

Causes of accidents and evaluation of safety system in Northern Iraq construction projects

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ABSTRACT

Construction work involves some of the most complex operational actions, where many activities require to be carried out at the same time and place. The nature of this type of work, subsequently, makes it an extremely hazardous environment for workers. By constructing sophisticated and intelligent safety systems to make construction work and sites safer, and bypasses any unforeseen costs caused by accidents that can occur during the construction work. To construct such systems, it is required to know the causes behind accidents. So that, to improve the overall safety performance, there is a need to investigate the causes of construction accidents and to evaluate the current safety systems used to give a picture of the weak points in systems currently adopted. The awareness of these things can be used in formulating safer working environments for construction work. This paper identifies the causes of the accident and evaluates the present safety systems in different construction projects in Northern Iraq. The study has been conducted by reviewing literature from articles and books, plus applied quantitative approaches to collect data by applying a questionnaire survey prepared for this study to collect data from the sites' users. The results of the current study show that the overall evaluation of the safety system is in poor condition, also found that there are many causes behind accidents. The most severe cause is considering safety as a second priority, and the study classified the causes into, unsafe actions and unsafe conditions.

1. INTRODUCTION

Construction work such as highways, bridges, buildings, etc. involves a tremendous number of accidents from injuries to fatalities. Where, the construction work is unsafe and considered as one of the most hazardous work sectors (Edwards & Nicholas, 2002), as it involves highly complex working environments (Behzadan et al., 2008). These accidents cost much on the level of human wealth, financial wealth, quality of work, and also productivity. Where the success of the construction work is not just involved in obtaining successful work, but also to create a safe environment with no fatalities and injuries among the people in the construction site. Where the factor of safety is essential for project success as the application of issues of safety in construction works will enhance the execution of the project (Cheung et al., 2004).

Despite the considerable refinement since the act of Occupational Safety of 1970, staff still experience high accident rates compared to other works (BLS, 2013). Where, many workers are being killed on construction sites due to accidents (Abderrahim et al., 2005). There are

over 60,000 deaths registered each year in the construction sector in the world (Lingard, 2013). Therefore, the influence of accidents on construction projects has become a severe issue worldwide (Navon & Kolton, 2006), and construction has become a major hazardous industry in many countries (Zhou et al., 2015).

Generally, the construction sector is far from achieving the zero accidents goal. Although the goal of zero-accident is far from achieving, developing effective safety systems can be critical as they can reduce the number of accidents and improve safety (Rowlinson, 2004). The process of establishing effective safety systems requirements to know the causes of accidents to know the reasons behind them. Besides, it is essential to estimate the performance of currently used safety systems to know the weak points in it so that it can be improved.

An accident is an undesirable unfortunate event that occurs suddenly and involuntarily, usually resulting in an injury or harm (Peyton & Rubio, 1991). It can be in terms of deterioration of machinery and especially those that lead to injury receive the utmost attention (Hinze, 1997).

The main reason behind accidents is the fact that time, cost, and quality are always considered to have priority over safety. Most companies have not established serious accident management plans but focus much more on increasing profits. They do not prioritize safety because they do not realize the consequences of accidents until they happen.

Accidents do not just occur. They are caused. They are results of unsafe actions, unsafe conditions, or both of them. Where, it was found that 99% of the accidents are occurred by either unsafe actions or unsafe conditions or both of them (Ridley, 1986).

The unsafe action is an infringement of acceptable safe steps that would allow accidents to happen. While the unsafe condition is a dangerous physical condition or situation that may cause an accident to occur. Most accidents arise from a combination of contributory factors and one or more unsafe actions and unsafe conditions.

A study in Kuwait was carried out and illustrated that reasons behind accidents are because of unsafe behaviours; unusable materials; and poor tool maintenance (Kartam et al., 2000). Another study found that 80% of all accidents on a construction site occur because of dangerous human behaviour (Li & Poon, 2013).

A study was carried out in the US, where reasons for accidents were attributed into two factors, human and physical. Human factors are results from failure to caution; failure to have personal protective equipment; rule in running machinery absence; etc. Whilst physical factors are because of the unsafe actions; ignoring specified steps; suit riskiness; and fire riskiness (Abdelhamid et al., 2000).

Another study in the US proposed that the reasons for accidents are poor training; imperfect safety execution; safety needs absence; risky procedures; and risky worksite conditions (O'Toole, 2002).

A study in Uganda was conducted and suggested that reasons for accidents are results of the insufficient realization of safety rules; improper consideration for safety issues by the workers; and physical and emotional stress (Lubega et al., 2000). Also, a study in Thailand was carried out and classified the reasons into an unsafe condition like work nature; worksite conditions; dangerous machinery; risky procedures and unsafe action like failing to use personal protective equipment; inappropriate storing and placing of necessities; incorrect tool utilization (Pipitsupaphol & Watanabe, 2000).

A study in China was conducted and found that the reasons of accidents are because of improper safety realization by managers; imperfect training; inappropriate machinery; lack of first-aid requirements; shortage of applying safety laws; lack of workers knowledge; lack of personal protective equipment; absence of team-work morale; and undue overtime for workers (Tam et al., 2004).

A study in the UK was carried out and found that unsafe actions can be increased due to workers' attitude, exhaustion, or stress. As well as, it showed that 10% of

accidents are because of unsafe conditions and 90% of accidents are due to unsafe actions (Schaufelberger & Lin, 2013).

Also, it was proved that many risks are unique to the work (Innes, 2006).

Another study found that the main reasons for accidents are related to the nature of work, workers' manner, worksite conditions, and inappropriate safety management, which lead to unsafe work procedures (Mahmoud, 2009).

Many studies illustrate the effect that inadequate safety systems have on the lives of human wealth in construction work. In some nations, such as the US, the construction sector is responsible for 20 per cent of all occupational deaths, while the construction sector in Hong Kong is responsible for more than 35 per cent of industrial accidents in the last ten years. In Kuwait, during the past 10 years, the construction sector had 42 per cent of all industrial victims (Enshassi et al., 2009).

The injuries in the US in construction work raised 16% from 2011 to 2014 (BLS, 2015).

In Iraq, the yearly numbers of the registered injuries caused according to the legislation and for more than 40 years were around 200 cases only. While according to the new plan, the number became between 4000 and 7000 accidents annually for the past 5 years (Sabre, 2018).

In Northern Iraq, 38 workers were killed in construction work just in 2019, and that explains the effect of the poor safety system used (Alsumaria, 2019).

Northern Iraq is a developing region and undergoing a considerable number of construction projects from highways, buildings, etc.. This paper aims to investigate the causes behind accidents in Northern Iraq to give an idea of the causes and to evaluate the safety systems used in the region to know whether they are good enough or not.

The study was carried out through a couple of stages, namely the review of the literature, collection of data, and analysis of data. The first objective was accomplished through a review of the literature.

The information and data needed gathering using a survey questionnaire. The study involved many construction projects in Northern Iraq (Duhok governorate case study). A quantitative technique was utilized for this goal, and the data was collected using a questionnaire survey. The questionnaire was distributed to stakeholders (managers, site-engineers, contractors, workers, and others) who participated in the conducting stages for these works. The projects were selected randomly in the construction sectors.

2.1. Questionnaire

The questionnaire contained closed questions, and the questionnaire was classified into three sub-sections. It was also distributed to people with different experience levels in construction work. The questionnaire was carefully worked out using appropriate statistical techniques, and the data was

analysed qualitatively using the Statistical Packaging for Social Science (SPSS) software, version 26. The survey questionnaire was written in English and Arabic languages to help the people participating so that they can understand the question and answer freely. The questionnaire was provided with a cover letter. It explained the concepts of the research, the approach for responding, the objectives of the study, and the protection of information to facilitate and encourage a high rate. A total of 135 copies of the questionnaire were distributed, and 130 copies of the questionnaire were received from the participants with a response rate of 96%.

The questionnaire in this research consists of three sections, as illustrated below:

a)- Basic and personal details of participants:

This part is correlated with details about the participant role in the project and some personal details. Participants were asked to answer with information about their roles and expertise in construction work. So, the segment was structured to gather participants' data.

b)- Accident cause details:

This section is associated with general information about reasons for accidents and what led to accidents.

c)- Safety system assessment:

This part was used to evaluate the safety conditions for the different construction sites. Thus, this part examined the views of the participants on the safety systems used in projects of northern Iraq.

This segment contains three segments:

- Segment 1, "Safety management" focuses on the management level to improve safety systems in construction projects. This section contains 9 items to measure the safety degree for each requirement and to gauge the safety practice levels in the construction projects.
- Segment 2, "Site safety", records the number of the site requirements, depending on several aspects, these requirements were provided in the construction site to ensure a safe site. This part consists of 9 items.
- Segment 3 "Workers safety", as the title states, the focus is on workers' safety requirements correlated to the worker's situation on the worksite. It was studied from several aspects, such as the cultural, behavioural, experience, and education level, and consists of 5 items.

Table 1. Scoring system

Evaluation	Value	Range
Very low	1	1.00 – 1.80
Low	2	1.81 – 2.60
Medium	3	2.61 – 3.40
High	4	3.41 – 4.20
Very high	5	4.21 – 5.00

To evaluate each section of the study, it was needed to create a scoring system using a five-point Likert scale

(Likert, 1932), and classified as: (very low, low, medium, high, and very high). Table 1, therefore, illustrates the scoring system for the Likert scale (1 to 5) to evaluate each item in the questionnaire.

3. RESULTS AND DISCUSSION

3.1. Basic and personal details of participants

Table 2 shows the basic data about the participants which contain information about, participants' gender, education, experience, and company type they work for.

Table 2. Participants data

Item	Answer percentage (%)	
Gender	Male	88
	Female	12
Company	Public	22
	Private	78
Position	Project Manager	16
	Contractor	11
	Consultant	2
	Site engineer	52
	Skilled Worker	7
	Worker	6
Experience	Designer	6
	< 5 years	14
	5 – 10 years	39
	10 – 15 years	20
	15 – 20 years	16
Level of Education	> 20 years	11
	Primary	13
	Diploma	8
	Bachelor	65
	Master	10
	Ph.D.	4

3.2. Accidents reasons and causes

The survey questionnaire contained 23 questions, and the participants were asked to evaluate how high each cause contributes to construction accidents. A cause was very high, 12 causes were high, and 10 were medium. Herein, only very high-contribution and high-contribution causes are considered for discussion, since they seem to be the significant contributors to construction accidents.

Inadequate scaffolding had a very high contribution. This cause is significant, as it leads to falling to the ground. Also, there are other serious causes like a poor application of safety requirements, inadequate training, poor maintenance of equipment, low educational level, etc.

So, in general, the causes can be considered, the most serious one is the neglect of safety issues and considering safety as a secondary thing, unsafe conditions and unsafe actions.

3.3. Safety system assessment

3.3.1. Segment 1, "Safety management"

The outcomes of the questionnaire analysis showed a noticeable inadequate application of safety requirements in different aspects. This misapplication of safety needs and requirements involves unsuitable funds specified for safety issues, flaws in the application of safety programs, inadequate training, and an insufficient number of safety meetings with site staff. Furthermore, many construction sites have no offices for safety management requirements. Table 3 summarizes the content of the questionnaire distributed for this segment.

Table 3. Questionnaire on safety management

No.	Question
1	Safety office's task on the construction site
2	Safety fund stated for a construction project
3	On-site safety requirements for the safety of construction workers
4	Laws of the safety system that is implemented in the construction project
5	Degree of priority the organization places on the construction site safety system
6	Strategies that the organization implementing on the construction site to enhance safety systems
7	Degree of significance the site engineer puts on the construction site safety system
8	Function of government check out in the construction project with respect to safety system
9	Daily meetings of the management for employees and workers to remind them of the need to support the safety system in the construction project

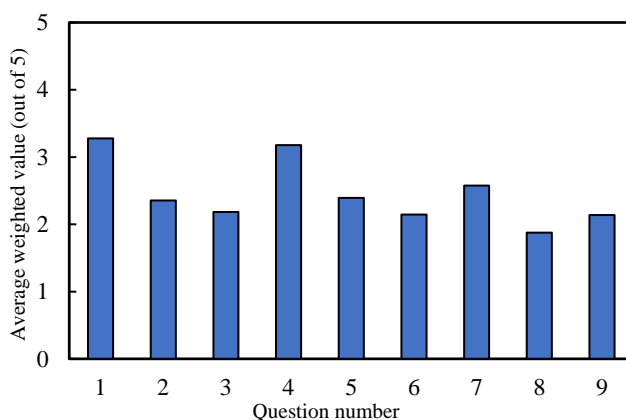


Fig. 1. Evaluation of safety management

The findings reflect the fact that project management is neglectful and unaware of safety importance. Management thinks that safety is a secondary thing and has no priority, which is the main problem. Also, it was clear that the

management of projects is not in earnest to supply safety needs and requirements.

Analysis of data represented in Fig. 1 illustrates that the rate of compliance with safety requirements according to the Likert scale scoring is 2.26, and that reflects the poorness of management safety. Where the percentage of items that are evaluated low is 67%, medium 22% and very low is 11%. Also, the standard deviation was 1.134.

3.3.2. Segment 2, "Site safety"

The outcome of the questionnaire analysis showed that there is an inadequate supply of the requirements needed for site safety. Where, this segment includes various issues on the construction site, as signs and signals, monitoring, fencing of the site, provision of public services, and firefighting system. So, it involves safety requirements on-site in general.

Generally, the result shows that the level of site safety is low, and that is maybe based on the fact of inadequate budget specified for safety as represented in Fig. 2 shows that there are insufficient levels in compliance with site safety requirements. Table 4 summarizes the content of the questionnaire distributed for this segment.

Table 4. Questionnaire on-site safety

No.	Question
1	Protection of site in the construction project's safety system
2	Number of checks and quantity of camera monitoring in the construction project site with regards to safety system
3	Preparations for emergencies at the construction site
4	Quantity of signs, signals and indicators in the construction project with regards to safety system
5	Provision of public services (such as smoking areas, restaurants, first aid, ambulances, etc.) in the construction project
6	Number and location of fire extinguishers inside the construction project
7	Number of personal protective equipment and helmets in the construction project
8	Level of on-site maintenance of the equipment and vehicles on the construction project
9	Quantity of illumination available on-site for night shifts

As an average, the rate of compliance with the safety requirements according to the Likert scale scoring is 2.46, and that reflects the lowest and poorest of safety compliance. Where the percentage of items that are evaluated low is 78% and the medium 22%. So, the results show that site safety needs are a little bit better than the state of management needs. Also, the total standard deviation was 1.189.

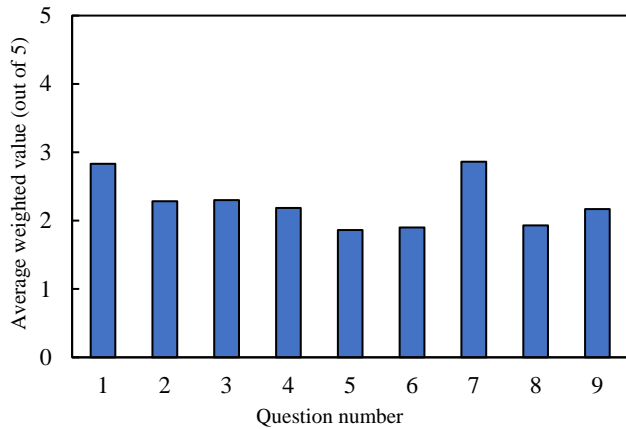


Fig. 2. Evaluation of site safety

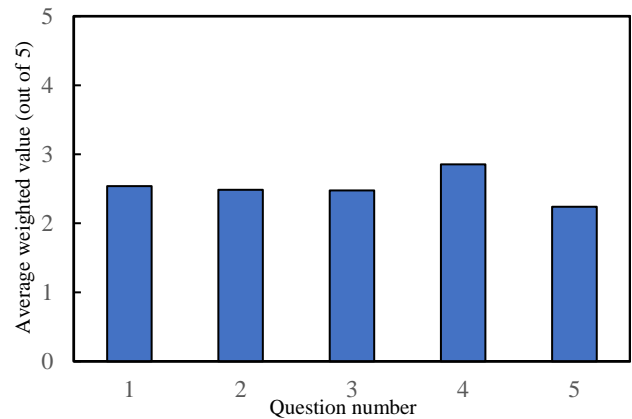


Fig. 3. Evaluation of workers safety

3.3.3. Segment 3, “Workers safety”

This segment introduces the outcomes of the survey questionnaire analysis of workers’ safety. Where, this segment includes various issues on the workers’ safety needs, as worker behaviour, culture, awareness, and realizing of workers.

The assessment of this segment, as illustrated in Fig. 3 showed a low state of it. The weaknesses in this section were due to a lack of attention or interest in workers’ safety. As an average, the rate of workers’ safety according to the Likert scale scoring is 2.46, and that reflects the lowest and poorest of workers’ safety needs. Where the percentage of items that are evaluated low is 78% and the medium 22%. So, the results show that site safety is a little bit better than the state of management. Also, the total standard deviation was 1.166. Table 5 summarizes the content of the questionnaire distributed for this segment.

Table 5. Questionnaire on workers safety

No.	Question
1	Quantity of the behaviour and culture of workers and staff in the construction project with the safety system
2	Age and experience of workers and personnel in the construction project with safety system
3	Recognition of the workers and personnel in the construction project with the health guidelines for the safety system
4	Decisions of the operators with trucks and machinery with respect to the safety system in the construction project
5	How well site workers follow the company’s safety guidelines and instructions

4. CONCLUSIONS

In this paper, an evaluation of the safety system in northern Iraq construction projects was made. The data was then discussed by analysing the questionnaire survey constructed for this aim. Generally, the results showed that the safety systems in Northern Iraq construction projects are in poor condition. In the section “safety management”, the average was low according to the scoring system, where the average was of 2.26, also “site safety” segment got a low evaluation, with an average mean of 2.46, and also “workers safety” got a low assessment with an average mean of 2.46.

Also, the study found that there are many causes of accidents but the most severe cause the lack of awareness to the significance of safety and considering it as a second priority also there are unsafe actions like the failure of workers to obey work procedures and unsafe conditions.

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