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Evaluation Of the Safety Management System of Building Construction Projects: A Case Study of Erbil Governorate.

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ABSTRACT

Any organization linked with construction needs to apply suitable standards, procedures, and structures to support the right acts by all the involved construction structures that are related to health and safety. This paper evaluates the safety management procedure of building construction projects by rating the importance of safety management factors and calculating the average practice. This has been done by conducting a case study of (94) projects constructed during 2013-2023 by designing a questionnaire that represents a successful plan of 49 factors of seven phases for a safety management system. And delivering it to stakeholders who worked on those projects. The results of the study show that the average practice of safety management is 61.27%, which is unacceptable. The typical safety management process falls between 37.54% for initial planning and 79.93% for precautions before scaffold implementation. The results revealed that the shortage in practicing safety management stages is noticeable in all building construction projects, especially for initial planning with a rate of practice of 37.54%, and the use of personal protection equipment with a rate of practice of 47.41%. There is a lack of practicing safety procedures. A team for emergency issues is rarely available in addition to the shortage of first aid centers. There are not enough medications in case of accidents. Also, the workers are not using suitable protection equipment often. There must be an emphasis on the issue of safety management in future construction projects.

1. Introduction

The construction industry is hazardous. Lots of fatalities result from accidents on construction sites. That affects project performance severely in terms of reduced quality, low productivity, cost overruns, and delayed completion (Umair et al., 2021). Many factors may affect the construction of any project. Work accidents are considered the most common (Cahyo et al., 2022).

There are a lot of construction companies that do not implement safety measures during construction at the worksite. Unfortunately, there are a lot of workers who ignore the importance of safety at work and don't implement it properly. This ignorance leads to increases in the risk of accidents including deaths, injuries, and disabling (Hoiri et al., 2022).

(Wu et al., 2016). stated that with the development of construction methods, injuries or accidents frequently occur`. Each year, there are about 60,000 construction fatalities occur worldwide. In other words, one accident occurs every nine minutes (Abdul Hamid et al., 2003). The International Labor Organization stated that there are more than 250 million accidents and more than 160 million workers become ill in the workplace every year because of the danger of the workplace. The high percentage of accidents makes the safety situation of construction projects very gloomy (Xiaoping et al., 2021). And make the construction industry one of the high-risk industries (Othman et al., 2018).

The safety management system is a means to manage actions that affect safety in the worksite to avoid the risk of accidents in construction. Thus, for any work, a management system of occupational safety and a health protocol is required to run in the workplace (Ansari et al., 2023). Using a proper safety management technique will increase the management level and the occurrence of safety incidents will be reduced (Xiaoping et al., 2021).

Recently, more people started to pay attention to the problem of safety evaluation in construction projects, because safety management is one of the most important elements of project performance and project success. There is an urban revolution in Erbil Governorate regarding construction projects. If safety management in construction projects is not carried out systematically, leads to accidents occur accidents and the economic growth of the country will be affected. This paper focuses on examining and evaluating the safety management system in Erbil Governorate of 94 building construction projects that were constructed during the last 10 years by calculating the percentage of practicing safety management techniques and revealing the failure in implementing safety systems to take suitable precautions in future projects to avoid or eliminate the problems in future projects.

2. Background and Literature Review

(Bakri et al., 2006), stated that the construction sites are not safe for workers because of the frequent and high number of accidents. It is one of the most dangerous workplaces because it consists of complex construction operations such as multiple disciplinary aspects in the project workforce, many workers, large heavy plants, and equipment, multiple methods of construction, multi-interface, and a great number of materials. All that leads to a higher accident rate. The accidents in projects include collapse, collision, electric shock, and falling from a height. The most common causes of accidents are collisions and falling from heights (Rahim et al., 2006).

(Saeed, 2017) concluded that the construction industry has a long-term injury and a high number of fatalities. He revealed that several factors cause the high rates of accidents such as lack of knowledge of site rules, poor construction planning, worker behavior, inherent health and safety risks of construction, inadequate safety training, and lack of safety in design.

(Othman et al., 2018) identified factors that affect safety as, availability of safety equipment, workers' attitude towards safety, safety training and awareness, organization safety policy, and safety inspections

According to (Chang, 2012), there are many causes for unexpected accidents on worksites such as the lack of supervision, lack of means to carry out work safely and the lack of knowledge, carelessness in making decisions, errors in judgment, total irresponsibility, inadequate safety precautions, unqualified officers, non-implementation and being safety practices at construction sites below acceptable standards.

(Alkaissy et al., 2020), analyzed safety data and found that the failure to model health and safety risks will lower productivity due to frequent incidents.

According to (Sajid et al., 2023), stakeholders involved in the project will bear all the enormous costs incurred due to these tragic accidents at construction sites. Thus, identifying the potential hazards in construction work sites before starting the actual work and a decisive one in mitigating risks is a very critical part of safety management (Eiris et al., 2018).

(Zhang et al., 2016), classified the traditional health and safety practice into 2 phases. Phase 1 is before starting the construction. Phase 2 is the construction phase when the safety is planned, executed, and monitored.

(Haji et al., 2023), determined a relationship between the two safety-leading indicators. They assessed the impacts of indicators on the project and then visualized them proactively throughout the time of the project. Also, they generated a system dynamics model on the building information modeling platform.

(Umair et al., 2021), identified a list of 63 safety factors and classified them into 6 clusters. In their findings, they stated that better safety performance requires an effective safety management system framework for organizational, social, environmental, legislative, personnel safety, and managerial factors.

(Abdulfattah et al., 2023), during their study of Egyptian construction projects, created a safety performance index. They found that the most important safety factors are a good work environment, safe clothing, safe equipment, and incentives. They used two fundamental procedures to create an indication. Through the identification of variables influencing safety performance and the creation of an index for safety performance assessment.

(Albert et al., 2014), stated that a lack of integration is leading to accidents during the construction phases. They added that when there is no assessment for hazard identification entirely with project planning, workers can suffer catastrophic damage because they will be more exposed to unexpected hazards.

Many researchers have studied safety management performance and explored the factors that may affect health and safety in construction project worksites. According to (Hare et al., 2006), effective safety planning plays a vital role in the success of any construction project. (Salman, 2017), argued about carrying out health and safety planning separately from project planning.

According to (Jaselski et al., 1996), safety legislation is a framework to regulate and control safety and health. Thus, management duly is to follow the regulations and rules. Thus, policies and safety legislation have a high impact on construction worksite safety levels. According to (Abas et al., 2020), safety management is a method of managing regulations, procedures, and safety practices on a construction worksite. According to (Nawaz et al., 2020) performing safety relies extremely on human perception of knowledge and safety experience, as well as on the cognitive abilities to identify hazardous situations.

(Akinlolu et al., 2020), examined BMI-based visualization systems and their effectiveness for safety management and health in construction project sites and compared them to other methods. They found that using BMI combined with a visualization system significantly lowered the number of injuries, accidents, and property damage. They revealed that the integration allowed safety managers to inspect the construction projects, collect data on safety violations and analyze them and discover minor hazardous situations in real-time, then develop adequate safety plans.

(Waheed et al., 2020), studied the health and safety considerations in mega projects to achieve efficient health and safety management. They concluded that risk management, contracts, and technology factors are the most important that impacting mega projects.

(Yang et al., 2024), propose a method for enhancing construction site safety management by integrating BMI and GIS technology. They Simulated the temporal and spatial safety of machinery, materials, and personnel in construction worksites.

(Choi et al., 2023), studied the impact of the safety technology system on safety performance in public construction project management sites. They determined the influence of competency factors, methodological factors, and institutional factors as independent variable factors on safety performance by implementing a safety technician system for public construction projects. The results of their study showed that the safety technician system improves safety and efficiency at public construction sites. They revealed that this system is an effective system for reducing accident costs and preventing accidents through continuous maintenance and improvement of the safety technician system.

3. Objective of the Study

The following are the study objectives:

1-Calculating the (RII) relative importance index of preidentified safety management factors and the degree of importance of the safety management proposed process.

2-To calculate the average practice of each factor and each phase of the safety management proposed process.

3-To calculate the degree of practicing the safety management process.

4. Methodology

Fig. 1 shows the framework of the research

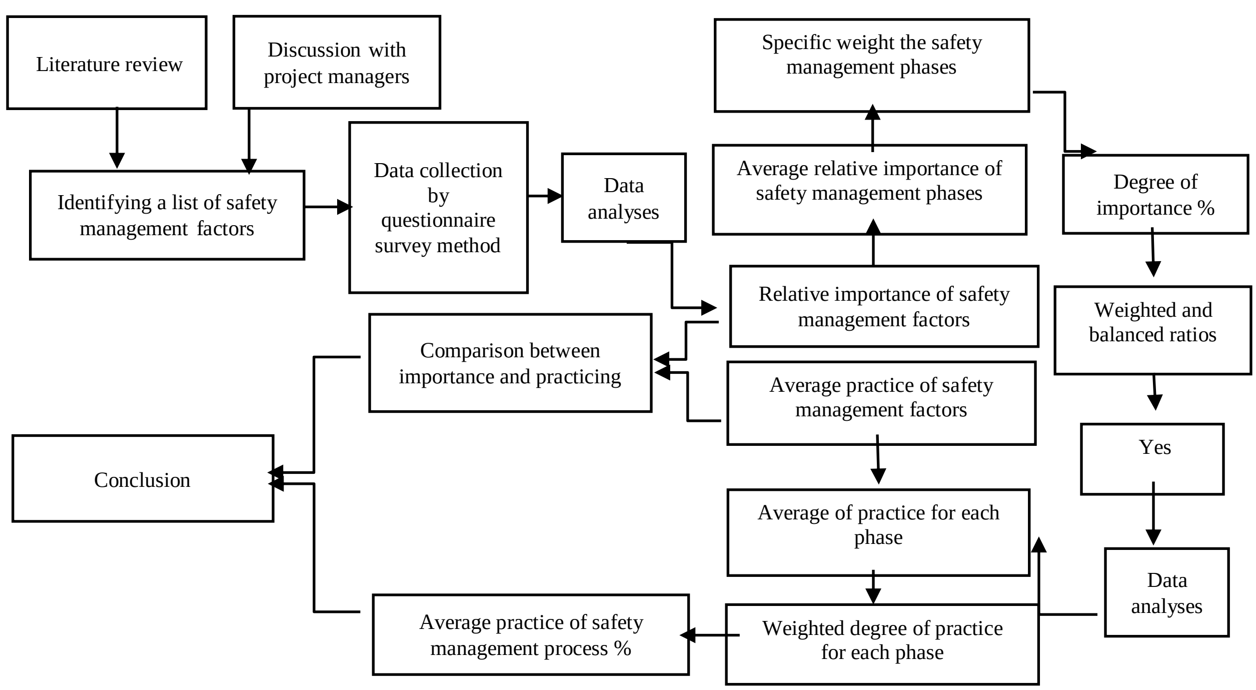

Figure 1: The framework of the research

4.1 Collection of Data

A theoretical background was provided by literature reviews about safety management that guided to preparation of a list of factors for safety management requirements that was presented safety management procedure has been designed by preparing a questionnaire. The questionnaire consists of 2 parts. Part 1 included general information regarding the respondents and Part 2 included 49 safety management factors divided into seven phases. Table (1) shows Safety management phases and factors.

Table 1: Phases and Factors of Safety Management

No.	Safety management factors	No.	Safety management factors
	Initial phase		**precautions before the scaffold implementation phase**
1	Availability of safety professional	1	Scaffold permission
2	The team trained for emergency response	2	Scaffold base to -height -ratio
3	First aid with medicines and accessories	3	Ensuring proper access to platforms
4	Availability of first aid center	4	Fixing of handrails, mid rails, and boards
5	Safety materials displayed on the site	5	Scaffold erected on level ground
6	Safety organisation	6	Scaffolds erected under supervision
7	Putting safety plans and safety procedures	7	Scaffold design
	Planningroject layout phase		**Ensuring tools and equipment safe phase**
1	Easy access to electrical control	1	Availability of instructions for tools and equipment
2	Adequate water supply	2	Good condition of welding cables
3	Having adequate storage for tools	3	Suitable storage for gas cylinders
4	Adequate disposal of waste materials	4	Ensuring power tools with Earth connection
5	Proper walkaway	5	Availability of safety instructions for tools and equipment
6	Access wide enough	6	Having adequate storage for tools
7	Visibility of entrance	7	Ensuring the condition of hand tools
	Personal Protection Equipment (PPE) phase		**precautions before the excavation phase**
1	Staircases with temporary railings	1	Excavation permission
2	Safety nets	2	Precautions while removing materials
3	Inspection of PPE	3	Controlling enter of water into pits
4	Wearing suitable hand gloves	4	Precautions against material falling
5	Wearing full body safety harness	5	Safe access in the excavation area
6	Workers using suitable PPE	6	Lifting accessories for manual handling
7	Safety shoes	7	Stacks protected from collapse
	Precautions before the implementation phase		
1	Availability of confined space		
2	Availability of fire extinguishers		
3	Electrical circuits free from overloading		
4	Fire precautions		
5	Adequate lightening		
6	Adequate ventilation		
7	Attachment of tags		

The questionnaire was designed to be distributed to stakeholders working on building construction projects. The target group of respondents will be managers, engineers, and contractors.

A case study was conducted for 94 building construction projects that have been implemented in the Erbil Governorate from 2013 to 2023. To verify the accuracy of the information given, 2 questionnaires were submitted to each project of the 94 projects to different persons who worked on the same project. the results presented have been checked and inquired about the discrepancy if any.

The profile of respondents is shown in Table (2).

Table 2:. Respondents profile

Years of experience	Project manager	Engineer	Contractor	Total
1 – 5	0	5	6	11
6 - 10	2	14	15	31
11 -15	15	15	20	50
16 -2	13	17	18	48
> 20	12	21	15	48
Total	42	72	74	188

During the first round, the respondents rated the importance of safety management suggested factors. The purpose of this round is to determine the average importance of the proposed factors and to determine whether the 7 phases have a balanced value.

4.2. Definitions

Relative importance index RII is the proportionate contribution each predictor makes to R2, considering both its direct effect (i.e., its correlation with the criterion) and its effect when combined with the other variables in the regression equation statistical technique used to determine the relative importance of predictor variables in a regression model. It involves comparing the predictive power of the full model with a series of reduced models, each missing one predictor variable.

Average practice is a kind of average found by dividing the sum of a set of numbers or percentages by the count of numbers in the set.

4.3 Data Processing

The RII (Relative Importance Index) has been used to compare the safety management factors as have been perceived by respondents to find out the most significant factors depending on the hierarchal assessment of factors for the seven phases. The respondents were asked to give ratings from 1 (not important) to 5 (extremely important), by using a five-dimension Likert scale as follows:

Extremely Important given a weight of 5
High Important given a weight of 4
Average Important given a weight of 3
Less important given a weight of 2
Not important given a weight of 1

The same method was adopted in the study of (Patel et al., 2018).

The data was analyzed using the Microsoft Excel program.

By calculating the weighted average for each factor. The following equation was used to calculate the relative importance of each factor of safety management (Mohammed, 2016).

RII = Weighted average * 100

$$RII = \frac{\sum W}{AN} * 100 \qquad (1)$$

Where:

RII = relative importance index of each factor

W= the weight of factors ranges (1-5)

A = the maximum weight, in this study = 5

N= the respondent's number, in this study, N = 188

The RII rankings made it possible to cross-compare the relative importance of the factors as perceived by the respondents. Each perceived by all respondents should be used to assess the general and overall rankings to give an overall picture of the factors affecting Safety Management.

Whenever the value of RII is higher, the factor is more important and has a greater impact on safety management.

The following is the method of calculating the degree of importance for each phase:

The number of phases =7

The total degree of importance of the 7 phases of the safety management process should be 100

The maximum weight of importance for each phase in case all respondents have been given the maximum weight for all factors would be 100/ number of phases

= 100/7 =14.285

The weighted degree of importance for each phase is calculated as follows:

The sum of the average weights for the 7 factors of each phase *14.285 /(7*5)

Where:

7 is the number of factors in each phase

5 is the highest weight given by the respondents

For example, the degree of importance for the initial planning phase = 31.799*14.285/35=12.98

By calculating the degree of importance of the 7 phases, the percentage of importance of the safety management process has been calculated.

Also, the average relative importance of the safety management process is calculated by using the following equation (Mohammed, 2023):

$$X = \sum fi / n \quad (2)$$

X is the average relative importance, fi is the weighted responses for the 49 factors, and the response number is n.

The average relative importance = 16155.02 / 188= 85.931

To determine whether the 7 factors are balanced in importance, the specific weight for each phase has been calculated as follows:

Specific weight for the phase = degree of importance of the phase/degree of importance of the safety management process

For example, the specific weight of the initial planning phase = (12.98 / 85.93) *100 = 15.10

The specific weight for the 7 phases =100

During the second round, and after approving the respondents of the proposed safety management process, they were asked to evaluate the percentage of practicing the requirements of safety management for each factor of the questionnaire according to their experience depending on the project they worked for. ISO standards define that a fully practiced factor is given a weight of 100%. Each partially practiced factor is given a weight of 50% because it is difficult to estimate the real percentage of practicing between 0 and 100. Never practiced is given 0 weight.

Depending on the sum of weights for each factor, the average practice has been calculated for the safety management factors of the proposed process.

Average practice for any factor = sum of weights for each factor/ number of respondents.

The average practice of each phase has been calculated as follows:

Average practice for any phase = sum of weights for the factors of each phase/ (number of respondents*number of factors in each phase, which is 7)

For example, the average degree of practicing for the initial planning phase = 49401 /188*7= 37.54

The weighted degree of practicing each phase = average degree of practice each phase divided by the number of phases in the safety management proposed process.

For example,

The weighted degree of practicing the initial planning phase = 37.54/7=5.36

By calculating the weighted degrees of practicing of the 7 phases, the weighted degree of practicing the safety management process in building construction projects has been calculated.

5. Results and Discussion

The outcomes in Table 2 demonstrate the level of importance and the specific weight of the proposed stages in addition to the practice of safety management in case study projects as shown in Table (3).

Table 3: Specific weight, degree of importance, and average degree of practicing safety management for suggested phases

Phase		**Specific weight (%)**	**Degree of importance (%)**	**The average degree of practicing %**	**Weighted degree of practicing (%)**
1	Initial planning	15.10	12.98	37.54	5.36
2	Planning project layout	13.80	11.86	72.8	10.40
3	Personal protection Equipment (PPE)	15.13	13.00	47.41	6.77
4	Precautions before implementation	14.46	12.42	60.44	8.62
5	Precautions before excavation	14.00	12.03	66.48	9.50
6	Precautions before scaffold implementation	14.65	12.60	79.93	11.41
7	Ensuring tools and equipment state	12.86	11.04	64.36	9.20
		100	85.93		61.27

The average relative importance for safety management proposed factors would be:

X=85.93% This is the weighted average of the questionnaire phases.

That very good ratio means that the proposed items of the questionnaire were approved by the respondents.

The weights of the seven stages range between 12.86% and 15.13%. This means the values of assessing the safety management of case study projects are balanced.

The most important phase of safety management is personal protection equipment followed by initial planning.

The average practice of safety management requirements has been 61.27. %. In comparison to the standards (0 - 100), it is considered a low percentage.

The range of average practice of safety management phases is between 37.54% for initial planning and 79.93% for scaffold implementation precautions. There is a significant shortage in initiating the planning for safety management although it was rated as the second most important stage by the respondents. On the other hand, more attention has been taken to scaffold implementation precautions.

There is a significant shortage of personal protection equipment (PPE) with a rate of 47.41% although it was rated as the first important phase. On the other hand, taking precautions before project implementation, ensuring tools and equipment state, and precautions before excavation have been 60.44%, 64.36%, and 66.48% respectively. Planning project layout was practiced with a rate of 72.80%. Good attention has been paid to this stage in comparison with the previous stages.

Table (4) shows the Average practice, the relative index, and the ranking for safety management factors.

Table 4: Average practice, relative index, and ranking

No.	Safety management factors	Average practice %	RII	Rank
1	Availability of safety professional	30.31	89.14	16
2	The team trained for emergency response	10.60	88.93	17
3	First aid with medicines and accessories	53.19	90.85	12
4	Availability of first aid center	23.93	90.85	12
5	Safety materials displayed on the site	44.14	90.85	12
6	Safety organization	52.12	89.78	14
7	Putting safety plans and safety procedures	48.40	94.89	4
8	Easy access to electrical control	81.38	85.10	25
9	Adequate water supply	84.57	84.46	26
10	Having adequate storage for tools	80.31	82.76	33
11	Adequate disposal of waste materials	67.55	82.76	33
12	Proper walkaway	67.02	79.78	37
13	Access wide enough	64.36	81.91	34
14	Visibility of entrance	64.36	84.25	27
15	Staircases with temporary railings	47.87	85.53	24
16	Safety nets	47.34	85.95	23
17	Inspection of PPE	32.97	90.42	13
18	Wearing suitable hand gloves	37.23	97.02	2
19	Wearing full body safety harness	40.42	88.51	18
20	Workers using suitable PPE	61.70	93.40	8
21	Safety shoes	64.36	87.87	19
22	Availability of confined space	60.10	87.66	20
23	Availability of fire extinguishers	64.36	86.17	22
24	Electrical circuits free from overloading	57.97	93.19	9
25	Fire precautions	50	96.59	3
26	Adequate lightening	78.72	83.19	30
27	Adequate ventilation	60.63	82.97	32
28	Attachment of tags	50.53	78.72	38
29	Excavation permission	85.10	82.97	32
30	Precautions while removing materials	72.87	81.27	35
31	Controlling enter of water into pits	64.89	83.40	29
32	Precautions against material falling	63.29	90.85	12
33	Safe access in the excavation area	65.42	85.95	23
34	Lifting accessories for manual handling	57.44	78.08	39
35	Stacks protected from collapse	56.38	87.02	21
36	Scaffold permission	76.06	91.06	11
37	Scaffold base-to-height ratio	80.31	88.93	17
38	Ensuring proper access to platforms	66.48	85.53	24
39	Fixing of handrails, mid rails, and boards	71.27	97.44	1
40	Scaffold erected on level ground	77.65	84.04	28
41	Scaffolds erected under supervision	67.02	89.14	16
42	Scaffold design	61.17	80.85	36
43	Availability of instructions for tools and equipment	51.59	87.02	21
44	Good condition of welding cables	66.48	82.76	33
45	Suitable storage for gas cylinders	47.34	91.27	10
46	Ensuring power tools with Earth connection	81.91	94.04	6
47	Availability of safety instructions for tools and equipment	57.98	93.83	7
48	Having adequate storage for tools	69.14	89.36	15
49	Ensuring the condition of hand tools	61.17	94.25	5

Table (4) shows the most important factors for safety management are the Fixing of handrails, mid-rails, and boards (RII= 97.44) rank1, wearing suitable hand gloves (RII=97.02) rank2, the fire precautions (RII= 96.59) rank3, putting safety plans and safety procedures (RII=94.89) rank4, ensuring the condition of hand tools (RII=94.25) rank5, ensuring power tools with earth connection (RII=
94.04) rank6, availability of safety instructions for tools and equipment (RII=94.04) rank7, workers using suitable PPE (RII= 93.40) rank8, electrical circuits free from overloading (RII= 93.19) rank9, suitable storage for gas cylinders (RII= 91.27) rank10, scaffold permission (RII=91.06) rank11, and (first aid with medicines and accessories, availability of first aid center, and safety materials displayed on the site) (RII=90.85) rank12.

5.1 Initial Planning Phase Factors

Fig. 2 shows the average practice and the average importance for the initial planning phase of case study projects.

Figure 2: The percentage of average practice and average importance of the initial planning phase of safety management

The most important factor for initiating safety management is putting safety plans and safety precautions (RII=94.89), followed by the availability of a first aid center, the existence of first aid with medicines and accessories, and displaying safety materials on the site (RII=90.85). These factors were practiced in case study projects with a rate of 48.40%, 23.93%, 53.19%, and 44.14% respectively. The practice of the initial planning stage for safety management case study projects ranges between 10.60% for training a team in emergency response. and 53.19 %. For having a first aid with medicines and accessories. There is a lack of availability of safety professionals. On the other hand, there is a lack of first aid center and there are not enough medications in case of accidents. The results show that 71% of the projects practiced the initiating phase of the safety management process with a percentage below 50%. 29% were practiced below 60%. The average practice of this phase was 37.54% as mentioned in table (2). The availability of safety personnel was practiced with a rate of 30.31%, which means the work site is lacking people with safety management knowledge. There is a lack in putting safety plans and procedures. On the other hand, safety materials are not displayed on the work site.

According to the results, the practice of initiating safety management requirements suffers from a big shortage in most building construction projects.

5.2 Planning project layout of safety management

Fig. 3 shows the average importance and the average practice of planning project layout of safety management for the case study projects.

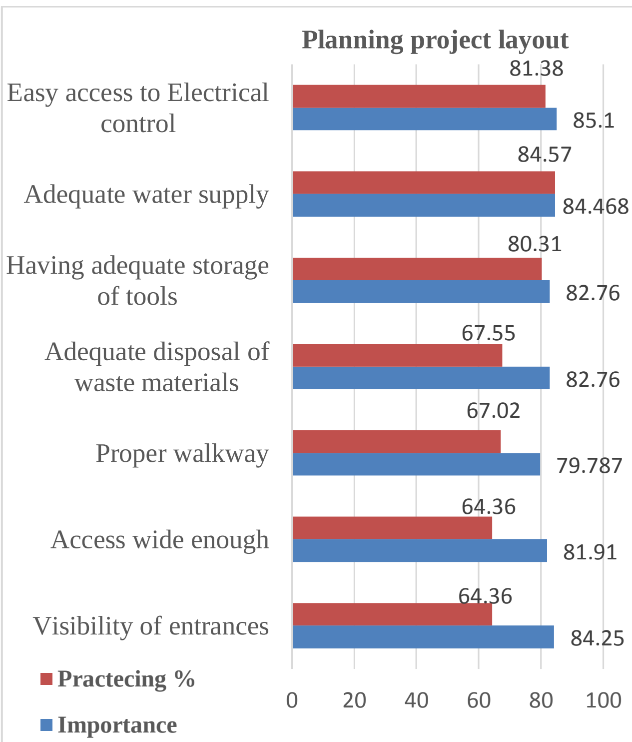

Figure 3: The percentage of average practice and average importance of planning project layout phase of safety management

According to the results, the most important factor for planning project layout is easy access to the electrical control (RII=85.1), followed by adequate water supply (RII=84.57) and the visibility of the entrances (RII=84.25). The average practice of these factors in case study projects is 81.38%, 84.57%, and 64.36% respectively. The results show that the entrance is not visible enough in most of the projects. The practice of this phase ranges between 64.36% for both the visibility of the entrance and the wideness of the entrance. And 84.57% for the adequate water supply. 43% of the projects practiced planning project layout requirements for safety management with a rate over 80% and 57% of them practiced above 60% of the requirements. The average practice of the overall phase is practiced with a rate of 72.80%. According to the results, there is a lack of proper walkways and the access to the project is not wide enough. This may lead to accidents at the entrance.

5.3 Personal Protection Equipment (PPE)

Fig. 4 shows the average importance and the average practice of personal protection equipment (PPE) for safety management for the case study projects.

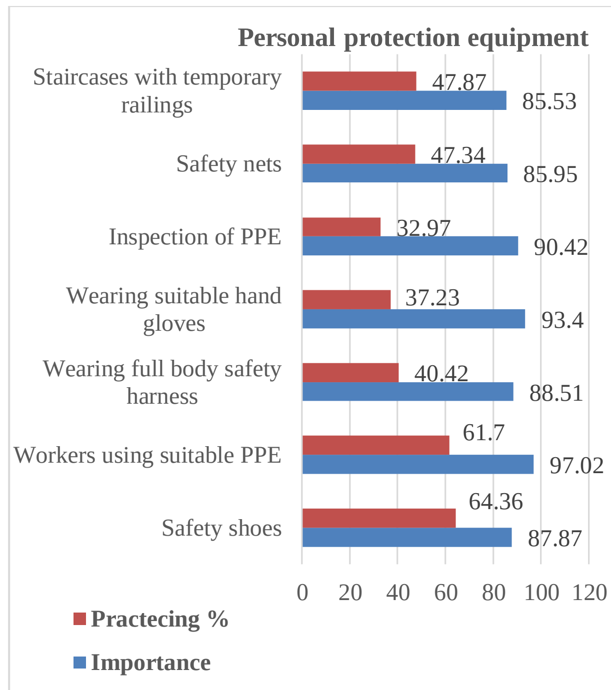

Figure 4: The percentage of average practice and average importance of personal protection equipment phase of safety management

The most important factor for personal protection equipment relates to using suitable PPE (RII=97.02), followed by wearing suitable hand gloves (RII=93.40), and the inspection of PPE (RII=90.42). The average practice of these factors in case study projects is 61.70%, 37.23%, and 32.97% respectively. The average practice of this phase ranges between 32.97% for the inspection of PPE and 64.36% for wearing safety

shoes. The results show that there is a big shortage in PPE inspection which may lead to using improper tools. On the other hand, workers rarely wear suitable hand gloves, safety nets, full-body harnesses, or staircases with temporary railings. Especially
While working in high places not using these tools is exposing workers to a huge hazard.

The results show that most of the projects practiced the personal protection equipment phase of the safety management process with a percentage below 50%. Wearing suitable safety shoes was practiced with a percentage over 60% which means that workers at the best are wearing safety shoes. The average practice of this phase was 37.54% which is very low in comparison with its importance.

5.4 precautions before implementation for safety management

Fig. 5 shows the average importance and the average practice of precautions before implementation for safety management for the case study projects.

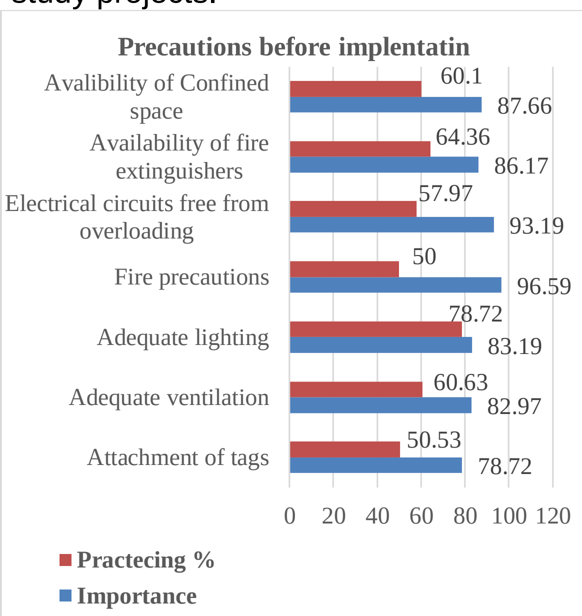

Figure 5: The percentage of average practice and average importance of precautions before the implementation phase of safety management

According to the results, the most important factor of precautions before the implementation is fire precautions (RII=96.59), followed by the electric circuits to be free from overloading (RII=93.19) and the availability of confined place (RII=87.66). The average practice of these factors in case study projects is 50%, 57.97%, and 60.1% respectively.

The average practice of this phase ranges between 50% for fire precautions and 78.72% for adequate lighting. 50% of the projects have neglected the suitable precautions for fire. Fire extinguishers are available at a rate of 64.365 only. The neglect of fire precautions poses a great danger to lives and causes material loss. There is a rare attachment of tags and mostly the electric circuit is overloaded. The confined space is practiced with a rate of only 60.10%. On the other hand, there is a lack of suitable ventilation. Most of the projects practiced the requirements for safety management with a rate of between 50% and 65%. But still, this percentage is far from the requirements of safety management. The average practice of the overall phase is practiced with a rate of 60.44%.

5.5 Precautions before excavation for safety management

Fig. 6 shows the average importance and the average practice of precautions before excavation for safety management for the case study projects.

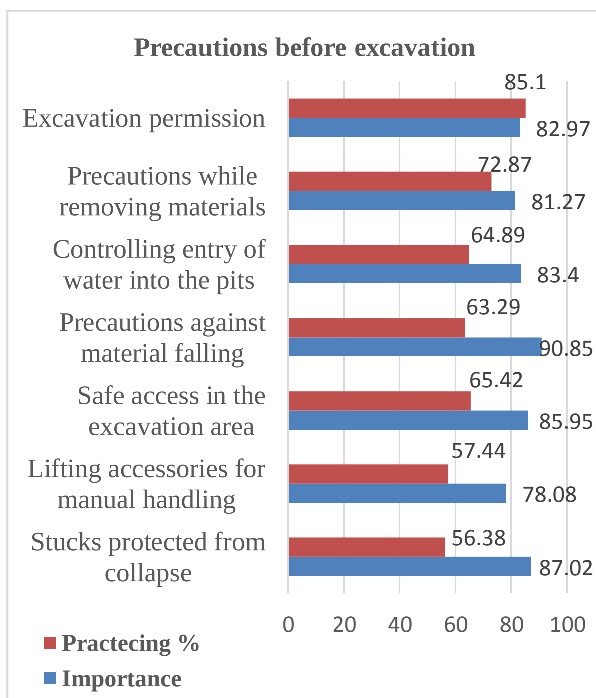

Figure 6: The percentage of average practice and average importance of the excavation precautions phase of safety management

The most important factor for precautions before excavation is precautions against material falling (RII=90.85), followed by stuck protection from collapse (RII=87.02), and safe access in the excavation area (RII-85.95). The average practice of these factors is 63.29%, 56..38%, and 65.42% respectively. Although the precautions from falling materials are rated as the most important factor for this phase, it is not practiced properly. The results show that the stacks are not always protected well from collapse and there is a shortage of lifting accessories for manual handling. On the other hand, the controlling entry of water into the pits is not always proper, and the access to the excavation area is not always safe enough. The average practice of case study projects for this phase ranges between 56.38% for stuck protection from collapse and 85.10% for excavation permission. The average practice of this phase was 66.48%.

5.6 Precautions before scaffold implementation for safety management

Fig. 7 shows the average importance and the average practice of precautions before scaffold implementation for safety management for the case study projects.

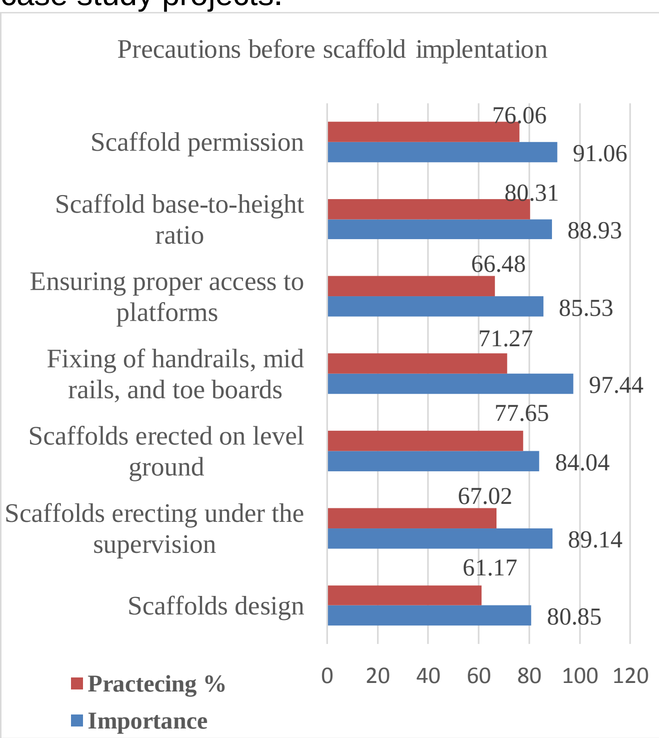

Figure 7: The percentage of average practice and average importance of precautions before the scaffold implementation phase of safety management

According to the results, the most important factor for the practice of precautions before scaffold Fixing of handrails, mid rails, and toe boards (RII=97.44), followed by obtaining scaffold permission (RII=91.06) and erecting the scaffold under supervision (RII=89.14). The average practice of these factors is 77.65%, 76.06%, and 76.02%. The shortage of erecting the scaffold on a level ground may cause catastrophic hazards to workers during construction. The results show that predesign for the scaffold is not always available and they are not always erected under supervision. Also, there is a shortage in fixing handrails, mid rails, and toe boards. On the other hand, the permission to erect a scaffold is not always earned. The average practice of case study projects ranges between 61.17% for scaffold design and 80.31% for installing scaffold base-to-height ratio. All projects have practiced the factors of this phase with a rate above 60%. The average practice of this phase was 79.93%. The results show that This phase has the highest percentage of practice compared with the other phases.

5.7 Ensuring tools and equipment state for safety management.

Fig. 8 shows the average importance and the average practice of ensuring tools and equipment state for safety management for the case study projects.

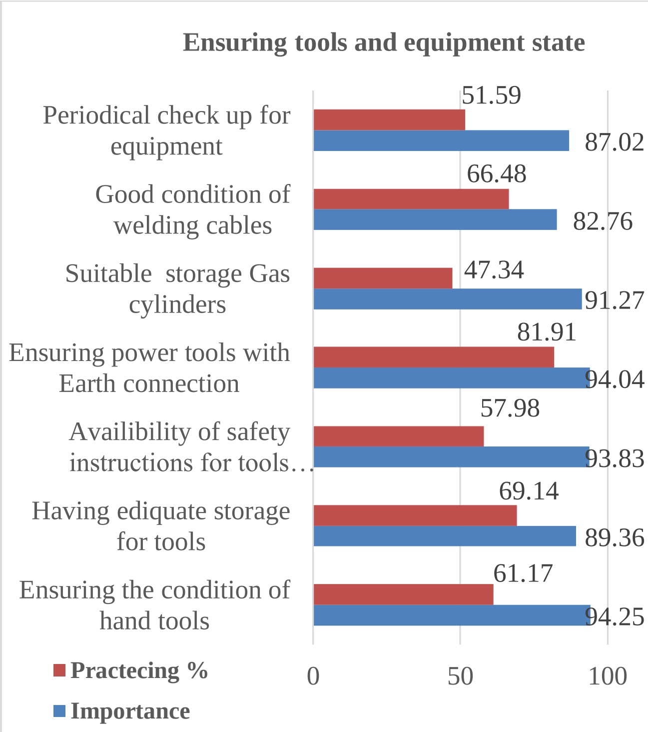

Figure 8: The percentage of average practice and average importance of ensuring tools and equipment state phase of safety management

The most important factors for ensuring tools and equipment state are ensuring the condition of hand tools (RII=94.25), followed by ensuring that power tools are connected to earth (RII=94.04), the availability of safety instructions for tools and equipment (RII=93.83), and adequate storage of gas cylinders (RII=91.27). The average practice of these factors is 61.17%, 81.91%, 57.98%, and 47.34% respectively. Although ensuring the condition of hand tools is rated as the most important factor for this phase, it is not practiced properly. The improper storage of the gas cylinders exposes the workers to a huge hazard. The results show a big shortage in vehicle inspection and the availability of safety instructions for tools and equipment. These factors are practiced with a rate below 50%. Also, there is a shortage in ensuring the conditions of hand tools. This factor was practiced with a rate of 51.59% which is very low. The average practice of case study projects for this phase ranges between (47.34% for the suitable storage of the gas cylinders and 81.91% for ensuring power tools with earth connection. More than 53% of the projects haven't practiced this requirement properly. The average practice of this phase was 64.36%.

Table (5) shows a comparison between this study and a study conducted in 2018.

Out of the 13 most important factors for safety management in both studies, there are 5 common factors which are: wearing suitable hand gloves, workers using suitable PPE, ensuring the power tools with earth connection, ensuring the condition of hand tools, and safety materials displayed on the site

Table 5: Comparison between a previous study and this study

Factors for Patel, D., and Pitroda, J. (2018).	**Rank**	**Factors for this study (2024)**	**Rank**
Safety shoes	1	Fixing of handrails, mid rails, and boards	1
Condition of hand tools	2	Wearing suitable hand gloves	2
Safety materials displayed on the site	3	Fire precautions	3
Wearing suitable hand gloves	4	Putting safety plans and safety procedures	4
Safety nets	5	Ensuring the condition of hand tools	5
Valid licenses	6	Ensuring power tools with Earth connection	6
	7	Availability of safety instructions for tools and equipment	7
Wearing full body safety harness	8	Workers using suitable PPE	8
Availability of tools	9	Electrical circuits free from overloading	9
Power tools with Earth connection	10	Suitable storage for gas cylinders	10
Workers using suitable Personal Protection Equipment	11	Scaffold permission	11
Handles of the tools free from splits/cracks	12	First aid with medicines and accessories, Availability of first aid center, and Safety materials displayed on the	12

		site	
Clear wood shavings, dust, and chips	13	Inspection of PPE	13

Out of the 13 most important factors for safety management in both studies, there are 5 common factors which are: wearing suitable hand gloves, workers using suitable PPE, ensuring the power tools with earth connection, ensuring the condition of hand tools, and safety materials displayed on the site.

Conclusions

The results show that there is a big deficiency in implementing safety management in all building construction projects. In modern society this is unacceptable. In addition, it makes the industry inefficient, with days lost due to injuries.

The case study results show that the average practice of safety management procedure was 61.27%. The range of average practice for safety management phases is between 37.54% for initial planning and 79.93% for precautions before scaffold implementation. The results show that the most important phase according to respondents affecting safety management is, personal protection equipment followed by the initial planning phase and precautions before the scaffold implementation phase.

The most important factor for the initial planning phase is putting safety plans and safety precautions with (RII=94.89) but its average practice is only 48.40%. The results show a low level of supervision for safety and accountability. There should be regular reviews and updates for the safety plans, to show the changing of the site conditions, not only relying on their validity at the start.

Despite classifying using personal protection equipment (PPE) as the most important phase for safety management there was a big shortage in practicing it with an average rate of 47.41%. There is a big shortage in PPE inspection with an average practice of 32.97%. This may lead to the use of improper tools. Workers rarely wear suitable hand gloves with an average practice of 37.23%. Safety nets were used with an average practice of 47.34%. Full-body harnesses are used with an average of 40.42%. Staircases with temporary railings are used with an average of 47.87%. The results show that most of the projects practiced the personal protection equipment phase of the safety management process with a percentage below 50%. Emphasis must be placed on the use of personal protection equipment to protect workers from any expected hazard during construction. The second important phase according to respondents was initial planning for safety management. The average practice of this phase was the least among the seven phases with a rate of 37.54%. There is a huge shortage in practicing the initial planning phase. Safety professionals are operating with an average of 30.31%. Securing of first aid centers with an average of 23.93%. The provision of medications in case of accidents with an average of 53.19%. Teams are trained in emergency response with an average of 10.60%, which is extremely low. On many construction project sites, it is noticeable that management doesn't have enough interest in the organization of training sessions for staff on safety policies and procedures. A strong awareness is needed, such as including displaying safety banners and posters, and giving instructions to employees about the importance of safety. Also, holding meetings to discuss safety measures and how employees can use safety tools and clothing. There should be a focus on the initial planning phase because it is the backbone for the implementation of safety management so special care should be taken for this phase.

The average practice of fire precautions is 50%. Lots of accidents and many fires occur at work sites due to the lack of fire precautions, which leads to serious consequences. The scaffolds are erected on level ground with a rate of practicing 77.65%. Which may expose workers to falls due to the collapse of scaffolds. Also, scaffolds are not always erected under supervision. The average practice of this factor is 67.02%. This shortage may cause catastrophic hazards to workers during construction. On the other hand, the average practice of obtaining permission to erect a scaffold is only 76.06%. Which means it is not always earned.

On the other hand, the most important factors affecting safety according to respondents are, fixing handrails, mid rails, and toe boards (RII=97.44), using suitable PPE (RII=97.02), taking precautions against fire (RII=96.59), putting safety plans and procedures (RII=94.89), ensuring the condition of hand tools (RII=94.25), ensuring that power tools are connected to the earth (RII=94.04), the availability of safety instructions for tools and equipment (RII=93.83), suitable hand gloves (RII=93.40), electrical circuits free from overloading (RII=93.19). These factors are practiced with a rate of 71.27%, 61.70%, 50%, 48.40%, 61.17%, 81.91%, 51.59%, 37.23.and 57.97% respectively. Despite the importance of these factors, most of them are practiced at a low rate except ensuring that power tools are connected to the earth.

Effective safety management is one of the real problems associated with implementing large projects in the construction industry. Because the worksites are one of the most high-risk places. There are high cases of safety problems that have been reported at construction sites. By monitoring safety management factors closely and addressing them safety problems will be minimized.

There must be an emphasis on safety management issues in construction projects. Safety plans in work should be available for every project in addition to a trained safety inspection committee must be available to follow up and ensure the implementation of safety procedures.

The Staff and stakeholders will make the required decisions and reduce the impact associated with events if they can identify the hazards proactively.

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