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RESEARCH ARTICLE / ARAŞTIRMA MAKALESİ

Determination of Subcontractor Selection Criteria from the View of Occupational Health and Safety in the Construction Industry

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Abstract

Construction industry is characterized by labor-intensive workforces, subcontractor-based production, diverse activities, and related hazards. Given the commonality of contingent forms of contracting, the majority of construction work is carried out by subcontractors. Unlike main contractors, subcontractors are typically smaller or medium-sized companies. Their awareness, practice, and compliance with health and safety legislation can be problematic. Furthermore, establishing and implementing a safety management system for a specific project requires coordination and management of multiple subcontractors. In this paper, a model has been created for selecting the most suitable subcontractor through an evaluation of their occupational health and safety (OHS) management implementation. The selection criteria have been determined based on a literature review focused on OHS, followed by the development of a questionnaire that assesses the importance of the criteria with the support of five occupational safety experts. Three shopping mall projects were chosen for implementation based on expert evaluations using scores calculated through the Analytical Hierarchy Process. Importance rates for each criterion were calculated, allowing for the identification of the most significant subcontractor selection criteria. Fifteen on-site subcontractors were evaluated using the proposed method. The research suggests that in the absence of qualification-based selection criteria for subcontractors, unskilled personnel could be selected. Consequently, this could impede the safety oversight mechanism, the execution of OHS measures, as well as the mitigation and/or prevention of potential risks, while jeopardizing compliance with the applicable legislation throughout the project. Therefore, it is imperative to choose only competent subcontractors to guarantee the welfare of workers.

Keywords: Construction Industry, Subcontractor Selection, Occupational Health and Safety, Analytical Hierarchy Process

I. INTRODUCTION

The construction industry in Turkey has acquired noteworthy experience and the capacity to execute intricate projects in various domains and regions globally. Although there have been positive developments in various areas, the industrial sector still has inadequate labour rights and poor levels of occupational safety and health. There have been some new legislative measures and on-site practices implemented in the industry. However, work-related accidents in construction have caused significant issues in several countries [1-3]. Occupational accidents, particularly those resulting in fatalities, continue to rise. The rate of fatal occupational injuries in Turkey is considerably higher in comparison to other European countries [4-6]. Technical term abbreviations, if any, have been explained accordingly.

According to Social Security Institution (SSI) statistics, in 2021, a total of 511,084 accidents occurred in all sectors, resulting in 3,123 individuals receiving incapacity benefits and 1,382 fatalities [7]. Out of these, 967 individuals from the construction sector received incapacity benefits, and 386 lost their lives due to occupational accidents. The language used is formal with a balanced approach and precise word choice to maintain objectivity. The text adheres to conventional academic structure, citation style, and grammatical correctness, with logical progression in sentence structuring. In other words, the construction industry accounts for a significant number of occupational accidents resulting in fatalities, with 31% and 28% of all accidents attributed to this sector (Table 1). These statistics suggest that current safety measures may be inadequate in reducing the overall incidence of such

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accidents. In other words, the construction industry accounts for a significant number of occupational accidents resulting in fatalities, with 31% and 28% of all accidents attributed to this sector (Table 1).

Table 1: Occupational Accident Statistics for Turkey, 1992-2021

	Total accidents			Fatality		
	All industries	Construction Industry		All industries	Construction Industry	
Year	Frequency	Frequency	%	Frequency	Frequency	%
1992	139414	22863	16.40	1776	559	31.48
1993	109563	17535	16.00	1516	464	30.61
1994	92087	13991	15.19	1191	421	35.35
1995	87960	12809	14.56	798	348	43.61
1996	86807	11784	13.57	1296	555	42.82
1997	98318	14703	14.95	1282	437	34.09
1998	91895	12355	13.44	1094	380	34.73
1999	77955	10278	13.18	1165	407	34.94
2000	74847	7845	10.48	1167	379	32.48
2001	72367	8459	11.69	1002	341	34.03
2002	72344	7982	11.03	872	319	36.58
2003	76668	8198	10.69	810	274	33.83
2004	83830	8106	9.67	841	263	31.27
2005	73923	6480	8.77	1072	290	27.05
2006	79027	7143	9.04	1592	397	24.94
2007	80602	7615	9.45	1043	359	34.42
2008	72963	5574	7.64	865	297	34.34
2009	64316	7924	12.32	1171	170	14.52
2010	62903	7102	11.29	1444	507	35.11
2011	69227	8543	12.34	1700	597	35.12
2012	74871	10002	13.36	744	285	38.31
2013	191389	26967	14.09	1360	542	39.85
2014	221366	29699	13.42	1626	501	30.81
2015	241547	33361	13.81	1252	473	37.78
2016	286068	44552	15.57	1405	496	35.30
2017	359653	62802	17.46	1633	587	35.95
2018	430985	77157	17.90	1541	591	38.35
2019	422463	47701	11.29	1147	368	32.08
2020	384262	44304	11.53	1231	347	28.19
2021	511084	58107	11.37	1382	386	27.93

It is notable that subcontracting is a widespread practice in the construction industry, observed globally including in Turkey. Ninety-nine percent of Hong Kong's housing sector relies on subcontracting, with only one percent being direct employment. According to a report, many countries, including Japan and the United Kingdom, rely heavily on subcontracting [8]. Turkey is among the countries where the use of subcontractors is widespread due to the specificity of the sector [9]. Subcontractors are a crucial aspect of a successful project, and selecting the appropriate subcontractor is key to achieving that success. However, research indicates that choosing the right subcontractor can significantly enhance project success [10]. Subcontractors are a crucial aspect of a successful project, and selecting the appropriate subcontractor is key to achieving that success. Despite the importance of this selection process, it is often overlooked or undervalue.

Subcontractor legislation in Turkey is generally determined by legal regulations such as the Turkish Commercial Code, General Specifications for Construction Works, Occupational Health and Safety Law. The Turkish Commercial Code contains general provisions on labour relations and regulates commercial law. The General Specification for Construction Works, which determines the general conditions applied in construction projects, includes the relations and contractual provisions between the subcontractor and the main contractor. The Occupational Health and Safety Law regulates occupational health and safety standards in the construction industry and sets out the rules that subcontractors must comply with. The Turkish Code of

Obligations regulates contracts and the obligations arising from these contracts, and contracts between the subcontractor and the main contractor are handled within the framework of this law. In addition, the Code of Ethics on Contractor-Subcontractor Relations set by the Turkish Employers' Association of Construction Industries (INTES) and the Turkish Contractors Association (TMB) sets out the standards of ethical behaviour in the sector. Within the framework of this legislation, construction companies operating in Turkey are obliged to comply with these regulations and fulfil their obligations in their subcontractor relations.

As working with subcontractors offers several benefits, owners typically prefer to do so. Eccles (1981) outlines advantages of subcontracting such as reducing the management burden, solving complex problems more easily, risk-sharing, and lowering material costs [11]. Costantino et al. (2001) outlined the benefits of employing subcontractors, which include reduced responsibility for the owner/main contractor, decreased overheads and costs for construction and equipment, market flexibility, decreased construction time, and improved quality of labour work [12]. Winch (1998) suggests that although safety regulations can be challenging to implement, especially when dealing with subcontractor workers, they face a lower risk of fatality than those employed by major contractors [13]. Working with subcontractors has several advantages, but it can make it challenging to maintain proper occupational health and safety (OHS) practices at the construction site [14]. This is because employers often prioritize criteria such as cost, quality, and experience when selecting subcontractors, instead of giving adequate importance to OHS. Factors such as Communication and Coordination, OHS Training, Contractual Arrangements, Monitoring and Enforcement, Risk Assessment, Penalties for Non-Compliance can be listed as problems that may be encountered in terms of occupational safety when working with subcontractors [15].

As subcontractors carry out the majority of the work, the selection process should prioritize OHS to ensure that owners make it one of their main concerns. The research aims to introduce a method to aid employers in subcontractor selection with a focus on Occupational Health and Safety (OHS) evaluation. The study presents a subcontractor selection approach using Analytic Hierarchy Process (AHP) to lessen occupational accidents.

2. MATERIAL AND METHODOLOGY

Since the purpose of this study is to furnish employers with a method for selecting subcontractors based on Occupational Health and Safety standards, the initial stage involved the identification of the top 20 most commonly experienced criteria. The Analytical Hierarchy Process (AHP) was utilised to ascertain the significance of these criteria. Analytical Hierarchy Process (AHP) is a mathematical technique employed by decision-makers to assess criteria and make informed decisions in complex processes [16]. Introduced by Myers and Alpert in 1968 and later developed by Thomas Saaty in 1977, AHP is a methodology based on individuals' intuition that solves issues relating to multiple variables. It is applied across several industries today [17-18].

The Analytical Hierarchy Process (AHP) is a mathematical theory that allows users to measure both quantifiable and non-physical criteria. The AHP process is based on the modelling of the human brain in terms of experience and knowledge, thus enabling its application in decision theory [16]. Researchers have long been concerned with evaluating physical and psychological events related to decision-making. Physical evaluations rely on objective measurements, whereas psychological evaluations involve subjective assessments based on concepts like ideas, beliefs, and feelings. AHP (Analytic Hierarchy Process) is a theory that bridges the gap between these two worlds [17]. Pairwise comparison is the basis of AHP, with a predetermined decision scale and percentage of importance guiding the final outcome.

The data analyse procedure involves the following steps. First the pairwise comparison matrix which is called matrix A is extracted from the data collected from the interviews. The principal right eigenvector of the matrix A is computed as ‘w’[19].
If $a_{ik} . a_{kj} = a_{ij}$ is not confirmed for all k, j, and i the Eigenvector method is selected [20].
If the matrix is incompatible and in case of incomplete consistency, pair comparisons matrix cannot be used normalizing column to get Wi.

For a positive and reversed matrix, Eigenvector technique can be used which in it:
$e^t = (1,1,\ldots,1)$

$$W = lim_{k\to\infty} \frac{A^k . e}{e^T . A^k . e} \quad \textbf{(1)}$$

To reach a convergence among the set of answers in to successive repetition of this process, calculation should be repeated several times in order to take a decision when facing an incompatible matrix. Then, the following formula is applied to transform the raw data into meaningful absolute values and normalized weight $w = (w_1, w_2, w_3,\ldots, w_n)$:

$Aw=\lambda_{max}\, w$, $\lambda_{max}\geq n$

$$\lambda_{\max}= \frac{\sum aiwj-n}{w1} \quad \textbf{(2)}$$

$$A=\{a_{ij}\} \text{ with } a_{ij}=1/ a_{ij} \quad \textbf{(3)}$$

A: pair wise comparison
w: normalized weight vector
λ_{max} : maximum eigen value of matrix A
a_{ij}: numerical comparison between the values i and j
The decision scale utilised in this investigation can be found in Table 2.

Prior to assessing the hierarchy, it is crucial to establish a goal and then outline the primary and secondary categories to facilitate decision-making. Subsequently, relationships are established and pairwise comparisons are conducted in accordance with the hierarchy table. Decision makers evaluate the criteria and determine their relative importance.

Table 2. The Scale of Importance.

Intensity of Importance	Definition
1	Equal Importance
3	Moderate Importance
5	Strong Importance
7	Very Strong or Demonstrated Importance
9	Extreme Importance
2,4,6,8	Intermediate Values

Once the pairwise comparison matrices have been completed, the same criteria are assigned an importance degree of 1. Each value in each column is then divided by the sum of its own column. This process is repeated for each component of the comparison matrix. An average of each row is taken to obtain a priority vector, which indicates the percentage of importance for each criterion. Despite the consistency of the AHP method, it is still necessary to measure its consistency. To assess the consistency of the approach, one should evaluate the Consistency Rate (CR) by multiplying the comparison matrix and priority vector. In order to validate the results of the AHP, the consistency ratio (CR) is calculated using the formula, CR = CI/RI in which the consistency index (CI) is, in turn, measured through the following formula:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad \textbf{(4)}$$

After obtaining a new vector, each of its components is divided by the components of the priority vector. The resulting values are then averaged to calculate the λ value, which is later used to calculate the Consistency Indicator (CI). The calculated CI values are then divided by the Random Indicators (RI) according to the number of criteria (n). To ensure necessary contingency, the CR value must be less than 0.1.

A hierarchical model was devised to assess 20 criteria, obtained as a result of literature review and expert opinions, achieved through AHP. The model comprises three principal categories: Training, OHS Management and Planning. The OHS Management has two sub-categories: Site Operation Management and General Management. The selection criteria are displayed in Table 3.

Table 3. Frequency of Criteria Presence in Literature.

No	Criteria	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Frequency
1	Fall Prevention and Trainings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%
2	Construction Machinery - Equipment Inspection, Maintenance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%
3	Material Loading / Unloading / Lifting Trainings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%
4	First aid training	✓		✓	✓	✓	✓	✓	✓	✓	✓	90%
5	Emergency Action Plan	✓		✓	✓	✓	✓	✓	✓	✓	✓	90%
6	Personal Protective Equipment	✓	✓	✓	✓	✓	✓		✓	✓	✓	90%
7	OHS Monitoring and Inspection System	✓		✓	✓	✓	✓	✓	✓	✓	✓	90%
8	Planning of Site Traffic	✓	✓	✓	✓		✓	✓	✓	✓	✓	90%
9	Job Description, Duties and Responsibilities of OHS Personnel	✓	✓	✓	✓		✓	✓	✓	✓	✓	90%
10	Standards related to scaffolding, installation, maintenance, inspection	✓	✓	✓	✓	✓	✓		✓	✓	✓	90%
11	OHS Management System			✓	✓	✓	✓	✓	✓	✓	✓	80%
12	Machinery - Equipment Use Trainings	✓	✓		✓		✓	✓	✓	✓	✓	80%
13	Trainings Related to Electrical Installation	✓	✓	✓	✓		✓	✓		✓	✓	80%
14	Health Screening	✓		✓	✓		✓	✓	✓	✓	✓	80%
15	Construction Method	✓	✓	✓			✓	✓	✓	✓		70%
16	OHS Registration and Reporting			✓	✓		✓	✓	✓	✓	✓	70%
17	The Participation of OHS Policies in Management			✓	✓		✓		✓	✓	✓	60%
18	Site Planning and Planning of Social Units	✓	✓						✓	✓	✓	50%
19	OHS Budget	✓		✓					✓	✓		40%
20	Arranging the entrance to the job site				✓			✓		✓	✓	40%

A survey was administered to nine occupational safety experts, all actively working engineers with at least 5 years of experience. They also have at least one certificate related to occupational health and safety. All respondents provided feedback, and the results were accepted. Of those, 5 meet the 0.1 consistency threshold and the remainder were excluded. The number of respondents required for the AHP depends on the complexity of the problem, the availability of data, and the desired level of accuracy and reliability. There is no definitive answer to this question, but some general guidelines can be followed. According to Saaty (1980), the minimum number of respondents should be at least three, and preferably more than five [21]. However, this number may vary depending on the nature and scope of the problem, and the degree of consensus among the respondents. Some studies have suggested using larger sample sizes, such as 10, 15, or 20, to increase the validity and robustness of the results. However, larger sample sizes also increase the complexity and cost of the data collection and analysis and may introduce more inconsistency and noise in the judgments. Therefore, a trade-off between quality and quantity should be considered when choosing the number of respondents for the AHP.

The Superdecision Packaged Program was utilized to apply the Analytic Hierarchy Process (AHP) Method. Survey responses were fed into the program to generate pairwise comparisons. Five significance levels were obtained for each criterion and their geometric mean was used to determine the level of significance. An evaluation method was developed by occupational safety specialists through generating a success scale categorized as “successful”, “adequate”, “average”, “below the average”, and “unsuccessful”. Finally, a case study was conducted to assess five subcontractors at three shopping malls.

3. QUESTIONNAIRE AND CASE STUDY

The data used in the AHP method were obtained from three successive questionnaire studies. Pairwise comparison questionnaires were sent to nine seasoned OHS experts. Only five experts were considered qualified as four of them had a consistency rate below 0.1. Table 4 shows that all CRs, except the three CR values of two experts, are below 0.1. A consistency ratio of just over 0.1 is generally an acceptable level, but this value depends entirely on acceptability. A lower consistency ratio may raise concerns about the reliability of decisions, in which case the decision matrix should be revised [22].

In the second phase of the study, a distinct survey was conducted by sending questionnaires to three OHS specialists actively involved in three distinct shopping mall projects located in Turkey. All of the respondents who expressed opinions are Class A occupational safety specialists with 4, 6 and 7 years of experience in large-scale construction projects, respectively. The first mall flaunts a capital budget of 100 million euros and occupies a construction area of 180,000 square meters, while the second has a capital budget of 60 million euros, covering an area of 120,000 square meters. The final project, with a capital budget of 25 million euros, encompasses a construction area of 45,000 square metres. Fifteen subcontractor companies were selected based on their specialty in areas such as rough works, electrical works, and mechanical works. The companies were then rated by a Specialist on a scale of 100. In the third section, Table 6 was sent to the Specialist, along with pairwise comparison surveys. By averaging these surveys, a success scale was determined.

Table 4: CR Values According to Specialist.

Main Headings	#1	#2	#3	#4	#5
Training	0.055	0.02	0.098	0.015	0.109
Site Operation Management	0.071	0.085	0.112	0.0833	0.097
General Management	-	0.099	-	0.043	0.099
Planning	0.022	0.029	0.135	0.028	0.026

Upon analysis of Table 5, it becomes apparent that these rankings offer the owner insights into appropriate actions to be taken against subcontractors regarding OHS. Table 5 clarifies that "Successful" means the subcontractor has fulfilled OHS obligations and is deemed suitable for OHS standard selection, while "Capable" denotes that the subcontractor has fulfilled its obligations but ought to improve OHS performance. An "average" subcontractor may have some deficiencies, therefore it is imperative to assess their experience before choosing and signing a construction contract. The term "below average" indicates that the subcontractor poses significant risks to occupational health and safety, hence the selection process should be approached with caution and it may be more sensible to consider another subcontractor. "Unsuccessful" refers to the subcontractor being unsuitable for further consideration due to their insufficient performance and problematic conduct, which is unacceptable.

Table 5: OHS Success Point Evaluation Scale Survey

When a firm evaluated in compliance with OHS on the scale of 100, how much point the firm should take?	Scores
Successful	
Capable	
Average	
Below Average	
Unsuccessful	

After conducting a questionnaire study, we developed a hierarchy model for the SuperDecision programme by categorising criteria. The model comprises main headings and subheadings, which are illustrated in Figure 1. Using the SuperDecision programme, we calculated the weights of criteria by comparing the pairwise matrices according to the hierarchy model. Using the SuperDecision programme, we calculated the weights of criteria by comparing the pairwise matrices according to the hierarchy model. Using the SuperDecision programme, we calculated the weights of criteria by comparing the pairwise matrices according to the hierarchy model. The programme then presented the weights and order of importance, as shown in Table 6. The total of average criterion weights is 4. Each criterion weight is normalised (divided by 4). The most important criterion is the first one with a weight of 9.35%, followed by the fourth criterion at 8.23%, and the fifth criterion at 7.30%. As demonstrated in Table 6, the first 7 criteria represent half of the total importance level.

Respondents to whom the pairwise comparison questionnaires were sent were also asked about the minimum scores that a subcontractor should receive in order to be "Successful", "Capable", "Average", "Below Average" and "Unsuccessful". The questionnaire was completed by an OHS Specialist and the findings are displayed in Table 7. To determine the performance of five primary subcontractors across three shopping malls based on OHS standards, we calculate the average of expert values. OHS assessments based on value ranges are used, including "successful," "capable," and others. These ranges are defined as follows: 86-100: Successful, 74-85: Capable, 58-73: Average, 42-57: Below Average, and 0-41: Unsuccessful.

After assessing the three shopping centres, success points are assigned based on the evaluation scores given by OHS specialists who work on site and the normalized criteria weights in Table 6. This process is applied to all criteria and each subcontractor, with points being calculated by multiplying the scores on a scale of 100. The review of subcontractors is conducted based on success points, and the findings are outlined in Table 8. The 5 subcontractors to be taken into consideration in this assessment are identified as Rough Construction, Mechanical Works, Electrical Works, Fine Works and Facade Works subcontractors with high work volumes and number of workers. The initial shopping mall receives the least favourable score in the category of facade works. When compared to the two other malls, this shopping mall also records the poorest score for rough works, which is the category in which on-site accidents take place.

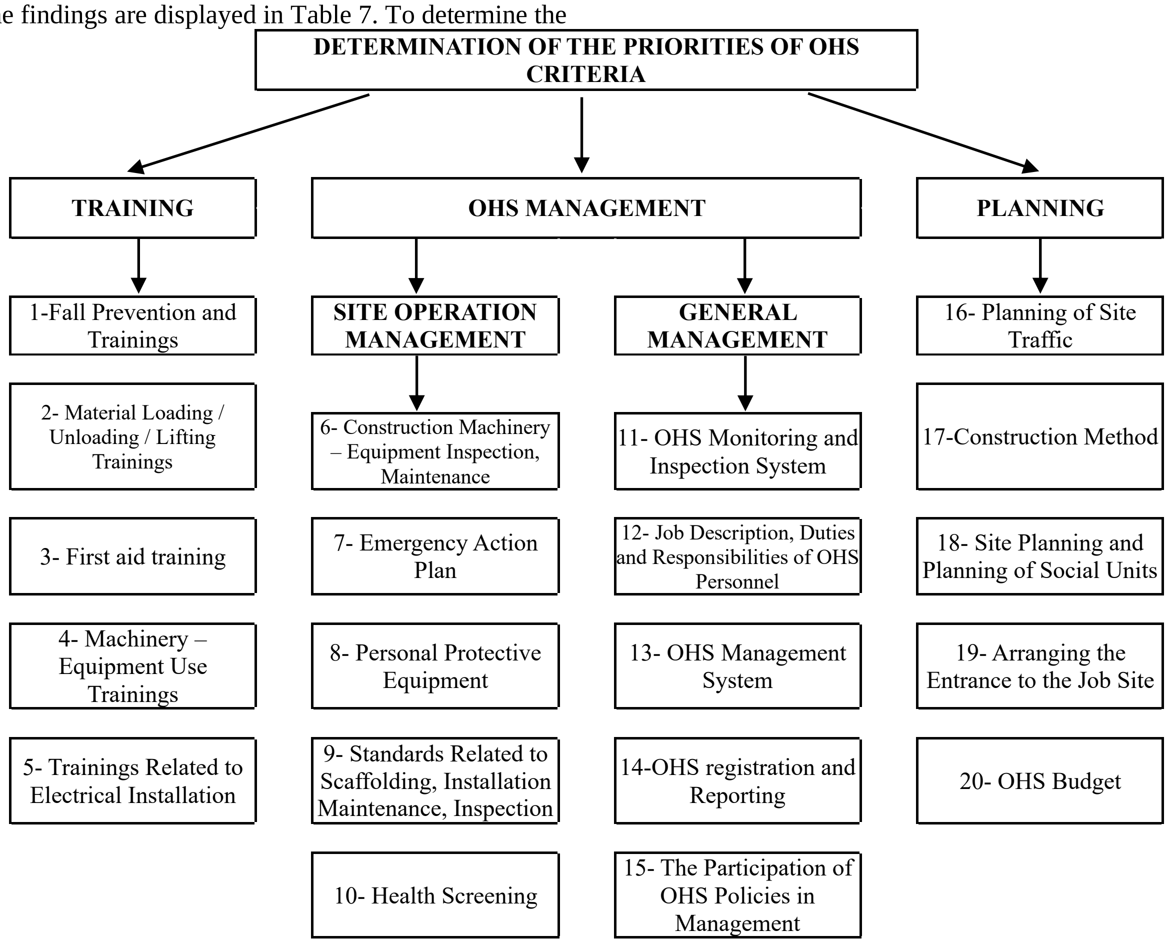

Figure 1. System of Hierarchy Model of SuperDecision Program

Table 6: Weights and Order of Importance and Importance Rate of Criteria

	Criteria Weight						Order of Importance					Importance Rate	
Criteria	Expert #1	Expert #2	Expert #3	Expert #4	Expert #5	Av.	Expert #1	Expert #2	Expert #3	Expert #4	Expert #5	Average	Priority Rate
#1	0,5826	0,3777	0,5055	0,3159	0,089	0,3741	1	2	2	4	11	0,0935	9,35%
#2	0,168	0,0837	0,1401	0,2238	0,1523	0,1536	7	16	15	9	8	0,0384	8,23%
#3	0,0372	0,0793	0,0362	0,0425	0,0573	0,0505	20	17	19	20	17	0,0126	7,30%
#4	0,0621	0,0935	0,1632	0,2958	0,0342	0,1298	18	15	12	5	18	0,0325	6,54%
#5	0,1501	0,3657	0,1551	0,122	0,6673	0,292	10	4	13	15	1	0,073	6,42%
#6	0,3059	0,2834	0,5956	0,3935	0,0666	0,329	5	6	1	1	15	0,0823	6,08%
#7	0,0839	0,0486	0,0367	0,0915	0,4199	0,1361	17	19	18	18	3	0,034	5,90%
#8	0,187	0,1831	0,1412	0,1365	0,0271	0,1349	6	10	14	13	20	0,0337	5,84%
#9	0,338	0,4446	0,1927	0,2665	0,0666	0,2617	4	1	11	7	15	0,0654	5,02%
#10	0,0853	0,0403	0,0339	0,112	0,4199	0,1383	16	20	20	16	3	0,0346	4,85%
#11	0,4286	0,2763	0,2	0,1854	0,0888	0,2358	3	7	6	10	12	0,059	4,33%
#12	0,1429	0,168	0,2	0,1405	0,1662	0,1635	12	11	6	12	7	0,0409	4,09%
#13	0,1429	0,1214	0,2	0,2447	0,5071	0,2432	12	12	6	8	2	0,0608	3,92%
#14	0,1429	0,2284	0,2	0,1065	0,1053	0,1566	12	8	6	17	10	0,0392	3,84%
#15	0,1429	0,206	0,2	0,3228	0,1326	0,2009	12	9	6	3	9	0,0502	3,55%
#16	0,0608	0,0614	0,3685	0,0672	0,4129	0,1941	19	18	3	19	5	0,0485	3,46%
#17	0,1446	0,3736	0,1063	0,172	0,0703	0,1734	11	3	16	11	13	0,0434	3,40%
#18	0,1571	0,1109	0,2409	0,1299	0,0703	0,1418	8	14	5	14	13	0,0355	3,37%
#19	0,1571	0,1141	0,2412	0,3595	0,4129	0,257	8	13	4	2	5	0,0643	3,24%
#20	0,4804	0,34	0,0431	0,2714	0,0337	0,2337	2	5	17	6	19	0,0584	1,26%

Table 7: OHS Success Point Evaluation Scale Survey Results

Expert	#1	#2	#3	#4	#5	Av.
Successful	85	90	81	85	90	86
Capable	70	80	71	70	80	74
Average	50	60	51	60	70	58
Below the Average	30	40	31	50	60	42
Unsuccessful	0	30	0	40	50	24

Table 8: Scores of shopping malls According to OHS Experts

	Rough Construction	Mechanical Works	Electrical Works	Fine Works	Facade Works
First Shopping Mall	44	71	70	45	30
Second Shopping Mall	54	87	78	72	93
Third Shopping Mall	65	69	69	68	63

The findings demonstrate the significance of the suggested method of choosing subcontractors. "Fall Prevention and Trainings" was the most important criterion with 9.35%. The 2nd most important criterion is "Construction Machinery – Equipment Inspection, Maintenance" with an importance level of 8.23% and the 3rd most important criterion is "Trainings related to Electrical Installation" with an importance level of 7.30%. There are 9 criteria with an importance level above 5%. The sum of the importance of the first 5 criteria is 37.84%, the sum of the importance of the first 7 criteria is 50%, the sum of the importance of the first 10 criteria is 65.54%, and the sum of the importance of the first 15 criteria is 85.26%.

To comply with current health and safety legislation and implement safety management on site, subcontractors must fulfil twenty requirements before tendering, allowing the prime contractor to pick the most suitable candidate. Nevertheless, the field study discloses that the majority of subcontractor firms (12 out of 15) were incapable of fulfilling the "successful" and "competent" criteria. The professionals at these three construction sites also noted that had this selection method been applied before the commencement of projects, not only safety concerns but also project management practices would have been enhanced.

IV. DISCUSSION AND CONCLUSION

Construction is a collaboration of businesses spanning various sectors, working together to complete a project within a specified timeframe. Each project presents unique challenges as a result of its individual characteristics. Multiple objectives are anticipated to be met simultaneously, including timely delivery to the owner, adhering to budget constraints, achieving desired standards of quality, and ensuring the absence of any workplace incidents. Every subcontractor that enters this intense environment must be carefully selected. If we consider the construction process as a machine, the gears in every part must run smoothly. Any issues within a single part of the machine can result in problems throughout the entire system, just as issues with a subcontractor can cause problems for not only themselves but also for other subcontractors. Thus, subcontracting is noted for its adverse health and safety (H&S) influence in construction [23]. Loosemore and Andonakis (2007) also mentioned that subcontracting has also created many management problems for principal contractors which have been widely recognised as contributing to inefficiencies in the industry, because of the complex contractual relationships which can confuse responsibilities for OHS management and reporting [15]. To avoid such problems, it is imperative that subcontractors are thoroughly evaluated and selected during the bidding process.

This study presents a method for assessing subcontractors' compliance with occupational health and safety standards, both during the selection process and throughout the project. Subcontractors can be evaluated based on these criteria during selection, and their performance can be regularly assessed for continuous improvement following globally recognised standards. The aim of this study was to create a projection for Turkey by examining three shopping centre construction projects from different provinces, which were selected as examples. A hierarchy model was created by dividing 20 criteria found through literature review into main and sub-headings, and "Binary Comparison Questionnaires" were formulated based on this model for OHS experts. AHP was applied in the study. The hierarchy was constructed using the Superdecision program. Participants' responses were entered in the program to generate paired comparison tables.

The study found that due to unique project characteristics, OHS practices are not amenable to standardization. A management system ought to be put in place at the outset of a project, taking into account its particular characteristics. Throughout the implementation, this system should be closely monitored and controlled. Interestingly, this matter has also been highlighted by Öztaş and Ökmen (2005) and Chinyio and Akintoye (2007) [24-25].

When carrying out bidding processes, it is necessary to enquire whether the subcontractor employs occupational safety personnel, assess the staff's OHS competencies, and ascertain if a management-approved job description exists. Additionally, Çiftçioğlu (2013) emphasizes the significance of selecting the most appropriate subcontractor for the subcontracting works during the bidding process [26]. An OHS organization lacking systematic management will not yield effective outcomes [27]. Marzok et al. (2013) also took into account safety consciousness on the job site while identifying the most important factors that influence the selection of sub-contractors [28].

The initial aspect to consider when assessing a subcontractor is the presence of an OHS management system. Ross (2002) identified that an OHS management provided the basis for improved OHS performance appraisal of a construction project [29].
The subcontractor employees must operate under an OHS Management System to ensure adequate comfort levels and minimize the risks to an acceptable degree. This system of management ought to oversee the processes of follow-up, audit, reporting, evaluation, and improvement while also being sustainable and meeting various needs.

Following the transfer of work to the subcontractor, a Health and Safety Recording and Archiving System must be implemented by the Employer's subcontractor and its subcontractors [30]. All relevant data and documents, including training records, meeting minutes, practice reports, accident documentation, signed personnel documents, employment records, and health reports, must be entered into this recording and archiving system.

In addition, both the company and its subcontractors must maintain accident records, utilizing them to investigate causes and prepare detailed reports. Based on the report findings, it is necessary to implement measures against the identified risk factors that led to the accident. These reports must be archived by the company and factored into the development of a by learning from the past, the occurrence of accidents could be prevented [31]. These records serve as invaluable tools for investigating the root causes of accidents and preparing detailed reports. The systematic documentation of accidents enables organizations to identify patterns, trends, and areas of concern, facilitating informed decision-making and the implementation of preventive measures. By consistently analysing accident records, both the company and subcontractors can proactively address safety issues, continuously improve safety protocols, and mitigate the risk of future incidents. This commitment to thorough record-keeping not only enhances overall safety performance but also demonstrates a proactive approach to ensuring.

OHS awareness should be promoted at all levels within the construction hierarchy. Thus, the selected company should not restrict training solely to on-site personnel but implement a dedicated OHS Training Program for management. The increased OHS knowledge at the main level of sanction power, the management, will enhance the efficacy of OHS Practices. Implementing a dedicated Occupational Health and Safety (OHS) Training Program for management is essential for fostering a culture of safety within a company. By extending training beyond on-site personnel to include managerial staff, organizations can leverage leadership influence to prioritize safety [32]. This approach not only ensures compliance with legal requirements but also equips managers with the knowledge and skills needed for effective risk management, decision-making, and emergency preparedness. Furthermore, OHS training for management contributes to improved communication, employee morale, and productivity, as well as a commitment to continuous improvement. Integrating safety into the daily operations and decision-making processes of management establishes a foundation for a robust safety culture, ultimately creating a safer and healthier work environment for all employees [33].

It is preferable for the subcontractor to carry out the work in-house, rather than outsourcing to other subcontractors, as the long chain of subcontractors can lead to weakened and lengthened inspection and control mechanisms in all areas. If the subcontractor intends to engage other subcontractors in the work, they must select their own subcontractors while considering OHS. Therefore, the employer should specify the criteria and training determined when selecting its own subcontractor for the other subcontractors to follow. When assessing the employer's preferred company, they must specify that all established criteria shall apply to subcontractors. In construction, occupational health and safety also incurs a cost. Budgeting for OHS should be a priority during the project planning stage, accounting for project characteristics, risk assessment, personnel, and other relevant factors. This aligns with Cıngıllıoğlu's findings [34]. Manu et al. (2013) suggests to restrict the layers of subcontractors on projects and to work with a regular chain of subcontractors [23].

When selecting a subcontracting company, it's crucial to take into account whether the proposal includes OHS expenses. In Turkey, these expenses aren't usually discussed during the proposal phase and are typically classified under general expenses. Subcontractors may cut costs in other areas in order to accommodate for unforeseen overhead expenses such as project extensions and additional personnel. When planning the OHS budget for the subcontractor company, it is important to avoid aiming to save money at the end of the work. Mayhew et al. (1997) specifically indicated that a large building contractor, using dozens if not hundreds of subcontractors, will find it extremely difficult to put an effective OHS control system in place, especially when competition in the tendering process makes cost minimisation the overriding criteria for survival [35].

The findings indicate that if selection criteria for qualified subcontractors is not conducted, unqualified subcontractors may end up being chosen. This, in turn, will have a direct impact on the safety management process, implementation of health and safety measures, risk mitigation and/or abatement and ensuring compliance with current legislation throughout the project. Therefore, it is crucial to select only qualified subcontractors to ensure the safety of workers and compliance with all legal requirements. The paper's approach illuminates how prime contractors can incorporate safety management into construction management practices on-site with qualified subcontractors.

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