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Relationships between safety climate and safety performance of building repair, maintenance, minor alteration, and addition (RMAA) works

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ABSTRACT

The importance of repair, maintenance, minor alteration, and addition (RMAA) works is increasing in many built societies. When the volume of RMAA works increases, the occurrence of RMAA accidents also increases. Safety of RMAA works deserves more attention; however, research in this important topic remains limited. Safety climate is considered a key factor that influences safety performance. The present study aims to determine the relationships between safety climate and safety performance of RMAA works, thereby offering recommendations on improving RMAA safety. Questionnaires were dispatched to private property management companies, maintenance sections of quasi-government developers and their subcontractors, RMAA sections of general contractors, small RMAA contractors, building services contractors and trade unions in Hong Kong. In total, data from 396 questionnaires were collected from RMAA workers. The sample was divided into two equal-sized sub-samples. On the first sub-sample SEM was used to test the model, which was validated on the second sub-sample. The model revealed a significant negative relationship between RMAA safety climate and incidence of self-reported near misses and injuries, and significant positive relationships between RMAA safety climate and safety participation and safety compliance respectively. Higher RMAA safety climate was positively associated with a lower incidence of self-reported near misses and injuries and higher levels of safety participation and safety compliance.

1. Introduction

Repair, maintenance, minor alteration, and addition (RMAA) works have been largely overlooked during the construction market boom. In fact, the volume of RMAA works often accounts for a considerable size of the total construction volume in many developed societies. For example, the RMAA sector accounted for an average of 50.2% of the construction volume in Hong Kong from 2006 to 2010 (Census and Statistics Department, 2007, 2008, 2009, 2010, 2011). The RMAA sector is expected to expand further due to the rising concerns for the safety of aging buildings and sustainability in the built environment. Repair and maintenance of dilapidated buildings is needed to protect the safety of the occupants and the public; whereas remodeling and retrofitting is needed to preserve or upgrade the building value (Yiu, 2007). With the rising importance of the RMAA sector, safety problems of this sector deserve more attention (Hon et al., 2010). The RMAA sector accounted for six out of ten (66.7%) fatal cases in the construction industry of Hong Kong in 2010. The RMAA sector accounted for 44.7% of accidents in the construction industry in 2011 while it only accounted for 39.2% of the construction volume in the same period (Legislative Council, 2011a,b). Research into safety of the RMAA sector; however, remains scarce.

Unsafe behavior is a decisive factor for accident to occur (Reason, 1995). Unsafe behavior often occurs because safety measures are likely to entail modest benefits but immediate costs, such as slower pace, extra effort or personal discomfort. If the likelihood of injury is underestimated in a seemingly safe environment, the expected utility of the unsafe behavior exceeds that of the safe behavior. Unsafe behavior is also naturally reinforced because people tend to place higher value on short-term results. In this sense, deterring unsafe behavior is a significant managerial challenge (Zohar, 2002).

Since RMAA works mainly involve labor rather than machines, most of the accidents occurred because of unsafe behavior rather than machine failure. However, unsafe behavior is only an ostensible cause or symptom, and other more fundamental factors also need to be considered. For example, building design affects safety of construction workers. As suggested by Behm (2005), safety hazards are often "designed into" the construction projects. A holistic approach of accident causation should be adopted (Reason, 1997). Broader organizational and contextual factors leading to unsafe behavior should not be neglected. A behavioral approach, which considers how employees think, behave, respond to situations,

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and how the work environment impacts upon personnel attitudes and behavior, would likely be more effective in managing safety of RMAA works (Lingard and Rowlinson, 2005).

Safety climate has been a useful construct to improve safety in the past few decades (Zohar, 2010). A handful of research studies show that a positive relationship between safety climate and safety performance exists in construction. For example, Mohamed (2002), Chan et al. (2005), and Choudhry et al. (2009) have successfully established a positive relationship between safety climate and safety performance on construction projects; however, little research has been done in the RMAA sector, which is increasingly important not only in Hong Kong, but also in other developed societies.

Safety practices of RMAA works differ from those in new construction works. Most RMAA contracting companies are small/medium-sized specialty contractors of RMAA works. The small/medium-sized companies often have limited resources for safety (Lamm, 1997). Unlike greenfield projects, RMAA job sites are often found in occupied buildings (Chan et al., 2010). RMAA workers may underestimate the risks of working in an occupied environment which does not resemble a construction site. Small size and widely scattered locations of RMAA projects make safety supervision more difficult, inefficient, and costly than those of new works. Close safety supervision on a RMAA contract with small contract sum and short duration of work is not cost effective (Hon et al., 2012). In light of these subtle differences, previous safety climate research findings on new construction projects may not be fully relevant to RMAA works. The relationships between safety climate and safety performance of the RMAA sector require further investigation.

This paper reports part of the findings of a wider scope safety research project on RMAA works in Hong Kong. It aims to determine the relationships between safety climate and safety performance of RMAA projects. The current study fills the knowledge gap of limited safety climate research in the RMAA sector of construction. A model unveiling the relationship of safety climate and safety performance of RMAA works would be useful for safety professionals in the industry to measure, monitor, and improve the safety performance of RMAA works.

2. Safety climate

Zohar (1980) applied the concept of behavioral climate for safety and produced a seminal paper on safety climate in the early 80s. Since then, safety climate has been widely applied in different contexts. Zohar (1980, p. 96) defines safety climate as "a summary of molar perceptions that employees share about their work environments... a frame of reference for guiding appropriate and adaptive task behaviors". As stated by Zohar (2003), safety climate reflects the true perceived priority of safety in an organization. Some researchers defined safety climate as a current-state reflection of the underlying safety culture (e.g., Mearns et al., 2001, 2003).

There is little consensus on the number and content of safety climate factors. Flin et al. (2000) identified five most frequently-occurring factors from 18 safety climate scales of different industries, they were: management/supervision, the safety system, risk, work pressure and competence. As reviewed by Hon et al. (2013), management commitment to safety, safety rules and procedures, and workers' involvement in safety, were the three most common safety climate factors found in construction (Dedobbeleer and Béland, 1991; Mohamed, 2002; Fang et al., 2006; Choudhry et al., 2009; Zhou et al., 2011). Safety climate studies in the construction industry have been focusing on new construction projects (e.g. Chan et al., 2005; HSE, 2012) but our understanding of the safety climate of RMAA works is largely unrealised.

3. Safety performance

Earlier safety studies tended to use statistical data of accidents or injuries to measure safety performance. By contrast, apart from actual injury records, more recent studies have also used alternative data such as self-reported injury data collected through questionnaires (e.g. Siu et al., 2004; Huang et al., 2006) and self-reporting has been shown to be a reliable and valid source of injury data (Begg et al., 1999; Gabbe et al., 2003) According to Gabbe et al. (2003), the accuracy of self-reported injuries could be as high as 80%. However, accidents or injuries are reactive measures and are relatively infrequent. They may not be effective indicators of safety because they only reflect occurrences of failures (Cooper and Phillips, 2004). They are also "insufficiently sensitive, of dubious accuracy, retrospective, and ignore risk exposure" (Glendon and Litherland, 2001, p. 161). Lingard et al. (2011) have also reported that injuries resulting in lost time and medical treatment occur infrequently and are ineffective indicators of safety performance. They suggested using a more fine-grained measure of workgroup safety performance, such as micro-accidents or minor (non-reportable) injuries in future research. According to Beus et al. (2010, p. 717) "safety climate should be more effective in predicting injuries of a less serious nature". It is because minor injuries, which often come before serious ones, are more proximal to safety climate than serious injuries.

In light of the deficiency in using injury as a proxy of safety performance, a growing number of studies have attempted to use safety behavior as a measure of safety performance. Safety performance can be defined as evaluative "actions or behaviors that individuals exhibit in almost all jobs to promote the health and safety of workers, clients, the public, and the environment" (Burke et al., 2002, p. 432). According to Neal and Griffin (2004), safety performance can be measured with *safety compliance* and *safety participation*.

Safety compliance is defined by Griffin and Neal (2000) as following rules in core safety activities. This includes "obeying safety regulations, following correct procedures, and using appropriate equipment" (Neal and Griffin, 2004, p. 16). It refers to "the core activities that individuals need to carry out to maintain workplace safety. These procedures include adhering to standard work procedures and wearing personal protective equipment" (Neal and Griffin, 2006, p. 947). Safety participation refers to "behaviors that do not directly contribute to an individual's personal safety but that do help to develop an environment that supports safety" (Neal and Griffin, 2006, p. 947).

4. Relationships between safety climate and safety performance

4.1. Theoretical linkages

Social exchange theory and expectancy-valence theory are two theoretical mechanisms that may help to explain and predict the relationship between safety climate and safety behavior (Neal and Griffin, 2006). Social exchange theory postulates that, when an organization cares for the well-being of employees (i.e., the organization has a positive safety climate), the employees are likely to develop implicit obligations to perform duties, using behavior beneficial to the organization. Apart from their standard core work duties, they also perform *organizational citizenship behavior*, i.e., extra-role functions other than core work activities. Hofmann and Morgeson (1999) have found that when an organization emphasizes safety, its employees reciprocate by complying with established safety procedures (Neal and Griffin, 2006).

The expectancy-valence theory postulates that motivation is a combination of employees' valence, expectancy and instrumentality.