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A framework to activate the health and safety regulations in the Egyptian construction industry

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Abstract

Purpose – The construction industry is considered one of the most dangerous industries especially in developing countries such as Egypt. Although safety in Egypt is regulated by mainly four pivotal legislations, namely, Law No. 12 (2003) and Ministerial Decrees No. 211, 126 and 134, construction accident records in Egypt are high. Accordingly, this paper aims to develop a framework to activate the health and safety regulations in the Egyptian construction industry.

Design/methodology/approach – To achieve this aim, a research methodology consisting of a literature review and a survey questionnaire was developed to accomplish three objectives. First, a literature review was used to identify the causes of site accidents and strategies adopted in different countries to improve and enforce safety, safety roles of stakeholders. Second, a survey questionnaire was conducted with a representative sample of large- and medium-sized construction firms in Egypt to examine their perception of the causes of site accidents. Finally, a framework was developed to activate the health and safety regulations in the Egyptian construction industry.

Findings – The research identified 16 causes of construction site accidents. These causes were classified into three categories based on the party responsible for the occurrence of site accidents, namely, workers, organization management and government. Results of data analysis showed that "lack of housekeeping" and "lack of governmental inspection for safety" were ranked the highest causes of site accidents in the Egyptian construction industry, whereas "inefficiency of old safety equipment or no safety equipment at all" and "reluctance to input resources for safety" were ranked the least causes.

Originality/value – This research provides valuable information about the nature of the construction industry with a particular focus on site accidents, causes and impacts of construction site accidents. The study highlighted the safety roles of the Egyptian Governmental bodies in Egypt to improve and enforce safety. The research tackled a topic that received scant attention in construction literature especially in the Egypt context. The framework presented in this paper represents a synthesis that is important and adds value to the knowledge in a manner that has not previously occurred in the Egyptian construction industry.

Keywords Egypt, Framework, Causes of site accidents, Impact of site accidents

Paper type Research paper

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1. Introduction

The occupational safety topic has been a long-standing source of concern in the construction industry. Based on its hazardous nature, the construction industry is considered one of the most dangerous industries and working environments worldwide. It has been argued that the construction industry's efficiency and safety performance is very poor if compared to other industries (Fernández-Solís, 2008). This could be attributed to its unique nature:

- It creates one-of-a-kind products, which makes it difficult to standardize safety procedures on all construction tasks.
- It produces immobile products, which makes a problem in replacing safety fixtures, in addition, being forced to use local workers.
- It is considered temporary multi-organizations, which engages temporary teams to do certain jobs for a certain client, which makes it difficult to control the safety (Koskela, 2000).

There are mainly three pivotal legislations in Egypt that regulates the industrial safety (Ata and Nahmias, 2005):

- Law No. 12 (2003): This is called the "Egyptian Unified Labor Law." It consists of six books, and its objective is to clarify the rights and duties of the parties involved in the employment agreement. This law devotes a complete chapter (BOOK V) called "occupational health and safety and assurance of the adequacy of the working environment," which discuss the occupational health and safety issues and problems.
- Ministerial Decree No. 211 (2003): Regarding the safety precautions and necessary conditions for preventing the physical, mechanical, biological and chemical hazards and ensuring a safe working environment. This 195-page decree is considered to be one of the most important legislations in Egypt as it was written by experts and it contains several safety practices for different types of hazards.
- Ministerial Decree No. 126 (2003): Reporting work-related accidents and injuries. It specifies different types of accidents and it includes a unified manual application that should be filled for reporting certain incidents.
- Ministerial Decree No. 134 (2003): Organizing the occupational health and safety in establishments.

Although there are safety regulations in Egypt, the accident rates in the construction industry in Egypt are considerably high. The industry records that the number of construction site accidents in Egypt is 539, 645 and 634 accidents in 2015, 2016 and 2017, respectively, and the number of site accidents is subject to increase if no actions are taken (Daoud *et al.*, 2018), specially that there are hardly any studies in occupational safety in the construction industry in Egypt. Accordingly, this paper aims to develop a framework to reduce accident rates in the construction industry in Egypt and enforce safety practices. To achieve this aim, a research methodology based on a literature review and survey questionnaire was designed to accomplish three objectives:

- Identifying the causes of accidents in the construction industry.
- Exploring the strategies adopted in different countries to enforce safety and address the safety roles of different stakeholders.
- Examining the perception of construction firms toward the identified causes of site accidents.
- Presenting the framework.

2. Literature review

2.1 Previous studies on occupational safety in the construction industry in Egypt

The topic of occupational health and safety in the construction industry has received little attention in Egypt. This could be attributed to the fact that Egypt is considered a developing country. In developing countries, construction is more labor-intensive. Many workers migrate from rural areas to cities seeking employment. Most of those workers are unskilled and may have not practiced any trade before in construction (Choudhry *et al.*, 2008). In addition, enforcement of safety regulations by government institutes in developing countries remains weak and ineffective due to a lack of adequate recourses (Kheni *et al.*, 2008). For example, one of the most important governmental institutes in Egypt that provides adequate safety trainings and international safety certificates is the National Institute of Occupational Safety and Health (NIOSH) in Egypt. There are only four branches of this institute in the whole country, which is of course insufficient to serve all areas (National Institute of Occupational Safety and Health, 2018). Another example is The Technical Inspection Department for Buildings Works (TIDBW), which is a governmental institute mainly responsible in inspection for violations in building projects in Egypt. There are only 98 employees who run this institute from the top managerial level down to the workers and who are responsible for inspection in the whole country (albawabhnews, 2019). This leaves this institute almost paralyzed in performing its duty.

While there are limited resources available to enforcement institutes and prevention services in developing countries, the safety regulations themselves can be very general and loose (Kheni *et al.*, 2008). For example, both Hassanein and Hanna (2008) and Fouad (2010) studied occupational safety regulations in Egypt (Egyptian Labor Law 2003) and compared them to safety regulations in the USA. Their analysis revealed, substantial differences in generality, responsibilities, accountability and penalties. For example, safety rules in the US have a very detailed engineering knowledge of specific work activities and methods, where in Egypt it is inadequate and very general. Another example, the penalties and fines in the US ranges from $5,000 to $70,000 per violation, where in Egypt, it ranges from EGP50 to EGP10,000 (equivalent to $3.1 to $626.2).

In Egypt, there are hardly any research studies in the field of occupational safety in construction. For example, El-nagar *et al.* (2015) have developed a safety performance index to evaluate the expected safety construction projects in Egypt. Their result pointed out that the most important factors affecting safety performance was: organizational factors such as management practices on site, working environment and the psychological factors for workers such as their relationship with their crew members, for instance. Another study in Egypt (Abdul-rashid *et al.*, 2007) aiming to identify factors affecting safety performance in the construction sector revealed that safety awareness of the company's top management, safety awareness of project managers and safety inspections were the most important factors.

2.2 Causes of site accidents in the construction industry

There are numerous causes of accidents in the construction industry. Accidents may happen by unsafe conditions or acts or both either by worker or management (Hamid *et al.*, 2008). Several previous studies attempted to identify these causes and classify them to provide a better way to understand them and eliminate or reduce their occurrence. The following section will summarize the key findings of these studies:

- A survey study was conducted by Hamid *et al.* (2008) to identify the causes of site accidents in the construction industry in Malaysia. The study revealed that the top-ranked main causes of construction accidents are "workers' low knowledge and negligence," "failure of workers to obey procedures and use personal protective equipment (PPE)," "employing unskilled workers," which results in poor attitude and "poor site management." In addition, the study categorized these causes into six groups, namely:
- Unsafe equipment.
- Job site conditions.
- Unique nature of the construction industry.
- Unsafe methods.
- Human factors.
- Management factors.

Moreover, the study pointed out that most of the accidents are related to workers (unsafe methods and human factors), and they scored 36.6% as compared to management, which scored 15.8%. The study elaborates more than unsafe methods are incorrect producers and work styles practiced by workers, which could be attributed to insufficient instructions from top management and poor knowledge of workers. As for human factors, excessive working hours result in workers' tiredness and fatigue.

- Chim *et al.* (2018) have presented a study identifying eight causes of construction site accidents. The top-ranked three causes were "failure to enforce safety measures" (which could be contributed to company management or government), "lack of workmen training" (which could be associated to the belief that training is on-going time consuming and costly) and "negligence of contractors to adhere to safety requirements and follow safety measures." The other causes were "failure to comply with occupational safety and health administration (OSHA)," "uncertain working procedures," "poor selection and design," "poor communication and coordination" and "the act of god." The study showed also that some respondents mentioned that workers' negligence and dissatisfaction are the major reason of accidents, while others linked the accidents to the contractors' practices (such as failure to provide PPE).
- Goh *et al.* (2016), investigated the causes of accidents at high rise buildings in Malaysia through conducting a series of interviews with seven highly qualified safety officers, and found that "lack of training" is the main reason of site accidents. Training provides workers with very specific skills in a certain task, so that it is achieved safely and effectively, so lack of training results in unskilled workers who will not be able to operate machines, handle their daily tasks or use PPE. Failing to provide adequate training makes the workers to improvise and do their tasks ineffectively. Safety officers stated also that workers behavior toward safety contributes toward site accidents, where most of them refuse to wear PPE, and operating cranes at high unsafe speed to meet a tight schedule. In addition, safety officers pointed out that in addition to lack of training and workers' poor attitude, "housekeeping" plays a pivotal role in controlling safety on site. Housekeeping is defined as the allocation of site responsibilities across the sub-contractors. So, poor housekeeping results in site congestion and creates a mess in the workplace causing accidents. In addition, some of them stated that "providing PPE and training workers" is expensive and employers might avoid financing for safety. Finally, safety officers stated that there is a lack of awareness about hazards associated with

the nature of this industry either by employers or employees. Even the governments do not have strong rules and regulations and are uncapable of enforcing them.

- Ali *et al.* (2010) identified seven causes of site accidents, namely, "poor site management," "failure to use PPE," "lack of education," "lack of training," "work overload," "financial restriction" and "lack of organization safety policy." Poor site management is caused mainly by poor housekeeping, which results in local hazards and failure to dispose of material wastes. These local hazards include protruding nails, some scattered scaffold components, unwanted ladders, unneeded or extra forms, defected rebars, trailing cables, etc. The study elaborated further that failure to wear PPE can be attributed to the fact that some PPE are old, defective and were not replaced for a long time, which makes workers uncomfortable wearing them. Dorji and Hadikusumo (2006) argued that most workers especially naive and new ones have never worn safety gears before. So, they are not used to them and feel that they restrict their movements and affect their productivity (Sa, 2005). Moreover, failure to provide clear instructions on how to use safety gears multiplies the problem.
- A field study conducted in the UAE by Al-Kaabi and Hadipriono (2003) highlighted the same reasons for not wearing PPE and added other causes such as the expensive cost of providing PPE to all workers. Samuel *et al.* (2017) added that more than half of the accidents were caused by falling from height and this was due to lack of edge protection specially floor openings.
- Tam *et al.* (2004) conducted a study in China to investigate the causes of construction site accidents. More than half of the respondents stated that workers do not have safety manuals and do not know most of the safety procedures. In addition, the majority of the respondents mentioned that top management rarely attends safety meetings, which reflects top management carelessness about safety issues. Moreover, the study revealed that the transient nature of the construction industry makes it difficult to provide training for all workers especially that most of them are uneducated labors. Moreover, Cheng *et al.* (2004), who also made a study in China, added that contractors tender for any construction job and most of them would take out loans to get started with a project. This leads to high competition in the market, delay of payments and poor safety management considering such circumstances.
- Other studies carried out in India by Kanchana *et al.* (2015), in Uganda by Lubega *et al.* (2000) and in South Africa by Othman (2012) confirmed the causes mentioned above and added other causes such as carelessness of workers, lack of enforcement of safety laws, lack of top management and clients commitment and awareness and poor choice of subcontractors.

To conclude and based on the previous studies, this research identified 30 causes of site accidents. Through reviewing these causes, merging similar and removing repeated ones, this research identified the most agreed 16 causes of construction site accidents. Some causes were not considered such as "act of god" and "being under drug influence" because they racked the least in the previous studies. Despite the different classifications adopted for categorizing causes of site accidents, these causes were classified based on the party responsible for or contributing toward their occurrence, see Table 1.

Table 1. Causes of construction site accidents in the construction industry (developed by the authors)

Cause no.	Causes of construction site accident	Source	Responsible party Workers	Construction firm's management	Government
C01	Lack of housekeeping	(Kartam and Bouz, 1998; Toole, 2002; Hamid *et al.*, 2008; Wong *et al.*, 2009; Ali *et al.*, 2010; Othman, 2012; Kumar and Bansal, 2013; Chi and Han, 2013; Kadiri *et al.*, 2014; Kanchana *et al.*, 2015; Bhole, 2016; Goh *et al.*, 2016; Carrillo-Castrillo *et al.*, 2017; Jaafar *et al.*, 2017)		X	
C02	Lack of governmental inspection for safety	(Tam *et al.*, 2004; Sa, 2005; Yilmaz, 2014; Kanchana *et al.*, 2015; Bhole, 2016; Goh *et al.*, 2016; Jaafar *et al.*, 2017)			X
C03	Lack of rigorous enforcement of safety regulations either by the organization or government	(Lubega *et al.*, 2000; Toole, 2002; Cheng *et al.*, 2004; Tam *et al.*, 2004; Hamid *et al.*, 2008; Kulchartchai and Hadikusumo, 2010; Othman, 2012; Kumar and Bansal, 2013; Kadiri *et al.*, 2014; Bhole, 2016; Goh *et al.*, 2016; Samuel *et al.*, 2017; Jaafar *et al.*, 2017; Chim *et al.*, 2018)		X	X
C04	Low level of worker's knowledge and education related to safety	(Al-Tabtabai, 2002; Tam *et al.*, 2004; Cheng *et al.*, 2004; Hamid *et al.*, 2008; Ali *et al.*, 2010; Kulchartchai and Hadikusumo, 2010; Othman, 2012; Chi and Han, 2013; Kumar and Bansal, 2013; Yilmaz, 2014; Goh *et al.*, 2016; Samuel *et al.*, 2017; Carrillo-Castrillo *et al.*, 2017; Jaafar *et al.*, 2017)	X	X	
C05	Excessive working hours	(Al-Tabtabai, 2002; Cheng *et al.*, 2004; Tam *et al.*, 2004; Hamid *et al.*, 2008; Ali *et al.*, 2010; Yilmaz, 2014; Jaafar *et al.*, 2017; Samuel *et al.*, 2017)		X	
C06	Unskilled labors provision	(Abdelhamid and Everett, 2000; Lubega *et al.*, 2000; Cheng *et al.*, 2004; Hamid *et al.*, 2008; Kulchartchai and Hadikusumo, 2010; Othman, 2012; Chi and Han, 2013; Kumar and Bansal, 2013; Yilmaz, 2014; Bhole, 2016; Goh *et al.*, 2016; Samuel *et al.*, 2017; Jaafar *et al.*, 2017; Chim *et al.*, 2018)		X	
C07	Lack of site supervision	(Kartam and Bouz, 1998; Abdelhamid and Everett, 2000; Lubega *et al.*, 2000; Al-Tabtabai, 2002; Manase *et al.*, 2004; Hamid *et al.*, 2008; Wong *et al.*, 2009; Kulchartchai and Hadikusumo, 2010; Othman, 2012; Kumar and Bansal, 2013; Chi and Han, 2013; Bhole, 2016; Samuel *et al.*, 2017; Carrillo-Castrillo *et al.*, 2017; Jaafar *et al.*, 2017; Chim *et al.*, 2018)		X	
C08	Poor investment in transient workforce	(Kartam and Bouz, 1998; Cheng *et al.*, 2004; Tam *et al.*, 2004; Sa, 2005; Hamid *et al.*, 2008; Kulchartchai and Hadikusumo, 2010)		X	
C09	Lack of organizational health and safety policy	(Al-Tabtabai, 2002; Cheng *et al.*, 2004; Ali *et al.*, 2010; Jaafar *et al.*, 2017)		X	

(*continued*)

Cause no.	Causes of construction site accident	Source	Responsible party: Workers	Responsible party: Construction firm's management	Responsible party: Government
C10	High cost of personal protective equipment	(Goh *et al.*, 2016)		X	
C11	Carelessness and improper behavior of workers	(Lubega *et al.*, 2000; Al-Tabtabai, 2002; Toole, 2002; Hamid *et al.*, 2008; Wong *et al.*, 2009; Kulchartchai and Hadikusumo, 2010; Othman, 2012; Chi and Han, 2013; Kumar and Bansal, 2013; Yilmaz, 2014; Kadiri *et al.*, 2014; Bhole, 2016; Goh *et al.*, 2016; Samuel *et al.*, 2017; Jaafar *et al.*, 2017; Chim *et al.*, 2018)	X		
C12	Lack of safety training provision	(Al-Tabtabai, 2002; Toole, 2002; Tam *et al.*, 2004; Cheng *et al.*, 2004; Hamid *et al.*, 2008; Wong *et al.*, 2009; Ali *et al.*, 2010; Kulchartchai and Hadikusumo, 2010; Othman, 2012; Kumar and Bansal, 2013; Chi and Han, 2013; Yilmaz, 2014; Kanchana *et al.*, 2015; Bhole, 2016; Goh *et al.*, 2016; Samuel *et al.*, 2017; Carrillo-Castrillo *et al.*, 2017; Jaafar *et al.*, 2017; Chim *et al.*, 2018)		X	X
C13	Poor safety awareness from top management	(Lubega *et al.*, 2000; Cheng *et al.*, 2004; Manase *et al.*, 2004; Tam *et al.*, 2004; Hamid *et al.*, 2008; Ali *et al.*, 2010; Othman, 2012; Kumar and Bansal, 2013; Bhole, 2016; Jaafar *et al.*, 2017)		X	
C14	Lack of providing convenient personal protective equipment	(Abdelhamid and Everett, 2000; Toole, 2002; Cheng *et al.*, 2004; Hamid *et al.*, 2008; Ali *et al.*, 2010; Kulchartchai and Hadikusumo, 2010; Othman, 2012; Chi and Han, 2013; Yilmaz, 2014; Kanchana *et al.*, 2015; Bhole, 2016; Samuel *et al.*, 2017; Carrillo-Castrillo *et al.*, 2017)		X	
C15	Inefficiency of old safety equipment or no safety equipment at all	(Abdelhamid and Everett, 2000; Al-Tabtabai, 2002; Toole, 2002; Tam *et al.*, 2004; Cheng *et al.*, 2004; Hamid *et al.*, 2008; Wong *et al.*, 2009; Ali *et al.*, 2010; Othman, 2012; Kumar and Bansal, 2013; Kadiri *et al.*, 2014; Yilmaz, 2014; Kanchana *et al.*, 2015; Bhole, 2016; Goh *et al.*, 2016; Samuel *et al.*, 2017; Carrillo-Castrillo *et al.*, 2017; Jaafar *et al.*, 2017; Chim *et al.*, 2018)		X	
C16	Reluctance to input resources for safety	(Cheng *et al.*, 2004; Tam *et al.*, 2004; Hamid *et al.*, 2008; Wong *et al.*, 2009; Ali *et al.*, 2010; Kulchartchai and Hadikusumo, 2010; Kumar and Bansal, 2013; Goh *et al.*, 2016; Jaafar *et al.*, 2017)		X	

Table 1.

The agreed 16 causes of accidents were also grouped according to casual influences for construction accidents (Haslam *et al.*, 2005). The model categorizes the causes of accidents into five groups. Figure 1 shows the 16 causes categorized into the 5 groups.

2.3 Safety roles of different stakeholders

This section will present the safety roles of stakeholders (designers, owners and contractors).

2.3.1 Designer. In fact, designers can play a very effective role in improving safety performance and increasing workers' safety. Five major roles have been pointed out by Toole (2005) (who have more than 10 years' experience in construction management) and are addressed in the following section:

- The first is: Review for safety. The role of the designer is to implement the conceptual and architectural knowledge and principles for designing a real physical facility. This process is achieved by taking into consideration project constrains such as cost, time and functionality. After the design process finishes, which results in producing plans, drawings and blueprints, usually, a peer review is made on these plans to make sure that the design meets proper engineering principles within the project constrains. At that exact point, designers can review the design to address additional checks such as workers' safety much like they review for functionality before the design is delivered to the contractor's office. This review for safety shall provide an adequate level of safety on site, and assert that the construction process is not too dangerous for workers to be executed. These checks can be made by a professional designer in the organization or by even by an external consultant if required. It was suggested by Toole (2005) and pointed out by Tymvios, etc. all (2015) that these checks in the peer review for safety can be (but

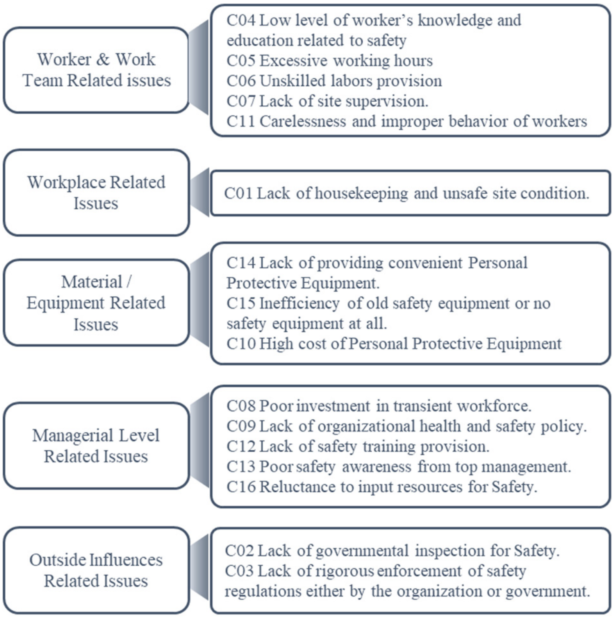

Figure 1.
16 causes categorized into the five groups

not limited to) checked, such as reducing roof pitches and ensuring that the windows bottom level is at least 107 cm in height, which correspond to OSHA standard of fall protection.

- The second is: Create design documents for safety. Instead of only considering the worker's safety during the peer review stage, designers consider construction safety problems during the design process itself. So, for example, the decision about windows heights and roof pitches are decided in the design process instead in the review process. Toole (2005) also points out that in addition to having a template of typical plans and specifications, designers also create their own documents, which can include details and specifications about construction safety problems. For instance, designers can provide in their drawings: excavation paths, appropriate locations of tie offs for fall protection and can also provide detailed sketches of the sequence of erecting or fixing a large prefabricated part.
- The third is: Procure for safety. Usually, designers help the owner in choosing the appropriate contractor. In addition to creating the drawing plans and specifications, designers also create request for proposal (RFP). The RFP is a document that requires the bidder to show evidences of their abilities to complete the project (such as information of cost, timeframe, scope and past projects). Designer can play a role in improving safety by requesting the bidders to provide their safety records, safety plans and programs in the RFP and making it as a selection criterion. Accordingly, designers can recommend the appropriate bidder for the owner (Toole, 2005).
- The fourth is: Review submittals for safety. Designers can review the detailed shop drawings and layout plans that are created by the contractor, to assure that safety requirements are being met (Toole, 2005).
- The fifth is: Inspect site operations for safety. Generally, designers are required to inspect the construction site to make sure that their designs are being implemented according to the drawings. They could extend their role of inspection by also getting involved in site safety-related issues. This will slightly improve the compliance to safety regulations (Toole, 2005).

There might be some challenges to designers to improve workers' safety. First is the lack of safety expertise. Majority of designers do not have the basic knowledge of safety, and were not exposed to any academic safety management training. With this limited knowledge in safety, designers may contribute much less to design for workers' safety. A solution to this problem would be to use external safety experts during each of the five tasks mentioned above. Another solution is to provide the designers with proper safety training on OSHA standards. The second challenge is a lack of understanding of the construction process. Many designers do not have the stuffiest knowledge of the construction process and sequence, which may lead to a design that is unsafe to be implemented in reality (Toole, 2002, 2005). The third challenge is the increased design fees. Designing for safety is likely to increase the design cost because of the extra work designers will exert to identify opportunities by communicating with personal and checking all databases. In addition to safety, experts could be consulted for that. A solution to this problem is to educate owners and clients about the high costs of accidents if occurred, and that paying additional fees for safe design is a saving for them.

2.3.2 Owner. Although some owners may not be fully aware of the construction process, yet they can still play a role in safety. According to Gambatese (2000), owners can participate in safety in both phases planning/design phase and construction phase. Owners can appoint a specific organization or individual and assign all safety responsibilities and authorities to them, as well as, allow them during construction to monitor safety performance. Moreover, this can be designated in the contracts. Owners can also include the safety performance of the contractor as a criterion for selection. Owners' involvement can also expand to include other roles such as: prevent any overtime work and night work and prohibit any schedule plans of that (Tymvios and Gambatese, 2015). Other studies revealed different practices used by owners with contractors (Huang and Hinze, 2006):

- Give short-term permits instead of long-term permits for hazardous activity.
- Conduct periodic safety audits of contractor during construction.
- Discuss safety-related issues in owner-contractor meetings.
- Conduct meetings with the contractor and all subcontractor to emphasize on workers' safety.

2.3.3 Contractor. Contractors are considered the main body responsible on the construction site, as they present the top management in the construction project. So, they have the capability to control the overall safety of the construction site through a wide range of safety practices. That is why they are held responsible under the law on any activity occurs on the construction site. Several studies were conducted to identify factors affecting safety performance in the construction industry. Many safety practices by contractors were extracted from these factors (Sawacha *et al.*, 1999; Aksorn and Hadikusumo, 2008a, 2008b; Hallowell, 2012; Ismail *et al.*, 2012; Yu *et al.*, 2014; Gunduz and Ahsan, 2018). The following will list these practices extracted from previously mentioned studies (identifying factors influencing safety performance in the construction industry). These safety practices are categorized into two categories, namely, safety practices on the managerial level and educational level (to be done by the contractors). As for the educational level:

- Providing safety trainings, campaigns and awareness to employees.
- Bulletin boards, signs, directions and presentations.
- Having safety mentors, teamwork and technical guidance.
- Providing toolbox talks to workers.
- Publishing safety newsletters and booklets.

As for the managerial level:

- Carrying out frequent jobsite inspections for violations and safety audits.
- Conducting risk assessments.
- Providing of PPE and following of safety rules and procedures.
- Using of safety management systems.
- Performing accident investigations and analysis.
- Rewarding safe practice among workers and penalties for unsafe acts.
- Conducting periodic safety meetings.
- Promoting safe methods for material handling, storage and transportation.
- Control on subcontractors' safety behavior.
- Safety coordination on jobsite through contractor's safety department and committee.

2.4 Strategies adopted in different countries

This section will discuss five different strategies adopted in different countries to improve safety performance and reduce accidents in the construction industry.

2.4.1 Incentives. One of the most powerful strategies for implementing safety practices is incentives. Incentives were recognized as one of the most effective ways of implementing safety over a wide spectrum of studies. Basically, it is a psychological approach in which workers and employees are rewarded for acquiring and practicing safety habits (Choi *et al.*, 2011). There are several ways of incentives practiced worldwide. Sims (2002) identified nine types of incentives other than money:

(1) Recognitions.
(2) Days-off or time-off.
(3) Stock ownership.
(4) Special assignments of tasks.
(5) Advancements and promotions.
(6) Increased autonomy and independence.
(7) Special trainings and education.
(8) Celebrations and parties and social gatherings.
(9) Prizes.

Safety incentive programs (SIPs) have proven to have a tangible effect on improving safety performance in the construction industry in both Thailand and India (Aksorn and Hadikusumo, 2008a, 2008b; Hasan and Jha, 2013).

As for recognitions, it has been argued that many managers and supervisors failed to give recognitions for a very simple reason that most of them do not know what to say and how to say it. In fact, recognition is delivered in a verbal way. Sims (2002) mentioned different verbal ways of recognitions acting as a series of guidelines to be followed such as:

- Thanking the worker or the person by his/her name.
- Stating exactly what they did to be recognized and explaining to them how you feel about their safe behavior.
- Stating how their safe behavior added to the companies' safety culture, and then thank them again.

Mainly there are two types of SIP, namely, outcome-based incentive programs (sometimes called injury/illness-based) and behavior-based incentive programs (Yeow and Goomas, 2014). The outcome-based incentive programs mainly deliver the reward based on the outcome of work. So, it works when the final results are low number of accidents and/or less number of injuries. So, employees are rewarded on final results of lower accidents and/or injuries not their particular behaviors during their work. This type of SIP is based on three assumptions:

(1) The facility equipment is safe.
(2) Workers are aware of using the equipment safely because, for example, got proper trainings.
(3) Accidents occur due to workers' fault or negligence (Goodrum and Gangwar, 2004).

There are several problems to this type of SIP, first, at some point, they encourage the workers to not report accidents or near miss, as documenting an accident may prevent them from getting the reward. Second, it may cause a miss communication and false feedback between crew members and management. Crew members may put a lot of effort to practice safety habits and prevent an accident yet experience an accident and not receive rewards, whereas, another crew may not pay attention to any safety practices and by coincidence not encounter any accident and receive a reward (Goodrum and Gangwar, 2004).

The second type of SIP is behavior-based incentive programs, which rewards the workers for their safe practices and behaviors regardless of accident records. This type of SIP is far away better than the outcome-based as it over time changes the safety climate in the organization. Although it is better than outcome-based, it is more difficult to implement as periodic measuring and monitoring safe behavior is complex. Moreover, it still does not tell, which behavior contribute to better safety performance. It can be reached by continuous inspection and audits. It should be noted that safety programs that boost a high considerable value have reverse effect and should be avoided as they discourage report or cause false reporting (Hinze, 2002; Yeow and Goomas, 2014).

2.4.2 Investigations and penalties. Investigations and punishments can form a very practical way of improving safety performance. It was found that perceived procedural justice leads to strong compliance with laws (Tyler, 1990). Not only this but also it brings up many post-accident learnings. It was argued that post-accident investigations are considered one of the most effective techniques for reducing accidents by determining root causes and executing appropriate preventive measures (Aksorn and Hadikusumo, 2008a, 2008b). Cedergren and Petersen (2011) investigated railway accident reports covering a span of two years, and after carrying out a comprehensive investigation on these reports, they came up with many causes of failures, which adds up to lessons learned from accidents. Another study involving deep investigation of 52 fatal construction accidents, which took place in Hong Kong between 1999 and 2011, produced high valuable lessons (Wong *et al.*, 2016). Each of these cases (the 52 fatalities) was analyzed carefully as it contained an audio recording of the summing-up and the verdict of the court, as well as the accident report of the Labor Department. The final investigation showed the root causes of fatal fall-from-height accidents in construction sites and developed a framework for extracting valuable information from accident reports (Wong *et al.*, 2016).

Investigations cannot be valuable unless accompanied with a punishment for failures and mistakes. Investigations followed by adequate punishments of industrial accidents bring social justice and also alert and educate others about the consequences of violations. Regardless of social justice and law awareness, which punishments arise, the fear itself of possible punishments will lead to strong law compliance (Wei and Lu, 2015). For instance, fatal accidents in the US have mainly two penalties on the contractor, namely, first is the increase in the insurance fee, which reduces the net profit, second is having a poor safety record, which can prevent future bidding. Although it might be hard to inspect all construction projects for violations, the fear of those two consequences can force a law compliance to safety (Ling *et al.*, 2009). Punishments can also take another form such as announcements. Publishing the annual accident reports, which contains contractors' names can also force a compliance and raise the fear of ruining perceived reputation. Bringing accidents into publicity (such as newspapers or media) increase the safety awareness among people as they will start to pay more attention to safety to protect themselves of future similar loss (Wei *et al.*, 2009).

2.4.3 Pay for safety scheme. Pay for safety scheme (PFSS) is a safety initiative that was first introduced by HONG KONG Works Bauru to the government of the Hong Kong Special Administrative Region and was implemented in 1996. This initiative (PFSS) is mainly a system that allows the government to pay for all of the safety expenses of a construction project under certain conditions (Chan *et al.*, 2010). As the construction industry is a project-based industry (Vrijhoef and Koskela, 2005), competitive bidding will always remain the main option of selecting contractors (Mokhtariani *et al.*, 2017). Because of that, contractors tend to cut off the prices of safety-related items to lower their prices and win the tender. The PFSS aims to take the contractor's pricing for site safety-related items out from the bill of quantity and, to encourage the establishment of the safety management system in governmental construction contracts (Chan *et al.*, 2010). There are about 2% of the total contract sum for the contractors to keep for safety-related items. This amount will be paid back to the contractor by the government in a monthly-based if the contractor fulfilled all the stipulated safety requirements and achieved acceptable safety performance (Choi *et al.*, 2011). PFSS has proven to be effective and resulted in a dramatic reduction in the construction site accidents since it was implemented in the mid-1990s. It has many benefits such as:

- Enhancing safety climate and attitude.
- Promoting effective safety-related communication.
- Streamlining the safety procedures.
- Ensuring adequate safety training (Choi *et al.*, 2011).

It should be also noted that several government agencies implemented PFSS. For example, the Hong Kong Housing Authority started to enforce a PFSS on all public housing projects in 2000 to encourage the contractors to give more attention to safety. The Hong Kong Construction Association and Real Estate Developers Association of Hong Kong have also promoted and launched a PFSS in the private sector on a voluntary basis in October 2005 (Choi *et al.*, 2012).

There are some obstacles that may challenge the implementation of PPSF. A recent survey study aimed to identify the difficulties in applying PFSS, showed that the top three significant difficulties (tested in the survey) are:

(1) Plenty of paperwork is required for certifying payments to contractor on a monthly basis, which could result in an ineffective process.
(2) Complicated contract documents, which may require legal expertise and lengthy assessment process.
(3) Over-tight project schedule requiring rush jobs (Choi *et al.*, 2012).

There were other challenges addressed in the study but not tested in the survey (Choi *et al.*, 2012), such as:

- Low literacy level of workers, which results in communication problems difficulties in training.
- The high turnover rates of workers, which results in having new workers continuously in one construction site.
- Challenges associated with contractors such as:

(1) Limited budget, human resources and facilities on-site safety.
(2) Inadequate safety attitude of top managers.
(3) Poor organization of SIP.

2.4.4 Prevention through design. Prevention through design (PtD) is basically "safety constructability." National Institute for Safety and Health has technically defined PtD as:

> "Addressing occupational safety and health needs in the design process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of facilities, materials, and equipment (López-Arquillos *et al.*, 2015).

So PtD is a strategy that entails addressing the safety-related issues in the design phase of the project. Some PtD practitioners included the safety of users during the serving period of the project, and the safety of workers during maintenance to be part of PtD (Toole and Carpenter, 2013).

Majority of industrial accidents can be linked to unsafe design especially in the construction accidents. The National Occupational Health and Safety Commission in Australia reported that 77 out of 210 workplace fatalities in the construction industry involved design-related issues (Lingard *et al.*, 2013). Moreover, another study in US analyzing 224 construction fatalities pointed out that unsafe design contributed as a causal factor in over 35% industrial accidents (Manuele, 2008). Another study in US analyzing 224 construction fatalities revealed that the unsafe design was related to 94 cases of them (almost 42%; Lingard *et al.*, 2013).

PtD is very beneficial in reducing construction accidents and injuries although there is not enough statistics on the benefits of PtS. There are many case studies, which point out that accidents are preventable in the design phase of the project (Toole and Carpenter, 2013). Examples of PtD are:

- Ensuring that the windows bottom level is at least 107 cm in height.
- Specifying cages on the circumference of the skylights, which can prevent workers from falling.
- Specifying groundwater watering wells location to be away from power lines to reduce the chances that the drill rig will destroy them.

Interest in PtD strategies and techniques has been increasing in different disciplines (both academic and industrial) since the 2003 symposium at the University of Oregon. Many studies related to PtD have been published since. Large companies have implemented many PtD programs such as United Research Services Corporation, Jacobs, Worley Parsons and Bechtel. The NIOSH acknowledged the PtD as a very promising prevention approach (Toole and Carpenter, 2013).

There are some challenges that might prevent the diffusion of PtD across the construction industry such as:

- designers' lack of construction safety knowledge,
- lack of construction process knowledge by designers and
- increased design fees (Toole and Carpenter, 2013).

2.4.5 Behavior-based safety. Behavior-based safety (BBS) is a safety intervention strategy, which incorporates one-to-one and/or group observations of workers performing their routine tasks, and then giving back a feedback on safety-related behaviors. So, basically, it is a system of observations and feedback delivery. It has been reported that BBS is one of the most effective strategies in accident prevention (Okoye *et al.*, 2017).

3. Research methodology

3.1 Data collection

Data collection in this research was based on literature and a survey questionnaire. First, the literature review was based on textbooks, academic and professional journals, conference and seminar proceedings, dissertations and theses, organizations and government publications, as well as internet and related websites.

Second, the results of a survey questionnaire conducted with a representative sample of large and medium-sized construction firms in Egypt were presented and analyzed to investigate their perception toward the causes of site accidents. The questionnaire consisted of close ended questions (e.g. rating questions based on four points Likert Scale). The use of four points scale instead of the most commonly used five points scale is due to the need to avoid selecting the middle value especially if respondents felt bored or would not exert cognitive effort to form an opinion about the question, which is called satisficing (DeMars and Erwin, 2005; Sturgis *et al.*, 2014). A pilot study of the survey was checked and tested with specialist engineers in the health and safety field working in major companies to determine its effectiveness and problems. After going over the responses of the preliminary test and making changes, the questionnaire was ready for formal testing (Baker, 1997; Blair *et al.*, 2013).

Figure 2 shows the research methodology plan.

3.2 Data analysis

The collected data was analyzed using to types of analysis. The first one was to measure the central tendency (mean, median and mode) and dispersion (variance and standard deviation) (Bernard, 2013). The second one is the Relative Importance Index (RII) as not all causes have the same impact. The RII can be calculated by:

$$RII = \frac{\sum W}{A \times N}$$

where (*W*) is the weight for each alterative (from 1 to 4), (*A*) is the highest weight (four in this study) and (*N*) is the total number of valid responses (Shash, 1993).

3.3 Sampling and questionnaire distribution

The statistics of contractors for complete building works were obtained from the Egyptian Federation for Construction and Buildings Contractors (EFCBC). Table 2

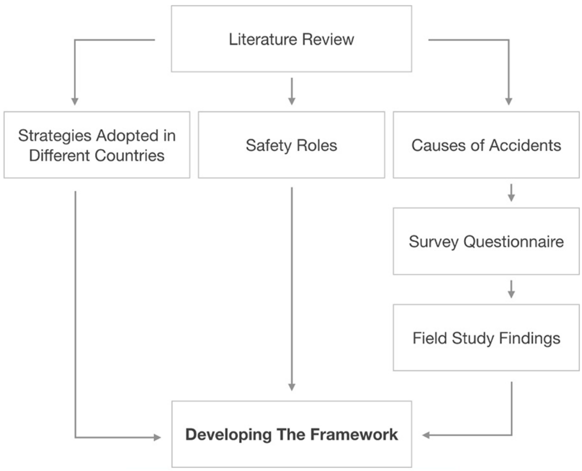

Figure 2.
Research methodology

shows the number of contractors in some governorates in Egypt and their total number in the seven classes. The EFCBC categorizes contractor companies based on company size into seven classes, where seventh class contractor is a small company, which can apply for a bid of a maximum EGP6m, and the first can apply for any bid with no limits. According to El Ehwany (2009), the large-sized firms are the first three classes, the medium-sized firms are the fourth and fifth classes and the sixth and seventh classes are the small-sized firms. This study targeted the large and medium-sized firms as they must be registered in the International Project Management Association and are expected to have health and safety procedures.

The total number of the large-sized and medium-sized firms was 1,570, which is the population size. The sample size was calculated using the most common fundamental equation for a large population (which should be adjusted if the population is small) by Cochran (Israel, 1992):

$$n_o = \frac{z^2pq}{e^2}$$

where (n_o) is sample size for large population, (p) is an estimated proportion of an attribute that is present in the population, (e) is the level of precision (5% in this case), (q) is equal to 1-p and (z) is a point on the abscissa of the standard normal curve that specifies the confidence level.

It is recommended to take the product $p * q$ (which is called the variance) as the maximum value. Therefore, $p = 0.5$ and $q = 0.5$. For a confidence percentage of 95% z value should be 1.96

$$n_o = \frac{z^2pq}{e^2} = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384.16$$

The previous equation assumes that the population is large. However, sometimes the population is small. If n_o (sample size derived from the previous equation = 384.16) is greater than 10% of the population (10% of the population is 157), then the population is not considered a large one. Therefore, n_o should be subjected to adjustment for true sample value. The true sample value can be calculated using the following equation:

Table 2. Number of contractors for complete buildings works in different Egyptian governorates (egyptian federation for construction and buildings contractors (EFCBC, 2019)

Class	Egypt	Cairo	Giza	Alexandria	Sohag	Minya	Dumyat	Asyut	Fayoum	Suez	Port Said	Others
1st	138	79	23	6	4	2	2	2	1	0	3	16
2nd	144	57	21	6	4	1	3	4	5	2	4	37
3rd	182	62	20	10	3	3	0	7	8	5	6	58
4th	453	154	44	24	11	13	4	10	21	13	10	149
5th	653	161	68	32	22	15	15	16	22	27	16	259
6th	565	100	66	35	20	17	6	19	31	11	13	247
7th	4,884	787	389	296	368	178	120	175	172	119	44	2,236
Total	*7,019*	*1,400*	*631*	*409*	*432*	*229*	*150*	*233*	*260*	*177*	*96*	*3,002*

$$n_R = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} = \frac{384.16}{1 + \frac{384.16 - 1}{1,570}} \approx 309$$

In total, 309 companies were contacted. The questionnaire was distributed in large construction sites in Cairo. In addition, it was sent through Linkedin to reach firms in Cairo and other governorates, which are inaccessible. The targeted respondents were all health and safety engineers working in the health and safety department of the companies.

4. Results and discussion

4.1 General information and response rate

Out of 309 questionnaires were distributed, 200 were completed and received representing 65%. The respondents were engineers working in the health and safety department in the companies. They had a working experience between 5 to 10 years and almost 25% of them had more than 10 years of experience.

4.2 Perception of causes of construction site accidents

All respondents mentioned that they are aware and understand the causes of construction site accidents. Table 3 shows the results of respondents' measure of central tendency and dispersion, as well as RII in Figure 3. The following section will explain a sample of causes of site accidents:

- By referring to Table 3, "lack of housekeeping" was ranked the highest cause of construction site accidents with RII (0.865). This is because improper cleaning and messed-up site and misplacing objects are noted by Goh *et al.* (2016), who explained that the unsafe conditions in high rise buildings are mainly due to poor housekeeping such as a messy crowded workplace, which leads to site accidents. These results are also in line with the findings of Ali *et al.* (2010), who quantitatively tested 20 causes, which affect the occurrence of accidents in construction sites and found that poor site management was ranked the second-highest cause. They pointed out that proper storage and continuous cleanup, as well as getting rid of the wasted and unwanted materials play an important role toward reducing site accidents. They also further elaborated that lack of site management wastes time, effort, energy and materials and also increases accident probabilities. In addition, these results agree with Carrillo-Castrillo *et al.* (2017), who analyzed more than 2,500 accidents in Spain and stated that severe and fatal accidents mainly occur due to bad site conditions such as improper workplace layout and poor housekeeping, as well as having many trades working in the same area (Toole, 2002).
- Respondents of the survey questionnaire ranked "lack of governmental inspection for safety" and "lack of rigorous enforcement of safety regulations either by the organization or government" as the second and third causes of site accidents with RII (0.839) and (0.805), respectively. Management of the organization and government share the responsibility of these causes. These results are confirmed by Goh *et al.* (2016), who mentioned that if government regulations and rules are not firmly established and strictly implemented will lead to site accidents. In addition, Tam *et al.* (2004) stated that among 25 causes of accidents, lack of rigorous enforcement of safety regulation was ranked the ninth in a row. They argued that most of the safety violations went unpunished. The results of the survey questionnaire is in line with several studies conducted in Malaysia, Britain and China, which mentioned that lack of enforcement of safety regulations (Cheng *et al.*,

Table 3. Causes of construction site accidents against their measures of central tendency, dispersion and ranking

Cause no. (1)	Causes of construction site accidents (2)	Mean (3)	Median (4)	Mode (5)	SD (6)	V (7)	RII (8)	Rank (9)
C01	Lack of housekeeping	3.46	4	4	0.693	0.481	0.865	1
C02	Lack of governmental inspection for safety	3.355	4	4	0.91	0.83	0.839	2
C03	Lack of rigorous enforcement of safety regulations either by the organization or government	3.22	3	4	0.92	0.84	0.805	3
C04	Low level of worker's knowledge and education related to safety	3.14	3	4	1.03	1.07	0.785	4
C05	Excessive working hours	3.075	3	4	1.01	1.02	0.769	5
C06	Unskilled labors provision	3.07	3	3	0.88	0.77	0.768	6
C07	Lack of site supervision	3.065	3	3	0.857	0.734	0.766	7
C08	Poor investment in transient workforce	2.92	3	3	0.78	0.6	0.730	8
C09	Lack of organizational health and safety policy	2.89	3	3	0.93	0.86	0.723	9
C10	High cost of personal protective equipment	2.865	3	4	0.98	0.96	0.716	10
C11	Carelessness and improper behavior of workers	2.83	3	3	1	1	0.708	11
C12	Lack of safety training provision	2.75	3	2	1.02	1.04	0.688	12
C13	Poor safety awareness from top management	2.675	3	2	0.874	0.763	0.669	13
C14	Lack of providing convenient personal protective equipment	2.535	3	3	1.01	1.03	0.634	14
C15	Inefficiency of old safety equipment or no safety equipment at all	2.33	2	2	0.96	0.93	0.583	15
C16	Reluctance to input resources for safety	2.2	2	2	0.821	0.673	0.550	16

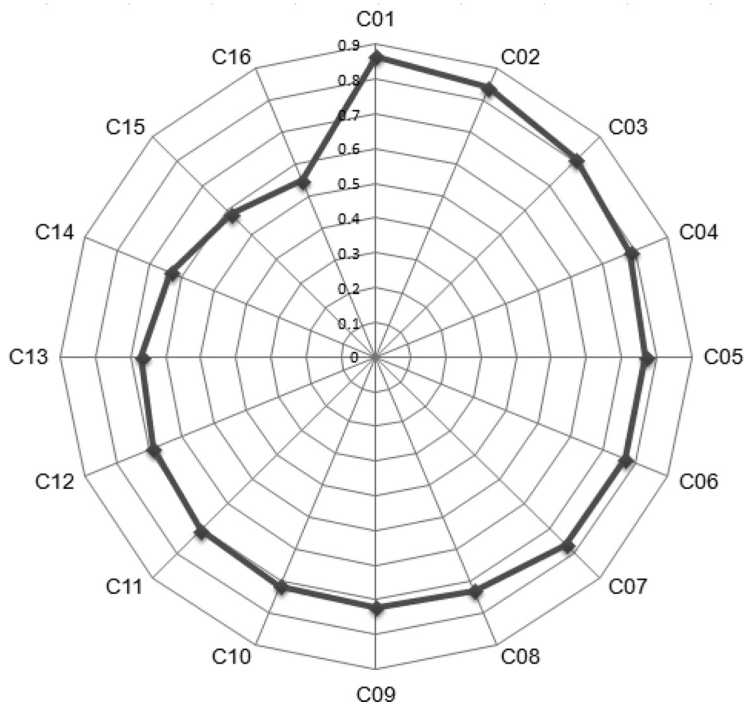

Figure 3.
RII of causes of construction site accidents

2004; Hamid *et al.*, 2008; Bhole, 2016) and paying no attention to safety issues and weak legislation (Kulchartchai and Hadikusumo, 2010) are direct causes to site accidents.

- Respondents ranked "low level of worker's knowledge and education related to safety" as the fourth cause of site accidents with RII (0.785). Most construction workers in developing countries are poor and seek any low-payment job that offers them a minimum wage to cover their living expenses. Due to their poverty, they drop education and start working. According to Tam *et al.* (2004), only 8% of construction workers in China attended high school, 39% finished their primary school and 44% finished their middle school. Besides, Kulchartchai and Hadikusumo (2010) mentioned that low level of workers' education in construction makes it more difficult to communicate health and safety regulations to with. In addition, Yilmaz (2014) emphasized that most of the construction workers are illiterate and uneducated. These results apply to Egypt as most of uneducated poor people ends up working in construction, which increases the number of site accidents.
- The fifth ranked cause of site accidents was "excessive working hours" with RII (0.769). Some contractors force the workers to work overtime beyond the agreed working hours (i.e. more than 40 h/week) or during the weekends and holidays. They rush to finish the assigned tasks to meet their deadlines, which resulted in workers got tired and raise their exposure to risk probabilities and accidents. Vernon (1945) discovered this when he compared two groups of workers in

munitions factories working 10-h shift and 12-h shift. He realized that the number of accidents among workers when working 12-h shift was almost 2.7 times greater than when working 10-h shift.

- Respondents ranked "unskilled labors provision" as the sixth cause of site accidents with RII (0.768). Most construction workers in developing countries are poor, unskilled and have not practiced any particular trade before. So, they just accept jobs that do not require high skills such as molders or mason to be able to cover the necessary cost of living. Yilmaz (2014) analyzed 200 accidents in Istanbul; Turkey and reported that 54% of accidents were caused by unskilled workers, molders and masons. These results are in line with the findings of Kulchartchai and Hadikusumo (2010), who mentioned that most workers in Thailand come from the agriculture sector to work in construction when they finish cultivation without having any construction background. Moreover, this cause of site accidents has another dimension related to the dominant culture of "anybody-can-do" and "learn-as-you-go." Some contractors force labors of a particular trade to do other tasks in other trades, which they do not have knowledge or skills to perform especially when there is shortage of labors. This cultural issue was confirmed by Abdelhamid and Everett (2000) in Malaysia and Lubega *et al.* (2000) in Uganda, for example.
- The seventh ranked cause with RII (0.766) is "lack of site supervision." Most of supervisors do not have the authority to most of their duties and tasks resulting in not being able to provide a proper and safe guidance to the workers. One of the major studies in Hong Kong (Rowlinson *et al.*, 2003) done on 69 site supervisors in 13 major construction firms with regard of safety responsibilities, revealed that one-third of them did not feel they had safety responsibilities and did not even know what their safety responsibilities are. These include: hiring new workers, accident investigations, inspections and discipline issues with workers. Moreover, almost half of the supervisors did not have the authority to do such tasks. In addition, this grows the culture of "make it work" or "can do" and promotes the production over safety as described by Kulchartchai and Hadikusumo (2010). Similarly, in Egypt lack of supervision creates all these cultures, which at the end increases accident probability.
- The 10th ranked cause of site accident is "high cost of personal protective equipment" with RII (0.716). Because of the traditional procurement approach, the selection of the contractor in the bidding process is usually based on the lowest prices. Selecting contactors on this basis does not ensure that the contractor is qualified or possesses the needs qualities to complete the project in a satisfying manner. To win tenders, contractors tend to reduce the price as much as possible, so they end up cutting the cost of PPE. This is in line and a result of the lack of governmental inspection for Safety and lack of rigorous enforcement of safety regulations either by the organization or government.
- The 12th ranked cause with RII (0.688) was "lack of safety training provision." Because of the nature of the construction industry, the lowest bid selection method between contractors and the "learn-from-your-brother" culture, senior management in construction companies perceives training as a waste of time and money. As the schedule might be tight, new workers sometimes do not get training and are asked to learn from their old crew members.
- Respondents ranked "poor safety awareness from top management" as the 13th cause of site accidents with RII (0.669). It has been pointed out that project managers

and leaders play a vital role in construction safety management through setting up the appropriate safe environment and raising the safety culture level among workers (Tam *et al.*, 2004). Unfortunately, many projects suffer from poor safety awareness from top management and project managers because priority is always given to other business objectives such as profitability, schedule and quality.

5. Framework aim, need and development

This framework aims to activate the health and safety regulations in the Egyptian construction industry. This will help improving safety performance and reduce accidents. To achieve this aim, five objectives have to be accomplished:

(1) Enhancing worker and work team safety performance.
(2) Ensuring safe site (workplace) condition.
(3) Providing means of protection (safe material/equipment).
(4) Improving the managerial role of the contractor in safety.
(5) Involving outside stakeholders in improving safety (government, designers and owners).

Accidents rates in the construction industry in Egypt have been dramatically increasing. Although there are three primary legislations, which regulate occupational health and safety in Egypt, the safety performance in the construction industry in Egypt is poor. Thus, it is essential to develop a framework to enhance safety performance in the construction industry and reduce accidents.

This framework was developed by using mainly two different phases, namely, literature review (safety roles and strategies) and creating an action plan by combining the first phase with results of the survey (causes of site accidents) categorized into five groups. Figure 4 shows the framework development flow.

The first phase is analyzing the literature review in detail to collect relevant data. This phase included three stages. Basically, analyzing literature review on three different topics:

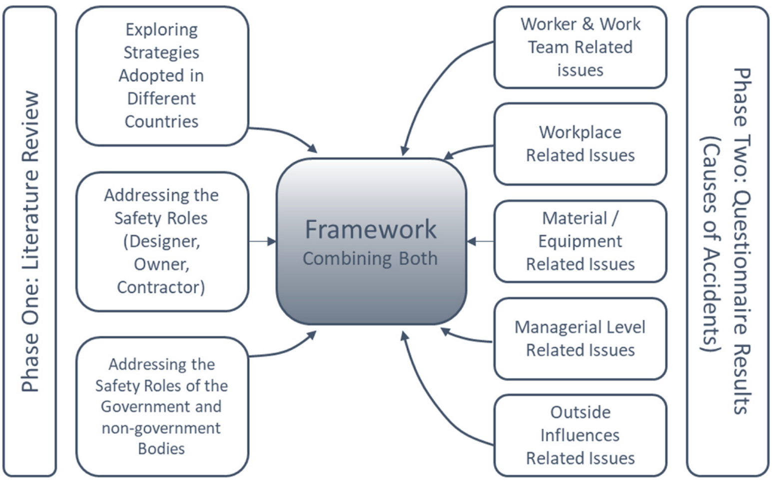

Figure 4.
Framework development flow

(1) First stage: is gathering relevant data of strategies adopted in different countries to enforce safety regulations and improve safety performance in the construction industry.
(2) Second stage: is gathering relevant data of different stakeholders' roles in enhancing the safety performance in the construction industry.
(3) Third stage: is addressing the role of Egyptian Governmental/non-Governmental state agencies concerned in occupational safety in workplace. Moreover, proposing additional roles to these agencies so that safety regulations can be implemented more efficiently.

The second phase comes from developing an action plan from combining the first phase (safety roles and strategies) and causes of accidents (which come from the results of the survey study) categorized into five groups:

(1) Worker and work team-related issues.
(2) Workplace-related issues.
(3) Material/equipment-related issues.
(4) Managerial level-related issues.
(5) Outside influences-related issues.

5.1 Phase one

As mentioned before this phase consists of three stages. Stages one and two were discussed extensively in the literature review section in this paper. Briefly, Stage one discussed the strategies implemented in different countries to improve safety and reduce accidents in the construction industry (incentives, investigations/penalties, PFSS, PtD and BBS). The second stage discussed the safety roles of different stakeholders like: designers, owners and contractors. As for the third stage, it discusses the safety roles of the Egyptian Governmental/non-Governmental state agencies, and it will be presented in this section.

As for the governmental agencies, two ministries mainly play important roles in safety regulations. The first ministry is the "Ministry of Manpower and Immigration." Under this ministry, two important agencies will be addressed "The Supreme Advisory Council on Occupational Safety and Health" SACOSH and "NIOSH." The second ministry is "Ministry of Housing, Utilities and Urban Communities." Under this ministry, two governmental agencies will be addressed "The TIDBW" and "Housing and Building National Research Center" HBNRC. Other governmental agencies will be addressed as they are somehow concerned in occupational safety such as: "Egyptian Federation for Construction and Building Contractors" EFCBC "supreme council of universities" SCU under "Ministry of Higher Education" and the municipalities (Local Councils) and for non-governmental agencies, "Egyptian Trade Union Federation" ETUF.

5.1.1 The supreme advisory council on occupational safety and health. The Egyptian labor law No. 12 (2003) has issued in act 230 the formation of the SACOSH. The law was followed by several ministerial decrees organizing the council task such as ministerial decree No. 985 (2003) and decree No. 154 (2003) and decree No. 3039 (2010) and decree No. 529 (2011). This council is chaired by the Minister of Manpower and consists of 25 members, including representatives of ETUF and organizations and of several ministries such as agriculture, industry and environment and agencies concerned with OSH issues. In general, the council was supposed to do the following tasks:

- Drawing up and planning the public policy for the country with regard of occupational health and safety.
- Studying and evaluating the following-up reports, which the Secretary General Office of the council release.
- Studying and discussing the problems and obstacles of the occupational health and safety coming from the advisory committees (each governate should have a joint advisory committee for occupational health and safety (H&S).
- Offering solutions to the problems and suggestion (by Secretary General Office and advisory committees) discussed.
- Following up the ratification of international conventions.
- Releasing an annual report on the status of occupational H&S with more details such as safety plans and safety program assessments.

Although the law issued the formation of this council and several ministerial decrees were also released about its tasks, this council was never held up to this moment. Thus, it is expected that if this council is set up and starts its work, the occupational H&S will improve.

5.1.2 National institute of occupational safety and health. This institute was first established by the presidential decree No. 932 (1965) and it was named at the time "National Institute of industrial safety." It was then rectified under the presidential decree No. 333 (2003) and was named "NIOSH." It is chaired by the Minister of Manpower and it has four branches (including the primary one in Cairo) in Egypt.

One of the most important safety roles, which NIOSH plays, is that it provides professional safety trainings in different fields such as: safety in construction sites, safety in factories, fires and emergencies and first aids. It also plays other safety roles like:

- Organizing local and regional conferences about safety, which increases the awareness.
- Participating in international conferences, which gives chances to safety practitioners to publish their field studies.
- Nominating scholars for scientific research expeditions.

As this institute is considered the only governmental institute, which provides professional safety trainings, the authors see that four branches are not enough at all to serve Egypt, and suggest that each governate should have a branch. The author also suggests that this institute should give training to undergraduate students studying engineering in the universities in summertime. This will raise their knowledge and awareness of safety.

5.1.3 The technical inspection department for buildings works. After the catastrophic events of the strong earthquake 1992, which hit Egypt, a presidential decree (No. 29 1993) was issued concerning the formation of a governmental agency called "The TIDBW." The TIDBW is chaired by the Ministry of Housing, Utilities and Urban Communities. This department plays a vital role in enforcing the laws. This assigned to do the following tasks:

- Carrying out the technical inspection of all works of the administrative bodies specialized in planning and organizing the local units, which issue the building licenses.
- Carrying out inspections on all building works and ensuring that all these works are being done exactly according to drawings and issued licenses.
- Informing all the judicial and administrative about violations for immediate action.
- Preparing periodic reports on the results of the inceptions.

- Preparing a full database of all the buildings in the city and creating a history of licenses and violations.

The TIDBW's safety role can be extended if special proactive safety practices were included as a pre-quest requirement for license issues.

5.1.4 Housing and building national research center. The HBNRC is one of the most important governmental bodies under the in conducting research on the field of buildings. This institute was first established in 1954 under the name of "Building Research Center" as a cooperative body between the "Ministry of Municipal and Rural Affairs" (at the time) and the external operation management of the American Government before the American cooperation was seized in 1956. The institute continued to be chaired by "Ministry of Scientific Research" until it was appended to "Ministry of Housing, Utilities and Urban Communities" in 1971. Finally, in 2005, the institute was named "HBNRC" by presidential decree.

This research center contains 11 complete research departments, which cover all building research fields. It plays an important role in safety as it develops all the building and materials design codes, as well as how these designs should be executed. It also hosts scientific conferences to allow research studies from all over the country to publish their research studies in the field of buildings.

Although this research facility has issued more than 50 codes/guides/stipulations/conditions, up to this moment, there are not any guides or codes of safety management or safety on construction sites. Thus, the author suggests and urges the need to develop a guiding handbook for safety management and another guide for safety on construction sites.

5.1.5 Egyptian federation for construction and building contractors. The idea of the Egyptian Federation was born in the late 1970s from the idea of the civil contractors federation in the UK. At the time, there was not any union or federation in Egypt to organize this industry. However, it was not until 1982 when pioneer engineer Mohamed Mahmoud Ali and others submitted a proposal to the Egyptian Parliament to establish the EFCBC. Finally, the EFCBC was established in 1992 by the parliament law No. 104 (1992).

The EFCBC categorized each specialty in the contracting works into seven categories. Each category has special requirements to join. It was noticed that all the requirements for all the seven categories for building works, do not include any safety requirements. So, it is suggested that the EFCBC can play a major role in safety if safety requirements are included as a compulsory requirement to join the federation.

5.1.6 Supreme council of universities. The SCU can play a part in activating H&S regulations. It can develop the current curriculums of engineering to include safety course as compulsory courses to be studied in the past year before graduation. This course shall include all the Egyptian safety laws and safety practices and safety management.

5.1.7 Municipalities (local councils). The author views that the municipalities can play a major role in safety because of their high authority as they are not chaired by any ministry. Instead, they have representatives of many ministries. The one most important role that can be played by municipalities (as they have a lot of authorities) is inspecting all construction sites and making sure that safety regulations are being followed.

5.1.8 Egyptian trade union federation. The ETUF was founded in 1957 and has a long history in defending on workers' rights in Egypt as it is the sole Federation in Egypt. ETUF owns many institutions such as the Workers University, the Labor Educational Association, the Resort of Al-Ahlam "Karyet Al-Ahlam" and many other provincial federations. The ETUF represents 2.5 million workers in 23 unions. It is affiliated with the International Confederation of Arab Trade Unions and the Organization of African Trade Union Unity.

ETUF can play a role in safety by:

- Providing awareness and training to workers.
- Assisting the governments on detecting any violations on workers' right at workplace because of safety-related issues.

5.2 Phase two

The second phase of the framework is developing an action plan by combining the first phase (strategies and safety roles) with the results of the survey (causes of site accidents) categorized into five groups.

Figure 5 shows how the five strategies explained earlier (from the first phase) is related to the five groups:

(1) As for Incentive: Incentives play an important role in both enhancing worker and work team safety. Improving managerial role in safety.

- Incentives can be introduced by the supervisors whose primary role is to ensure the safety of his team and workers. As mentioned before, there are several ways of presenting incentives, which will help reduce or eliminate problems related to "worker and work team."
- Incentives can also make a powerful impact on improving the managerial role on safety by introducing a monetary incentive scheme, which can only be done on the managerial level. This will help to reduce some of the problems related to the managerial level.

(2) As for investigation and penalties: Investigations and penalties play an important role in both: Improving managerial role in safety. Assisting the government in enforcing the laws.

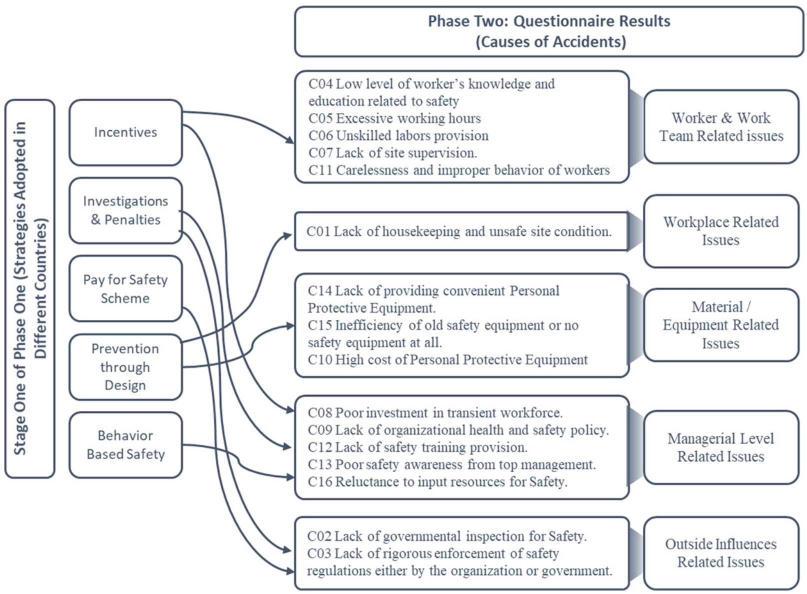

Figure 5.
Relating the strategies with causes of accidents

- Investigations help the company to extract the root causes of the problem/accident and mark them as lessons learnt. Paneities helps the workers to more comply with the internal regulations. By implementing both, some of the problems associated with managerial level will be reduced or eliminated.
- Raising up the government paneities on safety rules violations on companies, will help in enforcing these safety rules.

(3) As for PFSS: PFSS as explained before is a governmental decision, which aims to help the contractors implement more safety practices in their projects. It will improve the enforcement machinery.

(4) As for PtD: PtD plays an important role in both providing safe materials and equipment. Improving site condition.

- PtD involves designing safe construction materials so that it would not harm the users. An example for that is attempting as much as possible to make designs, which requires less on-site assembly. By implementing means of PtD, most of the material/equipment-related issues will be reduced.
- PtD also involves proper site planning, which involves arranging the construction site to include: safe access routes for both vehicles and people, footpaths, proper placement of essential services, proper location of damping areas, storage and parking provision. This helps to eliminate the workplace-related issues.

(5) As for BBS: It is a system of observation and delivering feedback. If implemented, will help to reduce some of the managerial-level-related issues.

Figure 6 shows how the safety roles of different stakeholders explained earlier (from the first phase) are combined to the five groups:

(1) As for the designers: designers can participate in reducing the hazards associated with construction site (workplace) by creating more appropriate site plans. In addition, they can also participate in reducing hazards associated with materials/equipment by creating safer designs, which requires less on-site assembly.

(2) As for the owners: Owners can make an impact on the managerial level during the contract period. Owners can increase the contractors' top management awareness but appointing certain official and delegating all safety responsibility to them.

(3) As for the contractor. Contractors are involved on every stage of the construction. So, many of the safety-related issues can be eliminated by them. They can:

- Enhance worker and work team safety performance.
- Improving the site condition by proper site plan.
- Providing all means of protection from hazards to ensure the safety of the personal. These include PPE and even providing safe materials.
- Improving the safety performance on a managerial level by providing safety policy, training, incentives, etc. (and many of which were discussed in the previous section).

Finally, the framework is constructed by putting all these (strategies and safety roles combined to form the action plan to overcome the causes of accidents categorized into five groups) together. Figure 7 shows the framework.

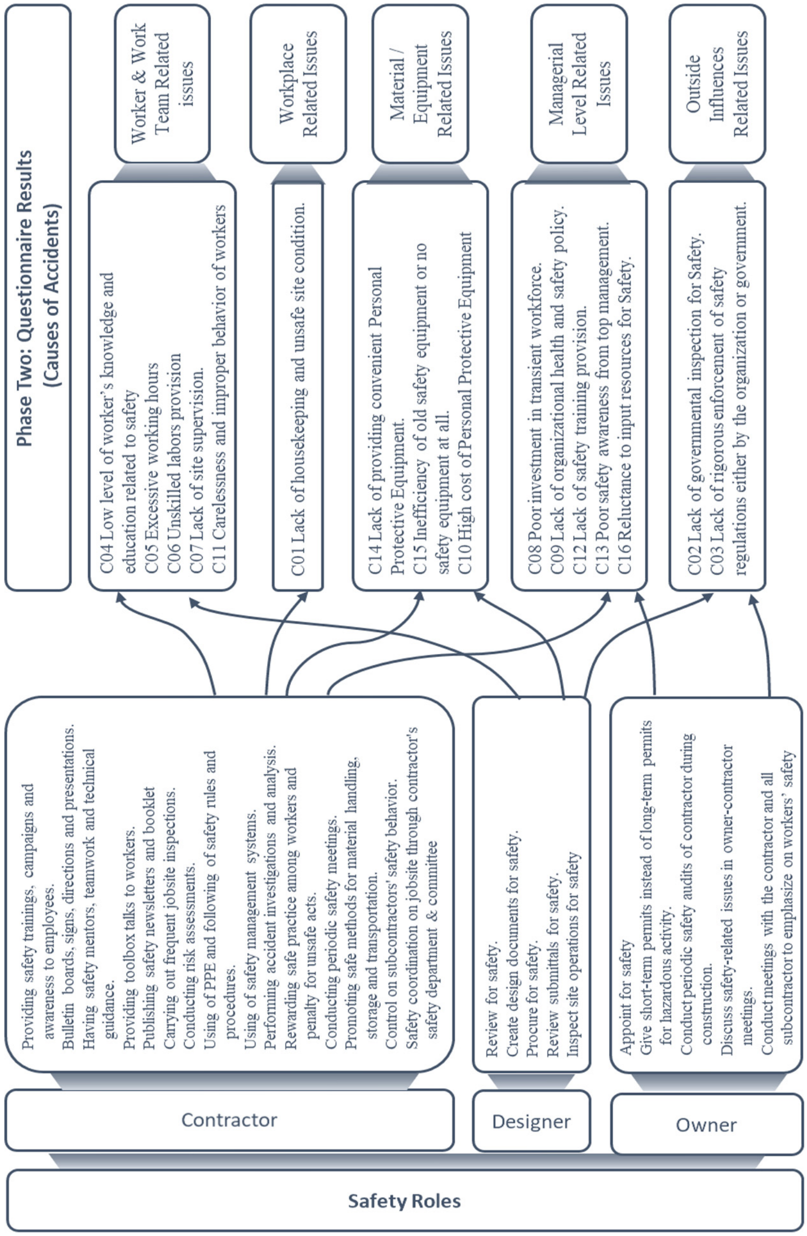

Figure 6.
Relating the safety roles of stakeholders with causes of accidents

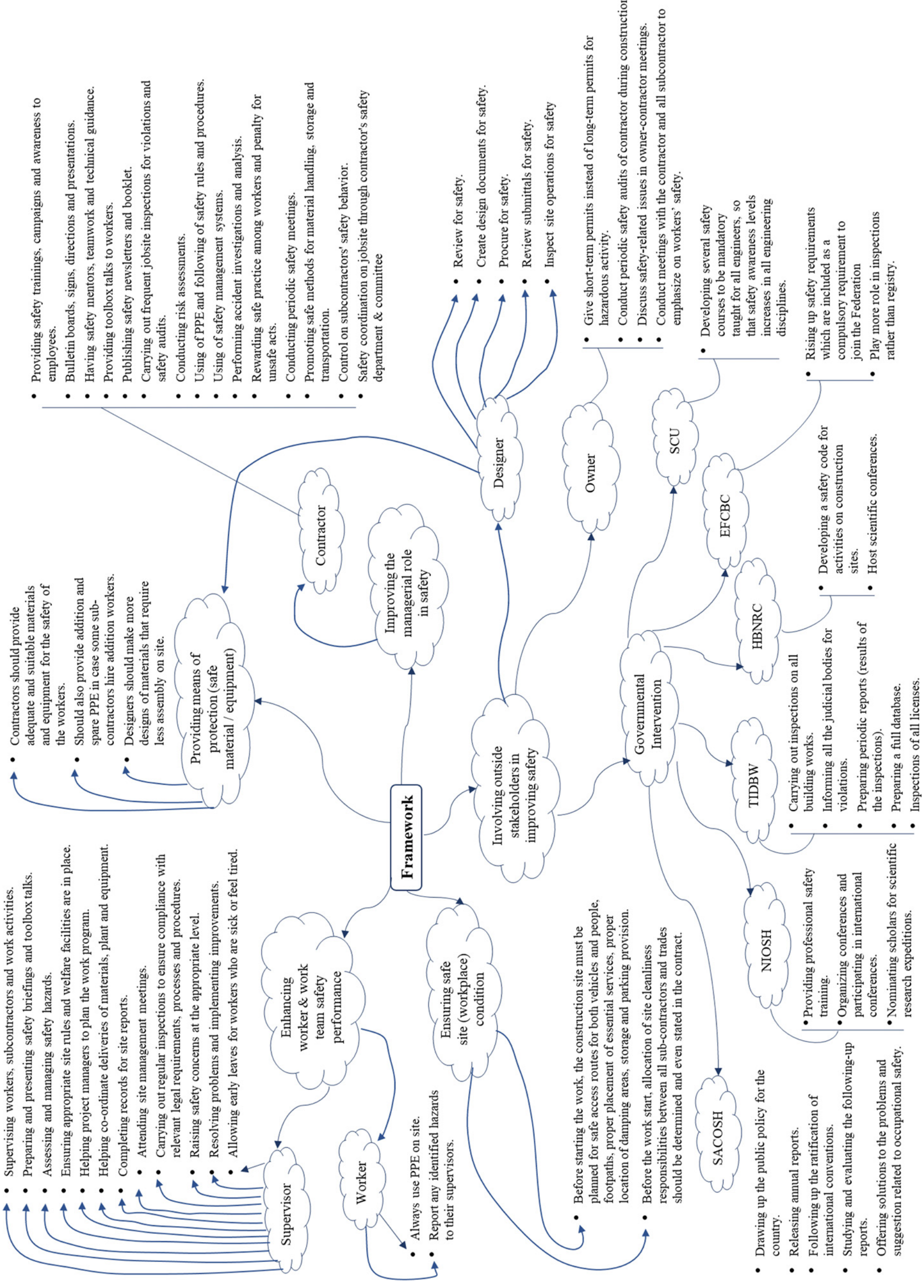

Figure 7.
Framework

6. Conclusion

The construction industry is a very hazardous business. Intensive literature review was conducted to identify the causes of site accidents. In total, 16 causes of accidents were identified and tested through a survey questionnaire conducted with a representative sample of large and medium-sized construction firms in Egypt to investigate their perception. The causes were analyzed and ranked using RII. Results showed that "lack of housekeeping" and "lack of governmental inspection for safety" were ranked the highest influential causes of site accidents. In addition, a conceptual framework was developed to reduce these causes. This framework was done by first addressing the safety roles of different parties and exploring strategies adopted in other countries to enforce the safety. Then, by developing an action plan, which combines the previous mentioned phase with the results of the questionnaire.

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