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Overview of the Causes of Accident in Construction Industry: A Comparative Perspectives

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Abstract

The construction industry is a high-risk industry and it is commonly acknowledged as one of the most hazardous occupations in the world. The statistics of accidents in Malaysia shows that Malaysian construction industry is one of the risky sectors that need a drastic overhaul from the current site safety practices. Therefore, a study has been conducted to identify the causes of accidents in construction industry. This study describes an overview of the accident causes occurred in construction industry by various researchers from the local and other countries through reviewing the literature review from journals, books and web pages. This study also highlights the steps which need to be taken to reduce the number of accidents throughout the incentive, awareness and effective training program.

Keywords: Construction Industry, Railroad, Occupational Accident, Occupational Safety, Safety Training, Safety Behaviour.

Introduction

Construction Industry is an important industry worldwide. The construction industry generally defined as a sector of the economy. The industry is playing an important role in economic growth of the country, but it faces many challenges currently that lead to affect project goal and steady growth of the economy. Construction is a high hazard industry which comprises a wide range of activities involving plan, design, construct, supply, installation, completion, testing, commissioning, alteration, maintains, repairs and eventually demolishes of buildings, civil engineering works, mechanical and electrical engineering and other similar works. Construction is always complex that make industry susceptible to disputes, delays and cost exceeding. The construction industry has characteristics that separately are share by other industries but in combination appear in construction alone (Hillebrandt, 1984).

In Malaysia, the voluminous growth of buildings, rails in construction contributes to the economy growth, however it causes the rises of death. The statistics of fatal accidents recorded by Department of Safety and Health Malaysia (DOSH) presented that Malaysian construction

industry has the highest number of fatalities, making it the most critical sector that requires efficient OSH management in order to reduce a significant number of fatalities in construction sites.



Figure 1. - Comparison Fatality Case between Malaysia and 5 Develop Countries

The Causes of Accident in Construction Industry from Local Perspective

In Malaysia, an important economic driver for the nation growth is construction industry. However, this industry always associated with dangerous, difficult, dirty and death or famous known as 4D. Began with site clearing to structural works and fitted with mechanical together with electrical works and finally with architectural indoor and exterior works. Throughout this process, workers are exposed in high risks of accidents mostly involving fall from height, hit by falling objects, lifting operations, and electrocution.

As highlighted by Zhou and Pang (2012), normally occupational accident occurs during construction process. The causes normally happen during working at heights where the possibility of falling due to human factors, unsafe condition or environment surrounding factors, selection of material factors i.e., substandard materials, incompetency of operators to handle the machinery or equipment factors and finally is safety technology factors. This growth also supported by strong demand in both residential and non-residential properties across nation (Malaysia Productivity Corporation, 2014).

According to Rahman (2015), a total value of construction works created by the civil engineering and residential activities during the first half of 2013 rose to 13.8% to RM 43.3 billion. Civil engineering contributed the highest share, at 36.1%, followed by non-residential (31.9%) and residential (27.5%) subsectors (Malaysia Productivity Corporation, 2014). However, there are 69 death cases and 83 permanent disability cases were reported by DOSH up to December 2013. These statistics were updated every 3 months by the DOSH. Meanwhile for the period of 1993 to 2003, there are 1,033, death cases from 49,260 reported cases to SOCSO.

As at to date, DOSH has taken several actions to deal with these problems. One of the approaches is to introduce incentive programme for employees to increase safety and health awareness among the staff and workers. Basically, incentives in the construction industry aims to motivate contractors or sub-contractor workers to comply with the requirements and achieve good performance on safety and health aspects. According to Khoo et al. (2018), Small and Medium (S&M) manufacturing sectors through human resource department need to improve their OSH practical to reduce accident cases at workplace.

Although it may incur cost but should not be a big issue because Malaysia government is preparing lots of incentives or grant for S&M implementing their OSH. The relevant government department and agency such as DOSH, NIOSH, National Human Resource Centre (NHRC), Human Resource Development Fund (advice and Training Fund), Federation of Malaysia Manufacturer (FMM) and Malaysia Employers Federation (MEF) also can provide an advice and training to S&M with zero or minimum cost. This training is part of continuing education for adult learner and provide the solution on how to train foreign workers.

In Malaysia, most of the accident cases today are caused by foreign workers due to communication and language problems. In modern construction era, most of the organization tend to be construction project management rather than purely construction company. This is way forward in construction industry in Malaysia. Most of the main players preferred to appoint its sub-contractors to deliver the project on behalf of them. This scenario led to the environment where the team members did not realize the importance of construction safety and its implication towards the project.

The Construction Industry Development Board (CIDB) in collaboration with the Department of Occupational Health and Safety (DOSH) have come out with several initiatives to improve construction safety through a comprehensive Master Plan. The short- and long-term objectives of this Construction Industry Master Plan is to reduce accidents, injuries and fatalities at construction sites. Rahman (2015) said that with the adoption of new design and technology such as the Industrialized Building System (IBS) and green technology, the productivity growth from 15.5% valued at RM21,765. This growth registered in 2012/2013 due to continuous effort by the industry players in line with some amendment made in several rules and regulations in construction industry in Malaysia.

Moreover, with the rapid launch of mega project in Malaysia e.g., MRT project under Economic Transformation Programme (ETP) and Malaysian Government Transformation Programme (GTP) have also contributed to the increase of growth. In view of these challenges and constraints, Harban Singh (2005), highlighted the necessity to ensure adequate provision in contract documents between the client or owner with the contractors. He added that the contracts document shall contain provision obligations of the contractors include but not limited to work progress, duration, insurance, supervision team and rectification works if deem necessary.

The success of construction for any project not only depends on the quality of the building, the timeline or cost effective, but also achievement on safety and health performance. The project may complete ahead of schedule or on time but sacrifices lots of live especially workers. Unlike project complete on time or delay one or two months but no loss of live. Hence, the safety and health performance are the critical factor which needs to be monitored closely. However, the number of articles regarding OSH in construction relatively small until fifteen (15) years ago. Since 2001 the number of OSH publications relating to construction has increased significantly.

From different perspectives and using different tools researchers have studied occupational hazards in construction and highlighted that there are several tools and methods to investigate and understand occupational accidents in the construction industry. In a systematic review of construction safety studies, (Zhou and Pang, 2012) found that of all the research topics 44.65% were pertinent to safety management process, 20.27% to the impact of individual and group/organizational characteristics, and 33.03% to accident/incident data. Zhou added that the body of research on safety management process involves safety planning, safety monitoring, safety assessment, safety measurement, safety performance etc.

There was a training on HSE aspects in other mega project such as MRT Line 2 and LRT 3 since 2016 but focusing on the competency of workers. Moreover, their focus is to establish multi safety card programme through one-off training programme. This training also tight back with their contractual obligation and enforcement is done not for effectiveness but compliance with contractual matters only. Hence, this training conducted just for the sake of having training for mega project only but not created a culture or sustainable programme to cater for future mega project. On the other hand, the root causes identified from accident cases during previous MRT Line 1 and LRT 2 were lack of safety awareness among workers and no schedule and specific training programme established to overcome those issues. Although, both projects have established its training centre but it is learnt that there was no integrated training programme for construction of railroad conducted for site management.

The Causes of Accident in Construction Industry from International Perspective

In UK, the accident reports are used due to its comprehensiveness and detail compare to accident investigation reports produced by other agencies such as Australian Transport Safety Bureau (ATSB), National Transport Safety and the U.S Federal Railroad Administration (FRA). For instance, all the accident investigation report is published by Rail Accident Investigation Branch (RAIB) from 2008 to 2010. RAIB is an independent accident investigation organization in UK and provides most of the information related the accidents in details such as the immediate cause, the sequence of the event and recommendations.

Gao et al (2019), highlighted that safety remain critical for the construction industry in worldwide. However, according to Hudson (2007), concurred that the third stage for improving safety in workplace is focusing in people actions. Meanwhile, Christian et al (2009) argue on that matter and highlighted that the importance of safety behaviour is underscored by meta-analyses that find a generalizable association between safety behaviour and accidents and injuries. Academics have also increased their attention toward safety behaviour in construction field. According to researcher, despite of arising number of research interest in construction safety behaviour but unfortunately there are limitation on the research domain to support.

Gao et al (2019) agreed that the safety remains a major challenge for the construction industry worldwide. Although, reduction number of workplace accidents and injuries have plateaued since the establishment of legal frameworks and implementation of hazard identification before work started. According to Dodoo and Al-Samarraie (2019), there are 70 empirical studies done to identify the contributing factors related to unsafe behaviour at the workplace. In that review, even though they covered eight (8) work domain, there are only 14 construction-specific papers published from 2007 to 2018. According to Snyder (2019), literature review is part of

methodology to identify the factors influencing the unsafe, safety behaviour, accident and injuries at the workplace.

Lingard (2013), highlight that over 60,000 work-related fatalities are reported from construction workplaces around the world every year. For example, in the United States, more than 700 fatalities and 200,000 non-fatalities injuries cases were reported every year (Bureau of Labour Statistics, 2017). More recently, in 2016, the United States construction industry reported 1034 fatalities – representing a 32% increase since 2011 (i.e., 781) (Bureau of Labour Statistics, 2017). Despite decades of safety management research, construction injuries remain extremely common. Apart from the emotional and physical trauma, the annual cost of these incidents exceeds \$48 billion – adversely impacting project success, profit margins, and the financial stability of contractors and their workers (Zhou and Pang 2012).

Moreover, according to Manu et al (2010), they have invested much effort towards understanding common injury causal factors related to poor safety performance. Similarly, the role of poor hazard recognition and the underestimation of safety risk has received much attention (Carter and Smith, 2006; Tixier et al., 2016). For example, a number of studies have found evidence linking a disproportionate number of injuries with poor hazard recognition and the inaccurate perception of safety risk (Tixier et al., 2016). Carter and Smith (2006) agreed that the construction hazards remain unrecognized, or the associated safety risk is underestimated, the adoption of effective safety risk management techniques will not naturally follow.

Similarly, a study from Australia found that the safety climate will be related to hazard recognition performance, such that a more positive safety climate will be associated with superior hazard recognition levels (i.e., a larger proportion of safety hazards will be recognized). Normally the safety climate relatively with the safety risk perception levels, such that a more positive safety climate will be associated with higher levels of perceived safety risk. Zohar (2010), highlighted that the development and research objectives have been identified as being particularly predictive. The safety in construction is generally measured using a multidimensional scale that includes factors such as management support, worker involvement, workplace policies, and other practices that are supportive of maintaining a safe and healthy work environment (Glendon and Litherland, 2001).

The literature is represented with examples of the benefits of establishing a positive safety training programme. For example, a research by Kievik et al (2018), safety training was proven effective in order to increase self-protectiveness as well as respond efficacy and self-protective behaviour. On the other hand, the past research has demonstrated that an inverse relationship exists between safety culture and undesirable outcomes such as (1) injury and accident rates, (2) under-reporting of safety incidents, and (3) workplace safety violations (Christian et al., 2009; Lingard, 2013). Much of these relationships are meta-analytically integrated in Christian et al (2009) workplace safety model.

The safety training programme within the construction industry is often quite mundane and generic which is a problem for an industry combating with high fatality rates on job sites for decades. Recent studies have found that the construction safety training programme severely lacking in developing hazard recognition and risk assessment skills among its workforce. Moreover, techniques used in these training programmes are not geared to help adult learners engage or retain information provided. Naturalistic Injury Simulations (NIS) in inducing interest among construction workers was established in order to address these shortcomings.

A simulation-based training programme was established by NIS to elicit targeted negative emotional experience among construction workers. It also generates situational interest in construction workers regarding safety. NIS has collected data from 489 construction workers on a construction job-site in an interventional experimental design. Analysis revealed that NIS were able to increase situational interest among workers and that these findings were consistent across all demographic dimensions captured in previous study.

According to NIS, the multiple linear regression analysis did not show clear evidence of a relationship between change in emotions and increase in situational interest among workers. This shows that learning among workers by keeping them interested in the safety training process while also generating risk-averse behavioural patterns through emotional manipulation. The United State construction industry contributes nearly 6% to the entire Gross Domestic Product, accounting for nearly \$1 trillion in annual spending and 40% of the nation's primary energy use as well as 9 million Americans jobs (Dong et al. 2014). Despite of size and importance, it substantially lags behind other industries in safety performance due to the highest injury and fatality rate of any single-service industry.

Bhandari and Hallowell (2017) attempted to address this deficiency by developing NIS, a new safety training programme that uses multimedia-based instruction to facilitate experiential learning. NIS were designed to deliver hyper realistic replications of common workplace injuries to promote emotional arousal during safety training. Initial analysis of the NIS confirmed that they were successful in eliciting an overall negative emotional state, especially among young workers and Hispanic workers Bhandari and Hallowell (2017). These down-trends required a deeper introspection on how to improve safety training and performance among workers of this critical industry. In recent years, many studies have concluded that current safety training techniques fail to develop necessary hazard recognition and risk assessment skills among workers (Carter and Smith, 2006).

There are five processes where workers' cognitive failures may occur in which are obtaining information, understanding information, perceiving responses, selecting a response, and taking action, can resulting in unsafe behaviour when confronted with potential hazards on construction sites. (Fang et al., 2016; Johnson et al., 2020). In order to build comprehensive learning and safety training module for adult learners, it is important to study if, and by how much, emotional arousal supports learning outcomes. Thus, the training will (1) exploring the possibilities if delivering NIS using the principles of adult learning generates immediate and sustained situational interest in workplace safety and (2) measuring the extent to which changes in emotional arousal predict changes in situational interest among adult learners.

The body of knowledge used to develop framework and specific points of deliverable in the subsequent section. Generally, the objective of this study is to increase knowledge of the site staff. This also will be able to identify the shortcomings of the current construction safety training programme. In recent studies revealed that the traditional safety training methods to be highly ineffective because for any given work period. The researchers also found that workers were only able to recognize and communicate less than half of all hazards in their work environment (Carter and Smith, 2006).

According to Bhandari and Hallowell (2017), the main shortcomings of traditional safety training is the reliance on child-focused pedagogical principles when training adult learners, which ignores the wealth of personal experience that adults bring to the learning experience. Meanwhile U.S.

Dept. of Education, 2013 agreed that the same principles used to teach university students who are typically 18 to 24 years of age. Similarly, in construction safety training where the median learner is 43 years of age (Bureau of Labour Statistics, 2017). Albert and Hallowell (2013), found most standard safety training programme failed to effectively communicate knowledge in a manner that can be retained by the workforce and most construction workers harbour a strong negative outlook towards safety training.

Figure 1.1 shows the trend on infrastructure workers fatalities and weighted injuries in railroad industry from 2003 to 2013 in United Kingdom. The rate of fatalities show improvement since 2003 to 2010. However, in 2011, the rate of fatalities shows a hike. By referring to Office of Rail Regulation, the main reason of the hike is due to the risk weighting associated with the two mainline infrastructure worker fatalities.

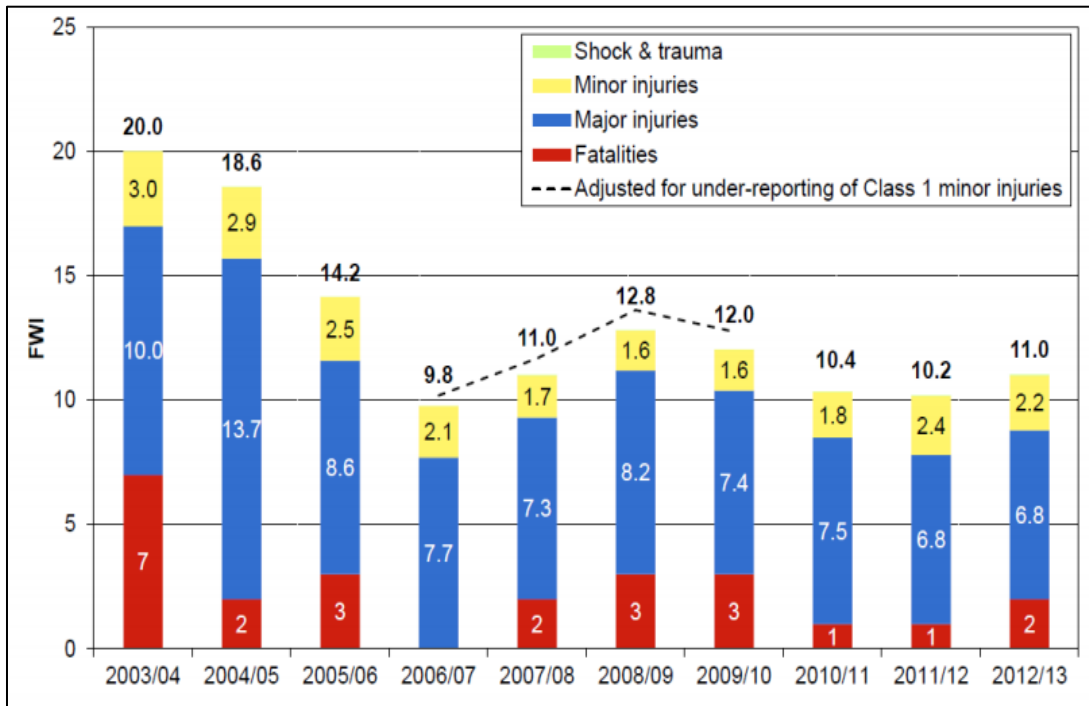


Figure 1.1 – Injuries and fatalities reported from 2003 to 2013 for infrastructure workers in UK (Railroad)

Table 1
 Category of major injury

Major injury category	2018-19	2019-20
Slip, trips and falls	68	53
Contact with object	33	31
Electric shock	3	1
Manual handling/ awkward body movement	0	5
Platform edge incidents	9	7
Road traffic accidents	4	4
On-board injuries	15	14
Other accidents	11	15
Total	143	130

Source: RSSB Workforce Safety 2019/2020

From 2018 to 2020, there were 173 mainline major injuries to workforce related to railroad in Britain. According to RSSB, there were 5099 minor injuries to workforces reported from 2019 to 2020. **Table 1.** shows the Category of the major injury and the number of the injuries reported. The highest reported injuries are slip, trip and falls. Even though there was a slightly decrease in the total number of major injuries, continual improvement should be implemented in order to minimize the number of major injuries and decrease the rate of accident related to the major injuries. This is to protect the workers and also to minimize the losses due to accident and injuries.

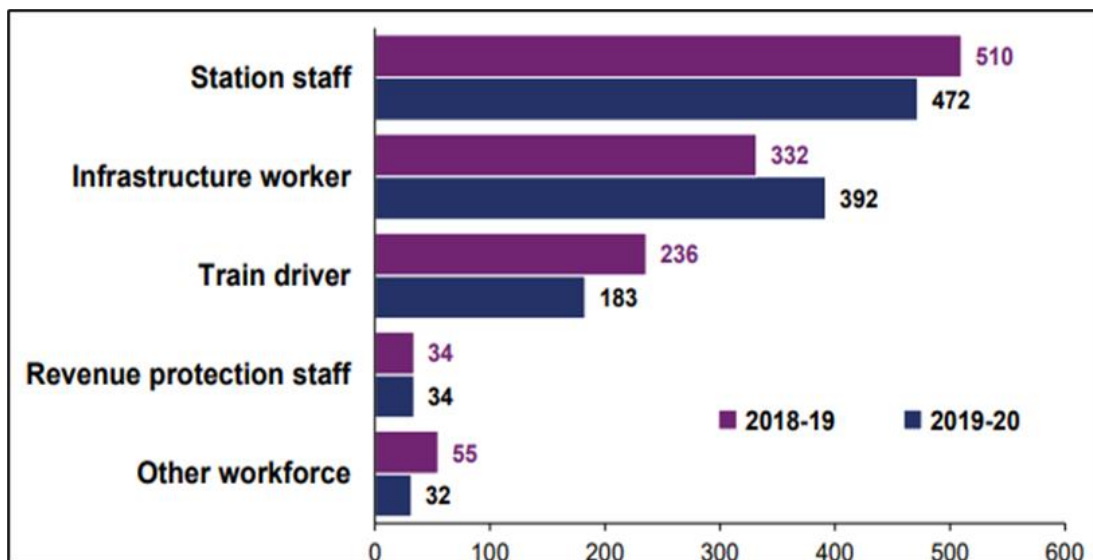


Figure 1.2 - London Underground Workforce Minor Injuries

Figure 1.2 shows the London Underground workforce minor injuries by worker type for 2018-2019 and 2019-2020. The statistic shows that the station staff reported the highest number of minor injuries for 2018-2019 and 2019-2020 followed by infrastructure worker which is 332 in 2018-2019 and 392 in 2019-2020. The total number of minor injuries for London Underground workforce is 1167 for 2018-2019. For the 2019-2020, the number of minor injuries for London Underground workforce reported is 1113. There is slightly decrease in the number for the total of minor injuries for London Underground workforce from 2018 to 2020. However, the statistic shows a hike for the infrastructure worker. There are still room for improvement to improve safety and reduce the number of accidents. Thus, the number of injuries can be reduced.

Identified Gaps

In Malaysia, the effectiveness of the training in railroad construction such as MRT, ECRL an LRT has not been studied and evaluated. This can be seen whereas there is no study or journal related was being published. There are several safety training programmes in construction of railroad were conducted in the past, but most of the training programmes were focused on specific aspects of construction safety either on railroad or track only without thorough evaluation on the effectiveness of that particular programme. Normally, they used questionnaire and interview session with the participants in order to identify factors and variables to conclude the effectiveness of the training programme. In some instances, they face difficulties to generalize the results from entire process of construction railroad since the approach varies from one country to another.

Conclusion

Majority of accidents in construction industry contributed from lack of training to identify and recognize hazard associated with construction activity. The appointment of subcontractor without appropriate and stringent requirement stated in the sub-contract document has also contributed to the inadequate safety measures implemented at the workplace. Furthermore, the appointed subcontractors have appointed foreign workers to deliver the construction works without proper guidance and training in order to understand the official language used at project site. Therefore, all parties should involve including the employer, employees, manufacturers, suppliers, governing agencies to work together in order to prevent future construction accidents occurred. Besides, it was found that the safety performance is directly affected by ineffective and inadequate safety training and competencies programme. Thus, the engagement or decision making from Top Management and authorities become a critical factor in obtaining substantial financial support, raising awareness among other employees and the general public, and strengthening the occupational health and safety management system. The improvement of safety performance through adequate safety training may contribute to a reduction in the number of accidents in construction works. Effective safety training that includes assessments, competency trainers, and certification may inspire workers to get more involved and participate in OSH matters for enhanced safety performance and job satisfaction.

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