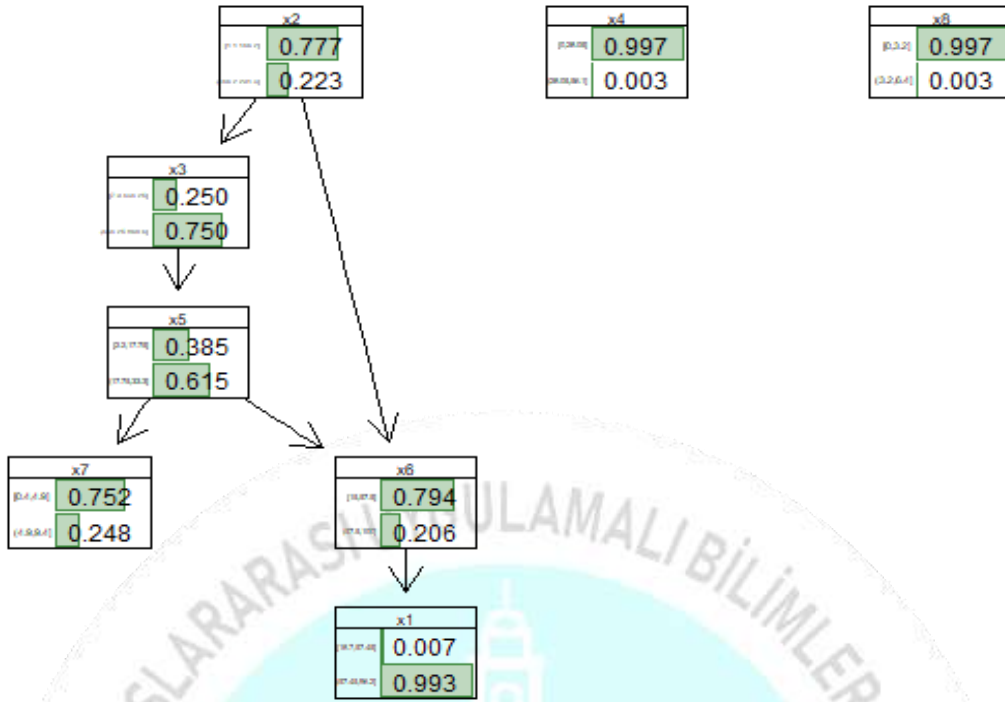
“d1”, “d2” ve “d3” isimli veri setleri ile elde edilen modellerin kıyaslanması için BIC kriteri ve k-kat çapraz doğrulama yöntemlerine başvurulmuştur. Modellerin BIC kriterleri karşılaştırılırken mutlak değerce küçük olan değerli model tercih edilmiştir. K-kat çapraz doğrulama yönteminde ise, BIC kriteri yerine her modelin beklenen kaybına bakılmıştır ve kaybın en az olduğu model tercih edilmiştir. “d1”, “d2” ve “d3” isimli veri setleri ile elde edilen modellere ait sonuçlar Çizelge 3’te verilmiştir.

**Çizelge 3. BN Model Karşılaştırılması**

Veri Seti	Algoritma	BIC	Beklenen kayıp	k	İterasyon	Kayıp Fonksiyonu
<b>d1</b>	<b>hc</b>	<b>-1386.918</b>	<b>2,592</b>	100	100	Log-olabilirlik
	<b>tabu</b>	<b>-1386.918</b>	<b>2,592</b>			
	mmhc	-1394.898	2,612			
	rmax2	-1394.898	2,612			
<b>d2</b>	hc	-2254.508	4,146			
	tabu	-2254.508	4,146			
	mmhc	-2254.508	4,146			
	rmax2	-2254.508	4,146			
<b>d3</b>	hc	-3045.489	5,576			
	tabu	-3045.489	5,576			
	mmhc	-3054.278	5,602			
	rmax2	-3054.278	5,602			

Çizelge 3'e göre, d1 isimli veri seti için hc ve tabu algoritmaları ile ulaşılan BIC skor puanının aynı ve diğer iki algoritmanın skor puandan daha iyi olduğu tespit edilmiştir. Benzer şekilde k-kat çapraz doğrulama yöntemine göre de puan tabanlı algoritmalarından yine hc ve tabu algoritmalarının kaybı en aza indirdiği görülmektedir. Bu nedenle, d1 veri seti için en iyi modelin hc ve tabu algoritması ile oluşturulan modeller olduğunu söyleyebiliriz. d2 isimli veri seti incelendiğinde, BIC skor puanlarının ve k-kat çapraz doğrulama yöntemi ile elde edilen kayıpların kullanılan algoritmalara göre farklılık göstermediğinin söyleyebiliriz. d3 isimli veri seti için ise hc-tabu ve mmhc-rmax2 algoritmalarına ait çıktıların benzerlik gösterdiği görülmektedir. Oluşturulan veri setlerinin kırılma noktaları da dikkate alındığında, d1 isimli veri seti üzerinde kesiklileştirme işlemi esnasında kullanılan kırılma noktasının (2) daha doğru sonuçlar verdiğini Çizelge 3'te ulaşılan sonuçlar ile desteklendiği görülmektedir. d1 üzerinde hc ve tabu algoritmalarının uygulanması sonucu oluşturulan ağ yapısının aynı olduğu tespit edilmiştir. Her iki modelin de aynı sonuçları verdiğini söyleyebiliriz. Bu modeller (hc ve tabu) ışığında, düğümlere ait parametre değerleri MLE ve Bayes yöntemleri ile tahmin edilmiş, ulaşılan nihai BN modeli Görsel 3'te verilmiştir.



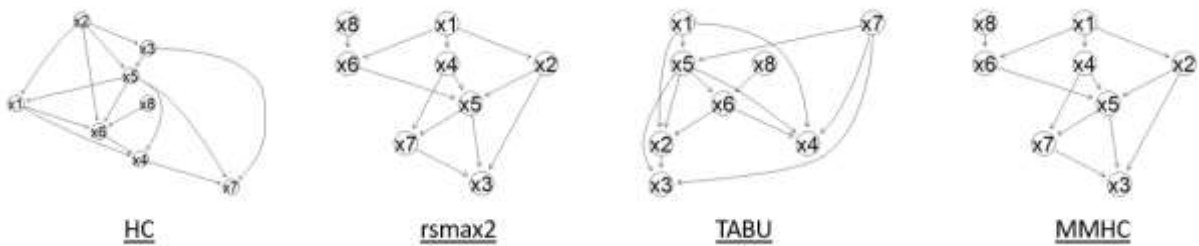


**Görsel 3. Kesikli BN Ağı**

Bu alt başlık altında, sürekli değişkenlerin mevcut olması durumunda eşit frekans/aralık kesikleştirme yöntemi kullanılarak üç farklı veri seti elde edilmiş ve ardından klasik BN uygulamasına yer verilmiştir. Oluşturulan ve Görsel 3'te verilmiş olan ağda görüldüğü gibi x4 ve x8 düğümleri ile modelde yer alan diğer düğümler arasında olasılıksal ilişkinin bulunmadığı sonucuna varılmıştır.

## 2.2. Sürekli Bayeşçi Ağlar

Çalışma kapsamında kullanılan veri setinin sürekli olması ve bir BN modeli elde edilmek istenmesi nedeni ile başvurulan ikinci yaklaşım, orijinal veri üzerinde GBN uygulanmasıdır. BN oluşturulurken ki ilk aşama olan yapı öğrenimi aşaması için öncelikle GBN ağ yapısının belirlenmesi amacıyla yine literatürde yaygın olarak kullanılan puan tabanlı algoritmalarından hc, tabu, mmhc, rmax2 algoritmaları seçilmiştir. Orijinal veri seti üzerinde uygulanan hc, tabu, mmhc, rmax2 algoritmaları ile oluşturulan ağ yapılarının birbirinden farklı olduğu tespit edilmiştir ve bu ağlar Görsel 4'te verilmiştir.



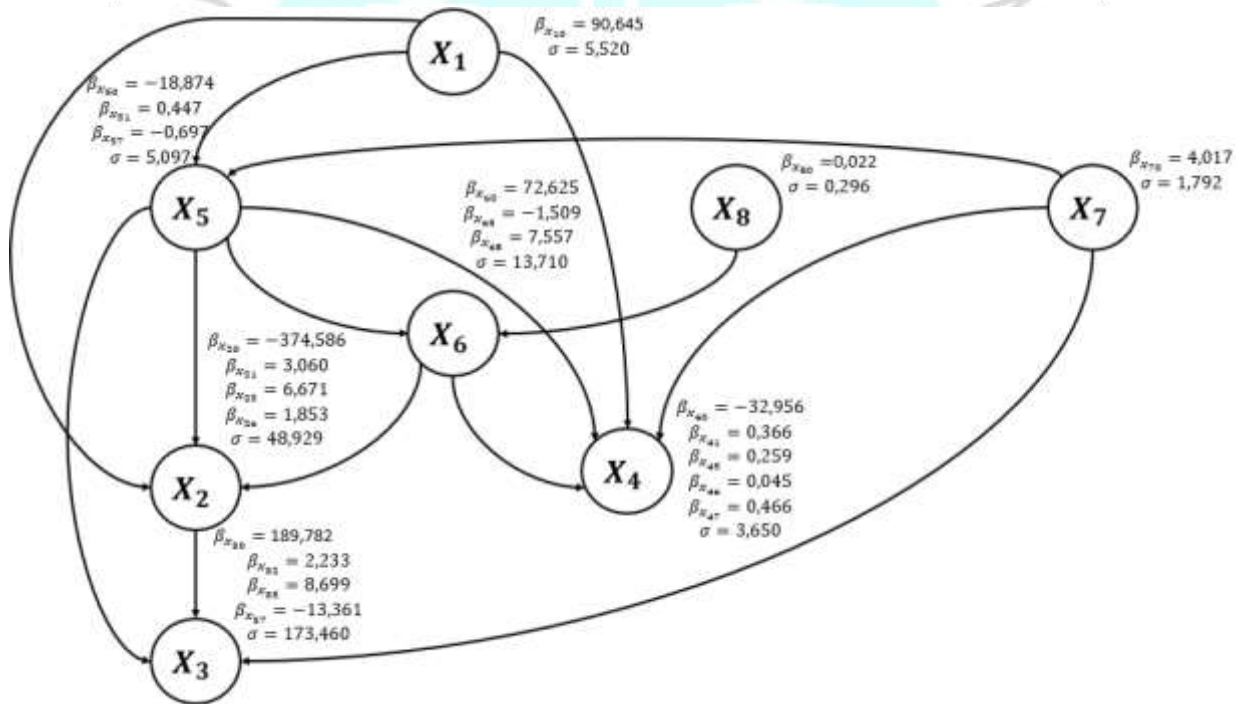
**Görsel 4. GBN Yapısı**

Orijinal veri üzerinden elde edilen modellerin kıyaslanması için AIC, BIC kriterleri ve k-kat çapraz doğrulama yöntemlerine başvurulmuştur ve ulaşılan modellere ait sonuçlar Çizelge 4'te verilmiştir.

**Çizelge 4. GBN Model Karşılaştırılması**

Algoritma	AIC	BIC	Beklenen kayıp	k	İterasyon	Kayıp Fonksiyonu
hc	-13985,4	-14051,24	31,567	100	100	Log-olabilirlik
tabu	<b>-13984,93</b>	<b>-14048,65</b>	<b>31,513</b>			
mmhc	-14001,07	-14060,55	31,671			
rmax2	-14001,07	-14060,55	31,557			

Çizelge 4'e göre, kullanılan dört algoritmaya ait AIC ve BIC skorlarının birbirinden farklı olduğu ve ancak tabu algoritması ile oluşturulan modelin AIC ve BIC skorlarının diğer modellere göre daha iyi olduğu konusunda tutarlılığı görülmektedir. K-kat çapraz doğrulama yöntemine göre de puan tabanlı algoritmalarından tabu algoritmasının kaybı en aza indirdiği ve kararı desteklediği görülmektedir. Dolayısıyla burada en iyi modelin tabu algoritması ile oluşturulan model olduğunu söyleyebiliriz.



**Görsel 5. GBN Ağı**

Bu model doğrultusunda, düğümlere ait parametre değerleri MLE yöntemi ile tahmin edilmiş ve ulaşılan değerler Görsel 5'te verilmiştir.

### 3. SONUÇLAR VE DEĞERLENDİRME

Sürekli verinin kesikleştirilmesi sonrası elde edilen veriler üzerinde klasik BN uygulanması sonucu üretilen ağda (Görsel 3) ile orijinal veri üzerinde GBN uygulanması sonucu üretilen ağda (Görsel 5) yer alan düğümler arasındaki bağımlılık yapılarında farklılıklar gözlemlenmiştir. Dolayısıyla bu durum, gerçekleştirilen analizlerde orijinal veriler üzerinde değişiklik yapılmasının çoğu zaman bilgi kaybına ve hatalı sonuçlara ulaşılması problemlerini doğurmaktadır. Ayrıca, sürekli verilerin kesikli hale dönüştürülmesi esnasında kesim sayısı seçiminin de yöntemin uygulanabilirliğini zorlaştıran etkenler arasındadır. Dolayısıyla, sürekli verilerin varlığı söz konusu iken klasik BN yaklaşımı yerine GBN yaklaşımına başvurmak daha sağlıklı sonuçlara ulaşılmasına yardımcı olacaktır.

### 4. GENEL DEĞERLENDİRME VE SONUÇLAR

Birçok veri seti sürekli değişkenlerden oluşmaktadır. Verilerin sürekli olması halinde, değişkenler arasında olası ilişkilerin incelenmesi için GBN yöntemi literatürde oldukça sık kullanılan bir yöntem olmakla birlikte, araştırmacıya bu ilişkilerin kolaylıkla yorumlanabilmesi için de görsel sunum sağlamaktadır.

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## TWEEDİE BAYEŞÇİ AĞLAR: PARKİNSON HASTALIĞI ÖRNEĞİ

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### ÖZET

Rastgele değişkenin bir dizi üzerinde ortak olasılık dağılımının temsili olan Bayeşçi Ağlar, değişkenler arasındaki bağımlılık ilişkilerinin incelendiği ve oklar kullanılarak olasılıksal ilişkilerin ifade edildiği grafiksel modellerdir. Klasik yaklaşım kullanılarak oluşturulacak ağı sürekli veriler içermesi, araştırmacılara değişkenlerin normal dağılıma sahip olması ve koşullu varyansın sabit olması varsayımlarını sunmaktadır. Bu iki varsayımın karşılanmadığı veri setlerinde alternatif yöntem olarak Tweedie Bayeşçi Ağlar kullanılmaktadır. Bu çalışmada, koşullu dağılımları Tweedie sınıfına ait olan sürekli Bayeşçi Ağlar yöntemi üzerinde durulmuştur. Tweedie sınıfı Normal, Gamma, Ters-Gauss vb. gibi birçok iyi bilinen olasılık dağılımını da içermektedir. Bu bağlamda, Tweedie regresyon modellerine dayalı olarak oluşturulan Tweedie Bayeşçi Ağlar (TBN), Bayeşçi Ağlar'ın geniş ve esnek bir sınıfını oluşturmakta olup çeşitli alanlarda birçok gerçek dünya verisi üzerinde kullanılabilmesi nedeniyle istatistiksel modellemede oldukça önemlidir. Çalışma kapsamında, UCI Machine Learning Repository<sup>1</sup> veri tabanında bulunan "Parkinsons Telemonitoring Data Set" adlı veri setinden seçilmiş 8 değişken ile oluşturulmuş veri üzerinde analizler gerçekleştirilmiştir. Analizler için Rstudio programı kullanılmıştır.

**Anahtar Kelimeler :** Bayeşçi Ağlar, Olasılıksal Grafik Modelleri, Parametre Öğrenme, Tweedie Bayeşçi Ağlar

<sup>1</sup> <https://archive.ics.uci.edu/ml/datasets/parkinsons+telemonitoring>

## 1. GİRİŞ

Bayesçi Ağlar (BN), ağda bulunan değişkenlerin ve bu değişkenler arasındaki bağımlılık ilişkilerinin incelendiği olasılıksal ve grafiksel bir veri modelleme yöntemidir. Modelde yer alan değişkenler düğüm olarak adlandırılmaktadır. Bu düğümler arası olası ilişkiler ise oklar kullanılarak görselleştirilmektedir. Düğümler arası olası ilişkilerin ifade edildiği oklar istatistiksel kararlara göre seçilmektedir. BN sayesinde değişkenler arasındaki ilişkilerin belirsizliği kolaylıkla çözümlenebilmektedir. Grafiksel bilgi sunumundan faydalanılarak hem dolaylı hem de nedensel ilişkiler tespit edilebilmektedir.

BN uygulamaları istatistik bilimi başta olmak üzere olasılık teorisi, bilgisayar bilimi ve grafiksel modeller alanlarından beslenmektedir. Ortak olasılık dağılımının oluşturulması ve koşullu olasılıkların elde edilmesinde olasılık teorisinden faydalanılır. Ebeveynleri belirlenen düğümler için koşullu olasılık çizelgeleri oluşturulur. BN'de düğümlerin yerel olasılık dağılımlarından hareketle bir ortak olasılık dağılımı elde edilir. Bağımlılık durumlarının da görsel bir dil ile ifade edilmesinde grafiksel modellerden yararlanılmaktadır. Bu modeller aracılığı ile düğümler arası ilişkiler ve koşullu bağımsızlık durumları hakkında istatistiksel çıkarımlar yapılmaktadır. Bir BN'nin oluşturulmasında başvuru alan en önemli alan ise istatistik bilimidir. BN'de yer alan düğümler arasındaki ilişkilerin belirlenmesi sürecinde çeşitli istatistiksel testler kullanılmaktadır. Ayrıca, parametrelerin öğrenilmesi aşamasında koşullu olasılık ve Bayesçi yöntemlerinden yararlanılmaktadır.

BN'ler, birçok alanda istatistiksel çıkarım yapmak için en etkili modelleme yöntemidir. Bir BN, üçlü  $(G, F, q)$  olarak tanımlanan özel bir grafik türü olarak da özetlenebilmektedir (Ristevski, 2015). Burada  $G$ , grafik yapısını,  $F$  olasılık dağılımları kümesini ve  $q$  ise parametre kümesini temsil etmektedir (Friedman ve Goldszmidt, 1998).  $G$  grafik yapısında bir dizi düğümü ve düğümler arasında bir dizi yönlendirilmiş oklar yer almaktadır. Düğümler rastgele değişkenlere karşılık gelirken, yönlendirilmiş oklar ise rastgele değişkenler arasındaki koşullu bağımlılıkları göstermektedir.  $X$  düğümünden  $Y$  düğümüne yönlendirilmiş bir ok  $X \rightarrow Y$  şeklinde gösterilmektedir. Burada  $X$  düğümü  $Y$  düğümünün ebeveyni,  $Y$  düğümü de  $X$  düğümünün çocuğu olarak adlandırılmaktadır. Modelde yer alabilecek ebeveyn ve çocuk sayısı sınırlandırılması bulunmamaktadır. Bu bilgiler doğrultusunda, modele ait birleşik olasılıklık denklemi

$$P(X_1, \dots, X_N) = \prod_{i=1}^N P((X_i | Ebeveyn(X_i)))$$

olarak yazılabilir (Nielsen ve Jensen, 2009).



BN’de çıkarım yapmak için öncelikle yapı öğrenme ve parametre öğrenme işlemleri gerçekleştirilmektedir. Yapı öğrenme işleminde, verilerle ilişkili en uygun ağ yapısının belirlenmesi amaçlanır. Bu amaçla literatürde çeşitli yapı öğrenme algoritması bulunmakta olup “arama ve skor bazlı algoritmalar” ise en popüler olan yapı öğrenme algoritmalarıdır. Genellikle bu algoritmalar sonucunda oluşturulan modellerin BIC ya da AIC skorlarına bakılarak değerlendirme yapılmaktadır ve uygun olan skor değerine karşılık optimal ağ yapısı belirlenmektedir. Parametre öğrenme işleminde ise, belirlenen ağ yapısı üzerinde ağda yer alan her bir düğüm için bilinmeyen model parametrelerinin tahmini gerçekleştirilir. Parametre öğrenimi, düğümler arasındaki koşullu bağımlılıkların belirlenmesini sağlamaktadır (Neapolitan, 2003). Parametre öğrenim süreci için literatürde yaygın olarak kullanılan yöntem ise Maksimum Olabilirlik yöntemidir.

Literatürdeki çalışmalar incelendiğinde, bugüne kadar BN yöntemi çoğunlukla kategorik değerler alabilen problemleri çözmeye yönelik çalışmalarda kullanılmıştır. Ancak, sürekli değişkenler içeren veri setleri ile de karşılaşmak mümkündür. Bu çalışmada, değişkenler arasındaki koşullu olasılık ilişkilerini grafiksel bir model ile yansıtılabilmesini sağlayan BN modeli elde edilirken sürekli verilerin varlığı söz konusu iken kullanılabilen Tweedie Bayesçi Ağlar (TBN) yöntemi ele alınmıştır.

Sürekli verilerin varlığı söz konusu iken bu veriler üzerinden kurulacak bir BN modeli için başvurulabilecek çeşitli yöntemler vardır. Bunlardan birincisi, sürekli verilerin öncelikle kesikli hale getirilmesi ve ardından klasik BN yönteminin uygulanmasıdır. İkincisi, Normal Dağılımlı Bayesçi Ağlar (GBN) yönteminin kullanılmasıdır. Üçüncüsü ise TBN’dir. Bu yöntemler arasından birincisinin kullanılırken karşılaşılan zorluklar, verilerin kesikleştirilme yöntemlerinin uygulanması esnasında verilerin kategorize edilebilmesi için belirlenecek bölme sayısının ve genişliklerinin seçilirken hatalara neden olabilmesi ve ortaya çıkan zaman kaybıdır. İstatistik biliminde özellikle de sınıflandırma problemlerinde yaygın olarak kesikleştirilme yöntemlerinden faydalanılmasına rağmen BN modellemesi için önerilmemektedir. Bu durumda alternatif yöntem olarak GBN kullanılmaktadır. GBN yöntemi, tüm düğümler için lineer regresyonların art arda kullanılması olarak özetlenebilir (Masmoudi ve Masmoudi, 2019). GBN, normal dağılım varsayımının avantajlarından yararlanarak çeşitli alanlarda başarıyla kullanılmasına rağmen her verinin normal dağılıma sahip olmadığı gerçeği de bulunmaktadır. Bu durumda, normal dağılım göstermeyen verilerin üzerinde dönüşümler yapılarak veriler normal hale getirilebilir ve yine GBN yöntemi uygulanabilir. Ancak, orijinal veriler ile yapılan analizler sonucunda yapılan çıkarımlar ile dönüşüm yapılmış veriler üzerinden yapılan analizlerden elde edilen çıkarımlar arasında farklılıklar oluşabilmektedir. Özellikle sağlık

sektörü gibi hayati durumların incelendiği çalışmalarda orijinal verinin önemi oldukça önemlidir. Dolayısıyla, sürekli veriler üzerinden doğrudan bir BN modeli oluşturmak için Masmoudi ve Masmoudi (2019) tarafından geliştirilmiş olan TBN yönteminin kullanılması uygun olacaktır. TBN, normal dağılımlı ve kategorik olmayan veriler için her bir düğümün koşullu olasılıklarının ortaya konduğu yönlendirilmemiş grafik modellerdir. Bu koşullu olasılık dağılımları Tweedie ailesine aittir. Modeller Poisson, Negatif Binom ve Normal dağılımları vb. gibi özel dağılımları içerir.

TBN üç parametre ile yönetilir. Bu parametreler ( $m, p, \phi$ ) olarak gösterilir ve sırasıyla ortalama, güç ve yayılım parametreleri olarak adlandırılmaktadır. Güç parametresinin aldığı değerlere göre sergiledikleri dağılım özellikleri Çizelge 1’de verilmiştir (Masmoudi ve Masmoudi, 2019).

**Çizelge 5. Güç Parametresi**

Güç parametresi	Dağılım
$p < 0$	Aşırı Kararlı
$p = 0$	Normal
$p = 1$	Poisson
$1 < p < 2$	Bileşik Poisson
$p = 2$	Gamma
$2 < p < 3$ ve $p > 3$	Pozitif Kararlı
$p = 3$	Ters Normal
$p = \infty$	Aşırı Kararlı

$X = (X_1, X_2, \dots, X_d)^T$   $d$ -boyutlu bir rasgele vektör iken TBN

$$X_i | Pa(X_i) \sim Tw_{p_i}(m_i, \phi_i), \quad m_i = g_i^{-1} \left( \beta_{i0} + \sum_{X_j \in Pa(X_i)} \beta_{ij} X_j \right)$$

olarak ifade edilir (Masmoudi ve Masmoudi, 2019). Denklemden yer alan  $Pa(X_i)$  ağdaki  $X_i$  düğümlerinin ebeveynlerini temsil etmektedir.  $g_i$ , link fonksiyonudur.

TBN parametreleri,

$$\beta = \begin{pmatrix} \beta_{10} & 0 & \dots & 0 \\ \beta_{20} & \beta_{21} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ \beta_{d0} & \beta_{d1} & \dots & \beta_{dd-1} \end{pmatrix}$$

şeklindeki katsayı matrisidir.

## 2. DENEYSEL ÇALIŞMALAR

Çalışmada kullanılan veri seti UCI Machine Learning Repository<sup>2</sup> veri tabanından alınmıştır. “Parkinsons Telemonitoring Data Set” isimli veri setinde yer alan değişkenler incelenerek 8 tanesi çalışmaya dahil edilmiştir. Oluşturulan veri seti 5875 gözlemden oluşan sürekli verilerdir. Bu veri setine ait tanımlayıcı istatistikler Çizelge 2’de verilmiştir.

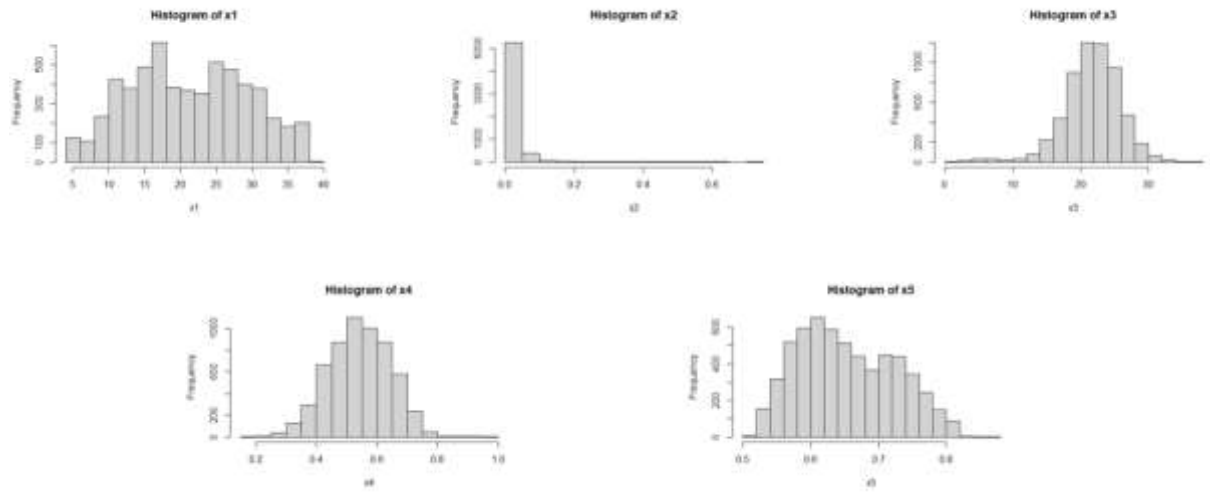
<sup>2</sup> <https://archive.ics.uci.edu/ml/datasets/parkinsons+telemonitoring>

Çizelge 6. Tanımlayıcı İstatistikler

	Min	Maks	$\bar{X}$	Ss	p
Motor UPDRS (X1)	5,038	39,511	21,296	8,129	6.466062e-59
NHR (X2)	0,000286	0,748260	0,032120	0,059	0.000000e+00
HNR (X3)	1,659	37,875	21,680	4,291	1.605096e-42
RPDE (X4)	0,1510	0,9661	0,5414	0,101	2.157667e-05
DFA (X5)	0,5140	0,8656	0,6532	0,071	6.489139e-67

X: ortalama, Ss: Standart Sapma, p: olasılık değeri

Çalışmada kullanılan her bir değişkenin dağılımlarına ait histogram grafikleri Görsel 1'de verilmiştir.



Görsel 6. Değişkenlerin Dağılımları

Çizelge 1'de yer alan p olasılık değerleri ve Görsel 1'de yer alan histogram grafikleri incelendiğinde hiçbir değişkenin normal dağılıma sahip olmadığı görülmektedir.

### 2.1. Tweedie Bayesçi Ağlar

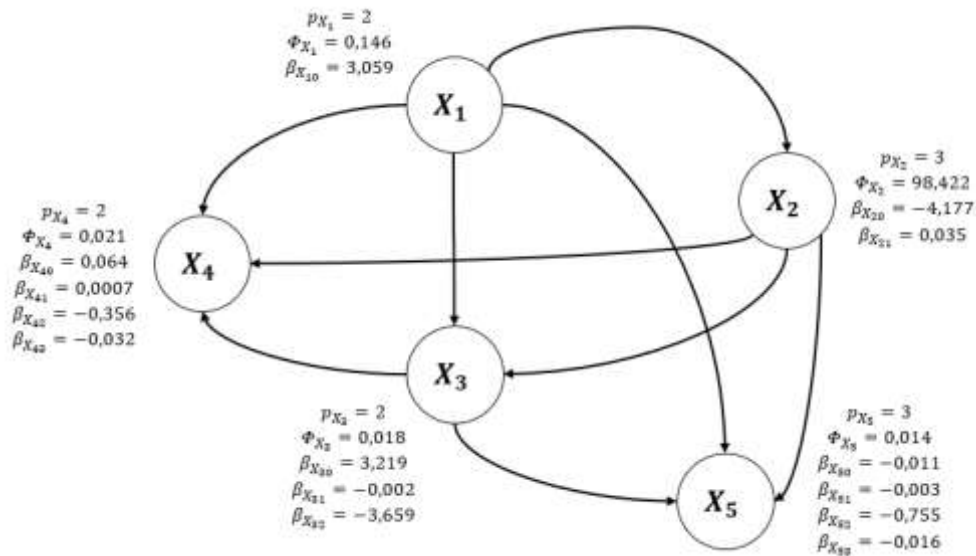
Çalışma kapsamında kullanılan verinin sürekli olması ve bir BN modeli elde edilmek istenmesi nedeni ile TBN yöntemine başvurulmuştur. Burada amaç, sürekli veri özelliği gösteren değişkenler üzerinde herhangi bir dönüşüm yapılmadan, verilerin gerçek dağılımı dikkate alınarak bir BN modeli oluşturmaktır. Kullanılan veri seti üzerinden oluşturulacak TBN için öncelikle ağ yapısının belirlenmiştir. Bu aşamada TBN'ler için önerilen yaklaşım, her bir düğüm için düğümler sıralanması ve Student t testi kullanılarak anlamlı model yapısının oluşturulmasıdır. Çizelge 2'de, Masmoudi ve Masmoudi (2019) tarafından önerilen TBN yapı öğrenme algoritması uygulanması sonucunda elde edilen özet bilgiler verilmiştir. Tahmin edilen TBN parametreleri ve kullanılan link fonksiyonları da bu çizelgede verilmiştir.

Çizelge 7.  $p=(2,3)$  tanım aralığında TBN çıktıları

Düğüm	$p$	$\phi$	Link	$\beta$	$t$
X1	2	0,146	log	3,059*	614,14
X2	3	98,422	log	-4,177*	-70,32
				0,035*	12,04
X3	2	0,018	log	3,219*	655,22
				-0,002*	-9,53
				-3,659*	-125,22
X4	2	0,021	log	0,064*	4,02
				0,0007*	3,02
				-0,356*	-8,15
				-0,032*	-51,77
X5	3	0,014	log	-0,011	-1,05
				-0,003*	-15,88
				-0,755*	-27,25
				-0,016*	-39,09

$p$ : güç parametresi,  $\phi$ : yayılım parametresi,  $\beta$ : katsayılar,  $t$ :  $t$  testi, \*: anlamlı

Çizelge 3'teki  $\phi$  parametre değerleri Pearson tahmincisi ile elde edilmiştir.  $p$  güç parametresi değerleri için her bir düğüm bazında (2,3) tanım aralığı dikkate alınmıştır. 5 değişken için literatürde yaygın olarak kullanılan log link fonksiyonu kullanılmış ve elde edilen dağılımlar incelenmiştir. Buna göre  $p=2$  olduğu X1, X3, X4 düğümlerinin Gamma dağılımına,  $p=3$  olduğu X2 ve X5 düğümlerinin ise Ters Normal dağılım özelliklerini taşıdığı tespit edilmiştir. Tüm düğümler için hesaplanan regresyon katsayıları ( $\beta$ ) da Çizelge 3'te verilmiştir. Tüm bilgiler ışığında ulaşılan TBN ağı ise Görsel 2'de ilgili düğümlere ait tahmini parametre ve katsayı değerleri ile sunulmuştur.



Görsel 7. TBN Ağı

### 3. SONUÇLAR VE DEĞERLENDİRME

Bu çalışmada sürekli değişkenlerden oluşan veri setlerinde değişkenler arasındaki olasılıksal koşul ilişkilerinin incelendiği sürekli BN yöntemlerinden biri olan TBN yöntemi ele alınmıştır. Bu yöntemde,  $p$  güç parametresinin aldığı değerlere göre ağda yer alacak değişkenlerin aynı zamanda gerçek dağılımları da belirlenmektedir. Böylece, orijinal veri üzerinde herhangi bir dönüşüm yapılmadan daha doğru çıkarımların yapılmasına olanak sağlamaktadır. Bu çalışmada kullanılan veri seti ile oluşturulmuş TBN'de yer alan tahmini yapı ve parametrelerin elde edilmesi süreci Masmoudi ve Masmoudi (2019) tarafından önerilmiş prosedürler ile elde edilmiştir.

### 4. GENEL DEĞERLENDİRME VE SONUÇLAR

Sürekli veriler ile oluşturulacak TBN için güç parametrelerinin tahmin edilmesi aşamasında büyük bir açıklık vardır. Bu çalışma, TBN oluşturulurken öncelikle verinin sahip olduğu en doğru dağılım özelliğinin tahmin edilmesi gerektiği konusunda farkındalık yaratacak olup ileriki çalışmalara ışık tutacaktır.

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## THE EFFECTS OF THE SCORE CRITERIA ON HYBRID STRUCTURE LEARNING IN DYNAMIC BAYESIAN NETWORKS

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### ABSTRACT

A Bayesian Network (BN) is a probabilistic graphical model that represents a set of variables and their conditional dependencies via a Directed Acyclic Graph (DAG). Dynamic Bayesian Networks (BDN) extend standard BN with the concept of time and DBNs can deal with discrete, continuous and both discrete and continuous variables. The task of structure learning for DBN refers to learn the structure of the DAG from dataset and there are three approaches for the structure learning: score-based approach, constraint-based approach and hybrid-based approach.

In this study, it was aimed to examine the effects of different score criteria on the hybrid structure learning process in continuous-state DBN. Thus, different hybrid-based algorithms with Akaike Information Criterion (AIC-G), Bayesian Information Criterion (BIC-G) and Bayesian Gaussian Equivalence score (BGE) were used and the analyzes were carried out to examine the effects of score criteria using both synthetic and an UCI multivariate time series datasets. Consequently, the performances of the network structures learned from datasets were compared according to the scoring criteria.

**Keywords:** Dynamic Bayesian Networks, Structure Learning, Scoring Criteria, Multivariate time series

### DİNAMİK BAYES AĞLAR' DA SKOR KRİTERLERİNİN KARMA YAPI ÖĞRENME ÜZERİNDE ETKİSİ

#### ÖZET

Bayes Ağı (BA), Yönlü Döngüsüz Grafikler (YDG) aracılığıyla bir dizi değişkeni ve bu değişkenler arasındaki koşullu bağımlılık yapılarını temsil eden bir olasılıksal grafiksel modeldir. Dinamik Bayes Ağları (DBA), standart BA' nın zaman kavramıyla genişletilmiş versiyonudur ve DBA' larda değişkenler kesikli, sürekli ve hem kesikli hem de sürekli değerler alabilirler. DBA' lar için yapı öğrenme süreci, bir veri kümesinden ağ yapısını öğrenmeyi ifade eder ve yapı öğrenimi için üç yaklaşım vardır: skor-tabanlı, kısıt-tabanlı ve karma-tabanlı yaklaşım.

Bu çalışmada, sürekli durumlu DBA' larda farklı skor kriterlerinin karma yapı öğrenme süreci üzerindeki etkilerinin incelenmesi amaçlanmıştır. Bu nedenle, Akaike Bilgi Kriteri (AIC-G), Bayesci Bilgi Kriteri (BIC-G) ve Bayesci Gaussyen Eşdeğerlik (BGE) skoru ile farklı karma tabanlı algoritmalar kullanılmıştır ve hem sentetik hem de UCI çok değişkenli zaman serisi verileri kullanılarak skor kriterlerinin etkilerini incelemek için analizler gerçekleştirilmiştir.

Sonuç olarak, veri setlerinden öğrenilen ağ yapılarının performansları skor kriterlerine göre karşılaştırılmıştır.

**Anahtar Kelimeler:** Dinamik Bayesci Ağlar, Yapı Öğrenme, Skor Kriteri, Çok Değişkenli Zaman Serisi

## 1. INTRODUCTION

BNs are graphical models that graphically describe causality and conditional independence relationships between random variables. Although they give successful results in many fields, they are insufficient in the analysis of temporal processing or datasets containing cyclical relationships. DBNs can be expressed as an extended version of BN with the concept of time. They allow modeling of time series or sequential datasets. In DBNs, variables can take discrete, continuous or both discrete and continuous values.

DBN have been used in feature recognition/detection, such as visual fatigue detection [1], handwriting and speech recognition [2,3]. It is used in fault detection and diagnosis [4], risk analysis [5] and analyzing gene networks [6]. In addition DBN is used for forecasting in time series analysis [7,8,9].

DBN generally consists of two parts, qualitative and quantitative. First, the qualitative part is the creation of the network structure, and then the quantitative part is the process of obtaining the conditional probability tables/distributions of the variables (nodes) over the known network structure. There are two approaches to generate the structure of network, it can be generated with use of expert knowledge or is learned through some algorithms over the existing dataset. The second way is also known as the learning process. These are Structural Learning, which is the process of creating the network structure of the model to be established, and Parameter Learning, which is the process of estimating the composite probability tables/distributions of the variables in the specified model. In this study, structure learning is emphasized.

There are mainly three different approaches for learning structure from dataset in DBN such as constraint-based, score-based and hybrid structure learning algorithms. The purpose of constraint-based methods using conditional independence tests to create a BN structure that will reflect the relationships between nodes, in score-based methods the most suitable network structure for the dataset is determined by a score function and a search method. And hybrid method combines a score-based method either with a constraint-based method or with a variable selection method. In hybrid methods, constraint-based methods and search-score-based methods are used together. The most frequently used scoring criteria in the literature are K2 [10], AIC [11], BIC [12], BDE (Bayesian Dirichlet Equivalence) [13] for discrete data and AIC-G, BIC-G, BGE [14] for continuous data. Therefore the scoring metrics have a direct effect on the performance of DBN structure. Therefore, it can be said that the scoring criteria have a direct impact on the performance of the DBN structure.

In this study, the effects of score criteria used in hybrid structure learning in DBNs were examined. In Section 2, theoretical information about DBN and structure learning from data were given. Section 3 and Section 4 describe experiments and the results. Finally in Section 5, we present conclusions.

## 2. MATERIAL AND METHOD

In this section, we gave the theoretical informations about the DBNs. Furthermore, the hybrid structure learning algorithms were introduced.

## 2.1. Dynamic Bayesian Networks

DBNs are probabilistic graphical models dedicated to modeling multivariate time series [15]. A DBN is a DAG that encodes a joint probability distribution over a set of random variable  $X$ . Formally, a DBN for  $X$  is a pair  $B = (V, E)$  where  $V$  is the set of the random variables  $X_1, X_2, \dots, X_n$  and  $E$  is the set of edges (arcs) between the nodes. The DBNs generally have two assumptions: first-order Markov property that each variable  $X_i$  is independent of its non-descendants given its parents, and the stationary assumption that the structure and parameters of the model do not change over time [16]. Let  $P_B$  be the joint probability distribution of variables with discrete time variable  $t \in [1:T]$ , the joint probability function for a DBN is represent

$$P_B(X[t]) = \prod_{t=1}^T \prod_{i=1}^n P_B(X_i[t] | Pa(X_i[t])) \quad (2.1)$$

where  $Pa(X_i[t])$  is the parent of variable  $X_i$  in time slice  $t$ . The DBN has an initial network and a transition network. An initial network is a network for which a dependency structure is defined between variables and the transition network refers to the relationship structures of variables between different time slices [17, 18].

Variables in DBN can take discrete, continuous, and both discrete and continuous values. The structure learning process in Gaussian DBN is generally similar to the Gaussian BN structure learning process. In continuous state DBNs, the joint probability distribution for the random variables  $X$  is assumed a multivariate normal distribution and this can be called an auto-regressive process [19, 20].

## 2.2. Hybrid Structure Learning Algorithms

The structure learning process in DBN is generally similar to the BN structure learning process. Learning a DBN structure from the dataset can be in two different ways according to the observability of the dataset. If the dataset is full observability that is, if the values of all variables are known, the structure can be obtained by searching through model space. If the dataset is partial observability, the Structural Expectation-Maximization (SEM) method is can be used. In this study, it is assumed that the datasets are full observability.

The process of obtaining a BN structure from the dataset is known as structural learning and is examined under three section: score-based methods, constraint-based methods, and hybrid methods.

In hybrid methods, first constraint-based methods are applied. In this step, all independence relationships between variables are determined by conditional independence tests and network structures showing these relationships are obtained. At this stage, the existence of undirected edges between nodes in the obtained network structure is examined. Commonly used conditional independence tests are Pearson correlation test, likelihood ratio test, conditional joint knowledge test and conditional partial relationship tests [21]. There are different constrained-based algorithms that are used: Grow-Shrink (GS) [22] Incremental Association Markov Blanket (IAMB) [23], Inter-Incremental Association Markov Blanket-IAMB (INTER IAMB) [24], Fast Incremental Association Markov Blanket (FAST IAMB) [24] and Min-Max Parents and Children (MMPC) [25] algorithms.

Then, as a second step, search-score-based methods are applied. In this step, the direction of the non-directional edges is determined and the network structure is formed. Search strategies are generally chosen from greedy search algorithms and heuristic optimization algorithms, and the most commonly used search methods are; Hill Climbing (HC), Genetic Algorithms (GA), Simulated Annealing, Tabu Research (TABU), Particle Swarm Optimization (PSO) algorithm and Artificial Ant Colony (AAN) algorithm [26, 27].



### 3. EXPERIMENTS

In this study, the hybrid-based method was used for the structure learning process in Gaussian DBN. The algorithms to be used in structure learning with different combinations were given in Table 3.1.

**Table 3.1. Hybrid algorithms combinations to be used for DBN structure learning**

Constraint-based method	Score-based method	Conditional independence test	Score Criteria
MMPC	HC, TABU	Pearson's Correlation	AIC-G, BIC-G, BGE
IAMB	HC, TABU	Pearson's Correlation	AIC-G, BIC-G, BGE
FAST-IAMB	HC, TABU	Pearson's Correlation	AIC-G, BIC-G, BGE
INTER-IAMB	HC, TABU	Pearson's Correlation	AIC-G, BIC-G, BGE
GS	HC, TABU	Pearson's Correlation	AIC-G, BIC-G, BGE

Analysis were performed on both synthetic and an UCI multivariate time series dataset. With the combinations of different structure learning algorithms determined, 10 different 2-time slices DBN structure learning processes were performed for each score criterion. Then, the score measure values were calculated for the performance of the learned network structures. The arithmetic mean of the score values obtained for different sample units after 50 iterations was calculated and the results were examined. “bnlearn” package [28] was used for the score measurement values of the learned networks.

#### 3.1. Simulated Datasets

Multivariate time series datasets with different variables were simulated. A first order vector autoregressive model was used to construct the multivariate time series datasets.

The multivariate time series dataset with different sizes (5,7,10,12) with 1000 unit sample size were simulated. In this study, it was accepted that the datasets provide stationarity and first-order Markov assumptions in DBN analysis. After the simulated datasets were generated, the DBN structure learning analysis were performed. Finally, AIC-G score values were obtained for the learned networks.

#### 3.2. UCI Dataset

The Istanbul Stock Exchange (ISE) dataset gives the returns of Istanbul Stock Exchange together with seven international indices (SP, DAX, FTSE, NIKKEI, BOVESPA, MSCE\_EU, MSCI\_EM) by taking daily price data. It was obtained between January 5, 2009 and February 22, 2011 on a daily basis and only for working days when the Istanbul Stock Exchange was open. It has 536 observations and 8 variables. In the case of missing data, the previous day’s value was used [29].

The optimal lag length was determined as 1 according to the Schwarz Information Criterion. The Augmented Dickey-Fuller (ADF) unit root test was used for the stationarity and the ADF test results were given in Table 3.2.

**Table 3.2. ADF Unit Root Test Results for ISE dataset**

Variables	ADF Test Statistics	Mackinnon Critical Values		
		%1	%5	%10
ISE	-22.459617	-3.442166	-2.866752	-2.569546





SP	-23.512105	-3.442166	-2.866752	-2.569546
DAX	-21.985594	-3.442166	-2.866752	-2.569546
FTSE	-22.454986	-3.442166	-2.866752	-2.569546
NIKKEI	-5.269939	-3.442166	-2.866752	-2.569546
BOVESPA	-22.405665	-3.442166	-2.866752	-2.569546
EU	-22.480380	-3.442166	-2.866752	-2.569546
EM	-19.758555	-3.442166	-2.866752	-2.569546

The Null hypothesis is the series is non-stationary (contains a unit root). The rejection of the null hypothesis based on the Mackinnon critical values. The ADF results in Table 3.2 indicated that ISE dataset is stationary.

The DBN structure learning process for the ISE dataset was carried out with the combinations of algorithms in Table 3.1. For analysis, firstly, 100 and 500 unit samples were taken from the dataset and network scores were obtained with 50 iterations. Then, structure learning was performed with 50 iterations for the entire dataset and the arithmetic average of the score measurements obtained for the three cases were taken. Finally, the score measures obtained for the learned networks with three score criteria were compared.

#### 4. RESULTS

While the number of variables was 5, the score measurement values obtained for the network structures learned with the AIC-G, BIC-G and BGE score criterion were given in Table 4.1.

**Table 4.1. When the number of variables was 5, the score values of the networks learned with the AIC-G, BIC-G and BGE score criterion**

		Scoring Criteria Used for Structure Learning and Score Measurement Values		
Score-based method	Constraint-based method	AIC-G	BIC-G	BGE
HC	MMPC	-12281.85	-12439.61	-12251.35
	IAMB	-12281.85	-12431.24	-12251.35
	FAST.IAMB	-12281.85	-12431.24	-12251.35
	INTER.IAMB	-12281.85	-12431.24	-12251.35
	GS	-12281.85	-12431.24	-12251.35
TABU	MMPC	-12281.25	-12439.60	-12249.99
	IAMB	-12281.25	-12431.23	-12249.99
	FAST.IAMB	-12281.25	-12431.23	-12249.99
	INTER.IAMB	-12281.25	-12431.23	-12249.99
	GS	-12281.25	-12431.23	-12249.99

In Table 4.1, it was seen that the highest score measurement values were obtained by using the TABU algorithm with the BGE score criterion. It was concluded that the same score measurement values were obtained for all constraint-based algorithms when the TABU algorithm, one of the score-based methods, was used.

While the number of variables was 7, the score measurement values obtained for the network structures learned with the AIC-G, BIC-G and BGE score criterion were given in Table 4.2.





**Table 4.2.** When the number of variables was 7, the score values of the networks learned with the AIC-G, BIC-G with the BGE score criterion

Score-based method	Constraint-based method	Scoring Criteria Used for Structure Learning and Score Measurement Values		
		AIC-G	BIC-G	BGE
HC	MMPC	-19641.6	-19415.15	-19463.36
	IAMB	-19433.81	-19329.76	-19334.55
	FAST.IAMB	-19433.81	-19319.82	-19334.55
	INTER.IAMB	-19433.81	-19329.76	-19334.55
	GS	-19433.81	-19319.82	-19334.55
TABU	MMPC	-19373.02	-19415.15	-19460.69
	IAMB	-19145.08	-19113.63	-19309.47
	FAST.IAMB	-19145.08	-19081.61	-19309.47
	INTER.IAMB	-19145.08	-19113.63	-19309.47
	GS	-19145.08	-19081.61	-19309.47

When the results were examined in Table 4.2, it was seen that the highest score measurement values were obtained by using the TABU score-based algorithm and the BIC-G score criterion, and using the constraint-based algorithms, FAST.IAMB and GS algorithms.

While the number of variables was 10, the score measurement values obtained for the network structures learned with the AIC-G, BIC-G and BGE score criterion were given in Table 4.3.

**Table 4.3.** When the number of variables was 10, the score values of the networks learned with the AIC-G, BIC-G with the BGE score criterion

Score-based method	Constraint-based method	Scoring Criteria Used for Structure Learning and Score Measurement Values		
		AIC-G	BIC-G	BGE
HC	MMPC	-35308.54	-34278.25	-34698.83
	IAMB	-33852.53	-32623.42	-33525.35
	FAST.IAMB	-33716.04	-32727.37	-33878.62
	INTER.IAMB	-33717.69	-32623.42	-33525.35
	GS	-33716.04	-32727.37	-33506.38
TABU	MMPC	-34742.46	-34050.56	-34516.72
	IAMB	-33883.13	-32644.06	-33714.9
	FAST.IAMB	-33747.44	-32748.01	-33941.77
	INTER.IAMB	-33747.53	-32644.06	-33714.9
	GS	-33747.44	-32748.01	-33569.62

In Table 4.3, it was concluded that the highest score measurement values of the learned network structures were obtained by using the HC score-based algorithm and the BIC-G score criterion, and using the constraint-based algorithms IAMB and INTER.IAMB.

While the number of variables was 12, the score measurement values obtained for the network structures learned with the AIC-G, BIC-G and BGE score criterion were given in Table 4.4.



**Table 4.4.** When the number of variables was 12, the score values of the networks learned with the AIC-G, BIC-G with the BGE score criterion

		Scoring Criteria Used for Structure Learning and Score Measurement Values		
Score-based method	Constraint-based method	AIC-G	BIC-G	BGE
HC	MMPC	-40076.26	-40076.26	-40076.26
	IAMB	-37692.86	-37699.14	-37699.14
	FAST.IAMB	-38377.9	-38384.18	-38384.18
	INTER.IAMB	-37620.44	-37620.44	-37620.44
	GS	-38164.33	-38170.61	-38170.61
TABU	MMPC	-39772.43	-39655.15	-39722.02
	IAMB	-37781.76	-37789.49	-37700.59
	FAST.IAMB	-38466.8	-38474.52	-38385.62
	INTER.IAMB	-37709.34	-37709.34	-37709.34
	GS	-38253.23	-38260.96	-38172.06

In Table 4.4, the highest score measurement values were obtained when the HC score-based algorithm and AIC-G and BIC-G score criteria were used with INTER.IAMB algorithm.

For ISE dataset, the average score measurement values obtained for the network structures learned with the AIC-G, BIC-G and BGE score criterion were given in Table 4.5.

**Table 4.5.** Average score values of networks learned with AIC-G, BIC-G and BGE score criterion for ISE dataset

		Scoring Criteria Used for Structure Learning and Average Score Measurement Values		
Score-based method	Constraint-based method	AIC-G	BIC-G	BGE
HC	MMPC	25963.67	25963.67	33691.93
	IAMB	26194.98	26194.98	33840.75
	FAST.IAMB	26206.52	26206.01	33831.2
	INTER.IAMB	26194.98	26194.98	33840.75
	GS	26153.42	26153.42	33795.79
TABU	MMPC	26031.57	26039.53	33691.93
	IAMB	26211.8	26211.8	33840.75
	FAST.IAMB	26206.52	26206.01	33831.2
	INTER.IAMB	26211.8	26211.8	33840.75
	GS	26186.2	26186.2	33795.79

In Table 4.5, it was concluded that the best learned network structure for the ISE data was obtained with the constraint-based algorithms IAMB and INTER.IAMB with the BGE score criteria. The same score results were obtained for the score-based algorithms HC and TABU with the BGE score criterion.

**5.CONCLUSION**

The structure learning process in DBN is a process that should be especially emphasized because further analyzes will continue through this determined network structure. In this study, the hybrid-based approaches were used for the DBN structure learning.

We examined the effects of three different score criteria on the continuous-state DBN hybrid structure learning. Hence, different algorithm combinations were generated and the DBN network structures were learned for different simulated and an UCI dataset with these algorithms. The score measurement values were calculated for the performances of the learned network structures.

As a result, the highest score measurement values for simulated datasets were obtained by BGE when the number of variables was 5, BIC-G when the number of variables was 7 and 10, and AIC-G and BIC-G score criteria when the number of variables was 12. For higher values of variable number, more reliable DBN network structures were learned with BIC-G score criterion. When the results obtained for the UCI dataset was examined, the highest average score measurements was obtained with the BGE criterion. It was observed that the results obtained for the UCI dataset supported the results obtained for the simulated datasets.

Furthermore, when the results obtained for the HC and the TABU algorithms in the hybrid structure learning methods were examined for both simulated and the UCI dataset, the higher score values were obtained with TABU when the number of variables was small (8 or less). When the number of variables is larger than 8, stronger network structures were obtained with the HC score algorithm.

## ACKNOWLEDGMENTS

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