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Examination of Effect of Gender on Occupational Accident

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Abstract: Competition among companies is increasing with the development of the technology and changing market conditions. Companies in this competitive environment need to reduce their costs (direct and indirect cost) and increase their productivity. Companies that want to reduce their costs should also give priority to occupational health and safety. So that in Turkey, legislation studies and programs about occupational health and safety are tried to gain the awareness of occupational helath and safety. Determining whether these studies are successful is only possible with statistical analyzes using past years' data. In Turkey, datas of work accident and occupational disease are published by Social Security Instution (SSI). In recent years, it has been seen that female employees take part in many sectors. In this study, in order to determine the effects of gender of occupational accidents, statistical analyzes were carried out in the sectors of "Electrical Equipment Manufacture" and "Manufacture of Textile Products" which female employees are more and most of the occupational accidents are experienced. After the analyzes, the relationship between the gender and living occupational accidents was determined and interpreted.

Keywords: Occupational health and safety, Occupational accident, Estimation

Introduction

The rapid progress of technology and changing market conditions from day to day cause firms to compete. These companies want to increase the production efficency and reduce their costs. In this case, employers do not give importance to occupational helath and safety because they think that it has increased the cost. However, when one of their employees is exposed to a job accident, employees will be exposed to much more Money than they would have to pay to prevent a job accident. Besides the physical burden of job accident, the spiritual burden is also very heavy. Therefore, it is much cheaper and more humane to prevent a job accident. In our country, proactive approach to occupational helath and safety has began to emphasized in recent years. Number of 6331 The Law of Occupational Health and Safety, which was enacted in 2012, aimed to gain the awereness of occupational health and safety to all employers. The obligations (for example job security specialist, workplace phsician, risk assesment etc.) imposed by this law have allowed employers to start paying attention to occupational health and safety. However, our country, Turkey, still ranks ranks first among European countries the terms of number of work accidents.

Occupational accident statistics in European countries Show that occupational accidents can be avoided with measures taken on occupational helth and safety. These measures will reduce both the number of occupational accidents and the employees will work in a safer and more peaceful workplace. This will ensure that productivity of employees is increased and costs are reduced.

In our country, planning of inspections for occupational helth and safety and development of policies according to the the results of work accident statistics is being carried out by the Ministry of Labor and Social Security. In recent years, women workers who are confronted in the most dangerous sectors are being affected by the job accidents. Therefore, issues such as what measures should be taken and what properties shold be developed for women employees sholud be determined.

The statistics of occupational accidents and occupational diseases are published annually by the Social Security Institution in our country. Since the most-up-to-date data during this study was for the year of 2016, so we used statistics of between the year 2001 to 2016 for this study.

In the research conducted, the methods used in previous studies have been investigated. These methods are generally divided into statistical estimation methods and heuristic methods. In past studies, the development of prediction models has benefited from fuzzy logic and artificial neural networks from intutitive methods. However, in past studies, statist,cal methods have been used in the development of most prediction models.

In recent years, female workers in many sectors have come up with antagonism. In many sectors whre male employees are the majority, the number of female employees are increasing. It is also wondered how women workers who face antogonism in many sectors are affeted from the work accidents and how much they are exposed to work accidents ın this study, the effect of gender on living work accidents was examined. Firstly, the sectors, in our country, in which the most occupational accident occured were determined, and it was determined in which sectors the female employees occupied the most in these sectors. Teherefore, statistical studies have been carried out for the effects of gender in occupational accidents in the sectors of "Electrical Equipment Manufacture" and "Textile Product Manufacture" sectors where the number of female workers are also dominant. Later estimating studies were carried out on the number of occupational accident experienced by the women. In calculations made using various estimation methods, estimation error methods were used to determine which method gave the cloesest results. In past studies, th Mean Absolute Persentage Error (MAPE) method has been used more often for determining the best estimation method. Therefore, in this study MAPE mthod is used for comparison of estimation methods.

Literature Review

Occupational safety has become a hot topic all over the World in recent years. It is necessary to use of past statistics to measure the succes of the measures taken to prevent the occupational accidents. Scientists using these statistics have studied to estimate the total number of occupational accidents during the year. It can be determined how succesful the measures taken and the tendency of the number of occupational accidents to be affected, with the help of these studies. The study of Takala (1999), benefited from the ILO fatal accident statistics, including traffic accidents that occured in the number of accidents that resulted in death reported to ILO. In order to reduce the forecast error, they improved the forecast by adding a certain percentage to account for unreported occupational accidents. In another study conducted by Driscol et al. (2005), the differences between the estimates of occupational accidents made up to now and the actual occupational accidents have been examined globally regarding the health and safety of work. In another study conducted by Driscol et al.(2005), they predicted by employing forensic medicine and risk approach data by developing a prediction model related to the number of occupaitonal accident injuries and the number of deaths resulting from occupational diseases. Hamalian et al. (2006) developed a statistical formulation by using the numbers of deaths, fatal accidents and the total population working in that country and insured employees for each group, by dividing the countries into groups according to similar characteristics. They predicted for years to come with using this formulation. In a study conducted by Atwood et al.(2006), they developed a model for offshore oil and gas industry that can estimate the frequency of occupational accidents and costs which are related to occupational accidents. Hamalian and colleagues (2009) conducted a study on the global trend of occupational accidents and occpational disesases resulting in death.

Scientists have also worked in this issue in recent years in Turkey. In a study conducted by Ceylan and Avan (2012), they estimated the number of occupational accidents by 2025 using artificial eural networks method.

Examination of Data

The statistics of occupational accidents and occupational diseases in Turkey are published anually by Social Security Instutitions (SSI) in the Statistical Yearbooks. The data between 2001-2016 were available on the SSI website. Figure 1 has been drwn up from the total number of occupational accidents per year in Turkey. When this figure is examined, it is seen that the number of job accidents is generally around 70000, but in recent years there has been an increase in the number of employees as well as an increase tendency in occupational accidents.

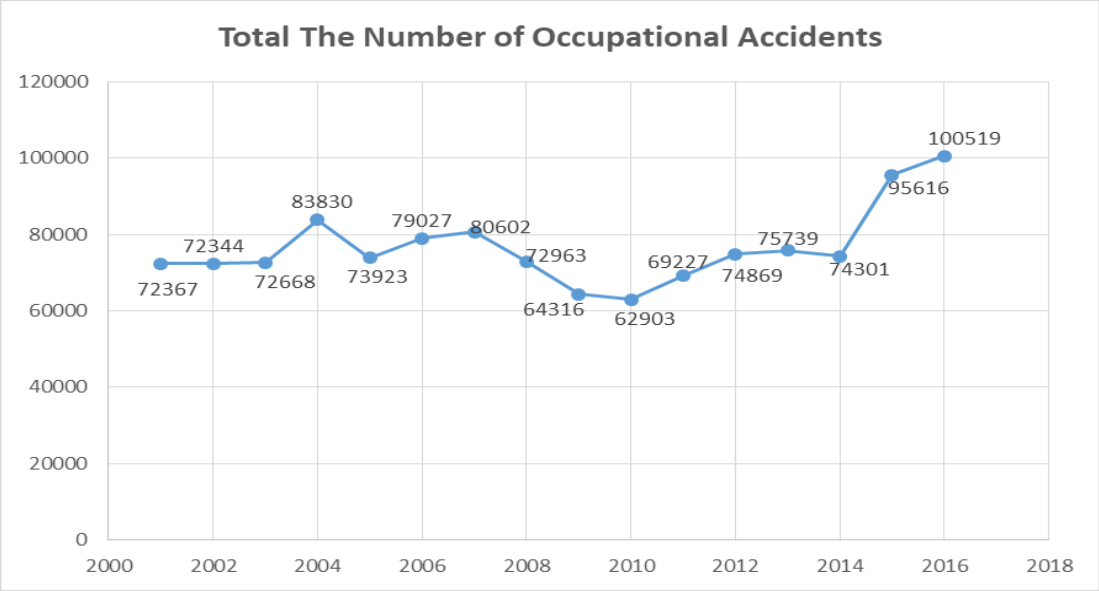

Figure 1. The total number of occupational accidents for years

Figure 2 shows the distribution of occupational accidents by sectors in 2016. According to this figüre, while 9.2% of the occupational accidents in 2016 are "Fabricated Metal Products Production (Excluding Machinary Equipment)", 6.4% are in "Basic Metal Industry" sectors and about 68% are in other 94 sectors it is creating occupational accidents. As seen in Figure 2, most occupational accidents among experienced sectors in Turkey, "Fabricated Metal Products Production", "Basic Metal Industry", "Textile Product Manufacture", "Building Construction" and "Coal – Lignite Removing Sector".

In this study, it is desired to measure the effect of gender on occupational accidents. Therefore, the sectors in which the most occupational accidents occured are the sectors in which the female employees are also located. It has been determined that the female workers of the "Textile Product Manufacture" and "Electrical Equipment Products Manufacturing" sectors mostly occupy the sectors where the job accident is most experienced by using the past datas.

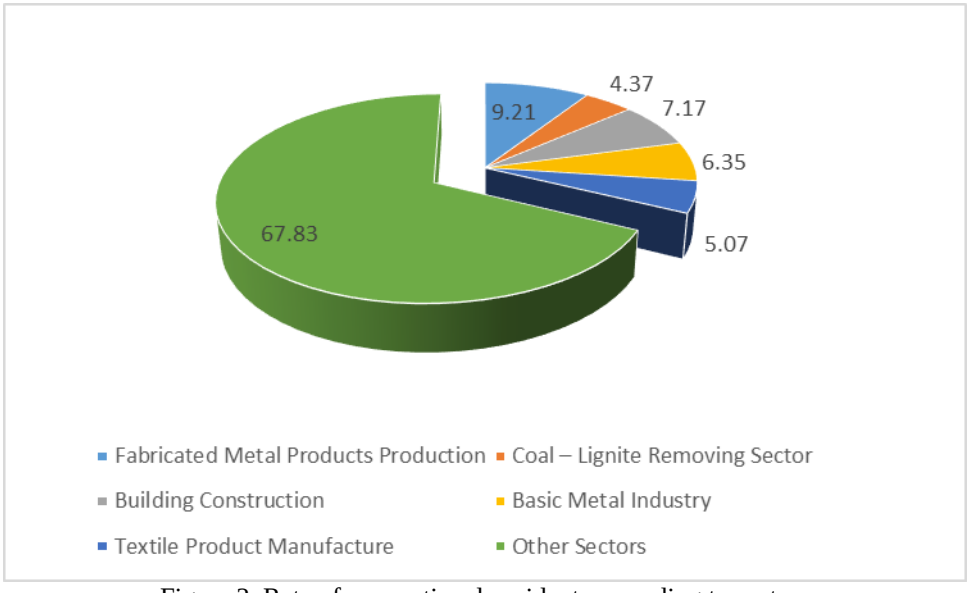

Figure 2. Rate of occupational accidents according to sectors

Figure 3 was created by using the data in Electrical Equipment Products Manufacturing sector. When the figure examined, it is seen that the number of both male and female employees has increased in recent years. Moreover, in recent years, it is seen that the number of female employees are about 1/3 of the number of male employees.

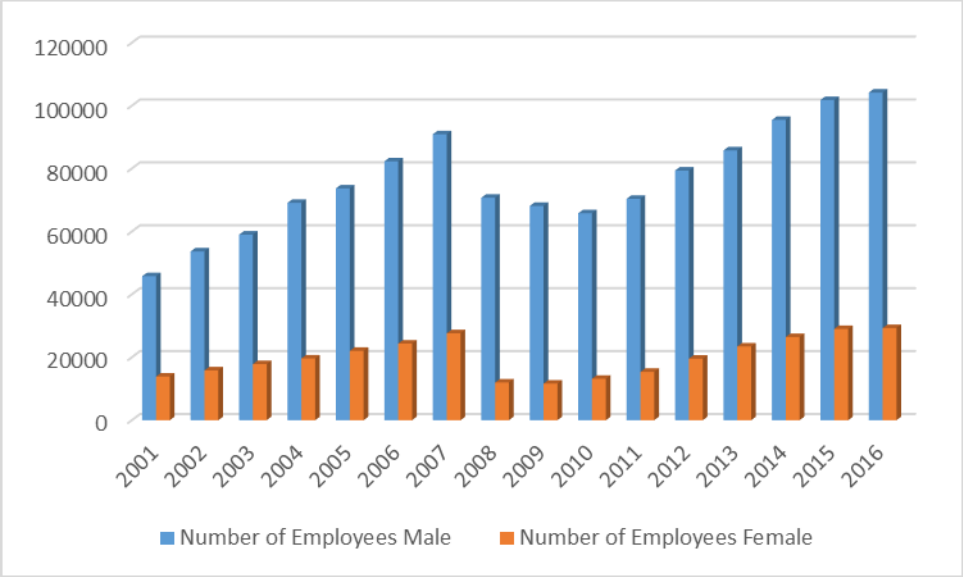

Figure 3. Number of employees in electrical equipment products manufacturing

Figure 4 shows that the number of occupational accidents in the Electrical Equipment Products Manufacturing sector. When the figure is examined, it is seen that the fluctiations in accident numbers are experienced, but they have increased in recent years. It is also seen that women are living with occupational accidents are compared with the number of occupational accidents taht men have experienced, the ratio is even under 1/4.

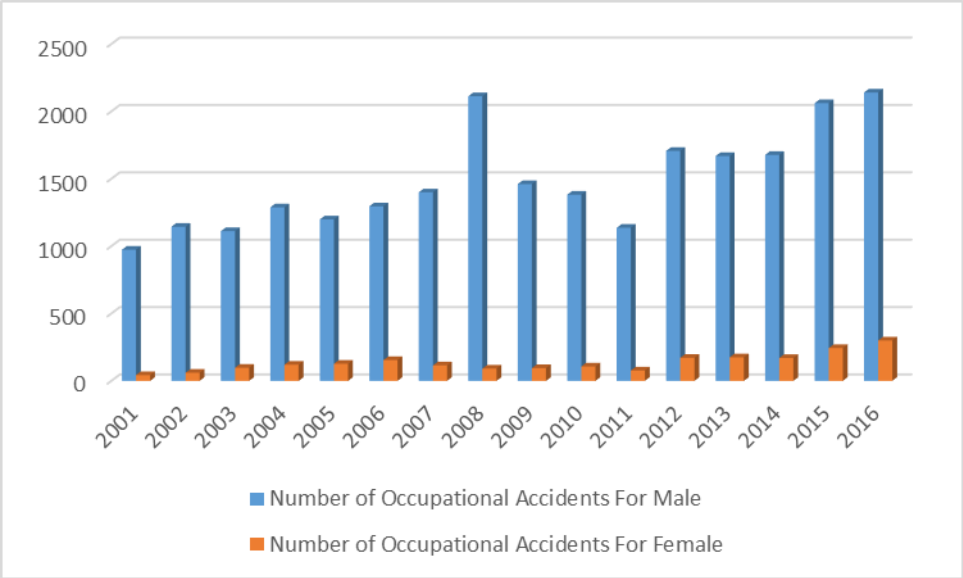

Figure 4. Number of occupational accidents in electrical equipment products manufacturing

One of the sectors where the occupational accident is most experienced is the “Textile Products Manufacturing” sector. Figure 5 shows the distribution of the number of men and women working in Textile Products Manufacturin sector by years. When the figure is examined, it can be seen that the number of male employees in the number of female employees is close to half in some years and in some years it is lower than.

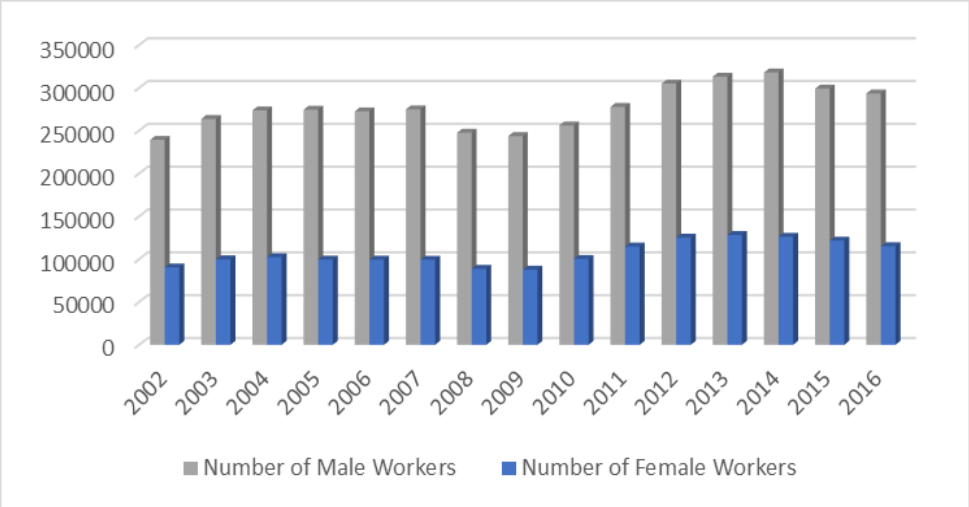

Figure 5. Number of employees in textile products manufacturing sector

Figure 6 shows the distribution of the occupational accidents by the Textile Products Manufacturing Sector according to their genders. When the Figure is examined, it is seen that the number of occupational accidents living in recent years have decreased. The graph shows that male workers have experienced about 3 times more occupational accidents in some years than female workers.

In our previous study, a prediction model was developed for the number of occupational accidents for the 5 sectors which the occupational accident was most experienced. Estimated sectors are especially dangerous sectors (mine, base metal etc.), female workers in these sectors are not generally found. Therefore, in this study, the sectors in which women experience the most ocupational accidents have been identified in order to be able to analyze the effects of women's occupational accidents. It has been thought that prediction models should be developed in order for women workers to predict their future job vacacies for years to come.

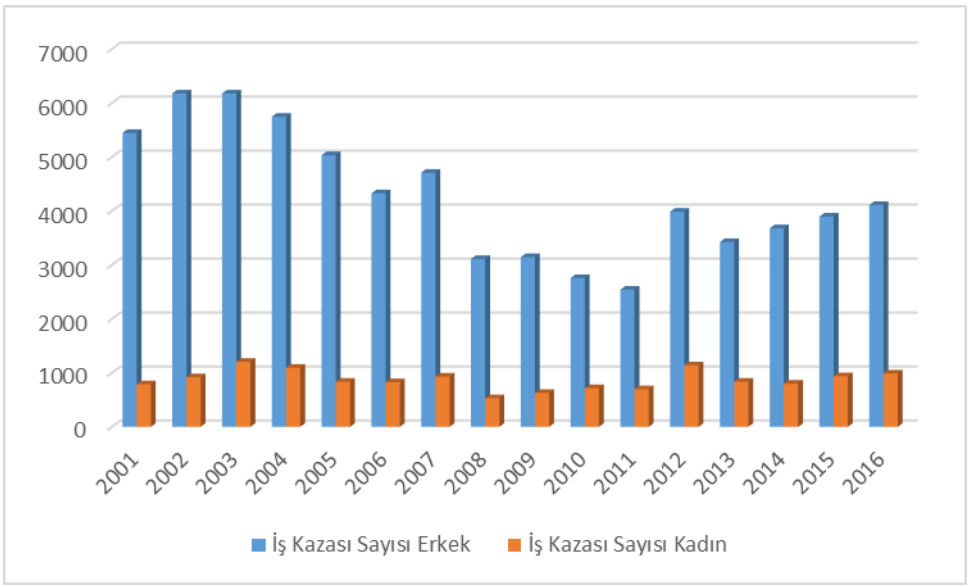

Figure 6. Numbers of occupational accidents in textile production sector by gender

Practice

In the majority of the Occupational Accident Prediction Models made, statistical prediction models were used from previous studies. Mean Absolute Percentage Error (MAPE) method was used for the comparision of prediction errorsin this study because MAPE methos was preferred in the evaluation of prediction errrors in similar studies in the past.

Analyzes For Electrical Equipment Products Manufacturing Sector

In this part of the study, a statistical estimation model was developed for the group of Electrical Equipment Products Manufacturing by making use of the number of work accidents that female workers are exposed to. These methods have been tried to calculete and it has been attemted to determine which method has the best results with the methods of prediction error. When the data for the past years are examined, it is ssen that female workers have suffered from about 150-200 occupational accident each year in recent years.

The calculations for the moving average method, 3 different values for m were calculated. As a result of comparison, it is ssen that estimates made by tking m=4 find the best MAPE value. In the Weighted Moving Average Technique, ten different weight grops were calculated. As a result of comparison, we tried to determine the weight group giving the best predict. The MAPE value was calculated as 24.4% in the calculation with m_1= 1, m_2= 2 and m3=5 weights and the best result was obtained when compared with the calculations made with other weights. The calculations for the Simple Exponential Smoothing Method, it is determined that the best prediction was found for the value of $\alpha = 1{,}00$. As a result of the calculations made in SPSS with Holt's Dual Parameter Exponential Correction Estimation Technique, the correction coefficents were found as $\alpha = 0.962$ and $\beta = 0.007$ and estimations were calculated using these values. When Brown's Exponential Correction Estimation Technique yielded $\alpha = 0.581$ as a result of calculations made in SPSS, the best prediction results were obtained.
In the regression technique, which is one of the statistical methods widely used in estimations, 2001-2012 datas are used. Estimation of the regression equation was made by using these datas and data for years 2013-2016 were used to calculate estimation errors. The equation created by simple regression analysis made with the years 2001-2012 is as follow. In this equation, x is used for the years.

$$\hat{Y} = 73{,}864 - 4{,}752x$$

It is thougt that the number of occupational accidents increase if number of workers increases in a sector. Therefore, while the multiple regression equaiton is being constructed, the number of employees as well as the number of years are used as input daat, and the prediction model for the coming years is created with this data. In this equation x_1 is used for years and x_2 is used for number of workers. The regression equation created using past years' data is as follows:

$$\hat{Y} = -12{,}2 + 5{,}414x_1 + 0{,}005x_2$$

For the years 2013-2016 the MAPE value was calculated as 13.6% in the result of comparison made.

As a result of calculations made by statistical estimation methods, estimation error methods were used to determine which method performed better. We used the MAPE method for the comparison. Table 1 has been generated with the results of estimation error calculated according to the methods used.

Table 1. Estimation errors for electrical equipment manufacturing products sector

Applied Estimation Methods	MAD	MSE	MAPE
Simple Moving Average Method	44,5	2676	29,00%
Weighted Moving Average Method	37,2	2035	24,4%
Simple Exponential Correction Technique	30	1574	29,13%
Holt's Two Parameter Exponential Estimation Technique	27,5	1321	19,85%
Brown's Exponential Correction Technique	28,3	1440	20,84%
Simple Regression Method	216,8	50 305	96,95%
Multiple Regression Method	34	1955	**13,6%**

When Table 1 is examined, it is found that about 20% of the prediction errors are compared with the MAPE method and the best prediction error is found in the Multiple Regression Method.

Analyzes For Textile Products Manufacturing Sector

Statistical estimation methods were used in order to estimate the accident in the textile products manufacturing sector.

With Simple Moving Average Method, estimations were made within three m values. The MAPE method, which is more frequently used than the other methods, is preferred for comparison. When m=3 was taken, MAPE was found to be 17.91% and it was found that if gave the best result according to other m values. In the calculations for the Weighted Moving Average Method, we calculated ten different weights for m values and compared them to each other. The calculations for the Simple Exponential Smoothing Method, it is determined that the best prediction was found for the value of $\alpha = 0.075$. . As a result of the calculations for Holt's Dual Parameter Exponential Correction Estimation Technique, the correction coefficents were found as $\alpha = 0.099$ and $\beta = 0$ and estimations were calculated using these values. When Brown's Estimation Technique was applied, it was determined that the best prediction results were reached wih $\alpha = 0.39$.

While applying Regression Estimation Techniques, regression equations were created by using the numbers of occupational accidents between 2001 and 2012 as input data. The regression equations were used to estimate between 2013 to 2016 and the estimated number of occupational ccidents were compared. The equation created by simple regression analysis made with the years 2001-2012 is as follow. In this equation, x is used for the years.

$$\hat{Y} = 966{,}152 - 16{,}414x$$

In this equation x_1 is used for years and x_2 is used for number of workers. The regression equation created using past years' data is as follows:

$$\hat{Y} = -598{,}568 - 55{,}544x_1 + 0{,}012x_2$$

In the equation, the number of occupational accidents were calculated fort he years between 2013-2016. Comparisons between the values found and the number of occupational accidents were made by prediction error methods.

After applying these estimation methods, MAD, MSE and MAPE values are calculated for each method. Table 2 below compares the methods calculations. In letrature, MAPE, which is the most benchmarking criterion, is compared with the estimation methods. Textile Products Manufacturing Sector Estimation errors were calculated as a result of calculations made for estimating the number of occupational accidents in the sector. When Table 2 is examined, it is determined that prediction errors are about 17% and the lowest prediction error is in Simple Exponential Correction Technique.

Table 2. Estimation errors calculated for textile manufacturing products sector

Applied Estimation Methods	MAD	MSE	MAPE
Simple Moving Average Method	142,9	37 773	17,91%
Weighted Moving Average Method	140,8	36 382	17,69%
Simple Exponential Correction Technique	151,3	35 234	**16,97%**
Holt's Two Parameter Exponential Estimation Technique	147,2	34 895	18,41%
Brown's Exponential Correction Technique	148,7	34 403	18,25%
Simple Regression Method	162	34 607	17,46%
Multiple Regression Method	206,5	56 420	22,4%

Estimation of the Number of Occupational Accidents for the Electrical Equipment Manufacturing Products Sector and Textile Manufacturing Products Sector

In this section, the estimation method fort he number of occupational accidents by female workers and the estimation model fort he future years are calculated by using the estimation model which has the best MAPE value. In the analyzes made, 13.6% MAPE value as the best prediction error resul were found with Multiple Regression Analysis method for Electrical Equipment Products Manufacturing Sector. Thus, fort he period

between 2017-2021, the number of occupational accidents for female workers were estimated by using the multiple regression analysis equation. Table 3 shows the estimation results calculated by the equation of multiple regression analysis.

Table 3. Estimation for electrical equipment products manufacturing sector

Years	Estimation of Number of Occupational Accidents
2017	234
2018	247
2019	260
2020	274
2021	289

When Table 3 is examined, it is expected that female workers will experience abaout 250 occupational accidents in the future years. When we examine the number of occupational accidents, we see that it tends to increase at a slight rate.

The lowest MAPE value is calculated for Simple Exponential Correction Method, according to forecast errors calculated for Textile Products Manufacturing Sector. We estimate the number of occupational accidents for 2017 using the value of $\alpha = 0.075$. since the Simple Exponential Correction Method is being used, estimates cannot be calculated for later periods because the data from the previous year are used. Therefore we could calculate only 2017 estimation. Using the formulation, the number of occupational accidents to be experienced in the bTextile Products Manufacturing Sector in 2017 was calculated as 877. The number of occupational accidents does not have a certain trend because there are flactuations in the number of occupational accidents that female workers are exposed to in the Textile Products Manufacturing Sector.

Conclusion

In recent years, as competiton between firms has increased steadily, companies are trying to reduce their costs in order to be able to take part in the sector. Employers avoid investing in occupational health and safety because they see unnecessary costs for occupational health an safety. However, the understanding of taking measures before a occupational accident is happening is both cheaper and more humanistic. Occupational Health and Safety is based on a preventive approach aimed at avoiding the accidents that wil be experienced before the danger occurs.

Occupational Health and safety has become a hot topic in Turkey as it is in many countries in recent years. Especially with the number of 6331 Law of Occupational Health and Safety which was published on June 30, 2012, aweraness about Occupational Health and Safet began to increase. The aim of this study is to investigate whether the measures taken by analyzing with statistical methods in sectors where occupational accidents are very experienced and female workers are concentrated are succesful in decreasing the number of accidents.

In this study, the effect of gender on the living occupational accident was examined. Sectors in which both most of female workers found and suffered from occupational accidents were also identified. As a result of the analyzes, it was determined that the sectors where the most occupational accidents occred are female workers in the " Electrical Equipment Products Manufacturing" and "Textile Products Manufacturing" sectors.

The prediction model was developed to forecast the number of occupational accidents for female people suffered in the Elecrical Equipment Products Manufacturing Sector from the sector where the most occupational accidents occured. If we look at the calculations, we estimate that the number of occupational accindents in this sector is increasing. In order to improve the number of occupational accidents estimate, necessary calculations were made with statistical estimation methods, and then estimation errors were calculated by using MAPE method in order to determine the best estimation model afterwards. When we compared to the MAPE values, we saw that the best result was found by the Multiple Regression Analysis method. Therefore, Multiple Regression Equation, which takes years and the number of employees as independent variables, estimates the number of occupationa accidents based on female workers for the period between 2017-2021. As a result of the calculations made. It is expected that the number of occupational accidents will be between 250-300 in the future years. When the regression equation is examined, it is found that the number of occupationa accident is increasing with the number of employees. Estimates of the number of occupationa accidents for female workers were made using different estimation methods fort he Textile Products Manufacturing Sector, which is another sector where the number of occupational accidents is the highest. Prediction errors were calculated to determine

the best prediction method, and the best prediction method based on MAPE results was found to be the Simple Exponential Correction Method. However, it is thouht that the fluctuations in the number of occupational accidents in this sector may be in the future years. Therefore we calculated the estimation only for the number of 2017 of occupational accidents.

When we examine the analyzes, it has seen that women are exposed to occupational accidents at a lower rate than men. While men are working in heavier jobs, it is effective for women to work in lighter jobs like jobs of assemble lines. When the results are examined, it is examned thar the number of occupational accidents are increasing. This suggests that the precautions on occupational health and safety are not enough and that workers and employers in occupational health and safety should be more conscious and that more precautions should be taken in this area. Bacause, compared with European Cuntries, turkey is located in the first place, unfortunately experienced inthe number of accidents at work.

Recommendations

In the following studies, it is thought that it is appropriate to study about the reasons for which most of occupational accidents happen.

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