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A New Risk Analysis Method in The Construction Sector: HES

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Abstract

Hazardous environments are frequently present in the construction industry during both the project planning and implementation phases, with different risks emerging at each stage. Although various risk assessment methods are available to reduce workplace accidents, the industry prefers techniques that are adaptable to changing site conditions and easy to apply. This study examines the effectiveness of the Hazard Evaluation System (HES) matrix method compared to the traditional X-type and L-type matrix methods. The HES method provides a more detailed and comprehensive assessment by incorporating human factors such as employee training, age, severity, and probability. Since 88% of workplace accidents in the country are human-related, focusing on these elements allows for better risk mitigation. The study was carried out on a construction project in the Demre District of Antalya Province. Findings reveal that the HES method is more practical and reliable than traditional methods, while also improving project safety, enhancing efficiency, and generating economic advantages in construction operations.

Keywords: *Construction sector, occupational safety, HES matrix method, risk analysis.*

İnşaat Sektöründe Yeni Bir Risk Analiz Yöntemi: HES

Öz

İnşaat sektöründe hem proje planlama hem de uygulama aşamalarında tehlikeli ortamlar sıkça görülmekte ve her aşamada farklı riskler ortaya çıkmaktadır. İş kazalarını azaltmaya yönelik çeşitli risk değerlendirme yöntemleri bulunsa da sektör genellikle değişken şantiye koşullarına uyum sağlayabilen ve kolay uygulanabilir teknikleri tercih etmektedir. Bu çalışma, Tehlike Değerlendirme Sistemi (HES) matris yönteminin etkinliğini, geleneksel X-tipi ve L-tipi matris yöntemleriyle karşılaştırmalı olarak incelemektedir. HES yöntemi, çalışan eğitimi, yaş, şiddet ve olasılık gibi insan faktörlerini dikkate alarak daha kapsamlı bir değerlendirme sunmaktadır. Ülkedeki iş kazalarının %88'inin insan kaynaklı olması, bu yöntemin önemini artırmaktadır. Araştırma, Antalya ili Demre ilçesindeki bir inşaat projesinde gerçekleştirilmiştir. Sonuçlar, HES yönteminin daha pratik ve güvenilir olduğunu, proje güvenliğini artırdığını ve ekonomik faydalar sağladığını ortaya koymaktadır.

Anahtar Kelimeler: *İnşaat sektörü, iş güvenliği, HES matris yöntemi, risk analizi.*

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1. Introduction

The construction sector is one of the industries in Turkey where occupational accidents and diseases are most prevalent. One of the main reasons for this is that the construction sector has unique and constantly changing working conditions. Each construction project creates different working areas and environments, thus the types of risks faced by workers vary from one project to another. According to the International Labour Organization (ILO), construction sites are among the most dangerous workplaces, with significant accident and fatality rates (ILO, 2020). During the execution of construction work, the need for labor is quite high. As a result, inexperienced, young, refugee, and migrant workers can easily find employment in these areas. The high-risk nature of construction projects makes them vulnerable to various adverse situations. Common workplace accidents in construction areas include falls from heights, crush injuries, and other types of injuries. Additionally, workers in the construction sector are more prone to occupational diseases due to the heavy physical work, as well as long and irregular working hours. Besides the inherently hazardous working conditions in construction sites, it is well known that human factors play a significant role in workplace accidents. These two factors create serious risks in construction work. Many jobs at construction sites follow one another, and workers' working periods are often short and temporary. Due to the focus on continuity and quick completion of projects, project managers often overlook these factors, making it difficult to establish awareness and practices related to occupational health and safety. This situation also complicates the management of occupational health and safety measures for employers and employees in subordinate units. In an ongoing construction project, the risk management method is very important. It consists of the stages of identifying, defining, and evaluating risks. Following this, the identified risks are ranked, and their impacts are examined. The process concludes with the aim of bringing the risks to an appropriate level. In construction projects, risk management is crucial for worker health, project cost, and project continuity. To ensure risk management on the project site, the method defined according to the Occupational Health and Safety Law No. 6331 states that the employer shall carry out or have carried out a risk assessment in terms of occupational health and safety in order to ensure, maintain, and improve the health and safety of the working environment and employees (Külekçi & Güvendi, 2023). In the risk analysis methods used in the construction sector, variations can be observed. Among these methods, the most suitable and practical one should be chosen based on the project's condition. In the construction sector, practitioners frequently use decision matrix methods to identify risks, calculate the likelihood and severity, analyze, and conclude using X and L-type matrix methods. The HES method, in contrast to these methods, is a technique that considers the age and education level of workers. This method facilitates the identification of risks during the execution of the job and helps select appropriate workers based on the condition of the work, thus adjusting the risk levels to an appropriate level. This study aims to investigate the applicability of the HES matrix method, which we have developed, in the construction sector, as an alternative to the existing risk assessment decision matrices, namely the X and L-type methods, to reduce occupational accidents in the sector.

1.1. Literature

In construction work environments, the accurate identification and assessment of hazards and risks require, first and foremost, a clear understanding of the concepts of *hazard* and *risk*, as well as the distinction between the two. Recognizing the difference between a hazard and a risk is a fundamental step toward the effective implementation of occupational safety measures. Risk may originate from personal or environmental factors, or from the specific nature of the task being performed. Moreover, the perception of risk can be influenced by the inherent characteristics of the risk itself and the degree of control an individual has over it. A *hazard* is defined as a condition or situation with the potential to cause harm or injury, whereas *risk* refers to the probability or likelihood of that harm or injury actually occurring as a result of the hazard (ILO. 2020). Various techniques are available for hazard and risk assessment. However, when it comes to planning in the construction sector, there is a need for a method that is specifically practical, applicable, and adaptable to the dynamic and diverse characteristics of construction sites, while also minimizing delays caused by time-related factors (Dizdar, 2000). Occupational health and safety is a primary concern in the construction sector. ISO

45001 is a global standard designed to ensure the safety of workers, prevent workplace accidents, and establish a healthy working environment. This standard aims to identify and eliminate potential hazards in the workplace and minimize risks through continuous improvement processes. Moreover, it contributes to the prevention of workplace accidents and occupational diseases by enhancing workers' safety awareness (Şahin & Gürcanlı, 2011). Directive 89/391/EEC, issued on June 12, 1989, in the EU Framework Directive, outlines the general principles and processes necessary for occupational health and safety (OHS) management, applicable to all organizations in both the public and private sectors. According to this EU Directive, the primary goal of occupational health and safety management in enterprises is to ensure the continuous improvement of workers' safety conditions and health. The Directive has been implemented across all EU member states, and its application is supported by national strategies and policies. It has been emphasized that risk assessment is essential in ensuring workplace safety, preventing accidents, and protecting workers' health (Gürcanli, 2008). Hazardous industries are faced with serious accidents and fatalities in the workplace due to high-risk operations. Therefore, this study proposes a new and comparative methodology to assess risk ratings in occupational health and safety risk assessment. In underground copper and zinc mines, severity and likelihood were determined using a 5x5 risk matrix. Fuzzy Technique (FTOPSIS) was applied to identify hazards, and their importance levels were determined using the Pythagorean Fuzzy Analytic Hierarchy Process (PFAHP) method (Gül & Ak. 2018). In construction work, the L-type matrix method has been used in risk assessment studies to assist in occupational health and safety assessments, ensuring compliance with occupational health and safety regulations and facilitating ease of use in construction projects (Aytekin, Kaya, & Kuşan, 2015) Comparisons have been made among various risk assessment methods used in hazard and risk analysis within the construction sector, including the L-type matrix, FMEA, Fine Kinney, Analytical Hierarchy Process (AHP), and Preliminary Hazard Analysis (PHA). It has been argued that the L-type matrix and PHA are insufficient for use in the construction sector (Ak, 2020). A study was carried out on the application of hazard analyses and risk assessment practices in cement plant construction sites and integrated city hospital construction sites, aimed at developing safety measures. The study concluded by emphasizing the importance of using matrix-type risk assessment methods on construction sites (Korkmaz, 2020). The Hazard Rating Number System (HRNS) method, which takes into account the exposure parameter often overlooked in existing construction risk assessment methods, has been applied in continuously operating manufacturing facilities. By basing the identification of workplace risks on worker exposure, the HRNS method offers a more comprehensive and realistic risk assessment (Bilir & Gürcanlı, 2015).

2. Methodology

In this study, a construction project consisting of 4 blocks and covering an area of 4000 m² in the Demre district of Antalya Province is examined. In this project, the 4000 m² construction work, which will last for 5 years, provides a large dataset for various types of workplace accidents. For this reason, it has been selected as the application area. The project will last for 5 years on the construction site, and a risk assessment has been carried out for 71 hazardous activities that may occur on the site. Within the construction sector, 71 activities have been identified from the project phase to the completion phase, and the types of hazards in these activities are provided in Table 1.

Table 1. Hazards that may occur in construction work

Activity Name	Hazards
Excavation	Collapse in the excavation area Falling materials into the excavation area Contact with infrastructure Collapse of nearby buildings into the accident area Accidents involving construction machinery (tipping, collision, compression) Falling from scaffolding
Formwork Preparation and Removal	Hazards due to manual material handling Hand tool accidents

	Material (nails, etc.) bouncing
	Falling materials from tower cranes or hoist cranes
	Body parts caught in iron workbenches or iron machines
Rebar	Body parts caught between reinforcement bars
	Material splashing (aluminum and iron sparks)
	Falling iron materials from tower cranes
	Collision with concrete pumps
Concrete Pouring	Crushing under the mixer during concrete pouring
	Formwork opening and collapsing onto workers during concrete pouring
	Worker falling from a height during concrete pouring
	Hand tool malfunction
	Worker falling from height while building walls
Wall	Material falling
	Hazards during manual material handling
	Worker falling from a ladder while building walls
	Wall collapsing onto the worker
	Falling of floor materials during transportation
Floor	Falling from floor gaps
	Hand tool malfunction
	Hazards due to manual material handling
	Electrical leakage in electric machines
Electrical	Hazards due to manual material handling
	Worker contact with high-voltage lines passing near the construction site
	Collapse of roof insulation
Insulation	Hazards due to manual material handling
	Worker falling from scaffolding while applying insulation
	Falling insulation materials
	Wall collapse during foundation insulation work
	Body parts caught between insulation materials (glass, etc.)
	Hand tool malfunction during installation works
Mechanical	Hazards due to manual material handling
	Splashes of parts and materials from air compressor vehicles
	Worker falling from the roof
Roof	Material falling
	Hazards due to manual material handling
	Hand tool malfunction
	Tower crane hitting a worker or scaffolding
	Hazards due to manual material handling
	Hand tool malfunction
Plaster	Collapse of ladder or scaffolding
	Body parts caught in plasterwork machines and tools
	Material falling
	Electric shock
	Hazards due to manual material handling
Painting	Hand tool malfunction
	Fire
	Collapse of ladder or scaffolding
	Material falling
	Falling from height during assembly

Doors and Windows	Collapse of ladder or scaffolding Material falling Electric shock from the use of electric tools Hand tool malfunction Hazards due to manual material handling Hazards due to manual material handling
Elevator	Hand tool malfunction Material falling Falling from height during assembly Electric shock from the use of electric tools Electric shock from the use of electric tools
General Site and Landscaping	Traffic accidents within the construction site Hand tool malfunction Warning signs

In the current study, decision matrices were first examined, and then project data was evaluated. Probability and severity values were determined for the 71 activities in the project, and in addition, the HES method risk assessment was prepared using age and education information. The results obtained were compared with other matrix methods. The comparison results were interpreted, and recommendations were provided.

2.1. HES Method (Hazard Evaluation System)

The basic concept matrix shows the relationships between variables. Risk assessment is obtained by multiplying probability and severity, and the chart showing this is called the Risk Assessment Matrix. The ease of use of this matrix in all sectors, its lack of need for expertise and records, and the fact that it is a method that can easily be applied by a single person will contribute to the widespread use of this method. In calculating the risk rating score, probability and severity values are determined according to the assumptions and predictions of the creator. For this reason, it can be preferred in areas where fast and practical solutions are needed, especially in construction and building works. Probability and severity values have been assigned to the anticipated potential hazards in the construction phase. The assignment of probability and severity values to hazards was prepared based on a literature review and my own professional experience (Bilir & Gürcanlı, 2014; Bilir & Gürcanlı, 2015). In the construction sector and building works, the HES method risk score is applied in process-based tasks and includes the man-hour factor. This method allows for more realistic values to be obtained. In the risk score calculation, the time spent in the work process and the effect of labor are taken into account, leading to a more accurate assessment of risks. In the HES method, the risk score is determined using hazard analyses and risk factors (such as probability, severity, exposure), and this scoring helps in the effective planning of occupational health and safety measures. The formula for this method is shown below (1). The values are determined by multiplying.

$HES = PxEAxEELxIS$ (1) (Özkılıç, 2005)

Probability ($\boldsymbol{P}$),

Employee's age ($\boldsymbol{EA}$),

Employee's education level ($\boldsymbol{EEL}$)

Injury severity ($\boldsymbol{IS}$),

According to the HES method, the probability degrees are provided in Table 2, The age range of the personnel working on the construction site and their educational status are given in Table 3, the Injury severity in Table 4 and the definition of the risk level according to the HES method is presented in Table 5.

Table 2. Probability degrees according to the HES method

Score	Result	Rating
1	Very Low	Almost none, practically impossible
2	Low	Very low (once a year), possible but low
3	Medium	Low (several times a year), possible
4	High	Frequently (once a month), quite possible
5	Very High	Very frequently (once a week, every day), expected, certain

Table 3. Age range and education status of personnel working on the construction site

Age Range	Risk Score
18-24	1,7
25-29	2,3
30-34	2
35-39	0,2
40-44	1,5
45-49	1
50-54	0,5
55-59	2
60-65	0,5
65+	0,1

Education Level	Risk Score
Illiterate	3
Primary Education	2
Secondary Education	1,5
High School	1
Higher Education	0,5

Table 4. The Injury severity

Score	Injury severity	Explanation
1	Negligible risk	Accident without injury or near-miss event
2	Mild	Minor injuries without permanent effects that can be treated on an outpatient basis or with first aid intervention
3	Medium	Work performance is negatively affected; it causes absenteeism from work, either outpatient or inpatient, resulting in up to 1 week of lost workdays
4	Severe	These are serious injuries that require long-term treatment, may lead to limb loss or occupational diseases, and can result in death
5	Very severe	These were mostly very serious injuries that resulted in death

Table 5. Definition of risk level according to the HES method

RISK = SEVERITY OF DAMAGE x LIKELIHOOD x EMPLOYEE AGE x EMPLOYEE TRAINING	
1 -55	**4.** Priority-Acceptable
56- 100	**3.** Priority-Medium
101- 150	**2.** Priority-Important
151- 200	**1.** Priority-Very Important- Unacceptable

The priority level of measures to be taken is determined based on the risk value, and the importance is established according to the risk level (Bilir & Gürcanlı, 2015; Bilir & Gürcanlı, 2014).

3. Results and Discussion

In the study, during the risk assessment using the HES method, hazards were assigned to each of the 71 activities. For each activity, the probability and severity values of potential hazards were determined. The risk scores (HES) were calculated by multiplying the parameters specified in (1): Injury severity (IS), Probability (P), Employee's age (EA), Employee's education level (EEL). The risk levels of the activities were determined according to the class in which these risk scores appear, as present in Table 3. The risk assessment conducted for each activity is provided in Table 6.

Table 6. Hazards identified in the construction site where the risk assessment was conducted

Activity Name	**Hazard**	**Probability**	**Severity**	**Employee Age**	**Employee Education Level**	**Risk Score**	**Risk Level**
Excavation	Collapse in the excavation area	3	5	2,3	2	69	Medium
	Falling materials into the excavation area	3	5	2,3	2	69	Medium
	Contact with infrastructure	4	5	2,3	2	92	High
	Collapse of surrounding structures into the accident area	3	4	2,3	2	55	Medium
	Construction machinery accidents (overturning, collision, compression)	3	5	2,3	2	69	Medium
Formwork Preparation and Removal	Falling from scaffolding	4	5	2,3	3	138	High
	Hazards due to manual handling	4	4	2,3	3	110	Medium
	Hand tool accidents	3	4	2,3	3	83	Medium
	Material (nails, etc.) splashing	3	4	2,3	3	83	Medium
	Falling materials from tower crane or jib crane	4	4	2,3	3	110	High
Iron	Getting body parts caught in the iron workbench and iron machinery	3	4	2	2	48	Medium
	Getting body parts caught between reinforcement bars	3	4	2	2	48	Medium
	Material splashing (aluminum and iron sparks)	3	4	2	2	48	Medium

	Falling iron material from the tower crane	4	4	2	2	184	High
Concrete pouring	Concrete pump collision	3	4	2,3	3	138	Medium
	Crushing under the mixer during concrete pouring	3	5	2,3	3	173	Medium
	Formwork opening and overturning	4	5	2,3	3	184	High
	Falling worker from the floor during concrete pouring	4	5	2,3	3	230	High
	Hand tool malfunction	3	4	2,3	3	138	Medium
Wall	Falling worker from the floor while bricklaying	4	5	2,3	1,5	184	High
	Falling material	3	4	2	1,5	110	Medium
	Hazards during manual handling	3	4	2	1,5	110	Medium
	Falling worker from the ladder while bricklaying	3	4	2	1,5	110	Medium
	Wall collapsing onto the worker	3	4	2	1,5	96	Medium
Floor	Falling of flooring materials during transport	3	4	1,5	2,3	96	Medium
	Falling from floor gaps	3	4	1,5	2,3	96	Medium
	Hand tool malfunction	3	4	1,5	2,3	96	Medium
	Hazards due to manual handling	3	4	1,5	2,3	110	Medium
Electricity	Electric leakage in electrical machines	4	5	1	2	230	High
	Hazards due to manual handling	3	4	1	2	138	Medium
	Worker contact with high-voltage lines passing near the building	5	4	1	2	230	High
Insulation	Collapse of roof insulation	3	4	2	2,3	110	Medium
	Hazards due to manual handling	3	5	2	2,3	173	Medium
	Falling worker from scaffolding while insulating	4	5	2	2,3	160	High
	Falling insulation materials	3	5	2	2,3	120	Medium
	Wall collapse while performing foundation insulation	3	4	2	2,3	96	Medium
	Body parts getting caught between insulation materials (glass, etc.)	3	4	2	2,3	96	Medium
Mechanical	Hand tool malfunction during installation works	3	4	1	3	72	Medium
	Hazards due to manual handling	3	4	1	3	72	Medium
	Splattering of parts and materials from pressure air delivery vehicles	3	4	1	3	72	Medium
Roof	Falling worker from the roof	4	4	2	3	96	High
	Falling materials	3	4	2	3	60	Medium
	Hazards due to manual handling	3	4	2	3	48	Medium

	Hand tool malfunction	3	4	2	3	48	Medium
	Tower crane colliding with a worker or scaffolding	5	5	2	3	200	High
	Hazards due to manual handling	3	4	3	1,5	120	Medium
Plaster	Hand tool malfunction	3	4	3	1,5	120	Medium
	Collapse of ladder or scaffolding	3	4	3	1,5	120	Medium
	Body parts getting caught in plastering workbenches and machines	3	4	3	1,5	96	Medium
	Falling materials	3	4	3	1,5	96	Medium
	Electric shock	3	5	3	1,5	60	Medium
Paint	Hazards due to manual handling	3	4	2,3	3	48	Medium
	Hand tool malfunction	3	4	2,3	3	48	Medium
	Fire	4	5	2,3	3	160	High
	Collapse of ladder or scaffolding	3	4	2,3	3	96	Medium
	Falling materials	3	4	2,3	3	96	Medium
Door and Window	Falling from height during assembly	3	4	1,7	1,5	96	Medium
	Collapse of ladder or scaffolding	3	4	1,7	1,5	120	Medium
	Falling materials	3	4	1,7	1,5	144	Medium
	Electric shock due to use of electrical tools	4	5	1,7	1,5	240	High
	Hand tool malfunction	3	4	1,7	1,5	144	Medium
	Hazards due to manual handling	3	4	1,7	1,5	144	Medium
Elevator	Hazards due to manual handling	3	4	2,3	1	144	Medium
	Hand tool malfunction	3	4	2,3	1	180	Medium
	Falling materials	3	4	2,3	1	110	Medium
	Falling from height during assembly	4	4	2,3	1	147	High
	Electric shock due to use of electrical tools	5	5	2,3	1	288	Intolerable
General construction site and landscaping	Electric shock due to use of electrical tools	4	5	1,5	2	184	High
	Traffic accidents within the construction site	4	5	1,5	2	184	High
	Hand tool malfunction	3	4	1,5	2	82	Medium
	Warning signs	3	4	1,5	2	82	Medium

In Table 6, the high numbers of risk scores cause the risk levels to fall into the "high risk" category. High risk values determine the priority level of the measures to be taken, and based on this, a ranking of the risk levels is made (Fine, 1974; Kinney & Wiruth, 1976). High risks require the immediate stoppage of work and the removal of employees from the work area until the necessary safety measures are taken. This situation, especially in the construction sector, often leads to work stoppages and delays in the construction schedule. This study also includes a risk assessment using the HES method, as well as X and L type matrix methods. The findings regarding the X and L type matrices were derived from previous studies (Aytekin, Kaya & Kuşan, 2015; Ak, 2020). The risk assessment performed was compared with the HES, X, and L matrices. The comparison of the obtained results is presented in Table 7.

Table 7. Comparison of results obtained from L matrix, X type matrix, and HES type risk assessment methods

Methods	**L MATRIX METHOD**			**X TYPE MATRIX**			**HES METHOD**		
Main Activity	INTOLERABLE	HIGH	MEDIUM	INTOLERABLE	HIGH	MEDIUM	INTOLERABLE	HIGH	MEDIUM
Excavation		4	1	3	2	0		1	4
Insulation		2	4	1	2	3		1	5
Formwork		5	0	5	0	0		2	3
Ironwork		1	3	0	4	0		1	3
Concrete		2	3	3	1	1		2	3
Wall		2	3	0	1	3		0	4
Floor		1	3	0	1	3		0	4
Electricity		2	1	0	2	1		2	1
Mechanical		2	2	2	1	0		0	3
Roof	2	2	1	2	3	0		2	3
Plaster		3	3	5	1	0		0	6
Paint		2	3	2	3	0		1	4
Door and Window		4	2	4	2	0		1	5
General		2	2	2	2	0		2	2
Elevator	1	2	2	0	0	5	1	2	2
Total	**3**	**36**	**33**	**29**	**33**	**16**	**1**	**17**	**52**
%	**4,23**	**50,70**	**46,48**	**40,85**	**46,48**	**22,54**	**1,41**	**23,94**	**73,24**

An examination of Table 7 clearly reveals significant differences in the results produced by the three different risk assessment methods applied to the same construction project. The column for the "Unacceptable" risk category was excluded from the evaluation, as no data were recorded under this classification. According to the analysis conducted using the L-type matrix method, 3 activities were classified as "intolerable risk", 36 activities as "high risk", and 33 activities as "moderate risk". When the X-type matrix method was applied, 29 activities were categorized as "intolerable risk", 33 as "high risk", and 16 as "moderate risk". In contrast, the HES (Hazard Evaluation System) method identified only 1 activity as "extremely high risk", 17 as "high risk", and 52 as "moderate risk". Based on these findings, 54.93% of the activities evaluated with the L-type matrix were classified as high or intolerable risk, whereas this percentage increased to 87.33% in the X-type matrix. On the other hand, the HES method identified significantly fewer extremely high-risk activities (1.49%) and a larger number of moderate-risk activities. This indicates that the HES method provides a more balanced and realistic distribution of risk levels. The comparative analysis suggests that both the X-type and L-type matrix methods tend to produce stricter and more safety-concerning outcomes compared to the HES method. In contrast, the HES method, by incorporating human-related factors such as employee training, age, severity, and likelihood, offers more realistic and applicable results. Therefore, it can be concluded that the HES method provides a more comprehensive and appropriate approach to risk assessment in construction environments.

4. Conclusion and Suggestions

This study examines the applicability of the Hazard Evaluation System (HES) method, developed to prevent accidents in the construction sector. By analyzing a construction project example carried out in Antalya, parameters such as probability, severity, age, and training were identified for each hazard, and comparisons were made using different risk assessment methods with these data. Based on the findings, each of the L-matrix, X-type matrix, and HES methods is applicable in the construction sector, with each having its advantages and limitations. The L-matrix method is frequently preferred due to its ease of application and low cost requirements. However, it has some limitations. The method does not take into account the age and education level of workers, which can lead to incomplete risk assessments. Furthermore, because the L-matrix method is experience-based, it can be difficult for inexperienced individuals to apply it correctly, and it may fail to prioritize risks adequately. The X-type matrix method, on the other hand, is more complex and requires more time and data, which may make it an unsuitable option in certain situations. Additionally, evaluations based on expert opinions can be subjective, making it challenging to obtain reliable and accurate results. The HES method, by directly considering factors such as exposure parameters, provides a more realistic and detailed risk assessment. Supported by data such as workers' age and education level, this method offers a more economically and effectively sustainable solution for preventing accidents and maintaining productivity in the long term. However, the implementation of the HES method requires prior planning with data such as age and education, making it difficult to apply quickly. Nevertheless, when applied at the beginning of a project, its long-term benefits are significant. The prevention of accidents in the construction sector is crucial, as it can avoid negative consequences such as work stoppages due to high-risk scores, ensuring that workflow is not disrupted. In conclusion, while all three methods are applicable in the construction sector, it is concluded that the HES method offers more comprehensive, accurate, and reliable results. In the long term, it provides a more economical and effective option for preventing accidents and improving work efficiency.

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All authors contributed equally to the article. There is no conflict of interest.

References

Ak, M. A. (2020). Comparison of risk assessment methods in the context of occupational safety in the construction sector, *European Journal of Science and Technology,* Volume: 18, Pages: 272-282.

Aytekin, O. & Kaya, M.Ü. & Kuşan, H. (2015). Suggestions for Selecting an OHS Risk Assessment Method Suitable for Project Type and Work Data in Construction Works, 5th Worker Health and Occupational Safety Symposium, Izmir, Turkey, pp.127-136.

Bilir, S. & Gürcanlı, G. E. (2014). Activity-Based Occupational Health and Safety Risk Assessment on Construction Projects, 11P thP International Congress on Advance in Civil Engineering, İstanbul. (Oral Presentation).

Bilir, S. & Gürcanlı, G. E. (2015). Applicability of The Hazard Rating Number System in The Construction Industry. The XXVIIth Annual Occupational Ergonomics and Safety Conference", Nashville, Tennessee, USA. (Oral Presentation).

Dizdar, E.N. (2000). Occupational Safety, Alver Publishing. October, Ankara.

Fine W.T. (1974). Mathematical evaluations for controlling hazards. *Journal of Safety Research.* 3, 157-166.

Gürcanli, G. E. (2008). Hazard Analysis and Risk Assessment, ITUSEM Occupational Safety Certification Program in the Construction Sector, Construction Site Occupational Safety Course Notes 3, Istanbul.

Gül, M. & M, Ak. (2018). Comparative outline for quantifying risk ratings in occupational health and safety risk assessment, Elsevier, *Journal of Cleaner Production*, Vol. 196: 653-664.

ILO. (2020). Safety and Health at Work.

Kinney, G. F. & Wiruth, A. D. (1976). Practical Risk Analysis For Safety Management. NWC Technical Publication 5865, Naval Weapons Center, China Lake CA, USA.

Korkmaz, A. V. (2020). Evaluation of large-scale construction sites in terms of occupational health and safety. *TÜBAV Science Journal,* 13(1), 1-16.

Külekçi, G. & Güvendi, A. (2023). Solid Waste Management and Solid Waste Recycling Facility in Gümüşhane Province. II. International Korkut Ata Scientific Researches Conference, 642-647.

Özkılıç, Ö. (2005). Occupational Health and Safety, Management Systems, and Risk Assessment Methodologies. Turkish Confederation of Employers' Associations (TİSK), Ankara, p.219.

Şahin, M. & Gürcanlı, G. E. (2011). Comparative Analysis of Occupational Safety Risks in Reinforced Concrete, Steel, and Light Steel Buildings, 3rd Worker Health and Occupational Safety Symposium. Pages 201-212.