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Research Article

Risk Analysis and Risk Assessment in Laboratory Studies

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Abstract

In this study, risk analysis is investigated by using 5X5 L Type Matrix Method in laboratories determined within the scope of occupational health and safety. In the risk analysis, 50 risks are identified, of which 30 (60 %) have a high risk level, 18 (36 %) have a medium risk level, and 2 (4 %) have a low risk level. Occupational health and safety rules are applied to control these risks in laboratory research and to minimize their effects. In this context, the things to be done in laboratory studies are listed as follows. Students, lecturers, and laboratory staff working in the laboratory should receive occupational health and safety training. Emergency plans, teams, and drills should be made for situations that may occur during laboratory studies. Chemical use, transport, and storage must be recorded in laboratory research. Physical inadequacies such as ventilation in the laboratory and work area should be eliminated. Chemical hygiene and an accident prevention program are recommended. This study, it is aimed to raise awareness about occupational health and safety in laboratory conditions.

Keywords: L type matrix, occupational health, safety rules, risk analysis, risk assessment.

Laboratuvar Çalışmalarında Risk Analizi Ve Risk Değerlendirmesi

Öz

Bu çalışmada iş sağlığı ve güvenliği kapsamında belirlenen laboratuvarlarda 5X5 L Tipi Matris Yöntemi kullanılarak risk analizi araştırılmaktadır. Yapılan risk analizinde 50 risk tespit edilmekte olup bunlardan 30 tanesi (% 60) yüksek risk derecesine sahip, 18 tanesi (% 36) orta risk derecesine sahip, 2 tanesi de (% 4) düşük risk derecesine sahip olduğu tespit edilmektedir. Laboratuvar araştırmalarında oluşan bu riskleri kontrol altına almak ve etkilerini en aza düşürmek amacıyla iş sağlığı ve güvenliği kuralları uygulanmaktadır. Bu kapsamda laboratuvar çalışmalarında yapılması gerekenler aşağıdaki gibi sıralanmaktadır. Laboratuvarda görev yapan öğrenci, öğretim üyesi ve çalışanların iş sağlığı ve güvenliği eğitimlerini alması gerekmektedir. Laboratuvar çalışmaları sırasında oluşabilecek durumlar için acil durum planları, ekipleri ve tatbikatları yapılmalıdır. Laboratuvar araştırmalarında kimyasal kullanılması, taşınması ve depolanması kayıt altına alınması gerekmektedir. Laboratuvarda havalandırma ve çalışma alanı gibi fiziki yetersizlikler ortadan kaldırılmalıdır. Kimyasal hijyen ve kaza önleme programı yapılması önerilmektedir. Bu araştırma, labaratuvar koşullarında görev yapan kişilere iş sağlığı ve güvenliği konusunda bir farkındalık sağlamak için yapılmıştır.

Anahtar Kelimeler: L tipi matris, iş sağlığı, güvenlik kuralları, risk analizi, risk değerlendirmesi.

1. Introduction

Occupational health and safety are branches of science that constantly develop as a result of the importance given to human beings in contemporary societies and undergo technology and innovation over time. The main purpose of occupational health and safety is to protect employees against work accidents and occupational diseases and to enable them to work in healthier environments. Depending on the industrial and technological investments made for high-quality and low-cost production, causes more competition in the sectors. The intense competition in industrial areas causes more mention of work accidents and occupational diseases. Although human power has been replaced by machinery and advanced systems due to the development and spreading of technology, the value of employees is gaining more and more importance.

The basic approach of occupational health and safety is to protect and secure the health of employees. Those working in the laboratory are exposed to various risk factors, including physical, chemical, biological, and psychosocial. For this reason, it is necessary to constantly monitor the health status of the employees and to reduce the risk factors arising from the working environment. Besides, it is necessary to prevent work accidents and occupational diseases by eliminating the sources of danger.

Occupational safety evaluates known, unknown, foreseeable, and unpredictable hazards and risks. The resulting hazards and risks threaten production, workflow, employees, production tools, and the environment. It is necessary to reduce the risks that may arise from the working environment and the production system so that the employees, the production system, and the environment are less affected by occupational accidents and emergencies. Once the danger arises, it can have irreversible consequences. Therefore, it is necessary to foresee, keep under control and eliminate the risks, and dangers that may occur [1].

The purpose of risk management in occupational health and safety is to evaluate the causes of work accidents and occupational diseases and the factors affecting them. It is also to establish an effective safety net to prevent the emergence of unseen threats by collecting information that will provide a valid and correct approach. A good risk analysis with a large team is of great importance in terms of protection from workplace accidents that may occur. Also, it provides the discovery of invisible dangers and the taking of effective security measures [1].

In Turkey, with Occupational Health and Safety Law No. 6331 enacted in 2012, serious responsibilities have been imposed on employees and employers. By law numbered 6331, employers are obliged to make a risk assessment in the workplace. Risk assessment is not an activity independent of management processes and should be fully integrated into all elements. Risk assessment consists of a comprehensive risk recognition process, risk analysis, and detection. The implementation of this process is based not only on the risk management process but also on the methods and techniques used in risk assessment [2].

World Health Organization defines occupational accidents as events that cause unplanned personal injuries, damage to machinery and equipment, and stop production for a certain period. International Labor Organization explains an occupational accident as an unplanned, unknown, and uncontrolled event that can harm the environment. It is very difficult to predict the size, impact, and consequences of occupational accidents that may occur and depend entirely on coincidence [1-4].

88 % of occupational accidents are caused by dangerous movements, 10 % by dangerous situations, and 2 % by unavoidable movements. The causes of dangerous actions are defined as personal faults arising from the employee's own body and structure. Hazardous situations are expressed as unsuitable mechanical conditions and environmental activities in the working environment. Loss of limbs and minor injuries can occur based on every event that results in serious injury or death in occupational accidents. Before occupational accidents occur, it is necessary to identify the hazards, predict the risks, reduce them to an acceptable level, take precautions, and carry out revisions. Risk assessment has provided an important roadmap for preventing occupational accidents.

When occupational accidents are examined, it is understood that they occur as a result of five basic factors coming together. Weakness of human nature against mechanical forces, personal defects, dangerous behavior (condition), accident event, and injury (damage or damage) constitute these five basic factors. These five basic factors make up the chain of accidents. Unless one of these happens, the next one does not occur, and unless the chain is completed, there is no accident or injury [1].

To prevent occupational accidents, and to ensure the health and safety of employees, it is of great importance to identify, rank, and evaluate hazards and risks. For this reason, Occupational Health and Safety Law No. 6311 makes risk assessment mandatory, and workplaces are subject to certain classifications. It makes it mandatory to repeat the risk analysis every 6 years in less dangerous workplaces, 4 years in dangerous workplaces, and every 2 years in very dangerous workplaces [5,6].

It is very important to carry out a risk assessment because it includes laboratory studies and multiple risks that may arise from studies. They are responsible for the work done in the laboratory, for their safety and the safety of other employees, as well as for the safety of the environment. Most of the accidents that occur in the laboratories are caused by the employees, although a small percentage of the accidents are due to technical errors. It is known that the rate of accidents occurring in laboratories is 10-50 times higher than the number of accidents occurring in the chemical industry [7].

Between 2006 and 2016, 120 fatal accidents occurred in university laboratories in United States. When the causes of these accidents are examined, it has been determined that there are events such as chemical burns, not paying attention to the waste rules, not knowing the quantities of the chemicals used, and incorrect applications [7].

There are differences in dangers and risks because they are used in many different areas such as educational institutions, health institutions, research centers, and forensic medicine centers since different scientific and technical research areas are diversified. Even when the researches, experiments, and analyses carried out in the laboratories are the same, there are differences in the methods and tools used. It makes it almost impossible to include the same degree of risks and hazards in laboratories due to features such as the different education levels

of the working personnel and the change in the number of employees [8].

While performing risk analysis and assessment, some basic concepts should be known in full detail. These are concepts such as hazard, risk, risk management, and risk assessment. Sources, situations, and processes that may cause injury to people, deterioration of health, or their occurrence together are defined as hazards. The combination of the probability of occurrence of an event or situation and the severity of the consequences if it occurs is a risk. Risk management is the assessment of risks related to human life and environmental safety and the systematic modification and implementation of policies. Risk assessment is a systematic approach to organizing and analyzing all kinds of materials with potential danger and all kinds of scientific knowledge and experience to be made about the situation [9-19].

Although the general laboratory rules are the same for all laboratories in which there is such a degree of differentiation, it is necessary to carry out special studies on risk analysis and evaluation in terms of occupational health and safety. In the literature research on laboratory activity areas, it is seen that there is no international classification standard according to the types of laboratories. It is striking that there are serious deficiencies in terms of occupational health and safety and that there is not enough work in this field. It is striking that there are serious deficiencies in terms of occupational health and safety and that there is not enough work in this field.

From the design and establishment phase of the laboratories, the infrastructure of occupational health and safety management systems is created with a series of measures. Employees should be informed about the dangers by organizing training. Occupational health and safety need to make risk analysis and assessment by considering the accidents that may occur in the laboratories.

2. Materials and Methods

The method used in risk analysis is listed as taking the necessary precautions according to the order of importance of the risks, finding the focus of the risks, and making the evaluations. In addition to minimizing the losses that may occur in work and equipment, it is to prevent work accidents that may occur and to determine the most economical method for businesses without sacrificing safety.

The workflow chart to be followed during risk analysis and assessment is given in Figure 1.

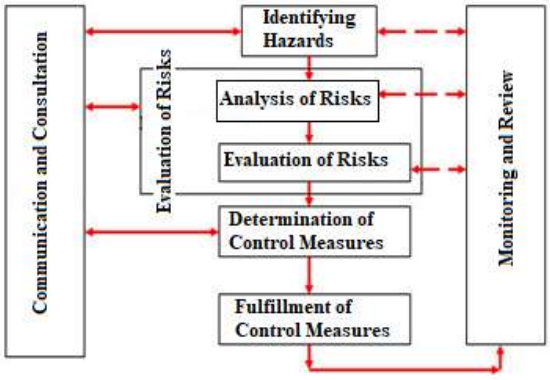

Figure 1. The workflow chart in risk analysis and assessment

It is the probability of not achieving a certain result or the probability of an undesired event occurring (probability) and the effect of the risk in case of occurrence (intensity). As stated, risk has two main components.

Risk = f (probability, intensity)

Risk = (Likelihood of the threat)·(Impact of threat)

In this study, 5x5 L Type Matrix Method has been used while evaluating the risks.

The occurrence (probability) of the event for each identified hazard is found using the probability scale shown in Table 1 and L Type Matrix method. Besides, the severity of the hazard has been determined by considering the severity scale in Table 2, L Type Matrix method.

Table 1. The probability of a risk

Score	Likelihood	Likelihood of occurrence
1	Unlikely	So unlikely
2	Remote	Unlikely, but possible to occur
3	Occasional	Likely to occur sometime in the life of an item
4	Moderate	Will occur several times in the life of an item
5	Frequent	Likely to occur frequently

Table 2. The severity of risk for occupational health.

Score	Likelihood	Potential Consequence
1	Negligible	Injuries and diseases that do not require medical treatment
2	Minor	Minor injuries that require first-aid only
3	Serious	Severe injuries that require hospitalization or multiple medical
4	Very Serious	Life-threatening injuries or multiple injuries that require
5	Critical	Death or multiple injuries that pose threat to life

In addition, 5x5 L type risk decision matrix is given in Table 3 and an occupational health risk assessment table is given in Table 4 [1].

Table 3. 5x5 L type risk decision matrix

		SEVERITY				
		Critical (5)	**Very Serious (4)**	**Serious (3)**	**Minor (2)**	**Negligible (1)**
LIKELIHOOD	**Frequent (5)**	Not tolerated (25)	High (20)	High (15)	Moderate (10)	Low (5)
	Moderate (4)	High (20)	High (16)	Moderate (12)	Moderate (8)	Low (4)
	Occasional (3)	High (15)	Moderate (12)	Moderate (9)	Low (6)	Low (3)
	Remote (2)	Moderate (10)	Moderate (8)	Low (6)	Low (4)	Low (2)
	Unlikely (1)	Low (5)	Low (4)	Low (3)	Low (2)	Insignificant (1)

Table 4. The risk assessment table for occupational health

Risk Score	Risk Degree	Actions should be taken to prevent the risk
25	Not tolerated	The process must not be operated until the risk is reduced to an acceptable level. it is necessary to stop single being studied actions. The activities must be canceled if the risk cannot be prevented.
15, 16, 20	Critical	The situation is an emergency or required actions must be taken at the nearest time. The action can be continued under supervision and control if the risk has no dangerous potential
8, 9, 10, 12	Moderate	The required protective actions must be taken to reduce the risk level.
2, 3, 4, 5, 6	Minor (maybe tolerated)	The emergency measure is not needed but the ruling measures must continue.
1	Negligible	Taking precautions is not the priority

3. Results and Discussions

In this risk analysis study, 50 risks are identified. The risks are categorized as high, medium, and low by rating them and are given in Table 5. 30 (60 %) risks with high risk, 18 (18 %) risks with medium risk, and 2 (4 %) risks with low risk have been determined.

Table 5. Frequency of risk grades

Risk Degree	Number of risks	% frequency
High Risk	30	60
Medium Risk	18	36
Low Risk	2	4
Total	**50**	**100**

The found risk scores and the distribution of the number of risks are shown in Figure 2. Considering the risk scores, there is a maximum number of hazards with a risk score of 20.

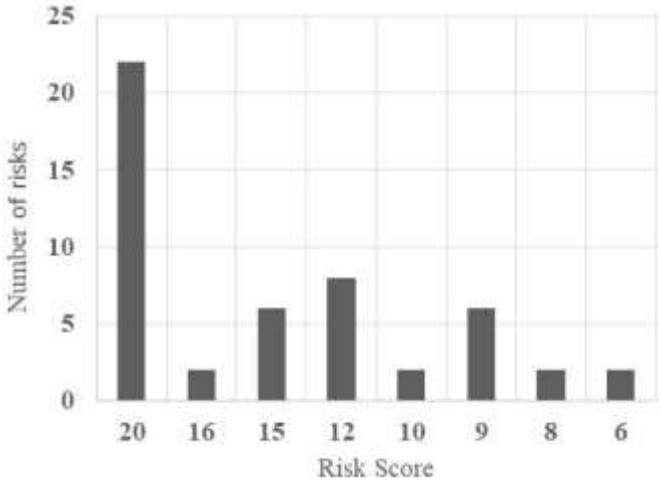

Figure 2. The risk score and number of hazards

The risk score and the number of risks identified as a result of the risk assessment performed are presented in Table 6.

Table 6. The risk score and number of risks

Risk Score	Number of Risks
20	22
16	2
15	6
12	8
10	2
9	6
8	2
6	2

4. Conclusions and Recommendations

In this study, hazards and the risks that may arise from these hazards have been evaluated by using L Type Matrix method in the laboratory. Appropriate (necessary) measures need to be taken to reduce risks with a high degree of risk to an acceptable level.

As a result, risks with a high risk level and a medium risk level should be reduced to a low risk level and made acceptable. Necessary measures are taken into account to eliminate the deficiencies and to provide a healthier and safer laboratory environment.

- Emergency exit plans and emergency escape routes should be determined for emergencies that may occur in the laboratory.
- In case of an emergency that may occur in the laboratory, the necessary information of the emergency teams should be visible in the laboratory.
- Employees should do these emergency drills for emergencies that may occur in the laboratory.
- Employees should know which fire extinguishing equipment should be used according to the type of fire in case of fire. The locations of equipment such as fire extinguishers must be at a height and marked, and annual periodic controls must be carried out by the determined legislation.
- The locations of the equipment in the laboratory should be marked, the users using the equipment should be determined, and the periodic maintenance of this equipment should be done.
- The identification cards of the equipment in the laboratory and the records of who was the last user should be kept regularly.
- Chemical materials should be stored considering their quantities.
- Chemical materials should be used under the control of authorized persons.
- Periodic maintenance of emergency showers and eye showers should be done.
- Contingency plans should be posted in a visible place in the laboratory and regularly updated.
- It should be ensured that laboratory personnel is stored regularly according to their qualifications.
- Appropriate personal protective equipment for the work of the employees in the laboratory should be provided and their use should be ensured.
- Tubes that are likely to burn and explode should be fixed, used, and stored by the legislation.

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