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Causes of Fall Hazards in Construction Site Management

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ABSTRACT

Statistics from Occupational Safety and Health Act 1994 has shown that the number of fatality in the construction industry is 5 times more than in other sectors. The total fatalities in construction are 796 in year 2013 and out of this 796, there were 294 fall fatalities. Hence, there is an urgent need to mitigate this problem. A study has been conducted to investigate the root causes of fall hazards in construction site. Therefore, this paper is intended to identify and highlights the types of fall hazards that are most commonly found at construction sites today and the most causes contribute to fall as well as the most effective solutions to overcome the fall hazards. The data collection was being carried out through questionnaire survey to the construction company within Kuching areas. The data were then analyzed by using Likert scaling method. The finding of this study indicates that most fall hazards are caused by roof falls and scaffolding falls where communication barrier is the main problem causes the fall hazards. Besides, the responses from the survey had shown that workplace inspection that conducted weekly and through checklist and by informing affected workers involved about the result of the checklist is the adoptable typical measure to reduce the fall hazards. In conclusion, the problem of fall hazards could be improved and the findings of this study will be helped for further research as well as relevant reference in order to mitigate fall accidents in Kuching.

Keywords: Fall hazard, site working condition, communication barrier, management commitment
JEL Classification: C51

1. INTRODUCTION

The construction sector is the most hazardous industries. The workers that work on construction site have a high rate of being killed at work. Normally accidents occur at construction sites is a result of the unawareness of the safety and health in construction sites. The other factors that lead to accidents are unsafe method, human element, unsafe equipment, job site conditions, management, and unique nature of the industry. In order to prevent accidents, one must know the causes of accident, more specifically the root cause of accidents and the approaches to reduce the falls (Rahim et al., 2008).

This study aims to investigate the root causes of fall hazards in construction site. In order to achieve the aims of the study, there are three objectives that have been focused as follow:

i. To identify the types of fall hazards in construction site
ii. To determine the causes contribute to fall hazards in construction site
iii. To suggest approaches to mitigate the fall hazards in construction site.

2. LITERATURE REVIEW

Falls are one of the OSHA's Focus Four that causes deaths of workers on construction site (Rice, 2012). Fall is defined as a downward movement all the way down to the floor. A fall hazard is a type of physical hazards that cause worker's loss body balance when work at construction site. Falls are usually causes by unsafe act, unsafe working condition, communication problems and

management commitment. The workers that are exposed to fall hazards are cause by their attitude on safety and health protection is an unnecessary expenditure that can be saved and the lack of communication between workers and the person in charge (Maznan, 2010). Thus, it is importance to reduce occurring of fall hazards as the fall fatalities is higher in construction sector. The typical measure such as training, fall protection systems, enforcement of Acts and regulations, safety awareness and fall prevention campaign, workplace inspection and effective safety management system can mitigate the fall hazards in construction site (Occupational Safety and Health, 2014).

3. METHODOLOGY

Data collections are collected through two methods as follow:

i. Primary data: Quantitative (questionnaires)
ii. Secondary data: Literature review (journals, books, thesis, articles, case studies, and magazines).

The data collected are then analyzed by using likert scaling method for the types of fall hazards, causes of fall hazards and typical measures to reduce fall hazards in construction site.

$$\text{Scale Index Interval} = \frac{\text{Highest Min Score} - \text{Lowest Min Score}}{\text{Total Scale Usage}}$$

Scale Index = Lowest Min Score + Scale Index Interval

The example of Likert scaling data analysis as shown in Tables 1 and 2.

4. RESULT AND DATA ANALYSIS

4.1. Identification the Types of Fall Hazards in Construction Site

As illustrated in Table 3, majority of the respondents strongly agreed that scaffolding falls and roof falls are the most risky types of falls accidents occur toward construction workers at site. This finding is consistent with findings of past studies by Goetsch (2003), which scaffolding falls and roof falls are the most common falls in construction site. This give more evidence that scaffolding falls and roof falls are the most critical types of falls occurs in construction site.

Table 1: Scale index

Scale	Level of agreement	Index
1	Strongly disagree	1.40≤Mean index≤2.35
2	Disagree	2.35≤Mean index≤3.30
3	Moderate	3.30≤Mean index≤4.25
4	Agree	4.25≤Mean index≤5.20
5	Strongly agree	5.20≤Mean index≤6.15

The respondents also agreed that falls through opening, ladder falls and falls from building girders or other structure cause falls in construction site although it is not as high as compared to scaffolding falls and roof falls. There are about 100 deaths are causes by ladder each year (OSHA, 2011). For falls from building girders or other structure, respondents agreed with it because the rate of fall is more than 10 times as compared to construction average. Falls from building girders or other structure are usually cause by the bodily action and improper use of personal protective equipment (PPE).

4.2. Causes of Fall Hazards in Construction Site

There are four categories of causes that contribute to the fall hazards at construction site which are: Unsafe act, unsafe working condition, communication barrier and management commitment.

4.2.1. Unsafe act

From the survey, it was found that most of the respondents are strongly agreed that failed to wear PPE and improper use of tools or equipments causes fall accidents occur in construction site as shown in Table 4. Similar research also showed that although the workers used fall protection system, they used it wrongly and the equipments used do not suit to the works carried out (Huang and Hinze, 2003).

4.2.2. Unsafe working condition

As can be seen in Table 5, most of the respondents were strongly agreed that poor site housekeeping and working at high level were the main cause of falls in construction site. Inadequate housekeeping caused site condition become messy and cluttered (Abdullah and Chai, 2010). The risk of workers to fell down increased due to this poor site condition. Working at high elevation is one of the construction activities that are dangerous as compared to other industry. The exposure to high elevation causes the severity of fall in construction site.

4.2.3. Communication barrier

As Table 6 indicates, most of the respondents are strongly agreed with the causes that cause falls in term of communication barrier as follow:

a. Unclear of the information;
b. Language barrier (speaking, writing and reading); and
c. Poor line of communication among safety officer and employees.

Most of the respondents are strongly agreed with the above causes since the construction sector consist of workers from

Table 2: Mean score table (Total respondent (R)=40 person)

Types of fall hazard	Scale (S)					Total score (C)	Mean score (M)
Item	1	2	3	4	5		
Roof falls	0	0	7	16	32	245	6.15
Scaffolding falls	0	0	0	16	27	199	4.98
Holes in flooring	0	1	11	8	20	167	4.18
Ladder falls	0	0	4	14	27	203	5.08
Falling from aerial lift platforms	0	0	5	12	0	63	1.56
Falls from building girders or other structure	0	2	4	10	0	56	1.40

different backgrounds that speak different languages. These workers have poor reading and writing skills as well as.cannot communicate properly with each other at construction site. As a result, the information cannot pass down clearly to the workers thus cause a falls to occur. Many falls occurs due to poor line of communication among safety directors and workers. There was a scaffolding falls occurs because lack of communication among workers, the workers are not aware that the scaffold had been partially dismantled (Dodge, 2012).

Table 3: Mean score of agreement for types of falls accident (Total respondent=40)

Falls	Total score (C)	Mean score (M)	Scale index
Roof falls	166	4.15	Strongly agree
Scaffolding falls	173	4.33	Strongly agree
Falls through opening (other than roof)	159	3.98	Agree
Ladder falls	151	3.78	Agree
Falling from elevated work platform (boom lift)	109	2.73	Strongly disagree
Falls from vehicles (bulldozers, diggers, excavator)	128	3.20	Disagree
Falls from building girders or other structure	150	3.75	Agree

Table 4: Mean score of agreement for unsafe act (Total respondent=40)

Unsafe act	Total score (C)	Mean score (M)	Scale index
Failed to wear PPE	177	4.43	Strongly agree
Improper use of tools/equipments	164	4.10	Strongly agree
Used defective construction plant/machineries	153	3.83	Agree
Improper positioning and posture during working	148	3.70	Agree
Attitude (taking for granted of safety policy)	100	2.50	Strongly disagree

PPE: Personal protective equipment

Table 5: Mean score of agreement for unsafe working condition (Total respondent=40)

Unsafe working condition	Total score (C)	Mean score (M)	Scale index
Poor site housekeeping	169	4.23	Strongly agree
Working at crowded space	148	3.70	Agree
Working at high level (expose to high level)	166	4.15	Strongly agree
Bad weather (rainy/windy)	154	3.85	Agree
Poor warning signage to indicate hole at ahead	115	2.88	Strongly disagree

4.2.4. Management commitment

Table 7 indicates that the highest mean score of 4.05 was due to failed of management to provide sufficient PPE and safety equipments, followed by lack of education (safety training and orientation) with mean score of 3.88. This indicates that most of the respondents are strongly agreed with these causes in term of management commitment. PPE is an importance safety equipments that should provided by management for workers every times they works at construction site. The failure of management to provide PPE such as safety boots, safety belts, and safety helmets causes fall accidents to occur. The percentage of risk explored to falls is high if management failed to provide PPE and workers failed to use the PPE as required. Previous studies have shown that lack of safety training had increase the risk of falls due to poor work practices (Rahim et al., 2008).

4.3. Typical Measures to Reduce the Fall Hazards

There are six categories of typical measures to reduce the fall hazards at construction site which are:

4.3.1. Training

Based on Table 8, most of the respondents are strongly agreed that CIDB Courses and training should consist of hazards identification, risk assessment and control (HIRAC) for effective training in order to reduce fall hazards. Training is importance for all workers especially the new workers. CIDB courses has provides program that consist of Occupational Safety and Health Act 1994 (OSHA94), housekeeping and cleanliness, roof work, working at height and personnel protective equipment. CIDB courses can increase the level of awareness of fall hazards and provide a knowledge regarding safety to workers. HIRAC is importance and it should be included for each of the training program. HIRAC training will increases the level of skills and knowledge of workers to work in safe environment (Geotecsch, 2003).

Other than that, some of the respondents stated that training are more effectively in reducing fall hazards when there is management commitment and daily tools box briefing involves in the training. Management commitments are important in affecting the altitude of the employees. Employees will more likely to participate in training when there is management commitment and they have opportunity to voice out their voice in daily tools box briefing (Dodge, 2012).

Table 6: Mean score of agreement for communication barrier (Total respondent=40)

Communication barrier	Total score (C)	Mean score (M)	Scale index
Unclear of the information	158	3.95	Strongly agree
Language barrier (speaking, writing and reading)	154	3.85	Strongly agree
Poor understanding of signage (safety information and warning signs)	141	3.53	Agree
Poor line of communication among safety officer and employees	151	3.78	Strongly agree
Forms of message transferred cause confusion	112	2.80	Strongly disagree

4.3.2. Fall protection system

Based on the survey findings as summarized in Table 9, most of the respondents are strongly agreed with the suggestions that provide appropriate PPE and fixing of barriers such as handrails and guardrails are the most effective to reduce falls in construction site. Appropriate PPE must be provided by employers to their workers to protect them from the risk of fall. This is because each types of PPE has its specific use and it only specific for certain works. The improper use of PPE had caused 10 victims died as a result of falls. Besides, fixed of barriers are effective to prevent falls from occurring (Chi et al., 2005).

However, least number of respondents are strongly disagreed with the suggestion that secure erected scaffolding can help to reduce fall hazards. In their opinion, fall occurs was not due to the unsecure erected scaffolding, but because of lack of communication between employers and employees or because of the unsafe act of workers.

Table 7: Mean score of agreement for management commitment (Total respondent=40)

Management commitment	Total score (C)	Mean score (M)	Scale index
Failed to provide sufficient of PPE and safety equipment	162	4.05	Strongly agree
Lack of education (safety training and orientation)	155	3.88	Strongly agree
Unaware of guideline of OSHMS	139	3.48	Agree
Poor safety policies	148	3.70	Agree
No safety inspection	99	2.48	Strongly disagree

PPE: Personal protective equipment, OSHS: Occupational safety and management system

Table 8: Mean score of agreement for training (Total respondent=40)

Training	Total score (C)	Mean score (M)	Scale index
CIDB courses	165	4.13	Strongly agree
Training should consist of HIRAC	167	4.18	Strongly agree
Should in the form of oral, written instruction and video	151	3.78	Agree
Training should consist of 8-hours training	118	2.95	Strongly disagree
Additional training for part-time safety officer	108	2.70	Strongly disagree

HIRAC: Hazards identification, risk assessment and control

4.3.3. Enforcement of acts, regulations and guidelines

As shown in Table 10, However, it is interesting to note that most of the respondents are strongly agreed that OSHA94 and Factories and Machinery Act 1967 (BOWECS) will reduce the fall accidents in construction site. OSHA94 can helps protect safety and health at construction site by providing a general duties for employers and employees where Factories and Machinery Act 1967 (BOWECS) required that all the work of installing, dismantle or maintain of the scaffold should supervised by the competent person (DOSH, 2013).

4.3.4. Safety awareness and fall prevention campaign

As mentioned earlier, having safety awareness campaigns can raise level of safety awareness among workers about falls in preventing fall accidents in construction sites. From the study, it was found that the highest mean score of 4.33 was fall into visual safety and health message, followed by banners and posters with mean score of 4.00 as shown in Table 11. Most of the respondents are strongly agreed with these two suggestions by saying that it is the most effective measure to reduce fall hazard. Visual safety and health message is the most effective ways to get the message transferred among the employees from different backgrounds in construction site. Employees are more likely to remember simple and short brief visual message as compared with long and messy message (Geotecsch, 2003).

4.3.5. Workplace inspection

As can be seen in Table 12, most of the respondents were strongly agreed with the suggestions that could reduce falls as follow:

a. Workplace inspection should conducted weekly;
b. Checklist (workers, materials, environment and management on site); and
c. Informed affected workers involved about the result of checklist.

Weekly conducted of workplace inspection could help kept site in good condition and without any obstacles that can cause falls. Through weekly conducted workplace inspection, any problems can be detected immediately and actions can be taken to prevent falls from happening. A checklist for materials or equipments can ensure that it meet the minimum requirements. Besides, informed affected workers can ensure that they improve their performance next times (Radomsky et al., 2001).

4.3.6. Effective safety management system

As illustrated in Table 13, it was found that most of the respondents are strongly agreed that commitment of management and supervisor and tool box safety meeting are effective to reduce fall accidents. It is shows that management or supervisor and tool box meeting are very important as typical measures to reduce falls accidents and lower down the statistic of fall fatalities in Malaysia. This finding indicates that management and supervisor not only

Table 9: Mean score of agreement for fall protection system (Total respondent=40)

Fall protection system	Total score (C)	Mean score (M)	Scale index
Provide appropriate personal protective equipment	169	4.23	Strongly agree
Active measure to prevent workers from falling (guardrails)	151	3.78	Agree
Passive measure to reduce fall injuries (safety nets)	152	3.8	Agree
Fixed barriers (handrails and guardrails)	160	4	Strongly agree
Secure erected scaffolding	89	2.23	Strongly disagree

Table 10: Mean score of agreement for enforcement of acts, regulations and guideline (Total respondent=40)

Enforcement of acts, regulations and guidelines	Total score (C)	Mean score (M)	Scale index
OSAH 1994	171	4.28	Strongly agree
Factories and Machinery Act 1967 (BOWECS)	160	4.00	Strongly agree
CIDB act 520	154	3.85	Agree
MS 1722 Occupational health and safety management system	153	3.83	Agree
Penalize if not obey OSHA 1994, FMA 1967, and CIDB Act	87	2.18	Strongly disagree

OSHA : Occupational safety and health act

Table 11: Mean score of agreement for safety awareness and fall prevention campaigns (Total respondent=40)

Safety awareness and fall prevention campaign	Total score (C)	Mean score (M)	Scale index
Visual safety and health message	173	4.33	Strongly agree
Banners and posters	160	4.00	Strongly agree
Annual construction industry safety award scheme	144	3.60	Moderate
Guides on work-at-height safety and case books	152	3.80	Agree
Safety seminars and talks related (work-at-height and proper use of PPE)	106	2.65	Strongly disagree

PPE: Personal protective equipment

Table 12: Mean score of agreement for workplace inspection (Total respondent = 40)

Workplace inspection	Total score (C)	Mean score (M)	Scale index
Workplace inspection should conducted weekly	161	4.03	Strongly agree
Commitment of safety auditor from DOSH	154	3.85	Agree
Checklist (workers, materials, environment and management on site)	168	4.20	Strongly agree
Informed affected workers involved about the result of checklist	158	3.95	Strongly agree
Inspection on equipments, construction plant/machinery	107	2.68	Strongly disagree

DOSH: Department of Occupational Safety and Health

Table 13: Mean score of agreement for effective safety management system (Total respondent=40)

Effective safety management system	Total score (C)	Mean score (M)	Scale index
Commitment of management and supervisor	176	4.40	Strongly agree
Written safety and health program	156	3.90	Agree
Provide safety and health evaluation each year	158	3.95	Agree
Tool box safety meeting	171	4.28	Strongly agree
Prepared a detailed safety program	107	2.68	Strongly disagree

have vital responsibility to introduced safety policies, but also need to ensure that each employee understand and comply with the safe work practice. It is interesting to note that tool box safety meeting attended by supervisors, workers, and subcontractors can prevent falls from happening. Safety rules, fall hazards, corrective actions and the prevention taken can be discussed in about 15 min tool box safety meeting. Besides, employees have the opportunity to ask their questions at the end of meeting. This will ensure that they are more understanding about safety issues and care about their safety (Ghule, 2008).

5. DISCUSSION AND RECOMMENDATIONS

Based on the result on approaches to mitigate the fall hazards in construction site, the focus areas, which is the workplace inspection has been determined as the most effective measure to mitigate fall in construction site. Therefore, the suggestion of the mind map will be intended to use to avoid fall hazards.

Workplace inspection can be done on scaffolding, PPEs, and workplace environment as shown in Figure 1. According to Construction Industry Development Board Malaysia (2006), scaffolding should inspect weekly to see whether the scaffolds consist of scaffold tag. Under the regulation of 73(2)(b) in Factories and Machinery Act 1967 requires that scaffold tag should be install around scaffolds to aware the workers the condition of the scaffolds.

For the PPEs, all the workers must be wearing fall arresters and safety helmet when working at height as required under the FMA (Safety, Health and Welfare) Regulations 1970, Regulation 32 and FMA (BOWEC) Regulations 1986, Regulation 24.

Furthermore, the workplace environment must be check regularly in term of site cleanliness and the materials arrangement orderly. The workplace environment must be inspected to ensure the overall workplace is clean and tidy, materials are stored in orderly manner and did not cause potential fall to workers.

From the study, it also found that the respondents were strongly agreed on the statement that workplace inspection through checklist is effective to mitigate fall in construction industry. Checklist permit easy on-the-spot recording of the finding on the workplace and it can help to clarify the inspection responsibilities. As shown in Figure 2 NIOSH, FMA and OSHA

as well as SHASSIC play an important guide in the checklist use for workplace inspection. FMA (BOWEC) Regulations 1986, Part X had set the requirements that should check on scaffolding when carried out inspection. The items that need to inspect as required in FMA are the stability of the scaffold footings, horizontal, diagonal and cross braces with no sign of damage, available of hand railings, secured working platform and toe board and scaffold tag. There are three color of inspection scaffold tag; green indicate "Safe for Use," yellow indicate "Caution: Potential or Unusual Hazard," and red indicate "Unsafe for Use." The tag must include the duty of rating of the scaffold, the date on which the scaffold was last inspected, the name of the competent worker who inspected the scaffold, any precautions to be taken while working on the scaffold, and the expiry date of the tag.

Other option to mitigate fall hazards is through toolbox meeting as shown in Figure 3. Based on OSHA 1994, Section 15, tool box meeting should conduct regularly to confirm the availability of tool box attendance name list or talk checklist text. Workplace inspection should generally conduct weekly or one per week. In the toolbox meeting, employers and employees can discuss about the emergency contact number and the assembly point. Besides, PPE, accidents and investigation report also need to discuss in tool box meeting. Accidents and investigation report are important. It can draw attention of the workers to the possible hazards that will happens when works and take precaution on it before the accidents happens.

By enhancing the workplace inspection as the main indicators in measuring fall accidents, good results can be achieved as compared with previous achievements.

Figure 1: Workplace inspection

Figure 2: Checklists for workplace inspection

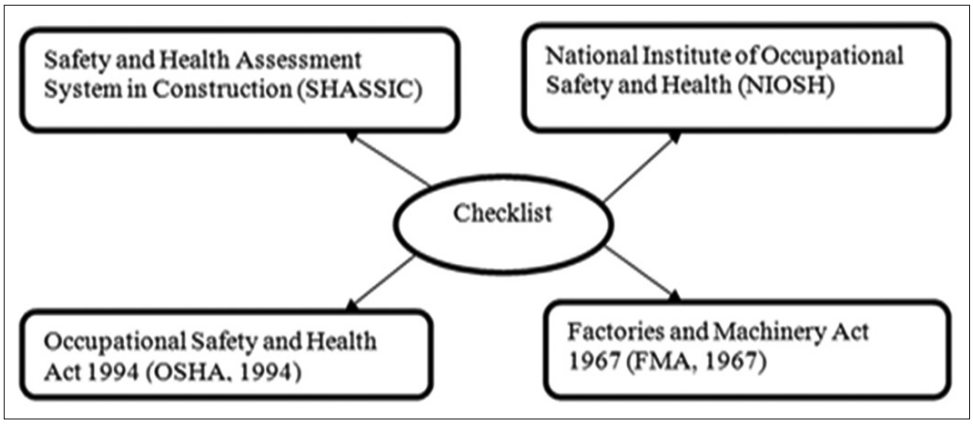
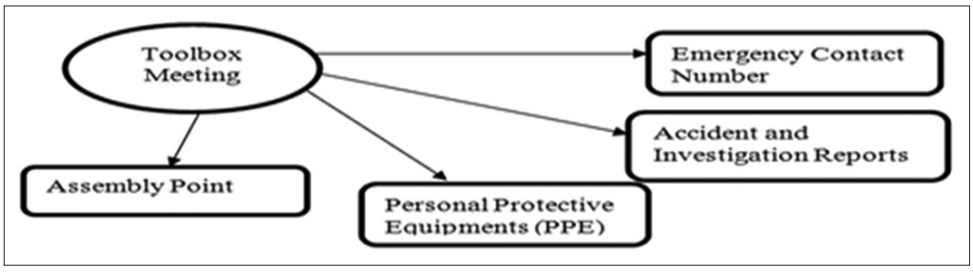


Figure 3: Tool box meeting



6. CONCLUSION

From the analysis of the types of fall accidents in construction site, it is obvious that the most risky types of fall hazards that occurred on construction site nowadays are roof falls and scaffolding falls.

From the study results, it is also found that the most causes that contribute to the fall hazards are communication barrier. The causes of fall accidents in the construction industry mainly attributed to workers' negligence, failure of workers to obey work procedures, work at high elevation, operating equipment without safety devices, poor site management, failure to use PPE and poor workers attitude about safety. The unclear of the information, language barrier in term of speaking, writing and reading, as well as poor line of communication among safety officer and employees contribute to fall hazards.

Based on the study, workplace inspection on construction site is suggested as the most effective to reduce the fall hazards on construction site. Workplace inspection can help reduced fall by conducted inspection weekly, create checklist in term of workers, materials, environment and management on site as well as informed affected workers involved about the result of the checklist. Informed affected workers are a type of communication between management and the employees. Thus these can ensure employees to improve their performance in future.

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