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Dear Researchers;

International Journal of Engineering and Applied Sciences ler has been published in Turkish and English since 2018 with 2 issues. Our journal will accept Turkish and English articles as 2 issues a year and the articles will be evaluated by at least two referees with the same system. Our magazine from December 2018; it offers many advantages to readers due to the practical and practical access to the authors as well as the process of publishing and publishing quickly and easily; The electronic journal (e-ISSN:2667-4165) accepts 2 numbers per year (June and December) in Turkish and English. The names of the judges evaluating the articles are not notified to the authors. The referees cannot see the names of the authors. The studies are evaluated as at least two referees. Our authors, who want to send articles, can register their original scientific articles online and follow the process by registering on our magazine page. Our journal is accepted as original and previously published research articles.

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Araştırma Makalesi / Research Article

Bitkisel Bir Kompozitin Yüzey Topografyası Basılabilirliğini Nasıl Etkiler?

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Anahtar kelimeler
Kabak lifi; Bitkisel lifler; Biyo-kompozit; Basılabilirlik

Öz

Bu çalışmada, kabak lifi takviyeli bitkisel kompozit malzemelerin yüzey topografyasının basılabilirliğine etkisi incelenmiştir. Bu amaçla, takviye olarak kabak lifi ve matris olarak epoksi kullanılarak biyo-kompozit plakalar üretilmiştir. Daha sonra bu plakaların yüzeylerine çizgi ve nokta gibi baskılar serigrafi baskı yöntemi ile gerçekleştirilmiştir. Baskıdan önce ve sonra, üretilen biyo-kompozitlerin yüzey pürüzlülük değerleri, 3D temassız optik profilometre kullanılarak ölçülmüştür. Daha sonra bu ölçümleri doğrulamak ve baskı kalitesini kontrol etmek için 3D Optik Profilometre biyo-kompozit malzemelerin yüzey pürüzlülüğünü taramak için kullanılmıştır. Elde edilen sonuçlara göre, kompozit yüzey topografyasındaki gelişme, yüzey pürüzsüzlüğünü arttırmaktadır. Bu sonuç ile yüzey pürüzsüzlüğünün, elde edilen görüntü netliği için basılabilirliğin ana parametresi olduğu açıkça anlaşılmaktadır.

How Does the Surface Topography of a Green Composite Affect its Printability?

Keywords
Luffa fiber; Plant fibers; Bio-composite; Printability

Abstract

In this study, the effect of surface topography of luffa fiber reinforced green composite materials on its printability was investigated. For this purpose, bio-composite plates using luffa fiber as reinforcement and epoxy as the matrix were produced. Then, printing such as line and dot on the surfaces of these plates was carried out by the screen printing method. Before and after printing, the surface roughness values of the produced bio-composites were measured using 3D non-contact optical profilometer. Afterward, to validate these measurements and to check the printing quality, 3D Optical Profilometer was used to scan the surface roughness of bio-composite materials. According to the obtained results, the improvement of the composite surface topography is increase surface smoothness. With this result, it is clearly understood that the surface smoothness is the main parameter of printability for the resulting image clarity.

1. Introduction

In recent years, it has been observed that studies on bio-composite materials have continued intensively. As underlined by Cheung et al. (2009) in the literature the use of renewable resources

such as plant and animal-based fiber-reinforced polymeric composites, has been becoming an important design criterion for designing and manufacturing components for all industrial products. The damage caused by chemical materials to nature and the concerns of recycling are the most important factors in the increase of these studies. Many of these studies are related to the characterization of new or green materials (Alemdar and Sain, 2008; Boynard and D'Almeida, 2000; Genc, El Hafidi, and Gning, 2012; Genc and Koruk, 2016, 2017; Wambua, Ivens, and Verpoest, 2003).

However, at this stage, studies focusing on the application of bio-composite materials have become important. In this sense, some studies when examined; Genc and Akkus (2018) studied, waste walnut shell reinforced bio-composite materials, and its machinability behavior to aim the recycle-able of natural waste materials and to find new usage fields of waste of natural materials. As presented in this study, they produced tea plates in order to prove the producibility of the product using walnut shells. Al-Oqla and Sapuan (2014), reported in their study that the feasibility of using the date palm fibers in the natural fiber reinforced polymer composites for the automotive industry. Behazin and et al. (2016) produced softwood chip biochars and characterized to evaluate their properties in light of potential alternative and novel applications.

In many engineering industrial applications, the exact characterization of the surface roughness is of great importance due to its significant impact on the functionality of the manufactured products. Also, the topographic method is the most applied method the evaluation of the surface quality of metallurgical or mechanical products (Deltombe et al., 2014).

The most commonly used method for evaluating the surface quality of composites is the Stylus method, which provides the accepted numerical values (Ulker, 2018). Stylus devices are the most commonly used instruments for measuring surface texture today. A typical stylus tool consists of a pen physically contacting the measured surface and a converter used to convert its vertical movement into an electrical signal (Richard, 2001). Nowadays, contactless surface roughness has been measured by modern optical technologies.

Petroleum-based composites are widely used in the printing industry. The signboard is one of the main product in this industry. In this study, the printability properties of plant-based composites were investigated. The aim of this study, to find new usage areas for plant-based composites and reduce the fields of usage the petroleum-based composite materials.

2. Materials and Methods

Luffa cylindrica fiber was used as reinforcement, and the epoxy resin was utilized as a matrix to manufacture the bio-composite laminate specimens. The properties of the liquid epoxy resin are given in detail in Table 1.

Table 1. Properties of the Liquid Epoxy Resin.

Test	Method	Value
Color	Observation	Transparent
Density	DIN EN ISO 2811	1.15 kg/L
Viscosity	ASTM D1545-07	330 mPa.s
Pot life	DIN 16945	170 min.
Water absorption	DIN EN ISO 175	46.5 mg

Produced bio-composite specimens were cut using the CNC Router machine to prepare it for the printing process. The volume fraction of these bio-composite specimens was calculated as 0.6 using rules of mixtures.

2.1. Printing on the Surface of the Bio-Composite Materials

The screen-printing technique was used for printing on the surface of the bio-composite sample, as shown in Fig. 1.

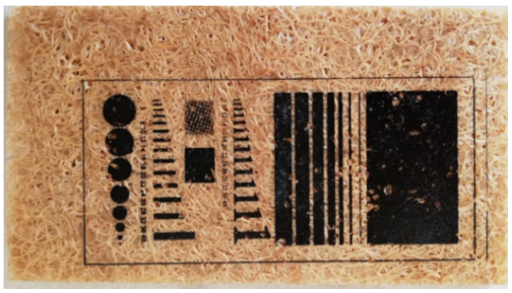


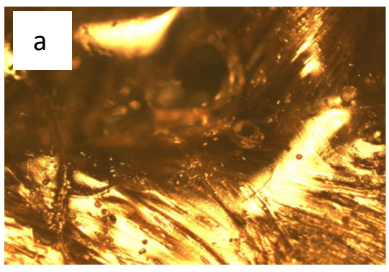
Figure 1. Printing on the surface of Bio-composite sample.

The used screen-printing machine is a semi-automatic. The mesh number of the print plate was 120 threads per cm (tpc), and the dot per cm was 40 (dpc). The angle of the squeegee was 45°, and the hardness of squeegee was 75 shore (Sonmez, 2017b). Solvent-based black ink was applied to the samples.

2.2. Measurement of the Surface Roughness of Bio-Composite Materials

In this study, the optical microscope for display and 3D profilometer was used to scan and measure the surface roughness. Surface roughness is that part of the irregularities on a surface left after manufacture which is held to be inherent in the material removal process itself as opposed to waviness which may be due to the poor performance of an individual machine. Surface roughness is generally examined in plan, i.e., sectional view with the aid of optical and electron microscopes, in cross- sections normal to the surface with stylus instruments and, in oblique cross-sections, by optical interference methods (Whitehouse, 2002).

Bio-composite plates were given 5X magnification and 10X magnification in 2D Optical Microscope images before printing as given in Fig. 2. In the images of before printing, the fiber structure of the bio-composite material is clearly visible. Bright areas are an epoxy image.



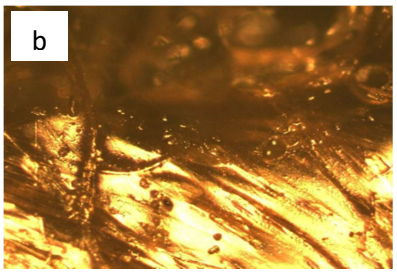


Figure 2. 5x (a) and 10x (b) images of bio-composite material under 2D Optical Microscope before printing.

3. Results and Discussions

Fig. 3 shows the solid pressure printed on the bio-composite material. It is seen that the loss of image in the ground pressure on the bio-composite surface is low. This bio-composite material shows that the ink adheres to the surface, providing good coverage.

Figure 3. Solid area printed on the surface of bio-composite material after printing.

Fig. 4 shows the images printed on the bio-composite material such as lines with different thickness, and dots with different diameters. It is seen to be printed the smallest 0.5 mm diameter dot and 0.5 pt. thickness line on the surface of the composite material. Both the lines and dots have good edge sharpness, but there are regional visual losses in the lines and dots due to the surface of the bio-composite material. The loss of image formed on the surface will cause the print quality to decrease, and this will result in the lack of perceived messages (Sonmez, 2017a).

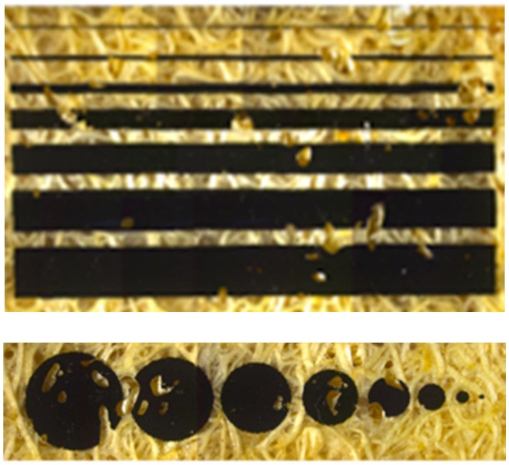


Figure 4. Lines and dots printed on the surface of bio-composite material after printing.

The images of the ink on the bio-composite surface after printing were obtained, as shown in Fig. 5. The image in Fig. 5.a shows a straight line in the printing, while the image in Fig. 5.b shows a cross-section of the scanning square area of the dots.

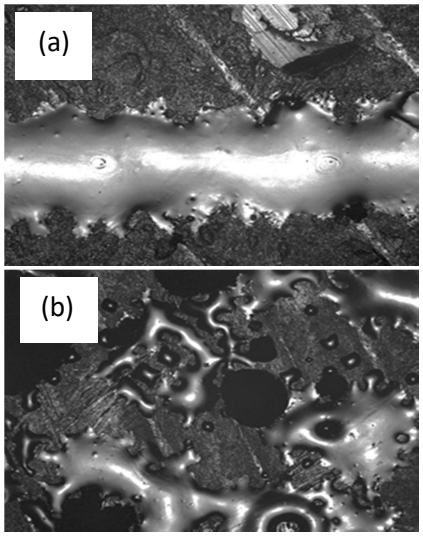


Figure 5. 20x (a) and 10x (b) images of the printed line (a) and the printed screen dot (on printed bio-composite material under a 2D optical microscope.

The interaction of the bio-composite material with the ink is clearly visible in Figure 6. Optical profilers are interference microscopes and are used to measure height variations – such as surface roughness – on surfaces with great precision using the wavelength of light as the ruler.

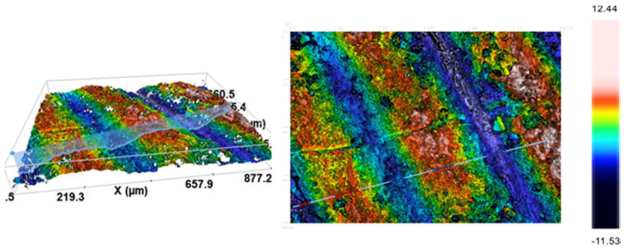


Figure 6. 3D and 2D topography images of bio-composite surface before printing.

The same method was used to scan and measure the surface roughness of the bio-composite material after printing. An EPI 20X v35 lens was used to measure the surface profile.

Optical interference profiling is a well-established method of obtaining accurate surface measurements (Pandey, 2018).

In this study, SENSOFAR Lynx 3D non-contact optical profilometer is used to scan and measure the surface roughness of composite boards. The 3D Optical Profilometer was used to scan the surface roughness of the obtained composite material. Interferometry method was used to measure the surface profile. A sample area of 0.8x 0.6 mm^2 on the sample was scanned. Measuring range in Z-axis was 70 µm. 3D surface topographic image is shown in Figure 6. In Figure 7, the profile of the surface was measured. Points 1 and 2, ΔZ values were found to be 7.5 µm and 7.3 µm, respectively.

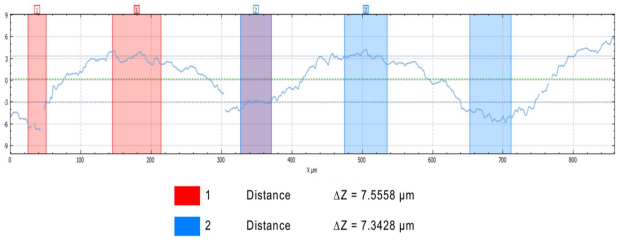


Figure 7. Profile of bio-composite material before printing.

Roughness and surface parameters of the material were determined according to ISO 25178. Table 2 shows the results obtained according to ISO 25178. These parameters involve only the statistical distribution of height values along the z-axis.

A sample area of 0.8x0.6 mm^2 on the sample was scanned. The measuring range in Z-axis was 80 µm 3D surface topographic image is shown in Figure 8.

Also, ΔZ, ΔL, and angular changes between the measuring points for the bio-composite material after printing are given in this Figure.

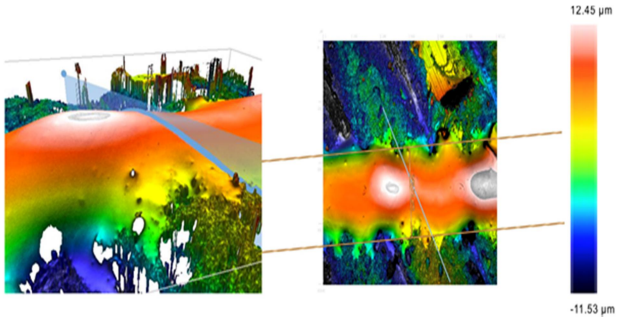


Figure 8. 2D and 3D topography images of one of the line on the surface of bio-composite after printing.

Table 2. Height parameters of the surface of the bio-composite specimen.

Arithmetical mean height of the surface (Sa, μm)	2.5
Kurtosis of height distribution (Sku)	28
Maximum height of peaks (Sp, μm)	21.3
Root mean square height of the surface (Sq, μm)	2.95
Maximum height of valleys (Sv, μm)	14.2
Maximum height of the surface (Sz, μm)	35.6

The trace, which is the smallest print on the surface of the bio-composite material, is also measured. A sample area of 1.5x 1.1mm^2 on the sample was scanned. In Figure 9, the profile of the surface was measured. Points 2 and 3, ΔZ values were found to be 9.5 µm and 10.4 µm, respectively.

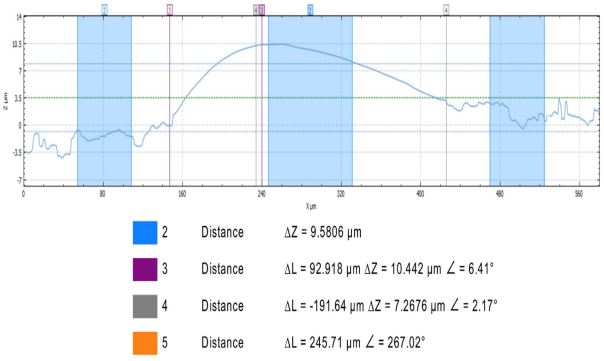


Figure 9. Profile of bio-composite material after printing.

Measuring range in Z-axis was 70 µm. 3D surface topographic image is shown in Figure 10. Also, the profile measurement of the surface given in Figure 11. ΔZ values, were found to be 21.1 µm by measurement in this area while the measured diameter (Dxy) was 0.9 mm, Area (Axy) was 0.76 mm^2.

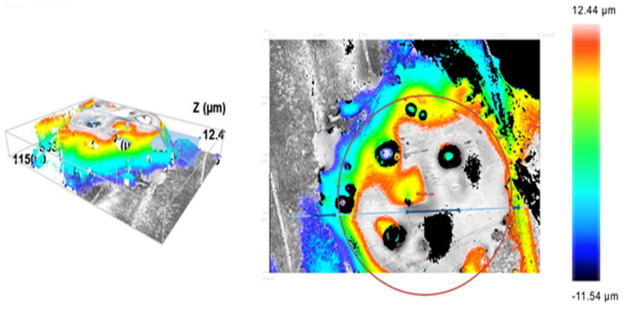


Figure 10. 2D and 3D topography images of the smallest print trace in the surface of bio-composite material after printing.

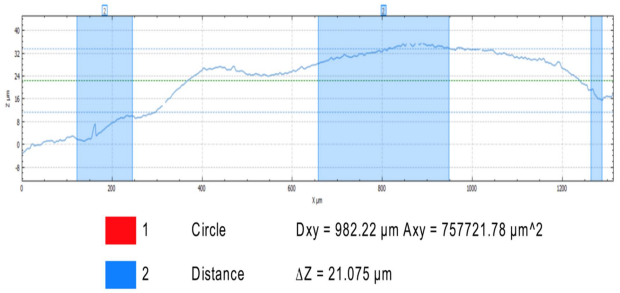


Figure 11. Profile of the smallest print trace in the surface of bio-composite material after printing.

5. Conclusion

Non-contact surface roughness measurement method is used, and very successful results were obtained in this study. In particular, the use of ISO 25178 standard introduces a new perspective in the study of surface roughness parameters of the composite material surfaces. Surface smoothness is an important parameter in obtaining quality printing. As the surface smoothness increases, the edge sharpness of the images to be obtained indicates that the print quality is at the desired level. Although the finest details were obtained in the pressures on the prepared bio-composite material, image losses were determined due to the volume fraction of resins. This problem can be eliminated by increasing the volume fraction of resin.

Consequently, it has been found that the improvement of the composite surface topography increased surface smoothness, which is the most important characteristic of printability.

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Afyon Kocatepe Üniversitesi Uluslararası Mühendislik Teknolojileri ve Uygulamalı Bilimler Dergisi

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Kabak ve Jüt Liflerinin Mekanik Özelliklerinin Karşılaştırılması

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Öz

Bu çalışmada, bitki esaslı lifler kullanılarak üretilen biyo-kompozit malzemelerin mekanik özellikleri karşılaştırılmıştır. Biyo-kompozit numunelerin üretiminde takviye elemanı olarak kabak lifi ve jüt kullanılmıştır. Üretilen biyo-kompozit numunelerin mekanik özelliklerinin karşılaştırılabilmesi için matris olarak epoksi reçine seçilmiştir. Mekanik özelliklerin belirlenmesi için eğilme deneyleri gerçekleştirilmiştir. Test sonuçlarına göre kabak lifi takviyeli kompozit numunelerin max. dayanımı 55 MPa jüt lifi takviyeli kompozit numunelerin max. dayanımı ise 36.5 MPa olarak ölçülmüştür. Ayrıca, Eğilme Modülü, kabak lifi için 5.7 GPa ve jüt lifi için 5.5 GPa olarak hesaplanmıştır.

Elde edilen sonuçlara göre kabak liflerinin – jüte göre daha yüksek mukavemet değerlerine sahiptir. Bu nedenle özellikle eğilme yüklerine maruz uygulamalarda Kabak lifleri tercih edilmelidir. Bu biyo-kompozit malzemelerin özellikle havacılık, otomotiv ve denizcilik sektörlerindeki potansiyel kullanım alanları için alternatif olabileceği öngörülmektedir. Bir sonraki çalışmamızda mevcut bitkisel liflerin mekanik özelliklerinin iyileştirilmesi ve geliştirilmesi çalışılacaktır.

Anahtar kelimeler
Kabak lifi, jüt lifi, biyo-kompozit, eğilme, eğilme dayanımı

Comparison of flexural properties of luffa and jute fibers

Abstract

In this study, the mechanical properties of bio-composite materials produced by using plant-based fibers compared. Luffa fiber and jute were used as reinforcement in the production of these bio-composite samples. To able to compare the mechanical properties of the reinforcement the same matrix (epoxy) was used in the production of all samples. Three-point bending tests were performed to determine the mechanical properties of these specimens. According to the test results, the Flexural Stress of luffa and jute fibers were measured 55 MPa and 36.5 MPa respectively. Also, Flexural Modulus calculated as 5.7 GPa for luffa and 5.5 GPa for jute fibers.

The strength of luffa fibers experimentally determined as obviously higher than jute fiber. Due to the high strength of luffa fibers should be preferred especially in applications that would be subjected to bending loads. Because of their design and strength characteristics of these green materials, it is envisaged that these materials could be an alternative for potential uses in aerospace, automotive and marine industries. We continue to work on the development of the mechanical properties of this kind of plant-based fibers in order to find a new alternative to glass fibers.

Keywords
luffa fiber, jute fiber, bio-composite, bending, flexural strength.

1. Introduction

In recent years, human beings have realized that if the environment is not protected, there will be a danger of the depletion of natural resources and the majority of areas producing fresh air. Chemical composites, which are widely used in many industrial fields, cause serious damage to nature due to the long years of recycling.

Therefore, the widespread use of recyclable bio-composite materials in the industrial field will be an important step for preventing damage to nature. In order to reduce the use of chemical fibers, researches on ecological fibers are carried out. In order to increase the application of environmentally friendly materials, not only new materials should be found, but also all characteristics of these materials must be defined and developed. That is why bio-composite materials have become the focus of many researchers in composite science in recent years.

Some researchers (Acharya, Mishra, Mehar, andDikshit, 2008; Balakrishnan, John, Pothen, Sreekala, andThomas, 2016; Caprino, Lopresto, andSantoro, 2007; Diharjo et al., 2013) draw the attention to the importance of this topic beginning with the question that Natural fibres: can they replace glass in fibre reinforced plastics? (Wambua and Verpoest, 2003).. For instance, Bodros and Baley (2008) and at all, use natural fibers reinforced thermoplastics, especially in the automotive industry. They set their major objectives as determining whether bio-composites would substitute for glass fiber reinforced polymer constructions analyzing the mechanic features of natural fiber and biopolymer composites.

Major bio-materials such as flax, jute, kenaf, and sisal analyzed in many studies. Although these materials have obstacles such as cultivation and continuity, their developed features gain great importance. Kocak and et al. (2008) according to the results of their study suggested that mechanic features of luffa fibers could be increased with the help of a chemical modification made using formic and acetic acid. The performance of natural fibers is attached to cellulose content. Luffa fibers, 63 percent of cellulose, 14.4 percent of hemicellulose, 1.6 percent of lignin, 0.9 percent of cinder and 20.1 percent of other materials. (Shen and et al. (2012) Besides, many studies Genc, 2015; Genc and Koruk, 2017; H. Koruk and Genc, 2015; Hasan Koruk and Genc, 2019) focused on the characterizations of plant-based fibers such as luffa fiber in the literature to understand the ability of application which can lessen the usage of chemical fibers.

In this research, producing bio-composites and comparing mechanic features are aimed using two types of herb-based fibers. In this context, luffa fibers grown on the South region of Turkey and jute fibers that imported from Bangladesh were used as reinforcement elements of natural fibers.

As a consequence, in consideration of obtained results from this research, the usage of recyclable bio-composite materials is going to be enlarged, and it is going to contribute to both industry and literature. At this point, it should be emphasized again that it is going to be used the same matrix (epoxy) while producing reinforcement elements (jute and luffa fiber) in order to compare them properly.

According to the results obtained in this study, some usage areas have been proposed for bio-composite materials. By, it is aimed in this study that to produce and develop a product which is both easy to produce in our country with its potentials and possible to recycle.

2. Materials and Methods

In this research, luffa fibers and jute have been used as reinforcement elements. The raw Jute that used was woven with 0 °/90 ° fiber arrangement. It is imperative to use the same matrix when comparing the properties of natural fibers with chemical fibers. Therefore, epoxy resin (DURATEK 1200) was used as a matrix to produce the composite samples.

To produce Luffa Fiber Reinforced Composite (LFRC) prepared 4 layers dry luffa fiber and to produce Jute Fiber Reinforced Composite (JFRC) prepared 10 layers dry jute fiber. These materials weighed using a scale, and their dry weight measured. Then, these fiber layers moulded by hand lay-up method and epoxy matrix added for curing step. To able to prepare curing conditions press machines that controlled by PLC (Programmable Logic Controller) used and the curing conditions set to 5 Bar and 120 ° C degree during 100 minutes.

Produced bio-composite specimens shown in Figure 1 were cut using the CNC Router according to the standard (ISO14125, 1999).

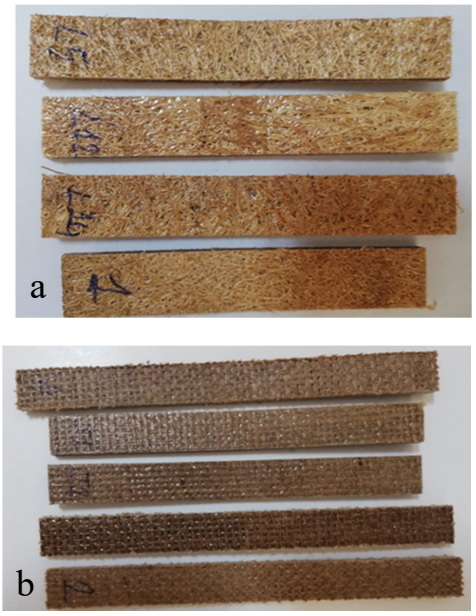

Figure 1. Composite samples for three-point bending test a) luffa composite samples b) jute composite samples

LFRC specimens were cut in two directions, Longitudinal (L) and Transverse (T) direction. Herewith, the flexural properties were determined in two directions. Also, JFRC specimens were cut in the fiber directions.The dimensions and volume fraction values of bio-Composite samples for three-point bending test are given in Table 1 which prepared according to the standard (ISO14125, 1999). The properties of the bio-composite material samples are shown in Table 1. The density of dry luffa fiber, jute fiber and epoxy resin used was 71.1 kg/m^3, 389.5 kg/m^3, 1100 kg/m^3, respectively. These values used to calculate the volume fraction of composite by the rules-of-mixtures method.

Table 1. The dimensions and volume fraction values of samples

Materials	Code	Dimensions			Weigh	Volume
		b	L	T	W	
LFRC	T1	15.0	80.0	4.0	3.4	0.6
LFRC	T2	15.0	81.0	4.0	3.2	0.7
LFRC	T3	15.0	81.0	4.0	3.4	0.6
LFRC	T4	15.0	81.0	4.0	3.4	0.6
LFRC	L1	15.0	80.0	4.0	3.6	0.6
LFRC	L2	15.0	80.0	4.0	3.6	0.6
LFRC	L3	15.0	80.5	4.0	3.6	0.6
LFRC	L4	15.0	80.0	4.0	3.6	0.6
JFRC	J1	15.0	126.0	4.2	8.6	0.6
JFRC	J2	15.0	126.0	4.2	8.8	0.6
JFRC	J3	15.0	126.0	4.0	8.8	0.6
JFRC	J4	15.0	126.0	4.3	8.6	0.6

3. Three-Point Bending Test

Three-point bending tests were performed to determine the mechanical properties of bio-composite specimens as shown in figure 2.

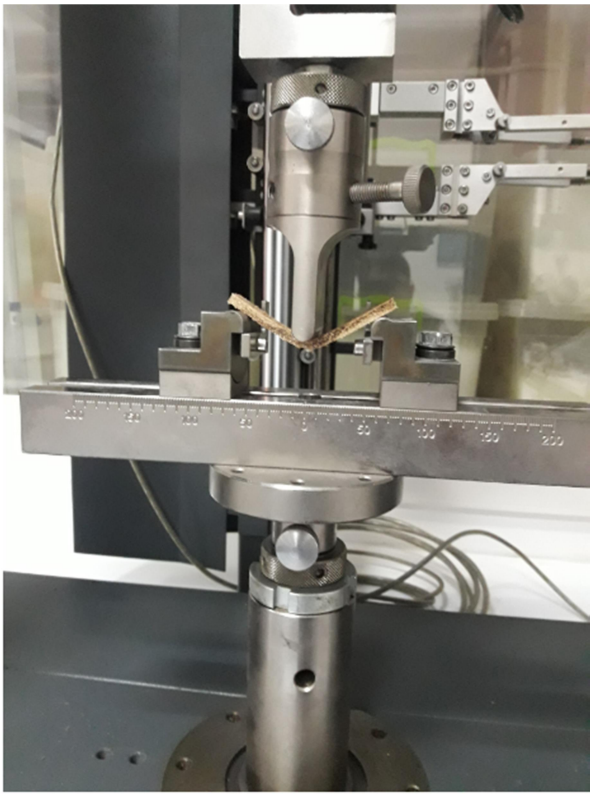

Figure 2. Bending test for bio-composite specimens

Three-point bending test performed according to the standard (ISO14125, 1999). Then, measured values used to calculate the flexural strength of the specimens using equation 1.

$$\boldsymbol{\sigma = \frac{3FL}{2bt^2}} \qquad \text{Eq.1}$$

F is the maximum load (N), the distance between the L supports is (mm), b is the width (mm), and t (mm) is the thickness.

The Flexural Modulus was used to evaluate the stresses obtained. The Flexural Modulus was calculated using equation 2.

$$\boldsymbol{E = \frac{L^3}{4bh^3}\left(\frac{\Delta F}{\Delta s}\right)} \qquad \text{Eq.2}$$

4. Results and Analysis

Flexural Strength and Flexural Modulus

In this part of the study, the elastic modulus was calculated to evaluate the bending strength of the samples and the samples. Bending strength was calculated for LFRC and JFRC samples.

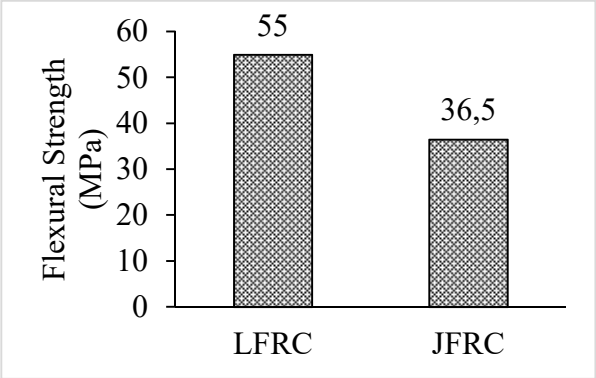

Figure 3. Flexural strength for LFRC and JFRC bio-composite specimens

Flexural strength for LFRC and JFRC were calculated according to the standard as shown in Figure 3.

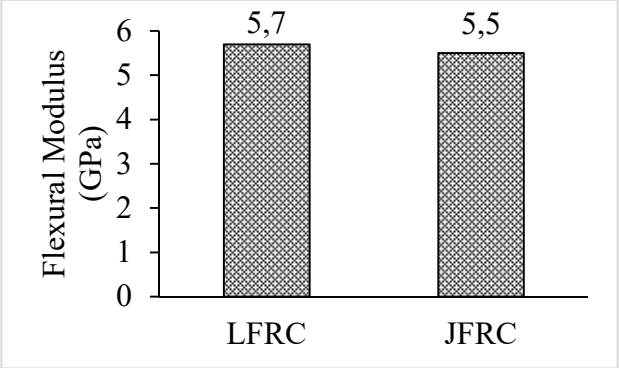

Figure 4. Flexural modulus for LFRC and JFRC bio-composite specimens

Besides, flexural modulus for LFRC and JFRC were calculated according to the standard as shown in figure 4.

5. Conclusion

According to the test results, the Flexural Strength of LFRC was determined higher than JFRC. Due to the high strength of LFRC, especially in applications that are subject to bending loading, these type bio-composites could be preferred. Because of their design and strength characteristics of these green materials, it is suggested that this kind of bio-composite materials can be alternative materials, especially for automotive and aerospace industries usage areas. We continue to work on the development of the mechanical properties of this kind of green fibers in order to find a new alternative to glass fibers.

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Araştırma Makalesi / Research Article

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A Historical Building Functioned As A Museum; Bursa Umurbey Bath

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Anahtar kelimeler
"Bath", "Turkish Bath", "Bursa", "Historical", "Restoration", "Renovation"maksimum 6 tane, 9 punto ve ortalanmış olmalıdır. Anahtar kelimelerin ilk harfleri büyük olmalı ve ";" ile ayrılmalıdır.

Abstract

The Umurbey Turkish Bath, located in the present Sericulture district, one of the most important Silk production centers of Bursa in the past, was built in 1430. It is important because the bath reflects its architectural characteristics. The Turkish Baths are divided into two groups: "Single Baths" where men and women benefit separately, or "Double Baths", where separate hammams adjacent to each other for men and women are constructed together. The Umurbey Hammam is the "Single" Hammam. The change seen in the societies changes the needs of the people as well as changing the structures because of the places that are shaped by the time they belong. Structures that can't carry their function from past to today are provided with a secondary function to continue their lives. The Umurbey Bath was given a function as a museum. In this study, the daily change of the Umurbey Baths from the past, survey drawings, survey reports, restoration projects, restoration reports and photographs before and after the restoration were included.

1. Introduction

Historic buildings often contribute to the character of the city landscape. They create the urban spaces that are enjoyed by residents and attract tourist visitors. It creates urban spaces that residents enjoy and attracts tourists. By law, it is not only limited to the preservation of visual appearance but can also be protected with respect to materials and construction techniques to be integrated into original architectures. (Cabeza, de Gracia, and Pisello 2018)

In general, most of the historical buildings were found to be in a state of collapse and deterioration. The physical quality of the building is gradually decreasing and does not proper its intended use. Renovation is becoming one of the most important sectors to ensure that the building is suitable for its intended use. (Aksah et al. 2016) The purpose of all disciplines related to heritage and historical structures is to protect their content, to examine the processes of decay and damage (chemical, physical, biological, mechanical, etc.) and to develop strategies to investigate and reduce or reduce their relative causes. (Fabbri and Pretelli 2014) Due to environmental conditions and the natural consequence of user errors, restoration applications have become necessary in order to ensure the sustainability of structural and non-structural elements in historical buildings. (Bozkurt et al. 2016) One of the most important intervention decisions in restorations in historic buildings is the consolidation of the structure. Article 10 of the Venice section of 1964 "Where traditional techniques prove inadequate, the consolidation of a monument can be achieved by the use of any modern technique for conservation and construction, the efficacy of which has been shown by scientific data and proved by experience". (Congress and Monuments 2011) The process should be well evaluated to ensure that the

building to be renovated meets the requirements and performance standard of the user. (Aksah et al. 2016) The complexity of construction regulations for renovation projects is one of the important factors affecting design performance. (Ali and Zakaria 2012) The refurbishment of historical buildings varies according to the countries, policies, and laws. (Kamaruzzaman et al. 2018) Approximately 50% of Turkey's housing stock consists of masonry buildings. (Sadık Durak 2008)

Umurbey bath's rooms are designed as square spaces in different sizes on the plan, creating rooms of coldness, warmth, hot and halvet rooms. Apart from these, there are sections of heating furnace and hell in every hammam which is heated. The biggest volume in Turkish baths is coldness part. (Önge n.d.)

Umurbey hammam has only one entrance gate. The hammam is entered from the street with marble steps. The hammam was damaged in the fire in 1518 and repaired in 1556 and damaged again in the 1854 earthquake. Section and plan drawings of Turkish bath are given in Figure 1.

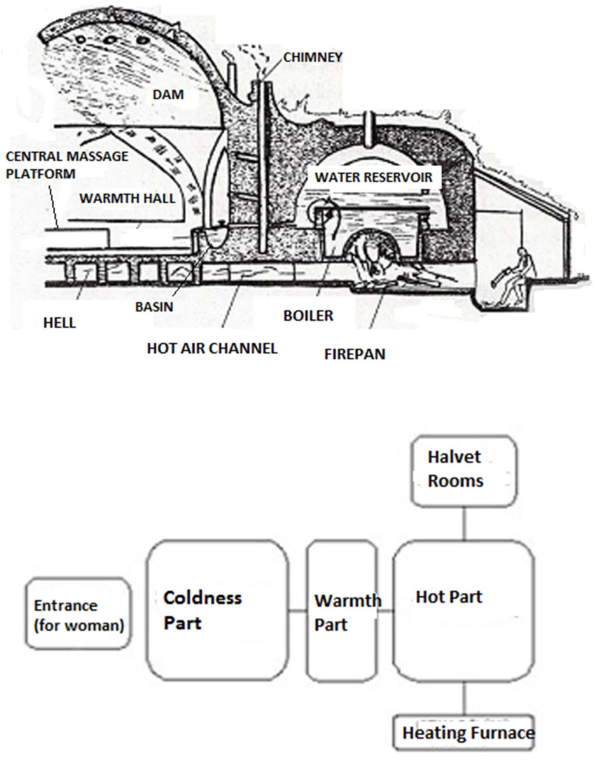


Fig. 1 Turkish bath cross-section and plan (Özbek n.d.)

2. Materials and Methods

2.1 Exterior of the hammam

The first construction technique is two or three rows of bricks, sometimes one or two rows of cut stones, and a vertical brick between them. The exterior walls of the hall of halvet are rubble stone walls. After that, most of these walls were renovated with cement mortar. Most of the exterior walls of the hammam were ruined because of the fire and earthquakes that occurred. In addition, a part of the rear wall was demolished and rebuilt in a recent period of the hammam. Lighting on the top of the dome there is no residue from the glass mounted on the metal parts. In addition, the boiler chimney was destroyed.

The window gaps in the front of the hammam were enlarged horizontally and vertically, and they were also changed. A water reservoir was added to the back of the hammam. The tops of the halvet rooms were covered with a roof with an octagonal plan but after that these shapes were deformed by renovation work. The parts where the lighting lanterns are located have been renovated with cement mortar. Most of the roof tiles are broken and lost. In addition, many plants are growing, with great wear on the roof. The bottom elevation levels of the windows on the northern side were lowered, the 90-degree angle of the side walls of the window is degraded. The original iron railings of the windows were rusted.

2.2 Interior of the hammam

The inside walls of the hammam were painted on top without scraping. It has been determined that there are eight layers of paint. Due to the dampness, most of the paint and the plaster on the wall have been damaged. Plants are grown in some cracks on the interior walls. All of the windows on the lanterns are broken. None of the doors in the hammams are available, but their location is determined. Hinge locations are visible. But the metal hinges are rusted and this rust also penetrated in the wall.

2.3 Coldness part

The coldness part of 10.75 X 11.00 m² which is the widest part of Umurbey Hammam is entered from the northeast. It is covered with a large dome over the coldness section. Transitions from the walls to the dome were made with squinch elements. The two windows on the eastern edge of the coldness part were laid up the brick. There isn't part of the fountain located in the middle of the coldness part. It was later found that a rectangular window was made on the western façade. There's no belt on this window. Most of the woodwork of the windows are deteriorated and broken.

2.4 Warmth part

The warmth area is close to the square plan with dimensions of 3.82 X 3.37 m². The dome is placed on the walls of the square plan. There are three doors opening to the warmth part; temperature, coldness and WC doors.

2.5. Hot part

The hot part is the rectangular plan in dimensions of 8.30 x 3.60m^2. There is a square plan height in the middle of the hot part. An octagonal tie beam was formed on the square plan to provide the dome connection. There are almonds shaped ornaments on the octagonal tie beam. There was a central message platform in the middle of the hot section. Today, there isn't this platform. There are iwans on the side and lancet arch vault was built on top of them. In the hot part, the seating steps were made. These steps are marble. The middle part of the hot section was collapsed. From the hot part, there are three doors open to the halvet rooms.

2.6 Halvet rooms

A dome was built on top of the square frame on the walls of the halvet rooms. It becomes a circular pulley which with an almond shaped ornamental on the square plan walls of the Halvet. There is a dome on this pulley. Most of the marble covering the walls of the halvet rooms has been torn down. The floor, which is raised 4 cm in the middle of all rooms, descends in a sloping manner to the edges, thus preventing accumulation of water in the middle.

2.7 Water reservoir

The top of the water reservoir is covered with a vault. Under the water reservoir there is a furnace (heating section) which is entered from the outside.

2.8 Materials

Masonry structures; composed of brittle materials such as stones and bricks that have little under tensile and compressive stresses due to their construction techniques. (Korkmaz et al. 2018). The mechanical properties of the materials used in historical buildings are given in Table 1 and 2. The poisson's ratio for masonry structures was accepted as 0.17 by Kocak (Ali Koçak 1999).

Table 1. Mechanical properties of materials (Ömer Dabanlı 2008) (Navzat Sallio 2005)

Sample	Compressive strength (MPa)	Tensile strength (MPa)	Elasticity modulus (E_m)	Density (kg/m^3)
Stone	18-35	2.0-6.0	12000-18000	0.25-0.30
Brick	17-25	0.2-0.5	2000-5000	0.20-0.50

Table 2. Mechanical properties of structural elements (Elyamani et al. 2017)

Yapısal elemanlar	Elasticity modulus (E_m)	Density (kg/m^3)	Poisson rate
Walls and domes	3816	2100	0,2
Buttress	3600	2100	0,2
Mortars	1908	2000	0,2

2.9 Pre-Restoration images

The pictures of east and west facades were given in Figure 1 before restoration.

Fig. 2 West and south façades

2.10 Restitution and surveying drawings

The ground floor survey drawing of the building is given in Figure 3. A-A cross section survey drawing of the building is given in Figure 4. East and north façade restitution and surveying drawings are given in Figure 5.

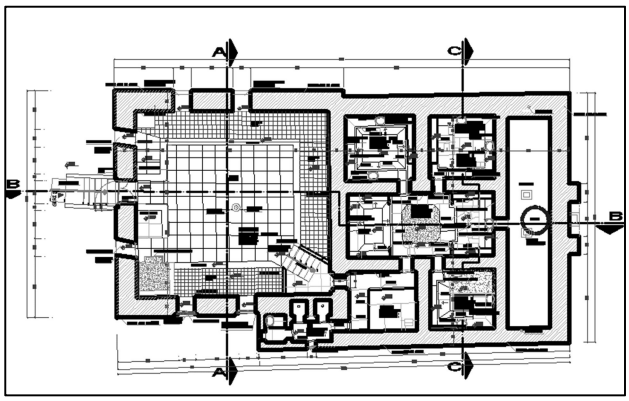


Fig. 3 Floor surveying drawings

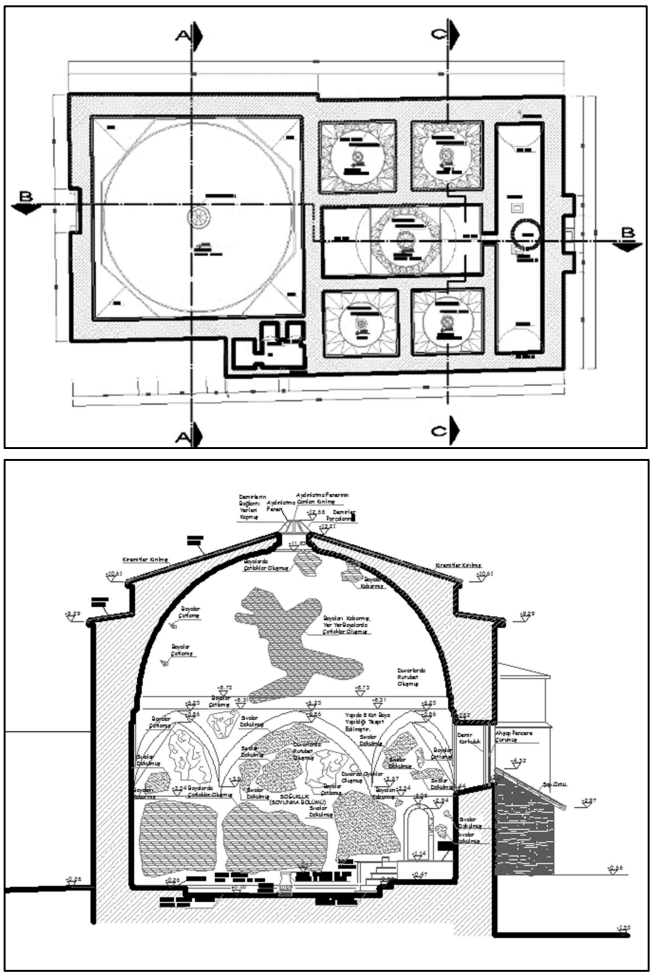


Fig. 4 Ceiling surveying drawings and A-A cross section

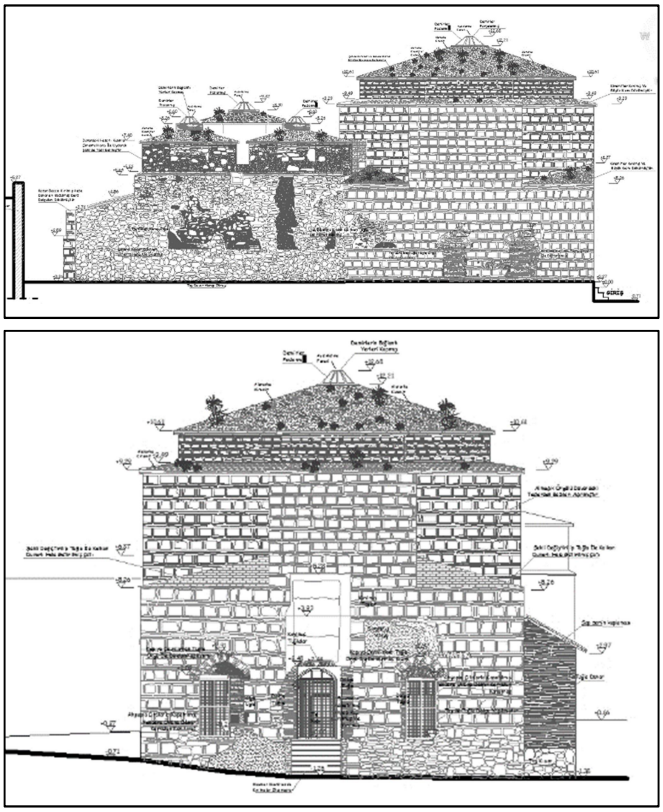


Fig. 5 East and north façade restitution and surveying drawings

3. Result And Discussion

Umur Bey Hammam is one of the most distinguished examples of architecture at that time. It is thought that the shape of the hammam shouldn't be deteriorated and it will be passed on to future generations as it is. It is thought that a new function should be given with minimum change of the hammam. Also, the different part should be built next to the hammam to make it function as a foyer.

3.1 Interventions made

The foyer building was built as a reinforced concrete and discrete arrangement on the east side of the hammam. The columns of the foyer building to be built have been designed so as not to damage the hammam. The foyer building is equipped with kitchen, relaxation room, male, female and disabled WC. The floor of the foyer part is covered with hexagonal brick. In addition, the roof of this additional building is kept lower and the terrace is germinated and adapted to the surroundings. Floors of wet areas will be covered with ceramic.

The exterior of the hammam; the worn out pieces of cut stone, rubble stone and blend bricks were replaced with new ones and a joint mortar was made between them. In addition, the interior walls of the hammam were scraped to reveal the masonry system and a joint mortar was made between them.

The main entrance door of the hammam was repaired. The damaged arched windows have been restored. The arch above the entrance door of the bath was unearthed. Additional steps that were added to the coldness part have been removed. The windows that were closed with bricks were opened. In order to establish a connection between the foyer and the hammam, the window in the coldness part was converted into the door. The difference in elevation between the foyer and the hammam was solved by the ramp.

The fountain in the coldness part was repaired and the missing parts were completed. The missing marble basins have been completed. The missing mirrors were made in accordance with the original, and the broken ones were repaired. Most of the marbles found at the site of all the rooms have been restored. In the region that has collapsed in the middle of the hot part; it is covered with marble, sloping to the sides to prevent water from accumulating in the middle. The doors that were not in place, were not made again because no information about their original state could be reached.

The metal parts of the lights above all the spaces are renewed and completely covered with glass to protect from external influences. The inside of the boiler was cleaned and the chimney was repaired. The top of the water reservoir is covered with khorasan (brick dust mortar) bricks as it was before. The roof coverings were removed and the insulation was applied to the roof's bottom and then covered with roof tiles. Landscaping of the garden was done.

3.2. Restoration projects

The restoration project of the ground floor is given in Figure 6. The restoration project of the eastern and western facades is given in Figure 7.

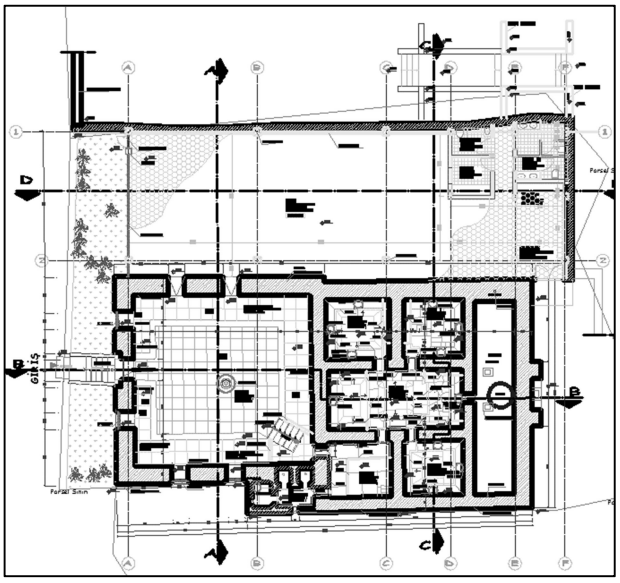
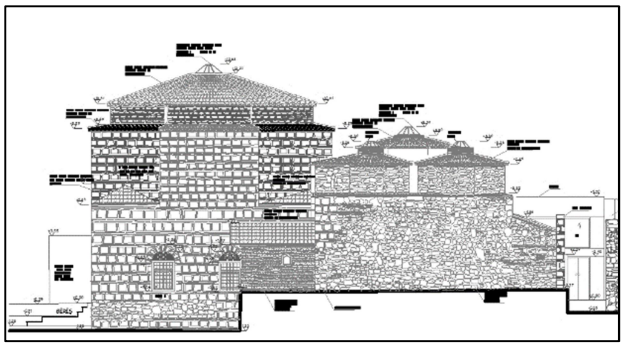


Fig. 6 Floor Plan



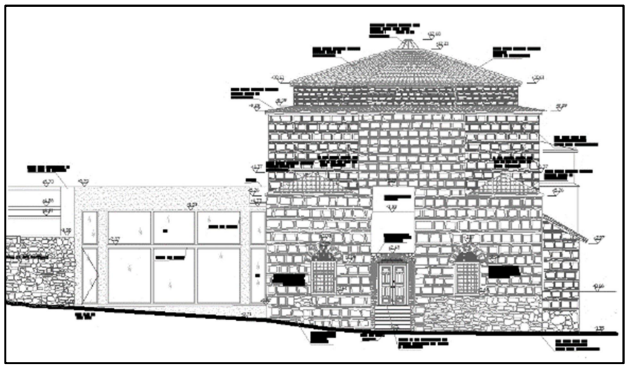


Fig. 7 West and North Façade and Foyer Building

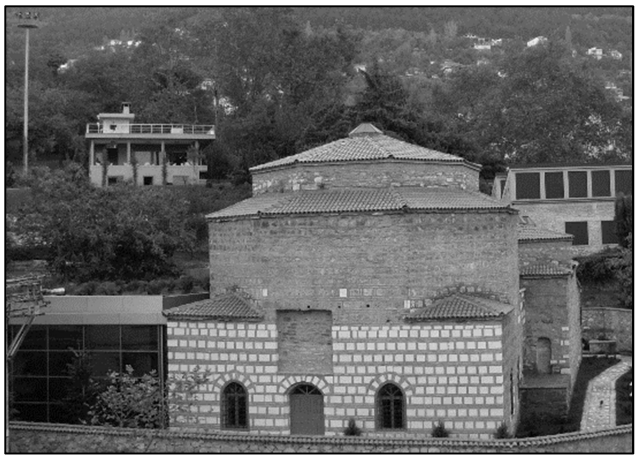
3.3. Images during restoration

The pictures of the restoration phase are given in Figure 8.

Fig. 8 Repairing of jointing

3.4. Post Restoration Images

The post-restoration images are given in Figure 8.



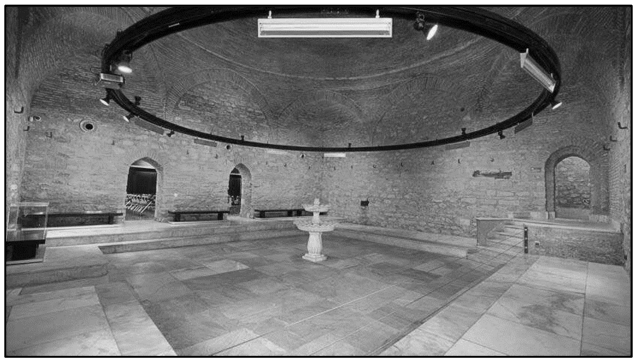


Fig. 9 Interior and exterior ımages of hammam (Sevcan Türe n.d.)

Fig. 10 Environmental landscape images of hammam (Sevcan Türe n.d.)

Conclusion

As a result of these restoration works, this structure, which was used as a hammam in advance, now has become a museum. Various works and collections are exhibited. At the same time, other historical buildings beside the hammam located in a complex were restored by Koç Holding and functioned as Tofaş car museum. These historical buildings, which are located in large and well-kept gardens, are transformed into a complex and these buildings have been benefited by society and transferred to the future with confidence.

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Elektrik Potansiyeli ve Sıcaklığın Ohmik Isıtma ve Sıcak Suya Daldırma Esnasında Makarnaların Rehidrasyon Davranışları Üzerine Etkisi

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Anahtar kelimeler
Ohmik ısıtma; Makarna; Rehidrasyon; Difüzyon; Peleg; Weibull

Öz

Söz konusu çalışma kapsamında, farklı elektrik potansiyelleri altında (10, 20, 30 ve 40 V/cm) ohmik ısıtma ve farklı sıcaklıklarda (75, 85 ve 95°C) suya daldırma işlemi esnasında makarna örneklerinin rehidrasyon özellikleri incelenmiştir. Makarnaların rehidrasyon davranışlarını ifade etmek için Fick'in ikinci difüzyon kanunu kullanılarak, normal daldırma denemeleri için iki ve ohmik ısıtma denemeleri için üç farklı efektif difüzyon katsayısı hesaplanmıştır. Uygulanan farklı voltaj ve sıcaklıkların difüzyon katsayıları üzerine etkisi ise Arrhenius tipi bir eşitlikte değerlendirilmiştir. Ayrıca, gıdaların rehidrasyon özelliklerinin tanımlanmasında yaygın olarak tercih edilen iki model, Peleg ve Weibull, rehidrasyon denemelerinin kinetik analizi amacıyla kullanılmıştır. Elde edilen veriler neticesinde, hem daldırma suyu sıcaklığının hem de ohmik ısıtma esnasında uygulanan voltajın artırılması, makarna örneklerinin su emilimini hızlandırıcı etki göstermiştir. Hem Peleg hem de Weibull modelleri, normal daldırma denemeleri için üst düzey bir performans ortaya koymuştur. Ancak bunlardan sadece Weibull, ohmik ısıtma esnasında gözlenen nem değişimini kabul edilebilir seviyede ifade edebilmiştir. Normal daldırma denemelerinden farklı olarak, ohmik ısıtma işleminin ilk safhalarında nem emiliminde bir gecikme dikkati çekmiştir. Ancak genel olarak ohmik ısıtmanın makarnaların nem absorpsiyonu üzerine hızlandırıcı bir etkiye sahip olduğu ifade edilebilir.

Effects of Electrical Potential and Temperature on Rehydration Behaviour of Pasta Samples during Ohmic Heating and Soaking

Keywords
Ohmic heating; Pasta; Rehydration; Diffusion; Peleg; Weibull

Abstract

In the present study, rehydration of pasta samples was examined during soaking at different temperatures (75, 85 and 95°C) and during ohmic heating at different electrical potential levels (10, 20, 30 and 40 V/cm) as an alternative method of pasta cooking. Two effective diffusion coefficients were defined using Fick's second law of diffusion for regular soaking experiments and three diffusion coefficients were calculated to describe the rehydration behaviour during ohmic heating. The effect of applied voltage and temperature on the diffusion coefficients were evaluated using an Arrhenius type equation. Moreover, the two common models that are used to describe rehydration behaviour of food materials, namely Peleg and Weibull models, were used for kinetic analysis of rehydration experiments. It was observed that an increment both in temperature of cooking water and applied voltage for ohmic heating enhanced the water absorption rate of pasta samples then the rehydration was completed faster. The Peleg and Weibull models showed promising performance for regular soaking experiments where the first one could not describe moisture change of pasta during ohmic heating at a desired level. Different from soaking testes, a delayed moisture uptake phase was observed at the very beginning of ohmic heating experiments however it can be concluded that ohmic heating led an increment in moisture uptake rate in general.

1. Introduction

Pasta is a well-known food product that is produced by drying the dough obtained from mainly semolina (from *Triticum durum* wheat) and some other ingredients such as egg, water, spinach etc. (Manthey & Schorno, 2002). There are some reasons that may be listed explaining why it is so popular around the world, e.g. economic reasons, favourable taste, ease of preparation and also, wide options of preparing/consuming in many different ways (Kim, Petrie, Motoi, Morgenstern, Sutton, Mishra, et al., 2008). Moreover, due to its low moisture content, pasta can easily be stored for a long time at room conditions (Doster & Kahn, 1986). From the point of health, it has a lower glycemic index than many other carbohydrate based foods (Cubadda, Carcea, Marconi, & Trivisonno, 2007).

Pasta is traditionally cooked in boiling water until a desired degree of starch gelatinization and rehydration is achieved. While rehydration occurs very fast at first, the moisture concentration of pasta increases, water absorption rate of starch molecules decreases and then moisture uptake gradually slow down as time progresses (Cafieri, Mastromatteo, Chillo, & Del Nobile, 2010). Although the traditional cooking method is pretty simple to operate, possible problems/disadvantages are generally arise or experienced especially after long cooking times such as excessive cooking, dry matter loss or excessive energy consumption (Cocci, Sacchetti, Vallicelli, Angioloni, & Dalla Rosa, 2008). Apart from the time that is spent to cook pasta, in traditional method, a notable amount of time is also required before cooking to heat the cooking water to boiling temperature. As easily be conduct, one should heat the cooking pot first, then water and finally pasta pieces present in water for traditional cooking technique. Thus, these successive heat transfer between different mediums increase the time normally needed to cook pasta like products (Kanjanapongkul, 2017).

One possible and promising alternative that can be used instead of traditional method to expedite pasta cooking is ohmic heating. Ohmic heating can briefly be defined as the method where the food material behaves as a resistance itself against the electric current, and as a result the electrical energy is converted to heat in the cooking domain and the temperature is increased (İçier, 2005; Varghese, Pandey, Radhakrishna, & Bawa, 2014). Ohmic heating was invented in 1987 and it has been used for different purposes such as pasteurization, sterilization, blanching, fermentation, extraction to save times and energy substantially until today (Knirsch, Dos Santos, de Oliveira Soares, & Penna, 2010). Due to uniform and volumetric heating behaviour, ohmic heating ensures homogenous temperature distribution through the food, but it depends on the electrical property of the cooking medium. The efficiency of ohmic heating is determined with electrical conductivity of the food, applied voltage and time applied (Mercali, Schwartz, Marczak, Tessaro, & Sastry, 2014). Ohmic heating has been previously studied for cooking different food materials such as rice (Jittanit, Khuenpet, Kaewsri, Dumrongpongpaiboon, Hayamin, & Jantarangsri, 2017; Kanjanapongkul, 2017), chickpea (Loypimai, Moonggarm, & Chottanom, 2009), artichoke (Guida, Ferrari, Pataro, Chambery, Di Maro, & Parente, 2013), quince (İçier, Yıldız, Eroğlu, Sabancı, & Eroğlu, 2013), cauliflower (Eliot, Goullieux, & Pain, 1999). It was previously stated that ohmic heating can accelerate moisture diffusion to starchy foods due to increased porosity as a result of the impact of electrical field (electroporation) (Cocci, Sacchetti, Vallicelli, Angioloni, & Dalla Rosa, 2008; Jittanit, Khuenpet, Kaewsri, Dumrongpongpaiboon, Hayamin, & Jantarangsri, 2017).

Mathematical models are very important in the optimization of processes such as rehydration. With the help of mathematical models, the most suitable conditions can be determined for

rehydration of a food, and one can figure out how the rehydration will be affected by process variables and how long the rehydration will take place under certain conditions (Sanjuán, Simal, Bon, & Mulet, 1999). The Peleg and Weibull models are widely used in the modelling of rehydration process (Demiray & Tülek, 2016) and they were previously used to describe the hydration of various food stuffs. For example Cocci, Sacchetti, Vallicelli, Angioloni, and Dalla Rosa (2008) used Peleg and Weibull models to predict water absorption of pasta while Dıaz, Martınez-Monzo, Fito, and Chiralt (2003) also used these two models to predict rehydration behaviour of orange slices. With Peleg's equation rehydration kinetics of firik, dovme and wheat (Maskan, 2002), amaranth grain (Resio, Aguerre, & Suarez, 2006), broccoli stem slabs (Sanjuán, Simal, Bon, & Mulet, 1999), red kidney beans (Abu-Ghannam & McKenna, 1997) were predicted adequately. However, any study investigating the water uptake behaviours of pasta during ohmic heating on pasta cooking and the performance of mentioned models on it could not found in the available literature.

Thus, the aim of this study is to (1) investigate the effect of applied voltage and time on the rehydration characteristics of pasta samples, (2) compare the rehydration characteristics of pasta samples during ohmic heating and soaking, and (3) describe and evaluate the moisture change of pasta cooking process with Peleg and Weibull equations and asses their efficiency.

2. Materials and Methods

2.1. Materials

Pasta samples (bow-tie pasta), purchased from a local market in Isparta, Turkey and they were kept under appropriate conditions at room temperature in a gas/moisture resistant plastic bags until the experiments. In order to reflect the industrial or home usage conditions, pasta samples were cooked using tap water (for further details about cooking experiments please see section 3.2). But it was thought that ionic strength of the tap water is possibly change depending on time and this may affect the results. Thus, the enough amount of water that was required for all cooking experiments were obtained at the same time as a batch. All the replicates were conducted within three days to ensure the results were not affected from any possible microbiological growth in the water.

2.2. Methods

Cooking: The pasta:water ratio (w/v) use in the experiments was 1:10 as recommended by (Alamprese, Casiraghi, & Rossi, 2011) both for ohmic heating and soaking. In order to shorten the cooking time and ensure the energy efficiency as aimed in ohmic heating process, required amount of pasta and water at room temperature were added in the ohmic cell at the same time for the ohmic heating experiments and four different voltage gradients (10, 20, 30 and V/cm) were applied. The soaking experiments were conducted using an electric heater in a cooking pot. However, in order to reflect the traditional cooking habit, the pasta samples were added into water after target temperature has reached. During cooking experiments, pasta samples were taken, drained and excess water over them were slightly removed using a tissue paper and weighed periodically. The weight change of the samples was monitored with the help of precision scale with a precision of 1/1000 g. All of the cooking experiments were carried out during the time where any noticeable change of the last four weight was not observed. A graphical summary of the study is presented in Fig. 1.

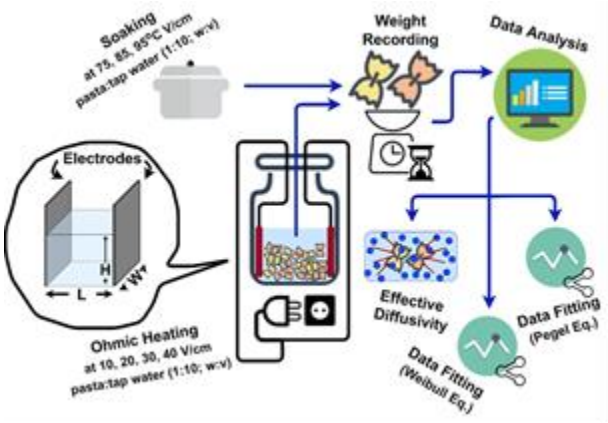

Figure 1. Graphical summary of the study

Effective water diffusivity and activation energy: Effective moisture diffusivity was determined to conduct an idea about moisture transfer mechanism and effect of different cooking procedures. Pasta pieces were assumed to be an infinite slab, since other directions were large enough compared to the thickness. The effective moisture diffusivity was defined by Fick's second law with the assumption of the diffusion is the only mechanism controlling the absorption of water molecules by the pasta samples and following the solution by Crank (1975). Irrespective of temperature, rehydration graphs (see Figs. 2 and 3) considered two straight lines for regular soaking and three straight lines for ohmic heating experiments. These lines were describing the number of stages characterising rehydration behaviour and one diffusion coefficient was calculated for every stages assuming that the diffusivity coefficients were to be constant during every step individually, initial moisture distribution was uniform, and equilibrium moisture and dry mater loss from pasta samples were negligible.

$$MR = \frac{M - M_e}{M_i - M_e} = \frac{8}{\pi^2}\sum_{n=1}^{\infty}\left[\frac{1}{(2n-1)^2} exp\left(-D\frac{(2n-1)^2\pi^2}{\delta^2}t\right)\right] \quad (1)$$

where *MR* is moisture ratio, *M* is a moisture content of the product at a time (kg/kg dry matter), M_e is equilibrium moisture content of the product (kg/kg dry matter), M_i is initial moisture content (kg/kg dry matter), δ is total thickness of the slab shaped product (m), *D* is diffusion coefficient of water inside the product (m^2/min) and *t* is time (min). For long-term cooking, only the first term of the (Eq. 1) was used to explain the rehydration process (n = 1). The M_e was accepted as the final moisture content at the end of the cooking experiments. With some simplifications, Eq. 2 were obtained, and effective diffusivity was calculated by fitting Eq. 2 to the curve of *ln(MR)* vs. time.

$$ln[MR] = ln\left(\frac{8}{\pi^2}\right) - D.t.\frac{\pi^2}{L^2} \quad (2)$$

The diffusion coefficient of water can be correlated either with temperature (see Eq. 3) or applied electrical potential (see Eq. 4) using the Arrhenius equation (Sanjuán, Simal, Bon, & Mulet, 1999):

$$D = D_0 e^{-E_a/RT} \quad (3)$$

$$D = D_0 e^{-E_a/FV} \quad (4)$$

where E_a is the activation energy (kJ/mole); *R* is the universal gas constant (8.314 kJ/(mole K)) for soaking experiments and *F* is Faraday constant (96.49 kJ/(mole V)), for ohmic heating experiments in order to endure the unit uniformity of E_a; *T* is the absolute temperature (K) where *V* describes applied voltage during ohmic heating (V) and D_0 is the pre-exponential Arrhenius factor (m^2/min).

Rehydration kinetics and model assessment: To analyse the rehydration kinetics of pasta samples during different ways of cooking as defined previously, two common models in the literature, i.e. Peleg and Weibull, were selected (Singh & Erdogdu, 2009), and moisture curves obtained from pasta samples were fitted these equations. These models were previously used to describe moisture uptake of pasta by Cunningham, McMinn, Magee, and Richardson (2007). Firstly, Peleg equation (Eq. 5) was used to fit rehydration data (Peleg, 1988).

$$M_t = M_i + \frac{t}{(k_1 + k_2 t)} \quad (5)$$

where k_1 is the Peleg rate constant (min $\%^{-1}$), k_2 is the Peleg capacity constant ($\%^{-1}$), M_i is the initial moisture content (kg/kg dry solid) and that was 0.1299, M_t is the moisture content (kg/kg dry solid) at time *t* (min).

The second mathematical model that was used to express rehydration behaviour of pasta samples was probabilistic Weibull model as described in (Eq. 6) (Machado, Oliveira, & Cunha, 1999):

$$M_t = M_i + (M_e - M_i)\left[1 - \exp\left[-\left(\frac{t}{\beta}\right)^{\alpha}\right]\right] \quad (6)$$

where α is the shape parameter (dimensionless), β is the rate parameter (min), M_i is the initial moisture content (kg/kg dry solid), M_e is the equilibrium moisture content (kg/kg dry solid), M_t is the moisture content (kg/kg dry solid) at time t (min).

The parameters of the proposed models were obtained be non-linear regression using SigmaPlot 12.0 (Chicago, IL). In order to evaluate the goodness of fit of the models, the determination coefficient (R^2), the adjusted determination coefficient (R^2_{adj}) and the standard error of the estimate (*SEE*) values were used (see Eq. 7).

$$SEE = \sqrt{\frac{\sum(y - y')^2}{n}} \qquad (7)$$

where y and y' were actual and predicted data, respectively; and n was the number of pairs of scores.

3. Results and Discussion

3.1. Water absorption

The rehydration curves of pasta samples rehydrated at various temperatures (75, 85 and 95°C) and voltage gradients (10, 20, 30 and 40 V/cm) respectively during soaking and ohmic heating were presented in Figs. 2 and 3. For regular soaking experiments (see Fig. 2), water absorption was initially rapid then slowed down as the moisture content increased. That is why rehydration process may be divided into two stages, namely initial period and final stage of rehydration (Cunningham, McMinn, Magee, & Richardson, 2007). Water absorption rate, and hence soaking time, were effected from water temperature where almost the same moisture content was achieved nearly in 100, 60 and 35 mins, respectively at 75, 85 and 95°C. During these soaking times, moisture content of pasta gradually increased however did not reach equilibrium as previously reported by Hasegawa and Adachi (2014). It was relatively in a small rate but water uptake of pasta samples was ongoing when experiments were ended.

During ohmic heating, somewhat different rehydration behaviour was observed (see Fig. 3). Because one more rehydration step, defined as "delayed rehydration stage", can be described other than two previously specified stages. In ohmic heating treatments, initial temperature of cooking water at room level which was same with pasta's temperature but the initial water temperature in soaking experiments. Thus, moisture absorption rate of pasta samples was almost zero during the first 5 to 15 mins of ohmic heating at 20-40 V/cm. After this delayed stage were passed, the water absorption behaviour was seem to be continue as it was in the initial stage of soaking. The transition between different stages of rehydration were quite smooth at 10 V/cm so it was difficult to specify a duration for delayed stage however from Fig. 3(a), it can be seen that this stage was ended sometime between from 40 to 60 mins. For ohmic heating experiments the time required to reach the slowed down rehydration rate were 140, 35, 25 and 20 mins, respectively for 10, 20, 30 and 40 V/cm electrical potential level. From these results it can be concluded that although delayed stage of rehydration due to low initial temperature of cooking medium were exists, the rehydration of pasta samples was achieved faster compared regular soaking.

In order to understand the rehydration behaviour of pasta samples and also for design and further optimisation of the processes, effective diffusion coefficients relating the moisture transfer phenomena is an important parameter (Maroulis & Marinos-Kouris, 1996). The calculated effective diffusivity parameters and associated activation energy results were shown in Table 1. As it is seen, because of the previously stated reasons respectively two and three effective diffusivity values were calculated for soaking and ohmic heating, for further details please see Section 3.2.3. These different effective diffusivity coefficients describes different single stages observed during rehydration experiments. One can easily conduct from the results that effective diffusivity of initial stage of the rehydration (D_1 for soaking) is higher than the diffusivity found for final stage (D_2)

meaning that the rate of moisture uptake by pasta samples were decreasing in time with increasing moisture content. On the other hand, temperature have shown so sound impact on effective diffusivity that the diffusivity coefficient calculated for 95°C were found almost two fold of 75°C. Similar observations about the moisture diffusivity coefficients of pasta samples during rehydration were previously reported by Cunningham, McMinn, Magee, and Richardson (2007). For ohmic heating, three different effective diffusivity, i.e. D_1, D_2 and D_3, were calculated for every previously defined single stage of rehydration. According to the results, it was observed that the higher voltage led an increment in diffusivity indicating that moisture diffused into pasta samples easier when electrical potential were raised. As expected, after the delayed stage of rehydration has passed an important increment in diffusivity was obvious.

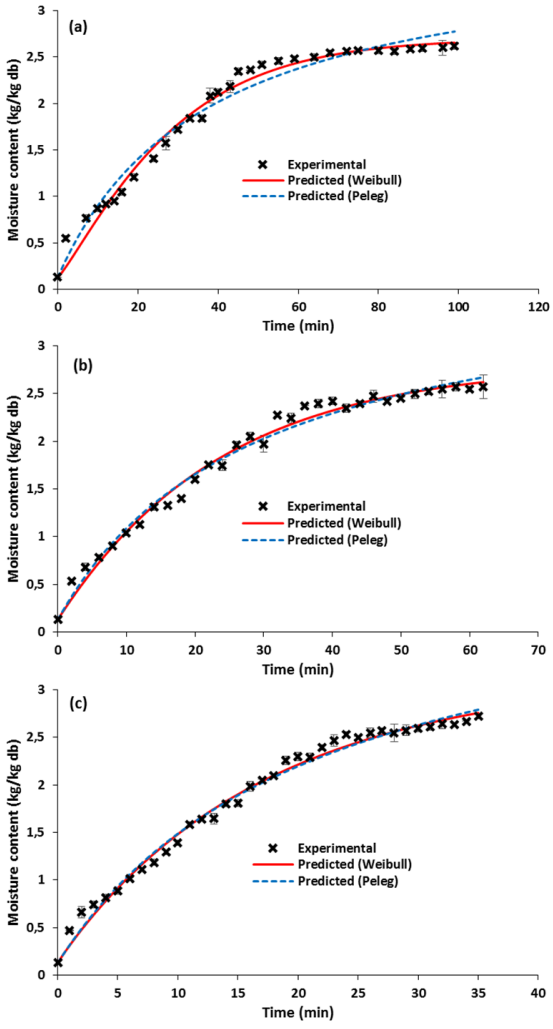

Figure 2. Experimental and predicted (Peleg and Weibull) moisture contents for rehydration behaviour of pasta samples during soaking ((a) at 75°C, (b) at 85°C, (c) at 95°C)

Surprisingly at final stage, diffusivities were found higher than that of for initial stage. However, activation energy required to achieve that diffusion was increasing in time indicating that moisture was being absorbed slower in the final stage of rehydration during ohmic heating while activation energy values for D_1 and D_2 were almost identical for regular soaking.

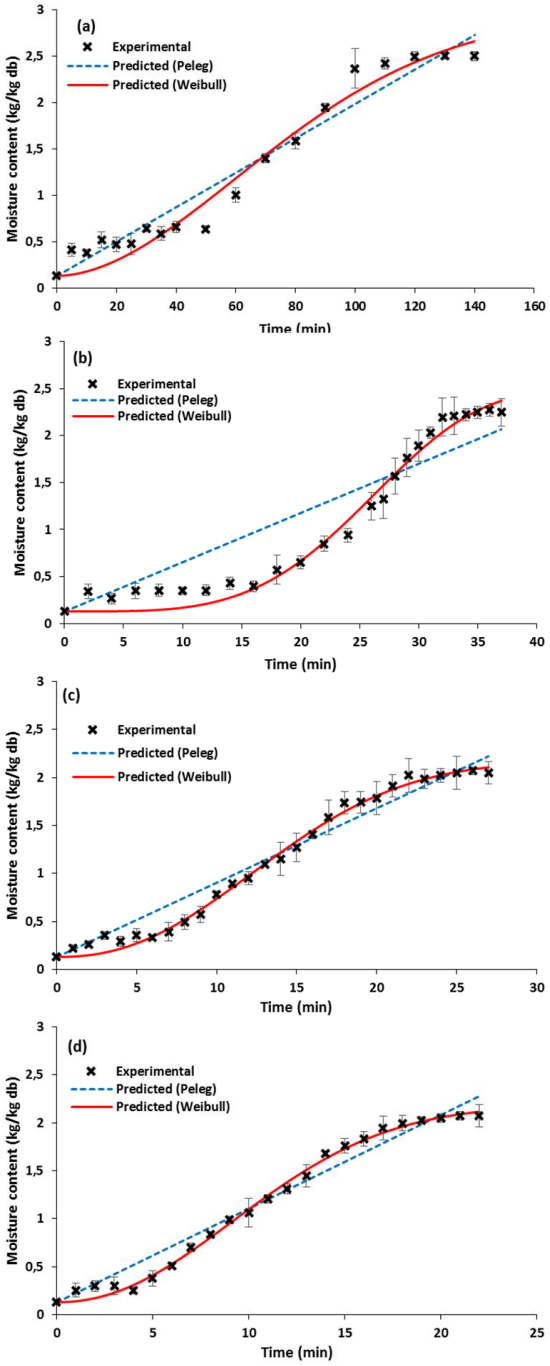

Figure 3. Experimental and predicted (Peleg and Weibull) moisture contents for rehydration behaviour of pasta samples during ohmic

heating ((a) at 10 V/cm, (b) at 20 V/cm, (c) at 30 V/cm, (d) at 40 V/cm)

Table 1. Effect of applied voltage and temperature on effective diffusion coefficient and activation energy for rehydration of pasta

Cooking method		Time	D_1 (x10^{10})	Time	D_2 (x10^{10})	Time	D_3 (x10^{10})
Ohmic heating							
10 V/cm		0-30	5.38	30-100	31.15	100-120	56.70
20 V/cm		0-12	7.24	12-32	129.61	32-36	357.91
30 V/cm		0-5	22.63	5-21	140.08	21-26	386.01
40 V/cm		0-5	27.58	5-15	165.06	15-20	427.64
	E_a	20459.20		21751.81		26940.84	
	D_0 (x10^9)	3.77		31.79		102.95	
Soaking							
at 75°C		0-65	50.53	65-96	47.14	-	-
at 85°C		0-36	62.26	36-52	51.98	-	-
at 95°C		0-25	100.65	25-30	91.62	-	-
	E_a	36.57		35.16		-	
	D_0 (x10^4)	14.84		8.21		-	

- E_a is activation energy (kJ/mole).
- D_0 is pre-exponential Arrhenius factor (m^2/min).
- Time is cooking time of pasta samples (min).
- D_1, D_2, D_3 are effective diffusion coefficients for rehydration of pasta samples during cooking (m^2/min).

Table 2. The calculated parameters of Pegel and Weibull equations at studied conditions of pasta rehydration during ohmic heating and soaking

Cooking method		Model Equations	
Ohmic heating		**Peleg**	**Weibull**
	10 V/cm	k_1 = 53.8724***	α = 2.8363***
		k_2 = 3.98E-18^{ns}	β = 90.8793***
		R^2 = 0.9505	R^2 = 0.9634
		R^2_{adj} = 0.9475	R^2_{adj} = 0.9588
		SEE = 0.2018	*SEE* = 0.1787
	20 V/cm	k_1 = 19.0001***	α = 2.3760***
		k_2 = 3.14E-16^{ns}	β = 28.2154***
		R^2 = 0.8396	R^2 = 0.9772
		R^2_{adj} = 0.8326	R^2_{adj} = 0.9751
		SEE = 0.3314	*SEE* = 0.1278
	30 V/cm	k_1 = 12.9243***	α = 2.0426***
		k_2 = 4.85E-18^{ns}	β = 15.7644***
		R^2 = 0.9582	R^2 = 0.9921
		R^2_{adj} = 0.9566	R^2_{adj} = 0.9914
		SEE = 0.1477	*SEE* = 0.0656
	40 V/cm	k_1 = 10.2440***	α = 2.0532***
		k_2 = 3.87E-18^{ns}	β = 12.3581***
		R^2 = 0.9659	R^2 = 0.9943
		R^2_{adj} = 0.9643	R^2_{adj} = 0.9938
		SEE = 0.1352	*SEE* = 0.0564
Soaking			
	at 75°C	k_1 = 10.2009***	α = 2.5659***
		k_2 = 0.2754***	β = 29.3043***
		R^2 = 0.9716	R^2 = 0.9835
		R^2_{adj} = 0.9706	R^2_{adj} = 0.9823
		SEE = 0.1283	*SEE* = 0.0995
	at 85°C	k_1 = 7.7448***	α = 2.6795***
		k_2 = 0.2684***	β = 23.5944***
		R^2 = 0.9833	R^2 = 0.9866
		R^2_{adj} = 0.9828	R^2_{adj} = 0.9856
		SEE = 0.0942	*SEE* = 0.0860
	at 95°C	k_1 = 5.0462***	α = 3.0400***
		k_2 = 0.2318***	β = 17.2290***
		R^2 = 0.9886	R^2 =0.9903
		R^2_{adj} = 0.9882	R^2_{adj} = 0.9897
		SEE = 0.0818	*SEE* = 0.0765

- *SEE* is "standard error of estimate"

*, significant at p≤0.05; **, significant at p≤0.01; ***, significant at p≤0.001; ^{ns}, not significant (p>0.05).

3.2. Kinetic analysis of rehydration process

The two common models in literature, i.e. Weibull and Peleg, were used to describe the deviation in moisture content of pasta samples as a function of time. Model parameters of fitted equations and their goodness of fit values (R^2, R^2_{adj} and *SEE*) were presented in Table 2.

Although both of the equations were found enable to explain more than 95% of the variation for regular soaking experiments, Weibull model was found to be one step ahead of Peleg equation (for fitted curves please see Figs. 2 and 3). As can be seen from Table 2, prediction capabilities of the models were found to be slightly vary depending on the temperature and both of the modes showed better performance when temperature was high.

For ohmic heating experiments, Weibull model proposed a good performance by explaining more than 95% of the variation in moisture content. Nonetheless, Peleg model was not as good for ohmic heating since it does not has the ability of explaining S shaped trends such as we obtained from ohmic heating rehydration curves.

It was previously reported that the Peleg constant k_1 is related to mass transfer rate and its reciprocal correlates with diffusion coefficient (Cunningham, McMinn, Magee, & Richardson, 2007; Maskan, 2002). From the results it can be concluded that the values of k_1 showed tendency of decrement when the processing temperature was increased indicating an enhancement in initial water absorption rate (Cunningham, McMinn, Magee, & Richardson, 2007). A similar result were also observed for ohmic heating of pasta samples since the higher voltage levels, the greater k_1 value. This result is reasonable because the increment in electrical potential would no doubt positively affect the heating rate of the cooking medium. The other Peleg constant, k_2 value, was previously announced to be a function of temperature and it decreases as the temperature increases (Cunningham, McMinn, Magee, & Richardson, 2007; Maskan, 2002). The k_2 values calculated in the present study for regular soaking were in agreement with the literature data.

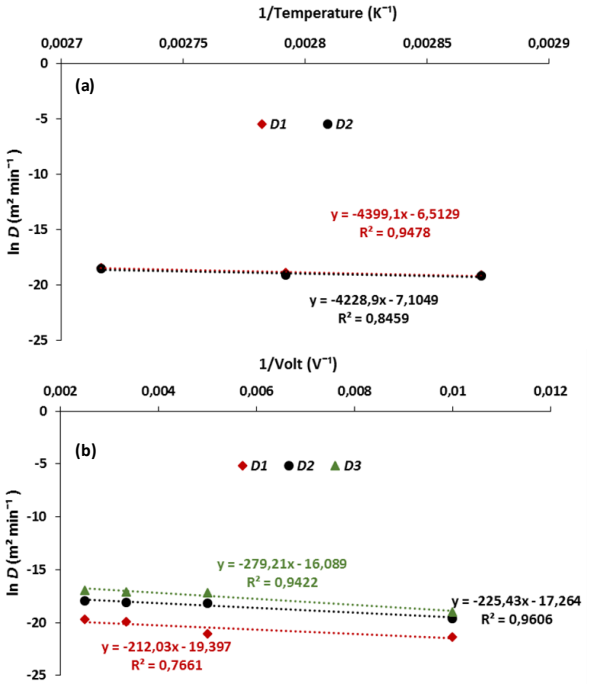

Figure 4. Effect of voltage gradient on effective diffusion coefficients (D_1, D_2 and D_3) ((a) for soaking, (b) for ohmic heating)

However for ohmic heating, any clear relation between k_2 and temperature were not observed and also k_2 value were found to be an insignificant parameter for ohmic cooking of pasta.

Regarding Weibull model parameters, the shape factor (α) could be considered as a constant value for the pasta samples, because of its limited change during rehydration experiments (Cunningham, McMinn, Magee, & Richardson, 2007). Although the variation of α was limited, a minor increment trend of it with respect to increase in applied temperature can be clearly observed. That can be related to increment of moisture transfer ratio with temperature as α was previously attributed to the existence of mass transfer where internal resistance against moisture transport prevails (García-Pascual, Sanjuán, Bon, Carreres, & Mulet, 2005). Nevertheless the variation of α for ohmic heating revealed an opposite behaviour and while the voltage increased, α were decreased as a consequence. That unexpected change may be attributed to the "delayed stage" of rehydration at the very

beginning of the rehydration process. Because this stage had a retarding impact on moisture uptake and it was possibly be reflected by the Weibull model parameters. However, another study stating the opposite results, meaning faster water absorption by lower α values can also be present in the literature (García-Pascual, Sanjuán, Melis, & Mulet, 2006). Another kinetic parameter obtained from Weibull model was the rate parameter, i.e. β. Sam Saguy, Marabi, and Wallach (2005) reported that β represents the required time to accomplish approximately 63% of rehydration. Thus, β value can directly be correlated with rate of moisture uptake. In the present study, both temperature and voltage increment resulted in less β value indicating shorter rehydration time as experienced.

4. Conclusions

In the present study, rehydration of pasta samples was examined during soaking at different temperatures (75, 85 and 95°C) and during ohmic heating at different electrical potential levels (10, 20, 30 and 40 V/cm) as an alternative method of pasta cooking. It was observed that water absorption of pasta samples were started at very beginning of the soaking experiments due to high initial temperature of medium where noticeable weight change were recognized after delayed phase of the ohmic heating. That is why three different diffusion coefficient were calculated for ohmic heating, while it was two for regular soaking and furthermore, ohmic heating was superior compared to soaking in terms of rehydration rate. According to the kinetic analysis results of rehydration experiments, the Peleg and Weibull models showed promising performance for regular soaking experiments where the first one could not describe moisture change of pastas during ohmic heating at a desired level.

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Sanayi Üretimde Elektrikle İlgili Yaşanan İş Kazalarının Belirlenmesi ve Çözüm Önerileri

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Anahtar kelimeler
Elektrik; İş Güvenliği; Ergonomi

Özet

Bilindiği üzere sanayi devrimiyle insana olan gereksinimin yerini makineleşmeye bırakmıştır. Bu makinelerin çalışması içinde elektrik enerjisi ihtiyacı doğmuştur. Zamanla sanayi teknolojisinin oldukça gelişmesiyle elektriğe bağımlılık daha da fazlalaşmıştır. Buda elektrik bakım teknisyenleri, elektrikle çalışma yapan çalışanlar açısından yeni bir sektör doğurmuştur. Bu sektörün yaygınlaşmasıyla iş güvenliği açısından da farklı sorunlar ortaya oluşmaktadır. Bu çalışmada çalışanların çalışma yaşamında yaşayabileceği veya yaşadıkları temel sorunları tespit edip öneriler sunarak bu sektörde iş kazalarını kaynağında yok etmeye yönelik olarak yapılmıştır.

Determination of Occupational Accidents in Industrial Production and Suggestions for Solutions

Keywords
Electricity;Work Safety; Ergonomics

Abstract

Determination of work-related accidents in industrial production regarding electricity experienced and their solutions. The need for manpower has replaced with mechanization since the industrial revolution. Electrical energy in the operation of these machines was needed. The addiction to Electricity has increased since the development of industrial technology, which has given birth to a new study in electrically sector in terms of employees and electrical maintenance technicians. With the spread of job security in this sector, different issues have been revealed. This thesis has been studied to destroy the sources of work-related accidents by offering suggestions to detect the underlying problems the employees might live, or live in their work life.

1.Giriş

İş sağlığı ve iş güvenliğinin gelişimi incelendiğinde henüz gelişemeyen toplumlarda çalışan kesimin sağlıklarını muhafaza etmeye yönelik herhangi bir önlemeye rastlanmamıştır (Yüksel, 2001). İş sağlığı hakkında bilinen ilk çalışma, maden işletmelerinde iş yeri hekimi olarak çalıştığı yıllarda, tarihte ilk iş hekimliği kitabı olan "De Morbis Metallicis"dir (Ersoy, 2004). Dünyada ilk mineraloji uzmanı olarak bilinen ve 1494 ile 1555 yılları arasında yaşayan Georgius Agricola; bazı zehirlerin etkilerini belirlemiş, koruyucu önlemler önermiştir. 1530 yılında "De Re Metallice" isimli eserini yayınlamıştır.1633 ile 1714 yıllar arasında yaşayan

iş sağlığı ve güvenliği açısından ciddi anlamda çalışmalar yapan Bernardino "De Morbis Artificum Diatriba" (Demir, 2003) adıyla çıkardığı kitabında bilhassa iş kazalarını önlemeye yönelik, iş yerlerinde koruyucu güvenlik önlemlerin alınması yönünde önerilerde bulunmuştur.

İş sağlığı ve güvenliğinde en çağdaş, en köklü nitelikteki çalışmalar Bernardino Ramazzini ile İtalya'da kendini göstermiştir. Bilimsel anlamıyla iş hekimliği kendini göstermeye başlamıştır. Ancak gelişmelerin devamı sanayi inkilapları sonrası İngiltere'de gerçekleşmiştir. 17.yy'ın ortalarına doğru İngiltere'de iş sağlığı ve güvenliğiyle (EPDK, 2016) ilgili olarak "On Saat Yasası ve 1833 yılında "Fabrikalar Yasası" çıkarılmıştır. 19. yy'da bu çalışmalarda artış görülmüş ve 1919 yılında kurulan Uluslararası Çalışma Örgütü (ILO) "Milletler Cemiyetine" kurulmuştur. 1946 yılındaysa Birleşmiş Milletlerle imzaladığı anlaşma sonucunda bir uzmanlık kuruluşu durumunda olmuştur (ILO, 2018).

Günümüzde var olan bilimsel teknolojik gelişmeler meslek hastalıkları ve iş kazalarının temelini ortadan kaldırma olanakları sunmuştur. Özellikle Uluslararası Çalışma Örgütü ve Dünya Sağlık Örgütü'nün sağladığı katkılarla olumsuz çalışma ve sağlık koşullarının iyileştirilmesi için yasal düzenlemeler bilimsel çalışmalarla başlayan süreç gelişkin ve oldukça kapsamlı bir iş güvenliği mevzuatının oluşmasını sağlamıştır. İş sağlığı ve güvenliği etkilerine teknik eleman, hukukçu, fen bilimci, hekim ve diğer uzmanlık alanlarında bilinen birçok bilim insanın katılmasıyla iş sağlığı ve güvenliği alanı ortaya çıkmış ve uygulama alanı bulmuştur.

İş kazalarının önlenmesi amacıyla yapılan ilk bilimsel yaklaşım H.W.Heinrich, Domino Teoremi ismiyle ortaya koymuştur (Sabet, 2013). Daha sonraki çalışmalarda Güvensiz Davranışlar ve Güvensiz durumların iş kazalarına sebep olduğu daha net ortaya konmuştur.

XXI. Dünya İş Sağlığı ve Güvenliği Kongresinde sunulan Avrupa İşçi Sağlığı ve Güvenliği Ajansı ve Uluslararası Çalışma Örgütünün hazırladığı raporda; düşük mesleki güvenlik ve sağlık harcamalarının neden olduğu belirtilmiştir. Yapılan işle ilgili yaralanma ve hastalıkların, yıllık yaklaşık 6 milyar avroya ulaştığı bununda GSYİH üzerindeki payının %3,9'a ulaştığı belirtilmiştir (Safety, 2018).

Dünya Kongresinde sunulan diğer hususlar şu şekildedir.

- İşle ilgili yaralanma ve hastalıkların bir sonucu olarak, DALY (engellilikten arındırılmış yaşam yılları) dünya çapında 123.3 milyon (AB'de 7.1 milyon) kaydedilmiştir.
- Bunlardan 67,8 milyonu (AB'de 3,4 milyon) ölümler, 55,5 milyonu (AB'de 3,7 milyon) engel oluşturan yaralanmalar olarak görülmüştür.
- Çoğu Avrupa ülkesinde, işe bağlı kanser, maliyetlerin çoğunluğunu (119,5 milyar Avro veya AB'nin GSYİH'nın % 0,81'i) oluşturmaktadır. Kas-iskelet sistemi rahatsızlıkları ikinci en büyük katkı yapmaktadır (Çetindağ, 2010).

Elektrik çarpması, elektrik akımının insan vücudundan geçmesi ile oluşan durumdur. Bütün akımlar vücut toprağa bağlı olduğunda daha tehlikeli olmaktadır.

Elektrik çarpması, elektrik akımının insan vücudundan geçmesi ile oluşan durumdur. Bütün akımlar vücut toprağa bağlı olduğunda daha tehlikeli olmaktadır.

Elektrik çarpması sonucu ortaya çıkan Klinik Bulgular şu şekilde sınıflandırılmıştır.

A- Kalp üzerine etkileri
- Sinüs taşikardisi
- Sinüs bradikardisi
- Atriyal taşikardi-fibrilasyon
- Ventriküler taşikardi-fibrilasyon
- Kalp blokları
- ST-T dalga değişiklikleri
- Hipertansiyon
- Myokard nekrozu
- Asistoli (kalbin durması)

B- Solunum sistemi üzerine etkileri
- Solunum arresti (solunumun durması)

C- Diğer organlar üzerine etkileri etkileri
- Şuur kaybı ya da şuur değişiklikleri
- Olayı hatırlamama(amnezi)
- Geçici motor paralizi,CK BB artışı
- Beyin ödemi
- Deride yanıklar
- Böbrek yetmezliği (myoglobinüri)
- Kompartman sendromu,CK,CK-MM,myoglobin

artışı,kas rüptürü
- Sindirim sistemi kanaması
- Katarakt vb göz hasarları
- İşitme kaybı, kulak çınlaması
- Kişilik değişiklikleri,konuşma kaybı,şimşek çakması-gök gürültüsü fobisi

Elektriğin vücuda girdiği ve çıktığı noktalarda her zaman birer yara vardır. Giriş yarası oldukça küçük ama çıkış yarası geniş ve derin olabilir. Yaranın boyutu iç organ hasarları hakkında bilgi vermemektedir (Yılmaz, 2003)

2.Yöntem

Araştırmada kullanılan model, evren ve örneklem, verilerin toplanması, işlenmesi bunları oluşturma çalışmaları, istatistik teknikler yer almaktadır. Bu araştırmada sanayi üretimde elektrikle çalışan tekniker, teknisyen gibi çalışanların karşılaştıkları iş güvenliği sorunları belirlenecektir. Bu sebeple araştırmanın yürütülmesi için tarama modelinden yararlanılmıştır. Araştırmada evrenini İstanbul Anadolu yakası sınırları içerisinde bulunan sanayi üretiminde elektrikle çalışan işçiler oluşturmaktadır. Belirlenen bu evrende tesadüfi örneklem yöntemi ile on sanayi üretim tesisi örneklemi oluşturmaktadır.

Bu çalışmada bilgi açısından katkı sağlayacak literatür taramasından sonra tespit ettiğimiz bulgular ve edindiğimiz tecrübelerin yanı sıra uzman görüşlerinden ve yapılmış araştırmalardan bilgi toplama yöntemi ölçeklerinden de yararlanarak çalışanlara uygulanmak üzere bir anket formu geliştirdik. Daha sonra bu formlar bir sanayi üretim tesisinde 10 çalışana uygulayarak görüşleri çerçevesinde revize edilmiştir. Anlaşırlığı test edilip gerekli düzeltmeleri yapıldıktan sonra çalışan grubu için 100 adet örneklem grubundaki deneklere ulaşılarak formlar uygulanmıştır.

Çalışanlara uygulanan anket iki bölümden oluşmaktadır. Birinci bölümde kişisel özellikleri ve araştırma konu ile ilgilii konumlarını sorgulayan 14 tane soru bulunmaktadır. İkinci bölümde ise çalışanların iş güvenliği konusundaki tutumlara dair 26 soru bulunmaktadır.

Çalışan anketlerin ikinci bölümünde sorulan 26 soru dörtlü derecelendirme ölçeği ile derecelendirilmiş her bir sorunun karşısına (1) Kesinlikle Katılmıyorum, (2) Katılmıyorum,(3) Katılıyorum, (4) Kesinlikle Katılıyorum anlamını taşıyan derecelendirme ölçeği verilmiştir.

Uyguladığımız bu anketler Windows Office 2007 Excel programında kodlanarak bilgisayara işlenmiş daha sonra bu veriler CROSSTAB istatistik analiz programının da yardımıyla tablo ve grafik şekline dönüştürülmüştür. Veri analizlerinde frekans, ortalama, yüzde ve standart sapma kullanılmıştır. Anket çalışmalarında anlamlılık düzeyi p olarak ifade edilmektedir. Çalışanlar için geliştirilen anketin $p<0,05$ düzeyindekiler anlamlı kabul edilmiştir. Elde edilen bilgilerin kolay analiz edilip yorumlanabilmesi amacıyla tablolar şekline getirilmiş ve bu bulgular yorumlanmıştır.

Yaş: İş Kazalarına ilişkin anketimize katılanların yaşları ve araştırmadaki yaş değişkenindeki yüzde oranları ile sekiz sınıfta toplanmıştır [<20;%16], [21-25;%17], [26-30;%0], [31, 35;%18], [36, 40;%12], [41-45;%14], [46-50;%16], [50>;%7].

Gelir Durumu: Gelir durumuna ilişkin verilen yanıtlarda; [<1500; %20] [1501-2500; %40], [2501-3000; %17], [3000; %19] olduğu belirlenmiştir.

Medeni Durum: Medeni hale ilişkin sorulara verdikleri cevaplarda; [Bekar; % 60], [evli, %40] olduğu görülmüştür.

Eğitim Durumu: Eğitim durumları incelendiğinde [non-education; %4], [ilköğretim; %43], [highschool; %23], [lisans ve üstü; %30] mezunlarından oluştuğu görülmektedir.

İş Deneyimi: Katılımcıları iş tecrübesi incelendiğinde oluşan dağılım şu şekildedir: [>1; %8], [1-3; %17], [3-5; %27], [5<%48], tecrübe süreliler oluşturmaktadır.

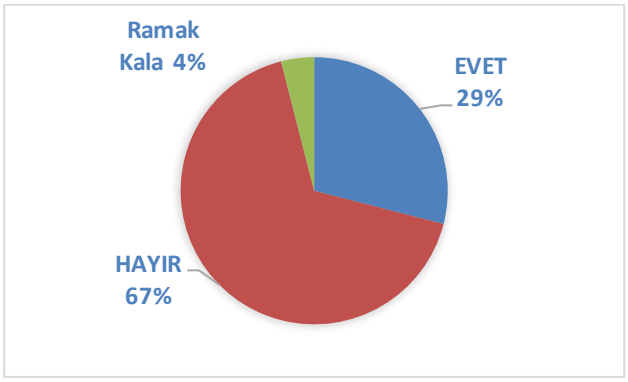
Meslek Seçme Etkeni: Meslek seçimlerine ilişkin sorulara; [aile/çevre etkisi; %37], [eğitim alanı; %23], [arkadaş; %33], [geliri; %7] şeklinde yanıtlanmıştır.

Sektör: Sektöre cevaplar şu şekildedir. [Üretim-İmalat; % 24], [servis-bakım; %76].

Çalışan Kişi Sayısı: İşletmede çalışan sayısına ilişkin oranlar şu şekildedir: [1-10; %51], [11-25; %28], [26-50; %10], [51<; %11].

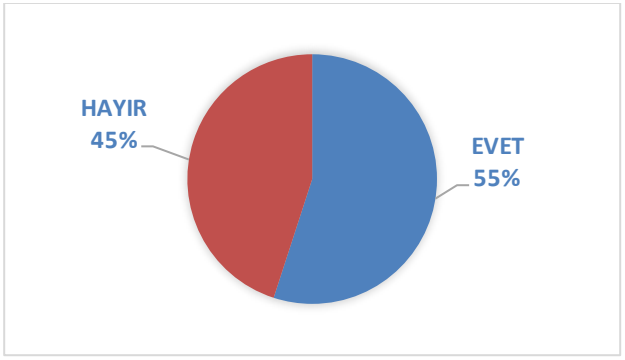
İşyerine Ulaşım Mesafesi: Deneklerin iş yerlerine ulaşım süreleri [5-%12], [6/10-%10], [11/30-%40], [31/60-%10], [61/120-%21] olarak belirlenmiştir.

Çalışanların iş kazalarına ilişkin durumları incelenmiştir. Çalışmaya katılan deneklerin iş kazası yaşamasına ilişkin sorulara verdikleri cevaplar şu şekildedir. %29 oranında yaşadığını, %67 oranında i yaşamadığını, %4 oranında ise ramak kala olayını yaşadığını belirtmişlerdir (Şekil 2).



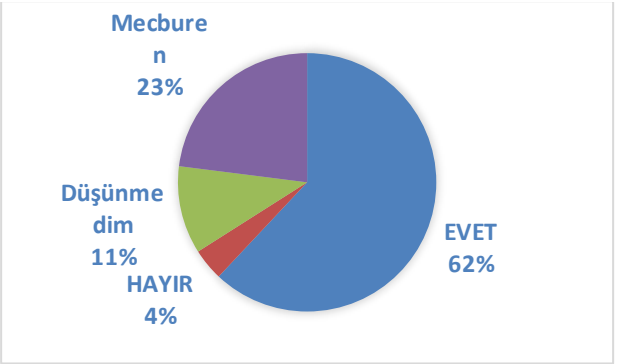
Şekil 1. Çalışanların İş Kazası Yaşamalarına" İlişkin Bulgular.

Araştırmaya katılanların iş kazasına şahit olmalarına ilişkin sorulara verdikleri cevaplar şu şekildedir. %55 oranında iş kazasına şahit olduğunu, %45 oranında ise iş kazasına şahit olmadığını belirtmişlerdir (Şekil 3)



Şekil 2. Çalışanların İş Kazasına Şahit Olma Durumuna" İlişkin Bulgular

İş yerinden memnun musunuz? Sorusuna verilen yanıtlar şu şekildedir: 62 - memnun, %11 - düşünmediğini, %23 mecbur olduğunu ve %4 - memnun değilim (Şekil 4).

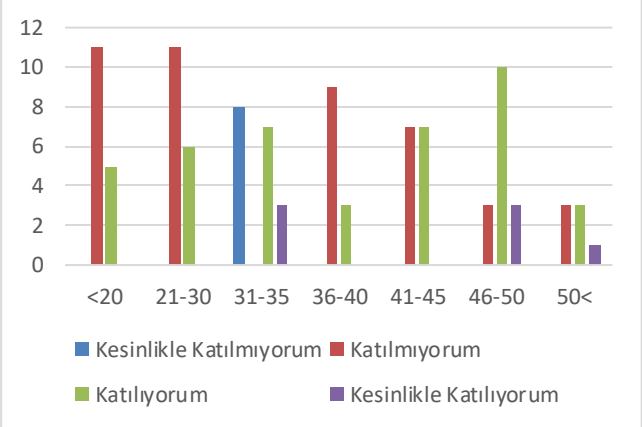


Şekil 3. Çalışanların İş Yerinden Memnuniyete İlişkin Bulgular

2.1 Sanayi Üretiminde Elektrikle Çalışanların İş Güvenliği Hakkındaki Görüşleri

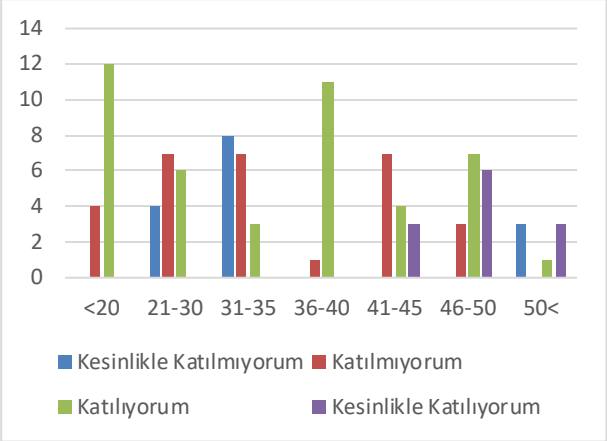
Çalışanların Yaşları ile İlgili İlişkili Bulgular:

"Sağlık Kontrollerin Yeterli Olduğunu Düşünüyor musunuz?" sorusunda çalışanların yaşları ile ilgisi incelenmiştir ve Şekil 5'te sunulmuştur. Toplamda % 52 oranında ifadeye olumsuz görüş verilirken, %48 oranında bu ifadeye katılım gösterdiği görülmektedir. Yaş değişkenine göre anlamlı bir ilişki görülmüştür ($p=0.008<0.05$).



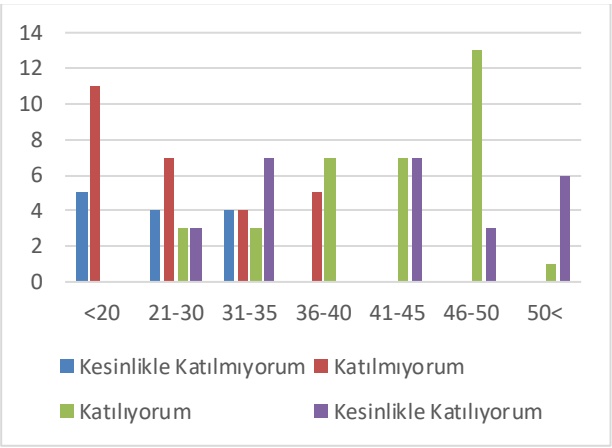
Şekil 4. "Sağlık Kontrollerin Yeterli Olduğunu Düşünüyor musunuz?'' ifadesine ilişkin dağılımları

"Şirketinizde İş Sağlığı ve Güvenliği Hakkında Etkinlik Düzenleniyor mu?'' sorusunda çalışanların yaşları ile ilgisi incelenmiştir ve Şekil 6'da sunulmuştur. Toplamda % 44 oranında katılım gösterilmemekle beraber %56 oranında bu ifadeye katılım belirlenmiş ve bu ifadenin yaş değişkeni ile anlamlı bir ilişkisi görülmüştür ($p=0.012<0.05$).



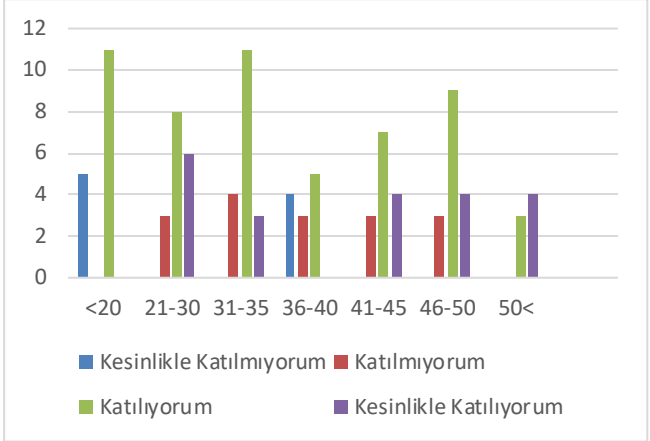
Şekil 5. "Şirketinizde İş Sağlığı ve Güvenliği Hakkında Etkinlik Düzenleniyor mu?" ifadesine ilişkin dağılımları

"Yaptığım İşle İlgili Özel Olarak Düzenlenmiş Eğitim Aldım." sorusunda çalışanların yaşları ile ilgisi incelenmiştir ve Şekil 7'de sunulmuştur. Toplamda % 40 olumsuz ve %60 oranında bu ifadeye olumlu katılım gösterilmiş ve değişkenine göre anlamlı bir ilişki bulunmuştur (p=0.000<0.05).



Şekil 6. "Yaptığım İşle İlgili Özel Olarak Düzenlenmiş Eğitim Aldım." ifadesine ilişkin dağılımları.

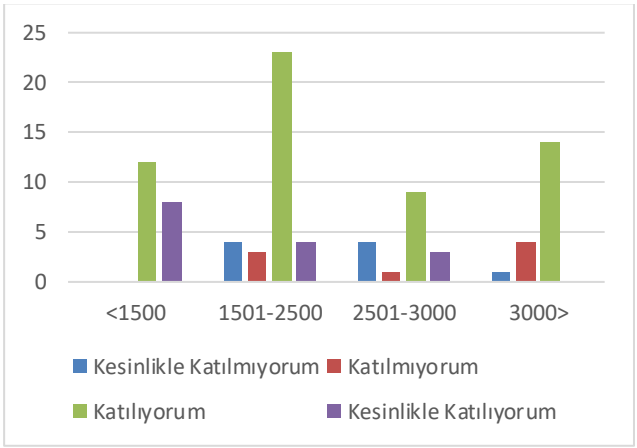
"Şirketimizde Kişisel Koruyucu Donanımlar Doğru Stoklanmıştır." İfadesinde ilişkin sonuçlar Şekil 8'de gösterilmektedir. İfadeye %25 olumsuz ve %75 olumlu görüş bildirilmiş olup yaş değişkenine göre anlamlı bir ilişki görülmektedir (p=0.027<0.05).



Şekil 7. "Şirketimizde Kişisel Koruyucu Donanımlar Doğru Stoklanmıştır." ifadesine ilişkin dağılımları.

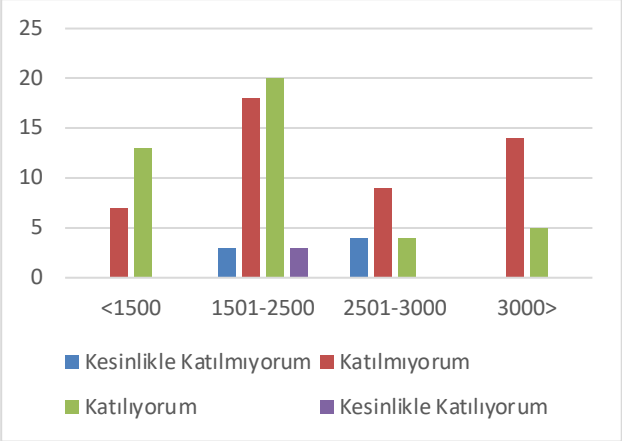
Çalışanların Aylık Gelirleriyle İlişkili Bulgular:

"İş Kazası ve Olasılığında İşyeri Üretimi Durdurulmaktadır." görüşüne ilişkin sonuçlar Şekil 9'de verilmiştir. İfadeye genel yaklaşım %27 olumlu, %73 olumsuz görüş ile gelir durumuyla anlamlı bir ilişki tespit edilmiştir (p=0.021<0.05).



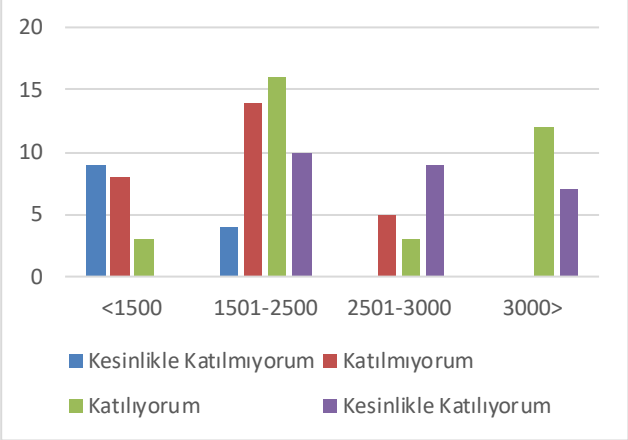
Şekil 8. "İş Kazası ve Olasılığında İşyeri Üretimi Durdurulmaktadır." ifadesine ilişkin dağılımları.

"Şirketinizde İş Sağlığı ve Güvenliği Hakkında Tüm Mevzuat ve Standartlara Uyuluyor." Maddesindeki sonuçlar Şekil 10'da verilmiştir. Toplamda %55 katılım gösterilmemiş ve %45 oranında olumlu yanıt verilmiştir. Gelir değişkenine göre anlamlı bir ilişki görülmektedir (p=0.010<0.05).



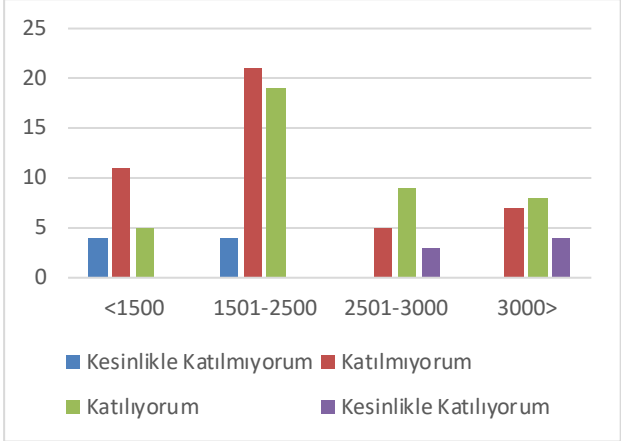
Şekil 9. "Şirketinizde İş Sağlığı ve Güvenliği Hakkında Tüm Mevzuat ve Standartlara Uyuluyor." ifadesine ilişkin dağılımları.

"Yaptığım İşle İlgili Özel Olarak Düzenlenmiş Eğitim Aldım." Görüşüne ilişkin sonuçlar Şekil. 11'de görülmektedir. Genel toplamda bu ifadeye %60 oranında olumlu görüş bildirilirken %40 gibi bir oran bu ifadeye katılmamaktadır. Gelir değişkenine göre anlamlı bir ilişki görülmektedir (p=0.000<0.05).



Şekil.10 "Yaptığım İşle İlgili Özel Olarak Düzenlenmiş Eğitim Aldım." ifadesine ilişkin dağılımları.

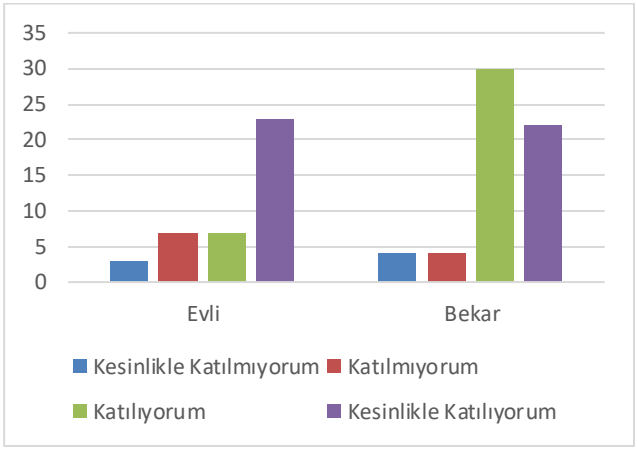
"Sağlık Kontrollerin Yeterli Olduğunu Düşünüyor musunuz?" ifadesine verilen yanıtlara ilişkin sonuçlar Şekil 12'de gösterilmektedir. Bu ifadeye katılım göstermeyenlerin oranı %52 iken %48 oranında olumlu görüş bilindirilmiştir. Bu ifade gelir değişkeni ile ilişkilidir (p=0.000<0.05).



Şekil 11. "Sağlık Kontrollerin Yeterli Olduğunu Düşünüyor musunuz?" ifadesine ilişkin dağılımları.

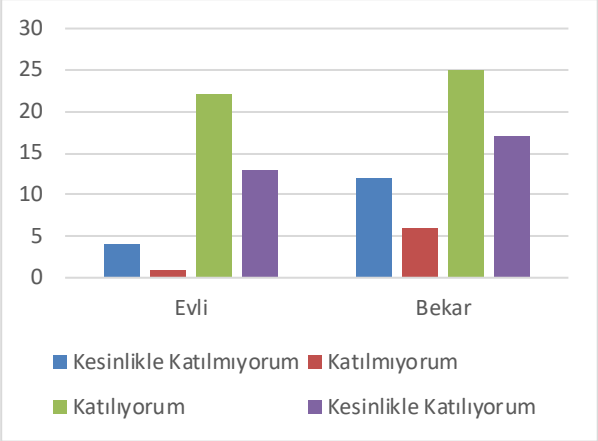
Çalışanların Medeni Durumu ile İlişkili Bulgular:

"İş Sağlığı ve Güvenliği Sisteminin Başarılı Olmasında Yönetimin Katkısı Önemlidir." ifadesinde belirlenen sonuçlar Şekil 13'de verilmiştir. Verilen yanıtların %82 olumlu görüş içermekte iken %18 olumsuz görüş bilirmiştir. Bu ifade ile medeni durum arasında anlamlı bir ilişki görülmüştür (p=0.006<0.05).



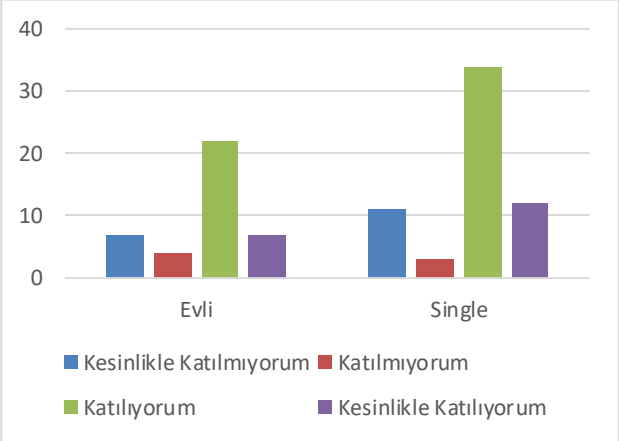
Şekil 12. "İş Sağlığı ve Güvenliği Sisteminin Başarılı Olmasında Yönetimin Katkısı Önemlidir." ifadesine ilişkin dağılımları.

"Haklarınızı ve Sorumluluğunuzu Biliyor musunuz?" ifadesine ilişkin verilen yanıtlar Şekil 14'de gösterilmiştir. Burada %77 oranında katılım gösterilmişken, bu ifadeye katılmayan kişi oranı %23'tür. Soru maddesiyle medeni hal değişkenine göre anlamlı bir ilişki görülmektedir (p=0.000<0.05).



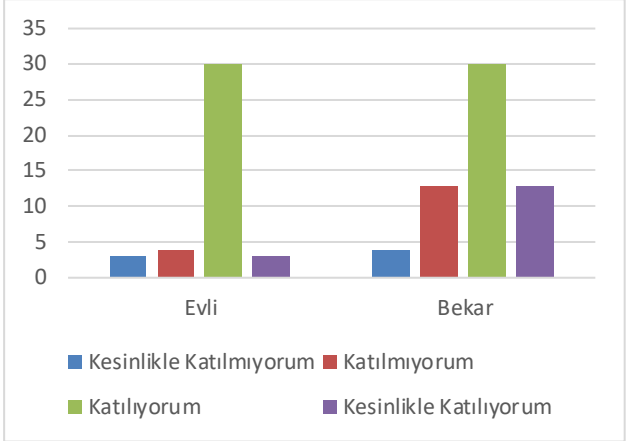
Şekil 13. "Haklarınızı ve Sorumluluğunuzu Biliyor musunuz?" ifadesine ilişkin dağılımları.

"Yaptığınız İşle İlgili Karşılaşabilecek Meslek Hastalıkların Farkındayım'' görüşüne ilişkin sonuçlar Şekil 15'de verilmiştir. Burada katılımcıların %75'i farkındalıklarını belirtmiş ancak %25 bu konuda farkındalığa sahip olmadığını bildirmiştir. Bu ifadeye ile katılımcıların medeni hal durumları arasında anlamlı bir ilişki görülmektedir (p=0.001<0.05).



Şekil 14. "Yaptığınız İşle İlgili Karşılaşabilecek Meslek Hastalıkların Farkındayım'' ifadesine ilişkin dağılımları.

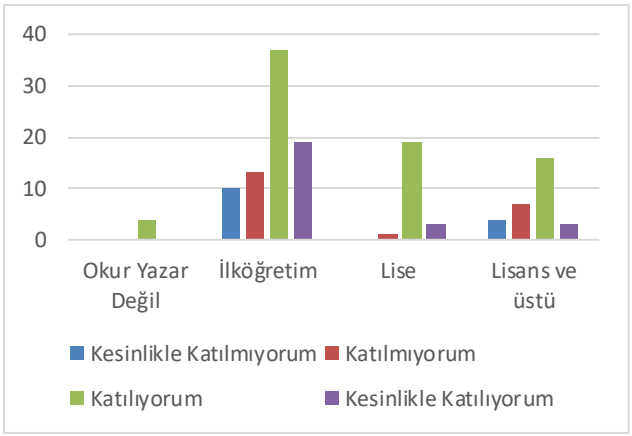
"İş Arkadaşlarımın Kaza Yaşaması Durumunda Onları Nasıl Kurtaracağımı Biliyorum" görüşüne ilişkin sonuçlar Şekil 16'da verilmektedir. Katılımcıların %76'sı bu riskin farkında olduklarını bildirmesine rağmen %24'ü bu konuda farkındalığa sahip olmadıklarını bildirmişlerdir. Bu risk ifadesi ile medeni hal değişkenine göre anlamlı bir ilişki görülmektedir (p=0.018<0.05).



Şekil 15. "Yaptığınız İşle İlgili Karşılaşabilecek Meslek Hastalıkların Farkındayım'' ifadesine ilişkin dağılımları.

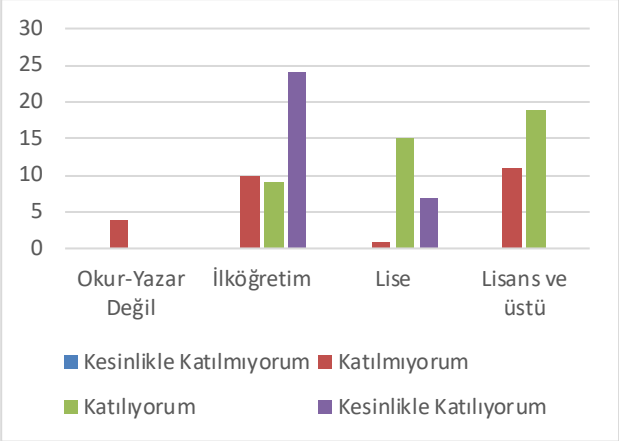
Çalışanların Eğitim Seviyesi ile İlişkili Bulgular:

"Elektrik Çarpılmasıyla İlgili Nasıl Kaza Olabileceği Konusunda Bilgi Sahibiyim." İfadesine ilişkin sonuçlar Şekil 17'de verilmiştir. %79 oranında katılımcı bu konu hakkında bilgi sahibi oluğunu belirtmiş ancak % 21 oranında ki katılımcının bilgi sahibi olmadığı belirlenmiştir. Bu ifade ile eğitim durumu değişkenine göre anlamlı bir ilişki görülmüştür (p=0.030<0.05).



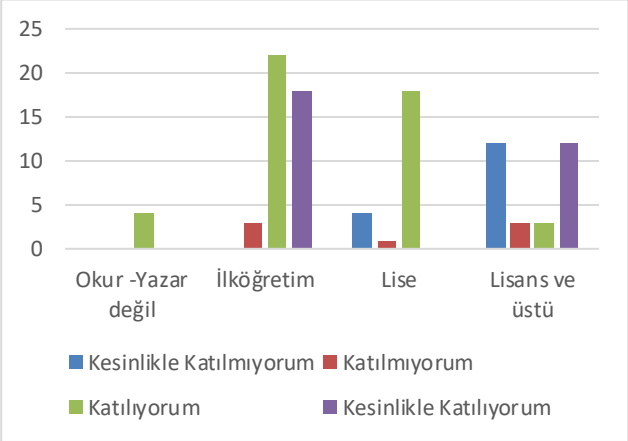
Şekil 16. "Elektrik Çarpılmasıyla İlgili Nasıl Kaza Olabileceği Konusunda Bilgi Sahibiyim." ifadesine ilişkin dağılımları.

"Statik Elektrik Tehlikesini Biliyorum." ifadesine ilişkin sonuçlar Şekil 18'de verilmiştir. Katılımcıların %74'ü bu konuda bilgi sahibi iken, %26 oranındaki katılımcıların bu konudaki tehlikenin farkında olmadığı anlaşılmaktadır. Bu ifade ile eğitim durumu değişkeni arasında anlamlı bir ilişki tespit edilmiştir (p=0.026<0.05).



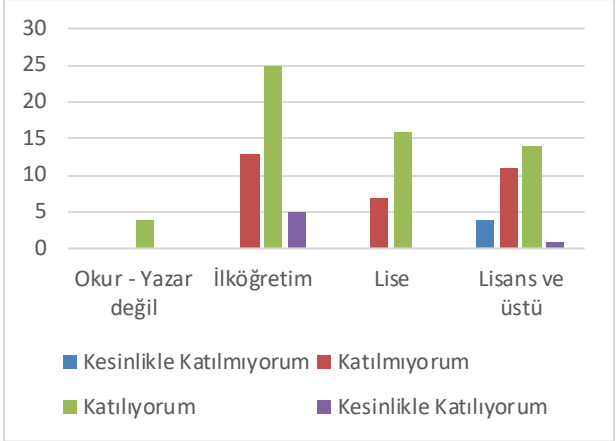
Şekil 17. "Statik Elektrik Tehlikesini Biliyorum." ifadesine ilişkin dağılımları.

"Haklarınızı ve Sorumluluğunuzu Biliyor musunuz?" sorusuna verilen yanıtlar Şekil 19'da verilmiştir. Burada katılımcıların %77'si hak ve sorumluluğunu bildiğini ifade etmiştir. Ancak % 23 oranında katılımcının bu konuda bilgisi olmadığı anlaşılmıştır. Sorunun yanıtlanmasında eğitim durumu değişkenine göre anlamlı bir ilişki olduğu görülmektedir (p=0.002<0.05).



Şekil 18. "Haklarınızı ve Sorumluluğunuzu Biliyor musunuz?" ifadesine ilişkin dağılımları.

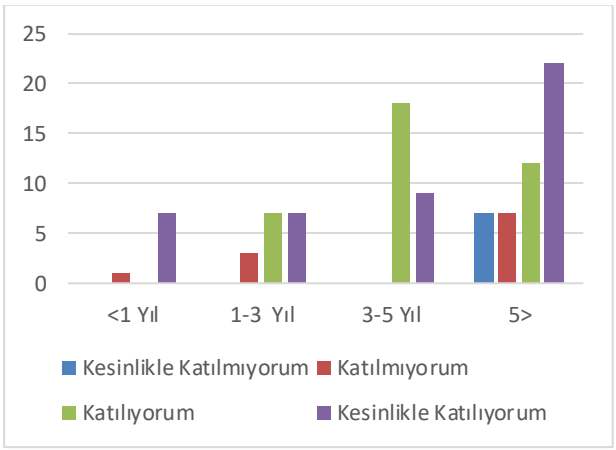
Çalışanların "İlk Yardım Konusunda Bilgi Sahibiyim." ifadesine verilen yanıtlar Şekil 20'de gösterilmektedir. Katılımcıların %65'i İlk yarım konusuna bilgi sahibi olduğunu %35'i ise bu konuda bilgi sahibi olmadığını görmekteyiz. Bu ifade eğitim durumu değişkeni ile anlamlı bir ilişkiye sahiptir (p=0.006<0.05).



Şekil 19. "İlk Yardım Konusunda Bilgi Sahibiyim." ifadesine ilişkin dağılımları.

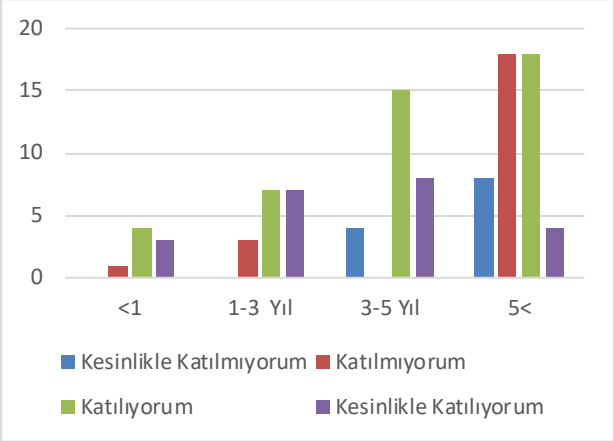
İş Tecrübesi Değişkeni ile ilişkili bulgular:

"İş Sağlığı ve Güvenliği Sisteminin Başarılı Olmasında Yönetimin Katkısı Önemlidir." cümlesine ilişkin bulgular Şekil 21'de verilmiştir. %82 oranında bu ifadenin önemli olduğunu ifade edenlere karşı %18 oranındaki katılımcı grubu önemli olmadığını düşünmektedir. Bu yanıtların tecrübe değişkenine göre anlamlı bir ilişki görülmektedir (p=0.040<0.05).



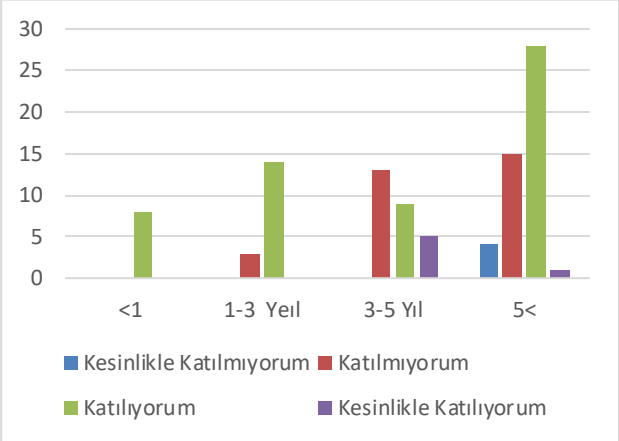
Şekil 20. "İş Sağlığı ve Güvenliği Sisteminin Başarılı Olmasında Yönetimin Katkısı Önemlidir." ifadesine ilişkin dağılımları.

"Yaptığım İşte Elektrik Çarpma Riski Vardır." ifadesine ilişkin katılımcı görüşleri Şekil 22'de verilmiştir. Katılımcıların %66'sı riskin farkında olduğu ancak %34'nün bu farkındalığa sahip olmadığı anlaşılmaktadır. Bu ifadede tecrübe değişkenine göre anlamlı bir ilişki görülmektedir (p=0.00<0.05).



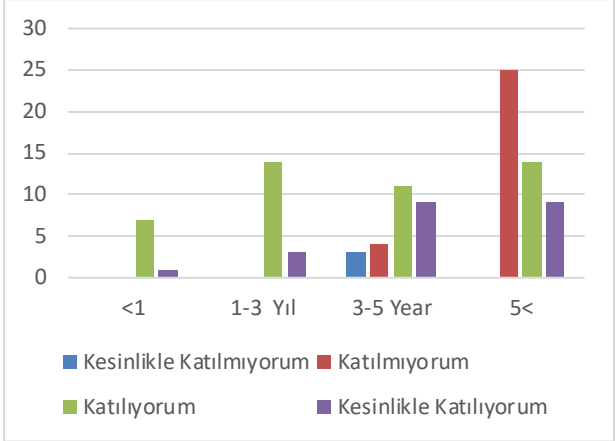
Şekil 21. "Yaptığım İşte Elektrik Çarpma Riski Vardır." ifadesine ilişkin dağılımları.

"İlk Yardım Konusunda Bilgi Sahibiyim." cümlesine katılımcı oranları Şekil 23'de verilmiştir. Katılımcıların %65'i bu konuda bilgi sahibi oluğunu belirtirken, bilgi sahibi olmadığını belirtenlerin oranı %35'dir. Sorgulanan ifade ile tecrübe arasında anlamlı bir ilişki görülmüştür (p=0.027<0.05).



Şekil 22. "İlk Yardım Konusunda Bilgi Sahibiyim." ifadesine ilişkin dağılımları.

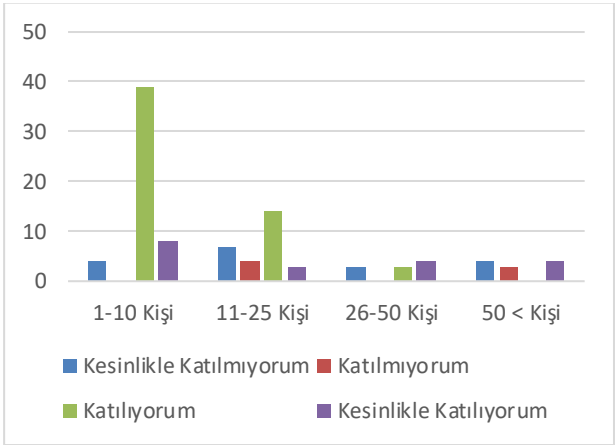
"Görev ve Sorumluluk Alanınızla İlgili Olarak Sağlık, Güvenlik, Tehlike ve Risklerin Doğru Şekilde Belirlendiğini Düşünüyor musunuz?" sorusuna verilen yanıtlar Şekil 24'de verilmektedir. Katılımcıların %68'i bu ifadeye olumlu görüş taşırken, % 32oranında ki katılımcı bu ifadeye katılmamaktadır. Bu ifadenin tecrübe değişkeni ile öre anlamlı bir ilişkisi görülmektedir (p=0.013<0.05).



Şekil 23. "Görev ve Sorumluluk Alanınızla İlgili Olarak Sağlık, Güvenlik, Tehlike ve Risklerin Doğru Şekilde Belirlendiğini Düşünüyor musunuz?" ifadesine ilişkin dağılımları.

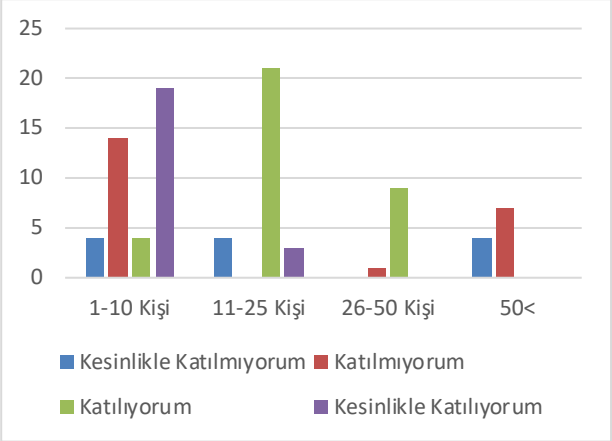
Kişi Sayısı ile ilişkili bulgular:

"Yaptığınız İşle İlgili Karşılaşılabilecek Meslek Hastalıkların Farkındayım." ifadesine katılım oranları Şekil 25'de verilmiştir. Çalışmaya katılanların %75'i bu riskin farkına olduğunu belirtmiş ama % 25 oranındaki katılımcı bu riski bilmediklerini ifade etmişleridir. Bu cümleye verilen yanıtlar ile firmada çalışan sayısı arasında anlamlı bir ilişki görülmektedir (p=0.034<0.05).



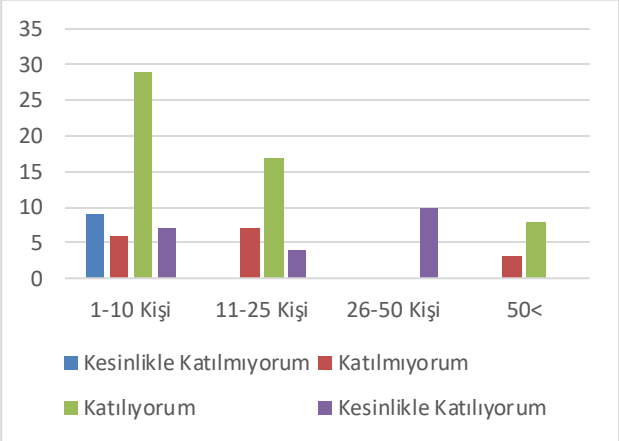
Şekil 24. "Yaptığınız İşle İlgili Karşılaşılabilecek Meslek Hastalıkların Farkındayım." ifadesine ilişkin dağılımları.

"Yaptığım İşte Elektrik Çarpılma Riski Vardır." İfadesine ilişkin katılımcı yanıtlar Şekil 26'da verilmiştir. Genel olarak incelendiğinde %66 oranında riskin bilindiği, % 34 oranında ise bu riskin bilinmediği görülmekte olup çalışan sayısı değişkenine göre anlamlı bir ilişki görülmektedir (p=0.001<0.05).



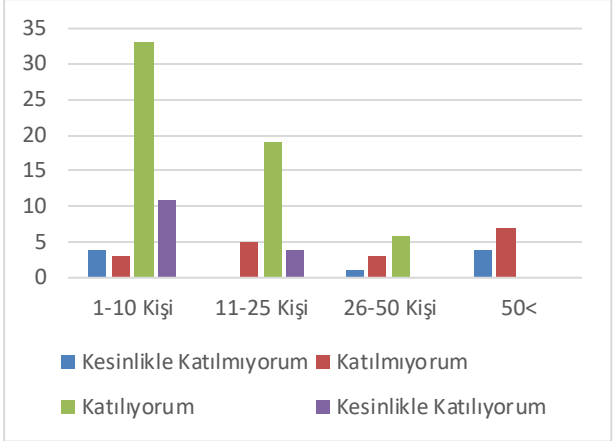
Şekil 25. "Yaptığım İşte Elektrik Çarpılma Riski Vardır." ifadesine ilişkin dağılımları.

"Şirketimizde Kişisel Koruyucu Donanımlar Doğru Stoklanmıştır." Sorgusuna ilişkin katılımcı oranları Şekil 27'de gösterilmiştir. Bu madde kapsamında genel katılım irdelendiğinde %75 oranındaki katılımcı işyerlerinde koruyucu malzemelerin doğru stokladığını ifade etmiş ancak %25'lik kesim bu düşüncede olmadığını belirtmiştir. Bu ifade ile çalışan sayısı değişkenine göre anlamlı bir ilişki bulunmaktadır (p=0.030<0.05).



Şekil 26. "Şirketimizde Kişisel Koruyucu Donanımlar Doğru Stoklanmıştır." ifadesine ilişkin dağılımları.

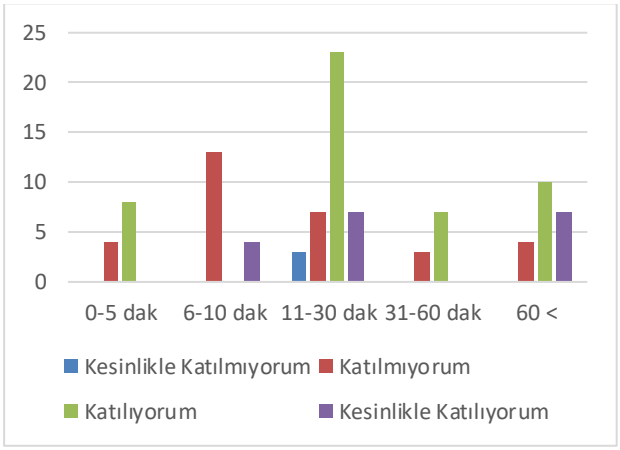
"İş Kazası ve Olasılığında İşyeri Üretim Durdurulmaktadır." ifadesine ilişkin gösterge Şekil 28'de verilmiştir. Burada katılımcıların %73'ü üretimin durdurulduğunu, %27 ise üretim devam ettiğini belirtmiştir. Bu ifadenin çalışan sayısı değişkeninde anlamlı bir ilişki taşıdığı belirlenmiştir (p=0.000<0.05).



Şekil 27. "İş Kazası ve Olasılığında İşyeri Üretim Durdurulmaktadır." ifadesine ilişkin dağılımları.

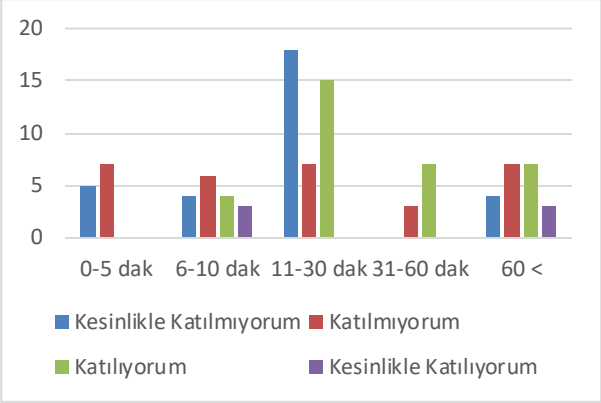
İşyerine Ulaşım Süresi ile ilişkili bulgular:

"Çalışma Davranışlarımız Kontrol Edilmektedir." Sorusuna verilen yanıtlar Şekil 29'da sunulmuştur. %64 oranında bu ifadenin doğru olduğu, %34'nün ise yanlış bulduğu görülmektedir. Bu soruda ulaşım süresinin verilen yanıtlar üzerinde anlamlı bir ilişki taşıdığı belirlenmiştir (p=0.021<0.05).



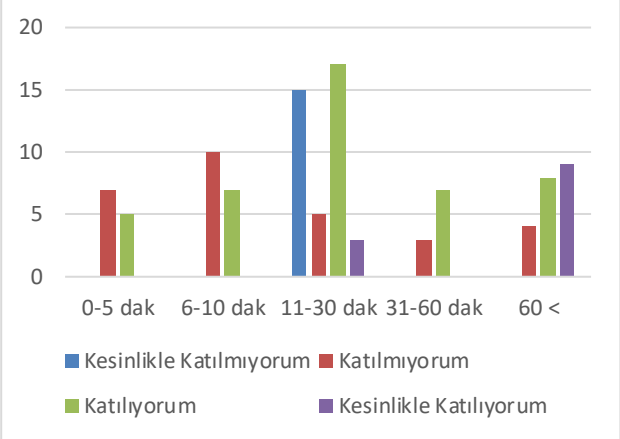
Şekil 28. "Çalışma Davranışlarımız Kontrol Edilmektedir." ifadesine ilişkin dağılımları.

"Parlama, Patlama, Yangın ve Yangın Riski Taşıyan İşler Yapmaktayım." Cümlesine katılımcıların oranı Şekil 30'da verilmiştir. Burada katılımcıların %61 bu işleri yapmadığı bildirmiş, ancak %31 oranında ki katılımcı grubun bu işlerde görev aldığı görülmektedir. Bu ifade ulaşım süresi ile ilişkilidir (p=0.019<0.05).



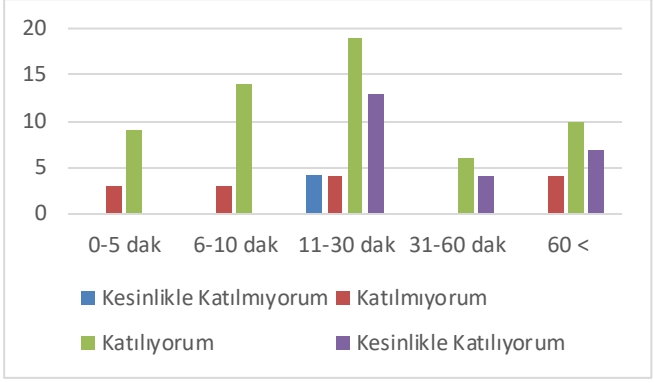
Şekil 29. "Parlama, Patlama, Yangın ve Yangın Riski Taşıyan İşler Yapmaktayım." ifadesine ilişkin dağılımları.

"Şirketinizde İş Sağlığı ve Güvenliği Hakkında Etkinlik Düzenleniyor mu?" ifadesine ait görüş dağılımları Şekil 31'de verilmiştir. Genel olarak bakıldığında katılanların %56'sı etkinliklerin düzenlendiğini düşünmekte, %44'ü ise etkinliklerin düzenlenmediğini belirtmiştir.



Şekil 30. "Şirketinizde İş Sağlığı ve Güvenliği Hakkında Etkinlik Düzenleniyor mu?" ifadesine ilişkin dağılımları.

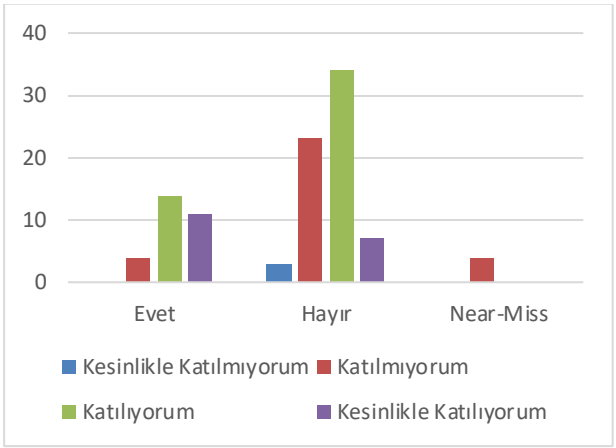
"İş Sağlığı ve Güvenliği Uygulamasının Başlamasıyla İş Yerinizde İş Kazaları Azaldı." cümlesine ilişkin sonuçlar Şekil 32'de verilmiştir. Görülmektedir ki %82 oranındaki katılımcı bu ifadeye katılmakta, %18 oranında ki katılımcı ise uygulamanın kazaları azaltmadığını belirtmiştir. Bu madde de ulaşım süresi değişkenine göre ilişki bulunmaktadır (p=0.043<0.05).



Şekil 31. "İş Sağlığı ve Güvenliği Uygulamasının Başlamasıyla İş Yerinizde İş Kazaları Azaldı." ifadesine ilişkin dağılımları.

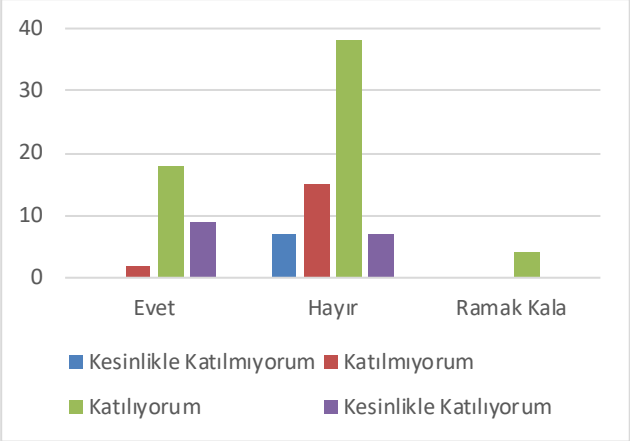
İş Kazası Yaşama Ulaşım Süresi ile ilişkili bulgular

"Çalışma Davranışlarımız Kontrol Edilmektedir." ifadesine ilişkin ulgular Şekil 33'de verilmiştir. Toplamda %66 oranında bu ifadeye katılım gösterirken, %34 oranında katılımcı aksi yönde görüş bildirmiştir. Verilen cevaplarda bu ifade ile iş kazası yaşama değişkenine göre anlamlı bir ilişki görülmektedir. (p=0.000<0.05)



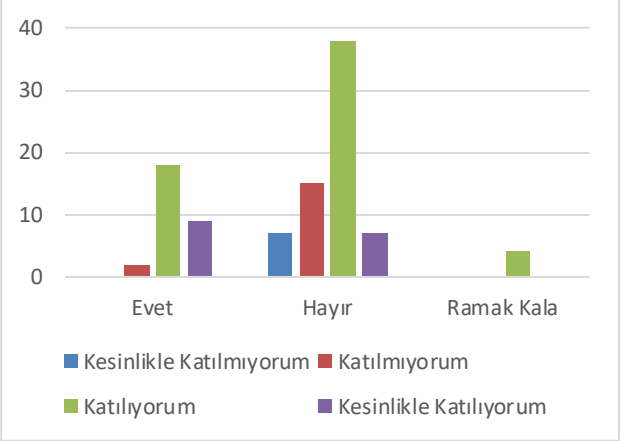
Şekil 32. "Çalışma Davranışlarımız Kontrol Edilmektedir." ifadesine ilişkin dağılımları.

"İş Arkadaşlarımın Kaza Yaşaması Durumunda Onları Nasıl Kurtaracağımı Biliyorum." İçin verilen yanıtlar Şekil 34'te sunulmuştur. Burada katılımcıların %76'sı kontrol mekanizmasının çalıştığı düşüncesinde iken %24'lük kısım bu ifadeye katılmamıştır. Burada, iş kazası değişkenine göre, anlamlı ilişki bulunmuştur (p=0.039<0.05).



Şekil 33. "İş Arkadaşlarımın Kaza Yaşaması Durumunda Onları Nasıl Kurtaracağımı Biliyorum." ifadesine ilişkin dağılımları.

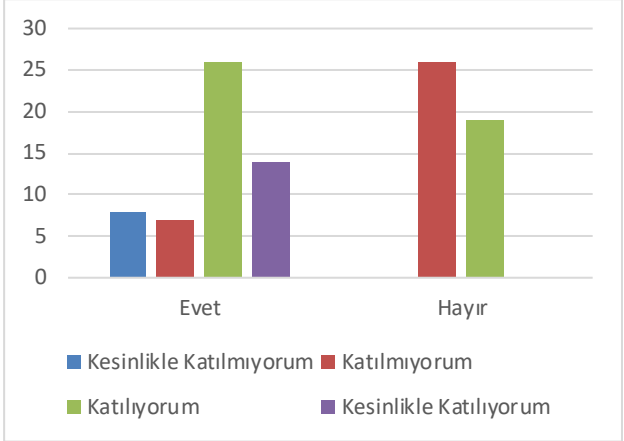
"İş Sağlığı ve Güvenliği Uygulamasının Başlamasıyla İş Yerinizde İş Kazaları Azaldı." Görüşüne ilişkin ağılımlar Şekil 35'de verilmiştir. Bu ifadeye katılım oranı %82 olmakla beraber %18 oranındaki katılımcı bu durum hakkında bilgi sahibi olmadığı belirtmiştir. Bu ifadede, iş kazası değişkenine göre anlamlı bir ilişki belirlenmiştir (p=0.045<0.05).



Şekil 34. "İş Sağlığı ve Güvenliği Uygulamasının Başlamasıyla İş Yerinizde İş Kazaları Azaldı." ifadesine ilişkin dağılımları.

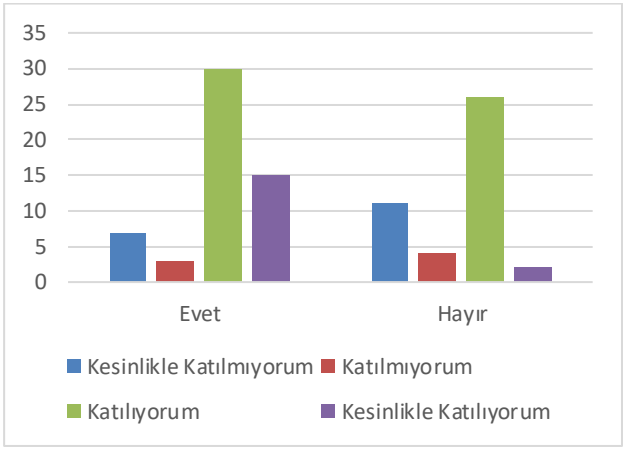
İş Kazasına Şahit olma değişkeni ile ilişkili bulgular

"Doğal Afet Durumunda Ne Yapmanız Gerektiğini Biliyor musunuz?" sorusuna ilişkin dağılım Şekil 36'da verilmiştir. Katılımcıların bu durum karşında yapılması gerekenler hakkında bilgi sahibi olanların oranı %59 iken %41 oranında katılımcı bu soruya olumsuz yanıt vermiştir. Verilen iş kazasına şahit olma değişkenine göre ilişki görülmektedir (p=0.012<0.05).



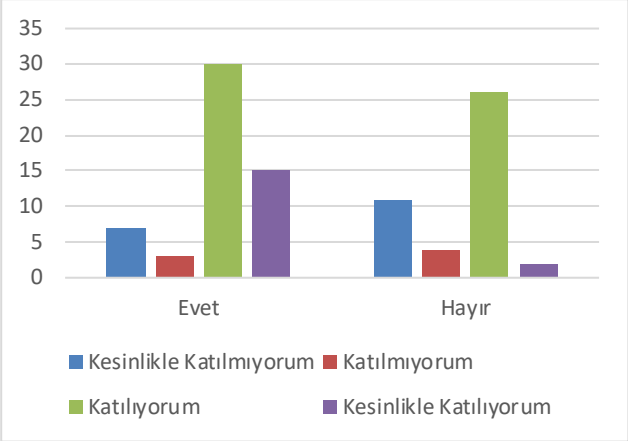
Şekil 35 "Doğal Afet Durumunda Ne Yapmanız Gerektiğini Biliyor musunuz?" ifadesine ilişkin dağılımları.

"Yaptığınız İşle İlgili Karşılaşabilecek Meslek Hastalıkların Farkındayım." İfadesine ilişkin sonuçlar Şekil 37'da gösterilmiştir. Araştırmaya katılanların %75'i bu konuda farkındalığa sahipken %25'lik kısmın ise bilgi sahibi olmadığı görülmektedir. Bu ifade ile iş kazasına şahit olma değişkeni arasına anlamlı bir ilişki bulunmaktadır (p=0.020<0.05).



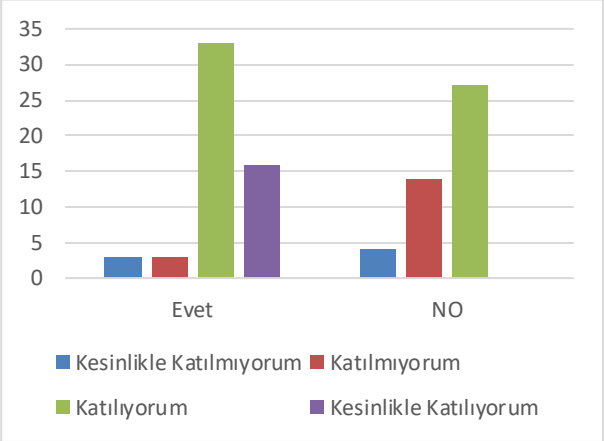
Şekil 36. "Doğal Afet Durumunda Ne Yapmanız Gerektiğini Biliyor musunuz?" ifadesine ilişkin dağılımları.

"Elektrik Çarpmasıyla İlgili Nasıl Kaza Olabileceği Konusunda Bilgi Sahibiyim." ifadesine ilişkin ağılım Şekil 38'de gösterilmiştir. İfade üzerindeki genel dağılım ise %79 oranı olumlu görüş bildirenler, %21 ise olumsuz görüş bilirinler olarak belirlenmiştir. Bu maddenin iş kazasına şahit olma değişkenine göre anlamlı bir ilişkisi bulunmuştur (p=0.039<0.05).



Şekil 37. "Elektrik Çarpmasıyla İlgili Nasıl Kaza Olabileceği Konusunda Bilgi Sahibiyim." ifadesine ilişkin dağılımları.

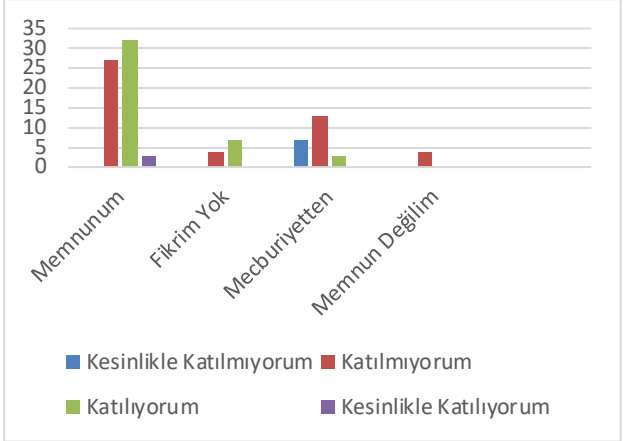
"İş Arkadaşlarımın Kaza Yaşaması Durumunda Onları Nasıl Kurtaracağımı Biliyorum." ile ilgili görüşlerin ağılımı Şekil 39'da görülmektedir. Katılımcıların %76'sı bu urum hakkında bilgi sahibi iken, %24'lük kısım bilgi sahibi olmadığını belirtmiştir. Bu ifade ile iş kazasına şahit olma değişkenine göre anlamlı bir ilişki görülmektedir (p=0.000<0.05).



Şekil 38. "İş Arkadaşlarımın Kaza Yaşaması Durumunda Onları Nasıl Kurtaracağımı Biliyorum." ifadesine ilişkin dağılımları.

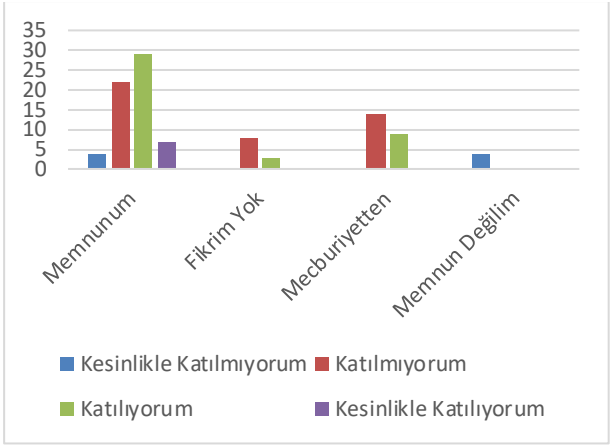
Çalıştığın Kurumdan Memnun Olma Değişkeni ile İlişkili Bulgular

"Şirketinizde İş Sağlığı ve Güvenliği Hakkında Tüm Mevzuat ve Standartlara Uyuluyor." ifadesine ilişkin yanıtlar Şekil 40'da verilmiştir. Bu ifadeye %55 katılım göstermezken %45 olumlu görüş bildirmiştir. Burada iş yerinden memnun olma değişkenine göre anlamlı bir ilişki görülmektedir (p=0.000<0.05).



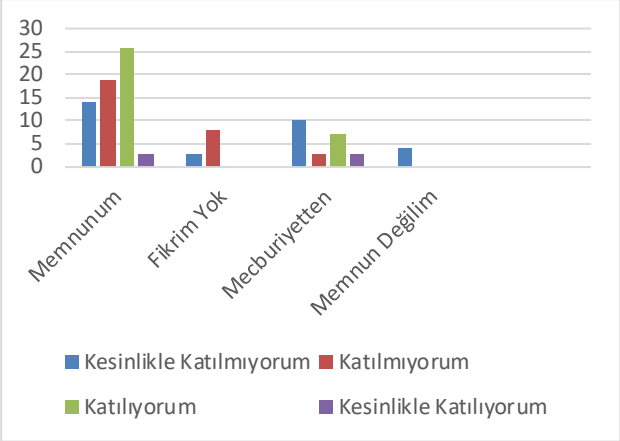
Şekil 39. "Şirketinizde İş Sağlığı ve Güvenliği Hakkında Tüm Mevzuat ve Standartlara Uyuluyor." ifadesine ilişkin dağılımları.

"Sağlık Kontrollerinin Yeterli Olduğunu Düşünüyor musunuz?" sorusuna ilişkin katılımcı yanıtları Şekil 41'de sunulmuştur. Bu ifade %52 olumsuz görüş bilirmiştir. %48 oranında ise olumlu yanıt verilmiştir. Bu soru ile iş yerinden memnun olma değişkeni arasında anlamlı ilişki görülmüştür (p=0.001<0.05).



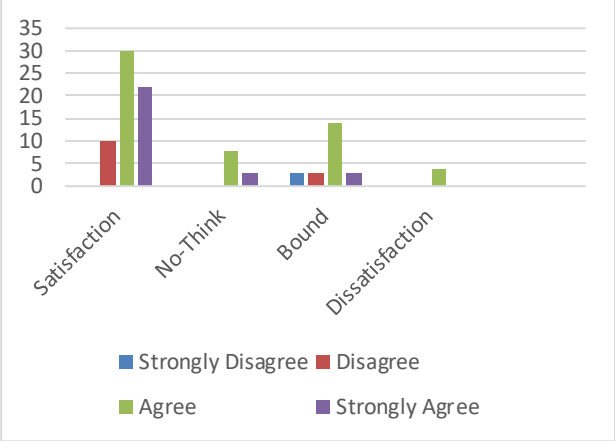
Şekil 40. "Sağlık Kontrollerinin Yeterli Olduğunu Düşünüyor musunuz?" ifadesine ilişkin dağılımları.

"Patlama, Parlama, Yangın ve Yangın Riski Taşıyan İşler Yapmaktayım." ifadesine ilişkin sonuçlar Şekil 42'de verilmiştir. Toplamda % 61 oranında katılım olmadığı, %39 oranında bu ifadeye katılım olduğu belirlenmiştir. İfadenin iş yerinden memnun olma değişkeni ele alındığında göre anlamlı bir ilişki görülmektedir (p=0.036<0.05).



Şekil 41. "Patlama, Parlama, Yangın ve Yangın Riski Taşıyan İşler Yapmaktayım." ifadesine ilişkin dağılımları.

"Yaptığımız İşler Adım Adım Planlanmış ve Tanımlanmıştır." ifadesine ait sonuçlar Şekil 43'de verilmiştir. Bu ifadeyi olumlu yanıtlayanlar %84 iken katılmayanların oranı %16'dır. Bu ifade ile iş yerinden memnun olma değişken arasında anlamlı bir ilişki bulunmaktadır ($p=0.028<0.05$).



Şekil 42. "Yaptığımız İşler Adım Adım Planlanmış ve Tanımlanmıştır." ifadesine ilişkin dağılımları.

5. Sonuçlar

Araştırmamızda sanayi üretiminde elektrikle çalışanların, çalışma hayatlarında iş sağlığı ve güvenliğinin sağlanmasıdır. Ayrıca ve verimli bir iş hayatı ile daha mutlu bir sosyal yaşantıya sahip olabilmeleri için karşılaştıkları veya karşılaşabilecekleri sorunların tanımlanmasıdır. Sonuç olarak sanayi üretimde elektrikle çalışanların, sorunlar ve düzeyleri belirlenmiş ve aşağıdaki sonuçlar elde edilmiştir.

5.1 Demografik Bilgilerine İlişkin Sonuçlar

1. Anket çalışmamıza katılan 100 kişilik araştırma grubumuzun yaşlarındaki dağılımın eşit şekilde dağıldığı görülmektedir. Burada sadece 50 yaş üstü katılımcının %7 olduğu ve çalışan kesimde en düşük orana sahip grup olduğu görülmektedir.

2. alışanların sahip olduğu gelir düzeyi incelendiğinde 1501-2500 TL arası kazanca sahip olanlar %44 ile en yüksek orana sahip grup olduğu belirlenmiştir. 2501-3000 TL alan grup %17 katılım oranı ile en düşük orana sahiptir. Çalışanların çoğu asgari ücret veya biraz üzerindeki rakamlarla çalışmaktadırlar.

3. Araştırmaya katılanların medeni duruma verdikleri cevapta %40'nın Evli ve %60 ise Evli olmadıkları görülmektedir. Evli ve çocuklu çalışanların iş güvenliği konusunda daha dikkatli olması beklenmektedir.

4. Çalışanlardan %86 çalıştığı yere yakın oturmakla beraber, %3'ü şantiyede, yüzde %11'i ise evinden uzakta konaklamaktadır. Ailesinde uzakta kalanların iş güvenliği riski ile daha sık karşılaşabilmektedir.

5.Eğitim durumu incelendiğinde %30 Lisans derecesine sahip iken %4 oranında okuryazar olmadığı görülmektedir. Çalışanların öğretim düzeyinin yüksekliği iş güvenliği konusunda farkındalığa sahip olabilecekleri göstermektedir.

6. Çalışanların %48'i 5 yıl ve üzerinde tecrübeye sahip oldukları görülmektedir.1 yıldan az tecrübeye sahip olanların oranı ise sadece %8.

7. Meslek seçme nedenlerinden aile ve çevre etkisi %37 ile en yüksek orandadır. İşi sevdiği için meslek seçimi oranı ise sadece %7'dir.

8. İş alanlarını incelendiğinde Üretim ve İmalat yapan işletmelerde çalışanların oranı %24 iken Servis ve Bakım alanında çalışanların oranı ise %74'tür.

9. İşletmelerde çalışan kişi sayısı incelendiğinde %51 oranında ki işletmenin çalışan sayısı 1-10 arasından ki küçük işletmeler olduğu görülmektedir. 25 kişi ve üündeki oran ise %20.

10. İşyerine 11-30 dakika içinde ulaşanların oranı %40. 31-60 dakika içinde ulaşanlar ise %10 oranındadır. Çalışanların işyerine yakın yerlerden geldiği görülmektedir.

11. Çalışma sırasında iş kazasına uğramadığını düşünenlerin oranı %67 iken iş kazasına uğrayanların oranı %33'tür.

12. Çalışanların %45'i herhangi bir iş kazasına şahit olmazken %55'lik kısım bir iş kazasına tanık olduğunu belirtmiştir.

13. Anketimize katılanların %62'si işyerinden memnun olduğu belirtmişken kalan kısım çalışmaya mecbur olduğunu ve işyerlerini sevmediklerini ifade etmişlerdir.

5.2 Sanayi Üretiminde Elektrikle Çalışanların İş Güvenliği Hakkındaki Görüşleri Durumlarına İlişkin Sonuçlar

1. Sağlık kontrollerinin yeterli olduğuna ilişkin yanıtlarda firma çalışan sayısı göz önüne alındığında küçük işletmelerde katılmama yönünde katılım olmasına karşı 41 ve üstü çalışan sayısına sahip işletmelerdekilerin bu ifadeye katılım yönünde görüş bildirdikleri görülmektedir. Çalışana sayısı fazla olan firmalarda yaşanabilecek olumsuz durumların yaşanamaması için gerekli önlemleri aldığı ve mevzuatı dikkate aldığı görülmektedir.
2. 'Şirketinizde İş Sağlığı ve Güvenliği Hakkında Etkinlik Düzenleniyor mu?' ifadesinde işletme çalışana sayısı değişkenine göre anlamlı bir fark oluşmuştur. 31-35 çalışanlı firmadakiler bu görüşe kesinlikle katılmayan en büyük grup olduğu görülmektedir. Bu ifadeye katılmayan gruplar ise 21-30 ve 41-45 çalışına sahip grup olduğu görülmektedir. 36-40 kişi çalıştıran firma çalışanları bu ifadeye %91,7 ile katılım gösteren grup olduğu görülmektedir. 46 ve çalışanlarda bu ifadeye tam olarak katılmaktadır. Çalışana sayısının artması Firmaların iş güvenliği ve sağlığı konusundaki etkinlikleri düzenlediği görülmektedir.
3. Çalışanların yaptığı işle ilgili düzenlenen eğitim programına dâhil olup olmadıkları sorulduğundan 35 kişi altında çalışanların bu ifadeye katılmadıkları görülmektedir. 36 kişi ve üstü çalışana sahip işletmeler mevzuatın önerdiği şekilde çalışanlara özel eğitimler düzenlemekte olduğu görülmektedir.
4. Kişisel koruyucu ve donanımların saklanmasının doğru yapıldığı görüşü sorulduğunda tüm grupların bu ifadeye katıldıkları görülmektedir.
5. İş Kazası veya olasılığında işyerinde üretimin durdurulması sorulduğunda çalışanların %73'ü bu ifadeye katıldıkları görülmüştür. En çok katılan ise geliri <1500TL olanların %100'ü bu ifadeye katılmaktadır.
6. İş yerinde iş mevzuatlarının en yoğun şekilde geliri <1500 TL altında olanların, en az da gelir grubu 3001< TL olanlarda uygulandığı görülmektedir.
7. Gelir grubuna göre yaptığı işte özel eğitim aldığını düşünenler %60 oranında olduğu görülmektedir. Gelir grubu <1500 TL altında olanların çoğu bu ifadeye katılmamaktadır.
8. Sağlık kontrollerinin yeterliliğinde gelir grubuna göre %52 bu görüşe katılmadıkları görülmüştür.
9. İş sağlığı ve güvenliği siteminin başarılı olmasının temelinin yönetimden geçtiği görülmektedir.
10. Hak ve sorumluluklarınızı biliyor musunuz sorusuna verilen cevap göz önüne alındığında önemli bir kısmının bilinçli oldukları görülmüştür.
11. Yaptıkları iş ile ilgili karşılaşabilecekleri meslek hastalıklarını konusunda bilgi sahibi olduklarını gözlenmiştir.
12. İş arkadaşının herhangi bir iş kazasına maruz kalmasında nasıl kurtaracağını bildiklerini düşünmektedirler.
13. Doğal afetler konunda oranlar birbirine yakın çıktığı görülmektedir.
14. Çalışanlar yaptıkları işlerle alakalı talimatların olduğu konusunda yeterince bilgi sahibi değillerdir.
15. Sanayi üretimde elektrikle çalışanların %34 elektrik çarpılma riskinin olmadığını belirtmişlerdir.
16. Elektrik çarpılmasına karşı en bilgili olduğunu düşünen grup okur/yazar olmayan grup olduğu gözlenmiştir. Ama statik elektrik tehlikesini de bilmediklerini ifade etmişlerdir.

17. Haklarını ve sorumluklarını, ilkyardım konularında okuryazar olmayan grup kendilerini yeterli görmektedir.
18. Az çalışanların oldukları işletmelerde görev ve sorumluluk alanınla ilgili olarak sağlık, güvenlik, tehlike ve risklerin doğru şekilde belirledikleri görülmüştür.
19. Elektrik çarpılma riski 50 ve daha fazla çalışanın olduğu işletmelerde daha fazla olduğu düşünülmektedir.
20. Çalışan sayısı fazlalaştıkça iş kazası ve olasılığında işin durdurulmayacağını düşünenlerin sayısı artmaktadır.
21. Kişi sayısının az olduğu işletmelerde çalışan davranışları daha az gözlemlediği tespit edilmiştir.
22. Çalışanların büyük çoğunluğu yaptıkları işte parlama, patlama, yangın riski olduğunu düşünmektedir.
23. İş yerine ulaşım süresinin 30 dakika üstünde olanlarda iş sağlığı ve güvenliği üzerine düzenlenen etkinlikler daha fazladır.
24. İş sağlığı ve güvenliği uygulamalarının başlaması iş kazalarının azalttığı düşünülmektedir.
25.İş kazası yaşayanlar çalışma davranışlarının kontrol edildiğini düşünmektedir.
26. İş kazası yaşayanların ve ramak kala olayını yaşayanlar, iş arkadaşının başına iş kazası gelmesi durumunda nasıl davranmasını gerektiğini bildiklerini düşünmektedir.
27.İş kazasını ramak kala yaşayanların iş sağlığı ve güvenliği uygulamalarının işe yaradığını düşünmektedir.
28. İş kazası yaşayanların birim yöneticisi tarafından denetlenmedikleri, en çok ramak kala olayını yaşanların denetlendikleri görülmüştür.
29. İş kazasına şahit olanlar daha çok doğal afet konusunda bilinçli olanlar.
30. İş kazasına şahit olanlar olmayanlara kıyasla meslek hastalıkları konusunda daha bilinçli oldukları gözlenmiştir.
31. Elektrik çarpılma riski konusunda çalışanların bilgi sahibi oldukları gözlenmiştir.
32. İş arkadaşlarının iş kazası yaşaması durumunda nasıl yardımcı olabileceği konusunda iş kazasına şahit olanlar daha çok bilinçlidir.
33. İş yerinden memnun olamayan, mecburi çalıştıklarını ifade edenler mevzuat ve standartla pek uyulmadığını düşünmektedir.
34. İş yerinden memnun olmayanların hepsi kesinlikle sağlık kontrollerinin yetersiz olduğunu düşünmektedir.
35. Çalışanlar yaptıkları işlerin adım adım planlanmış olduğunu düşünmektedir.

6. Öneriler

Kişisel koruyucu ve donanımların şirketler tarafından özenle saklandığı görülmektedir. Bu malzemeler kolay ulaşılabilir olması ve uzun süre kullanılabilmesine etkilidir. Firmaların bu malzemeleri doğru yönde saklamasının önemi anlatılmalıdır.

Sağlık kontrollerinin küçük işletmelerde yeterli olmadığı görülmektedir. Sağlık raporlarının kapsamı genişletilmeli ve bu raporları düzenleyen kurumlar daha fazla denetlenmelidir.

Çalışan sayısı azaldıkça gerek iş sağlığı ve güvenliği eğitimleri, gerekse mesleki anlamda eğitimlerinin yetersizliği gözlenmiştir. Bununla ilgili olarak en başta az çalışan sayısı olan işletmeler olmak üzere verilecek eğitimlerin kapsamı genişletilmeli, iş sağlığı ve güvenliği açısından, çalışan sayısı gözetmeksizin bütün işletmelere uygulanması gerekmektedir. Mesleğin yarattığı riskler için çalışanlar eğitimlerle daha fazla bilinçlendirilmedir.

Çalışanlar iş kazası yaşadıktan veya ramak kala olayını yaşadıktan sonra iş güvenliği eğitimlerinin biraz daha sıkılaştığını ama birim yöneticilerinin ise hala aynı şekilde devam ettiklerini belirtmişler. Çalışanlar iş sağlığı ve güvenliği çalışmalarının yönetimin katısının olacağını ama birim yöneticilerin bilhassa yeterli katkı sağlamadıklarını düşünüyorlar, bununla alakalı olarak yönetim birimi en başta eğitilmesi gerekmektedir. Birim yöneticisi sertifika programları uygulanmalı, sertifikası olmayan yönetici olmamalıdır.

Meslek hastalıkları konusunda iş kazasına şahit olanlar, olmayanlara oranla daha bilinçli olduğu gözlenmiştir. Meslek hastalığı konusunda tüm çalışanlar daha fazla bilinçlendirilmedir. Bu eğitimler sağlık raporu alındıktan sonra verilip istenen tahliller üzerinden anlatılması daha kalıcı etki yaratır.

İş yerinden memnun olmayanların çoğu gerekli mevzuat ve yasalara uyulmadığını düşünmektedir. Çalışma koşullarının denetimi daha sıkı bir şekilde ve cezai yaptırımları daha fazla olmalıdır.

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Mühendislik Öğrencilerinin Seyahat Tercihlerine Göre Sınıflandırılması

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Öz

İstanbul'da yükseköğrenim okumakta olan öğrenci sayısı 2017-2018 eğitim-öğretim yılında yaklaşık 1 milyona ulaşmıştır. Bu sayı bazı ülkelerin nüfusundan daha fazladır. Bu öğrencilerin bir kısmının Türkiye'nin dört bir yanından geldiği de bilinen bir gerçektir. Bu öğrenciler, düzenli olarak kendi memleketlerine seyahat etmektedir ve seyahat tercihleri de seyahat firmaları tarafından başlıca unsurlardan biri olarak görülmektedir. Bu çalışma; bahsedilen seyahat firmalarının, yükseköğrenim öğrencilerine yönelik pazarlama amaçlı çalışmalarında kullanabileceği bir içgörü sunmaktadır. Bu çalışmanın amacı Marmara Üniversitesi'nde öğrenim görmekte olan mühendislik öğrencilerinin şehirlerarası seyahat tercihlerini araştırmaktır. Bu çalışmada, 260 mühendislik öğrencisine 26 soru ve 9 bölümden oluşan bir anket uygulanmıştır. Demografik bilgilerin haricinde, öğrenciler; en çok seyahat edilen şehirler, tercih edilen seyahat türü, seyahat sırasında tercih edilen firmalar, seyahat bileti satın alma tercihleri ve şehirlerarası seyahat ederken karşılaştıkları problemler hakkında sorular yanıtladılar. Dikkat edilmesi gereken bir nokta, bu çalışma için sadece kategorik değişkenlerin kullanılmış olduğu dikkate alınmalıdır ve öğrencilerin seyahat tercihleri ile ilgili tutumlarının sonuç olarak dikkate alınmadığı göz önünde bulundurulmalıdır. İlk olarak anket verisinde yapılan analizler; betimsel istatistiksel analizler ve ardından çeşitli değişkenlerin bağımsızlık durumu için yapılan chi-kare testlerinden oluşmaktadır. Sonrasında yapılan analizler Hiyerarşik Dendogram, Yığılma Tablosu ve K-Means algoritmasını içermektedir. Yığılma Tablosu için Ward's linkage kullanılmıştır. Dirsek noktası 222. noktada işaretlenmiştir. Bu değeri kullanarak, K-means algoritmasındaki küme sayısı 6 olarak belirlenmiştir. Son olarak, mühendislik öğrencileri 6 küme içerisinde sınıflandırılmıştır ve bu kümelerin özellikleri verilmiştir.

Anahtar kelimeler
Sınıflandırma; K-means algoritması; Kümeleme; Seyahat Tercihleri

Classification of Engineering Students for Traveling Preferences

Abstract

Higher education students in Istanbul was nearly one million in 2017-2018 academic year, which is more than some countries' population. It is known that a portion of them are coming to Istanbul from all around Turkey. These student travel to their hometowns regularly, and their preferences are thought to be essential for traveling companies. This research offers an insight to these companies when they provide campaigns for marketing purposes to university students. The aim of this paper is to investigate intercity travelling preferences of engineering students in Marmara University. A survey with 9 sections and 26 questions is conducted on 260 engineering students. Apart from demographics, the students answered questions on their most frequently visited cities, preferred mode of transportation, companies they choose while traveling, ticket purchase preferences, and problems that they come across during intercity travel. Note that, only categorical variables are collected for this study and students' attitude on choosing the traveling mode isn't projected hereby. Former analysis conducted on survey data is descriptive statistical analysis, following are chi-square tests for

Keywords
Classification; K-means algorithm; Clustering; Traveling Preferences

independence of several cross variables. Latter analysis consists of Hierarchical Dendogram, Agglomeration Schedule and K-means algorithm. Ward's linkage is used for Agglomeration Schedule. Elbow point is indicated at 222nd point, using this value the number of clusters for K-means algorithm is selected 6. Finally, the engineering students are classified into 6 clusters and their cluster characteristics are provided.

1. Introduction

This study is researched for determination of traveling preferences and their reasons with conducting an online survey to the respondents from engineering students who are from different departments in Marmara University.

The results from the respondents (students) whose families are living in another city are important because these students generally travel intercity more than other students and it is expected that their rate of consciousness is higher in traveling decisions.

The main aims of the study are finding what affects the decisions of students on traveling especially in intercity travels (i.e. money, time, distance, service quality, etc.), classifying the students according to their traveling preferences (i.e. preferring airway, railway or road) and preparing a valuable research on that topic which can be helpful to tourism companies such as airlines, bus companies, etc. In addition, this research offers an insight to these tourism companies about when they make campaigns to reach more students and make much money.

On the topic of traveling preferences there are limited number of valuable studies which can be helpful to the tourism companies in Turkey. This problem causes unconscious campaigns and waste of money which target the young people between 18 and 25 years old. As an illustration, if a company make a discount on tickets at the rate of 50% in first week of the January to the students who are registered to their loyalty program, their expectations about the increase in sales will be failed probably because majority of the students won't travel during their final exams period.

While applying the survey, the main challenge that is met are the participants who give answers without consistency and accuracy. In order to prevent related problems, the number of questions in the survey is a wide area about intercity traveling. The survey researched customer preferences in many aspects.

The rest of the paper is as follows. Section two presents the literature review. Section three gives a brief information about methodology and analysis conducted. Section four consist of survey parts and each part gives the descriptive analysis about the participants. Section five explains clustering application and shows the variables that are used in clustering. Section six provides information about the six clusters' characteristics and Section seven concludes the study.

2. Literature Review

Keskin (2007) studied about the factors that are affecting the intercity traveling preferences of university students within the scope of least squares method and Tobit model. In the data, the main variables as distance between university and the hometown, grade, grade point average (GPA), and gender of the student, size of the family, and household income. Also, Acikalın (2014) examined the traveling preferences of the university students and the demographic, economic effects on these preferences and the long-distance, short-term traveling preferences. Results of the surveys has three main factors: i) demographics of the participants ii) transportation vehicles iii) important factors on the preferences Inner city and upstate traveling preferences were examined in detail. And on different continent, Slabbert and Van Der Merwe (2012) studied about the travel behavior of South African tourism students. Main focus areas on the survey is demographic characteristics,

holiday preferences, travel types, and motivations on traveling.

Chiou and Chen (2010) investigated the service expectation and perception, passenger satisfaction, airline image and behavioral intentions of the Low Cost Carriers (LCC) services. Then, validated results compared with the Full Service Carriers (FSC). And on this topic, Lin and Huang (2015) aimed to develop and evaluation model to determine the relative weights of the factors influencing passenger choice of LCCs through Analytic Network Process (ANP) during group decision-making. ANP was utilized to solve multi-criteria decision-making problems in which the criteria affect passenger choice of LCCs. On this topic, Buaphiban and Truong (2017) examined how Southeast Asian passengers' attitudes and behaviors affect their purchase of LCC tickets. Lu (2017) searched that low cost and full service carries in Taiwan and compared them in many aspects. Data was collected from an online survey which is made before by different company and assessed the potential of principal component analysis with biplot technique to define different passengers based on their preferences of services and valuations of the importance of factors. Koklic et al. (2017) investigated relationship between customer satisfaction and service quality. Authors compared two airline types: LCC and FSC.

Shields, P. O. (2011) aimed to determine the impact of wanderlust on past travel profiles, attitudes toward travel destinations for business and leisure. Also impact of gender on travel related attitudes and behaviors was the another aim.

Valdes (2015) investigated what effects on the air travel demand for Middle Income Countries (MICs). Data of 32 countries during the period between 2002 and 2008 were used.

Losada et al. (2016) aimed to identify the variables that influence the travel frequency of Spanish seniors, one of the most important collectives for the tourism industry given its high travel frequency which depends on variables determining travel participation. Tomsic et al. (2016) investigated the relations between the old users who are using the Ljubljana city buses, their traveling habits, and their physical (dis)abilities.

Celikkol et al. (2017) examined the demand and usage of High-Speed Rail (HSR). Aim of the survey was clarifying travel preferences of HSR users. The survey includes questions about socio-demographic data (gender, age, household income, occupation, etc), the rating of 6 factors (travel time, cost, safety, punctuality, comfort, and environmental sensitivity) with the 4 levels of importance, traveling modes depending on the purpose, and HSR usage.

Graham and Metz (2017) prepared a paper which aimed to analyze the characteristics of infrequent flyers and the reasons for their travel habits, using the United Kingdom (UK) as a case study. In this research, data from the UK, Germany, Belgium, and Netherlands was used.

Yaylalı and Dilek (2017) examined the factors affecting the airline company preferences of the persons in domestic travels. The factors were subjected to the 5-point Likert analysis. For all of the airline companies; ticket prices, along with timely departure-arrival, safety, comfort, and cancellation status of the flights were factors that having the highest averages.

Katona et al. (2017) used in this research based on a previous research a multimodal technic. Routing algorithm was developed and prepared to recognize and take into account the habits of the travelers, to reach this a model was constructed which involves these parameters.

De Vos (2018) investigated that travel mode is affected by travel related attitudes of people. According to collected data, people are separated with their socio-economic and demographic characteristics.

Kouwenhoven and de Jong (2018) searched for empirical evidence to support that the value of travel time can theoretically be defined as the opportunity cost of travel minus the direct utility from spending the time during the trip. The topics which analyzed are effect of finding a shorter trip useful and a longer trip very inconvenient, effect of

having devices available during a trip and effect of being able to spend travel time in a useful way.

18 articles were analyzed and summarized. Generally, the articles are searched for answers to these types of questions:

- What exactly do they want to research about travelling preferences?
- Which methods are used by researchers?
- How do they use different methods for their data?
- How do they select their respondents?
- How do they categorize the respondents?
- How do they create a survey about travelling preferences?

In general, answers to such questions were sought. The answers found shed light on us for this study. It was understood which methods are used in the articles. Considered issues were taken in the creation of the questionnaire created. In these surveys, it was seen which questions categorized the respondents.

3. Methodology

In this study, intercity travelling preferences Marmara University is investigated with an empirical survey. The survey is designed after a literature review of previous studies. The survey is focused on demographic information, most frequently visited cities, preferred mode of transportation, companies they choose while traveling, ticket purchase preferences, and problems that they come across during intercity travel. The 26 questions are prepared with that considerations and survey is prepared and started to apply on respondents who are engineering students in Marmara University. The survey is applied with Google Forms and answered by 260 respondents between December 2018 and March 2019. The descriptive analysis is applied after the application which includes preprocessing of data in order to make proper analysis. For the descriptive analysis part, some inferences are obtained, and results are examined with chi-square tests for independence of several cross variables. Finally, clustering analysis is applied on the data set in order to group students according to their preferences. The analysis includes Hierarchical Dendrogram, Agglomeration Schedule and K-means algorithm. Ward's linkage is used for Agglomeration Schedule. The methodology is shown in (Figure 3.1).

4. Data

Survey consists of 8 sections and 26 questions. 260 students who are studying at Marmara University Faculty of Engineering participated in the survey. The results of the questionnaire include the personal information of the students, their income status, the cities they travel, the reasons for traveling, their travel frequencies, travel mode and the campaigns preferred.

4.1. Personal Information

This section contains 6 questions which include gender, age, living area, grade, personal and family income to find out participants' demographic information (Figure 4.1.1 and Figure 4.1.2).

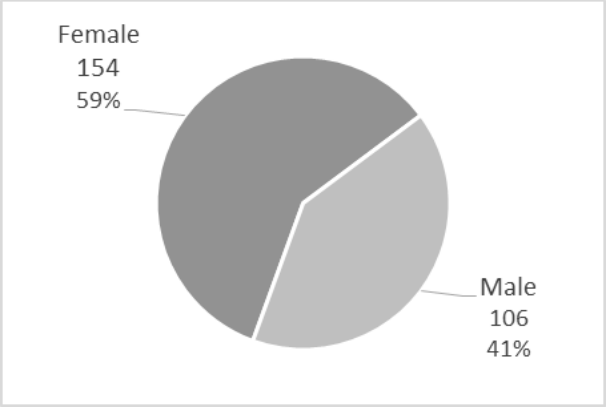

Figure 4.1.1. Distribution of Gender

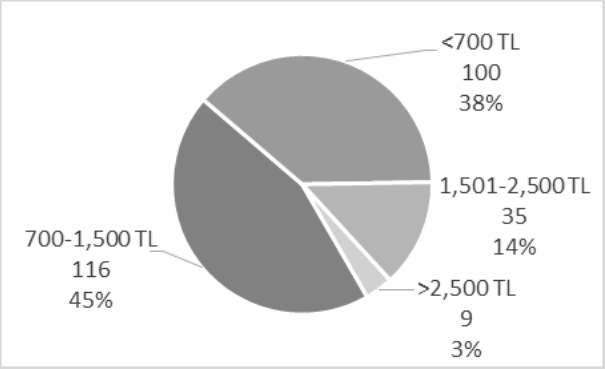

Figure 4.1.2. Distribution of Personal Income (TL)

4.2. Traveling Regions

In this section, most three visited cities are surveyed. Since there are 81 cities in Turkey, wide variety of cities are collected. Therefore, the cities are grouped according to their regions (Table 4.2.1).

Table 4.2.1. The most visited regions

Regions	Frequency	Percentage
Marmara	103	40 %
Aegean	56	21 %
Black Sea	34	13 %
Mediterranean	29	11 %
Central Anatolia	29	11 %
Null	7	3 %
Eastern Anatolia	2	1 %

4.3. Traveling Reasons

In this section, the traveling reasons of respondents and their traveling motivations are requested. Respondents could select more than one reason (Figure 4.3.1).

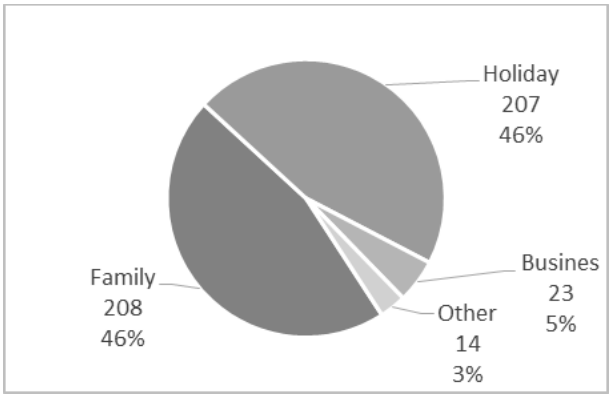

Figure 4.3.1. Traveling Reasons

4.4. Transportation Preferences

This section contains 4 questions which include travel mode, reasons to choose that travel mode, the time they prefer to travel and car sharing preferences (Figure 4.4.1 and Figure 4.4.2).

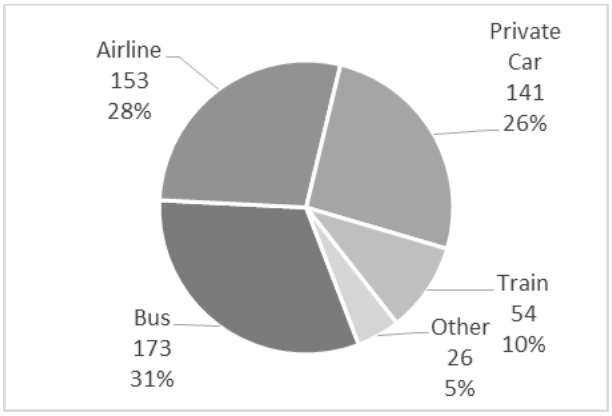

Figure 4.4.1. Travel Mode

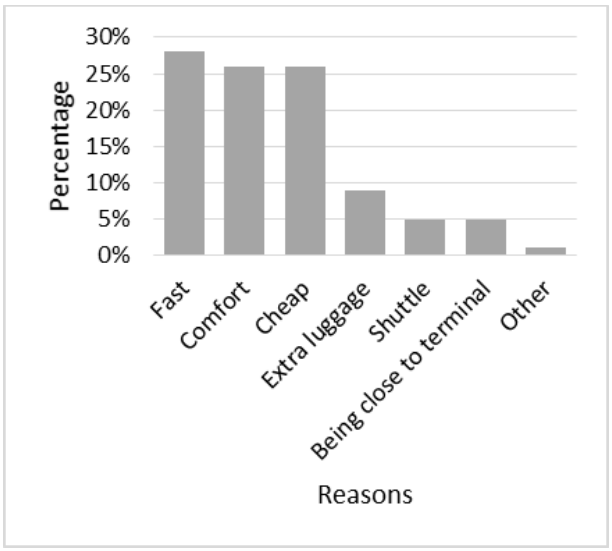

Figure 4.4.2. The reasons to choose that travel mode

4.5. Travel Frequency and Purchasing Types

In this section, five questions are asked which are about ticket purchasing type, preferences about search engines, payment choice, traveling frequency and traveling period (Figure 4.5.1 and Figure 4.5.2).

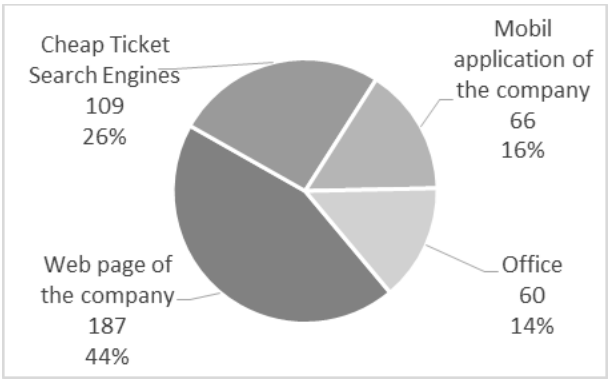

Figure 4.5.1. Ticket Purchasing Types

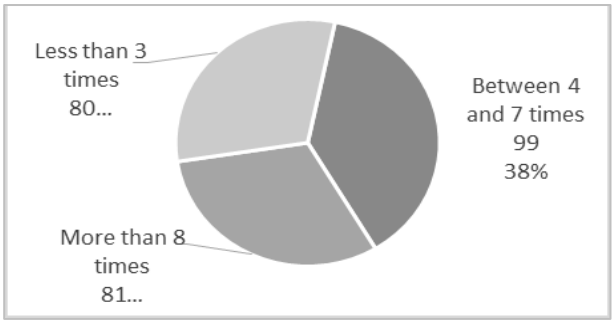

Figure 4.5.2. Traveling Frequency (in a year)

4.6. Airline Company Preferences

This section is about respondents' airline company preferences and the reasons to choose that company (Figure 4.6.1 and Table 4.6.1).

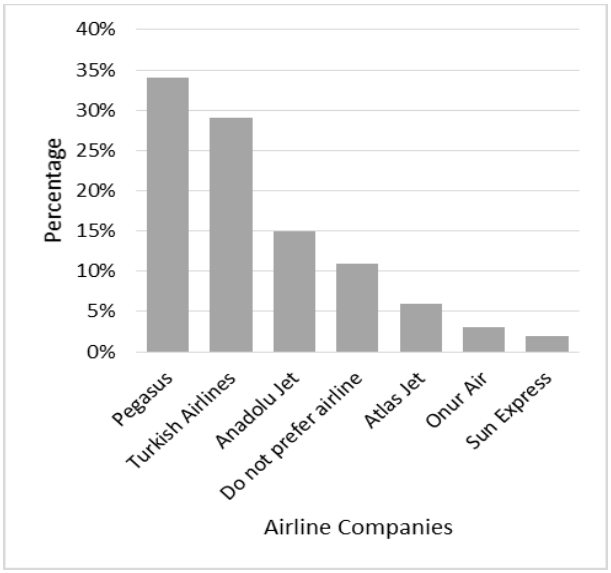

Figure 4.6.1. Airline Company Preferences

Table 4.6.1. The reasons to choose that company

	Frequency	Ratio
Ticket Price	168	39 %
Customer Relationship	77	18 %
Do not prefer airline	52	12 %
Catering	51	12 %
No Delay	47	11 %
Free Seat Selection	29	7 %
Lounge Service	5	1 %

4.7. Bus Company Preferences

This section is about respondents' bus company preferences and the reasons to choose that company. (Table 4.7.1 and Figure 4.7.1)

Table 4.7.1. Bus Company Preferences

	Frequency	Ratio
Kamil Koç	142	31 %
Pamukkale	102	22 %
Metro	55	12 %
Ulusoy	52	11 %

Other	45	10 %
Nilüfer	34	7 %
Do not prefer	32	7 %

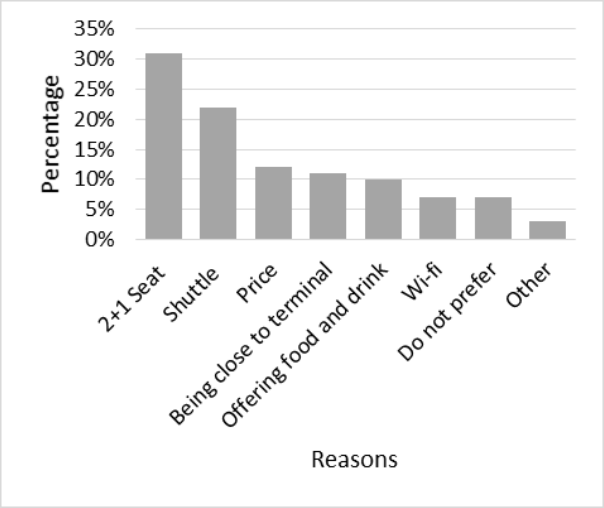

Figure 4.7.1. The reasons to choose related company

4.8. Campaigns and Problems

This section contains four questions about the being informed by the campaigns, variety of campaigns, reservation dates and traveling problems (Table 4.8.1 and Figure 4.8.1).

Table 4.8.1. Campaign Types

Campaigns	Frequency	Ratio
Two-way ticket	104	40 %
Early reservation	76	29 %
Mobile application	44	17 %
Loyalty program	19	7 %
Mile campaign	12	5 %
Null	5	2 %

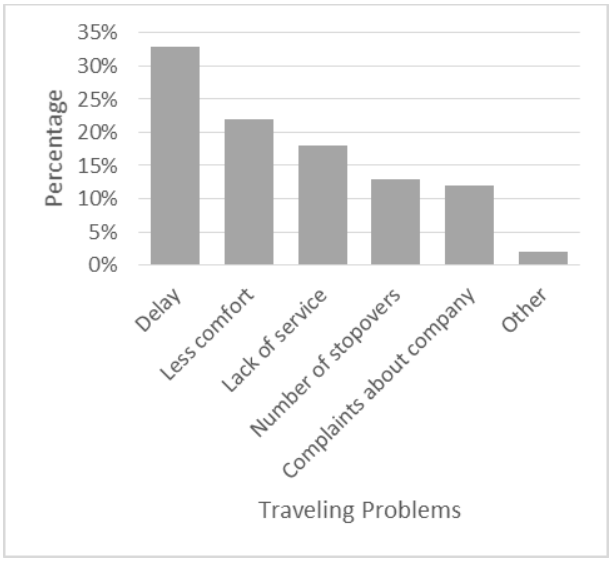

Figure 4.8.1. Traveling Problems

5. Clustering Application

Clustering is the best-known data mining method used to classify observations into homogeneous groups (Giudici and Figini (2009)). In this study, clustering is applied on the data set in order to group students according to their traveling preferences. Hierarchical Dendrogram, Agglomeration Schedule and K-means algorithm are implemented for clustering purposes.

From the survey questions 15 variables are selected for analysis. (Table 5.1) Note that, 260 students answered the survey, however due to missing values 228 of them are used in clustering analysis. First a Hierarchical Dendrogram is produced, continuing with an Agglomerative Schedule using Ward's linkage method. In order to determine the number of clusters an Agglomeration Graph is drawn in Figure 5.1. The Elbow point in Figure 5.1. is used to decide on the number of clusters. It is clear that the breaking point is on 222th point. After this point, fast increments are observed and 228-222=6 clusters are appropriate for this study. Hence, 4 and 5 clusters with k-means is also analyzed and revealed that with 6 clusters a more suitable distribution of the students is obtained.

Table 5.1. Variables and their options

Variable	Alternative Choices
Gender	Female, Male
Age	18-20, 21-23, Above 23
Living Area	Dormitory, Separate house, With family, With relatives
Grade	Prep class, 1st grade, 2nd grade, 3rd grade, 4th grade
FamIncome	< 2000 TL, 2000-5000 TL, 5001-8000 TL, > 8000 TL
PerIncome	< 700 TL, 700-1500 TL, 1501-2500 TL, > 2500 TL
Trav1stRegion	Marmara, Aegean, Black Sea, Mediterranean, Central Anatolia, East Anatolia, Southeastern Anatolia
Trav1stReason	Family visit, Vacation, Business trip, Other
Transport1st	Bus, Airline, Train, Private car, Other
Transport1stReason	Comfort, Velocity, Price, Being close to terminal or airport, Extra luggage, Shuttle service, Other
TravTime	Night, Day, Both
CarSharing	Yes, No, I do not travel by car
TicBuy1st	Company's website, Ticket engine, Mobil app, Agency
TicEng1st	Skyscanner, ucuzabilet, aerobilet, obilet, turna.com, kiwi.com, I do not use ticket engines
PayChoice	Cash, Credit card (One), Credit card (Installment), Transfer/EFT, BKM Express, Other
TravelFreq	3 or less in a year, between 4 and 7 in a year, more than 8 in a year
WhenTravel	After first exam week, After final exam week, Public holiday, Summer holiday
Air1st	Turkish Airlines, Pegasus, Atlas Jet, Onur Air, Sun Express, AnadoluJet, I do not travel by airline
AirReason1st	No delay, Catering, Price, Customer relationship, Lounge, Free seat selection, I do not travel by airline
Bus1st	Pamukkale, Kamil Koç, Nilüfer, Uludağ, Ulusoy, Metro, Çanakkale Truva, Vivalines, I do not travel by bus
BusReason1st	Catering, Price, Shuttle service, Easy access, 2+1 Seat selection, Wi-Fi, Meal Service
CampInform	Family and friends, Internet, TV advertisement, Newspaper
WhichCamp	Early reservation, Return-ticket advantage, Mile campaign, Membership program, Special offer for mobile app
WhenBuyTic	0-2 weeks ago, 3-5 weeks ago, More than 5 weeks ago
TravProb1st	Delay, Lack of service, Low comfort, Excessive number of breaks, Complaints about facilities

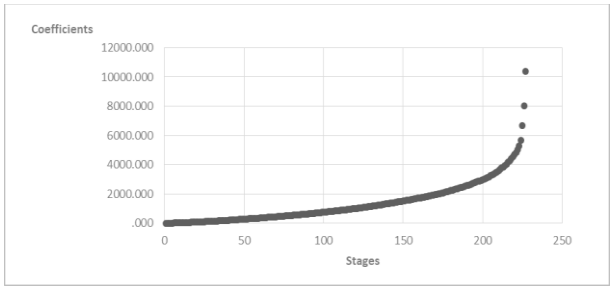

Figure 5.1. Agglomeration Graph

6. Cluster Characteristics

In this section, 228 students are classified using 15 different variables into 6 clusters. Table 6 with the help of found correlations in each cluster, engineering student's answers about traveling preferences are seen that in which points they grouped together and according to findings, clusters are interpreted.

Marmara region is the most visited region for the Cluster 1, Cluster 2, Cluster 4, and Cluster 5. However, it is not traveled region for the Cluster 3 and Cluster 6. Cluster 3 and Cluster 6 are generally divided by three regions which are Black Sea, Mediterranean and Central Anatolia (Figure 6.1).

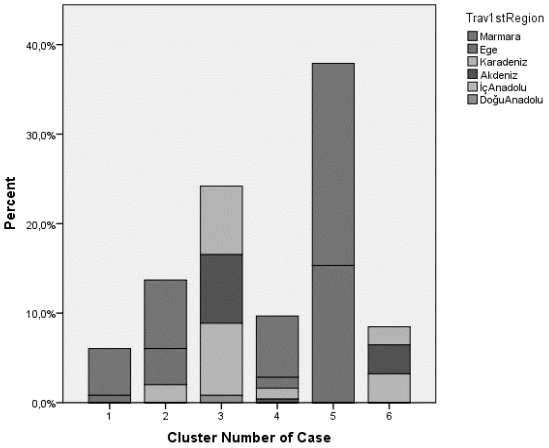

Figure 6.1. Traveled regions in each cluster

All kind of family incomes have distributed to the each of the six clusters. 2,000-5,000 TL is the dominant family income for all clusters. The highest ratio of family income which is more than 8,000 TL belongs to Cluster 5 (Figure 6.2).

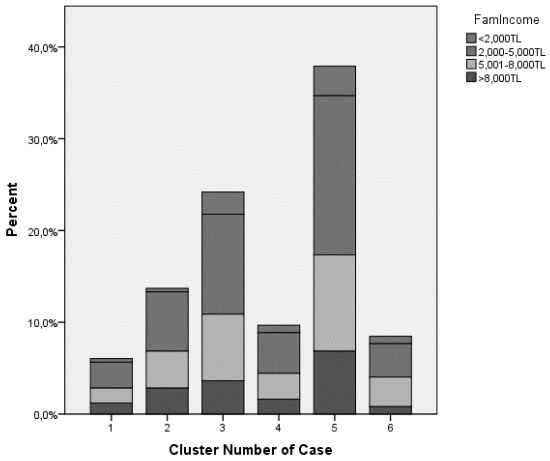

Figure 6.2. Family income in each cluster

Generally, <700 TL & 700-1,500 TL are distributed to the each of the six Clusters. Personal Income that is more than 2,500 TL is only found in Cluster 2, Cluster 3, and Cluster 5 with low percentage. There are no students with personal income over 2500 TL notwithstanding there are students with family income over 8000 TL in the Cluster 1 (Figure 6.3).

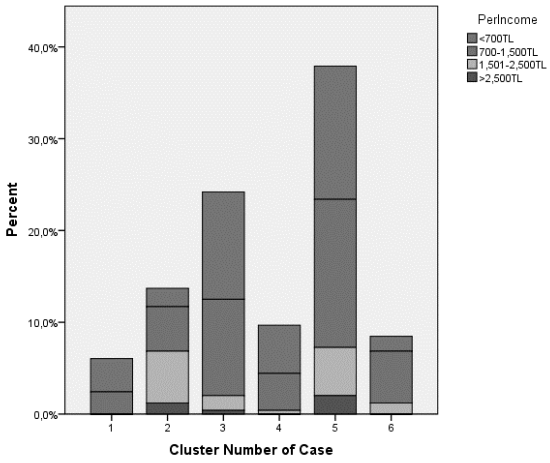

Figure 6.3. Personal income in each cluster

Bus and plane are the most preferred transportation type except Cluster 4. Because Marmara Region and Aegean Region is close to the Istanbul, bus is the most used transportation type for Cluster 1, Cluster 2, and Cluster 5. Private Car is the dominant travel mode for the Cluster 4 (Figure 6.4).

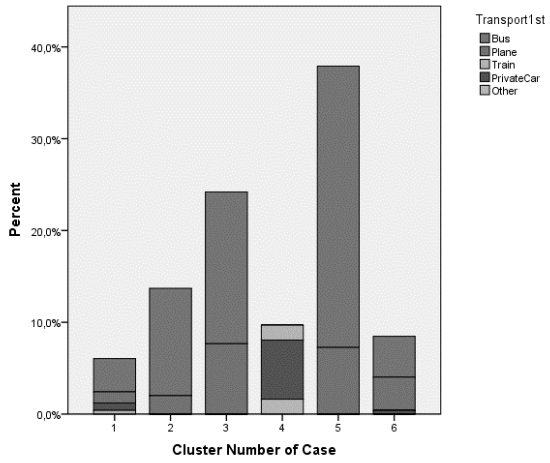

Figure 6.4. Preferred transportation in each cluster

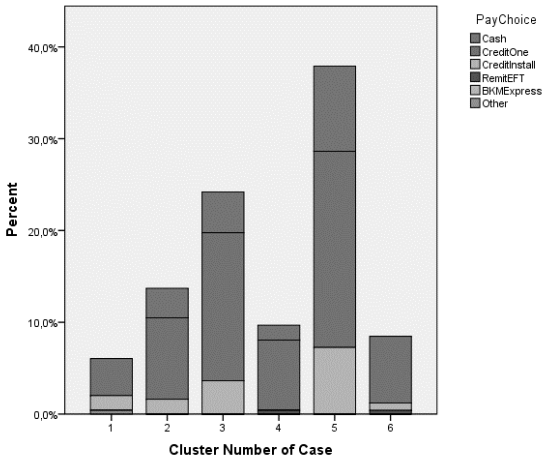

Figure 6.6. Payment choice in each cluster

The option of web sites of the companies has the maximum percentage for each cluster. Agency option is not be included in Cluster 1 and Cluster 6. (Figure 6.5).

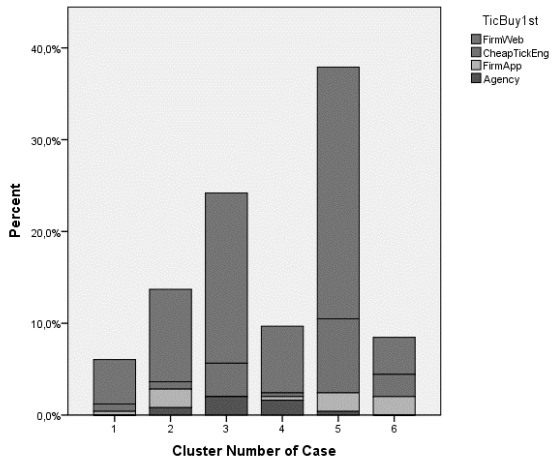

Figure 6.5. Ticket purchasing way in each cluster

Credit card for single payment is used dominantly for each Cluster. Cash option is not be included in Cluster 1 and Cluster 5. Remit/EFT and other options is rarely used (Figure 6.6).

Most of the students prefer traveling at summer. All the options are available in each cluster with certain percentages (Figure 6.7).

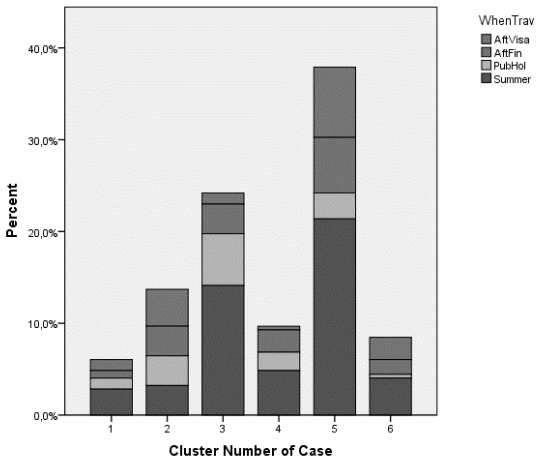

Figure 6.7. Traveling period in each cluster

Traveling frequency is equally distributed between less than 3 and 4-7 at all Clusters except at Cluster 2. All kind of traveling frequency equally likely distributed at Cluster 4 and most of the people who are at Cluster 4 generally pay their tickets by credit card with single payment (Figure 6.8).

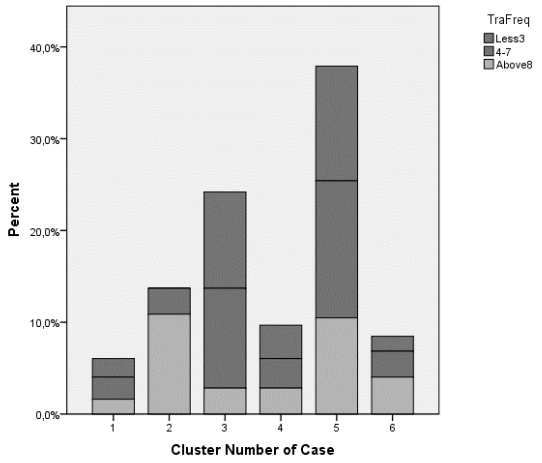

Figure 6.8. Traveling frequency in each cluster

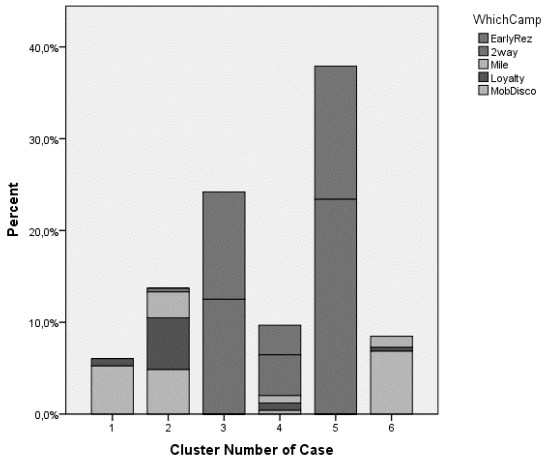

Figure 6.10. Preferred campaigns in each cluster

Internet is the favorite platform that people being aware of the campaigns in each cluster. The second option is from family and friends as seen (Figure 6.9).

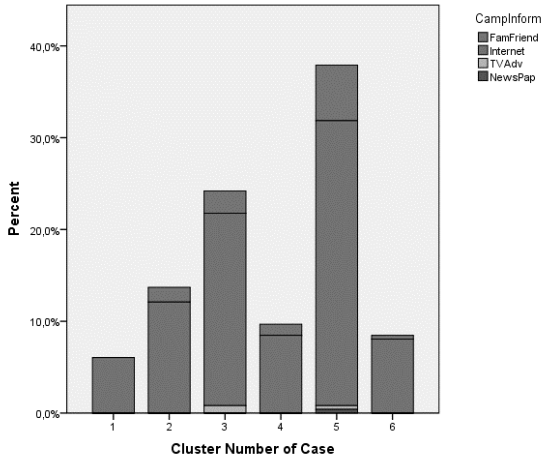

Figure 6.9. Platforms to hear campaigns in each cluster

Early reservation and 2-way tickets campaigns are equally distributed and fundamental choices for the Cluster 3 and Cluster 5. Most of the people who are at Cluster 3 and Cluster 5 prefer traveling at summer. This means that most of them use plane at summer. Special discounts for mobile application is favorite campaign for Cluster 1, Cluster 2 and Cluster 6 (Figure 6.10).

Late arrive is the basic traveling problem for each of Cluster. Because bus is not preferred in Cluster 4, there is no stop over problem in Cluster 4 (Figure 6.11).

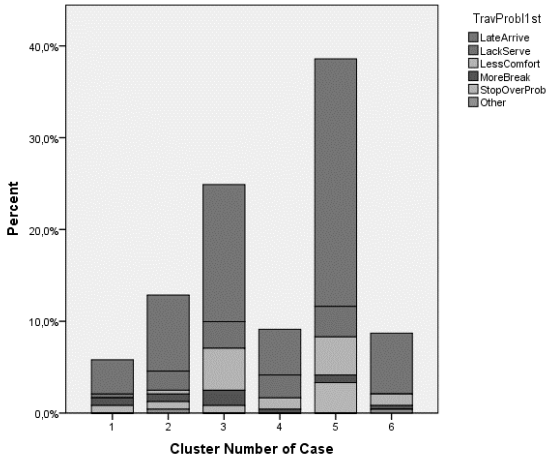

Figure 6.11. Traveling problems in each cluster

Buying tickets 0-2 weeks ago, before traveling is the dominant behavior. Ratios of buying tickets above 5 weeks ago are higher in Cluster 3 and Cluster 5. It is connected by early reservation and 2-way tickets campaigns (Figure 6.12).

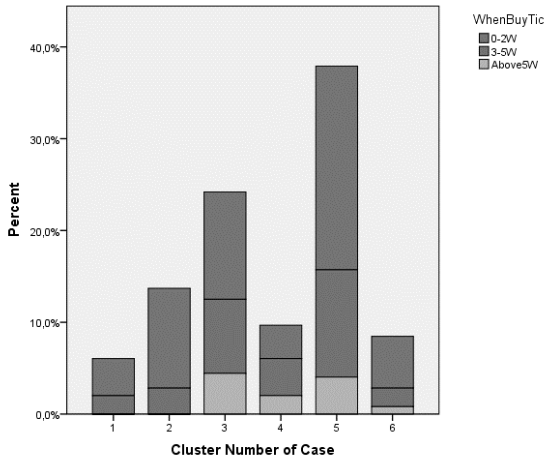

Figure 6.12. Time to buy tickets in each cluster

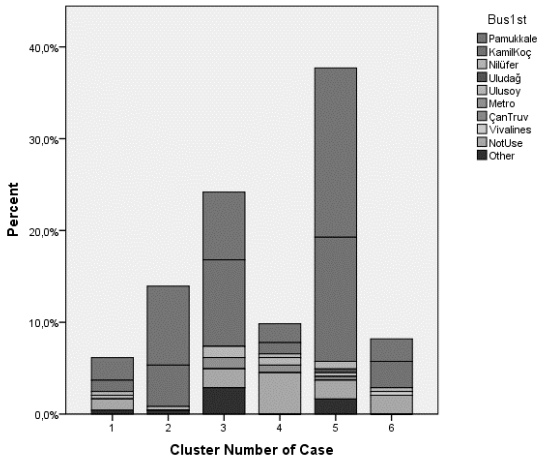

Figure 6.14. Preferred bus companies in each cluster

Turkish Airlines is the favorite airline company for each Cluster. Ratio of people who do not use air plane in Cluster 2 and Cluster 5 is high. Because, Marmara region has the highest ratio at most traveled region chart in Cluster 2 and Cluster 5. There is no any flight from Istanbul to any city which is located at Marmara region (Figure 6.13).

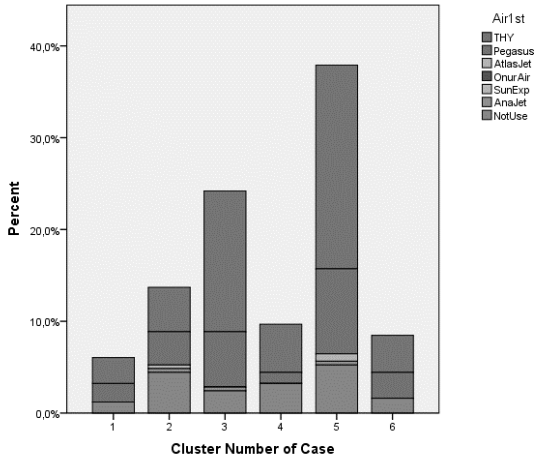

Figure 6.13. Preferred airline companies in each cluster

Pamukkale and Kamil Koç are the dominant bus companies for each Cluster. Çanakkale Truva is widely used in Cluster 4 (Figure 6.14).

As a result of the information obtained from the survey, 72.5% of students buy their tickets from firms' web site. 64% of these students' payment way is cash or remit. Payment by credit card with one installment is preferred payment choice with 68.9% by participants who are using firms' web site, cheap ticket engine or companies' mobile application. Payment by credit card with one installment is the most preferred payment type for all clusters. Cluster 1 has only 15 members. Most of the members are gathered in Cluster 5 with 37.9%. 79.4% of students who are in Cluster 2 travel more than 7 times in a year. No one who uses cheap ticket engine and agency to buy ticket, travel more than 8 time in a year. In Cluster 4, no one prefers bus and plane for the first transportation choice. Marmara and Aegean regions are the most traveled regions for participants who are in Cluster 5 and whose the most demanded transportation mode is bus or plane. Students who are in Cluster 5 do not prefer special discounts for mobile phone campaigns. 67.7% of participants who are in Cluster 5, prefer loyalty and mile campaigns. It is seen that no student who belongs to Cluster 1 uses 2-way and early reservation campaigns. In addition, only one student who belongs to Cluster 2 and use 2-way and early reservation campaigns, prefers bus and plane. 60 people who all of arxe in Cluster 3 and prefer bus or plane for the first traveling mode and use 2-way or early reservation campaigns go to Central Anatolia, Mediterranean, Black Sea or

Eastern Anatolia. The cluster characteristics are provided in (Table 6.1).

7. Conclusion

The starting point of this study was preparing a resource to tourism companies in Turkey with reference to customers that are traveling regularly over the year. In this manner, university students are selected as the framework. Istanbul which includes many universities that have students from every city of Turkey is selected for main working area. Then, students on Marmara University engineering faculty are selected as sample group to application of survey.

The survey was consisting of 26 questions in 8 sections and applied to 260 respondents from Marmara University Engineering Faculty students. The information such as personal information, preferred traveling modes, companies, problems, etc. is collected.

Discrete statistics methods and clustering are applied on the data set in order to group students according to their traveling preferences. Hierarchical Dendrogram, Agglomeration Schedule and K-means algorithm are implemented for clustering purposes.

The discrete statistics methods are resulted with some answers to questions of how students are traveling, where they are going, how they are buying tickets, which campaign types are affecting them, what problems they are facing with, etc. The clustering methods are resulted with 6 clusters which includes engineering students that have more similar characteristics to each other.

After deciding cluster numbers by using agglomeration graph, their characteristics are investigated by examining and deciding dependent and independent variables. Also 50 parent nodes and 10 child nodes are applied in CHAID method on clusters.

When the first traveling mode is taken a dependent variable, it is observed that 66.5% of participants choose bus. 50% of students who are in Cluster 1, Cluster 3, Cluster 6 and whose family income is less than 2,000 TL choice is bus. In addition, ratio of students who are in Cluster 2 and Cluster 5 pay tickets with credit one is 81.3%. These whose traveled first region is Marmara, Black Sea and Aegean do not prefer train, private car and other.

Moreover, first ticket buying option is selected as a dependent variable, 72.5% of respondents are observed that they prefer firm's website to buy a ticket and among the whose choice is credit install, credit one or other for buying ticket, 74.5% of them prefer web sites. Also these whose first travel preferences are bus, private car or train prefer firm web site as 80.5% to buy a ticket.

Respondent's answer observed that they prefer credit one as 65.9% as a payment choice when payment choice is selected as dependent variable and 68.9% of respondents who use firm website, cheap ticket engine motors or firm's application to find tickets prefer credit one as a payment choice. In cluster 4 and 6, people choices for payment is observed as 89.8% as a favor of credit one and in cluster 2, 5 and 3; credit one has a ratio of 63.3%. Among whose first transportation choice is bus or plane, it is got that none of the respondent's prefer remit EFT or other options than cash, credit one or credit install.

When traveling frequency is selected dependent variable, frequency of between 4 or 7 has a ratio of 38.1%. In cluster 1, 5, 4 and 6; 37.7% of respondents are observed that they travel between 4 or 7 in a year and among whose personal income is between 700 TL and 1500 TL, 42.9% of them travel between 4 or 7. Also people who use cheap ticket engine or agency to buy a ticket travel less than 3 times in year with 72.2%.

Among persons whose first traveling choice is bus or plane, 42.7% of them form cluster 5 when cluster number of case is selected as dependent variable and in cluster 5; 69.5% of respondents is observed that they prefer Marmara or Aegean region for traveling. Also in cluster 3, 72.2% of people prefer Central Anatolia or Mediterranean to travel and among whose first choice is firm web site or agency to buy a ticket consist of 84.6% of cluster 3. 67.7% of respondents are observed that

they prefer current company to travel because of loyalty and mile points. Also in cluster 1, 2, 3, 5 and 6; none of the respondents prefer private car or train as a first choice of transportation. Among whose first choice for transportation is bus or plane in cluster 5, 98.9% of them prefer Marmara or Aegean as a first selected traveling region. 39.5% of people who are in cluster 6 prefer company for mobile discounts and 54.5% of respondents in cluster 5 prefer company because of 2-way tickets and early reservation choices.

The university students consist a major customer group for bus and plane traveling companies who visit hometown frequently. Both type of companies can provide discounts and campaigns for students especially at the beginning, mid and end of semester. Most of the students use internet and mobile applications for ticket purchasing. Apart from these, the companies may keep campaigns through these tools with 2-way tickets, early reservation, loyalty programs, and free traveling with mile. The majority of students whose hometown is far away from İstanbul (Black Sea, Mediterranean, and East Anatolia) use private car. Hence, their choice can be analyzed further. Moreover, as a future work this study can be extended with the application of survey to more students from different universities in Turkey in order to find out different characteristics for the traveling preferences of university students.

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Lisakovski Katmanı Of Demir Cevheri Özellikleri

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Anahtar kelimeler
İnce taneli yapı; Oolit; Demir konsantresi: Hidrogetit ; manyetit; Klorit

Öz

Makalede, Lisakovski birikintisinin oolitik cevherlerinin manyetik ayırma yöntemiyle zenginleştirilmesine yönelik laboratuvar çalışmalarının sonuçlarını sunmaktadır. Morfometrik analiz sonuçları ve üç çeşit cevher ve konsantre kalitesinin incelenmesi, zenginleştirme parametreleri değiştirilerek elde edilmiştir.

Specific Features Of Iron Ore Of Lisakovski Deposit

Keywords
Fine-grained structure; Oolite; Iron concentrate; Hydrogetite; magnetite; Chlorite.

Abstract

The article presents the results of laboratory studies of the enrichment of oolitic ores of the Lisakovski deposit by the method of magnetic separation.The results of morphometric analysis and the study of the quality of three types of ore and concentrates, obtained by changing the enrichment parameters, are presented.

1. Introduction

The authors conducted laboratory researches of iron ore at the Lisakovskiy deposit. Scientific research was carried out on the Grant of Commercialization, funded by JSC "NATD" on the topic "Assessment of the distribution of non-ferrous, rare and dispersed elements in technogenic waste of JSC “ArcelorMittalTemirtau”.

MPP	Inventory stocks on 01.01.2013		Ore production		The content of iron in the concentrate, %
	Category	Stocks (millions of tonnes)	Size, mm	Costs, tenge/tonne	
Lisakovskiy	A+B+C	1111,2	0-2	355	54*
Atasu	A+B+C	480,6	0-80	1527	54
Kentobe	B+C	239,2	0-80	2859	53
Atansor	C	44,8	0-80	1789	54

*Note: * The iron content in the Lysakovkiy concentrate of ore is indicated by the calcined weight.*
Table 1 Technical and economic indicators of MPP in LLP “Orken”

The iron ore component of the metallurgical raw materials of JSC “ArcelorMittal Temirtau”, supplied by LLP “Orken”, which is not rich in iron content, ore concentrates of the Central Kazakhstan deposits and concentrates from the Lisakovskiy ore, ore concentrate of SSMPPA with high iron content.

2. Ore delivery

LLP "Orken", which is a subsidiary of JSC "ArcelorMittalTemirtau", includes mining and processing plants that process ore from the Karazhal, Kentobe, Atansor and Lisakovskiy deposits. Technical and economic indicators of MPP in LLP “Orken” are represented in Table 1.

Iron ores involved in the metallurgical redistribution at JSC "ArcelorMittalTemirtau" are characterized by reduced iron content by 12-14% compared to concentrates of the world's leading metallurgical companies. The reason for this is that iron ores have a fine-grained structure, and when grinding to size, which was provided by grinding-crushing stations of the last century, the grain is not opened, and as a consequence, the ore is not effectively concentrated and removed during preparation process.

The most promising way to reduce the production costs of JSC “ArcelorMittalTemirtau” is to increase the efficiency’s enrichment of iron ore deposits of its own.

After the devaluation of tenge in 2014, the metallurgical processing of Lisakovskiy concentrates with iron content of 54.0-55.0% and during 2015 became economically unprofitable. JSC “ArcelorMittalTemirtau” the Lisakovskiy gravitational-magnetic concentrate is practically not used in the stock of “ArcelorMittalTemirtau” and Lisakovskiy Mining and Processing Plant (LMPP) stores a significant part of its output on the site of the plant.

Lisakovskiy ore lies at a shallow depth, extraction requires stripping 5-15 m. Mining is conducted without the production of explosions by excavators, which ensures production costs at the level of $ 1 per ton. The ore mainly consists of oolithes of 0.2-0.6 mm in size bound by clayey constituents. Oolithes have low strength and are easily crushed in a ball mill to a particle size of less than 0.044 mm for 12 minutes. In the ore base of Lisakovskiy MPP there are 4 groups of deposits: Main, South, Steppe and East. The main reserves (75%) are concentrated in the Main Deposit, which is currently being processed. Areas 1, 2, 3 are developed with the average mass fraction of iron 38.2% [1].

Geological and technological classification of ores of the Lisakovskiy deposit is shown in Table 2.

3. Mineral composition and ore characteristics of the Lisakovskoye deposit.

The main ore mineral is hydrogelite, nonmetallic is quartz. According to texture-structural genetic characteristics and physical properties, oolithic ores are divided into two types: loose oolithic and massive. Three structural species are distinguished in the ores: thick-oolithic ore composed mainly of ore oolithes (50-80%) with a subordinate amount of cement and quartz; rare-oolithic ores, consisting of ore oolithes (less than 50%) with predominance of cement and free quartz and fine-oolithic cemented ores. A component of the oolithes is the hydrogenerite of two generations with a finely dispersed admixture of ferrochlorite clay substance. The sizes of oolithes range from 0.05 to 0.60 mm, 0.2-0.6 mm predominate.

The main ore mineral is hydrogelite, nonmetallic is quartz. According to texture-structural genetic characteristics and physical properties, oolithic ores are divided into two types: loose oolithic and massive.

Characteristics of ore			Mass fraction, %		Grain-size class, mm						Concentrate	
					1,6		-0,6+0,3		-0,3+0,15			
Type of ore	Grade of Ore	Structural, textural and mineralogical	Fe	Oolithes	Ore outcrop %	m.f. Fe,%	Ore outcrop %	m.f. Fe,%	Ore outcrop %	m.f. Fe %	Ore outcrop %	m.f. Fe,%
1	1-1	Bondless stiff Oolithic	42-49	60-85	0-7	27-46	35-65	44-49	4-24	38-47	-	-
	1-2	Large – Medium Oolithic	40-42	55-75	0-10	25-44	33-60	42-48	4-24	35-46	65-85	49-51
2	2-3	Bondless stiff Oolithic, medium and Fine Oolithic	38-40	50-70	0-10	23-44	29-57	33-47	6-31	33-45	60-75	48-50
	2-4	Bondless Rare Oolithic	34-38	40-65	0-15	21-42	24-52	32-46	7-38	27-44	53-70	47-49
	2-7	Mediumfine-Oolithic	30-34	25-60	0-10	19-42	11-50	20-43	8-48	20-42	40-65	44-47
3	3-5	Rare Oolithic	34-38	40-65	10-45	24-47	19-15	38-46	3-20	30-46	45-70	47-50
	3-6	Fine Oolithic	34-38	30-60	10-45	22-46	12-47	21-45	3-35	25-45	45-60	44-47
	3-8	Rare and Fine Oolithic	30-34	25-60	10-45	19-45	9-44	17-45	3-35	15-43	30-60	42-47

Table 2. Geological and technological classification of the Lisakovski deposit

Three structural species are distinguished in the ores: thick-oolithic ore, composed mainly of ore oolithes (50-80%) with a subordinate amount of cement and quartz; rare-oolithic ores, consisting of ore oolithes (less than 50%) with predominance of cement and free quartz and fine-oolithic cemented ores. A component of the oolithes is the hydrogenerite of two generations with a finely dispersed admixture of ferrochlorite clay substance. The sizes of oolithes range from 0.05 to 0.60 mm, 0.2-0.6 mm predominate.

Layered natured ores are often of the oolithic structure, often deformed, consists mainly of hydrogite, chlorite and calcium phosphate. Oolithes are fissured, so they resist weakly to grinding. Magnetite is represented by thin crystalline particles smaller than 0.005 mm. The ore can be slightly oxidized (martitized). Chlorite belongs to the chamoisite type, it contains magnesium and ferrous iron. Calcium phosphate belongs to the apatite group, its molecule can contain one or more OH groups and, possibly, a little SiO_2 instead of PO4 (Muhammed M., Zhang Yu. 2011). Its morphology can be different - amorphous and pseudohexagonal. A theory is known that phosphate anions absorb and grow on the surface of the gel ferrohydrate and phosphorus is excluded from the iron ore lattice inside the crystals of liquid cement dehydrate and recrystallized. Limited phosphorus removal is achieved by grinding and magnetic separation, which is partly technically feasible, so this technology of removing phosphorus from iron ores is used.

Part of the phosphorous is part of the cement mass, which connects finely-dispersed grains of magnetite. Therefore, it is impossible to remove it mechanically to contents that meet the requirements of the metallurgical processing.

4. Laboratory Results.

The phosphorus content of various types of Lisakovskiy ore varies from 0.6 to 0.8% according to many studies and is explained by the presence of stilpnosiderite (iron hydroxides enriched in phosphorous) and single apatite grains.

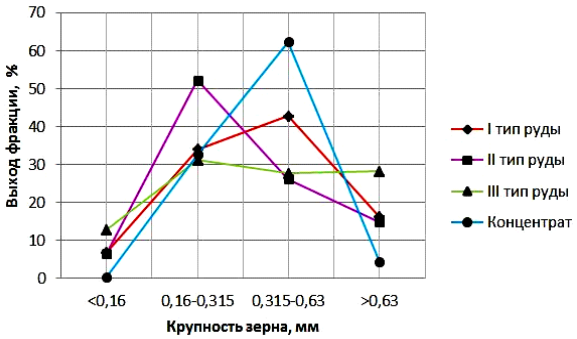
The phosphate found in the ore is represented by a white, loose mass of microspherolitic structure. Spherolithes, forming phosphate, closely adjoin each other. The size of the spherolithes varies from 0.004 to 0.018 mm. Phosphate of calcium is not the main carrier of phosphorous in concentrates, i.e. it is an insignificant part. Along with calcium phosphate, the presence of aluminophosphate was first detected in the hydroghetite, which in its parameters of the crystal lattice corresponds to the wavellite with iron ions.

Quality of I, II and III types of Lisakovski ore and concentrate is shown in picture 1, grain-size composition of iron-ore materials is shown in picture 2

Based on the iron content, type II ore of all fractions contains less than 30% and it cannot be enriched, leaving it in the deposit or moving it to the tailings pond. In fractions of more than 0.63 mm I, III types of ores, less than 30% of iron is contained.

5. Characteristics of the technological properties of ore.

Sorting allows you to remove 17% of the ore type I, 28% of the ore type III. Taking into account the



fact that type II ore can be excluded from the enrichment process, the total reduction of ores larger than 1.0 mm excluded from enrichment will be 40.5%.

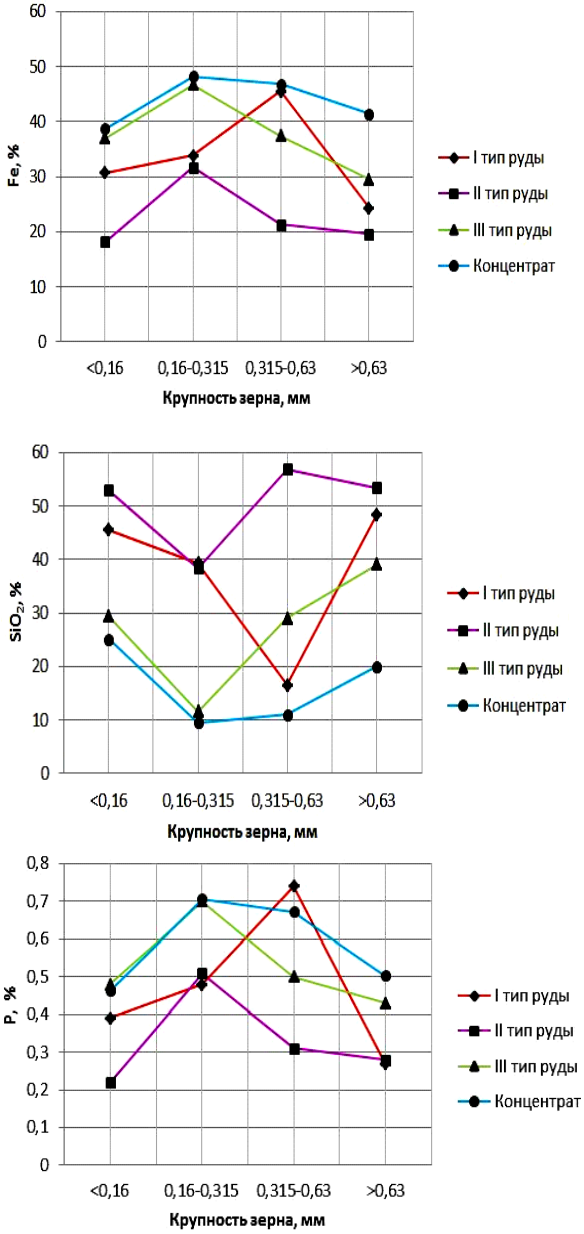


Figure 1. Quality of I, II and III types of Lisakovskiy ore and concentrate

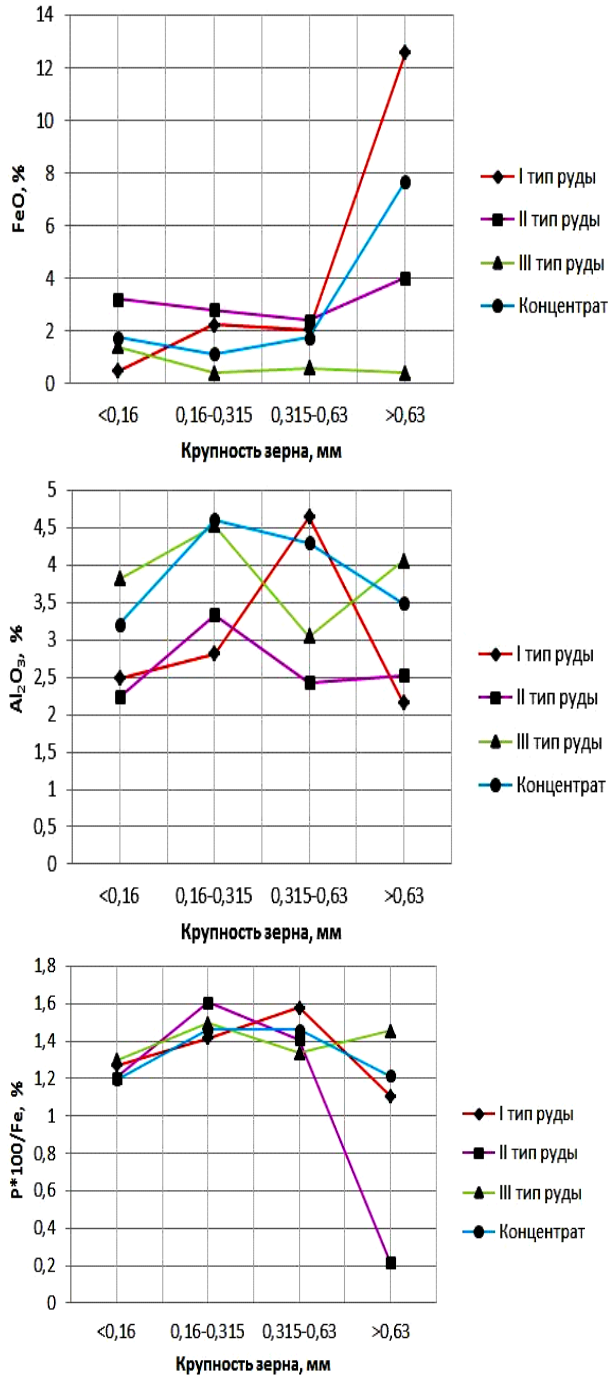


Figure 2. Grain-size composition of iron-ore materials

In ores I, II, III, types contain respectively 8.7 and 12% of the fraction less than 0.16 mm. The total amount of fines in the initial ore will be 10%.

The removal of these fractions of ore will significantly improve the efficiency of the enrichment process.

The structure of fractions of types I, II and III is shown in Fig. 3, 4, 5, where it is seen that oolithes are iron-containing nuclei and complex iron-containing iron-containing shell. The photographs shown in Fig. 4 and 5 indicate that the oolite grains have a complex structure: some grains have a shell structure, some of the oolithes are represented by a mixture of grains of various minerals less than 50 microns, so that grinding to a fineness of less than 0.044 mm is necessary to separate the iron-containing minerals. Studies carried out at LLP “Centrgeolanalit” found that the grinding time of the original Lisakovskiy ore and concentrate is 27 and 12 minutes.

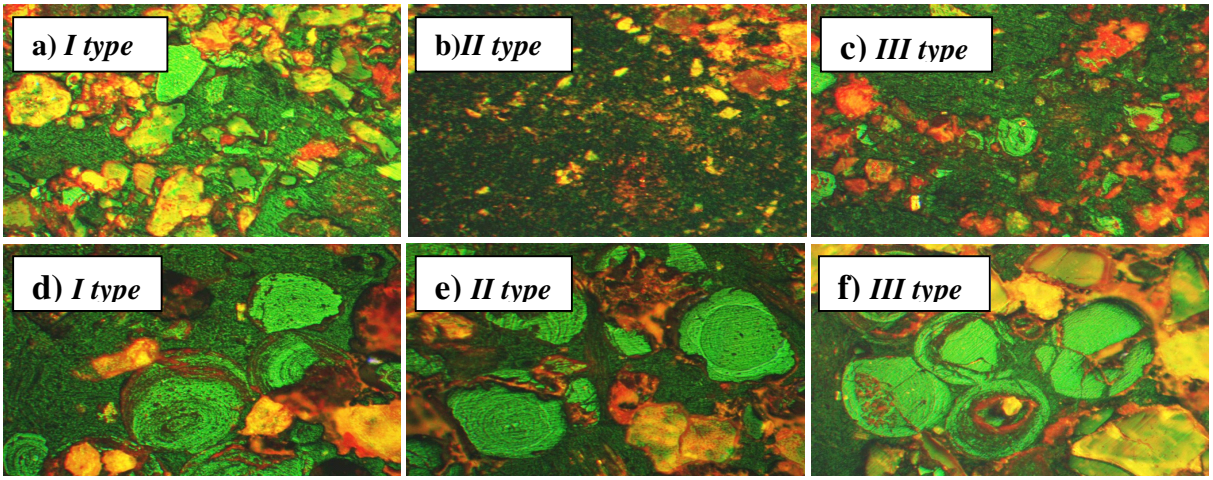


Figure 3. Structure of fractions: a, b, c - 0÷0,2 mm and d, e, f - 0,4÷0,2 mm I, II and III types of Lisakovskiy ores. Reflected light; zoom 10x

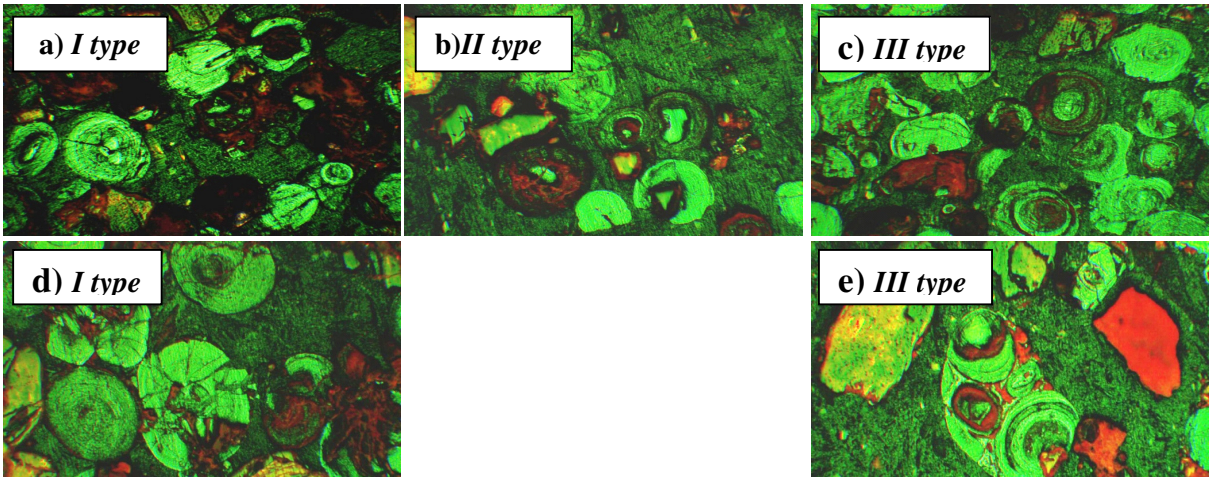


Figure 4. Structure of fractions: a, b, c – 0,63÷0,4 mm I, II and III types of Lisakovskiy ores; d, e – 1,25÷0,63 mm I and III types of Lisakovskiy ores. Reflected light; a, c - zoom 10x, b, d, e - zoom 5x

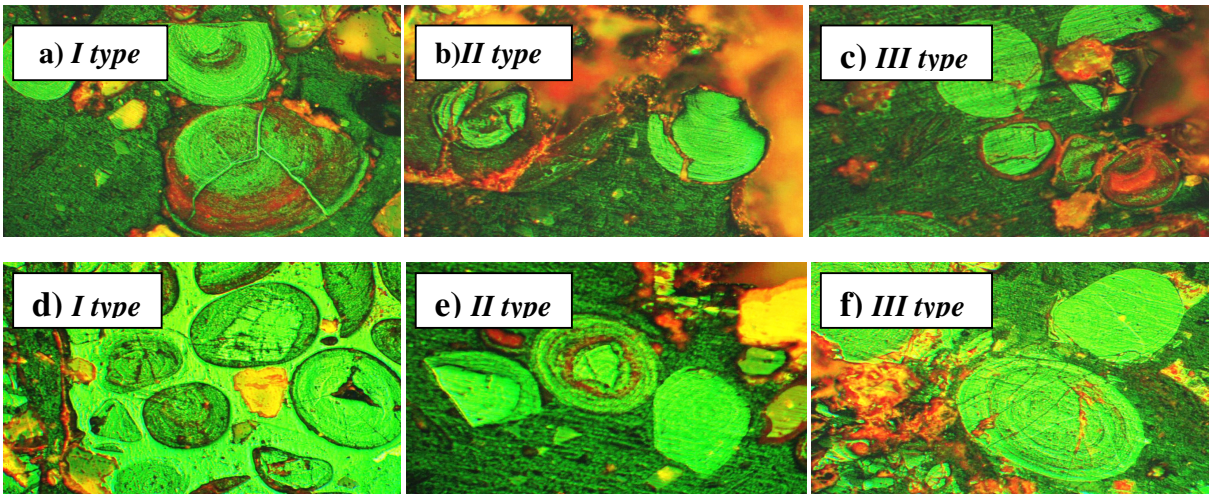


Figure 5. Structure of fractions:a, b, c – 3÷1,25 and d, e, f - 5÷3 mm I, II and III types of Lisakovskiy ores. Reflected light, zoom 10x

6. Conclusion

• High-phosphorus ores of the Lisakovskoye deposit with reserves of 1.11 billion tons are the main components of the sinter blend of ArcelorMittal Temirtau. The advantages of ore are the minimum costs in the extraction and grinding of ores, the lower cost of iron ore concentrate compared to concentrates of other mining and processing plants of Orken LLP.

• The relevance of this work lies in the fact that in Kazakhstan there are also the largest deposits of oolitic iron ore, which include: Ayatskoye with reserves of up to 7 billion tons and the Aral Sea deposit with reserves of up to 2 billion tons.

• The concentrate produced by the mining and processing plants of Orken LLP contains 54-56% of iron, which is 12-14% lower than in the leading enterprises of the near and far abroad. Production of high-quality iron ore concentrates from Orken LLP is possible with the enrichment of products crushed to a particle size of less than 0.074 mm or 0.044 mm.

• Lisakovskaya ore is currently being enriched using the method of jigging with the cleaning of middlings using wet magnetic separation without grinding the oolites.

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AFYON KOCATEPE ÜNİVERSİTESİ ULUSLARARASI MÜHENDİSLİK TEKNOLOJİLERİ ve UYGULAMALI BİLİMLER DERGİSİ

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