Research Article

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THE EFFECT OF THERMAL CONDITIONS ON OCCUPATIONAL ACCIDENTS FREQUENCY IN TEXTILE SECTOR AND HUMAN HEALTH

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ABSTRACT: Occupational accident is an unplanned event that occurs in the workplace, resulting in death or that renders bodily integrity mentally or physically disabled. However, very few studies have investigated the effect of thermal change on occupational accident frequency. In this study, in addition to general factors, the effects of heat and humidity, which are thermal factors, on occupational accident frequency were investigated. According to the results of the analysis with fuzzy logic method, the variable of frequency of work accident after work accident; It has been concluded that the frequency of the accident increases with high humidity and temperature values, and the frequency of the accident decreases at ideal humidity and temperature values. Therefore, it is considered that taking thermal values into account in risk assessments will affect the reduction of occupational accident frequency. The textile sector has an important place in world trade and production as well as in our country. With the increase in production and competition, the dangers to the health and safety of the employees as a result of occupational accidents are increasing.

Keywords: Textile, Accidents frequency, Thermal conditions, Fuzzy logic.

1. INTRODUCTION

We encounter uncertain situations in many events in our daily lives. It becomes impossible to explain the uncertainties found in these events and to make precise definitions. As a result of these situations, the concept of uncertainty is a concept that inevitably affects almost every level of our lives. Solves people's problems as a result of decisions made by using non-numerical linguistic expressions (very hot, hot, warm, cold, very cold, etc.) in people's lives. Fuzzy logic is actually a mindset that uses reasoning logic to optimize the result within various operations. The concept of fuzzy logic is machine thinking that helps computers.

These concepts are evaluated as low, medium and high, and also include intermediate values. The fact that some systems are complex today and the thought that future systems will have more complex structures has led to the development of different methods in the audit process.

An accident is defined as an event that occurs unexpectedly and causes material and moral damage. Most of the accidents involve complex causes and occur as a result of the combination of more than one cause. On the other hand, an occupational accident is an unplanned event that occurs in the workplace, resulting in death, or that renders bodily integrity mentally or

physically disabled [1]. Occupational accident occurs due to the nature of the work performed by the employee and generally as a result of negligence.

Occupational accidents have many material and moral negative effects on the state, employers, employees and their relatives. Of course, the party most affected by the result of work accidents is the employee who had an accident, namely the casualty himself. Casualty after work accident; not being able to work in his previous capacity until he regains his former health, and sometimes losing his working ability partially or completely, he suffers financial losses. In addition, the casualty suffers from a work accident, becomes disabled or dies. The relatives of the casualty are also adversely affected by this process, both materially and morally [2-3].

Unlike the previous ones, Dumrak investigated the effects of climatic factors on occupational accidents and accident frequency in some studies, albeit a little [4]. In a study investigating the effect of heat, which is one of the thermal factors, on employee health and safety by Varghese, it was concluded that very low temperature and humidity levels and very high temperature and humidity levels increase occupational diseases and injuries [5]. In a study investigating occupational accidents by Ricco, a positive relationship was determined between high ambient temperature and injury status after occupational accident [6].

In the studies by Rameezdeen and Elmualim in which the effects of casualty and workplace thermal characteristics on occupational accident and accident frequency are investigated, it is of great importance to consider differences such as humidity and temperature [7].

Despite the significant contribution of the textile industry to the national economy, there are various workplace hazards that pose a risk to the health and safety of the employee. These hazards can be listed as: mechanical, physical, chemical, ergonomic and physiological hazards [8].

In the studies carried out in Turkey, the situation of the textile industry in terms of occupational health and safety has been revealed. In the study conducted by Yılmaz to investigate the adequacy of occupational health and safety studies of the sectors in Turkey, it was stated that the textile sector is the worst sector in terms of the adequacy of occupational safety studies [9]. He stated that occupational health and safety studies are insufficient or partially sufficient in a significant part of the workplaces operating in the textile sector, such as 75%. In the study carried out, the textile sector; It is stated that mining (64.7%) and construction (45.7%) sectors follow.

1.1. Accident Frequency Calculation

In the glossary of terms prepared by the British Health and Safety Administration (HSE) in 1999; The accident frequency rate calculation is calculated by dividing the total number of fatal and/or non-fatal injuries in occupational accidents occurring in a working year by the total working hours of the employees examined during this working year, multiplying the value with a coefficient of 1.10^6 [10].

1.2. Thermal Conditions and Human Health

One of the basic conditions for a person to continue his life in a healthy way is to keep his body temperature at a normal temperature. Thermal comfort refers to the fact that the majority of employees in the working environment are at a certain level of comfort while continuing their

physical and mental activities in terms of climatic conditions such as temperature, humidity and air flow speed. If thermal comfort conditions are insufficient in the working environment, distress and discomfort begin to be felt, and accordingly, the person's working capacity and work efficiency decrease[11-13]

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Especially in winter and summer, works carried out outside such as construction, machine assembly, piping and welding, which often need to be completed in a limited time, bring about significant occupational health and safety risks and deterioration of human health.
Under the influence of high temperature, the heartbeat accelerates to keep the body's internal temperature low[14-16]. Capillaries in the skin carry more blood, so both the cooling rate and body temperature gradually increase. If the thermal environment can withstand it, after a while these measures reach an equilibrium where heart rate and body temperatures remain constant. If equilibrium is not reached until the body temperature reaches 38.8°C, the corresponding sweat rate of two liters poses the danger of heat stroke[17].

The basic condition for the good functioning of the body, human health and life is provided by keeping the body temperature at normal levels. The person must have thermal comfort and live in thermal balance with the environment. This means: Excess heat that increases the body temperature, resulting from metabolic work at rest and work or from the heat absorbed by the organism from the environment, must be eliminated from the body surface[18-20].

In industry, problems mostly arise from exposure to high temperatures. The body constantly produces heat through its own metabolic process. The body process is designed in such a way that it operates within a very narrow limit of temperature (35°C - 38°C). Heat must be lost as soon as it is produced so that the body can function effectively and well. A series of very sensitive and very fast-acting thermostatic devices in the body also control the speed of the temperature-regulating process[21].

Temperature in the environment is not just a single variable. In addition to the increase or decrease in temperature in degrees, the state of humidity and air flow speed also increases or alleviates the effect of temperature. As a result of various combinations of these three variables, a person can feel the same feeling of warmth and psychological effect. The temperature effect created by air temperature, air humidity and air flow speed on a person is called effective heat. Various combinations of air temperature, air humidity and air flow velocity, which have an equal warming effect on the person, are called equivalent effective heat values. In addition to temperature, the effect of humidity is also very important. The amount of moisture in the air is expressed as absolute and relative humidity. Absolute humidity; Unit refers to the amount of water in the air. Relative humidity is; It shows the percentage of the absolute humidity in the air that is saturated at the same temperature. The value of relative humidity is important in terms of occupational health and safety. When evaluating the relative humidity of a workplace environment, other conditions such as temperature and air flow rate must also be evaluated. However, it is generally recommended that the relative humidity in any workplace be between 30% and 80%. High relative humidity causes suffocation if the ambient temperature is high, and gives a feeling of cold and shivering if the ambient temperature is low. In order to remove the dirty air generated in the workplace and replace it with clean air, there must be appropriate ventilation and therefore a suitable air flow. However, if this air flow exceeds 0.3 m/s, disturbing breezes occur. Considering that people are significantly affected by the working environment, the temperature value, humidity, etc. of the environment. The negative effects of thermal conditions on human health must be taken into consideration. It is possible that work accidents will increase as a result of decreased attention and psychological effects of the person

who is negatively affected by the working environment. For this reason, thermal comfort in working environments should be kept under constant control[22].

2. MATERIAL AND METHODS

The fuzzy logic tables created in this study were described by the MATLAB program, and the resulting data were examined. With the fuzzy logic module of the MATLAB program, the Mamdani model with two inputs and one output has been established. In this model, the method of obtaining the results with the center of gravity method is based [23].

In the study, it is the gbellmf method in the type of membership functions used in the input sets, so that the geometric shape, trapezoidal shape, is obtained. In this way, approximate values are obtained within the framework of fuzzy logic rules, the reason for using the gbellmf method is that trapezoidal fuzzy numbers have a special shape compared to triangular fuzzy numbers and are more understandable with verbal variables. Trimmf method has been chosen in the type of membership functions used in output sets. A total of two hundred and fifty fuzzy rules were created and used for the output graphics.

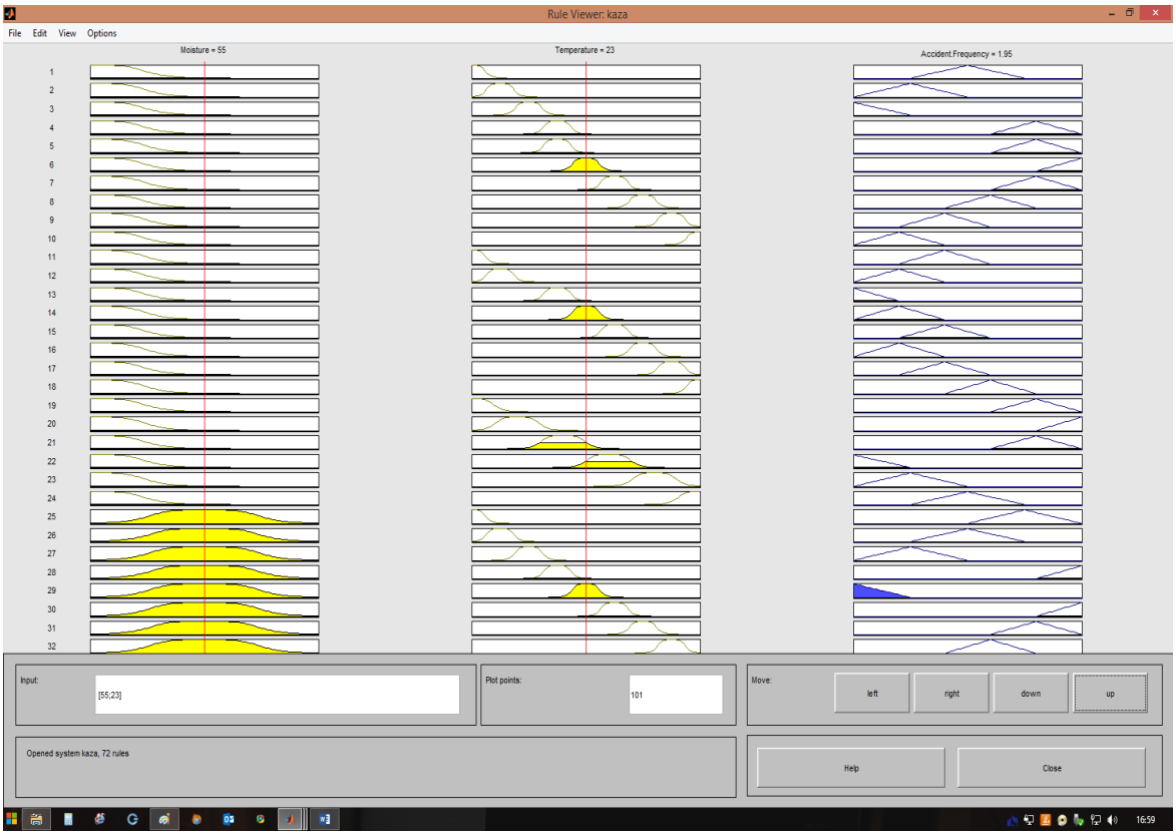

Figure 2. Rule table

3. RESULTS AND DISCUSSIONS

The textile sector in Turkey is one of the risky sectors in terms of the number of occupational accidents. However, when comparing sectors with each other, acting only on numbers may not give accurate results. For this reason, making calculations based on the total number of employees in the sector who have an accident or die while making comparisons will help us to get healthier results. For this reason, in the study, a comparison of the textile sector and other sectors was made over internationally accepted parameters. When the sector is examined in

terms of the number of accidents, sector employees are exposed to an average of 28816 accidents per year.

Table 1. Number of Insured Persons Who Had Occupational Accidents in The Manufacture Of Textile Products in 2021 . [24]

Man	Woman	Total
22047	6769	28816

As a result of the studies carried out in the accident registry, the cause and effect relationship of the accidents and the way they occur were examined and the distribution of occupational accidents was graphically shown by evaluating the source of the accidents, thermal data.

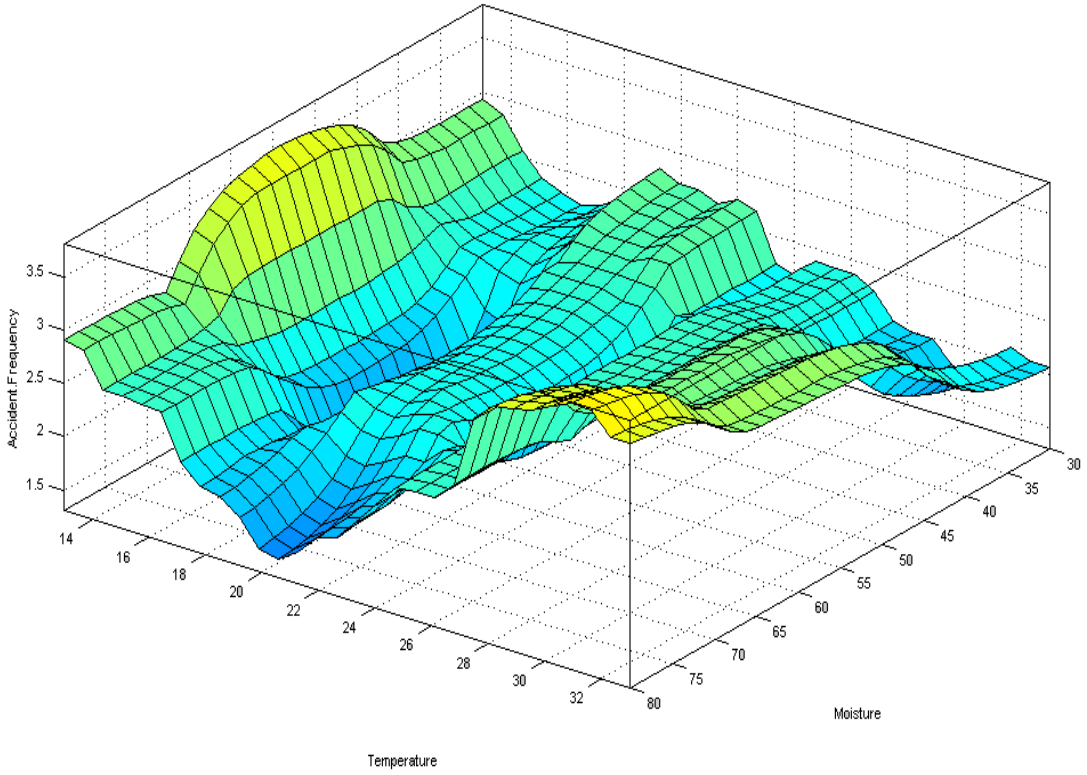

Figure 3. MATLAP Output showing temperature and humidity and accident frequency rate

When figure 3 is examined, it has been found that the frequency of the accident decreases in occupational accidents occurring in the average temperature range (16 °C - 26 °C). It was determined that the frequency of occupational accidents increased at other temperature values. In all temperature values, it was found that the frequency of the accident increased with the increase in the humidity value in the workplace. It was found that the frequency of the accident increased at low temperature and low humidity (14 °C and 30 g/m^3). When the results of the analysis were examined, it was observed that the frequency of the accident increased when the high temperature and high humidity (32 °C and 80 g/m^3) values were reached. In all temperature values, it was found that the average humidity on the day of the accident affected the frequency of the accident. It has been found that increases in temperature increase the frequency of work accidents with the increase in work accidents. When the relationship between the increase in the temperature value and the frequency of the occupational accident at low humidity (30 g/m^3) is investigated, it is seen that the accident frequency rate remains low.

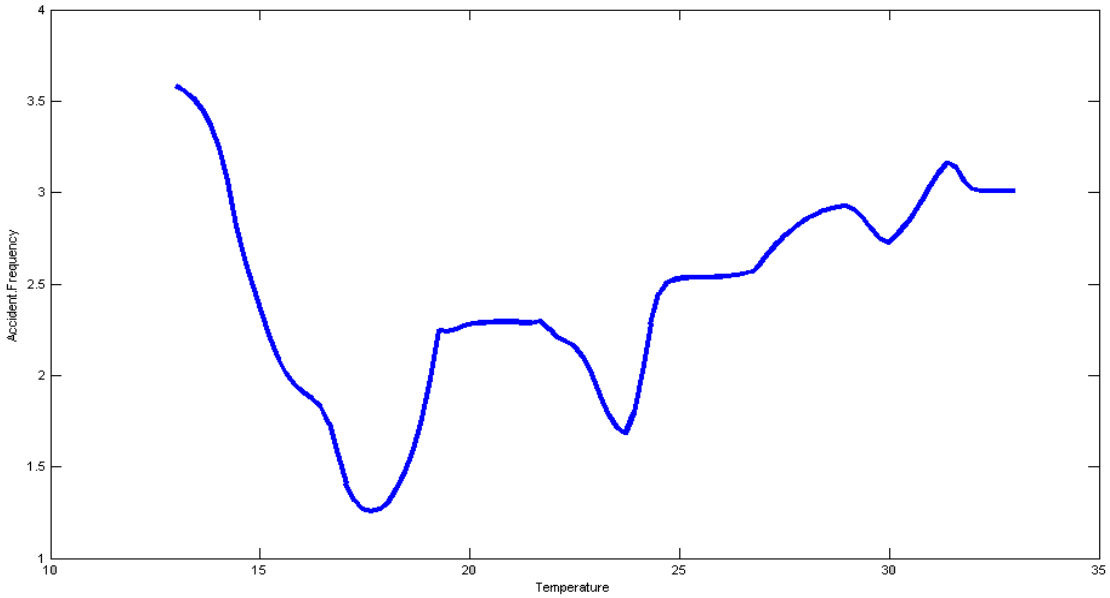

Figure 4. Change between temperature and accident frequency rate

The temperature accident frequency rate graph is given in the figure 4. In the graph, it has been found that the frequency of the accident decreases in work accidents that occur in the temperature range of around 18°C - 24°C.

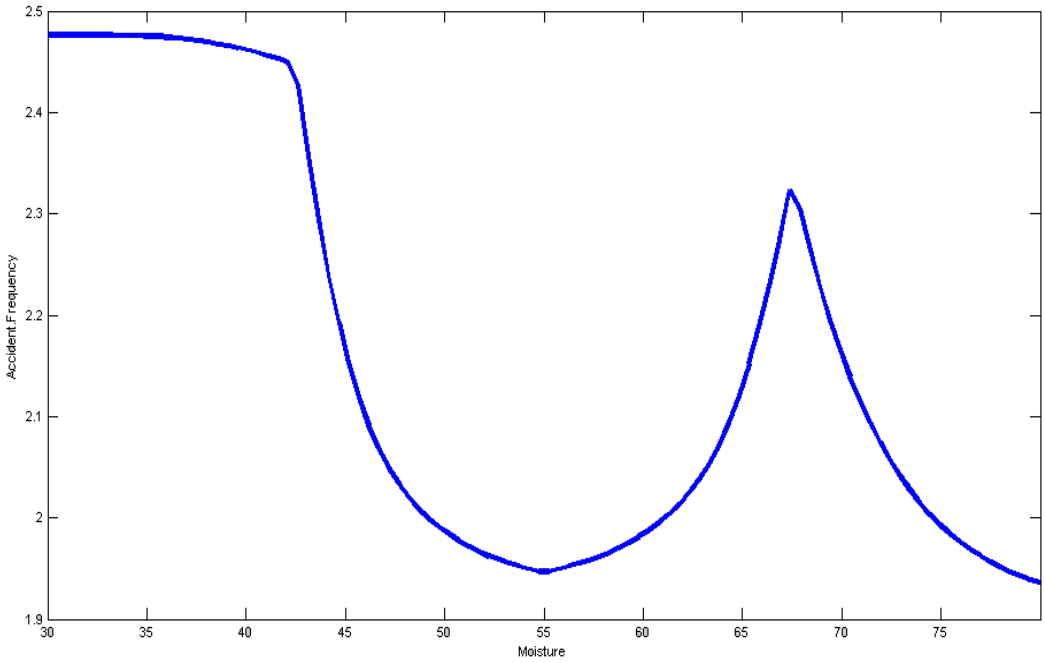

Figure 5. Change between humidity and accident frequency rate

Humidity accident frequency graph is given in the figure 5. In the graph, it has been found that the frequency of accidents decreases in occupational accidents that occur in the range of 40-65% relative humidity optimum for human health.

4. CONCLUSIONS

Humidity and heat, which are among the factors affecting the frequency of occupational accidents, were evaluated and the effect of each factor on the frequency of the occupational accident occurring at different values was questioned. It is considered that this study is a first

in the literature and will bring innovation to the field. It has been found that the frequency of the accident decreases in occupational accidents that occur in the temperature range of 16 °C - 26°C. It was seen that this finding is in agreement with the studies in which the relationship between occupational accident frequency was investigated by Dumrak, one of the researchers in the literature. It was determined that the frequency of occupational accidents increased at other temperature values. In all temperature values, it was found that the frequency of the accident increased with the increase in the humidity value in the workplace. This result was found to be in agreement with the studies of some researchers Fabiano, Chi, Sa, Chen. Accident frequency at low temperature and low humidity has been found to increase. When the results of the analysis were examined, it was observed that the frequency of the accident increased when high temperature and high humidity values were reached. The results at this level were found to be in agreement with the findings of some researchers Rameezdeen and Elmualim, Ricco, Varghese. In all temperature values, it was found that the average humidity on the day of the accident affected the frequency of the accident. It has been found that increases in temperature increase the frequency of work accidents with the increase in work accidents. When the relationship between the increase in the temperature value and the frequency of the occupational accident was investigated at low humidity, it was found that the accident frequency rate remained low. In addition to the personal factors of the employees, in determining the hazards in the workplace and calculating the risks. It is evaluated that taking into account the thermal factors will contribute to the reduction of the frequency of work accidents that may occur. In this context; Preventing drowsiness and dangerous behaviors that may occur in employees due to changes in thermal values in the working environment. It can be recommended to carry out in environments with suitable thermal values as much as possible. It may be recommended to use thermal factors together with other factors in researches on occupational accidents. In recent academic studies, determination of the factors affecting the frequency of work accidents, work accident and work accident frequency model studies are frequently encountered. It is very important for the reliability of the analysis results that the data used in such academic studies are up-to-date, micro and sufficient. For this reason, it is considered that sharing the data with researchers will increase the quality of future studies. Among the causes of occupational accidents in the textile sector, the failure of small enterprises, which is common in the sector, to take the necessary occupational safety measures, can be cited. In order to prevent or reduce occupational accidents, the factors causing occupational accidents should be determined by analysis and evaluations, all necessary precautions should be taken with precision, and strict controls should be made to determine whether the measures are applied effectively.

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