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Investigation of Risk Perception of Employees Using Clustering Analysis: A Case Study of Iron-Steel Industry

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Iron and Steel Industry, Risk Perception, Work Safety, Two-Step Clustering

Abstract: Iron and steel sector is a heavy industry sector and its contribution to the country's economy is quite high. However, the exposure of sector employees to heavy and dangerous materials during the production stage reveals the importance of risk perception and highlights occupational safety and risk management. In this research, risk perception and awareness of the employees of an iron and steel enterprise were determined according to their social and demographic data. The results of the research were presented using descriptive and inferential statistical analyzes. In the modeling part of the study, the two-stage clustering method, which is one of the multivariate statistical methods, was used. The similarities and differences in risk perception of the characteristics of the employees in the iron and steel enterprise were revealed. According to the results of the research, it has been determined that the education and age status of the employees are important in risk perception awareness.

Çalışanların Risk Algısının Kümeleme Analizi ile İncelenmesi: Demir-Çelik Endüstrisi Örneği

Anahtar Kelimeler
Demir-Çelik Sektörü, Risk Algısı, İş sağlığı ve Güvenliği, İki Aşamalı Kümeleme

Öz: Demir-çelik sektörü ağır bir sanayi sektörü olup, ülke ekonomisine katkısı oldukça yüksektir. Ancak sektör çalışanlarının üretim aşamasında ağır ve tehlikeli malzemelere maruz kalması, risk algısının önemini ortaya koymakta ve iş güvenliği ve risk yönetimini ise ön plana çıkarmaktadır. Bu araştırmada bir demir-çelik işletmesinin çalışanlarının sosyal ve demografik verilerine göre risk algı ve farkındalıkları tespit edilmiştir. Araştırmada sonuçlar tanımlayıcı ve çıkarımsal istatistiksel analizler kullanılarak ortaya konulmuştur. Çalışmanın modelleme bölümünde çok değişkenli istatistiksel yöntemlerden olan iki aşamalı kümeleme yönteminden faydalanılmıştır. Demir-çelik işletmesinde çalışanların özelliklerinin risk algı benzerlik ve farklılıkları ortaya konulmuştur. Araştırma sonucuna göre çalışanların eğitim ve yaş durumunun risk algısı farkındalığında önemli olduğu tespit edilmiştir.

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1. Introduction

It is seen that there is a direct relationship between the development of the industry and the economic growth of the countries. Developed and developing countries use industry as a development tool by increasing their production capacities. Countries that can meet their own needs can get rid of foreign dependency and take great steps in terms of social development. Many different sectors such as defense, mining, iron and steel, construction, textile and food are growing rapidly by renewing themselves with the development of the industry. Countries and companies that want to produce the most products in the shortest time with the lowest cost compete. This competition also enables improvement studies in terms of quality and efficiency [1]. Since the industrial revolution, which started with the transition to mechanical production, improvement studies have been carried out in the industry. Creating ergonomically appropriate conditions and making improvements to prevent occupational accidents increase production and productivity [1, 2]. Between the years 1760-1830, the industrial revolution was experienced with the replacement of coal and steam machines by factory production. The replacement of human power by steam machines has provided diversity in production [3]. With the industrial revolution, lifestyles have changed and many important transformations have been experienced in daily life. It has paved the way for international trade, labor relations, legal structure and political structure and has been effective in the development of engineering sciences. It also paved the way for new revolutions by enabling the development of social and health sciences. As a result of the urban migration that occurred as a result of the first industrial revolution, there was a change in the social structure [4].

From the beginning of the twentieth century, the second industrial revolution has been experienced with assembly lines and the use of electricity in industries. In the 1960s, the third industrial revolution was experienced with the use of microchip technologies, automation and computers. With communication technologies and new production systems, the limits of capitalist production systems have been pushed. In the three industrial revolutions that took place, there were differences in the structure and form of production and the need for labor [5]. Businesses like artificial intelligence, robot technology and 3D printers etc. They have started to transition to Industry 4.0 with technologies. The transformation process started with the introduction of the Industry 4.0 concept at the Hannover Fair in Germany in 2011. Industry 4.0 differs from the other three revolutions in that production technologies are more efficient and faster. Countries such as Germany, the United States and Japan, which have determined their strategies for increasing productivity on a global scale, have made remarkable progress with clear and rapid changes. Countries that want to get their share from the developing economy have started to conduct research showing the current situation for this transformation process. Studies have been started to determine the current situation in order to determine which sectors primarily need new technologies, which sectors have these technologies, and the financial situation and infrastructure required for the transition to these technologies [6, 7]. In today's globalizing world, the fact that there are many competitive criteria such as efficiency and quality brings low cost superiority to the fore. Countries and businesses that want to achieve this superiority are working with the aim of raising themselves to a higher category by maintaining sustainable production and flexible competitive power [8].

The industrial revolution causes a radical change in all industrial areas. With the production technologies that can respond flexibly to the disruptions and malfunctions that occur in the production processes, there are great developments in the communication, transportation, trade and manufacturing sectors [9]. In parallel with the developments in the manufacturing sector, sub-sectors related to iron and steel are developing. When the major developments in the iron and steel industry and the development process of the countries are examined, it is seen that iron and steel are effective in the development of all sectors that provide raw materials economically [10]. Developments in the manufacturing sector increase the quality of life by providing superior quality and productivity [11In order to increase the efficiency of the enterprise, the human factor should be given more importance by the enterprises and serious measures should be taken for the safety of the employees in the work environment [12]. However, employees who are aware of the risks in the business environment and trust the workplace can add value to the company they work for [13]. The risk factors that may cause occupational accidents should be examined and the awareness of the employees against these risks should be measured. Elimination or minimization of the measured risks is possible with the correct management of the risk [14].

The risk expression is a probability of loss of an event that occurs under certain conditions and occurs materially and morally. It is also stated that the risk is equal to the potential losses [15]. The concept of danger can be defined as a harm that affects the employees in the enterprise. Every possible situation is defined as a risk and arises from danger [16]. The risk of a business could be production, sales, finance, marketing, etcAs a result of avoiding these

risks, the profit and loss situation of the enterprise occurs [17]. Risks are considered as internal risks if they can be predicted, prevented or the damage to be caused can be minimized according to their source. External risks, on the other hand, are uncontrollable risks, generally related to changes in the market or government policies. It is possible to identify these risks with risk assessment studies and turn them into opportunities. If it is not possible, it is necessary to eliminate the risks or to minimize the damage it may cause. It is of great importance that the necessary care is taken in the workplaces and that the employer and employee have knowledge about risk [18].

The risk perception of everyone working in the enterprise may be different, such as working conditions, workload, education, experience, age, employer attitude and physical characteristics. Each employee's perception of risk is also different. This may be due to differences such as gender. It can be defined as not knowing, trivializing and ignoring occupational health and safety, ignoring the dangers and risks that may occur in the workplace. Occupational Health and Safety Law No. 6331 (İSGK) aims to prevent possible dangers and risks in public and private workplaces. Within the scope of this law, responsibilities imposed on both employers and employees, regardless of their field of activity, have been determined. The most important of the responsibilities within the scope of this law is to carry out occupational health and safety training of employees in the form of continuous training and to ensure that they are informed about possible accidents, dangerous situations and all kinds of risks in the workplace [19-21].

1.1 Current Situation of Iron and Steel Industry in the World and in Türkiye

The main input of durable consumer goods of countries is iron and steel production. In many sectors such as automotive, defense, transportation and construction, raw material input, iron and steel production and consumption are also increasing. Approximately 95.6 million people work in the sector and create an added value of 2.9 trillion dollars for the country's economy. The development of the iron and steel industry is directly proportional to the development of all the industries it provides inputs, and it is of strategic importance for the countries [22, 23]. Steel, one of the strongest materials in the world, consists of an alloy of iron and carbon [24]. In the iron-steel industry, crude steel is produced with scrap and ore, and long and flat steel is produced with this crude steel [25]. It is the most recyclable material with 71% recycling rate. The slag produced by steel production can be used as a raw material in the cement factory [24]. Steel was produced in the periods before the Renaissance and became widespread with the development of new production methods in the 17th century. Mass production was achieved with the invention of the Bessemer Modifier. Today, iron, which is the most common metal used with other industrial activities, has the quality of being an increasingly important material over time [26]. In 2020, crude steel production in the world decreased by 0.9 percent compared to 2019. It was observed that crude steel production in the world contracted in all regions except Asia and the Middle East in 2019 [27].

There are three big companies as iron and steel factories in Türkiye. Among them, Kardemir is the first integrated iron and steel factory of the country and the first national brand in railway rail production, and is Türkiye's twenty-fifth largest industrial company. Kardemir, which has a capacity of 3.5 million/year, employs 4123 people according to October 2021 data [28]. Erdemir, on the other hand, is a company that brings organic wastes into production as iron and carbon inputs. It is an important company in the automotive sector with its metal forming laboratory. The capacity of the enterprise is 3.85 million/year and employs 5400 people according to the latest data of 2020 [29]. According to the latest data of 2020, İsdemir is Türkiye's largest iron and steel factory, employing 4702 people. It has the only integrated facility that produces long and flat products at the same time. Türkiye produces 154.4 million tons of steel with these three integrated facilities and is the seventh in the world and the leader in Europe with this production [30].

1.2 Occupational Health and Safety in the Iron and Steel Industry

The improvements made in order to produce the best steel in the sector at the least cost and to increase the quality within the countries continue at an increasing pace day by day. However, in the iron and steel industry, where millions of people work in the world, the occupational health and safety of employees is an important issue. It is the responsibility of the enterprise to use personal protective equipment, to apply to local and general ventilation, to prevent work accidents and occupational diseases that may occur in the sector. Businesses should have departments related to occupational health and safety, and the work to be done for occupational health and safety should not be seen as unnecessary costs [31]. One of the most dangerous sectors in industrial enterprises is the iron and steel sector. The most common occupational accidents in iron and steel enterprises; Occupational accidents may occur in cases such as failure to comply with the warnings of occupational health and safety rules, failure of the safety system, unsuitability of the working environment, insufficient ventilation and insufficient

lighting. In order to prevent occupational accidents, it is necessary to examine the accident records, eliminate the problems and provide the necessary trainings [32, 33].

1.3 Concept of Risk

According to the Turkish Language Association, risk is defined as the danger of being harmed [34]. According to the Occupational Health and Safety Law No. 6331, 27 losses due to danger are expressed as the possibility of injury or other harmful consequences [35]. Risk in the field of insurance; While it is defined as the existence of the risk of loss, probability of loss, uncertainty, the possibility that the actual result will be different from the expected result, the possibility of the emergence of any situation other than the expected situation, risk in banking; means the probability of failure in the collection or fulfillment of a loan given or a commitment made. In decision theory, risk refers to situations where the decision maker cannot determine the consequences of an event. In the field of finance, risk; It is the probability of deviation in the occurrence of any planned or expected situation related to the financial aspect of the enterprise [36]. Occupational accident risk in the enterprise can also be expressed as a combination of probability and severity [37]. Risk can be evaluated with the concept of opportunity. As the profit of the business increases, the acceptability of high-level risks can also increase. Thus, profit can be obtained from a risky activity. If there is no real opportunity, it is necessary not to continue the activity because the opportunity cannot be obtained from the risky activity [38].

Risk is any uncertain situation that will prevent the business from realizing its future goals and objectives, or factors that can contribute positively to the business and can be evaluated as an opportunity. The fact that the risk is uncertain does not mean that the risk cannot be managed. If the risk is predicted very well, this uncertainty can be eliminated and turned into a positive factor that will contribute to the business [39]. In today's world, which is globalizing and developing every day, it is important for businesses that develop themselves to manage risks and turn them into opportunities. In order for the business to gain value, especially in terms of quality and efficiency, risks must be identified, measured and eliminated. It is possible to draw a roadmap to minimize the risks that cannot be eliminated or to benefit the business from these risks [40].

Today, with the increasing institutionalization activities, different risk factors have started to emerge. Risks are divided into two main groups as systematic and non-systematic risks. There are operational risks in the iron and steel enterprise operating in the province of Karabük, where this study was conducted.

1.4 Risk Assessment and Analysis Methods

Risk assessment is defined as the probability of occurrence of a certain accident or hazard, and it is the evaluation of how much it affects the business in case of risk occurrence [41]. Risk assessment is the process of measuring the risks in the working environment, estimating the unmeasurable risks, controlling the measures taken for the risks and deciding which risks are acceptable or not. Risk assessment according to the Occupational Health and Safety Law No. 6331, it is stated as the studies that need to be carried out in order to determine the hazards that exist in the workplace or that may come from outside, the factors that cause these hazards to turn into risks, and the analysis and grading of the risks arising from the hazards, and to decide on control measures [42]. It is one of the risk duties imposed on the employer with the Law No. 6331. Every work environment has risks and it is the right of all employees to know these risks. Risk assessment employees aim to protect the business, individuals and organizations that may be adversely affected by the activities of the business. For the risk assessment, the opinion of the employees should be taken. Occupational diseases and work accidents may occur as a result of not making a risk assessment in an enterprise [43].

There are many risk assessment methods, but they can be grouped into two main groups. Risk assessment methods, which are classified as qualitative and quantitative methods, differ from each other in terms of calculating and defining risk. Qualitative methods are a method of estimating and verbally classifying risks using verbal logic. In the qualitative method, which is evaluated subjectively such as high or very high risk, the knowledge and ability of the specialist who performs risk assessment is important. In the quantitative risk assessment method, numerical logic methods are used. The severity of the risk and the probability of an accident are calculated to determine whether the risks are acceptable and what precautions should be taken for unacceptable risks [44]. Risk analysis is the process of identifying all uncertain situations and possible outcomes for specified objectives. Risk analysis is to determine the size, probability of occurrence and impact of the risk [45].

1.5 Perception of Risk

Calculation of risk with scientific methods gives objective results. Another dimension of risk that complements these objective results is the subjective expression of risk. Risk studies reveal the subjective aspect of risk. Perception of risk refers to individuals' subjective judgments of the magnitude, impact, and significance of risk

[46]. The way each employee perceives, manages and lives with risk differs. In the fact that the risk perception differs in each employee; Various factors such as social, cultural, economic, education, age and gender are effective. Employees who do not know the risks in their workplace have little attention for work. In this case, it reduces the work efficiency in the working environment. It also prevents the business from achieving its goals. In enterprises that want to prevent this situation, the risks to which the employees are exposed should be measured, measures should be taken for these risks and the risks they are exposed to should be explained to the employees. In addition, in the event of a risk, what needs to be done should be determined in advance so that employees are not affected by this situation or are least affected by it. Risk can be transformed into a positive factor in businesses where necessary precautions are taken and awareness of risks is created [47].

In this research, risk perception and awareness of the employees of an iron and steel enterprise were determined according to their social and demographic data.

2. Literature Review

In the literature study; risk in the manufacturing sector, risk in the iron and steel sector, risk method, risk perception, occupational health and safety studies were examined.

This study by Alkış and Taşpınar (2012) was carried out to measure the occupational safety and health perceptions of workers working in the metal sector operating in Konya. A survey was conducted with 150 randomly selected workers. However, data from 120 workers were evaluated. Statistical methods such as frequency distribution, arithmetic mean, standard deviation and descriptive statistics were used by using the SPSS program. It has been concluded that the education level of the workers is low, they belong to the young or middle age group, they have low work experience, and about half of them have had a work accident. It has been determined that older workers have lower security perceptions than younger workers, and those who have worked for many years in the workplace have higher security perceptions [49].

Gulhan et al. (2012) conducted this study to determine the causes of accidents in a heavy metal industry in Ankara. In the study, a survey was conducted with 201 participants. The status of being affected by accidents according to age, marital status, education, working hours and income level was investigated. While occupational accident was chosen as the dependent variable in the study conducted using the SPSS analysis method, as independent variables; age, marital status, education level, income level, smoking and alcohol use, duty, department and shift status. As a result of the research, it was concluded that the accidents were mostly caused by the lack of use of protective equipment and the lack of education. It has been determined that health surveillance should be done on an ongoing basis [50].

Gerami (2014) conducted this study to predict future accidents in the steel industry. It has been stated that the effect of future accidents in a workplace is predictable and managers who anticipate the risk can reduce the number of occupational accidents by taking precautions against hazards. In this study conducted with the help of Weka software, 2396 events were recorded between 2011 and 2013 in Isfahan-Mobarakeh Steel Complex, one of the largest steel producers in the Middle East. With the applied method, predictions were made for future accidents [51]. Topaloglu et al. (2015) examined the risks posed by blast furnaces on occupational safety in a company and investigated the causes of occupational accidents with the appropriate risk assessment method. Hazard and Workability Analysis (HAZOP) has been used. As a result of the research, it was stated that there were no fatal accidents in the company examined since 2002 [52].

Aytac et al. (2015) conducted a survey consisting of 52 questions with 1750 people in order to raise awareness for women working in the metal industry and to measure the risk perceptions of women workers. Data were evaluated with SPSS analysis and factor analysis, reliability analysis, correlation analysis and Stepwise regression analysis were applied. It has been determined that female workers with high security awareness have a high level of risk perception, there is a negative relationship between the perception of fatalism and the perception of safety precautions awareness, and there is a strong positive relationship between the perception of security awareness and awareness of security measures. It has been concluded that the occupational health and safety rules applied in the workplaces should be adopted and implemented by the employees and that the trainings should be continued continuously [53].

This study by Arpat (2015) was carried out to determine the relationship between safety culture and work accidents in the metal sector in Denizli. A survey method consisting of 17 questions was applied in 27 workplaces. 854 valid questionnaires were obtained. SPSS analysis method was used for quantitative data and content analysis method was used for qualitative data. While analyzing the quantitative data, reliability analysis, normality test,

frequency distribution, Chi-square test, factor analysis, Mann-Whitney U test, one-way analysis of variability Sperman correlation analysis were used. Analyzes were made in two stages. In the first stage, the survey analysis was done, and in the second stage, the open-ended questions in the survey were analyzed. As a result of the research, it has been determined that the characteristics of the enterprise, the working environment, occupational accident exposures and management systems strongly affect the safety culture, but the demographic components are ineffective [54].

Aytac et al. (2017) conducted a survey consisting of 51 questions with 1918 female employees working in the metal sector in Bursa. With the Kaiser-Mayer-Olkin (KMO) Conformity Test, female employees' perceptions of fatalism in occupational health and safety culture and their perception of risk factors in the workplace were measured. As a result of the study, it was determined that there is a significant relationship between safe behavior, which is a precursor to the establishment of a safety culture, and risk perceptions, and that the perception of fatalism negatively affects the risks in the working environment [55].

Karadal and Merdan (2017) conducted this study in order to determine the relationship between the safety climate and accident causes in the foundry industry in Kırıkkale and Kırşehir. A survey was conducted with 283 employees. Obtained data were tested with Anova test, t test, correlation and regression analysis. The results showed that the safety culture is effective in workplace accidents. It was concluded that training should be done frequently, ergonomic risk factors should be considered, workplace protective equipment should be used, managers should be in contact with employees and occupational health and safety audits should be carried out [56].

Kukhar et al. (2018) conducted this study to analyze the effectiveness of introducing international methods in the field of health safety and to evaluate the effectiveness of the safety management system in Metinvest, an iron and steel factory located in Mariupol, Ukraine. The risk assessment matrix was made with the HAZID method, the evaluation of the working capacity of the technological processes with the HAZOP method and the safety evaluation of the works with the JSA method. A specific list of hazards has been compiled by assigning a separate number to each technological item. In the second stage, the current risk level for each element was calculated with the help of the health safety engineering, occupational safety and environmental engineering risk assessment matrix. In the third stage, the probability of occurring the predicted results was calculated by giving points from one to five. As a result of the study, technical and organizational measures to reduce the production risks of the rail fasteners workshop of the enterprise in the energy sector reduced the remaining total risk level to an "Acceptable level" (74 points) by 61% [57].

Aytac et al. (2018) aimed to determine the ergonomic risk factors affecting women working in the metal industry. In this study, which was conducted with 2549 female employees working in 23 different workplaces, the data obtained by the survey method were analyzed by using SPSS analysis, correlation and t tests. As a result of the study, it was determined that the risk perception levels of the female employees who work the night shift are higher than those who do not, and that the risk perception levels of the female workers who work longer hours are higher than those who work less. It has been determined that correct posture and musculoskeletal problems are highly effective and affect productivity in the working environment [58].

Akarsu and Tükenmez (2018) conducted this study in order to determine the risks that may occur in the acid regeneration section of an enterprise operating in the iron and steel field. A risk assessment matrix was created by ordering the risks according to their priority status with the HAZOP method. It has been determined that the most important factor that can cause an accident is equipment damage and this can be controlled with the help of computers. It has been determined that the use of barriers in the enterprise is necessary for the prevention of explosion, fire and toxic gases, 13 out of 30 accident factors. It was concluded that the cost of stopping the whole system would be high and preventive actions should be carried out according to the order of importance of the risks [59].

Büyükyılmaz et al. (2018) investigated the organizational health perceptions of Kardemir A.Ş., which operates in the iron and steel industry. The questionnaire technique was applied to 500 employees, but 450 questionnaires were valid. The data obtained by Anova and t test were tested. Leadership dimension was found to be higher among female employees. In terms of age, it has been found that there are differences in the organizational identity dimension of employees aged 30 and below and those aged 31-40 and over. Perception levels of employees with bachelor's and master's degrees were found to be lower than those who graduated from vocational school and high school. As a result of the study, it was determined that the stress in the workplace should be controlled and a satisfactory working environment should be created [60].

Ayanoğlu and Kurt (2019), in the study conducted in 165 metal sector workplaces, handled the accident data set and determined dangerous risks with a data set consisting of 192 accidents and 39 variables. In addition, after it was understood that the most suitable mining method was artificial neural networks, a double-layer feedforward accident prediction model artificial neural network was developed by teaching the data set. With 90% accuracy, it has been revealed that overlooked hazards in the metals industry pose a major risk [61].

This study by Nasution (2019) was conducted to evaluate the safety system in a foundry company that manufactures cast iron products such as wheel pans and fan blowers. Job Hazard Analysis (JHA) method was used to systematically identify potential hazards in the foundry company. The analysis covered the work process, work phases, hazard, sources, risks, impacts and current management. It was determined that the risk reduction average in the metal casting process was 19.02%, the highest value was 21.67% and the lowest value was 12.86%. The most dangerous of the seven stages of production; finishing and iron metal melting process. Interviews were held with the workers, who were all male and whose average age was 27, in charge of these two stages. As a result of the study, based on the basic risk and current risk calculation, it was concluded that the highest risk working process was the molten metal pouring process with 14.44%. It has been determined that the workers on the production lines do not have the habit of using personal protective equipment in the working environment [62].

Kahya et al. (2019) evaluated the physical conditions and use of personal protective equipment for 92 workers in eight metal enterprises operating in Eskişehir with an observation registration form. It has been determined that the most important factor causing occupational disease is noise and it reduces productivity by distracting workers. While it was determined that glasses were not used in more than half of the 21 benches observed, and there were workers who did not use gloves even if they were very few, it was determined that the use of special shoes was common. It has been concluded that the trainings to be given will have a positive effect on the reduction of occupational accidents [63].

Karadal et al. (2019) conducted this study to determine the effect of safety behaviors on workplace injuries. Data were obtained by survey method from 309 employees working in metal casting industry in Kırıkkale and Kırşehir. The obtained data were analyzed with the IBM SPSS Amos statistical program. It has been concluded that as safety culture increases, safe behaviors increase and there is a decrease in occupational accidents [64].

Keskin et al. (2020) identified 83 risks in an underground mine in Gümüşhane using the decision value matrix method. Eight of the risks were found to be unacceptable risk, 37 high risk, 35 medium risk, and three low risk. With this study, which has a risk score of 14, it is aimed to prevent occupational accidents. This risk analysis was made according to the physical conditions of the enterprise, and suggestions were made to the enterprise, such as continuing the trainings, making gas measurements, continuing the scavenging of the poplars and building a pig roof in order to manage the risks [65].

Köse and Ersöz (2020) conducted this study with the aim of estimating real events in an enterprise operating in the field of iron and steel. Data of 205 occupational accidents were analyzed with SPSS according to accident severity and demographic situation. It was determined that CRT (Classification and Regression Trees) among the decision tree techniques gave the highest accuracy rate. As a result of the study, it was determined that the subcontracted personnel had frequent and severe accidents and that the inspections should be increased in order to reduce these accidents. It has been found that the most important cause of workplace accidents is the workplace and age is a very important accident factor [66].

Korkmaz (2020) conducted this study in order to determine the risks in a business that produces magnesium metal. Using the Fine-Kinney risk method, 14 different primary risks were identified. As a result of the study, it was determined that the most accident was the result of combustion, therefore more information was needed on this subject, the working hours of the workers should be regulated and a magnesium fire team should be established for emergencies [67].

Yussof et al. (2021) conducted this study to determine the relationship between strategic communication, leadership roles, organizational design and employee. Questionnaire method was applied to 379 people. The findings of this study, which used stratified sampling, showed that all variables were significant. It has been determined that institutional-wide risk management and improvement studies should be carried out in the workplace [68].

Durmaz and Atalay (2021) conducted a safety climate study on occupational accidents in the metal sector. Two sub-dimensions, the safety climate scale and a form with 18 questions, were used for data collection. Chi-square and regression analysis were used to determine the relationships with occupational accidents. Correlation analysis

was performed between the scale total score and its sub-dimensions. In this study, which was conducted with 289 workers, the survey results showed that 28.4% of the workers in the current workplace had at least one work accident, married workers had 3.24 times more work accidents than unmarried workers, and monitoring the safety of workers was associated with a safe environment and work accidents [69].

Ersöz and Bulut (2021) conducted a risk study in the metal sector in order to measure the way employees perceive risk according to their socio-demographic characteristics. The data were obtained by questionnaire technique and cluster analysis was performed. In the research, risk perception levels of employees in a high-risk business in the iron and steel sector were determined according to their socio-demographic status. As a result of the study, it was determined that the risk perceptions of the employees were mostly affected by the level of education, length of service, occupation and age [48].

3. Material and Method

The research on risk perception in the iron and steel enterprise was applied to the employees of an iron and steel enterprise operating in the center of Karabük. The target audience of the survey is employees. The survey questions were asked to the participants determined by the random sampling method from the employees working in the enterprise by face-to-face interview method. It was assumed that all the participants participating in the study correctly perceived and answered the questionnaire questions.

The population of the research conducted on the risk perception in the Iron-Steel enterprise is all employees of an iron-steel enterprise operating in the center of Karabük. According to the data of 2021, there are a total of 400 employees in the iron and steel company. The data of the research were obtained from 106 participants working in the iron and steel plant between April and July 2021, using the questionnaire method, which is one of the quantitative research techniques.

In the risk perception survey of the employees in the iron and steel enterprise; There are socio-demographic questions including gender, age, marital status, educational status, occupation, status in the company, length of service in the company, working time in the same unit and leave periods used in the last year. In the second part, there are closed-ended questions consisting of four sub-dimensions (Concepts Related to Occupational Safety and Risk, Occupational Safety and Risk Studies in the Workplace, Risk Awareness and Health Risk Status) and a total of 45 statements about occupational safety, occupational accidents and risk perceptions. A five-point Likert scale, one of the metric scale types, was used as an evaluation scale. In scale; 1 represents “Strongly Disagree”, 2 “Disagree”, 3 “Undecided”, 4 “Agree”, 5 “Strongly Agree”. In addition, the statement “I Have No Idea” was also included in the scale. While the "I have no idea" option was included in the analysis only as a percentage, it was not included in the analysis when calculating the mean values.

The results of the research were presented using descriptive and inferential statistical analyzes. In the modeling part of the study, the two-stage clustering method, which is one of the multivariate statistical methods, was used. The similarities and differences in risk perception of the characteristics of the employees in the iron and steel enterprise were revealed.

4 Findings

4.1. Descriptive Statistics Results

The socio-demographic characteristics and employment status of the participants are given in Table 1.

Table 1. Descriptive statistics of the research

Variables	Subgroup Variables	n	(%)	Values Defining Variables	
				Mode	Median
Gender	Male (1)	104	98.1	1	
	Female (2)	2	1.9		
	Total	106	106.0		
Age	15-17 (1)	0	0.0		4
	18-25 (2)	9	8.5		

	26-33 (3)	9	8.5		
	34-41 (4)	37	34.9		
	42-49 (5)	29	27.4		
	50-57 (6)	18	17,0		
	58-64 (7)	3	2.8		
	65 + (8)	1	0.9		
	Total	106	100.0		
Marital Status	Single (1)	13	12.3	2	
	Married (2)	87	82.1		
	Divorced (3)	4	3.8		
	Widow/Widower (4)	2	1.9		
	Total	106	100.0		
Education Status	Illiterate (1)	0	0.0		4
	Who Can Read and Write but Does Not Finish a School (2)	2	1.9		
	Primary School (3)	3	2.8		
	Elementary Education (4)	34	32.1		
	Secondary School and Equivalent Education (5)	19	17.9		
	General High School (6)	12	11.3		
	High School Equivalent Vocational School (7)	22	20.8		
	Associate Degree (8)	6	5.7		
	Bachelor's Degree (9)	7	6.6		
	Master’s degree (10)	1	0.9		
	PhD Degree (11)	0	0.0		
	Other (12)	0	0.0		
	Total	106	100.0		
Status at Company	Employer (1)	1	0.9	2	
	Employee (2)	104	98.1		
	Unpaid Family Worker (3)	0	0.0		
	Intern (4)	0	0.0		
	Other (5)	1	0.9		
	Total	106	100.0		
Working Time in the Company	0-5 years (1)	43	40.6	1	
	6-10 years (2)	32	30.2		
	11-15 years (3)	11	10.4		
	16-20 years (4)	5	4.7		
	21 years and above (5)	15	14.2		
	Total	106	100.0		
Working Time in the Same Department	0-5 years (1)	43	40.6	1	
	6-10 years (2)	32	30.2		
	11-15 years (3)	11	10.4		
	16-20 years (4)	8	7.5		
	21 years and above (5)	12	11.3		
	Total	106	100.0		
Weekly Working Hours	0-10 (1)	0	0.0		5
	11-20 (2)	0	0.0		

	21-30 (3)	0	0.0		
	31-40 (4)	5	4.7		
	41 hours or more (5)	101	95.3		
	Total	106	106.0		
Working Time	0-4 (1)	0	0.0		3
	5-8 (2)	8	7.5		
	8 hours or more (3)	98	92.5		
	Total	106	100.0		
Number of Permits used in the Last Year	0 (1)	39	36.8		2
	1-5 (2)	22	20.8		
	6-11 (3)	14	13.2		
	12-17 (4)	8	7.5		
	18-22 (5)	13	12.3		
	Over 23 Days (5)	10	9.4		
	Total	106	100.0		

According to the research results;
- In terms of gender, 98.1% of the participants are male,
- In terms of age, 34.9% of the participants are between the ages of 34-41,
- In terms of marital status, 82.1% of the participants are married,
- In terms of education level, 32.1% of the participants are primary school graduates,
- In terms of professional status, 4.3% of the participants are engineers,
- In terms of the situation at work, 98.1% of the participants are paid or daily wage earners,
- In terms of position at work 94.3% of the participants are workers,
- In terms of service period, 40% of the participants are employees between 0-5 years,
- In terms of weekly working hours, 95.3% of the participants work 41 hours or more,
- In terms of Working time, 92.5% of the participants work eight hours or more, and
- It was determined that 36.8% of the participants did not take leave in the last year.

4.2. Inferential Statistical Results

Hypothesis tests were used to compare the dimensions of interest in the study according to their socio-demographic information. However, since the data were not normally distributed, non-parametric statistical techniques were used for statistical group comparisons. In the study, Kruskal-Wallis H tests were used to determine whether the answers given about the dimensions of risk showed a significant difference in terms of socio-demographic characteristics of the employees. In this framework, hypotheses have been developed for the purpose of the study. The accepted hypotheses are given below. It was taken as $p<0.05$.

The Kruskal-Wallis H test was performed to determine whether the answers given to the concepts related to occupational safety and risk differ significantly according to the marital status of the employees, and the results are shown in Table 2.

Table 2. Comparison of the answers given to the concepts related to occupational safety and risk according to the marital status of the employees**.**

Dimension	Marital Status	n	M.R.	Chi-Square	p
Concepts Related to Occupational Safety and Risk	Single	13	44.04	8.316	0.040*
	Married	87	53.64		
	Divorced	4	91.63		
	Widow/Widower	2	32.75		

*p<0.05

The knowledge level of the participants about the concepts related to occupational safety and risk shows a significant difference in terms of their marital status. ($\chi 2=8.316$; $p<0.05$). Considering the weight averages of the groups; It is seen that the answers given by the divorced people to the concepts related to occupational safety and

risk are the most positive, and the answers given by the spouses of the deceased are the most negative. Therefore, the H_1 hypothesis of the research was accepted.

The Kruskal-Wallis H test was performed to determine whether the responses given to the statements regarding health risk status and perception differ significantly in terms of the age of the employees, and the results are shown in Table 3.

Table 3. Comparison of responses regarding health risk status and perception according to age status of employees.

Dimension	Age	n	M.R.	Chi-Square Value	p
Health Risk Status and Perception	15-17	0	-	13.255	0.039*
	18-25	9	32.39		
	26-33	9	31.94		
	34-41	37	53.68		
	42-49	29	56.60		
	50-57	18	66.67		
	58-64	3	70.33		
	65 +	1	53.50		

*p<0.05

The level of knowledge of the participants in the questions about their health risk status and perception differs significantly according to their age ($\chi 2=13.255$; $p<0.05$). Therefore, the H_1 hypothesis of the study was accepted.

The Kruskal-Wallis H test was performed to determine whether the responses to health risk status and perception differ significantly according to the marital status of the participants, and the results are shown in Table 4.

Table 4. Comparison of the responses regarding health risk status and perception according to the marital status of the employees

Dimension	Marital Status	n	M.R.	Chi-Square Value	p
Health Risk Status and Perception	Single	13	29.96	11.698	0.008*
	Married	87	56.46		
	Divorced	4	76.38		
	Widow/Widower	2	32.00		

*p<0.05

The level of knowledge of the questions about the health risk status and perception of the participants shows a significant difference in terms of their marital status. ($\chi 2=11.698$; $p<0.05$). Considering the weight averages of the groups; It is seen that the answers given by the divorced people to the concepts related to occupational safety and risk are the most positive, and the answers given by the spouses of the deceased are the most negative. Therefore, the H_1 hypothesis of the study was accepted.

The Kruskal-Wallis H test was performed to determine whether the responses to health risk status and perception differ significantly according to the leave periods they have used in the last year, and the results are shown in Table 5.

Table 5. Comparison of the responses given regarding the health risk status and perception according to the leave duration of the employees in the last year

Dimension	Number of Permits used in the Last Year	n	M.R.	Chi-Square	p
Health Risk Status and Perception	0	39	45.17	14.796	0.011*
	1-5	22	62.18		
	6-11	14	52.61		
	12-17	8	29.69		
	18-22	13	67.00		
	Over 23 Days	10	69.65		

*p<0.05

The level of knowledge of the participants to the questions about their health risk status and perception differs significantly according to the leave periods they have used in the last year. ($\chi 2=14.796$; $p<0.05$). In this context, the H_1 hypothesis of the research was accepted.

4.3. Two-Stage Clustering Results

In this part of the study, multivariate statistical methods were used. "Two-Step Clustering" clustering analysis was applied to investigate the similarities of the answers given regarding the risk perception of the employees according to the socio-demographic information. Cluster analysis model result is given in Figure 1.

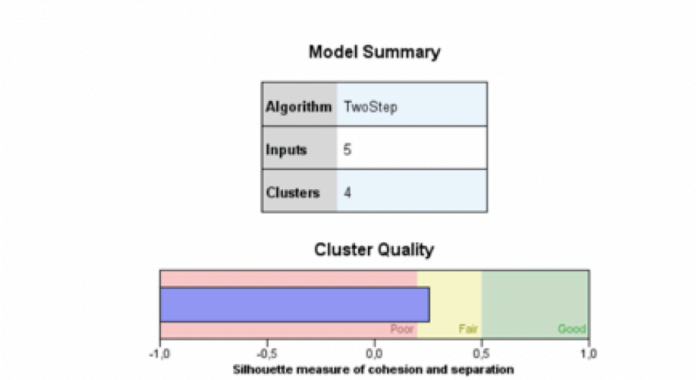

Figure 1. Silhoutte indexed clustering performance.

When Figure 1 is examined, it has been evaluated that the performance of the two-stage clustering model is good and its results can be used. In Figure 2 the distribution percentages of the clusters related to the concepts related to occupational safety and risk are given.

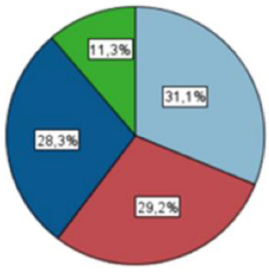

Figure 2. Distribution percentages of clusters.

When Figure 2 is examined; It was determined that the distribution of the 1st cluster was 31.1%, the 2nd cluster was 29.2%, the 3rd cluster was 28.3% and the 4th cluster was 11.3%. In Figure 3, the order of importance of the variables related to the level of knowledge regarding the socio-demographic characteristics of the concepts related to occupational safety and risk is given.

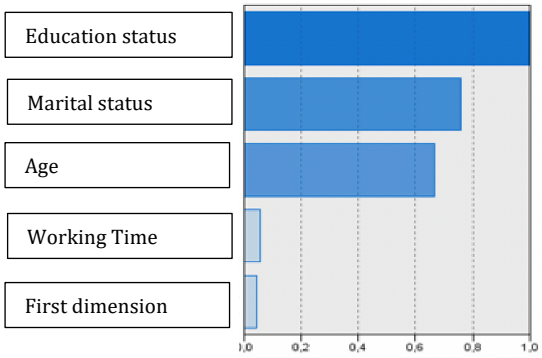

Figure 3. Significance level of variables in two-stage clustering method.

When Figure 3 is examined; It has been determined that the most influencing factor on the level of knowledge about occupational safety and risk concepts is "Educational status" and the least influencing factor is "Working time". Since the Working time in the enterprise are the same for all participants, it was not included as an important variable in the model. The distribution of socio-demographic characteristics within the cluster is given in Figure 4.

Cluster	1	2	3	4
Label				
Description				
Size	31,1% (33)	29,2% (31)	28,3% (30)	11,3% (12)
Inputs	educationstatus	educationstatus primary education(100,0%)	educationstatus	education status undergraduate education
	maritalstatus married (87,9%)	maritalstatus married (96,8%)	maritalstatus married (93,3%)	maritalstatus single(100,0%)
	age 50-57 (33,3%)	age 42-49 (48,4%)	age 34-41 (86,7%)	age 18-25 (58,3%)
	dailyworkinghours 8 and above (84,8%)	dailyworkingabove 8 and above (100,0%)	dailyworkinghours 8 and above (96,7%)	dailyworkinghours 8 and above (83,3%)
	Firstdimension 3,50	Firstdimension 3,90	Firstdimension 3,89	Firstdimension 3,52

Figure 4. Intra-cluster distributions.

The following summary results were obtained as a result of the two-stage clustering analysis of the knowledge levels of the employees on the concepts related to occupational health and risk.

• In the 1st cluster, the marital status of the participants is married, their age is between 50-57, and the working time are 8 hours or more,

• In the 2nd cluster, the education level of the participants is primary education, the marital status is married, the age is between 42-49 and the working time are 8 hours or more,

• The marital status of the participants in the 3rd cluster is married, their age is between 34-41, and the working time are 8 hours or more,

•In the 4th cluster, it was determined that the education level of the participants was undergraduate, the marital status was single, the age was between 18-25, and the working time were 8 hours or more.

As a result of the second dimension of the study, it was seen that the level of knowledge about occupational safety and risk studies in the workplace consisted of three different clusters because of two-stage clustering. The Silhoutte indexed clustering quality regarding the concepts related to occupational safety and risk studies in the workplace is given in Figure 5.

Figure 5. Silhoutte indexed clustering performance.

It is seen that the performance result of the two-stage clustering model given in Figure 5 is good. It has been evaluated that the model results can be used. In Figure 6, the distribution percentages of the clusters related to the concepts related to occupational safety and risk studies in the workplace are given.

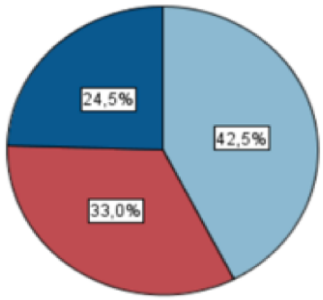

Figure 6. Distribution percentages of clusters.

When Figure 6 was examined, it was determined that the 1st cluster was 42.5%, the 2nd cluster was 33.0% and the 3rd cluster was 24.5%. In Figure 7, the order of importance of the variables related to the concepts of socio-demographic characteristics, occupational safety at work and risk studies is given.

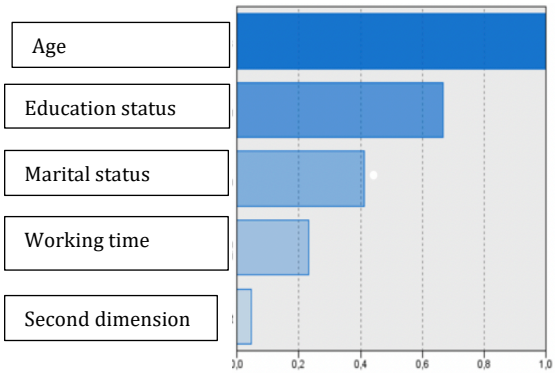

Figure 7. Significance level of variables in two-stage clustering method.

When Figure 7 is examined, it has been determined that the factor affecting the level of knowledge about the concepts related to occupational safety and risk studies in the workplace the most is "Age" and the least affecting factor is "Working time". Since the Working time in the enterprise are the same for all participants, it was not included as an important variable in the model. The distribution of socio-demographic characteristics within the cluster is given in Figure 8.

Cluster	1	2	3
Label			
Description			
Size	42,5% (45)	33,0% (35)	24,5% (26)
Inputs	age 42-49 (46,7%)	age 34-41 (48,6%)	age 50-57 (69,2%)
	educationstatus primaryeducation (53,3%)	educationstatus generalhighschool (31,4%)	educationstatus
	maritalstatus married (100,0%)	maritalstatus married (60,0%)	maritalstatus married (80,8%)
	dailyworkinghour 8 and above (100,0%)	dailyworkinghour 8 and above (77,1%)	dailyworkinghour 8 and above (100,0%)
	seconddimension 3,99	seconddimension 3,68	seconddimension 4,02

Figure 8. Intra-cluster distributions.

According to the results of the two-stage clustering model, the knowledge levels regarding occupational safety and risk studies in the workplace are summarized below.

• The education level of the 1st cluster is primary education, the marital status is married, and the working time are 8 hours or more,

• The education level of the 2nd cluster is general high school, the marital status is married, and the working time are 8 hours or more,

• It was determined that in the 3rd cluster, the marital status was married, the age was between 34-41, and the working time were 8 hours or more.

As a result of the third dimension of the study, it was seen that the level of knowledge on risk awareness consisted of three different clusters in two-stage clustering. Silhoutte indexed clustering quality regarding risk awareness is given in Figure 9.

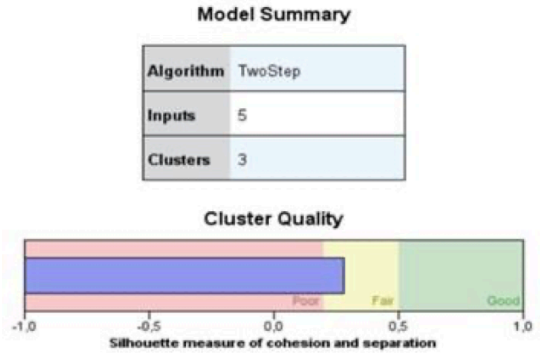

Figure 9. Silhoutte indexed clustering performance.

When Figure 9 is examined, it is evaluated that the performance of the two-stage clustering model is good and its results can be used. Distribution percentages of clusters regarding risk awareness are given in Figure 10.

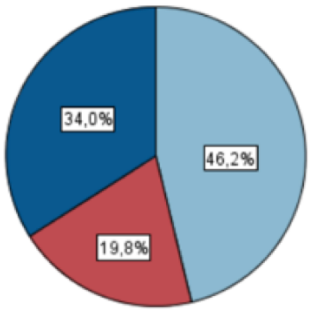

Figure 10. Distribution percentages of clusters.

When Figure 10 is examined, it was determined that the 1st cluster was 46.2%, the 2nd cluster was 34.0% and the 3rd cluster was 19.8%. In Figure 11, the order of importance of the variables related to the level of knowledge about risk awareness of socio-demographic characteristics is given.

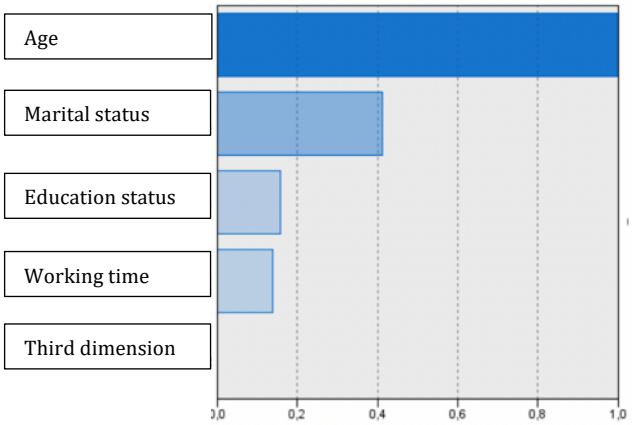

Figure 11. Significance level of variables in two-stage clustering method.

When Figure 11 is examined, it has been determined that the factor affecting the level of knowledge regarding risk awareness the most is "Age" and the least affecting factor is "Working time". Since the working time in the enterprise were the same for all participants, it was not included as an important variable in the model. The distribution of socio-demographic characteristics within the cluster is given in Figure 12.

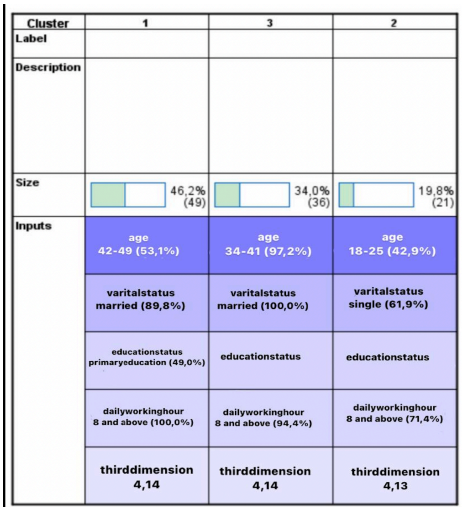

Figure 12. Intra-cluster distributions.

When Figure 12 is examined, the risk awareness knowledge levels as a result of two-stage clustering are summarized below.

• In the 1st cluster, age status is between 42-49, marital status is married, education level is primary school and working time are 8 hours or more,
• The age status of the 2nd cluster is between 34-41, the marital status is married, the working time are 8 hours or more,
• It has been determined that the age status of the 3rd cluster is between 18-25, the marital status is single, and the working time are 8 hours or more.

As a result of the fourth dimension of the study, it was seen that the level of knowledge about health risk status and perception consisted of three different clusters in two-stage clustering. Silhoutte indexed clustering quality regarding health risk status and perception is given in Figure 13.

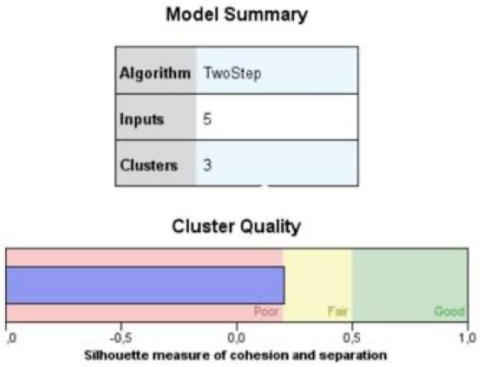

Figure 13. Silhoutte indexed clustering performance.

When Figure 13 is examined, it is evaluated that the performance of the two-stage clustering model is good and its results can be used. Distribution percentages of clusters related to health risk status and perception are given in Figure 14.

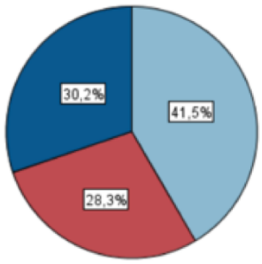

Figure 14. Distribution percentages of clusters.

When Figure 14 was examined, it was determined that the 1st cluster was 41.5%, the 2nd cluster was 30.2% and the 3rd cluster was 28.3%. In Figure 15, the order of importance of the variables related to the health risk status and perception of socio-demographic characteristics is given.

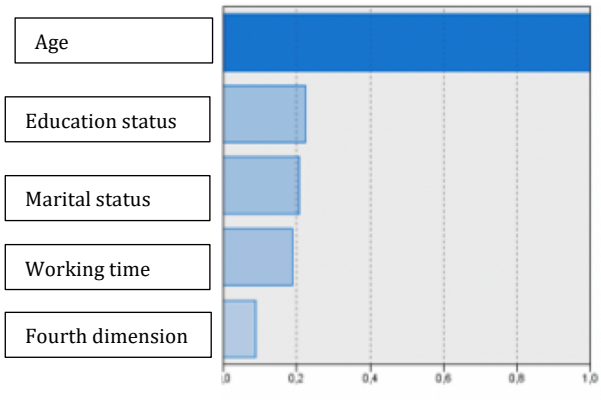

Figure 15. Significance level of variables in two-stage clustering method.

When Figure 15 is examined, it has been determined that the most influential factor on the level of knowledge regarding health risk status and perception is “Age” and the least affecting factor is "Working time". Since the Working time in the enterprise are the same for all participants, it was not included as an important variable in the model. The distribution of socio-demographic characteristics within the cluster is given in Figure 16.

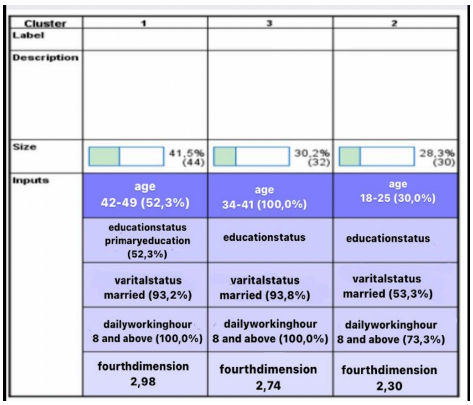

Figure 16. Intra-cluster distributions.

As a result of two-stage clustering, the knowledge levels regarding health risk status and perception are summarized below.

- In the 1st cluster, age status is between 42-49, education level is primary school, marital status is married and working time are 8 hours or more,
- The marital status of the 2nd group is married, the working time are 8 hours or more,
- Marital status of the 3rd cluster was found to be married, and the working time were 8 hours or more.

5. Discussion and Conclusion

The iron and steel industry are a dangerous industry where heavy and extremely large and dangerous materials are used. Occupational diseases that can be caused by molten metals and heat and noise up to 1800 degrees pose a risk in terms of occupational health and safety. As in other industrial sectors, the establishment of the safety and working environment of the workers in the iron and steel sector, the protection of the welfare and health of the workers have positive effects on increasing the efficiency, quality and continuity of production.

In this study, occupational accidents, risk awareness and risk perception levels of employees were measured on an iron and steel enterprise operating in Karabük province, and the differences of these perceptions according to socio-demographic conditions were investigated. Two dimensions (Concepts Related to Occupational Safety and Risk, Health Risk Status and Perception) were examined according to non-parametric statistical hypothesis test results. According to the two dimensions, the age, marital status and leave status of the employees in the last year differed. As a result of the studies of Büyükyılmaz et al. and Ersöz and Bulut, age and education factors were found to be important in risk perception. In this study, which was conducted to determine the risk perception levels of iron and steel workers, a two-stage clustering technique was used to reveal socio-demographic situations with the same risk perception. According to the two-stage clustering results, it has been determined that the most effective factor in the level of knowledge about the concepts of occupational safety and risk is "educational status". It has been determined that the factor affecting the level of knowledge about workplace safety and risk studies the most is “age”. It has been determined that the knowledge level of employees in the age range of “50-57” regarding occupational safety and risk studies at the workplace is higher than that of other employees. It may be due to the experience of employees in this age group over time. It has been observed that risk awareness is high among employees between the ages of “34-41”. Employees outside this age group should be informed about risk awareness through trainings that can positively affect risk awareness. Age factor was found to be the most influential factor on the level of knowledge about the concepts related to occupational safety and risk studies in the workplace. It has been determined that the least affecting factor is “Working time”. Since the Working time in the enterprise are the same for all participants, it was not included as an important variable in the model.

Employees in the iron and steel industry are exposed to heavy workloads, long working hours, harsh conditions, and dangers arising from the working environment that will endanger the health and safety of the employee. There is a risk dimension for every hazard and this needs to be estimated and checked beforehand as a precaution. It is impossible to completely eliminate the risks involved in the sector. However, it is possible to reduce these risks. When the safety of every employee, manager and employer in the enterprise becomes a priority, risks will be brought under control when hazard analyzes and risk assessments are carried out periodically.

Acknowledgment: This article was produced from a master's thesis [70].

References

[1] Korkmaz, O. 2011 IAş Kazaları ile Verimlilik Arasındaki IAlişki: Türkiye Taşkömürü Kurumu OArneği. Yaşar UAniversitesi E-Dergisi, 6(23), 3805-3813.

[2] Aydın, E. 2018. Türkiye'de Teknolojik İlerleme ile İstihdam Yapısındaki Değişme Projeksiyonu: Endüstri 4.0 Bağlamında Ampirik Analiz. Yönetim Bilimleri Dergisi, 16(31), 461-471.

[3] Çelik, N., Can, E. 2019. Endüstri 4.0 Sisteminde İş Sağlığı ve Güvenliği Yönetim Sistemi Muhtemel Problemleri ve Çözüm Önerileri. Ohs Academy, 2(3), 119-126.

[4] Özsoylu, A. F. 2017. Endüstri 4.0. Çukurova Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 21(1), 41-64.

[5] Günaydın, D. 2019. Türkiye'de Dördüncü Sanayi Devrimini Beklerken: Çerezköy Organize Sanayi Bölgesi'nde bir Araştırma. İstanbul Üniversitesi İşletme İktisadi ve Enstitüsü Yönetim Dergisi, 29(85), 73-106.

[6] Carvalho, A. C. P., Carvalho, A. P. P., Carvalho, N. G. P. 2020. Industry 4.0- Current Status And Future Trends. Hamilton Ortiz, London, 29-44.

[7] Yiğitol, B., Sarı, T. 2020. Küresel Salgınlar ile Mücadelede Endüstri 4.0 Teknolojilerinin Rolü. Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 41, 53-73.

[8] Demirkan, S., Coşun Arslan, M. 2019. Endüstri 4.0 ve Muhasebe Sistemi Etkisi UAzerine Kuramsal bir IAnceleme. Enderun, 3(1), 40-56.

[9] Weyer, S., Schmitt, M., Ohmer, M., Gorecky, D. 2015. Towards Industry 4.0- Standardization as the Challenge For Highly Modular, Multi- Vendor Production System. 15th IFAC Sysmposium on Information Control Problembs in Manufacturing, Kaiserslautern, 579-584.

[10] Ersöz, T., Düğenci, M., Ünver, M., Eyiol, B. 2016. Demir Çelik Sektörüne Genel Bir Bakış ve Beş Milyon Ton Üstü Demir Çelik İhracatı Yapan Ülkelerin Kümeleme Analizi ile İncelenmesi. NevşehirBilim ve Teknoloji Dergisi, 4(2), 75-90.

[11] Prisecaru, P. 2017. The Challenges of The Industry 4.0. Global Economic Observer, 5(1), 66-72.

[12] Karamık, S., Şeker, U. 2016. İşletmelerde İş Güvenliğinin Verimlilik Üzerine Etkilerinin Değerlendirilmesi. Gazi Üniversitesi Fen Bilimleri dergisi, 3(4), 575-584.

[13] Efe, Ö. F., Efe, B. 2019. Tekstil Sektöründe İş Kazalarına Sebep Olan Risk Faktörlerinin Dematel Yöntemiyle Analizi. Düzce Üniversitesi Bilim ve Teknoloji Dergisi, 7(3), 1162-1175.

[14] Ceylan, H. 2011. Türkiye'deki İş Kazalarının Genel Görünümü ve Gelişmiş Ülkelerle Kıyaslanması. Uluslararası Mühendislik Araştırma ve Geliştirme Dergisi, 3(2), 18-24.

[15] Uludağ, S. 2017. Değişen Risk Algısı ve İç Denetim. Muhasebe ve Denetime Bakış, 16(51).

[16] OAzcan, N. 2018. Sağlık Kurumlarında Risk Yönetimi. Sağlık Hizmetleri ve Eğitimi Dergisi, 2(1), 15-24.

[17] Yarız, A. 2012. Bankacılıkta Risk Yönetimi: Risk Matrisi Uygulaması. E-journal of Banking and Insurance Institute, 1(1), 1-33.

[18] Demir Pali, Ç., Adiloğlu, B. 2019. Kontrol Edilebilen Riskler ve Risk Yönetimi Açıklamaları: Borsa İstanbul Uygulaması. Çözüm Dergisi, 30(157), 77-102.

[19] 6331 Sayılı IAş Sağlığı ve Güvenliği Kanunu (2012).

[20] Yılmaz. A. İ. 2013. İş Sağlığı ve Güvenliğinde Kaza Zinciri Teorisinin Önemi ile Açık İşletmelerdeki Tehlikeli Hareket ve Tehlikeli Durumlar. MT Bilimsel, 3, 27-39.

[21] Yılmaz, Ş, Bilici, M. 2020. Mühendislik Fakültesi Bünyesinde Bulunan Laboratuvarlarda İş Sağlığı ve Güvenliği. Ohs Academy, 102-113.

[22] Başkol, M. O., Bektaş, S. 2021. Türkiye Demir-Çelik Sektörünün Ürün Haritalaması: Widodo Yöntemiyle Bir Analiz. Yönetim Bilimleri Dergisi, 19(özel sayı), 57-84.

[23] Turkmen, C., Turkmen, B. 2017. An Attempt for Applying The Lcr and Car Requirements to Turkish Iron and Steel Sector. PressAcademia Procedia, 3(1), 222-228.

[24] Mondol, S. S. 2017. A Review of Steelmaking Technologies. International Journal of Science and Research (IJSR), 5(2), 282-286.

[25] Gökcecik, G., Dulkadiroğlu, H. 2021. Elektrik Ark Ocağı ile Üretim Yapan Bir Demir- Çelik Tesisinin Mevcut En İyi Teknikler Kapsamında Değerlendirilmesi, Niğde Ömer Halisdemir Üniversitesi Mühendislik Bilimleri Dergisi, 10(2), 465-471.

[26] Ersöz, F., Ersöz, T., Erkmen, İ. N. 2016. Dünyada ve Türkiye'de Ham Çelik Üretimine Bakış. Erciyes Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 32(2), 0-0.

[27] T.C. Sanayi Bakanlığı. https://www.sanayi.gov.tr/plan-program-raporlar-ve-yayinlar/sektor-raporlari /mu 1406011405 (Accessed 25.12.2021).

[28] Kardemir. https://www.kardemir.com/ (Accessed on 06.12.2021).

[29] Erdemir. https://www.erdemir.com.tr (Accessed on 06.12.2021).

[30] İsdemir. https://www.isdemir.com.tr/ (Accessed on 06.12.2021).

[31] Karabay, M. 2007.Teknik Bilirkişi Gözü ile İş Kazalarının Değerlendirilmesi. Makine Tasarım ve İmalat Dergisi, 9(2), 97-102.

[32] Güyagüler, T., 1990. İş Kazaları ve Meslek Hastalıklarının Önemi, Nedenleri ve Öneriler. Bilimsel Madencilik Dergisi, 29(4), 31-34.

[33] Ulusal IASG Politika Belgesi. 2014. Ankara.

[34] Sözlük. https://sozluk.gov.tr/ (Accessed on 27.09.2021).

[35] T.C. Resmî Gazete, 29 Aralık 2021, sayı: 28512.

[36] Emhan, A. 2009. Risk Yönetim Süreci ve Risk Yönetmekte Kullanılan Teknikler. Atatürk Üniversitesi İktisadi ve İdari Bilimler Üniversitesi Dergisi, 23(3), 209- 220.

[37] Kalkan, M. E., Deniz, V. 2018. Risk Kavramı Üzerine. TBB Mesleki Sağlık ve Güvenlik Dergisi, 13(48), 43-48.

[38] Balıkçı Y. 2005. Risk Yönetimi ve Metal Sektöründe Faaliyet Gösteren İşletmelerde bir Uygulama. Marmara Üniversitesi, Sosyal Bilimler Enstitüsü, İşletme Anabilim Dalı, Yönetim ve Organizasyon Bilim Dalı, Yayınlanmış Doktora Tezi, İstanbul.

[39] Çelik, B., Altan, M. F. 2017. Evaluation of Risk in Turkish Construction Sector. Journal of Sustainable Construction Materials And Technologies, 2(2), 120- 131.

[40] Mandacı, P. E. 2003. Türk Bankacılık Sektörünün Taşıdığı Riskler ve Finansal Krizi Aşmada Kullanılan Risk Ö Ölçüm Teknikleri. Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 5(1), 67-84.

[41] İstanbul Üniversitesi. https://cdnacikogretim.istanbul.edu.tr/auzefcontent/20_21_Guz/is_sagligi_ve_guvenligi/ 14/index.html (Accessed on 24.12.2021).

[42] Ceylan, H. 2011. Türkiye'deki İş Kazalarının Genel Görünümü ve Gelişmiş Ülkelerle Kıyaslanması. Uluslararası Mühendislik Araştırma ve Geliştirme Dergisi, 3(2), 18-24.

[43] Akçın, H., Uzun, A. H., Atalay, C. ve Şekertekin, A. 2015. Endüstriyel Alanlarda Risk Haritalarının Oluşturulması. "TMMOB Harita ve Kadastro Mühendisleri Odası", 15. Türkiye Harita Bilimsel ve Teknik Kurultayı, Ankara.

[44] Birgönül, M. T., Dikmen, IA. 1996. İnşaat Projelerinin Risk Yönetimi. Teknik Dergi, 7(34), 1305-1326.

[45] Zabun, A. OA 2012. Proje Yapım Sürecinde Risk Yöntemi Üzerine Örnek Olay İncelemeleri. İstanbul Teknik Ü Üniversitesi, Fen Bilimleri Enstitüsü, Mimarlık Anabilim Dalı, Yayınlanmış Yüksek Lisans Tezi, İstanbul.

[46] Akçakanat, Ö. 2016. Kurumsal Risk Yönetimi ve Kurumsal Risk Yönetim Süreci. Süleyman Demirel Ü Üniversitesi Vizyoner Dergisi, 4(7), 30-46.

[47] Önen, L. 2012. İş Kazası Riski Yüksek Yerlerde Çalışanlarla İş Kazası Riski Az Yerlerde Çalışanlar Arasındaki Psikolojik Özellikler. Psikoloji Çalışmaları, 20(0), 137-150.

[48] Ersöz, T., Bulut, B. 2021. Risk Perception and Data Mining in the Iron and Steel Industry. International Journal of 3D Printing Technologies and Digital Industry, 5 (2), 313-325.

[49] Alkış, H., Taşpınar, Y. 2012. İşçi Sağlığı ve İş Güvenliğinde Yeni Yaklaşımlar, Demir Çelik Sektöründe Çalışanlarının İşçi Sağlığı ve İş Güvenliği Algısı: Konya Örneği, Karabük.

[50] Gülhan, B., IAlhan, M. ve Civil, E. F. 2012. Ankara'da Bir Metal Sanayi Fabrikasında İş Kazaları ve Etkileyen Faktörler. Türkiye Halk Sağlığı Dergisi, 10(2), 76-85.

[51] Gerami, F. 2014. Human Incidents Analysis By Knowledge Discovery Method in a Steel Maker Company. International Journal of Innovative Science, Engineering & Technology, 1(5), 327-333.

[52] Topaloğlu, G., Koç, A., Öztürk, N. 2015. Yüksek Fırınların İşletilmesinde Risk Değerlendirmesinin Yapılması ve Geliştirilmesi. Mühendis ve Makine, 56(661), 55-63.

[53] Aytaç, S., Özok, A. F., Yamankaradeniz,N., Akalp, G., Çankaya, O., Gökçe, A., Tüfekçi, U., Parçali, A. & Snaet, C. 2015. Metal Endüstrisinde Çalışan Kadın İşçiler Arasında Algılanan Risk Faktörleri. Journal of Engineering Sciences and Design, 3(3), 141-148.

[54] Arpat, B. 2015. İş Güvenliği Kültürünün İş Kazalarına Etkileri: Metal Sektörü – Denizli ili Örneği. Sakarya Ü Üniversitesi, Sosyal Bilimler Enstitüsü, Yayınlanmış Doktora Tezi, Sakarya.

[55] Aytaç, S., Özok, A. F., Yamankaradeniz, N., Akalp, G., Çankaya, O., Gökçe, A., Tüfekçi, U. 2017. İsg Kültürü Oluşmasında Metal Sanayinde Çalışan Kadınların Risk Algısı Üzerine bir Araştırma, Özel Sayı: 22. Ulusal Ergonomi Kongresi, 5, 59-67, Mühendis Bilimleri ve Tasarım Dergisi.

[56] Karadal, H., Merdan, E. 2017. ,İşyeri Yaralanmaları Üzerinde Güvenlik İklimi ve Güvenlik Kültürünün Rolü. Uluslararası Yönetim İktisat ve İşletme Dergisi, 136(13), 912-919.

[57] Kukhar, V., Yelistratova, N., Burko, V., Nizhelska, Y. & Aksionova, O. 2018. Estimation of Occupational Safety Risks at Energetic Sector of Iron and Steel Works. International Journal of Engineering & Technologyi 7(2.23), 216-220.

[58] Aytaç, S., Özok, A. F., Yamankaradeniz, N., Gökçe, A., Akalp, G., Çankaya, O., Tüfekçi, U. 2018. Metal Sanayiinde Çalışan Kadınların Ergonomik Risk Algısı: Bir Araştırma. Ergonomi, 1(1), 29-38.

[59] Akarsu, H. Tükenmez, İ., 2018 Demir Çelik Endüstrisinde bir Asit Rejenerasyon Reaktöründe Tehlike ve İşletilebilirlik Analizi. Ohs Academy, 1(1), 1-11.

[60] Büyükyılmaz, O., Yurdasever, E., Horuzoğlu, K. 2018. Kardemir A.Ş. Çalışanlarının Örgüt Sağlığı Algılarını Belirlemeye Yönelik Bir Araştırma. Balkan Sosyal Bilimler Dergisi, 7(14), 60-79.

[61] Ayanoğlu, C. C., Kurt, M. 2019. Metal Sektöründe Veri Madenciliği Yöntemleri ile bir İş Kazası Tahmin Modeli Önerisi. Ergonomi, 2(2), 78-87.

[62] Nasution, S. R., Sa, H. & Valencia, F. 2020. Improving Employees Safety Behaviour on the Production Process by Designin Occupational Health And Safety System. International Joint Conference on Science and Technology, 1(1), 155-164.

[63] Kahya, E., Ulutaş, B., Özkan, N. F. 2019. Metal Endüstrisinde Kişisel Koruyucu Donanım Kullanımının Analizi. Selçuk Üniversitesi Mühendislik. Bilim ve Teknoloji Dergisi, 7(2), 420-433.

[64] Karadal, H., Merdan, E., Abubakar, M. 2019. Güvenlik İklimi ve Güvenlik Kültürünün İşyeri Yaralanmaları Ü Üzerine Etkisinde Güvenlik Davranışlarının Aracılık Rolü: Döküm Sanayisinde bir Araştırma. Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi, 7(6), 341-351.

[65] Keskin, M. Ö. Doğan, O., Ersoy, S. 2020. Metalik Bir Maden İşletmesi, Cevher Çıkarma, Üretim ve Nakliyat Aşamalarında Risk Değerlendirmesi. Gaziosmanpaşa Bilimsel Araştırma Dergisi, 9(2), 84-98.

[66] Köse, N., Ersöz, F. 2020. Veri Madenciliğinde Karar Ağacı Algoritmaları ile Demir Çelik Endüstrisinde İş Kazaları Üzerine bir Uygulama. Avrupa Bilim ve Teknoloji Dergisi, 397-407.

[67] Korkmaz, A. V. 2020. Endüstriyel Kaza Araştırmaları ve Düzenleyici Müdahaleler; Magnezyum Metal Üretimi. Çalışma ve Toplum, 4(67), 2271-2294.

[68] Yussof, K., Idris, S. M., Ayob, M., Mohd Shahren, N. 2021. Risk Management: Safe Work Culture in Manufacturing Industry. International Journal of Accounting, Finance and Business (IJAFB), 6(34), 9-18.

[69] Durmaz, S., Atalay, S. 2021. The Relationship Between Occupational Accidents and the Safety Climate of Blue-Collar Workers In The Metal Industry. Medical Science and Discoverry, 8(6), 384-388.

[70] Bulut, B. 2022. Demir Çelik Sektörü Çalışanlarının Risk Algısı. Yüksek Lisans Tezi, Karabük Üniversitesi Lisansüstü Eğitim Enstitüsü.