

Impact of Occupational Health and Safety Strategies on Reducing Construction Site Accidents

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Abstract

Construction industry is a risk industry awing to severe accident occurrence, accidental deaths, and work-related injuries. Although construction managers focus on productivity in terms of cost, quality and time, construction projects can never achieve their objectives unless professionals become responsible for the safety-related issues. Previous researches suggested that the early introduction of occupational safety & health management systems (OHSMS) is an important asset in decision-making, as it directs towards the abatement of occupational hazards in the workplace. Thus, this paper aims to study the impact of OHSMS on reducing construction site accidents. The paper explored through literature review the major causes of construction accidents, and factors to prevent them. Afterwards, the implementation of occupational health and safety practices at construction sites in three case study projects was analyzed; two projects in Malaysia and a case study in Egypt. The data for the local case study was collected through a semi-structured interview that targeted the site safety manager who was responsible the implemented OHSMS. The study concluded that implementing OHSMS, would lead to a significant reduction in site-accidents. Moreover, in order to improve safety, health and safety should be included from preparation of contract documents.

Keywords: Occupational Health and Safety Management System(OHSMS), Site-accidents, construction health and safety, Construction sites

1. Introduction

Health and Safety are vital in construction industry due to being a high hazard industry, where, the main force behind any construction site is the man power. It is found that without safety, the risks and hazards at a very dangerous place like construction sites can get people injured, hurt or even killed and accordingly this can cause any construction site delays and extra expenditures. In addition, protections in construction sites are considered the prime right of laborers, but for years' construction workers have been struggling to attain this right (Shamsuddin and Norzaimi 2015). The main objective of an Occupational Health and Safety Management System (OHSMS) certification scheme is to encourage and enhance safety awareness, to promote safe work practices, and to raise the safety standards of the construction industry (Teo et al., 2005). It is argued by Smallwood that accidents are inevitable in the construction

industry because it is believed that the industry is inherently dangerous (Smallwood, 2002). Where, the high rates of injury are primarily due to inadequate or non-existence of an OSH management systems (Zolfagharian et al., 2011).

The process of implementing safety and health management in construction projects is linked to applying specific measures including strengthened safety regulations, safety training, better planning and engineering controls, awareness, and cooperation among industry stakeholders (Baxendale and Jones, 2000). According to studies conducted by Griffith and Howarth, Kin and Bonaventura, Permana, Gordon, Parringa, from the principle elements of occupational health and safety, safety practices that should be implemented at construction sites are concluded to be safety policy, education and training, site safety inspection, safety auditing, safety meeting, site safety organization, personal protective equipment, emergency support and safety measuring devices, fall protective systems, and safety promotions, Griffith and Howarth (2001), Kin and Bonaventura (2006), Permana (2007), Gordon (1999), and Parringa (2010).

1.1. Research Methodology

The first part of this paper explores through a literature review the major causes of construction accidents and factors that prevent risks in construction sites and explains OSHMS, then implementation of occupational health and safety practices at construction sites will be discussed and analyzed. The second part of this paper is concerned with the analysis of three case study projects two examples in Malaysia and a case study in Egypt. A semi-structured interview was conducted for site safety manager of the case study project who was responsible the implementation of OHSMS to evaluate the safety procedures and compare them to the safety practices in Malaysian examples. In addition, an examination of the number, causes and types of construction site accidents in the three projects was performed, where the role of occupational health and safety management system on decreasing of accidents has been investigated.

1.1.1. Data Collection Procedures for the Case Study

Based on the findings extracted from the literature review, a semi-structured interview questions were designed for the safety site manager. The respondent selected has extensive working experience in health and safety management as well as construction industry. The questions developed had two main sections; the first section represented general information about the company. The second section of the questions evaluated in details health and safety procedures and questions were asked in detail about the occupational health and safety practices implemented in the construction sites; safety policy, education and training, site safety inspection, safety auditing, safety meeting, site safety organization, personal protective equipment, emergency support and safety measuring devices, fall protective systems, and safety promotions. Finally, the questions aimed to establish the number of accidents in each construction site for the last three years, common construction site accidents, and safety and causes of construction site accidents.

2. Construction Site Accidents

Construction-sites are highly risk prone therefore construction-site accidents are very common and the accident will have severe consequences when it involves vehicles, scaffolding, structures, or ladders. According to Lopez et al. workers themselves are the main factor for site- accidents (Lopez. et al.,2008). However, (Halperin and McCann, 2004) have blamed the lack of training not the workers themselves, where they pointed out that most laborers who use the scaffold do not have adequate training to help them realize when a scaffold is unsafe. They added that falling from heights is one of the most common hazards that take place in sites. Therefore, occupations such as construction laborers, roofers, carpenters, and structural metal workers are commonly involved in falls, whether it's their own fault or not (Huang and Hinze 2003).

2.1 Major Causes and Preventive Factors of Construction Site Accidents

Unsafe acts and conditions cause accidents, where unsafe conditions represents hazards that can cause injuries, including unprotected openings, and improper storage of equipment and materials. Unsafe acts on site are hazards caused by actions of people on site, these actions can be categorized in 3 ways: things a person should have done (e.g. inform others about unsafe conditions), things a person should have done differently, and those that a person should have not done at all (Frederick and Nancy 2009). (Abdul Rahim,2008) and (Ohdo et al., 2011) revealed that the most common type of accident at the construction site is due to fall and the frequency of accidents due to fall is the most critical problems in the construction industry. Major causes of death and injury in construction industry according to

Neal 1995, are summarized in table 1, (R. Neal, 1995). Table 2 shows a more comprehensive approach for analyzing the root causes of site accidents that has been adopted by (Abdelhamid and Everett, 2000) and (Suraji et al., 2001). Where these root causes include both the behavioral aspects and the physical aspects discussed by (Hinze et al., 1998) These factors are beneficial for an entity to prevent them and therefore reduce construction accidents (T. Michael, 2002).

Table 1. Major causes of accidents and injuries (R.Neal, 1995).

Major Causes of death and injury	Percentage of occurrence	Examples from construction site
Fall from Height	(52.1%)	Fall from scaffolding, maintenance cradle, falls from roof, ladders
Slips	(24%)	Slips from roof, into trenches, over handrail, on oil, trips over materials and badly fitting scaffolding board
Being struck by moving object	(20.5%)	Materials falling from height, e.g. off scaffold, material being handled by cranes
Machines	(3.4%)	Excavation pants, cranes

Table 2. Factors needed to prevent root causes of construction accidents. (Abdelhamid and Everett,2000), (Hinze et al., 1998) and (T. Michael,2002)

Root Cause	Factors needed to Prevent Root Cause
F1.Lack of proper training	Have expertise in task; Have expertise in training requirements; Able to interview; test; or observe employee; Have access to prior training records
F2.Deficient enforcement of safety	Able to monitor work on frequent basis; Know safety requirements for task; Able to enforce safety.
F3.Lack of safety equipment	Know what safety equipment is required for task; Able to provide and enforce use of equipment; Know inspection and maintenance history of equipment being used
F4.Unsafe methods or sequencing	Know standard methods and sequencing for task; Able to observe actual methods and sequencing; Able to control methods or sequencing
F5.Unsafe site conditions	Know proper site conditions; Able to observe actual site conditions; Able to control site conditions
F6.Not using provided safety equipment	Able to observe employee constantly; Able to influence behavior through evaluations;
F7.Poor attitude toward safety	Interact with worker frequently; Able to influence attitude through evaluations;
F8.Isolated freak accident	Cannot predict or prevent unless employee's emotional or physical condition contributed and this condition was obvious to others

3. Occupational Health and Safety Management System

OHSMS can be explained to be part of the overall management system that facilitates the management of the Occupational Safety & Health risks associated with the business of the organization. This includes the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the organization's OS&H policy and continual improvement directed towards the abatement of occupational hazards in the workplace. The management system specific to occupational health and safety is comprised of four interrelated components; management leadership and employee involvement, worksite analysis, hazard prevention and control and safety and health training (OSHA, 2008).

3.1 Implementation of Occupational Health and Safety Practices at Construction Sites

Based on the previous studies, it is concluded that there many issues involved in implementing safety and health management in construction projects. Almost all of the occupational injuries are preventable through measures including strengthened safety regulations, safety training, better planning, engineering controls, awareness, and cooperation among industry stakeholders (Baxendale and Jones, 2000). According to studies conducted by (Griffith and Howarth, 2001),(Kin and Bonaventura 2006),(Permana 2007),(Gordon, R. 1999) and (Paringga 2010). , the

principle elements of occupational health and safety that should be implemented at construction sites are related to safety policy, education and training, site safety inspection, safety auditing, safety meeting, site safety organization, personal protective equipment, emergency support and safety measuring devices, fall protective systems, and safety promotions. Table 3 summarizes the role of the safety practices at construction sites. The table also highlights the affected root factor of site accidents upon the application of each safety practice, based on the authors analysis.

Table 3. The role of safety practices at construction sites, Source: authors based on extant literature

Safety Practices	The role at Construction Sites	The affected root factors of site-accidents
Safety Policy	<ul style="list-style-type: none"> This represents the written statement of principles and goals which can demonstrate top management’s commitment to ensure safe working methods and environment at site. Safety policy is a requirement reflects the management commitment towards the organization’s safety and health. (Ahmadon et al.,2006) 	<p>This is considered a prerequisite that shall affect all root causes of Site accidents. However it will mostly impact the mitigation of F4.Unsafe methods or sequencing methods .</p>
Education and Training	<p>All workplace personnel have a right to be trained to ensure their own health and safety and that of others (Paringga, L. A. 2010). Safety training is the most effective tool to mitigate hazard since training helps to improve workers’ skills and abilities to identify hazards (Lai et al., 2011). The training program should include:</p> <ul style="list-style-type: none"> Instructions on the use of equipment, substances, work practices and other safety matters. Information related to work processes and substances, such as warning labels on chemical containers and material safety data sheets. Instructions on how to carry out tasks in a safe and healthy manner Supervision to ensure that instructions are understood and that the person is capable of carrying out the task. 	<p>F1.Lack of proper training: the application of efficient training would help eliminate the root factor of site accidents that is related to poor or improper training .</p>
Safety Inspection and Safety Audit	<p>Safety inspection has been the main tool for maintaining safe conditions and monitoring unsafe practices at workplace and safety audit was created as a requirement for safety management system.</p> <ul style="list-style-type: none"> Safety audit is a detailed examination and evaluation of all components of the system to ensure that they comply with prescribed standards. These include safety inspections, inspection of documents and interviews. Audits tend to apply to the longer-term operations of a business, and include checks and comparisons of documentation, including OHS programs, policies and procedures (Nikolaos, 2010). 	<p>F2. Deficient enforcement of safety:</p> <p>Safety inspection should insure monitoring work and thus shall leverage safety enforcement in the construction site.</p> <p>F6.Not using provided safety equipment: Safety audits shall also help to observe employees behavior towards the application of safety.</p>
Safety Meeting	<p>A gathering at workplace which involves all the construction team members to discuss on the health and safety matters.</p> <ul style="list-style-type: none"> The purpose of safety meeting is to ensure that all the construction team is aware about the safety matters (Holt, 2001) Masayuki included morning safety meeting for all workers and safety meeting on danger prediction as safety activities at construction site (Masayuki, N. S. 2006). 	<p>F7.Poor attitude toward safety: Safety meetings shall help in creating engagement in site , where responsibility for achieving safety is distributed among all.</p> <p>F8. Isolated freak accident: Meetings can also help in sharing experience among each one of the team, which shall surely minimize freak accidents.</p>
Safety Organization	<ul style="list-style-type: none"> Supervisors are found to have a critical role in setting the expectations for safety on sites (Masayuki, N. S. 2006) and (Roelofs et al., 2011). Proper safety zones around the construction areas should be provided to prevent harm from falling objects and some of the regulations were described by the uniform building code (UBC 1985) including at least 3 meters’ clearance from buildings or structures shall be kept clear from using, Driveways between and around open yard storage shall be at least 4.60 meters wide and free from accumulation of rubbish, 	<p>F5.Unsafe site conditions: Safety organization shall make sure that the site conditions have been investigated, and the accessibility areas have been included according to the code of the site.</p>

	<ul style="list-style-type: none"> • And materials stored inside buildings under construction shall not be placed within 1.80 meter of any hoist way or inside floor opening (Elbeltagi and Hegazy, 2002). 	
Personal Protective Equipment	<p>DOSH explained PPE as any equipment worn by a person at work to protect him against risk to safety and health and any additional accessory designed to protect him while performing task, these include HPDs (hearing protection devices).</p> <p>(DOSH, 2005).</p> <ul style="list-style-type: none"> • This includes head protection equipment, face and eyes protection equipment, ear protection equipment, hand protection equipment, foot protection equipment, respiratory equipment and body protection. Minimum PPE required in this area are safety boots, glasses, helmets and long-sleeved jacket. • The construction site will be divided into two zones according to Rosli Ahmad which are ‘green zone’ (non-fabrication area) and ‘red zone’ (fabrication area); it requires the workers to wear Personal Protective Equipment (PPE) because it can cause danger (Rosli, 2008). 	<p>F3. Lack of safety equipment: PPP shall eliminate the lack of safety equipment as long as the equipment are equivalent to the number of site workers , are standard and are usually maintained.</p> <p>This safety practice won’t work without Safety meetings .</p>
Emergency Support and Safety Measuring Devices	<p>There should be an emergency drill conducted once in every three months (Rosli, 2008).</p> <ul style="list-style-type: none"> • All workers will be given a briefing on emergency procedure. They are reminded not to be panic and required to leave their workplace once an emergency siren is activated. • They need to gather at designated assembly areas where their attendances will be recorded by appointed safety wardens • Emergency support and safety measuring devices include work accident record, medicine and first aid, further medical treatment and emergency devices such as fire extinguisher, safety nets and hydrants (Permana, 2007). 	<p>This safety practice would tackle both root factors of risks F1. Lack of proper training and F7. Poor attitude toward safety. Where all site workers will be directly involved in the emergency training, besides creating an engaging environment as well.</p>
Fall Protective Systems	<ul style="list-style-type: none"> • DOSH emphasized that fall protection systems shall be supplied and used in any place where an employee is at risk of a fall of 2 meters or more. The employer can select the fall protection systems that are most compatible with the type of work being carried out (DOSH, 2007). 	<p>This safety practice shall directly affect the F5.Unsafe site conditions in a positive way, where it will enhance the actual site conditions and mitigate the impact of site accidents related to falls .</p>

Based on the previous analysis it is clear that the application of safety systems has a direct impact on either eliminating or mitigating the root causes of construction-site accidents. However, this analysis can’t be verified until the actual application in real case studies is investigated.

4. Analysis of Examples and a Case Study

The coming part shall offer a qualitative analysis of two examples representing Malaysia and a case study representing Egypt. The three construction projects were selected due to their appropriateness for this research; they are high rise buildings that are facing high level of site safety risk. The first Example represents a building complex comprising three basement levels of car parking, seven levels plus one mezzanine level of podium for car parking, one level for amenities and swimming pool, and one tower of thirty-eight levels for an office at the city of Kuala Lumpur, Malaysia. The second example is a 2 block of 40-storey condominium project in Malaysia; a complex of buildings containing a number of individually owned serviced apartments or houses with 2 basements and with car parking podium at the city of Kuala Lumpur, Malaysia (Abdul Razak and Keng, 2014), (Waleed, 2017) and (Alpha,2018). The case study is a two towers of extension industrial buildings of line of creation of Ariel Powder one of them is 42 meters high and the other is 18 meters, it’s called the Henkel Towers, and is allocated in Port Said, Egypt. The building includes steel structure works and is constructed by the consultant ACE Moharram Bakhoum, and by the Contractor Alpha industries & Construction.

4.1 Data Analysis

From the literature review, implementation of occupational health and safety practices at construction sites have been identified to be safety policy, education and training, site safety inspection, safety auditing, safety meeting, site safety organization, personal protective equipment, emergency support and safety measuring devices, fall protective systems, and safety promotions. Table 4 shows an analyses of each of the previous safety practices in the examples the case study.

Table 4. Analysis of the examples and case study as to the occurrence of safety practices at construction sites (Abdul Razak and Keng, 2014),(Waleed, 2017) and (Alpha,2018).

Implemented OHS practices	Example 1:	Example 2:	Case Study
Safety Policy	The responsibilities are shared to prevent accidents from happening. Policy is reviewed every 2 years The company is under the process of upgrading the safety policy It is displayed on the safety notice board which is put at the main entrance of the construction site.	The policy is provided for all key players in compliance with the occupational safety and health act 1994. The policy is to conduct its operation in a manner that will ensure reasonable practice of safety, health and welfare at work for the employees. Safety, health and environment is everyone's responsibility It is reviewed annually.	The policy is complying with HSE requirements; Health, Safety and Environmental Policy. Making monthly HSE review for all company sites to ensure the active application of HSE policy to improve and modify it as required. The policy is provided to all key players licensed with the National Examination Board in Occupational Safety and Health; an independent awarded body founded in 1979.
Education and Training	A training plan which consists of a training schedule is available. After conducting training, a monthly report is submitted Types of trainings include induction training, job specific training and toolbox talk.	Induction training is provided weekly. Job specific trainings are provided every month. Health and safety training is provided for supervisors and managers. Management team attend training courses organized by National Institute for Occupational Safety and Health (NIOSH)	Induction training is provided to all new workers in the project. On daily basis there are job specific trainings. General Manager (GM) must ensure disciplinary procedures regarding training are adhered to; action against any personnel who refuse to attend and participate in job-specific training and fire and evacuation drills. GM participates in consultative review of training needs analysis, programmes and procedures, with all relevant parties, including OHS Committee, at least once a year.
Site Safety Inspection,	Held every week by the safety officer and the safety manager. A safety tour is conducted The safety committee uses safety checklist and if there are any workers who didn't comply with safety requirements, notes are taken. The safety officer checks the air compressor, scaffold, welding set, vehicle and excavation support The safety committee was divided in 2 groups for the 2 towers. As a result of the inspection, the safety committee gives notice to the subcontractor for any offences done by the workers.	Held every week by the safety officer. A site safety walk is conducted The safety officer fills in the checklist which includes a score system that indicates the level of safety. The safety officer takes immediate action for workers who fail to comply with the safety regulations.	Held every day by the safety site manager and safety officer A safety tour is conducted. The safety officer fills in the checklist which includes a score system to indicate the level of safety The site safety manager increases the safety meetings if he found workers failing to comply with the safety regulations.
Safety Auditing,	Conducted twice a year. Carried out by representative of Department of Safety and Health together with the top management of the company. The representative reports results of inspection they issue a Notice of Implementation and sent it to the safety officer and the company has one week to implement the right	Conducted twice a year. Carried out by International Organization of Standardization's representatives It includes safety inspections, inspection of documents and interviewing the safety officer in charge.	Conducted twice a year. Carried out by two trained OHS Representatives. These two representatives would apply the 'Due Diligence' audit tool provided, prepare a report which would include conformance and non-conformance issues. From this, plans of appropriate control are made by management. The OHS Reps may

	practice, Then the notice is withdrawn.	The level of safety is evaluated whether it meets the safety standard requirement or not.	then carry out another audit to check non-compliance issues have been corrected.
Safety Meeting,	Conducted by the company on monthly basis. Attended by the main contractor, sub-contractor, engineer, quantity surveyor, architect and safety committee. They discuss current accident statistic, recent accident cases, implementation of safety practices at construction sites Awards are given to workers who exhibit excellent safety performances. Penalty to be imposed on workers who have broken the safety rules and regulations is also discussed.	Conducted by the company on monthly basis. Safety committee discusses current safety issues and plans strategies to keep and maintain the site safety level. The safety officer conducts daily toolbox meeting for all subcontractors and topics discussed as personal protective equipment, personal health, security, fire prevention, safety facilities and others.	Conducted by safety committee whenever needed. Safety committee discusses current safety issues and plans strategies to keep and maintain the site safety level. Awards are given to workers who exhibit excellent safety performances. Safety meetings increase in cases of non-compliance of workers with the safety regulations.
Site Safety Organization,	Each site has one safety officer who coordinates the implementation of the company's safety policy. Safety committee consists of safety officer, safety supervisor, safety workers and others 12 Safety workers are in charge of installation of safety equipment and ensure there is a clear access and stable working platform.	Safety officers and safety organizers control the safety on site. Safety and Health committee consists of all who are involved in the project is established by the company. The objective is to have zero major accident.	Safety committee consists of safety officer, safety supervisor, site safety manager, five safety watchers, safety workers and others.
Personal Protective Equipment,	The company emphasizes the importance of PPE starting from the induction of workers. The basic PPE is compulsory to be used by all is safety helmets and safety boots. The safety officer makes sure safety helmets obtained the official approvals. To ensure the proper use of PPE, a penalty is imposed by deduction of wages or fine for those who do not wear PPE. The company provides lockers for the workers.	The safety officer urges all workers at the construction site to wear and use basic personal protective equipment. Team management, authority or visitors who are on site wear safety helmet and safety boots. The company provides other PPE depending on the kind of work The safety officer has a PPE record for the workers and provides a PPE checklist every time he conducts site inspection.	The safety officer and site safety manager urges all workers and visitors to wear five things; helmet, boots, safety glasses, vest and gloves.
Emergency Support and Safety Measuring Devices	It comprises of first aid and medical treatment for common injury. First aid room and a site nurse is provided. Fire prevention equipment such as fire alarm, fire poison, fire extinguisher. According to the uniform building by law, the company provides a temporary wet riser. There is a fire escape plan at each level.	In case of emergency, the company provides an assembly point for all workers to gather if needed. The first aid equipment is available on site. There is emergency access.	In case of emergency, the company provides an assembly point for all workers to gather if needed. The first aid equipment is available on site. There is emergency access. There is a clinic on site. There is an ambulance ready on site and another car for any emergencies.
Fall Protective Systems, and	The company provides safety harness for a worker who works 1.7 m or more. The company provides fall protect systems which consists of guardrails, safety nets, holes cover, life line, and catch nets.	The company provides safety harnesses to all workers who work at a 2.5 m height. The company provides safety nets, handrails and guardrails, safety ladder to prevent falls.	The company provides safety harnesses to all workers who work at a 5.5 m height There are constant watchers The company also provides safety nets, handrails and guardrails, safety ladder and anchor points to prevent falls
Safety Promotions.	The safety bulletin board and safety warning signs are placed at the main entrance of the construction site. The company supplies safety booklet to all written in Malay and English.	The company provides safety signs and warning signs at construction site. The safety signs are written in the language of the workers	The company provides safety signs and warning signs at construction site. The warning signs are formed mainly of pictures with few words because many of the workers are of little or no education.
Other Safety practices	The company is concerned with the scaffoldings and are inspected by the safety supervisor.	The contractor provides a two way direction for accessing the passenger lift, where the left side	The company is concerned with the scaffoldings and are inspected by the safety supervisor with three tags red for dangerous, yellow for special use and green

The company provides specific places for chemical materials. is for those who come in and right side is for those who exit. to be used. The drill has a string to be stopped before the saw by 20-30 cm

4.2 Basic Findings

The main findings that were extracted from the comparative analysis between the three case projects is explained table 5. It summarizes the challenges facing the efficient application of OHSP in each of the analyzed cases.

Table 5: The problems upon applying occupational health and safety practices that contribute to construction site accidents, (Abdul Razak and Keng, 2014), (Waleed, 2017) and (Alpha,2018).

	Example 1	Example 2	Case Study
The Problems upon Applying Occupational Health and Safety Practices that Contribute to Construction Site Accidents	<p>Lack of staff in the safety department to control and manage the site's safety well.</p> <p>Attitudes of workers and carelessness in performing their tasks. The workers ignore the safety procedure required by rules and regulations. Most workers lack awareness on safety matters.</p> <p>The workers need time to adapt with working in a high rise building project.</p> <p>The language barriers between supervisors and workers since most workers are from Myanmar and Bangladesh.</p> <p>Management commitment needs to be improved because they want their work to finish fast so they ignore safety matters.</p> <p>Lack of budget allocation on safety management.</p> <p>The cost for safety training course is high so the company needs to allocate more of the budgets on safety.</p>	<p>Lack of awareness on safety matters among workers and the management team.</p> <p>Some of the workers did not wear safety helmet while performing their tasks because they feel uncomfortable wearing it. And in order to finish their work faster, the workers will usually use defective equipment or tools. As long as they can complete their task on time, they will proceed with any tools that are available.</p> <p>Some workers ignore the work procedure required by the rules and regulations</p> <p>A lack of financial allocation for safety management. For this project, it needs more budget allocation to help in safety promotion (i.e. provides safety bulletin board, add more safety signs or warning signs and etc</p>	<p>Lack of staff in the safety department to control and manage the site's safety well</p> <p>Attitudes of workers and carelessness in performing their tasks.</p> <p>Some workers ignore the work procedure required by the rules and regulations</p> <p>Some workers are illiterate so it's hard during education and training</p> <p>Most of the workers lack awareness on safety matters</p> <p>A lack of financial allocation for safety management. For this project, it needs more budget allocation to help in safety.</p>

5. Findings and Discussion

Findings of this paper were extracted from the analysis of examples according to the occupational health and safety practices that have been implemented in the three construction sites by the contractors which have been aforementioned. In addition, the results of the semi-structured interview that show the responses towards the effectiveness and awareness of the Occupational Health and Safety Management System. Finally, the strategies to reduce construction site accidents to be taken into consideration from pre-construction stage shall be discussed.

5.1 Implementation of Occupational Safety and Health Practices at Construction Sites

From the studied construction projects, the three projects have implemented occupational health and safety practices in the construction sites. The table shows that the three companies have safety policies for the works on site and provide education and training for workers at construction site .In addition, they also carry out site safety inspection and safety auditing regularly. Furthermore, and safety meetings are conducted at construction sites to discuss safety matters with workers and the management team. Safety organizations have been established by the three companies in order to manage and control the safety of the construction site. In order to ensure safety of workers, the three companies provide personal protective equipment to workers such as safety helmets, safety boots, gloves and others. In case of emergency, they provide emergency support and safety measuring devices such as first aid, medical

assistance for common injury. Also fall protection systems are provided such as handrails, guardrails, safety nets and catch nets. The three companies promote safety at construction sites to make sure the construction site is always in a safe condition. Each company has different ways of promoting safety. In addition, the three construction projects provide other safety practices such as providing safety access, different color tagging for scaffolding and specific places for chemical materials. A summary of the OHSP that were applied in each of the three analyzed projects is offered in table 6.

Table 6. The existence of occupational health and safety practices at construction sites.

Occupational Health and Safety Practices	Example 1	Example 2	Case Study 3
Safety policy	Y	Y	Y
Education and training	Y	Y	Y
Site safety inspection	Y	Y	Y
Safety auditing	Y	Y	Y
Safety meeting	Y	Y	Y
Site safety organization	Y	Y	Y
Personal protective equipment	Y	Y	Y
Emergency support and safety measuring devices	Y	Y	Y
Fall protection systems	Y	Y	Y
Safety promotions	Y	Y	Y
Other safety practices	Safety access	Safety access	Color Tags for Scaffolds

5.2 The Occurrence of Construction Site Accidents

Upon implementation of occupational health and safety practices at construction sites, the probability of accident occurrence was decreased to 95 %. Figures 1 and 2 respectively show the occurrence of accidents at construction sites, their types and their root causes. In figure 1, accidents were divided into three types according to the numbers of days off needed for the injured workers. The figure shows the number of accidents in the past three years in construction sites during construction phase. The first example in Malaysia had the highest number of accidents but they were mostly of minor 1 type; needed no time off duty, whilst, the case study of the two industrial towers in Port Said had the least number of accidents, where one accident only took place and was of minor 2; which needed up to three days off duty. Figure 2 shows the causes and types of accidents that took place in the three projects; where in the three projects four workers were hit by falling objects, three workers fell from heights, four were injured from motor operated machines, one was electrocuted and one suffocated. In general, there were no severe accidents nor fatalities in the three projects.

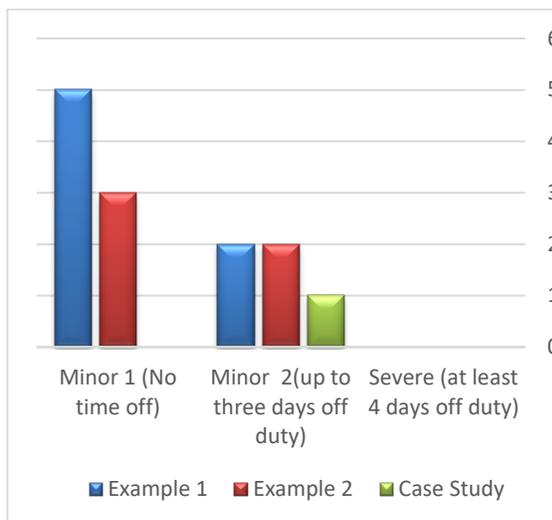


Fig 1. Comparison between three projects of the number of accidents at each site in the past three years and the severity of the accident.

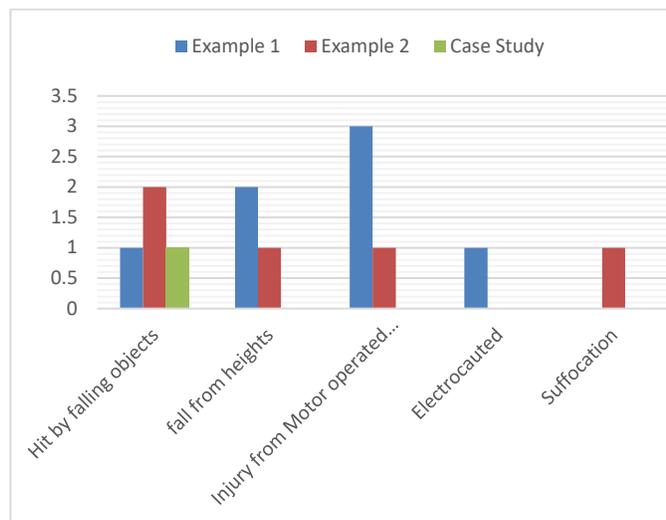


Fig 2. Types and root causes of construction site accidents.

5.3 The Challenges of Applying Occupational Health and Safety Practices on Construction Site Accidents

The major challenges found common in the three construction projects are ignorance of workers on work procedures, lack of financial allocation for safety management, lack of awareness among workers and language barrier between supervisors and workers. None of the three projects faced the following problems that contribute to accidents ; improper use or wearing of personal protective equipment, nor workers using tools in a wrong way and/or for the wrong task nor incompleteness of the content in the training programme, but the third case study faced the following problems that contribute to accidents are lack of enforcement by the authority, lack of safety knowledge and information among the top management and lack of promotion on safety matters.

The OHSP challenges that were faced by the contractors and that contributed to accidents encountered at construction sites in the three projects were:

- Ignorance of workers on work procedures
- Carelessness of workers in performing their tasks
- Lack of financial allocation for safety management
- The training for safety officer is costly
- Lack of experience of workers on safety matters
- Lack of awareness among workers
- Language barriers between supervisors and workers
- The workers use defective equipment or tools
- Lack of awareness among the management team
- Lack of staff for safety department
- Lack of promotion on safety matters
- Poor management commitment

5.4 The Suggested Health and Safety Management Strategies for Reducing Construction Site Accidents

In this part of the research findings the authors explain the strategies that are suggested based on the previous analysis in order to reduce construction site accidents. Where these strategies are to be taken into consideration from pre-construction stage and are relevant to the problems that have been encountered in safety practices at construction sites. The strategies are found to be interrelated with the four components of a successful occupational health and safety management system which are:

5.4.1. Management Leadership and Employee Involvement,

- Top management must give full commitment towards safety matters to ensure that safety equipment is adequate, to enhance their awareness on safety matters
- The company needs to recruit more staff members for the safety department
- The contractor should provide an allocation of budget for safety management.
- Commitment from the management team can be enhanced by having a systematic information delivery among the management team and workers. Management does not take any action to the workers who do not obey the safety rules.

5.4.2 Safety and Health Training

- The workers need to have knowledge on principles in working at high rise building before they get involved in the project so they will be aware of which are they need safety precautions and the action that can cause the accident
- The content of safety training program needs to be improved

- Cost of training is reduced by inducting an in-house training
- To inculcate the awareness of the workers and the management team, the interviewee suggests conducting an effective training course for the workers by having a briefing through photographs, video graphs and animations. In fact, he emphasizes that the content of current training course needs to be revised and improved.

5.4.3 Worksite Analysis

- To overcome the language barrier the company can provide a safety booklet in various languages and more photos than words warning signs
- A safety campaign needs to be conducted with a specific theme monthly
- having a multilingual safety manual, safety warning signs and safety booklets in order to solve the language barriers between workers and supervisor

5.4.4 Hazard Prevention and Control

- Enforcing the safety rules strictly by imposing penalty to the workers who have offended the safety rules and regulation
- It is important to have a fixed budget for safety management in order to facilitate the safety officer or safety committee to improve the safety and health culture at construction sites.

Table 7 shows the occurrence of applying the OHSM strategies to reduce accidents as applied in the two Malaysian examples and Egyptian case study.

Table 7. Strategies and guidelines to reduce construction site accidents to be taken into consideration from pre-construction stage

No.	Strategies and Guidelines to Reduce Accidents	Example 1	Example 2	Case Study 3
1	Provide effective safety training (e.g. using photographs and videos)	Y	Y	Y
2	Allocation of budget for safety management	Y	Y	Y
3	Impose penalty to the workers who have offended the safety rules and regulations.	N	Y	N
4	Provide occupational safety and health campaign	Y	Y	N
5	Give rewards to the workers who exhibit excellent safety performances	N	Y	Y
6	Full commitment from the top management	Y	Y	N
7	Recruit more staff for the safety department	Y	N	N
8	Conduct in-house safety and health training	Y	N	Y
9	Provide safety booklets in various languages	Y	Y	N
10	Provide safety and health training for free	N	N	N
11	Include cost for safety management in the Bills of Quantity (BQ)	N	N	N
12	Distribute a copy of safety policy to each of the workers (pocket size)	N	N	N

6. Conclusions

Despite the contributions and important role construction industry plays in countries' growth, it has always been blamed for the high rates of accidents and fatalities. Construction sector is generally more hazardous than other sectors, due to the use of heavy equipment, dangerous tools and hazardous materials all of which increase the possibility for serious accidents. The aim of this research was to study the impact of OHSMS on reducing construction site accidents in the construction sites. This objective was fulfilled through the analysis of previous literature sources and the analysis of three different construction projects.

The literature review showed that accidents were usually caused by an extensive choice of issues, some of which are unsafe equipment, job site conditions, unique nature of the industry, unsafe method, human element and management. The cause of accidents in construction industry was mainly credited to workers' carelessness, failure of workers to obey work procedures, work at high elevation, operating equipment without safety devices, poor site management, harsh work operation, low understanding and skill level of workers, failure to use PPE and poor workers' attitude about safety. Upon comparing the Malaysian experience in implementing occupational health and safety practices at construction sites to the Egyptian one, it was clear that the number of accidents in construction sites were decreased upon implementing the OHSM practices as there were no severe accidents that required at least four days off in neither

of the three projects under study. Moreover, the cases of accidents were minor requiring maximum three days off. Furthermore, several major problems in implementing occupational health and safety practices that contribute to construction accidents were concluded from the analysis; ignorance of workers on work procedures, lack of financial allocation for safety management, lack of awareness among workers and language barrier between supervisors and workers. Finally, several strategies were suggested to reduce construction site accidents. These are interrelated with the four components of a successful occupational health and safety management system, that are shown in figure 3. The suggestions cover three aspects for the implementation of safety practices, i.e. awareness of workers, commitment of top management and the allocation of resources.



Figure 3: Summary of the suggested OHSM strategy

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