Health Hazards, Risk factors and Safety Practices in Construction Sites –A Review Study

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Abstract: Construction workers face several health hazards and risk in construction sites. Paying minimum attention to construction site safety may directly associate with loss of productivity, accidents and health problems among workers. This review attempts to identify the health hazards and risk factors in construction site, and causes for lacking safety practices in construction sites. In addition, the differences in safety practices in both developed and developing countries and methods for improving construction site safety are discussed.

Health hazards among construction workers are several types: physical health hazards, chemical health hazards and biological health hazards. Effects of some health hazards are chronic while some are acute. Hazardous substances were identified as the most hazardous risk factor in construction sites. Mostly reported risk factors in construction sites are, physical hazards (i.e., noise, heat, humidity, solar radiation, radiation from nuclear power plants), and skin sanitizers, irritants (i.e., bitumen, acids, alkalis, cement). Lack of awareness about site safety or dislike to wear Personal Protective Equipment (PPE) was identified as the one of main causes for scarcity of safety practices in construction site. In addition, loss of productivity after lunch, lack of training facilities and lack of effective labour training (possibly due to the transient nature of the construction workforce) were identified as other possible causes of poor safety practices in construction sites.

Key words: Construction site, Health hazards, Risk Factors, Safety Practices, Acute effects, chronic effects

1 INTRODUCTION

Construction site is defined as “the land and other places, on, under, in or through the works are to be executed and any other lands or places provided by the employer for the purpose of the contract together with such other places as may be designated in the contract or subsequently agreed by the engineer as forming part of the site” (ICE Conditions of Contract).

Construction site becomes a very important place as a considerable number of people are involved in construction activities. Based on educational background, employments in construction industry can be categorized into three: unskilled and semi-skilled manpower, skilled manpower, and technical and management. Site labour with little or no construction qualifications are identified as unskilled and semi-skilled workforce while persons who possess extensive knowledge and experience in their construction activity or profession are identified as skilled workforce. Personal with the high educational qualifications, usually graduate degrees, trained to design, manage and instruct the construction process can be, generally, identified as technical and management level. Generally, both unskilled and skilled labourers are at risk in a construction site, although the level of risk varies with activities they are engaged in.

A hazard is a potential source of harm or an adverse health effect on a person or persons. “Hazard” and “Risk” are often used interchangeably. Risk is the likelihood that a person may be harmed or suffers adverse health effects if exposed to a hazard. Therefore, risk can be minimized, although the hazard is there.

Construction site safety is identified as one of major factor affecting on the image of the project manager and the organization (Grandjean, 1983). “Safety, health and welfare on construction sites”, the training manual published by the International labour office in Geneva explains the contribution to the high rate of accidents is the characteristics to manufacturing sector. Manufacturing sector consists of high proportion of small firms and self-employed workers, variety and comparatively short life of construction on sites, the high turnover of workers, large number of seasonal and migrant workers (many of them are unfamiliar with construction process). In addition, workers are exposed to bad weather and involved in many different trades and occupations. However, the manual published by International Labour office Geneva,
(2012) stated that, “The concern work should be safe and conditions on the construction site should not cause damage to life, health and professional skills”. Further, it explains employer needs to have a written safety and health standards, which should be an objective to be achieved by employer. Effective safety management is to make the environmental safe, to make the job safe and to make workers safety conscious.

Objective of this study is to review previous studies on investigation of health issues of workers and safety practices on construction sites. Common health hazards, risk factors and causes of poor safety practices on construction sites are identified. Based on the review, methods for improving construction site safety are discussed.

2 CONSTRUCTION SAFETY

Health hazards and risk factors associated with construction activities identified from the previous studies are presented in this section. In addition, causes of poor safety practices were identified.

2.1 Health Hazards

Two major hazards that are common in construction sites in Malaysia were identified by Abdul et al (2003). The hazard that are normally associated with process of works or equipment used were identified as "physical injury hazard", while any chemical, physical and biological hazards were categorized as “health hazards”. Physical injury hazards are often caused by equipments used such as scaffolds, power access equipment, ladder, plant and machinery for excavation and processes such as manual handling, and roof work. These hazards were identified by visiting 140 construction sites: infrastructure works (15 sites), housing development (45 sites), high-rise building (45 sites), industry building (15 sites) and institutional building (20 sites). Hazard that has risk of physical injury can cause direct injury to worker at site and, if severe, it can cause death. Physical hazards are caused by different types of energy such as noise, vibration, radiation and temperature extremes. Noise is inevitable in construction sites due to the nature of construction activities. However, in the previous study (Archer) construction noise has been identified as one of risk, which can cause for hearing loss (one of adverse health effects). Workers may be exposed to chemicals generated during construction activities. Asbestos, welding fumes, spray paints, cutting oil mists, solvents and hexavalent chromium are some of examples for chemical hazards found in construction work.

Work related back pain, work related upper limb disorder, Hand-arm vibration syndrome, work–related dermatitis, respiratory sanitizers, pneumoconiosis-Asbestos, pneumoconiosis-Silicosis, radiation diseases (ionizing radiation), heat stress, ultraviolet radiation, hyperbaric risks- decompression illness and Weil’s disease are common health problems among construction workers (Pendlebury et al, 2006). Nevertheless, Abdul et al [2003] found only common hazards. They are protective clothing, noise, fire, and emergency.

In a study funded by UK government, Pendlebury et al (2006), conducted awareness events to develop and test a comprehensive list of the hazards and provide advice on their individual risk to the health of construction workers. As part of awareness event, a series of implementation seminars was conducted. Before each seminar started, the audience filled out questionnaires and the response has been used to investigate the knowledge about health issues. Two of questions were to list three construction materials they might encounter on a building site that can damage health and list the three major construction site hazards, they believe, that can most affect their health. In the order of magnitude, workers considered asbestos, cement and adhesives or solvents, to be the material can damage their health. They considered the dust as the major construction hazards.

Effects of some health hazards are chronic while some are acute. Chronic effects produce slowly and shall cause sickness or death after a certain period. Therefore, the worker neglects them. People, who are exposing to vibration, noise and many other hazards face with the chronic effects, although workers are often not aware of them.
2.2 Risk Factors

Risk factors associated with construction activities were studied in previous studies conducted in different countries (Abdul et al. 2003, Pendlebury et al. 2006, Rameezdeen et al. 2003 and Farooqui et al. 2008). Principal construction risk factor that was often reported is “working in high levels”: Pendlebury et al. (2006) show that the workers considered working in high levels as the principal construction risk activity through one of their questionnaire survey study. Scaffolds, which are types of temporary structures, contribute towards the accident occurrences at the construction workplace (Ismail and Ghani, 2012). Hazardous substances, physical hazards (noise, heat, humidity, solar radiation, radiation from nuclear power plants), and skin sanitizers, irritants (i.e., bitumen, acids, alkalis, cement) were identified as risk factors in many of studies.

2.3 Causes of Poor Safety Practices

Possible causes of the common risk factors can be identified from previous studies by Farooqui et al. (2008), Rameezdeen et al. (2003), Pendlebury et al. (2006), Ahamad et al. (2011), Gunawardana and Jayawardana (2003) and Tam et al. (2004). The causes of accidents were investigated by Rameezdeen et al. (2003) from the records maintained on occupational accidents that have resulted the victim to be absent from work for more than three days (the data reported to Industrial Safety Division (ISD) of Ministry of Labour, Sri Lanka between 1984-2001). The study was based on a series of unstructured interviews with different administrative including the Deputy commissioner of Ministry of Labour, chief factory inspecting engineer of the Ministry of Labour, factory inspecting engineers based in Colombo South and Colombo North, Directors of training and development from the Institute for Construction Training and Development (ICTAD) and the Deputy director of research from ICTAD.

They have identified loss of productivity after lunch might be one of causes of accidents, as relatively high percentage of fatal accidents has occurred during 2.00 pm to 6.00 pm. Rameezdeen et al. (2003) have also identified that, “falls” play a dominant cause among fatalities, similar to that has been reported in Pendlebury et al. (2006). In an analysis of construction sector accidents in Spain, between 2003 to 2008, Antonio et al. (2012) found that the severity of accidents was related to age of workers, size of company, length of service, location of accident, day of the week, days of absence, injury, and climatic zones. In the aspects of fatal accidents, a large company is not always necessarily safer than a small company (Antonio et al., 2012). For example, the largest sites, generally, have highest noise exposure levels (Department of Environmental and Occupational Health Sciences).

Lack of awareness about site safety or dislike to wearing PPE by unskilled labours was another cause. This was identified, possibly, because electricians and unskilled workers were found to be over presented among accident victims: proportion of unskilled victims in non-fatal accidents (71%) was higher than their representation in the construction workforce (50.4%) (Rameezdeen et al., 2003). In addition, Farooqui et al. (2008) also identified unavailability of personal protective equipment as a possible cause of poor safety practices, from a survey in 27 sites, in Pakistan, where the environment in the construction sites may be similar to Sri Lankan sites as Pakistan has a developing economy.

Workers willingness to wear the safety devices (Figure 1) has been investigated (Somasundaram et al., 2006). The study has conducted among 200 workers employed under 80 contractors. Workers, who are employed by M1 and M2 contractors, M3 and M4 contractors, and, M5 and M 6 are grouped as Group A, B, C, respectively. Figure 1 clearly shows that, irrespective of level of contractors, unskilled labours are not interested in wearing PPE. This also proves that poor practices in wearing PPE could be one reason for increasing in construction accidents among unskilled workers, similar to that implies in (Rameezdeen et al., 2003). Working without personnel protective equipment was also identified as an issue related to building construction site safety by Ahamad et al. (2011).

It has been found that hardhat is often used in construction sites and safety boots are occasionally used. However, Hi-Viz jacket is rarely used in construction sites. Safety gloves, earplugs and safety glasses are also very rarely used in construction sites (Ahamad et al., 2011) possibly because of financial difficulties. Availability of personal protective equipments in 200 large and medium-sized construction firms was studied by Tam et al. (2004). Most commonly provided PPE are gloves, hard hats and eye goggles, although many workers considered that hard hats are not convenient for their operations. Farooquei et al. (2008) also imply that young workers do not follow safety norms, similar to the findings that the severity of accidents was related to age of workers (Antonio et al., 2012), or do not use personal protective equipments. The site workers themselves are either unaware of the importance of personnel
safety practices or they do not want to wear protective gears and kits as they consider it as a hindrance in their work productivity (Farooqui et al., 2008).

Figure 1: Workers willingness to wear personal protective equipments

Lack of training facilities would also be a cause of scarcity of site safety. In construction industry, availability of skilled workers directly contributes to improve quality of construction work, but indirectly contributes to improve the site safety. It has been suggested by Gunawardana and Jayawardana (2003) that providing good training facilities for workers would help to retain skilled work force in construction sites. This might be a possible solution to sustain a skilled work force on a long-term basis in construction sites compared to the other industries. Gunawardana and Jayawardana (2003) also revealed that the training facilities available for areas such as masonry, equipment operator training, aluminum work, bar bending or steel finishing, and scaffolding in the usual workplace had more severe consequences. Tam et al. (2004) showed that in construction industry, workers have high mobility and they switch from one company to another, frequently. The transient nature of the construction workforce makes it difficult to train workers.

Causes that may lead to construction site accidents, in Sri Lankan building construction sites, have been investigated by Jeykanthan (2012) and Ahamad (2011). Sixty-one causes have been identified through a structured questionnaire that was used to collect the opinions of the professionals based on their experience related to accidents at building construction sites. The identified causes have been grouped under the major frame of work of job factors (e.g. material handling, working in heights, electricity or gas, hand and power tools, excavation and demolition), human factors (e.g. Manpower), managerial factors (e.g. Site layout, Training, Planning and Administration,) and acts of nature. Ten major causes of accidents related to building construction in Sri Lanka were identified from the Relative Important Index (RII); a method that was used to determine the relative importance of various causes of accidents and their implication. In addition, “failure to appoint a safety officer”, was identified as the most significant cause for the accidents in building construction industry. However, this previous study was limited to collect opinions of professionals based on their experience related to accidents at building construction sites. Workers view on causes on accidents will also be helpful to enhance safety practices in construction sites.
The study conducted by Ahamad et al (2011) investigated the issues related to building construction site safety and propose measures to improve the site safety of the Sri Lankan building construction industry. This study consists with site observations, questionnaire surveys among contractors, conducting interviews and discussions with leading construction industry organizations and other industrialists, implying number of participants in the survey might be high. The common unsafe behaviors found at industry are operating without authority, working with moving machinery, wearing dangling clothes, use of hand, and unsafe lifting, carrying and placing. Use of tools for unsafe handling of hazardous materials was recommended. In this study, contractors were interviewed and difficulties of the organizations, which prevent further improvement of safety, were also identified: financial problems were identified as most significant difficulty.

A survey, similar to Ahamad et al (2011), has been conducted in China to explore the status of construction safety management, by Tam et al (2004). It (Tam et al, 2004) reveals the behavior of contractors on safety use of safety manuals, conducting of safety meeting, arrangement of training program. It seems that safety manuals were not documented in many construction firms: 62% of the construction firms do not have documented safety manuals, while 38% have. However, all the respondents (safety representatives in construction firms who participated in the survey) had documented procedures for safety management on construction sites. In this study, it was found majority of workers are not aware of safety manual: 92% of the workers do not know about procedure for safety managements. Moreover, 36% of construction firms had regular safety meetings and others are in the opinion that safety issues are discussed and presented at other meetings, such as construction progress meetings, implying that safety manuals or similar meetings to discuss safety issues are generally conducted in China. Abdul et al (2003) have identified that most of workers in project sites had a low level of awareness toward using the personal protective equipment.

Labours and staff are sometimes under the influence of alcohol, and drugs (Farooquei et al, 2008), possibly because they are not checked for drugs and alcohol before the start and during work. It has also been identified top ten non-performance practices. These include mainly lack of use of PPE; ear defenders, protective footwear, face masks, safety helmets, gloves, goggles or other items of eye protectors were not worn with the activities associated with noisy equipment, dusty conditions, handling materials which have sharp edges, motorized cutting equipment, respectively. In addition, missing of guard lines on working scaffold platforms, uncovered or unguarded openings in the site, timbers planks left in nails and tools or small machineries which were not placed or were not stored properly have been identified as other non-performance practices.

It reveals that the site management seemed non-interested in emphasizing the need of personnel safety practices among their workers (Ahamad et al, 2011), although this might not be very common, nowadays.

3 DISCUSSION

Comparing the risk identified in different studies, it can be seen that musculoskeletal injuries, respiratory diseases, skin diseases and health hazards such as noise, irritants and stress were identified as risk in construction sites. It was reported that 1107 major injuries, as a result of falling from a height in 2003-2004 (HSE 2004), reoccurring musculoskeletal injuries range from 30,000 to 50,000 every year, respiratory diseases affect up to 20,000 construction workers every year and skin diseases affect up to 10,000 workers every year (Pendlebury et al, 2006). However, in studies, especially conducted in countries like Pakistan, Sri Lanka, Malaysia, musculoskeletal injuries, respiratory diseases, skin diseases among construction workers were not reported. This does not imply that the workers in these countries did not suffer with these chronic effects. It seems that construction sites in developed countries pay their attention on both acute and chronic effects of construction workers. Many of acute effects identified in previous studies include injuries. Possible causes of these hazards might be an unclear and risky slips, trips and falls. Generally, workers walk in the site, by carrying things. Therefore, the worker may not be able to balance the body and difficult to see things in the site. Uncovered holes or trenches in the site might also be a cause for slips and falls in construction sites as workers carrying things cannot see such obstacles. Therefore, keeping the clean pathways in construction sites will help to reduce the injuries, as well as, will improve the efficiency of workers. Keeping the site clean with the help of workers could be part of responsibility of site supervisors. Wearing boots will also help to prevent some injuries although many workers wear thin-soled athletic shoes.

Contractor can give a site plan to safe access to the site, provide fences to keep the unauthorized persons away, display warning signs, declare proper walking and vehicle paths to lead safe access to
working places, keep the site tidy and clean to avoid from disease, similar to the recommendations made by Ahamad et al (2011).

It seems noise and vibrations are risk factors which are having chronic effects for the workers although the workers are not aware of them. However, the construction workers exposed to a combination of noise and vibration, which is inevitable with construction sites. Exposure levels of construction workers to noise and vibration are generally high. Negative effects of noise and vibration on construction workers have been reported in previous studies. However, vibration and noise have been identified as a construction hazard by 3% and 11% of workers, respectively (Pendlebury et al, 2006).

Many of loudest construction tasks had an average level above 85 dBA, loud enough to consider that workers should have worn hearing protection. Exposure to high noise levels may have risk in losing hearing of workers. Depending on the type of construction sites, workers may expose to noise induced by one or more of sources. It addition, it was found that type and size of the work sites are important factors in noise level: the largest sites, generally, have highest exposure level (Department of Environmental and Occupational Health Sciences). Welding and cutting equipment, hand power tools, hand power saw, screw gun and drill motor, roto hammer, chop saw, rattle gun, stationary power tool, powder actuated tool and chipping gun are identified as the ten loudest tools, as the average noise level of these tools are exceeding 94 dBA (Department of Environmental and Occupational Health Sciences).

Vibration induced from construction machines may affect on major part of the worker’s body or only a particular organ to vibrate. As a result, workers exposed to two different types of vibrations: segmental vibration and whole-body vibration. The most common type of segmental vibration exposure is Hand Arm Vibration (HAV) exposure, which affects hands and arms only (Griffin, 1996). Hand Arm Vibration (HAV) is commonly occurred in the frequency range of 15 Hz - 1000 Hz. Most severe effect of HAV is white finger and people affected every year from this disease, as a result of using vibratory tools.

A study conducted by Eger et al measured WBV exposure levels at the vehicle-seat interface and the operator-seat interface, during the operation of both small and larger Load-Haul-Dump (LHD) vehicles. WBV levels were recorded during loading and unloading and mucking tasks of 16 different LHD vehicle models operated. At 8 underground mine sites in Ontario, vibration prevailing in LHD were compared to the ISO 2631-1 health guidance caution zones, so as to determine safe exposure durations. Preliminary test results indicated that LHD operators were exposed to whole-body vibration levels putting them at risk for injury. They have found that ISO 2631-1 exposure guidelines for the health caution zone were exceeded during the operation of several different vehicles. Some seats were also found to amplify the vibration signal resulting in a reduction in the recommended exposure duration. Further research to evaluate the effectiveness of seating used in construction machineries is necessary.

Causes of poor site safety have often been determined (Section 2.3). To develop the knowledge on using PPE and risk factors in construction sites, awareness campaign, through many methods like on site safety charts, displaying pictures, posters or films, can be used. In addition, practical demonstrations on site, arrange appropriate form of formal or informal education and training for the workers on the site can be recommended, although the workers participation in such programs would be totally dependent on their interest. Incentives on completion of such trainings would be a good process to enhance workers interest, as suggested by Farooqi et al, 2008. It would be better to introduce a system to evaluate the attitude towards safety implementation plan of project construction firms before them giving a contract. Contractor top management should formulate strategies and develop policies to create a safe culture as a catalyst for maintaining a safe project, while considering construction needs to be completed within given period and given cost. Designing for safety has also been identified as viable and needed intervention to improve safety performances (Gambatese et al, 2008).

Annual safety audit programs, also recommended by Tam et al (2004), possibly, conducted by Ministry of Construction to ensure safety practices in construction site will enhance safety practices. The scope of the audits may include the safety management system of the construction firms, labour protection measures, safety pitfalls on construction sites. Appointing full time safety officers would also be a good approach to establish safety practices among construction workers, although it can hardly be found in studies in developing countries. However, in China, construction sites having 50 workers or more, main contractors have to nominate a full-time safety inspector; for sites with an area exceeding 10,000 m² there must be 2-3 safety inspectors; wherever the site exceeds 50,000 m², the main contractor has to establish a safety
management team. In addition, to improve safety, engineers, architectures and technical officers should be exposed to construction site safety as part of their educational programs in a university or a technical college.

Educational programs can help make construction workers aware that many activities on the job site have potentially hazards including noise. In addition, company may look into possible methods to reduce noise exposure levels in construction sites.

Most of the previous studies were based on survey among professionals or statistical data collected from authorities, while few studies were based on interviews and questionnaire surveys. However, it will be better to visit construction sites and get views of range of workers (i.e., skilled workers, semi skilled workers and unskilled workers) in order to find effective method to reduce risk. A comprehensive research study based on face-to-face to interviews and questionnaire surveys among construction workers is required, to understand whether unskilled, semi skilled and skilled workers have an idea on risk factors and safety practices.

4 CONCLUSIONS

This review study attempts to investigate the health hazards and risk factors in construction site, causes for lacking safety practices in construction sites. Previous research published on health and safety on construction sites in both developed and developing countries were reviewed so as to identify the differences in safety practices and methods for improving construction site safety.

Mostly identified risk factors in construction sites are hazardous substances, physical hazards (noise, heat, humidity, solar radiation, other radiation from nuclear power plants), and skin sanitizers, irritants (i.e., bitumen, acids, alkalis, cement). Lack of awareness about site safety or dislike to wearing Personal Protective Equipment (PPE) was identified as the one of main causes for scarcity of safety practices in construction site. “Lack of productivity after lunch”, “lack of training facilities”, “lack of effective labour training (possibly due to the transient nature of the construction work force), “lack of understanding of the job”, “unsafe behavior found at industry (working with moving machinery, wearing dangling clothes, unsafe lifting, carrying and placing), “financial difficulties and “influence of alcohol and drugs” are the other identified causes of poor safety practices. Workers and contractors awareness on possible risk factors and site safety were more concentrated in studies in developed countries compared them in developing countries.

There is no systematic study on the chronic effects of health hazards on construction workers, although possible risks were reported in some studies, implying that less attention has been paid for chronic health effects of workers in construction industry. Noise and vibration associated with construction activities may have an effect on the health of workers.

It can be identified that a one of the major needs to the construction industry is to enhance professionals’ interests in active safety management and implementation of awareness programs, which must be developed and implemented among construction workers. An additional training for the workers, which could be provided by contractors about equipments they use, before workers engage in their duty, would also help to prevent accidents. Awareness on possible risk factors and knowledge on how to reduce these risk factors among workers and contractors will enhance site safety.

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