Fatal occupational injuries in the Malaysian construction sector– causes and accidental agents

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Abstract. The construction sector is associated with various accidents and fatal injuries. These occupational accidents are caused by numerous factors, such as lack of supervision; lack of adherence to safe work technique; failure to wear personal protective equipment; and failure to comply with the safe use of tools, vehicles, and machines. Using 2013–2016 secondary data from the Department of Occupational Safety and Health and Social Security Organization, this study conducted a descriptive exploration survey to identify common fatal occupational injuries associated with the Malaysian construction sector, as well as their causes and accidental agents. Results indicated that construction, followed by manufacturing, agriculture, forestry, logging, and fishery, are the riskiest job sectors in Malaysia. The highest incidences of occupational casualties were reported in Sarawak, Johor, and Selangor. These states accounted for approximately 13.33% to 18.18% of all cases of fatal occupational accidents. In these states, the lack of safety and health regulations and poor execution of risk management increased the risk of occupational accidents. Falls from heights accounted for 46.28% of fatal occupational injuries. Furthermore, being crushed by objects, materials, or vehicles accounted for 9.09% to 17.36% of fatal occupational injuries. Substandard work environment and transportation and lifting equipment, such as scaffolds, are primary accidental agents. Results of this study could enhance the knowledge and awareness of construction workers and management of job-related injuries to decrease the incidence of fatal occupational accidents.

1. Introduction
The construction industry is growing extremely progressive and profitable. It is one of the topmost industries that contribute to the economy of a country. This industry provides employment opportunities and enhances economic development, especially in developing countries, such as China, India, Indonesia, and Malaysia. However, construction is a risky activity in which different parties engage in myriad challenges in one environment. By analyzing secondary data from Malaysia Social Security Organization (SCOSO), Abas et al [1] found that 2,822 casual occupational injuries occurred in Malaysia with an average annual incidence of 9.2 fatal job-related injuries per 100,000 workers. Recently published data from the Department of Occupational Safety and Health (DOSH) revealed that 1,116 work-related accidents occurred over the period of 2011 to 2016 and that 37.85%–51.50% of accidents resulting in non-permanent disability, permanent disability, and death occurred on construction sites [2]. The US Bureau of Labor Statistics reported that 183,000 workers have been...
injured onsite and 775 workers died. The fatal work injury rate is estimated at 9.5 deaths per 100,000 full-time equivalent workers [3]. Thus, the construction sector is one of the most unsafe and high-risk job sectors in the world given its association with a high number of injuries and deaths.

The Malaysian construction sector is characterized by accident-prone work sites [4]. Onsite accidents interrupt projects and increase cost. Hence, work safety with respect to overall construction activities should be prioritized to sustain the reputation of a company [5]. At the same time, risk hazard can be decreased by closely following procedures provided by the authorities [6]. Zhu et al [7] believed that site safety regulations must be implemented to maintain work safety. They proposed the use of Kalman device to predict the movements of workers and mobile equipment on a work site. The commitment of the top management to safe work conditions and that of workers to safe work attitude are required to maintain a safe work environment [8]. Management should become involved in the prevention of job-related accidents by showing leadership and vision and by incorporating the appropriate safety targets, safety analysis, and emergency procedures to existing safety regulations. Preventative regulations against job-related accidents promote safe work conditions and habits, such as appropriate housekeeping, site layout space availability, good communication, personal attitude, and personal competency. Designing effective safety regulations for construction projects eliminates or reduces hazards and provides an opportunity for a safe work environment [9].

In Malaysia, the surveillance of, as well as empirical studies on, fatal occupational injuries remain fragmented and do not focus on the construction sector. Therefore, in this study, alternative data sources collected over the period of 2013 to 2016 from DOSH and SOCSO were used to identify the riskiest occupational sector in Malaysia. This study specifically aimed to highlight fatal occupational injuries reported from 2013 to 2016 by state, causes, and accidental agents.

2. Literature review
Malaysia has statutes that are crucial for the safety, health, and welfare of employees. The DOSH was established in 1994 and is under the Ministry of Human Resources. It is accountable for enforcing laws on occupational, safety, and health. A health and safety policy is a written statement of principles and objectives that embodies the commitment of an employer to occupational health and safety [10]. Safety policy demonstrates the commitment of the top management to ensure safe work environments, techniques, methods, and procedures for workers in every single job-related category. Hospitals and clinics of the Ministry of Health report occupational accident injuries, poisoning, and diseases [11]. SOCSO was initially established in 1971 to equip non-government employers with socioeconomic security. The Employees Social Security Act 1969 instructs all employers to provide assistance to their employees in case of job-related accidental injuries and diseases by subscribing to SOCSO.

Standard operating procedure (SOP) is a guideline for top management to manage workplace health and safety. Typically, the SOP is determined once the risk for each job in a project has been identified. The safety regulation provision is then established. A safety manual communicates a solid safety policy, identifies safety factors, defines responsibility, and controls the safety management system. The manual, which is the backbone of the management system, defines safety procedures and instructions and identifies specific safety and health requirements [12].

Risk management is implemented to minimize the number of accidental occupational injuries and to control the required measures for risk exposure prevention. Risks that accompany safety and accidental injuries are extremely weighed as part of contractor responsibility [13] and are closely related with onsite risk management practices. The understanding of risk management should be emphasized to encourage workers to create a good work environment. Risk management is a vital management tool that controls construction project risks [14]. Generally, risk is an event that is likely to occur and can adversely affect a project outcome in terms of time, cost, quality, and other relevant performance criteria [15, 16]. Risk management should be easily understood, employed, and applied for predicting the unpredictable by all project teams. Therefore, risk management should be identified, and its safe implementation should be managed effectively. Kang et al [17] and Rahman et al [18] stated that risk management practice in the
Malaysian local industry is still a new concept; only a few companies and industrial professional practitioners have utilized the appropriate tools and techniques for risk management. Risk analysis requires appropriate experience, training, risk management software, and specialist advice on appropriate response techniques. In Malaysia, however, contractors usually apply straightforward, fast, and inexpensive methods, such as preparing checklists and brainstorming, to identify risk only after the occurrence of job-related accidental injury [19]. Thus, in this country risk analysis is applied as feedback after an event.

The inherent physical risk associated with basic construction jobs leads to fatal injuries among workers. The construction sector is characterized by the extensive movement of site workers within the work environment, where numerous movements increase the possibility of accidents. Accordingly, work risk worsens on a site for a complex building or infrastructure that requires the use of advanced tools and equipment. All construction sites constantly evolve from the initial basic constrained space to a confined task as the work day progresses. Unsafe acts or conditions are classified as primary or immediate accidental agents, which directly occur at the moment of the accident. Secondary accidental agents are failures of the management system to predict and anticipate accidents. These agents include training, maintenance, adequate task planning and instruction, and poor safety communication in the workplace [20].

Fatal occupational injuries are caused by various factors, such as falling from high structures or being crushed by objects, machines, or vehicles. The work environment category, which is associated with the accidental agents of floor and wall opening, stairs, and confined spaces, caused the majority of 17,106 total numbers of accidents that were reported over the period of 2000–2009 [21]. Floor openings should be approximately 31 cm with additional access to floors, roofs, confined spaces, or platforms, whereas wall openings, such as open windows, should be approximately 76 cm high and 46 cm wide. A person may fall from such openings. Occupational accidents are linked to permanent disability or fatality. Thus, companies obtain a bad reputation and negative perception from clients and must be investigated by the authorities. In many cases, workers and management can be the sources of occupational accidental injury. Most occupational accidents stem from the combination of management failure, potential hazards in the work environment, and unsafe action or procedures.

3. Methods

3.1 Descriptive exploratory study

A descriptive exploratory study was undertaken over the period of February to April 2017. Experienced construction professionals were given open-ended survey forms with questions on the following: (i) accident cases and causes, (ii) risk management practices, and (iii) improvement of safety awareness level. The respondents hold executive and managerial positions and are senior employees of their companies in the states of Perlis, Kedah, and Pulau Pinang (table 1). DOSH and SOCSO secondary data were reviewed following the face-to-face interviews with the respondents and directly via written exercises.

| Position               | Company                                           | Working Experience |
|------------------------|---------------------------------------------------|--------------------|
| Safety Officer         | Construction                                      | 5 years            |
| Technical Officer      | Department of Occupational Safety and Health      | 8 years            |
| Head Director          | National Institute Occupational Safety and Health | 12 years           |
| Safety Manager         | Department of Occupational Safety and Health      | 8 years            |
| Safety and Health Officer | Construction                               | 4 years            |
4. Data analysis and discussion

4.1 Fatal occupational injuries in all sectors

Table 2 shows 851 fatal occupational injuries that occurred in all sectors in Malaysia from 2013 to 2016. These data were retrieved from DOSH reports and include all sectors: manufacturing; mining and quarrying; construction; agriculture, forestry, logging, and fishery; utility; transport, storage, and communication; wholesale and retail trade; hotel and restaurant; financial, insurance, real estate, and business services; public services and statutory bodies.

| Occupational Sectors                                      | 2013 | 2014 | 2015 | 2016 |
|----------------------------------------------------------|------|------|------|------|
| Manufacturing                                             | 58   | 45   | 46   | 72   |
| Mining and quarrying                                      | 5    | 15   | 4    | 4    |
| Construction                                              | 69   | 72   | 88   | 99   |
| Agriculture, forestry, logging, and fishery               | 33   | 42   | 31   | 25   |
| Utility                                                  | 7    | 1    | 6    | 2    |
| Transport, storage, and communication                     | 8    | 15   | 22   | 13   |
| Wholesale and retail trade                                | 5    | 6    | 3    | 0    |
| Hotel and restaurant                                      | 2    | 1    | 0    | 3    |
| Financial, insurance, real estate, and business services  | 2    | 4    | 14   | 16   |
| Public service and statutory bodies                       | 2    | 5    | 0    | 6    |
| **Total**                                                | **191** | **206** | **214** | **240** |

Overall, from 2013 to 2016, the total number of occupational fatal injuries slightly increased from 21.72% to 30.30%. The number of casualties increased from 69 to 72, 88, and 99, implying that workers in the construction sector are exposed to high risks of occupational accidents. In the same period, the manufacturing and agriculture, forestry, logging, and fishery accounted for 26.0% and 15.39% of total fatalities, respectively, and are thus the two sectors presenting the highest risks for occupational hazards. Similarly, a previous study revealed that transportation, agriculture, and construction are the most hazardous job sectors for the period of 2000 to 2013 [10]. The manufacturing category reported the highest number of accidenta l injuries from 1995 to 2008: 229,033 [22].

However, the slight increase in total casualties noted by the present study is inconsistent with that noted by Abas et al [1]. They found that fatal injuries among non-governmental employees in all occupational sectors declined. Safety effectiveness, regulatory enforcement requirements, professional practices, safety policies, effective management practices, and strategies at workplaces decreased work-related accidents during the years of 2003 to 2006. In addition, Chong and Low, 2014 [21] reported that the number of construction workers significantly increased to 33.68% from 759,900 to 1,015,900 from 2000 to 2009. The authors retrieved SOCSO reports and summarized the number of accidents in all occupational sectors as 656,555, with 42,775 accidents in the construction industry. Out of these cases, 890 were fatal and 5,985 resulted in permanent disabilities. The numbers of fatal accident cases according to the states are presented in table 3.

The number of fatal injuries in all job-related sectors fluctuated over the period of 2013 to 2016. The highest number of death cases was recorded in Sarawak, followed by those in Johor and Selangor. This result could be caused by the growing construction industries in these states. The highest casualty figure, 151 cases (18.08%), was recorded in Sarawak. The increment in death cases in this state, however, fluctuated from 22.51% to 25.83% then to 23.84% and 27.81% in 2013, 2014, 2015, and 2016.
Table 3. Fatal occupational injuries for all sectors according to the states in Malaysia.

| States                        | 2013 | 2014 | 2015 | 2016 | Total |
|-------------------------------|------|------|------|------|-------|
| Johor                         | 16   | 30   | 41   | 33   | 120   |
| Kedah                         | 3    | 1    | 2    | 7    | 13    |
| Kelantan                      | 2    | 7    | 4    | 9    | 22    |
| Melaka                        | 6    | 6    | 8    | 10   | 30    |
| Negeri Sembilan               | 9    | 3    | 8    | 12   | 32    |
| Pulau Pinang                  | 7    | 4    | 23   | 10   | 44    |
| Pahang                        | 6    | 12   | 9    | 17   | 44    |
| Perak                         | 29   | 16   | 15   | 9    | 69    |
| Perlis                        | 1    | 5    | 2    | 2    | 10    |
| Sabah                         | 24   | 29   | 21   | 15   | 89    |
| Sarawak                       | 34   | 39   | 36   | 42   | 151   |
| Selangor                      | 29   | 30   | 13   | 39   | 111   |
| Terengganu                    | 16   | 10   | 4    | 2    | 32    |
| WP Kuala Lumpur/Putrajaya     | 9    | 13   | 28   | 16   | 66    |
| WP Labuan                     | 0    | 2    | 0    | 0    | 2     |

The State Occupational Safety and Health Department (OSHD) Director mentioned that most cases in the construction sector involved falling from heights or being injured by a falling object. They recommended that onsite execution process, the implementation of policy, and adherence to safety procedures be reviewed regularly [4]. Thus, in October 2013, the Sarawak OSHD implemented the program “Ops Cegah Runtuh” at 30 construction sites. It resulted in 112 total notices for various offenses, including failure to ensure scaffolding inspection by a competent person within seven days and no safe declaration for mold and support from professional engineers. Thus, although the incidence of fatalities in Sarawak significantly increased, it is under control. Nevertheless, employers should organize their operating system to minimize accidents on construction sites.

The construction industry is expected to continue growing in Malaysia, particularly in developed Malaysian states. Therefore, it should maintain its growth by implementing various high-impact projects. The second-highest rate of fatalities (14.37%) related to construction work was recorded in Johor due to the emergence of high-rise buildings and new infrastructure in this state. In Johor, the rate of work-related fatalities increased to 13.33% in 2013 and to 25.00% in 2014. The highest rate of occupational fatalities (34.17%) in 2015 was recorded in Johor. The rate of work-related fatalities in Johor slightly decreased to 27.50% in 2016. These observations could be attributed to business and economic growth in Johor and the construction of several mega infrastructures, such as the Pengerang Integrated Petroleum Complex at Kota Tinggi and Sultan Iskandar Complex Custom, at Johor Baharu.

Approximately 600 registered and active construction works are present in Johor, and most of these sites are based in Johor Bharu, where 62% of accidents occurred. Moreover, the majority of sites in this state have received a Grade C rating for standard safety measures. In the 11th Malaysia Plan 2011–2016, Johor is partially responsible for the high investment in the construction sector toward stable economic growth of 12.30%. Hence, the rate of occupational injury increased with increases in sector investment. Meanwhile, certain states, including Perlis and Labuan, showed a downward work-related accidental statistic of 0%–1.19%, explaining the influence of construction cycle over job-related accidents (table 3).

4.2 Fatal injuries in construction sectors

Figure 1 shows the occupational fatality accident figures and their causes in the Malaysian construction sector. Construction projects are categorized as residential, non-residential, mixed development, social amenities, and infrastructures. Accidents involving falls from heights accounted for 46.28% of construction-related accidents reported over the period of 2013 to 2016. This observation indicated that the proportion of fall-related fatalities increased among construction workers. Meanwhile, from 2013 to 2015, the incidence of occupational fatal accidents involving being crushed by objects and materials increased from 19.05% to 42.86%, whereas those involving being crushed by vehicles slightly decreased...
from 27.27% to 18.18%, and no fatalities attributed to these caused were recorded up to May 2016. Similarly, numerous studies have identified that the main causes of job-related accidents in the construction sector include falling, being hit by falling objects, and being buried under excavated sand soil [1, 2, 10, 22]. The details of fatal accidents, such as date and locations, are not presented in this paper.

![Figure 1](https://via.placeholder.com/150)

**Figure 1.** Cases of fatal injuries in the construction sector and their causes.

4.3 Causes of fatal occupational injuries

4.3.1 *Falling from heights.* The majority (46.28%) of fatalities due to falls were mainly recorded at Johor, Pulau Pinang, WP Kuala Lumpur/Putrajaya, Sarawak, and Kedah (Fig. 1). Falling from heights is the most common occupational fatal hazard, with 26 and 15 cases reported in 2014 and 2015, respectively. The highest number of fall-related fatalities occurred in Johor, Pulau Pinang, and WP Kuala Lumpur/Putrajaya; 56 fall-related casualties occurred in these states within the study period (Fig. 1). Several factors, such as failure to wear appropriate personal protective equipment by the workers [23], ignorance of safety and health standards, and lack of safe occupational procedure by onsite workers, contribute to fall-related casualties [24].

4.3.2 *Crushed by objects and materials.* Being crushed by objects and materials ranks second among the causes of death at construction sites, with 17.36% total fatalities over three years (2013–2016; Fig. 1). Meanwhile, 19 missing-in-action cases occurred mainly in Johor, Pulau Pinang, and WP Kuala Lumpur/Putrajaya. One of the cases occurred when a hollow pipe suddenly fell from a high floor and hit the head of the victim while he was walking onsite in WP Kuala Lumpur/Putrajaya on March 2015. Reports stated that the safety helmet used broke due to the great impact of the pipe, and the victim sustained serious and fatal head injuries. Therefore, the employee should be provided with the appropriate type of equipment and protective clothing according to the scope of the job to directly maintain the effective safety standards onsite [25].

4.3.3 *Crushed by vehicles.* The third most common cause of work-related casualties is being crushed by vehicles, which caused approximately 9.09% of all cases (Fig. 1). Eight cases of vehicle-related casualties were recorded at Pulau Pinang in 2014 and 2015. Thus, routine inspections of materials or vehicles are important before starting a project. Typically, however, employees will only take action once an equipment or vehicle breaks down because they often do not follow an inspection schedule [25].
In 2014, one vehicle-related incident occurred in Pahang when a mobile crane was lifting a bundle of scaffolding while the victim was working within the radius. The crane overturned and toppled over the victim due to excessive load. Investigation showed that the accident occurred because no safety work procedure was followed at the site, and the safety attitude of the workers was not regularly monitored. As reported by Omra et al [26], the behavior of the workers in Libya is significantly and positively related with the execution of safety and health requirements.

4.4 Causes of Fatal Accidents in the Construction Sector

Table 4 presents secondary data from SOCSO on fatal accidents in the construction sector. Data recorded on occupational accidents until 2015 were retrieved and categorized in accordance with the causes and genders of the workers involved in the accidents.

| Agent Causes                      | 2013  | 2014  | 2015  |
|-----------------------------------|-------|-------|-------|
|                                   | Male  | Female| Total | Male  | Female| Total | Male  | Female| Total  |
| **Working Environment**           |       |       |       |       |       |       |       |       |       |
| Outdoor                           | 3,384 | 944   | 4,328 | 3,063 | 893   | 3,956 | 2,844 | 833   | 3,677  |
| Indoor                            | 12,833| 2,821 | 15,654| 12,018| 2,851 | 14,869| 11,038| 2,482 | 13,520 |
| Underground                       | 165   | 46    | 229   | 208   | 63    | 271   | 165   | 48    | 213    |
| **Lifting Machines**              |       |       |       |       |       |       |       |       |       |
| Crane                             | 22    | -     | 22    | 22    | 1     | 23    | 37    | -     | 37     |
| Lift and elevators               | 5     | -     | 5     | 6     | 2     | 8     | 8     | 1     | 9      |
| Winches                          | 5     | -     | 5     | 7     | 1     | 8     | 5     | 1     | 6      |
| Pulley blocks                    | 12    | 2     | 14    | 24    | 9     | 35    | 18    | -     | 18     |
| **Other means of transport and lifting equipment** | 91    | 6     | 97    | 97    | 17    | 114   | 80    | 11    | 91     |
| **Total**                        | 16,517| 3,819 | 20,354| 15,445| 3,837 | 19,284| 14,195| 3,376 | 17,571 |

The number of occupational accidents ranged from 16,517 to 20,354. Agents in an indoor work environment caused the highest number (44,043) of occupational accidents. Meanwhile, the incidence of occupational injuries in an outdoor work environment decreased by 30.74% from 2013 to 2015. Approximately 81.49% of these accidents caused by indoor working agent involved male workers. Some accidental agents include equipment use, such as the use of scaffolds, power access equipment, ladders, and excavation and concreting equipment (table 4). A supportive work environment is an environment that attracts individuals in maintaining a healthy environment, encourages them to remain in the healthy workforce, and enables them to perform effectively [27].

Details of fatalities accidental agents, such as work environment, transport and lifting equipment, other equipment, and machines, are shown in table 5. Work environment refers to actual work conditions. Workers are exposed to unsafe work surfaces, floors, wall openings, stairs, and confined quarters. Unsafe work environments resulted in the highest number of death occupational accidents: 43 cases or approximately 47.78%. Accidents caused by transportation and lifting equipment can be classified into falls, being hit by falling objects, and overexertion in lifting objects. This causal agent accounted for 26.67% of all occupational accidents (table 5). These results are consistent with those reported by Abas et al [1], who concluded that transportation and lifting equipment and work environments are main accidental agents and accounted for 41% and 28%, respectively, of all occupational accidents that occurred over the period of 2002 to 2006.

Accidental agents in the transport and lifting category involve certain vehicles, including crane, lift/elevator, and lorry. Accidents with cranes, which are commonly used for transporting and lifting,
are extremely critical. In addition, vehicles used to deliver materials, including reinforcement bars, bricks, tiles, and timber, from suppliers to job sites are common causes of accidents [21].

Table 5. Details of fatalities accidental agents causes in the construction sector from 2013 to 2015.

| Agent Causes                          | Cases |
|---------------------------------------|-------|
| Working Environment (Indoor)          |       |
| Working surfaces                      | 13    |
| Floor                                 | 10    |
| Floor and wall opening                | 7     |
| Stairs                                | 6     |
| Confined quarters                     | 2     |
| Working Environment (Underground)     |       |
| Roof, faces of mine and tunnels       | 5     |
| Transport and lifting equipment       |       |
| Crane                                 | 11    |
| Lift/elevator                         | 5     |
| Lorry                                 | 3     |
| Motor vehicle                         | 2     |
| Pulley blocks                          | 1     |
| Tractors                              | 1     |
| Trucks                                | 1     |
| Other equipment                       |       |
| Scaffolding                           | 4     |
| Others                                | 3     |
| Machines                              |       |
| Cable, pulley, chain and gear         | 3     |
| Molding machines                      | 1     |
| Others                                | 12    |

A recent data found that a victim was crushed by a vehicle while working due to misunderstanding of instructions between workers [2]. Other death accidental agents at construction sites include electric shock while testing circuits and being buried under bricks and concrete while brick binding. The fatality cases reviewed in this study should be addressed to improve the safety and health of workers onsite. These job-related incidents can be used as a measure to sustain a safe work environment. Thus, individuals in this industry should implement the effective risk management and develop adequate safety measures [28].

5. Conclusions
This review reveals that construction, manufacturing, agriculture, forestry, logging, and fishery are the riskiest and most hazardous job categories in Malaysia during the period of 2013 to 2016. The highest incidence of work-related fatal injuries occurred in Sarawak, Johor, and Selangor due to the rapid economic growth in the construction industry in these states. Lack of safety and health regulation and poor implementation of risk management practices could also contribute to the high number of fatal occupational injuries in these states. The most commonly reported occupational accidents include falling from heights (46.28%), being crushed by objects or materials (17.36%), and being crushed by vehicles (9.09%). Meanwhile, the causes of work-related casualties include poor work environment and inferior transportation and lifting equipment, such as scaffolding. The causes of accidents and the elimination of onsite risks are important given the variable effects of occupational safety and health on the construction sector. Moreover, the design of safety concepts should be recognized as a route for minimizing safety risk in work sites. The inferior safety of the work environment influences risk assessment. Hence, to prevent any accidental occupational injuries, all involved parties should maintain the safety of the work environment. The top management should focus on implementing safety regulations and effective management practices in the work environment to protect employees. Although the occurrence of
occupational accidents is unpredictable, protecting worker safety would decrease the risks of occupational accidents.

Acknowledgement
This research is partly supported by the Research of Acculturation Grant Scheme (RAGS 9018-00078) from the Ministry of Higher Education Malaysia

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