The Relationship between Mindfulness and Safety Performance of Building Repair and Maintenance: An Empirical Study in Australia

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Abstract. The importance of building repair and maintenance (R&M) has become more significant in recent years as the volume of building stock has expanded globally. With this growth in building stock coupled with R&M complexity unforeseen safety risks has become an increasing problem to solve. In such complex working environment a type of organisation known as high reliability organisation (HRO) is known to operate successfully. The concept of mindfulness from HRO theory has been identified as a key strategy for addressing unforeseen risks derived from the complexity in socio-technical systems. Therefore, this study aims to examine the relationship between mindfulness and safety performance of building R&M companies. Initially, a comprehensive literature review was conducted on HROs and the concept of mindfulness to develop the research hypothesis. A questionnaire survey was utilised to collect the data from Australian building R&M professionals. A Pearson correlation analysis was conducted to examine the relationship between mindfulness and safety performance. This study found that mindfulness has a significant impact on accident prevention in building R&M companies through discovering and managing the unexpected events owing to the complexity. The findings have implications for organisations in the way they train and implement professional development programs for their staff.

1. Introduction

The volume of building repair and maintenance (R&M) works have considerably increased in recent years [1]. Along with the expansion of this sector, safety of R&M works has become a major concern [2]. As noted by previous researchers (e.g., Chan, Wong, Hon and Choi [3], Chan, Wong, Hon and Choi [1]) the inherent nature of R&M works creates a complex and dynamic work environment, which could cause unforeseen safety risks for its workers. The High Reliability Organisations (HRO) has been recognised as a potential approach to managing the unexpected, as it has the distinctive ability to be able operate in complex, uncertain and hazardous environments nearly error-free [4].

HROs manage the unexpected by effectively addressing errors and variations that occur [5]. HROs shift the attention from accident causation to key features of organisations that successfully manage safety risks [6] and they are considered as social systems that have developed a culture sensitive to safety which enables workers to cope with uncertainties [7]. HROs enhance their ability to anticipate

and control unexpected errors by improving mindfulness, which is the crucial concept for organisations to enhance their safety performance [8, 9].

Although previous research (e.g., Enya, Dempsey and Pillay [4]; Gracia, Tomás, Martínez-Córcoles and Peiró [10]; Pillay, Tuck and Klockner [11]) has significantly contributed to introducing the concept of mindfulness to improve workplace safety performance, it seems that no research has been conducted to introduce the mindfulness concept in enhancing the workplace safety in building R&M context. Against this background, this study aims to examine the relationship between mindfulness and the safety performance of building repair and maintenance companies.

2. Literature Review and Hypothesis

2.1. High Reliability Organisations

The development of HRO theory was inspired by Perrow's [12] normal accident theory, indicating that it is possible for some organisations to prevent inevitable accidents [13]. The theory was led by Berkeley-based group of researchers including LaPorte, Rochlin, Schulman and Roberts [14]. The notion of HRO was established based on a range of successive studies on Mann Gulch forest fire [15], the Challenger explosion [16], and naval aircraft carriers [17].

HRO is referred to an organisation that is known to be risky and complex, yet effective and safe [18]. HROs operate nearly accident-free in highly uncertain settings, where complex guidelines, procedures, and technology are adopted to manage complex systems and conditions [19]. As a result, the prime principle of HRO theory is that although failures can occur, highly reliable organisations rarely do so. Also, the theory stresses the tenet that when errors or near misses occur HROs should utilise the knowledge gained from those events to avoid recurring similar errors in the future [5].

By observing organisations that function successfully in challenging and complex environments, Karl Weick conceptualised HROs as mindful organisations [6]. In essence, mindfulness refers to the "capability to induce a rich awareness of discriminatory detail and capacity for action" [9]. It emphasises on "clear comprehension of emerging threats and on factors that interfere with such comprehension" [20]. This state of mindfulness can be achieved through a set of five principles. These principles are: (i) preoccupation with failure, (ii) reluctance to simplify, (iii) sensitivity to operations, (iv) commitment to resilience, and (v) deference to expertise [9].

2.2. Principles of mindfulness

2.2.1. Preoccupation with failure. Preoccupation with failure is an ongoing attentiveness towards the possible unexpected events that may endanger safety by establishing proactive and pre-emptive analysis and discussion [21]. This means that people in HROs keenly hunt for weak signals and surprises that functions the system in unexpected ways [22]. Therefore, worries about failure are regarded as the main feature that delivers a distinctive quality to HROs, and this distinctiveness can be accomplished at least in three ways: (i) by treating any failure modes as windows for the success of the system, (ii) by thoroughly analysing near failures, and (iii) by providing the attention on the liabilities of success [9].

2.2.2 Reluctance to simplify. Reluctance to simplify operations focusses on avoiding oversimplification [6] by taking deliberate steps to question assumptions and receiving wisdom to create a nuanced and more complete picture of the current situation [22]. Knowing the complexity, unpredictability instability, and unknowability of the world that they face, people in HRO direct themselves to perceive as much as possible [23]. As a result, HROs encourage their people to search for alternative perspectives and often express their viewpoints, and bring up issues and problems [22].

2.2.3 Sensitivity to operations. Sensitivity to operations involves ongoing interaction and information sharing on current human and organisational aspects [21] in order to create a 'bigger picture' of ongoing situations [22]. Weick and Sutcliffe [23] revealed that "the 'big picture' in HROs is less strategic and more situational than is true of most other organisations". To be sensitive to operations, HROs should

be cautious of their front-line workers, where the actual operations are done [23]. As noted by Sutcliffe [22] if individuals are sensitive to what is going on here and now, they can anticipate the accumulation of small failures or problems by making numerous small adjustments and such adjustments can stop errors from growing into a bigger crisis.

2.2.4 Commitment to resilience. Commitment to resilience is the capability to detect, contain, and bounce back from failures before they escalate and create more serious harm [21]. HROs effectively recover from mishaps because of their commitment and ability to learn from previous incidents [4]. They rely on the assumption that errors are inevitable, therefore HROs make provisions for alternative ways of controls in the form of back-ups (redundancies) in order to cope with the consequences when required [4]. In cultivating resilience, Sutcliffe [22] indicated that it is essential to have superior skills at improvisation, multi-tasking, learning, and adapting.

2.2.5 Deference to expertise. This is the capability of switching decision making in case of high-tempo situations to the individuals with the most expertise, irrespective of their authority and rank in the organisation [21]. As noted by Weick and Sutcliffe [23], rigid hierarchies from their nature are susceptible to errors and thus HROs encourage decentralised decision-making during emergency situations. Organisation reverts to the usual hierarchy when the emergency is over [4].

2.3. Research hypothesis

Having reviewed the literature on the concept of HRO, it was evident that HROs operate nearly accident-free in highly complex environments by creating a higher state of mindfulness. Accordingly, it can be inferred that mindfulness has a positive relationship with safety. The five principles of mindfulness (i.e., preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise) can be used as the dimensions of mindfulness. Thereby, in this study the following hypothesis is proposed:

Hypothesis: Mindfulness has a positive impact on building repair and maintenance safety performance

3. Research Methodology

3.1. Measures

According to the hypothesis proposed in this study, the main research variables consist of safety performance and mindfulness.

Safety performance: to assess safety performance, the following formula for calculating Lost Time Injury Frequency Rate (LTIFR) is given below [24]:

$$\text{LTIFR} = \frac{\text{Number of lost time injuries in accounting period}}{\text{Total hours worked in accounting period}} \text{ X } 1{,}000{,}000$$

The lost time injuries as defined in Australian standard AS 1885.1-1990 are those occurrences that cause a fatality, permanent disability or time lost from work of one day/shift or more.

Mindfulness: In this study, mindfulness is measured with the five dimensions of preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise. Each dimension of mindfulness was evaluated using the measurable scales identified from previous studies [21, 22, 25].

3.2. Sample and data collection

A questionnaire survey was used to collect the data. The research defined a building R&M contracting company as the unit of analysis. Accordingly, building R&M contracting companies registered in the Australian Business Register and the Master Builders Australia were chosen. A professional (e.g.,

maintenance manager, safety officer) from each randomly selected building R&M company was contacted through email to request to participate in this research.

The questionnaire included three sections. Section A consists of questions about general information of the respondents. Section B includes questions to measure the five dimensions of mindfulness. Respondents are asked to indicate their level of agreement on a 5-point Likert scale (between 1 = "strongly disagree" to 5 = "strongly agree") for each statement found in this section. Section C asks respondents to provide information on the safety performance of the company, as measured by lost time injury frequency rate.

Of the 724 R&M professionals contacted, 180 were participated in this research, representing a response rate of 24.86%. After removing the incomplete responses and outliers, the information of 145 responses was kept for the final data analysis purpose. This study adopted Pearson correlation for the data analysis purpose. The next section explains this research technique in more detail and the rationale for the choice of this approach. In Pearson correlations, the statistical inference is quite robust with a sample size higher than 40 [26]. Similarly, previous studies (e.g., Vithanage, Sing, Davis and Newaz [27]; Wu, Li, Yao, Luo, He and Yin [28]; Zhang, Lingard and Oswald [29]) which used Pearson correlation analysis have been conducted with small sample sizes. Therefore, the sample size of this study was deemed sufficient for the data analysis purpose.

3.3. Data analysis method

A correlation analysis was conducted to analyse the data gathered through this study. Correlation represents the relationship between two continuous research variables [30]. Therefore, the relationship between two variables can be assessed using a correlation coefficient. In this study, Pearson's correlation coefficient (r) is used to conduct the correlation analysis. This method has been widely used by construction safety researchers (e.g., Vithanage, Sing, Davis and Newaz [27]; Wu, Li, Yao, Luo, He and Yin [28]; Sawacha, Naoum and Fong [31]) for data analysis. Pearson's correlation supports measuring the degree of a linear relationship between two continuous research variables [32]. Therefore, in this research, Pearson correlation was used to examine the impact of mindfulness on the safety performance of building R&M companies.

4. Results and Discussion

4.1. Results

The data were analysed with the aid of Statistical Package for Social Science (SPSS) software. The overall relationship between mindfulness and safety performance (i.e., lost time injury frequency rate) was analysed by the correlation analysis. The Pearson correlation between mindfulness and injury rate is -0.277 at the significance level of 0.01, indicating a significant and negative correlation between mindfulness and lost time injury frequency rate. This means that the hypothesis established through this study is valid. Moreover, the relationships between the five dimensions of mindfulness and safety performance of building R&M companies were analysed through the Pearson correlation analysis, and the results are presented in Table 1. Accordingly, the results show that (1) reluctance to simplify is significantly ($p < 0.01$) correlated with lost time injury frequency rate ($r = -0.254$), (2) sensitivity to operation is significantly ($p < 0.01$) correlated with lost time injury frequency rate ($r = -0.221$), (3) commitment to resilience is significantly ($p < 0.01$) correlated with lost time injury frequency rate ($r = -0.334$), and (4) deference to expertise is significantly ($p < 0.05$) correlated with lost time injury frequency rate. The results indicate that these four dimensions have significant impact on accident prevention in building R&M companies. However, no significant ($p < 0.1$) correlation was found between preoccupation with failure and lost time injury frequency rate ($r = -0.113$).

Table 1. Correlation analysis of each dimension

The Variable		Preoccupation with failure	Reluctance to simplify	Sensitivity to operations	Commitment to resilience	Deference to expertise
Lost time injury frequency rate	Pearson correlation	-0.113	-0.254**	-0.221**	-0.334**	-0.197*
	Significance level	0.178	0.002	0.008	0.000	0.018

*p < 0.05 (2-tailed), ** p < 0.01(2-tailed)

4.2. Discussion

This study examined the impact of mindfulness on the safety performance of building R&M companies. Through the results of correlation analysis, it was found that the Pearson correlation between mindfulness and lost time injury frequency rate is -0.277 with the significance level of 0.01. This means that the higher the mindfulness is the greater the safety performance will be. This finding is in line with the findings of Mitropoulos and Cupido [33] who investigated mindfulness of residential framing crews. They found that high reliability crews could be able to prevent production failures while reducing the risk of safety incidents. This finding also supports Feng and Trinh [25] study, which indicated that building construction contractors with a higher level of mindfulness, could be able to provide effective responses to on-site safety risks. As indicated in previous research (e.g., Chan, Wong, Hon and Choi [1]; Hon and Chan [34]), compared to new construction works, R&M works are unpredictable and ad hoc and thus unforeseeable safety risks are inevitable in R&M worksites which may cause workplace accidents. Such accidents are the consequences of a combination of unknowns [25]. In discovering and preventing such unwanted circumstances, researchers (e.g., Olde Scholtenhuis and Dorée [14]; Enya, Pillay and Dempsey [35]) indicated the importance of mindfulness. According to them, these unwanted circumstances can be managed through two capabilities of mindfulness: (i) anticipation: capability to discover and avoid the potential unwanted situations, and (ii) containment: capability to react to and recover from unwanted situations. Therefore, it is evident that a higher level of mindfulness has a significant impact on avoiding unexpected hazards and thereby supports to reducing workplace accidents in the building R&M sector.

The results of this study showed that there are different levels of negative correlations between the five dimensions of mindfulness and lost time injury frequency rate. This indicates that the magnitude of the correlations between the dimensions of mindfulness and safety performance is different. Accordingly, the three dimensions of reluctance to simplify, sensitivity to operations, and commitment to resilience were greatest negatively and significantly ($p < 0.01$) correlated to lost time injury frequency rate (Table 1). Reluctance to simplify supports to enhance safety performance through collecting information that can be employed to monitor activities, recognise warning signals, and analyse near misses and accidents [19]. Sensitivity to operation enables to effectively anticipate potential future failures and thus seek the opinion of workers to obtain the realistic picture of operation [19]. This may be highly beneficial to improve the safety performance of R&M companies, as safety supervision of building R&M worksites is difficult due to widely scattered locations [36]. Commitment to resilience allows organisations to effectively recover from failures, which is achieved through an actual commitment to learning from previous incidents [23]. Moreover, Wang, Liu, Cao and Tan [37] noted that learning from the past is extremely valuable in identifying safety risks which supports to avoid repeating same mistakes in future. Deference to expertise was the second lowest negatively and significantly ($p < 0.05$) correlated to lost time injury frequency rate (Table 1). This indicates that deference to expertise has the second most significant and negative impact on lost time injury frequency rate of building R&M workers. Deference to expertise supports improve safety performance by shifting decision making during a hazardous event to person or team with the most expertise to manage the situation [22]. As Mitropoulos and Cupido [33] found through their study, high reliability crew foremen

more consistently applied the principle of matching skills with task demands compared to average-performing crew foremen. They observed that the person with the most expertise was allowed to conduct the most hazardous tasks, whereas inexperienced crew members were not allowed to conduct such tasks. Preoccupation with failure was the third lowest negatively correlated to lost time injury frequency rate (Table 1). This support enhancing safety by operating proactively with more concern about unexpected situations that can impact safety performance [22].

Considering the significant negative relationship between mindfulness and lost time injury frequency rate, building R&M companies should consider improving the level of mindfulness by considering the principles of mindfulness. Among them, a higher level of attention should be put on reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise as they have significant and positive impacts on accident prevention in building R&M context.

5. Conclusions and Further Research

This study examined the relationship between mindfulness and safety performance of building R&M. The results indicated that mindfulness has a positive relationship with safety performance in building R&M companies. The research findings suggest that improving the level of mindfulness is significant to achieve a sustained safety performance in building R&M companies, which can be achieved through establishing the principles of mindfulness. Therefore, this study offers building R&M companies with a frame of mindful safety practices to achieve a higher level of safety performance irrespective of the complexity in building R&M context.

The findings of this study were interpreted in the context of building R&M in Australia. Therefore, generalization of the findings based on this set of data to other populations may be difficult. In the future, research may be carried out to examine whether the impact of mindfulness on safety performance vary with different geographic contexts.

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