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Managing Occupational Health and Safety Risks in Precast Factories: A Case Study in Australia

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Abstract

Statistics show that precast factories are linked to a high degree of occupational health and safety (OHS) risks. The aim of this study is to analyse the health and safety risks in precast factories in Australia through a case study. The specific objectives of this research are (1) to identify OHS risks in precast factories; (2) to investigate the severity and occurrence of those risks; (3) to rank those risks to help devising appropriate cost-effective control measures. A case study was conducted to obtain quantitative data regarding OHS risks in a precast factory. A data collection instrument was designed to facilitate the collection of data. Participants at the selected factory were required to rate the identified hazards in terms of frequency and severity. The results indicate that the most significant risks identified in this case-study were traffic hazards, machinery hazards, occupational noise hazards, airborne hazards and hand and power tools hazards. The results may provide better understanding of OHS risks in precast factories in Australia and be used to help decision makers of the precast factories to formulate cost-effective control measures for the precast factory in Australia.

Keywords

Risk management, occupational health and safety, precast factories, construction, Australia

1. Introduction

Precast concrete is fabricated in a factory environment before being transported on site for assembly. The manufacture of precast concrete involves machinery, equipment and tools as well as a range of procedures, tasks and processes both related to the manufacturing and construction industry (Candiah, 2004). Statistics (Safe Work Australia, 2012) show that both the construction industry and manufacturing industry are associated with a high degree of risk. Even though the incidence rate and fatality rate have been considerably decreasing in the past decade, the actual rates in these industries are nearly twice the rates for all industries. The

Cooperative Research Centre for Construction Innovation (2007) outlines some limitations of off-site manufacture (OSM) stating that it may be perceived to potentially increase consequences of incidents, possibly due to lack of professionals skilled in OSM and lack of knowledge portal, probably due to insufficient industry investment in Research and Development (R&D). These concerns mandate for further analysis and research in risk identification and mitigation strategies to support OSM (Cooperative Research Centre for Construction Innovation, 2007). Against this background, this research aims to identify occupational health and safety (OHS) risks in precast factories in Australia.

2. Methods

2.1 Instrument

The hazards applicable to precast factories were identified through a literature review (NIOHS, 1984; Goetsch, 2003; Grammeno, 2009; Griffith University, 2012; RTA, 2012; Feng, 2013). The hazards were classified into safety hazards and health hazards (see Table 1). Safety hazards refer to a condition that can lead to injury; and health hazards refer to a condition that can lead to illness (Goetsch, 2003).

Table 1: Summary of Safety and Health Hazards

Safety hazards	Health hazards
Material handling hazards	Occupational noise hazards
Electrical hazards	Ultraviolet radiation hazards
Falls from height hazards	Airborne toxic hazards
Falling object hazards	Psychosocial hazards
Traffic hazards	Overexertion hazards
Machinery hazards	Repetitive movements hazards
Hand and power tools hazards	
Radiation hazards	
Slips and trips hazards	
Plant or vehicle overturn hazards	
Caught under or between hazards	
Stuck by hazards	
Chemical hazards	
Fire hazards	

The development of the data collection instrument is based on the risks identified in Table 1. The instrument comprises the following two sections:

Section A: In this section, respondents were asked to provide information about their position within the company, the number of years they have been working in the current factory, the number of years they have been working in the construction industry etc.

Section B: In this section, participants were required to rate the identified hazards in terms of frequency and severity using a 5-point Likert scale. The frequency were expressed in descriptive terms, such as ‘highly likely’, ‘likely’, ‘possible’, ‘unlikely’ and ‘rare’; and the severity were also expressed in descriptive terms, such as ‘catastrophic’, ‘major’, ‘moderate’, ‘minor’, and ‘negligible’.

2.2 Data collection

Data collection was conducted at a modern factory of precast company A located in the Sydney metropolitan area. Company A is a major player in the Australian precast market which offers a precast concrete solution for most building applications. The questionnaire was administered with all the 30 employees at the selected precast concrete factory. We conducted two presentation sessions in the meeting room of the factory in order to explain the purpose and procedures of the survey. After the presentation, each participant was requested to complete a questionnaire and return to the researcher, provided that they consent to participate. Out of the 30 questionnaires distributed within the factory, seventeen questionnaires were returned to the researcher, representing a response rate of 57 per cent. The profile of respondents was reported in Table 2.

Table 2: Profile of Respondents

Profile	Frequency
Position	
Apprentice	2
Tradesman	7
Supervisor/engineer	2
Management	4
Others	2
Years working in the current company	
<2	5
2-5	3
6-10	5
≥10	4
Age	
<25	5
25-34	4
35-44	4
≥45	4

2.3 Data analysis method

According to Goetsch (2003), risk assessment in the context of construction safety amounts to determining quantitatively the level of risk associated with a given process, procedure or activity. It involves assessing how likely it is that a hazardous event will occur and what the consequences are likely to be (RMS, 2012). A common method of risk assessment in the construction industry is through the use of a matrix. Basically, each hazard is associated with a block in the matrix to establish the relative risk. The relative risk is classified in terms of the likelihood of it happening and in terms of its consequences. Hazards can thus be classified in terms of priority once the relative risks have been established (Kremljak, 2010). That is, hazards can be ranked from high to low risk. Tools such as the WorkCover NSW's Hazard rating system which rates risks from one (high risk) to six (low risk) may be used (RMS, 2012).

Since it is generally accepted that 'Risk' is equal 'Likelihood' multiply by 'Consequence' (Donoghue 2001; Standards Australia/Standards New Zealand, 2004; Cox, 2009), the relative importance of a risk item will be established by multiplying the frequency with the severity of this risk item. The risks are then categorised into three levels, namely, 'high', 'medium', and 'low'. The 'high' category can refer to be 'broadly unacceptable'; the 'medium' category as 'tolerable' and the 'low' category as 'broadly acceptable' (Ho, 2010). The category was based on the principle that all cells in the left column and bottom row represent the lowest risk category; and that all cells in the second column from the left and second row from the bottom do not represent the highest risk category (Cox, 2008). This method thus set up the 'low' and 'high' risk category, while accepting some inconsistency for the 'medium' category (Cox, 2008).

3. Results and discussion

Figure 1 presents the summary of the average rating of the frequency and severity for the each of the twenty (20) risks. The averages were calculated from the 17 questionnaires collected. For example, for the 'material handling hazard', the frequencies of the 17 participants for that risk were added together, and then divided by 17. The same procedure was applied for the severity. The frequency and severity of a risk were multiplied to compute a risk index for each hazard. Table 3 shows how the risks were categorised according to their average frequency and severity rating; and table 4 presents the risks ranked in order of relative importance.

As shown in table 4, the risk category with the higher relative importance was traffic hazards, followed by machinery hazards and occupational noise hazards. Eleven (11) risks were categorised as 'tolerable' while the remaining (9) were classified as 'broadly acceptable'. None of the risks were classified as 'broadly unacceptable' in this case-study. The following paragraphs present further analysis on key results.

Traffic hazards, machinery hazards, occupational noise hazards, airborne toxic hazards and hand and power tools hazards were ranked in the top five in order of relative importance. Traffic hazards may refer to accidents from trucks entering, existing or reversing in the precast site. Machinery hazards were ranked in second place and scored a frequency rate value of 2.6 and a severity rate value of 3.6. Machinery hazards may refer to those hazards posed by the machinery in a precast factory. For instance, machines with moving parts can tangle in a worker's clothes or come into contact with a worker's body. Statistics show that more than 30% of the worker fatalities were those employed as machinery operators and drivers. Out of the 68 non-traffic vehicle incident deaths, construction workplaces accounted for 11 deaths of which three were trucks drivers; four were driving construction vehicles such as dozers and excavators; and four were workers on foot who were hit by vehicles (Safe Work Australia, 2012). The construction industry recorded the highest number of truck-related deaths and had the highest number of workers on foot (9) who were killed when they came into contact with a truck. Five of the 9 workers on foot were on road construction sites (Safe Work Australia, 2012). The construction and manufacturing industry are among the industries recording the highest number of fatalities when trucks are involved. These are consistent with the findings of this study, where it can be seen that traffic hazards were ranked in the first place among all the hazards in the factory.

Occupational noise hazards were ranked in the third place and scored a frequency rate value of 4.0 and a severity rate value of 2.3. Occupational noise hazards refer to exposure to noise at the workplace that exceeds prescribed levels. The high frequency rate value of 4.0 means that occupational noise hazards are highly likely to occur at the precast factory site. This result is confirmed by a study in the United States, which found that noise is omnipresent on construction worksite and that about 9% of people in the industry were exposed to a levels of noise that pose a risk to their hearing (Hager, 2005). The study also claimed that construction workers exposed to such levels of noise will lose between 12 and 30 per cent of their hearing on site (Hager, 2005). Noise hazards were found in 31% of workplaces, 30% of which were in the construction industry, 27% in the manufacturing industry and the rest in 8 other industry sectors (Work Safe Australia, 2012a, b). The national hazards exposure worker surveillance survey 2008 which represented a sample of 4500 workers interviewed by telephone claimed that 32% said to be exposed to loud noise at work, of which 68% were in the mining industry; 58% in the manufacturing industry; 53% in the construction industry; and 39% in primary industries. The numbers show that occupational noise hazards are indeed a major concern, coinciding with the results of this case-study which ranked occupational noise hazards as the second significant OHS risk for workers in the precast factory.

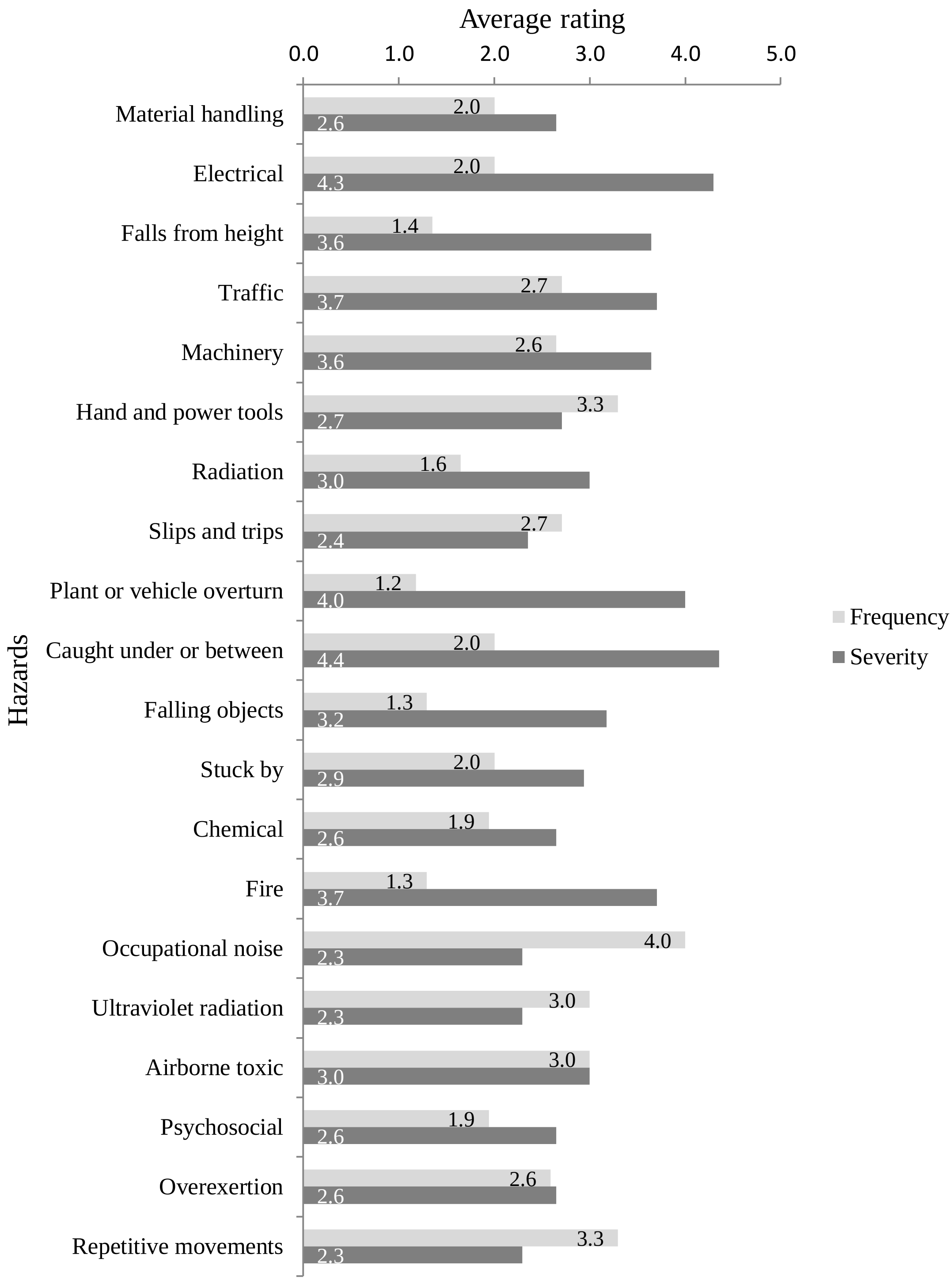

Figure 1*:* Hazards Summary by Average Frequency/Severity Rating

Table 3: Relative Importance Risk Category

Relative importance of the risk	**Risk index**
High	15 - 25
Medium	6 - 14
Low	1 - 5

Table Error! No text of specified style in document.**: Ranking of Risks in Order of Relative Importance**

Risk description	**Risk index**
Traffic hazards	10.0
Machinery hazards	9.7
Occupational noise hazards	9.2
Airborne toxic hazards	9.0
Hand and power tools hazards	8.9
Caught under or between hazards	8.7
Electrical hazards	8.6
Repetitive movement hazards	7.6
Overexertion hazards	6.9
Ultraviolet radiation hazards (health)	6.9
Slips and trips hazards	6.4
Stuck by hazards	5.9
Material handling hazards	5.3
Psychosocial hazards	5.1
Chemical hazards	5.1
Radiation hazards (safety)	4.9
Falls from height hazards	4.9
Fire hazards	4.8
Plant or vehicle overturn hazards	4.7
Falling objects hazards	4.1

Airborne toxic hazards were ranked fourth in this case-study. Airborne toxic hazards refer to exposure to dusts, fumes, smoke and gases. A score of 3.0 were averaged for both its frequency and severity. Hand and power tools hazards came fifth in the ranking in this case-study. Hand and power tools hazards may refer to the improper use of such tools, as they need to be handled with care to avoid any type of injury. Power tools may be electrical or hydraulic. The frequency rating value means that it is more than just possible for these hazards to occur and the severity rating value means that in some instances, more than just first aid may be required, thus this may include some medical treatment.

Fire hazards, plant or vehicle overturns hazards and falling objects hazards were ranked in the bottom three in order of relative importance in this case-study. Fire hazards may refer to those hazards that may cause fire in the factory. Some common fire hazards are: electrical systems that are overloaded; combustible storage areas with insufficient protection; combustibles near equipment that generates heat, flame, or sparks; smoking (cigarettes, cigars, pipes, lighters, etc.); equipment that generates heat and utilises combustible materials; flammable liquids etc. These hazards are generally dependent on the set up of the precast factory plant or site. Fire hazards scored a really low frequency rate value, meaning that those hazards are very unlikely to happen. However, if it were to happen, it would be quite severe and may cause the victim extensive injuries. Plant or vehicle overturns hazards may refer to the overturn of a crane, mobile plant, tractors, bobcats and the likes. These hazards scored a low frequency rate value, meaning that it is very unlikely for it to happen. However, if the hazard was to happen it may cause extensive injuries. Falling objects hazards may refer to any objects, materials, or concrete components falling from scaffolds, aerial lifts, hoists, cranes and so on. This may also include debris from grinding operations. Falling objects hazards scored a low frequency rate value, meaning that it is very unlikely for it to happen in the precast factory site.

The third objective of this study was to rank the hazards and discuss control measures for each group category of risk, namely, 'broadly unacceptable risks'; 'tolerable risks'; and 'broadly acceptable risks'. As previously discussed in section 2.2.3, the most effective control measures involves eliminating the hazard, that is, by not introducing the hazard into the workplace. If is not reasonably practicable to eliminate the hazards, substituting the hazard with a safer approach should be considered, and if not reasonably practicable, next measures of control down the hierarchy of control should then be considered. That is isolating the hazard from people; using engineering controls; using administrative controls; and finally using personal protective equipment.

4. Conclusions

This study examined the health and safety risks in a precast concrete factory in Australia. Twenty health and safety hazards pertinent to precast factories were identified through literature review. A questionnaire survey was conducted to collect peoples' perceptions towards frequency and severity of the hazards. It was found that the most significant risks identified in this case-study were traffic hazards, machinery hazards, occupational noise hazards, airborne hazards and hand and power tools hazards. The result may provide better understanding of OHS risks in precast factories in Australia and be used to help decision makers of the precast factories to formulate cost-effective control measures for the precast factory in Australia. The limitations of this study need to be highlighted. The first limitation lies in the generalizability of the findings. The findings were reached based on the data collected from a single precast concrete factory in Australia. Thus, the generalizations of the findings to other populations may be difficult.

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