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Factors influencing workplace accident costs of building projects

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ABSTRACT

Workplace accidents would incur various losses to the injured workers and their families, employers and society. This study aims to investigate the magnitude of workplace accident costs to building contractors and identify factors influencing workplace accident costs of building projects. Data were collected using multiple techniques (structured interviews, archival records and questionnaires) from 47 completed building projects in Singapore. Data were analyzed using bivariate correlation analysis and moderated regression analysis. It is found that the average direct accident costs, indirect accident costs and total accident costs of building projects account for 0.165%, 0.086% and 0.25% of contract sum, respectively. It is concluded that workplace accident costs of building projects are influenced by accident rates, project hazard level, project size, company size and the involvement of sub-contractors. The findings of this study may enhance decision makers' understanding of financial implications of workplace accidents in their building projects and motivate them to undertake accident prevention initiatives voluntarily.

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1. Introduction

For the past few decades, efforts have been made by the government and industries in Singapore to address the problem of construction safety. The construction industry accounts for 29% of the total number of industrial workers, but accounts for 40% of workplace accidents (Chua and Goh, 2004). The Workplace Safety and Health (WSH) statistics published by Ministry of Manpower, Singapore (MOM, 2012) revealed that the accident frequency rate (AFR) and accident severity rate (ASR) are far higher than the average level among all the industries in Singapore.

In the "*Workplace Safety and Health* (*Incident Reporting*) *Regulations 2006*" of Singapore (MOM, 2006), a workplace accident is defined as any unintended event which causes bodily injury to a person and a workplace accident is any accident occurring in the course of a person's work. Various losses would be incurred by the injured worker(s) after the occurrence of an accident. These losses may include costs to victims and their families, to employers and to society (Davies and Teasedale, 1994). Accidents and the corresponding damage they cause to productivity, property, equipment and morale can have a detrimental effect on a construction company's profit and loss statement (Goetsch, 2013). According to Levitt et al. (1981), accidents costs in construction companies in USA were found to be as high as 3% of the total construction project costs (10% of labor costs). The costs of accidents have long been regarded as a motivating factor for improving safety performance (e.g., Heinrich, 1931; Levitt, 1975; Lingard and Rowlinson, 2005).

Many researchers have examined the factors influencing the occurrence of accidents on construction sites. For example, Feng (2013) and Feng et al. (2014) concluded that the occurrence of construction accidents is the result of the interactions between safety investments, safety culture and project hazard level. López-Alonso et al. (2013) found that the average number of accidents varies positively with the total number of workers, the average number of subcontractors and the health and safety budget, while it varies inversely with the cost of accident prevention. As suggested by López-Alonso et al. (2013), once the number of accidents on a construction site has been estimated, it is possible to estimate their cost. Previous studies have focused on the causes of construction accidents occurrence; whilst this study focuses on the consequences (i.e., costs) of the occurrence. This study aims to examine the magnitude of workplace accident costs to building contractors in Singapore and identify factors influencing workplace accident costs of building projects. The outcomes of this study are expected to enhance the decision makers' understanding of the implications of workplace accident costs on their construction sites and promote them to undertake accident prevention initiatives voluntarily. This study was conducted in the context of building construction in Singapore. Accident costs are confined to the financial losses of contractors (including principal contractors

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and sub-contractors) which are allocated to the project. Unlike the financial costs of accidents, social costs are those '*costs incurred by the society because additional resources are required to be utilized when construction accidents occur, and if there were no accidents, the utilization of these society's resources could have been saved*' (Saram and Tang, 2005, p. 645–646). The social costs and non-material losses due to pain, suffering and loss of enjoyment of life undergone by the victim are not included in this research because they do not reflect the losses born by the contractors. The intangible costs of accidents (e.g., damage to company reputation and morale of employees) were also excluded from this study because this study concentrated only on financial aspects of accidents due to the constraints of time and resources.

2. Literature review

The study on costs of accident was pioneered by Heinrich (1931) more than 80 years ago. Heinrich (1931) classified the costs as direct and indirect costs, and concluded that indirect costs are significant as he found that indirect costs accounted for as much as four times of the direct costs of accidents. In *the Wealth of Nations* Adam Smith (1776) wrote that a man educated at the expense of much labor and time may be compared to one of those expensive machines. This view helps to shed light on the vast costs of workplace accidents. The concept of Human Capital developed by Schultz (1961), Mincer (1958) and Becker (1964) refers to the stock of skills and knowledge embodied in the ability to perform labor so as to produce economic value. The Human Capital concept indicates that the losses of skilled labor services due to injury or illness is likely to incur additional losses to employers and impact upon the competitiveness of the employers (Lingard and Rowlinson, 2005). Human Capital concept has been applied to the analysis of injuries and illnesses costs, and the Human Capital method was popularized by Rice (1967). This method also posits two broad categories of costs: direct costs and indirect costs.

Direct accident costs are those actual cash flows that can be directly attributable to or associated with injuries and fatalities (Everett and Frank, 1996; Hinze, 1997). The direct costs of injuries tend to be those associated with the treatment of the injury and any unique compensation offered to workers as a consequence of being injured (Hinze, 1997). Different definitions exist for the indirect costs of accidents, but in general they are regarded as consisting of all the costs that are not covered by worker's compensation insurance (Hinze, 1991). The categorization of accident costs into direct and indirect costs implies that focus on the direct costs may fail to reveal the true losses to employers due to an accident. Many of the losses incurred by an accident are "hidden" and difficult to quantify. These "hidden" costs may be significant, and some may be particularly prominent in construction industry. For example, there are heavy penalties for time-overruns on construction projects (Lingard and Rowlinson, 2005). Therefore, both direct and indirect costs of accidents need to be examined to reflect the true costs of accidents to an employer. The indirect cost theory of workplace accident developed by Brody et al. (1990) suggests that the identification of indirect costs will motivate cost-minimizing firms to increase investments in accident prevention to improve safety performance of building projects. The Accident Cost Iceberg proposed by Bird (1974) showed that the proportion of hidden costs could be much larger than the costs directly related to the accident.

In addition to traditional classification of accident cost as direct and indirect costs, several researchers proposed different accident cost typologies based on the specific characteristics of the accident costs. For example, in the cost typology proposed by Riel and Imbeau (1996), health and safety costs are classified into three categories: insurance-related costs; work-related costs; and perturbation-related costs. They are also classified as quantifiable, irreducible and intangible costs in this typology. Rikhardsson and Impgaard (2004) argued that the traditional cost components are rather difficult for management to use, as it would require a number of definitions and clarifications before use including asset specifications and income definitions. Thus, they categorized accident costs as time, materials and components, external services and other costs. These categories reflect traditional accounting classifications in accounting systems, thus they are believed to be simpler to apply by managers. Despite the debates on various typologies of accident costs, the consequences or cost components of accidents seem to be consistent among literature. The various components of indirect costs originate from studies that have been focused on accident costs in various industries (e.g., furniture, forestry, chemistry, cleaning service, financial service, and manufacturing). Nonetheless, the components of indirect accident costs from various industries demonstrate strong similarities. Based on the review of 16 past studies on accident costs, a set of components of indirect accident costs in construction environment was identified. The indirect costs of accidents comprise the following 13 possible components: (1) lost productivity due to the injured worker (e.g., Heinrich, 1931; Simonds and Grimaldi, 1956; Hinze, 1991); (2) lost productivity due to crew of injured worker (e.g., Heinrich, 1931; Hinze, 1991; Monnery, 1999); (3) lost productivity due to other workers in vicinity of accidents (e.g., Heinrich, 1931; Laufer, 1987; Hinze, 1991); (4) losses due to replacement of the injured worker (e.g., Laufer, 1987; Everett and Frank, 1996; Monnery, 1999); (5) lost productivity due to the investigation or inspections as a result of the injury (Simonds and Grimaldi, 1956; Head and Harcourt, 1997); (6) cost of supervisory or staff effort (e.g., Heinrich, 1931; Simonds and Grimaldi, 1956; Hinze, 1991); (7) losses due to damaged equipment or plant, property, material or finished work due to the accident (e.g., Heinrich, 1931; Brody et al., 1990; Hinze, 1991); (8) cost of transporting injured worker (e.g., Simonds and Grimaldi, 1956; Hinze, 1991; Monnery, 1999); (9) consumption of first-aid materials in this accident (Hinze, 1991; Head and Harcourt, 1997); (10) additional work required as a result of the accident (e.g. cleaning, additional barriers and so on) (e.g., Simonds and Grimaldi, 1956; Laufer, 1987; Everett and Frank, 1996); (11) fines and legal expenses (Leopold and Leonard, 1987; Head and Harcourt, 1997); (12) losses due to Stop Work Orders (SWO) issued to the project (disruption of schedules) (Brody et al., 1990; Everett and Frank, 1996); and (13) additional benefits to the injured worker beyond the Work Compensation Act (WCA) (Heinrich, 1931).

3. Research hypothesis

The total costs of accidents to a building project are the sum of the losses incurred by all the accidents occurred in the project. Total costs of accidents to a building project are influenced by not only the frequency of accidents but also the severity of accidents of the project. According to Imriyas et al. (2007), the project hazard is a natural part of the initial construction site conditions owing to the scope and location of the project. It is possible that higher level of project hazard (i.e. greater heights of building, more work in confined spaces, and so on) is associated with greater chance of severe accidents, which would incur more medical expenses, more compensation for the injured workers and longer period of absence of injured workers. Moreover, the components of indirect accident costs suggest that the indirect accident costs of building projects are likely to be influenced by project characteristics. For example, when an accident occurs in larger companies, larger projects, or projects involving more sub-contractors, it is possible that more people would be involved and more internal administrative processes need to be complied, which would incur more costs.

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