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RELATIONSHIPS BETWEEN SAFETY CLIMATE AND SAFETY PERFORMANCE OF REPAIR, MAINTENANCE, MINOR ALTERATION AND ADDITION (RMAA) WORKS

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Relationships between Safety Climate and Safety Performance of Repair, Maintenance, Minor Alteration and Addition (RMAA) Works

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

August 2011

CERTIFICATE OF ORGINALITY

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ABSTRACT

Repair, maintenance, minor alteration, and addition (RMAA) works are playing an increasingly important role in the construction industry of developed economies. Research on the safety performance of RMAA works, however, has been limited. A sharp increase in the percentage of accidents on RMAA worksites has been noted in Hong Kong, from 17.9% in 1998 to 51.3% in 2008. Even more shockingly, the RMAA sector accounted for 66.7% of all fatalities in the construction industry in 2010. Unsafe behavior is considered one of the key causes of accidents. Thus, the organizational factors that influence individual safety behavior at work continue to be the focus of many studies. The safety climate, which reflects the true priority of safety in an organization, has drawn much attention.

The present study aims to examine the relationships between the safety climate of RMAA works and safety performance. Its objectives are to examine the safety problems and practices of RMAA works; identify the safety climate factors of RMAA works; scrutinize the relationships between the safety climate and the safety performance of RMAA works; examine how demographic variables affect the levels of safety climate; and recommend strategies for improving safety of RMAA works. A sequential mixed methods research design is adopted, employing both qualitative and quantitative research strategies. Data are collected through interviews, Delphi surveys and questionnaire surveys.

In the current study, the major causes of RMAA accidents and the difficulties of implementing safety practices of RMAA works have been unveiled. The safety climate factors of RMAA works which encapsulate 22 variables are derived by exploratory factor analysis and validated by confirmatory factor analysis. The three key RMAA safety climate factors are found to be: (1) management commitment to occupational health and safety and employee involvement, applicability of safety rules and practices; and (3) responsibility for health and safety. After testing and validation by running a structural equation modeling analysis separately on two equal halves of the data, the structural equation model of safety climate and safety performance of RMAA works shows that safety climate is positively related to safety participation and safety compliance, but negatively related to injuries. Safety climate

is a valid construct for explaining and predicting safety performance. Strategies for improving the safety of RMAA works are proposed. The safety awareness of RMAA workers needs to be raised. RMAA subcontractors with good track records of safety performance should be selected for bidding. The safety of RMAA works should be promoted.

The current study sheds light on how to further enhance construction safety. It contributes to filling the research gap arising from limited safety studies in the RMAA sector, a sector of rising importance. The discovery of the three key RMAA safety climate factors enables industry practitioners to assess the safety climate level of their RMAA projects, and to identify any management and system deficiencies. The model revealing the causal relationship between safety climate and safety performance of RMAA works should be useful for safety professionals in the industry to measure, monitor, and improve safety performance. Finally, recommendations are also offered for various stakeholders to improve the safety of the RMAA sector.

LIST OF PUBLICATIONS

Journal Papers (Published and Accepted)

Hon, C.K.H., Chan, A.P.C. and Chan, D.W.M. (2011). Strategies for improving safety performance of repair, maintenance, minor alteration and addition (RMAA) works. *Facilities - Special Issue on Infrastructure Management*, 29(13/14), 591-610.

Hon, C.K.H., Chan, A.P.C. and Wong, F.K.W. (2010). An analysis for the causes of accidents of repair, maintenance, alteration and addition works in Hong Kong. *Safety Science*, 48(7), 894-901.

Hon, C.K.H., Chan, A.P.C. and Yam, M.C.H. (2011). An empirical study to investigate the difficulties of implementing safety practices in the repair and maintenance sector: a case of Hong Kong. *Journal of Construction Engineering and Management*, doi:10.1061/(ASCE)CO.1943-7862.0000497.

Journal Papers (Under Review)

Hon, C.K.H. and Chan, A.P.C. (2012). Fatalities of repair, maintenance, minor alteration, and addition works in Hong Kong. *Safety Science*, under review.

Hon, C.K.H., Chan, A.P.C. and Yam, M.C.H. (2011). Determining safety climate factors in the repair, maintenance, minor alteration, and addition sector. *Journal of Construction Engineering and Management*, under review.

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Chan, A.P.C., Wong, F.K.W., Yam, M.C.H., Chan, D.W.M., Hon, C.K.H., Wang, Y., Dingsdag, D. and Biggs, H. (2010). RMAA safety performance – how does it compare with greenfield projects? *Proceedings of the CIB World Congress 2010, Building a Better World*, The Lowry, Salford Quays, United Kingdom, 10-13 May 2010, Paper ID:457, p.154.

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CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION

This chapter sets the background, provides the problem statement, states the aims and objectives, explains the significance and value of the current study, and outlines the research approach.

1.2 BACKGROUND

1.2.1 Importance of the RMAA sector

The repair, maintenance, minor alteration, and addition (RMAA) sector of the construction industry is often overlooked because RMAA works are often small in size and carried out by small-sized contractors. Statistics, on the contrary, show that the RMAA sector accounts for a considerable size of the construction market in many developed countries. For example, repair and maintenance works accounted for 48% of the construction market in the United Kingdom in 2009 (Office for National Statistics, 2010).

The importance of the RMAA sector is expected to grow after the 2008 financial turmoil, when many new construction projects were being halted. For instance, the RMAA sector in the United States has been expanding after the credit crisis. The Bureau of Labor Statistics of the United States forecasts the creation of new jobs for alteration, remodeling, and maintenance works. During an economic recession, fewer new buildings are built because capital is scarce. Consequently, more existing buildings are remodeled for sale or retrofitted to green buildings to save mounting energy expenses (Bureau of Labor Statistics, 2010a, 2010b).

The construction market of Hong Kong has also experienced a remarkable expansion of its RMAA sector over the past few years. The RMAA sector has gained a greater share of the market, contributing 53.5% of the total construction volume as of 2006. As shown in Table 1.1, the proportion of RMAA works to the total construction volume nearly doubled from 1998 to 2010.

RMAA projects have been employed as an immediate measure to create employment and to boost the economy. In 2008, the global financial crisis severely hit the economy of Hong Kong. To counteract the disastrous impact of the global financial crisis on the construction industry, the Hong Kong government launched more minor works to create immediate employment opportunities in the construction industry (Development Bureau, 2008). For example, the Development Bureau of the Hong Kong government spent HKD 8.56 billion (approximately USD 1.1 billion) on minor works in the fiscal year of 2009/2010 in order to create 1,600 jobs. These projects included the refurbishment of the exterior of 50 government buildings, the renovation of aged protective surfaces of 500 slopes, the installation and retrofitting of energy-efficient facilities for various government departments, and the provision of green roofs on 40 government buildings (The Standard, 14 January 2009).

Table 1.1

Gross Value of Construction Work at Current Market Prices (1998–2010). (Unit: HKD Million at Current Prices)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Residential (A)	48,761	56,225	51,920	41,774	36,503	28,612	20,085	16,945	15,518	16,064	20,613	22,804	22,381
Non-residential (B)	33,866	20,455	17,407	16,026	16,502	18,243	17,425	17,060	14,161	17,289	17,287	16,938	18,206
Civil Engineering (C)	19,349	16,873	20,583	24,491	21,358	20,710	19,044	14,686	12,311	10,123	10,934	12,516	20,388
Total Construction Investment (A+B+C)	101,975	93,553	89,910	82,290	74,362	67,564	56,553	48,691	41,990	43,476	48,834	52,258	60,974
Repair, Maintenance, Minor alteration and Addition (D)*	31,341	32,884	32,161	31,696	31,638	31,468	36,618	42,160	48,240	49,390	50,765	48,686	49,966
Total Construction Market (A+B+C+D)	133,316	126,437	122,071	113,986	106,000	99,032	93,171	90,851	90,230	92,866	99,599	100,944	110,940
Percentage of RMAA Works to Total Construction Market (%)	23.5	26.0	26.3	27.8	29.8	31.8	39.3	46.4	53.5	53.2	51.0	48.2	45.0

Note. Data source from Report on the Quarterly Survey of Construction Output, Tables 1A and 3, Census and Statistics (CS&D) Department, Hong Kong.
*The CS&D named this figure as "Locations other than sites" which refers to "Works at locations other than construction sites includes minor new construction activities and renovation works at erected buildings and structures; and electrical and mechanical fitting works at locations other than construction sites."

The importance of RMAA works to the construction industry of Hong Kong is expected to increase further. Approximately one-third of the housing blocks in Hong Kong were built more than 20 years ago (Chan et al., 2006). In view of the aging building stock and the long-standing problem of building neglect, the Hong Kong government intends to launch the Mandatory Building Inspection Scheme (MBIS) and Mandatory Window Inspection Scheme (MWIS).

Under the MBIS scheme, every year, 2,000 private buildings aged 30 years or above, except domestic buildings not exceeding three stories, will be selected by the Buildings Department to undergo building inspection. The selected buildings will be required to undergo an inspection, followed by appropriate repair and maintenance work. Thereafter, inspections are to be performed every 10 years (Development Bureau, 2010). The MWIS will cover private buildings aged 10 years or above, except domestic buildings not exceeding three stories. Approximately 5,800 private buildings will be selected every year, requiring their owners to carry out inspection and repair works. After the first inspection, window inspections will be required once every five years (Development Bureau, 2010).

With the implementation of the Minor Works Control System on 31 December 2010 (Buildings Department, 2011), the approval procedures of minor RMAA works have been simplified. To dovetail the implementation of these new policies, the Hong Kong government has set up various subsidy schemes and has provided technical assistance to encourage the maintenance of old buildings.

1.2.2 Safety performance of the RMAA sector

Safety has long been a problem in the construction industry. Fatalities in the construction industry are often the highest among all industries in a number of developed countries. For example, 42 fatalities occurred in the construction industry of the United Kingdom from 2009 to 2010. This figure far outweighed other industries in the United Kingdom in the same period (HSE, 2010). By comparison, in 2009, out of 21 fatalities occurring in all industries of Hong Kong, 19 fatalities occurred in the construction industry (Labor Department, 2010).

In the past decade, safety performance has improved remarkably in the construction industry of Hong Kong. As shown in Table 1.2, the number of industrial accidents in the construction industry dropped dramatically by 85.3%, from 19,588 in 1998 to 2,884 in 2010. The accident rate per 1,000 workers fell dramatically from 247.9 in 1998 to 52.1 in 2010. However, the accident rate per 1,000 workers in the construction industry has more or less leveled off since 2004 after a sharp decrease from 1998 to 2003.

Despite an encouraging safety improvement in the whole construction industry, the accident rate of the RMAA sector is alarmingly high. The percentage of RMAA accidents to all construction accidents has increased nearly threefold from 17.9% in 1998 to 51.3% in 2008 (Table 1.2).

In 2010, the RMAA sector accounted for 49.3% of accidents in the construction industry (Table 1.2), whereas it contributed to only 45.0% of the construction volume (Table 1.1). Even more shockingly, six out of nine fatalities in the construction industry in 2010 were from RMAA works (Table 1.2), accounting for 66.7% of the overall fatality rate in the construction industry. With the surging RMAA sector, the spate of RMAA accidents is expected to increase. Thus the safety issue of RMAA works urgently needs to be addressed.

The top five fatal accidents and non-fatal accidents of RMAA works are shown in Table 1.3. Fall of person from height and contact with electricity or electric charge are the two primary causes of death in RMAA works. Table 1.4 indicates that July and August are comparatively the more accident-prone months. Table 1.5 gives a summary of the various top two RMAA accident analyses.

Table 1.2

Industrial Accidents of the Construction Industry.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
(a) All reported construction accidents*	19,588	14,078	11,925	9,206	6,239	4,367	3,833	3,548	3,400	3,042	3,033	2,755	2,884
	(56)	(47)	(29)	(28)	(24)	(25)	(17)	(25)	(16)	(19)	(20)	(19)	(9)
(b) Accident rate per 1,000 workers	247.9	198.4	149.8	114.6	85.2	68.1	60.3	59.9	64.3	60.6	61.4	54.6	52.1
(c) All reported accidents in RMAA Works*	3,510	3,328	3,402	2,582	1,925	1,485	1,454	1,509	1,697	1,524	1,557	1,379	1,422
	(7)	(10)	(12)	(4)	(10)	(8)	(6)	(12)	(9)	(6)	(N/A)	(N/A)	(6)
Percentage of RMAA accidents to all reported construction accidents [(c)/(a)]	17.9%	23.6%	28.5%	28.0%	30.9%	34.0%	37.9%	42.5%	49.9%	50.1%	51.3%	50.1%	49.3%

Note. Data from Labor Department of Hong Kong (2008b, p. 3; 2010) and Legislative Council (2011a, 2011b). * Figures in brackets denote the number of fatalities. N/A = not available.

Table 1.3

Industrial Accidents in RMAA - Analyzed by "Type of Accident" (1998 to 2007).

Fatal Industrial Accidents in RMAA Top-5 Accident Types	No. of Cases	%	Non-fatal Industrial Accidents In RMAA Top-5 Accident Types	No. of Cases	%
Fall of person from height	53	63.1%	Striking against or struck by moving object	4,888	21.9%
Contact with electricity or electric charge	13	15.5%	Striking against fixed or stationary object	3,278	14.7%
Contact with moving machinery or object being machined	4	4.8%	Injured whilst lifting or carrying	3,113	13.9%
Trapped by collapsing or overturning object	3	3.6%	Fall of person from height	2,823	12.6%
Asphyxiation	3	3.6%	Slip, trip or fall on same level	2,772	12.4%

Note. Adopted from Labor Department (2008, p. 5).

Table 1.4

Top -5 RMAA Accident-prone Months (1998 to 2007).

Fatal Industrial Accidents Top -5 Months	No. of Cases	%	Non-fatal Industrial Accidents Top -5 Months	No. of Cases	%
August	16	19.0%	August	2,385	10.7%
July	12	14.3%	July	2,284	10.2%
June	9	10.7%	May	2,019	9.0%
October	8	9.5%	June	2,018	9.0%
February	8	9.5%	September	2,010	9.0%

Note. Adopted from Labor Department (2008, p. 8).

Table 1.5

Summary of Various Top -2 RMAA Accident Analyses (1998 to 2007).

RMAA Accidents Analyzed by	Top -2 Fatal Accidents	Non-fatal Accidents
Type of work being performed	1. Bamboo scaffolding 2. Electrical wiring	1. Material handling 2. Manual work
Body part injured	1. Multiple parts 2. Skull/scalp	1. Finger 2. Hand/palm
Injury nature	1. Multiple injuries 2. Contusion & bruise	1. Fracture 2. Contusion & bruise
Age group	1. 30-34 2. 25-29	1. 40-44 2. 35-39
Sex	1. Male	1. Male 2. Female

Note. Adopted from Labor Department (2008, p. 8).

The safety problems of the RMAA sector are complicated by the inherent difficulties in maintaining the aging building stock in Hong Kong. More than 10,000 housing blocks out of the total of 38,400 private multi-storey buildings have no owners' corporations and are not managed by property management companies (Housing

Planning and Lands Bureau, 2003).

The RMAA sector also largely involves small/medium-sized contractors that may not have adequate resources and awareness for safety (Legislative Council, 2011c). This sector employs large numbers of unskilled workers who may not have sufficient safety training. This sector is not subject to the same stringent safety regulations of new construction. To cite an example, the employment of a safety officer is required for a site with 100 workers; however, an RMAA work project rarely has such a large number of site workers (Chan et al., 2006). Rather than having a safety officer solely responsible for safety issues, an RMAA project usually has a safety supervisor who also simultaneously plays the role of site agent or project engineer.

With the implementation of MBIS and MWIS and the repair and maintenance subsidies of the government for dilapidated building owners, the volume of RMAA works is expected to increase substantially (Legislative Council, 2011c). A sudden increase in demand for RMAA works will possibly further worsen the safety problems of the RMAA sector. Therefore, the need to improve safety performance in this growing sector has become more urgent.

1.3 PROBLEM STATEMENT

1.3.1 Safety climate

Although safety in construction sites of new works has been improved, safety in the RMAA sector is definitely the focal point of further safety improvement. Safety legislation and policies can effectively drive down the accident rate to an acceptable point; however, the rate has reached a plateau in recent years. Continuing safety improvement can only be accomplished through promoting a positive safety culture in the construction industry (Lingard and Rowlinson, 2005). The Hong Kong Construction Industry Review Report (HKCIRC, 2001) recommends nurturing a positive safety culture at all levels of the construction industry to strive for continuous safety performance.

Unsafe behavior is considered a key cause of accidents; however, there may be more distal underlying reasons for such accidents. Mullen (2004) argues that the majority of workplace accidents are attributed to unsafe work practices of employees rather than to unsafe working conditions. Rather than blaming the unsafe behavior of employees, Hofmann and Stetzer (1998) advocate that organizational factors may influence individual safety behavior at work (Griffin and Neal, 2000). Researchers have attempted to investigate unsafe behavior by identifying inherent organizational factors. Safety climate, which reflects the true priority of safety in an organization, is an organizational factor that has drawn much attention.

Safety climate has been used to predict organizational safety performance for more than two decades. Industrial and organizational psychology researchers have attempted to use safety climate to deal with unsafe behavior in industries and organizations. The notion of safety climate has been applied in different industries such as manufacturing (Brown and Holmes, 1986; Clarke, 2006a), chemical processing (Hofmann and Stetzer, 1996; Vinodkumar and Bhasi, 2009), nuclear processing, and construction (Chan et al., 2005; Choudhry et al., 2009; Dedobbeleer and Béland, 1991; Fang et al. 2006; Mohamed, 2002; Siu et al., 2004; Zhou et al., 2011). Safety climate is relatively new to the construction industry, compared to the other industries.

As research proliferates, safety climate has emerged as a promising construct that affects safety behavior of people, and in turn, safety outcome. Despite this fact, safety climate research in construction has yet to mature. A handful of studies show a positive relationship between safety climate and safety performance in the construction industry. For example, Mohamed (2002), Chan et al. (2005) and Choudhry et al. (2009) have successfully established a positive relationship between safety climate and perceived safety performance in the construction site environment.

Safety climate is industry- and context-specific (Cooper and Philips, 2004). It is affected by the commitment of the organization to safety. Safety behavior is shaped by contextual factors and personal attributes. Thus, subsector differences exist in safety climate. For example, Glendon and Litherland (2001) have revealed significant differences in two safety climate factors, namely “relationship” and “safety rules” between the construction and maintenance crew in road construction.

They attribute such a difference of subgroup safety climates difference to variations in work conditions. Construction workers have more supervision contact than maintenance crews, contributing to a higher score in the relationship factor. They further argue that maintenance crews score higher than construction crews on the safety rules factor because maintenance crews have fewer rules to follow.

RMAA workers may have entirely different perceptions towards safety and resultant safety behavior in response to different types of employers, working environment and regulatory requirements of the RMAA sector. Thus, a model to explain and predict the relationship between safety climate and safety performance of RMAA works is needed.

1.3.2 Uniqueness of the RMAA sector

The RMAA sector was largely overlooked during the construction market boom. Construction safety research on the RMAA sector has been very scant. Hinze and Gambatese (2003, p. 159) point out that "general contractors, construction management firms and design/build firms" have been the focus of construction safety studies. They suggest that the safety performance of specialty contractors that are small in scale and that undertake the majority part of construction activities should be better understood.

Recently, the United Kingdom Health and Safety Executive (HSE) conducted a study to investigate the peculiar safety practices of small construction site operators. According to the study (HSE, 2009), the safety practices of small construction site operators could be classified into "Duckers and Drivers," "Confident Captains," and "Ex Big Site Conformists," respectively. "Duckers and Drivers" do not want to spend money on safety, except for basic personal protective equipment (PPE). "Confident Captains" establish and enforce their own good working practices. "Ex Big Site Conformists" transfer some of the good working practices they have learned from large companies in which they were previously engaged to their current smaller sites.

Poor safety practices are more prevalent in small/medium-sized enterprises (SMEs) than in the large-sized ones (Brace et al., 2009). Small companies tend to work in greater isolation. Thus, owing to limited resources, these companies may experience more difficulty in meeting health and safety requirements (Lamm, 1997). For these reasons, more research is needed to be done in the RMAA sector, where small companies dominate the industrial sector.

RMAA works involve more small contractors than new building works do. Many of these contractors have less knowledge and experience in health and safety. The small project size and short duration of RMAA works tend to make the working environment of RMAA works more difficult to control than new building works. The risk of falls is high in RMAA works because of the temporary, short-term, and precarious nature of access to the task. When the task duration is short, workers are tempted to take higher risks (Cameron et al., 2007).

Because of the peculiar safety practices of the small/medium-sized contractors and working environment in the RMAA sector, prior safety climate studies in the construction industry focusing on new construction works may not truly reflect the situation in the RMAA sector. Thus, the present study is conducted to fill the research gap of a rather untapped RMAA sector, particularly the safety climate of RMAA works.

1.4 RESEARCH AIM AND OBJECTIVES

The current study aims to establish a model that explains and predicts the relationships between the safety climate and safety performance of the RMAA works in the construction industry. The specific objectives are as follows:

1. Examine safety problems and practices of RMAA works;
2. Identify factors of safety climate of RMAA works;
3. Scrutinize the relationship between safety climate and safety performance of RMAA works;
4. Examine how demographic variables affect the levels of safety climate; and
5. Recommend strategies for improving safety in the RMAA sector.

As depicted in Figure 1.1, the study begins by examining safety problems and practices of RMAA works (Objective 1). With a better understanding of safety in the RMAA sector, safety climate factors of RMAA works are to be identified (Objective 2). Objective 2 is related to Objectives 3 and 4. Safety climate factors derived from Objective 2 are firstly employed to test the relationship between safety climate and safety performance of RMAA works (Objective 3). Then, these safety climate factors of RMAA works are used to calculate the safety climate scores to see whether respondents with different demographic backgrounds have different safety climate scores (Objective 4). Finally, strategies for improving safety in the RMAA sector will be recommended (Objective 5).

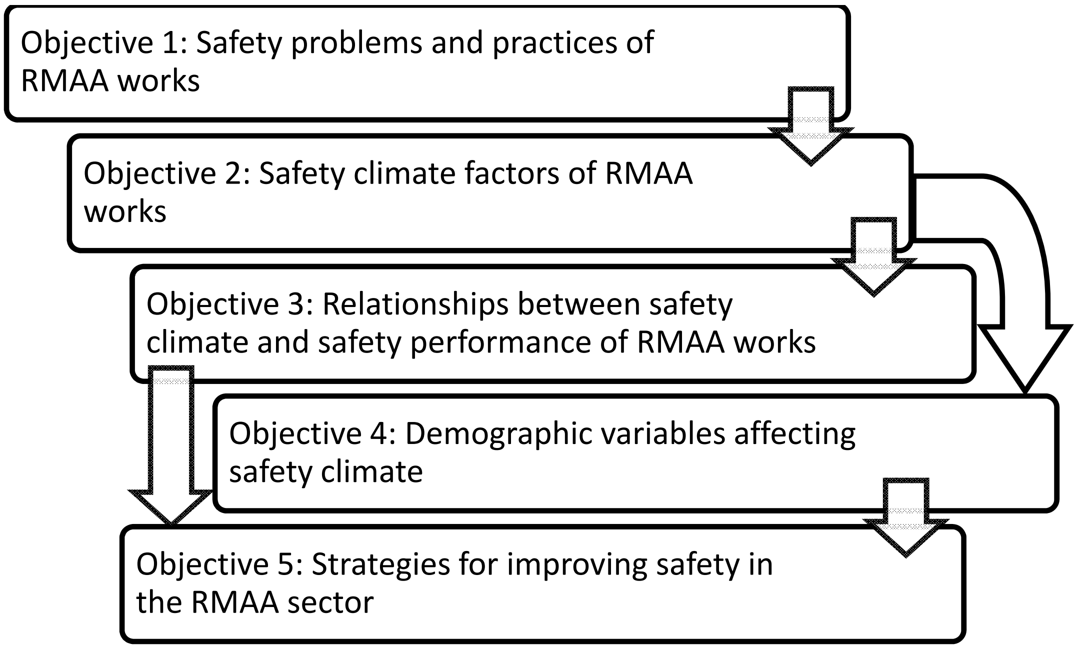

Figure 1.1 Relationships between the objectives.

1.5 SIGNIFICANCE AND VALUE

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. The Hong Kong government intends to implement the MBIS, which requires buildings, aged 30 or more to have safety inspections every 10 years, and MWIS, which requires window inspection every five years. Retrofitting or refurbishment works to improve building energy efficiency are becoming increasingly popular. However, the RMAA sector has long been overlooked and only limited safety research has been conducted in this sector. The present study attempts to fill this knowledge gap.

Safety climate research has attracted much attention; however, studies in the construction industry remain limited, especially in the RMAA sector, which is increasingly important not only in Hong Kong, but also in other developed countries. Prior safety climate studies have suggested that safety climate factors may be industry-specific (Cooper and Philips, 2004). RMAA works have different job characteristics from new works. Although the RMAA sector is a subset of the construction industry, it may have its own specific safety climate factors. By identifying safety climate factors of the RMAA sector, the current study can strengthen the existing knowledge of safety climate in the construction industry and reveal the deviation of RMAA safety climate factors, if any.

Unlike new works that have an accident rate per 1,000 workers as a benchmark, the RMAA sector in Hong Kong has no such indicator. This is because of the lack of proper records on the number of workers engaged in RMAA works. Proper safety performance measurement is a problem in the RMAA sector. The present study attempts to establish a valid safety performance measurement for the use of RMAA safety performance evaluation.

Safety climate has been hypothesized to predict safety performance; however, prior studies (e.g., Cooper and Philips, 2004) have failed to support such a relationship empirically. The current study contributes to determining the relationship between safety climate and safety performance of RMAA works with structural equation modeling techniques. 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. Recommendations on improving safety performance of the RMAA sector are also given.

1.6 RESEARCH APPROACH

To accomplish the aim and objectives of the current study, a comprehensive literature review on the background of the RMAA sector of the construction industry and on the concepts of safety climate and safety culture was conducted. A mixed-research method approach was selected. Interviews, Delphi surveys and questionnaire surveys were conducted to collect data. The collected interview data collected were analyzed with the help of NVivo 8 for constant comparisons. To determine the safety climate factors of RMAA works and establish the relationships between safety climate and safety performance, the collected data were analyzed with software package SPSS 18.0 for general statistical analyses and with LISREL 8.80 for structural equation modeling techniques. Further details can be found in Chapter 3. An overall flow chart of the research is shown in Figure 1.2. The sequence of chapters in the thesis is shown in Figure 1.3.

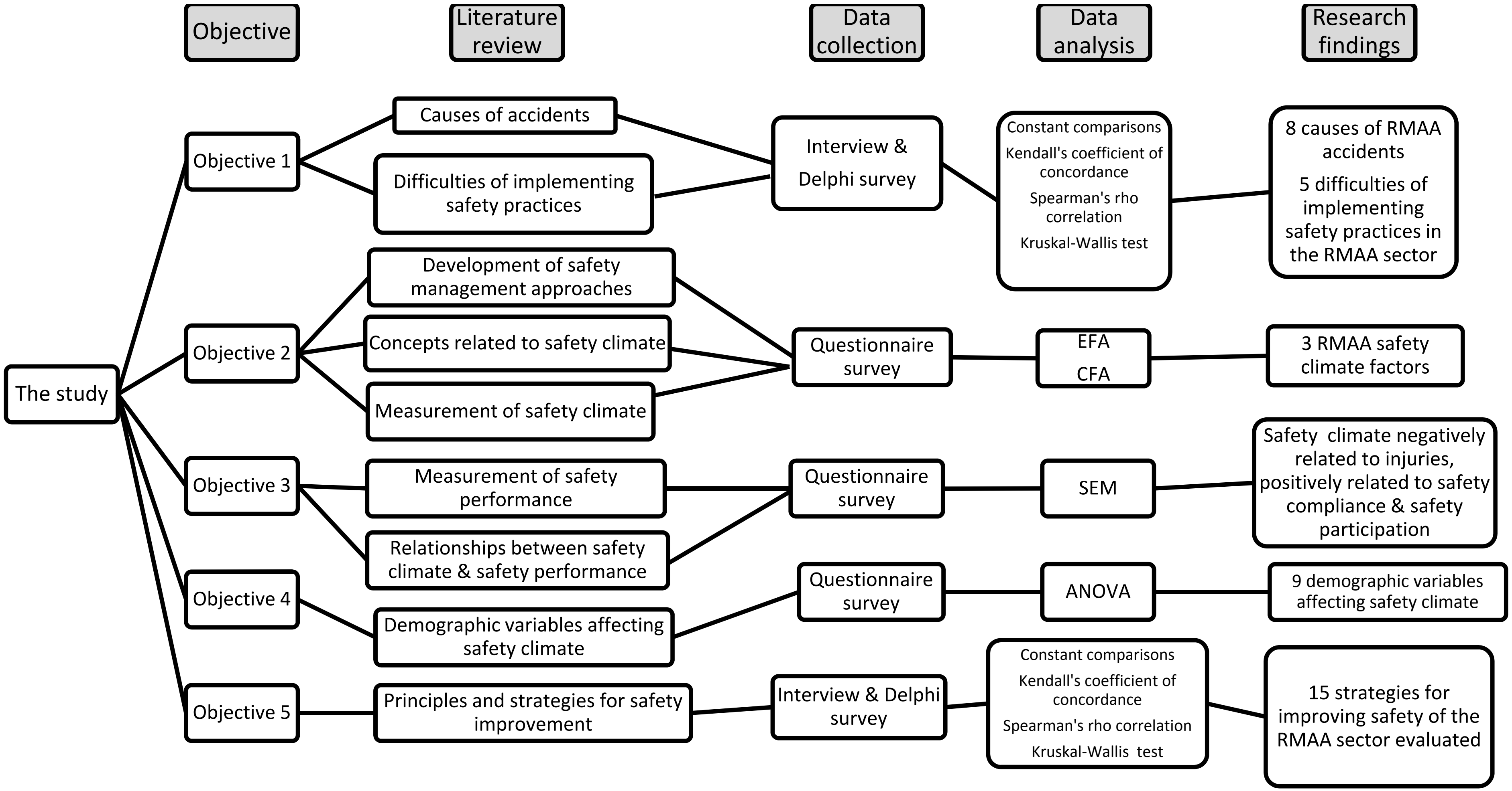

Figure 1.2 Overall flow of the research.

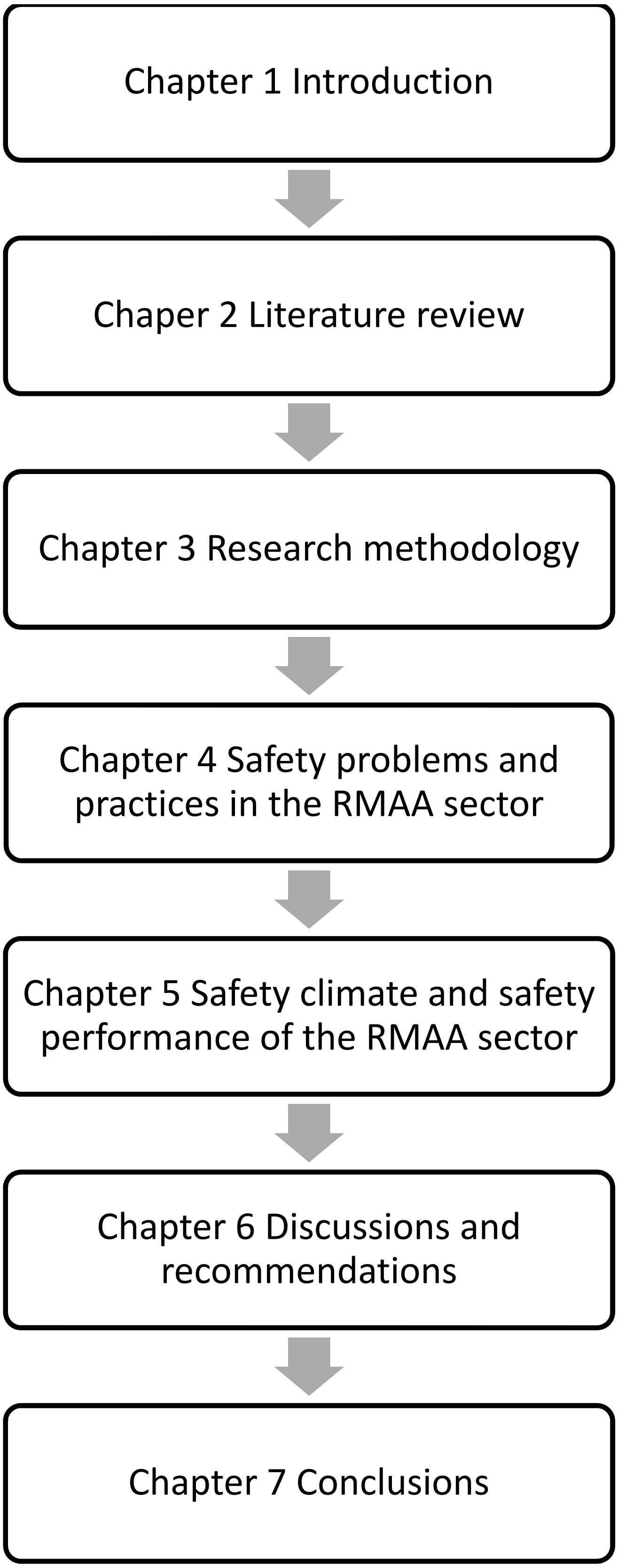

Figure 1.3 Sequence of chapters in the thesis.

1.7 CHAPTER SUMMARY

The RMAA sector has become increasingly important to the construction industry. As the RMAA sector expands, the safety performance of RMAA works needs to be addressed urgently. The objectives of the present study are to explore the safety problems and practices, identify factors of safety climate, examine the relationship between safety climate and safety performance, examine how demographic variables affect the levels of safety climate, and recommend strategies for improving safety within the RMAA sector.

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews the literature that has laid the foundation and has led to the achievement of the research objectives set in Section 1.4. As delineated in Figure 1.1, the literature review mainly focuses on the following nine areas:

- Causes of accidents;
- Difficulties of implementing safety practices;
- Development of safety management approaches;
- Concepts relating to safety climate;
- Measurement of safety climate;
- Measurement of safety performance;
- Relationship between safety climate and safety performance;
- Demographic variables affecting safety climate; and
- Principles and strategies for safety improvement.

To help achieve the objective of examining the safety problems and practices of RMAA works, literature related to causes of accidents and difficulties of implementing safety practices were reviewed. Having grasped an overall view of safety problems and practices in the construction industry, literature on development of safety management approaches, concepts relating to safety climate, and measurement of safety climate were evaluated to achieve the second objective of identifying factors of the safety climate of RMAA works. To achieve the third objective of scrutinizing the relationship between safety climate and safety performance of RMAA works, literature on measurement of safety performance and relationship between safety climate and safety performance were reviewed. Literature discussing the relationship between demographic variables and safety climate were subsequently examined to achieve the fourth objective. Finally, to achieve the fifth objective of recommending strategies for improving safety in the RMAA sector, literature on principles and strategies for safety improvement were included in this literature review.

The literature search initially utilized keywords in a broader sense, such as "construction safety", "safety management", "accidents in the construction industry" and then narrowed down to "safety attitude", "safety climate," "safety culture", "safety performance", and "repair and maintenance". Relevant textbooks were searched through The Hong Kong Polytechnic University Library Catalogue. A systematic keyword search for journal articles and conference proceedings was conducted through the electronic database *ISI Web of Knowledge*, which contains a wide coverage of academic journals with scientific citation index and peer-reviewed conference proceedings. Another electronic database *Scopus* was also searched for cross-referencing and to capture additional articles not published in journals within the scientific citation index, if any. Follow-up searches were conducted on selected relevant journals and reference lists of individual papers. Similar keyword searches were performed in a number of journals in the construction and engineering field.

2.2 CAUSES OF ACCIDENTS

Every accident investigation deals with how accidents happen and why accidents happen (Abdelhamid and Everett, 2000). Over the years, the focus for workplace accident investigation has changed from an engineering system focus towards human behavior to a focus on organizational factors, such as the safety climate (Choudhry and Fang, 2008). Most accidents are not caused by a workplace system failure but by unsafe human behavior (Mullen, 2004). Approximately 80% of the accidents are caused by human behavior (HSE, 2002). However, unsafe behavior can be regarded as a resultant action that is stimulated and reinforced by organizational factors, such as a poor safety climate.

Using grounded theory approach, Mullen (2004) has provided an insightful discussion of underlying factors leading to unsafe behavior in a workplace. Mullen (2004) has synthesized the factors into three broad categories: organizational factors, image, and avoiding negative consequences. Organizational factors substantially contribute to unsafe behavior. The organizational factors include role overload, production performance over safety, socialization influence, safety attitudes, and perceived risks. Image negatively influences the safety behavior of workers because workers want to be seen as "macho" or tough and competent. To avoid negative consequences, workers want to avoid teasing and harassment from coworkers, and do not want to lose their jobs.

Human and organizational factors have been identified as the key causes of construction accidents in different countries. For example, Kartam et al. (2000) have identified nine causes of safety problems in the Kuwait construction industry. The majority of the causes are human and organizational factors, such as disorganized labor, extensive use of foreign labor, extensive use of subcontractors, low priority given to safety, small size of most construction firms, and competitive tendering. Abdelhamid and Everett (2000) broadly classify the root causes of accidents in the United States construction industry into three areas: failure to identify an unsafe condition, decision to proceed with a work activity after identifying an unsafe condition, and working unsafely. Abdelhamid and Everett (2000) also find that unsafe conditions are often formed by interlinked management actions, unsafe acts of workers or coworkers, non-human related activities, and the construction site environment. Lam and Rowlinson (1997) have investigated the common causes of accidents in the construction industry of Hong Kong. They attribute most of the causes of accidents to human and organizational factors, such as high mobility of workers, influx of immigrants or unskillful workers, excessive overtime, changes in supervisory staff, shortage of safety inspectors, and inadequate safety training for workers.

Cheng et al. (2004) have revealed six root causes of construction accidents in China. Three causes are related to workers: lack of attention to personal safety protection by workers, insufficient safety training, and tiredness of workers. Two causes are related to organizational management: lack of attention to safety management by main contractors or project managers, and inadequate setting of the safety level. The remaining root cause is the poor quality of construction materials and equipment. Tam et al. (2004) have further revealed that the behavior of contractors in China toward safety management is of grave concern. Poor safety awareness of top management, lack of training, poor safety awareness of project managers, reluctance to input resources to safety and reckless operation are the attributes of poor safety management that lead to accidents.

Haslam et al. (2005) have identified a hierarchy of factors leading to accidents in the construction industry of the United Kingdom. These factors include problems arising from workers or the work team, workplace issues, shortcomings with equipment (including personal protective equipment (PPE)), problems with suitability and condition of materials, and deficiencies with risk management. Haslam et al. (2005) attribute over two-thirds of the accidents to the behavior and capabilities of workers. This finding is supported by Reason (1995) who claims that unsafe behavior is a decisive factor in the accident chain of events.

Brace et al. (2009) have unveiled the causes of fatal construction accidents in the United Kingdom. They identify three levels of factors: macro, mezzo, and micro (see Table 2.1). Accidents occur when these three levels of factors are concurrently aligned. Six out of the nine micro-level factors are related to human behavior: lack of individual competency and understanding of workers and supervisors; ineffectiveness of lack of training and certification of competence; lack of ownership, engagement and empowerment of communication with, and responsibility for workers and supervisors; poor behavior; misuse of equipment (including PPE); and itinerant workforce. Most macro and mezzo-level factors are related to the safety attitudes and safety practices of organizations.

Table 2.1

Underlying Causes of Construction Fatal Accidents at Different Levels.

Macro-level factors	Mezzo-level factors	Micro-level factors
● Immature corporate systems ● Inappropriate enforcement ● Lack of proper accident data ● Lack of leadership from 'Government' as a key client ● Lack of influence of trades unions	● Immature project system and process ● Inappropriate procurement and supply chain arrangements ● Lack of understanding and engagement by some of the design community ● Lack of proper accident investigation/ data ● Lack of organizational learning	● Lack of individual competency and understanding of workers and supervisors ● Ineffectiveness of lack of training and certification of competence ● Lack of ownership, engagement and empowerment of communication with, and responsibility for workers and supervisors ● Poor behavior ● Cost ● Poor equipment or misuse of equipment (including PPE) ● Site hazards ● Poor employment practices ● Itinerant workforce

Note. Adapted from Brace et al. (2009).

The above review on causes of construction accidents shows that human and organizational factors play a substantial role in the occurrences of accidents, whether in the Western world or the Eastern world. Thus, more safety research focusing on examining how organizational factors, such as safety climate, affect safety performance should be conducted.

2.3 DIFFICULTIES OF IMPLEMENTING SAFETY PRACTICES

Most contracting companies need to set up their own safety management system in accordance with the government regulations; however, the implementation of safe practices at site level remains a huge challenge. Wilson and Koehn (2000) have investigated the difficulties of implementing safety practices encountered by general contractors and subcontractors in the United States. Although the general contractor has the responsibility to oversee the safety of all subcontractors, the general contractor may not have sufficient comprehensive safety knowledge to take up the duty because of the lack of hands-on safety knowledge of a specific trade. It is difficult for small subcontractors to build a comprehensive safety program which satisfies both the requirements of the general contractor and the standards of Occupational Safety and Health Administration of the Department of Labor of the United States. Many small subcontractors lack sufficient resources for safety. While striving to survive, the emphasis of these subcontractors on safety is proportionate to the size of the company or the scale of the project.

The RMAA sector has many small/medium-sized contractors. Loosemore and Andonakis (2007) have identified the need to investigate barriers of implementing occupational health and safety (OHS) reforms in small trade subcontractors. Their study highlights that small subcontractors face particular difficulties in complying with safety rules and regulations. As small trade subcontractors account for over 90% of the project value of the Australian construction industry, the importance of improving their safety performance should be recognized. As suggested by Loosemore and Andonakis (2007), a small improvement in safety performance in this sector would have a huge impact on OHS standards across the industry. To most small/medium-sized companies, costs of implementing safety measures, language and educational barriers, and fear of change are the key obstacles for implementing OHS reforms.

Halse et al. (2010) investigated the difficulties of implementing safety in SMEs. According to their study, owner-managers of small enterprises face specific management problems. These owner-managers need to take care of all the issues in addition to direct production. Business survival is often their top priority. OHS issues usually have lower priorities due to limited resources. Authorities and regulatory bodies experience difficulty in reaching out to these small enterprises for preventive safety measures and monitoring. Halse et al. (2010) suggest that intermediaries who have frequent connection to these small enterprises could play a role to uphold OHS of these small enterprises. These intermediaries could be the chambers of commerce, local authorities, various public business advisory services, and accountants. Their study concludes that appointing an accountant as a health and safety intermediary to SMEs is the feasible solution. This innovative approach, however, also faces difficulties of implementation. For example, accountants have limited knowledge on OHS issues despite having attended safety training workshops.

2.4 DEVELOPMENT OF SAFETY MANAGEMENT APPROACHES

In the past few decades, safety management has focused on job redesign, an engineering approach and consideration of human factors to maintain workplace safety (Mullen, 2004). Traditional safety management has focused on engineering aspect of safety; however, only about 10% of accidents are related to mechanical failure or unsafe physical conditions (Vredenburgh, 2002). Many accidents occur not because of single human error but a series of interacting factors at system levels. Thus, it is rather restrictive to only examine safety from an engineering aspect or human error. More and more researchers have recognized that organizational factors should not be neglected in safety management. Hale and Hovden (1998) call this trend of employing organizational constructs (e.g., culture, safety climate, and organizational commitment) to explain additional variations of safety-related outcomes as the third age of safety research (Johnson, 2007).

Unsafe behavior has been attributed as one of the main causes of accidents. Self-preservation, overriding other motives, is a basic tenet of psychology (Maslow, 1970). Paradoxically, people often behave unsafely because safety measures are likely to entail modest benefits with 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 reinforced because people tend to place higher value on short-term results. In this sense, deterring unsafe behavior is a significant managerial challenge (Zohar, 2002a).

Unsafe behavior is only the resultant symptom. Broader organizational and contextual factors leading to unsafe behavior should not be neglected. The behavioral approach suggests reciprocal relations among attitudes, behavior, and situation. Bandura (1986) has put forward the social cognitive theory, which explains human behavior from not only one's attitudes but also from reciprocal relationships among situation, behavior, and attitudes.

Figure 2.1 depicts these reciprocal relationships. This model theoretically underpins safety climate as a valid construct to explain and predict safety behaviors. People tend to adjust their attitudes in response to the environment and behaviors expected from them. Safety climate, the perception of safety in the working environment, is likely to alter the original cost-benefit function towards unsafe behavior. Unsafe behaviors persist because they are naturally reinforced (Clarke, 2006a). The consequences of taking short-cuts are immediate and positive whereas punishment may be weak, delayed, or infrequent. Given that punishment is rare, the experience of workers may reinforce their behavior by maintaining false perceptions of their actual skill and ability to avoid injuries. A positive safety climate counteracts this natural reinforcement by increasing the motivation to comply with rules and by raising employee awareness of rules and the importance of following them.

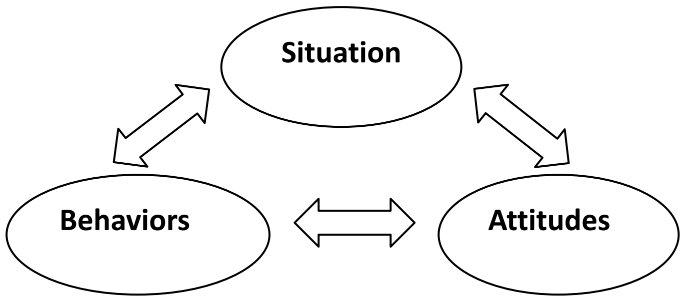

Figure 2.1 Reciprocal relationships between attitudes, behavior, and the situation. (Bandura, 1986, as cited by Lingard and Rowlinson, 2005, p. 319)

2.5 CONCEPTS RELATING TO SAFETY CLIMATE

2.5.1 Defining safety climate

Before defining safety climate, organizational climate must first be defined. *Organizational climate* is widely defined as the perception of formal and informal organizational policies, practices, and procedures (Reichers and Schneider, 1990). Ostroff et al. (2003, p. 566) define organizational climate as "an experientially based description of what people see and report happening to them in an organizational situation. Climate involves employees' perceptions of what the organization is like in terms of practices, policies, procedures, routines, and rewards."

Organizational climate has been viewed as a function of the organization's structure, the people inside the organization and their efforts to understand the organization (Ashforth, 1985). According to Schein (2010), climate is the manifestation of culture. Whereas culture deals with beliefs, perceptions, and behavior, climate is built from measures of individual perceptions.

Safety climate and culture are considered to be subsets of organizational climate and culture (Coyle et al., 1995). Whereas safety culture forms the context within which individual safety attitudes develop and persist and safety behavior are promoted, safety climate is regarded as the manifestation of safety culture in the behavior and perception of employees (Cox and Flin, 1998).

Zohar (1980) produced a seminal paper on safety climate in the early 80s. Since then, safety climate has been widely applied in different contexts. Guldenmund (2000) has affirmed that most of the researchers follow Zohar's (1980) definition of safety climate. Zohar (1980, p. 96) applies climate for safety and 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 define safety climate as a current-state reflection of the underlying safety culture (e.g., Mearns et al., 2001, 2003). Zohar (2003) further delineates safety climate into two dimensions: level and strength. Level of safety climate reflects shared perceived priority of safety, whereas strength of safety climate is homogeneity of perceptions of the importance of safety.

2.5.2 Safety climate vs. safety culture

Safety climate and safety culture are sometimes used interchangeably. Safety climate is the manifestation or snapshot of safety culture (Flin et al., 2000). Denison (1996) has shed some light on the distinction between climate and culture as follows:

> "Climate refers to a situation and its link to thoughts, feelings and behaviors of organizational members. Thus, it is temporal, subjective and often subject to direct manipulation by people with power and influence. Culture, in contrast, refers to an evolved context (within which a situation may be embedded). Thus, it is rooted in history, collectively held, and sufficiently complex to resist many attempts at direct manipulation." (p. 644)

According to Denison (1996), climate and culture can be regarded as different representations of values and assumptions of an organization. According to Schein (2010), culture can be shown in different levels: the central core is "basic assumptions"; the first level is "espoused values"; and the second level is "artifacts". Climate can be better described as the espoused values and artifacts, whereas culture is more associated with the basic assumptions. Climate is temporal and relatively easy to change whereas culture evolves from a longer period and is relatively stable. As concluded by Denison (1996), the difference between culture and climate lies in the *interpretation* rather than in the *phenomenon.*

DeJoy et al. (2004) suggest that the difference between safety climate and safety culture lies in the research methodology. Most studies on safety climate collect data using questionnaires, whereas most studies on safety culture use a qualitative or an ethnographic approach (Mearns and Flin, 1999; Guldenmund, 2000). Guldenmund (2007), concurs with Denison (1996), asserts that safety climate and safety culture are not separate entities; rather, they are different approaches towards the same goal of determining the importance of safety within an organization.

2.5.3 Safety climate vs. safety attitude and perception

Safety attitudes frequently appear in the literature of safety climate. Some studies have implicitly inferred safety climate as safety attitude (e.g., Siu et al., 2004) whereas some studies have included safety attitude as one of the factors constituting safety climate (e.g., Zhou et al., 2011). Guldenmund (2007, p. 726) claims that "safety climate research is basically attitude research". According to the definition of Zohar (1980), safety climate is the shared safety *perceptions* of employees towards the organization with which they work. Although safety attitudes and safety perceptions share some commonalities, they must be distinguished carefully.

Steers (1981) defines attitude as “a predisposition to respond in a favorable or unfavorable way to objects or persons in one’s environment”. Fishbein and Ajzen (1975, p. 6) define attitude as “a learned tendency to act in a consistent way to a particular object or situation”. These two definitions suggest that attitudes are learned and nurtured through social interactions and experiences. People are not born with attitudes. Attitudes refer to a tendency to act in a certain way; however, they are not perfect predictors of actual behavior. Attitudes are reasonably consistent and cannot be changed easily. By contrast, perception is defined as the process by which people interpret and organize sensation to produce a meaningful experience of the world (Linsay and Norman, 1972). Thus, perceptions are more likely to change when the environment changes.

Attitudes tend to be personal “evaluations” of the same object whereas perceptions can be regarded as “descriptive” and referring to “external objects” (Guldenmund, 2007). By definition, attitudes and perceptions are separate entities. However, in reality, separating perceptions from attitudes and having purely descriptive perceptions are difficult. Perceptions may be infused with underlying attitudes and perceptions actually reflect attitudes. In this sense, the claim made by Guldenmund (2007) that “safety climate is actually attitude research” is understandable. However, to avoid confusion, this study has selected the safety climate definition of Zohar (1980) as shared perceptions of employees regarding their workplace.

2.6 MEASUREMENT OF SAFETY CLIMATE

The perception of employees on the organizational policies, procedures, and practices related to safety comprises the safety climate (Griffin and Neal, 2000). Safety climate, which can be gauged easily and periodically with the help of predetermined questionnaire survey, is considered a leading indicator of organizational safety. Safety climate helps to identify potential pitfalls in organizational management that may lead to serious accidents (Zohar, 2010).

Zohar (1980) has identified eight factors of safety climate: 1) perceived importance of safety training programs; 2) perceived management attitudes toward safety; 3) perceived effects of safe conduct on promotion; 4) perceived level of risk at the workplace; 5) perceived effects of workplace on safety; 6) perceived status of the safety officer; 7) perceived effects of safe conduct on social status; and 8) perceived status of safety committee. Brown and Holmes (1986) tested the factor structure of a shortened version of Zohar's (1980) measures using confirmatory factor analysis, and have identified three factors: management concern, management action, and physical risk. In conducting a study of safety climate factors in two different organizations using similar questions, Coyle et al. (1995) have identified seven factors for one organization and six factors for another organization; however, the factor structures in both organizations differ from the factor structures identified in the previous studies. Thus, Coyle et al. (1995) conclude that the factor structure of safety climate has been unstable.

Cox and Flin (1998) suggest that factor structure is industry-specific. For example, Cox and Cox (1991) have developed a questionnaire consisting of 18 items to measure the safety climate of industrial gas companies. Their study has identified five factors: personal skepticism, individual responsibility, safeness of the work environment, effectiveness of arrangements for safety, and personal immunity. Based on the questionnaire developed by Cox and Cox (1991), Cheyne et al. (1998) conducted a safety climate study in the manufacturing sector, and have identified five safety climate factors: safety management, communication, individual responsibility, safety standards and goals, and personal involvement. Except for individual responsibility, the results of Cheyne et al. (1998) differ from that of Cox and Cox (1991). As noted by Cooper and Phillips (2004), each structure is unique to each population under consideration, and factors developed in one industry cannot be generalized to other industries. A priori prediction of factor structure is not possible. A number of reasons contribute to differences in safety climate factor structure (Lin et al., 2008), including different population in different industries or cultures and the discretion of the researcher to determine the structure by different procedures of factor analysis, such as, extraction and rotation.

Despite the instability of a safety climate factor structure, the review of Flin et al. (2000) of 18 scales of safety climate from different industries has revealed five widely occurring factors. These factors are related to management or supervision, the safety system, risk, work pressure, and competence. During approximately the same time, Clarke (2000) reviewed 16 safety climate research studies. Coincidentally, Clarke (2000) has identified five dominant themes of safety climate factors. Listing the dominant themes in descending order by the number of counts, they are safety management system, individual responsibility and involvement, work task or work environment, management attitudes, and management actions. Recently, Beus et al. (2010b) have argued that these most commonly found safety climate factors might not be the best representation of safety climate. They cite "inherent risk" as an example, arguing that it is associated with nature of work, but not necessarily with safety climate. They further argue that individual differences such as safety attitude should not be included as safety climate factors. Zohar (2010) has advanced a similar claim as follows:

> "Safety climate perceptions should thus focus on the nature of relationships between safety policies, procedures, and practices, taking into account that oftentimes rules and procedures associated with safety compete with those associated with other domains (e.g. safety vs. productivity or efficiency)." (p. 1518)

Going back to the conceptualization of safety climate, Zohar (2010) lists three key arrays of safety climate to distinguish safety climate from other perception-based constructs: relative priorities of competing demands, espousal-enactment gaps or discrepancies, and internal consistencies among policies and procedures. To provide a reflection on the development of safety climate in the past 30 years, Zohar (2010) has encouraged the development of industry-specific climate scales to identify new and context-dependent safety climate perceptions in different industrial contexts.

In the context of the construction industry, a few notable safety climate studies have been conducted, as summarized in Table 2.2 (Dedobbeleer and Béland, 1991; Glendon and Litherland, 2001; Mohamed, 2002; Fang et al., 2006; Choudhry et al., 2009; Zhou et al., 2011). The two earliest studies listed in Table 2.2 are by psychology researchers. The studies of Dedobbeleer and Béland (1991) and Glendon and Litherland (2001) were conducted in the construction industry by using safety climate questionnaires originally developed for other industries. The remaining three studies were conducted by researchers in the construction industry. Mohamed (2002) may be one of the earliest researchers in construction to measure construction safety climate. Fang et al. (2006), Choudhry et al. (2009), and Zhou et al. (2011) are closely related studies contributing to the recent development of safety climate research in the construction industry.

Based on 71 questions of the safety climate questionnaire developed by HSE (2001) and 16 items covering 14 safety management elements complied by the Hong Kong government, Fang et al. (2006) empirically tested the 87-item questionnaire with data from construction sites in Hong Kong, yielding ten key factors. Choudhry et al. (2009) conducted a follow-up study, greatly reducing the number of items in the questionnaire to 22 and the number of factors to two. Zhou et al. (2011) also conducted a closely related study in China in 2004 and 2007 using a shortened version of the questionnaire of Fang et al. (2006), thereby deriving a four-factor structure of construction safety climate and further reducing the questionnaire to 24 items.

A comparison of safety climate factors of the above studies is shown in Table 2.2. The comparison shows that management commitment to safety, safety rules and procedures, and workers' involvement in safety are the three most common construction safety climate factors. These three factors are believed to be key safety climate factors in the construction industry because they appear in studies involving construction projects of different sizes and nature conducted in different time and places.

Table 2.2

A Review of Safety Climate Factors in Construction.

Dedobbeleer and Béland (1991)	Glendon and Litherland (2001)	Mohamed (2002)	Fang et al. (2006)	Choudhry et al. (2009)	Zhou et al. (2011)
Management's commitment to safety		Commitment	Safety attitude and management commitment	Management commitment and employee involvement	Management commitment
Workers' involvement in safety		Workers' involvement	Worker's involvement		
	Safety rules Adequacy of procedures	Safety rules and procedures	Improper safety procedures	Inappropriate safety procedure and work practices	Safety regulations
	Personal Protective Equipment		Safety resources		
	Communication and support	Communication			
		Personal appreciation of risk Appreciation of hazards	Appraisal of safety procedure and work risk		Safety attitude
	Work pressure	Work pressure			
	Relationships		Supervisor's role and workmate's role Workmates' influence		
			Safety consultation and safety training		Safety training and workmates' support
		Competence	Competence		
		Risk taking behavior	Risk taking behavior		

2.7 MEASUREMENT OF SAFETY PERFORMANCE

The whole idea underlying the study of safety climate is that safety climate influences one's safety behavior. To examine the relationship between safety climate and safety performance, safety performance has to be first well defined for measurement.

Reliable and valid safety performance measurement indicators have to be selected. As Muckler and Seven (1992) advocate, objectivity-subjectivity distinction is not a valid rule for selecting performance measures. This is because all measurement would be filled with certain level of subjective elements in selecting measures or in collecting, analyzing, or interpreting data. Rather, good performance measures should be relatively simple, adequately valid, sufficiently reliable and appropriately precise.

Safety performance measurement techniques can be categorized into statistics, behavioral measures, periodic safety audits and a balanced score card approach (Chan et al., 2005). The latter three take a relatively longer time to prepare and may not be easily measured in the questionnaire (Choudhry et al., 2009).

Earlier safety studies tend to use statistical data of accidents or injuries to measure safety performance; however, accidents or injuries are reactive and 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 lost time and medical treatment injury rates occur infrequently and are ineffective indicators of safety performance. They suggest using a more fine-grained measure of workgroup safety performance, such as micro-accidents or minor (non-reportable) injuries in future research.

Including minor injuries will enlarge the pool of injury data available for analysis because minor injuries often occur more frequently than serious ones (Beus et al., 2010b). According to Beus et al. (2010b, p. 717), "safety climate should be more effective in predicting injuries of a less serious nature".

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). These behaviors include activities such as "participating in voluntary safety activities, helping coworkers with safety-related issues, and attending safety meetings" (Neal and Griffin, 2006, p. 947).

Table 2.3 shows 37 research articles reviewed on safety performance measurement in relation to safety climate. Most of the studies rely on accidents or injuries as safety performance indicators. However, as indicated by Cooper and Phillips (2004), proactive measures of safety assessing the current safety activities in the workplace would be better indicators. Safety compliance to rules and regulations and the degree of safety participation are possible safety performance measurement dimensions for a questionnaire survey.

Table 2.3

Safety Performance Measurement.

		Accidents/Self-reported injuries	Safety Compliance	Safety Participation
1.	Brown and Holmes (1986)	√		
2.	Donald and Canter (1994)	√		
3.	Hofmann and Stetzer (1996)	√		
4.	Cree and Kelloway (1997)	√		√
5.	Williamson et al. (1997)	√		
6.	Hayes et al. (1998)	√	√	
7.	Mearns et al. (1998)	√		
8.	Lee (1998)	√		
9.	Zohar (2000)	√		
10.	Garavan and O'Brien (2001)	√		
11.	Giffin and Neal (2000)		√	
12.	Lee and Harrison (2000)	√		
13.	Neal et al. (2000)		√	√
14.	Probst and Brubaker (2001)	√	√	
15.	Barling et al. (2002)	√		
16.	Zohar (2002b)	√		
17.	Eklof and Torner (2002)	√		√
18.	Gillen et al. (2002)	√		
19.	Oliver et al. (2002)	√		
20.	Goldenhar et al. (2003)		√	
21.	Mearns et al. (2003)	√		
22.	Hofmann et al. (2003)			√
23.	Prussia et al. (2003)		√	
24.	DeJoy et al. (2004)			√
25.	Probst (2004)	√	√	
26.	Siu et al. (2004)	√		
27.	Zohar and Luria (2004)	√		
28.	Michael et al. (2005)	√		
29.	Morrow and Crum (2004)	√		
30.	Wallace and Chen (2005)	√	√	
31.	Zacharatos et al. (2005)		√	√
32.	Zohar and Luria (2005)		√	
33.	Clarke (2006a)	√		
34.	Huang et al. (2006)	√		
35.	Neal and Griffin (2006)	√	√	√
36.	Lingard et al. (2011)	√		
37.	Lu and Yang (2011)		√	√
Total		28	12	8

2.8 RELATIONSHIPS BETWEEN SAFETY CLIMATE AND SAFETY PERFORMANCE

2.8.1 Theoretical linkages

Social exchange theory and expectancy-valence theory provide the theoretical mechanisms 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 its employees' well-being, the employees are likely to develop implicit obligations to perform behaviors beneficial to the organization. Apart from their standard core work duties, they also perform organizational citizenship behavior, that is, 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 employees will comply with established safety procedures and rules when they perceive that such behaviors will bring valued outcomes. Safety climate is defined by Zohar (1980) as the employees' perception of the true priority of safety in the organization. When the company values safety, a high level of safety climate exists. Based on behavior-outcome expectancies, employees are likely to comply with the safety rules and procedures of the organization and participate in safety activities when they perceive that there are valuable outcomes (Neal and Griffin, 2006).

As explained by Zohar and Luria (2004), safety climate is a social-cognitive construct. Thus, people make sense of the organizational safety priority from procedures-as-pattern, rather than as discrete procedures. With this in mind, unsafe behavior can be explained. Safety systems and policies do not automatically generate safety; it is the true priority of safety consensually perceived by people affects their safety behavior. As an example, a company may impose overt safety policies and management systems. When safety and time come into conflict, managers give the message that time overrides safety. People inside the organization will thus project a low priority of safety (i.e., a low level of safety climate). Safety climate influences behavior through behavior-outcome expectancies (Zohar, 2003). A low safety climate implies that people assign lower weight to safety, and greater value to short-term gains, such as finishing the work faster. In a low safety climate, people also underestimate the likelihood of possible injury. Expectancies are believed to influence the prevalence of safety behavior, which in turn influences company safety records.

2.8.2 Empirical relationships

Safety climate is theoretically expected to have a positive relationship with safety performance. However, empirical studies show that such relationship varies in different industrial context and safety performance measurement. While there are studies showing positive relationships between safety climate and safety performance (Gillen et al., 2002; Siu et al., 2004; Pousette et al., 2008), there are also studies that are unable to find any significant relationship between safety climate and safety performance (Glendon and Litherland, 2001; Cooper and Philips, 2004).

Among studies with significant safety climate and performance relationships, some of them show relatively weak relationships. For example, Neal et al. (2000) have found that safety climate has significant influence on safety participation (standardized path coefficient = 0.23); however, safety climate does not significantly affect safety compliance. A meta analysis conducted by Clarke (2006b) has revealed that safety climate and safety performance is only weakly (0.20) related. Morrow et al. (2010) have found a similar result that safety climate accounts for only 18 % of variance in unsafe behavior.

In contrast, some studies show a relatively strong relationship between safety climate and safety performance. The study of Lu and Yang (2011) on passenger ferries shows that safety climate accounts for 48% and 57% of variance in safety compliance and safety participation respectively. Two safety climate factors, safety training, and emergency preparedness are significantly related to safety compliance and safety participation. Larsson et al. (2008) have found a significant correlation (r = 0.34) between psychological climate and structural safety behaviors of construction workers. The study of Seo (2005) on the United States grain industry workers has revealed a direct influence of safety climate on safe work behavior (standardized path coefficient = 0.73).

Several possible reasons may lead to the above contrasting results. The first is the research design and the measurement of safety climate and safety performance. When some arguable safety climate factors (e.g., safety attitudes) are included, safety climate and performance relationship may be inflated (Beus et al., 2010b). Research design is a possible moderator of the safety climate and performance relationship (Beus et al., 2010b). Limited by the small cases available for analysis, the preliminary findings of Clarke (2006b) show that only *prospective design*, which measures accident involvement in a period after the assessment of safety climate, has validity generalization. In contrast, *retrospective design*, which gauges accident involvement in the period before the assessment of safety climate, does not. Insensitive safety performance measures, such as objective injury data, have limitations in capturing the variances of safety performance at different levels of safety climate (Lingard et al., 2010). Second, climate strength may be the moderator for this climate-behavior relationship because the less homogenous climate perceptions are, the weaker the climate-behavior relationship becomes (Zohar and Luria, 2004).

Another possible explanation is the level of analysis. Research shows that relationship between safety climate and safety behavior varies when their relationships are modeled on different levels of analysis. Findings at the individual, group, or organizational level may be different even with the same data set. For example, Hofmann and Stetzer (1996) have found negative correlations between climate scores and unsafe behaviors at the team level, and, in contrast, positive at the individual level. Recently, safety climate at the group level in the construction industry has drawn attention (Lingard et al., 2009); the importance of safety supervisors and coworkers in enhancing safety performance has been recognized (Lingard et al., 2010, 2011). With all the above possible reasons, the influence of safety climate on safety performance varies across different work settings and environments (Clarke, 2006b).

To explore further the influence of safety climate on safety performance, some studies have encapsulated antecedents of safety climate into the model of safety climate and safety performance. Several studies have tested the mediating relationship of safety climate between organizational factors and safety performance (Neal et al., 2000; Barling et al., 2002; Neal and Griffin, 2002; Zohar, 2002a, 2002b). Safety climate has been found to mediate the relationship between organizational climate (Neal et al., 2000), leadership style (Zohar, 2002a, 2002b) on measures of safety performance. Techniques of structural equation modeling (SEM) are commonly used, such as confirmatory factor analysis, testing measurement model fit and establishing structural path models.

2.9 DEMOGRAPHIC VARIABLES AFFECTING SAFETY CLIMATE

2.9.1 Age, marital status, family members to support

In investigating age differences in safety attitudes and safety performance of Hong Kong construction workers, Siu et al. (2003) conclude that occupational injuries and age have a curvilinear relationship. The number of injuries initially increases with age but then declines as age increases. Older workers experience fewer injuries. Fang et al. (2006) conclude that employees who are older, married, and with more family members to support have higher levels of safety climate. This may be due to the increased cost of mishaps. As social responsibility increases, the likelihood of risk-taking behavior may decline.

2.9.2 Education

Fang et al. (2006) have found that education level is an important influencing factor for safety climate. Employees with education levels below primary school have far less positive perceptions of the safety climate than others do. Gyekye and Salminen (2009) have attempted to answer the research question of whether educational attainment influences workers' perceptions of workplace safety. Findings reveal that the higher the education attainment of workers, the better their perceptions towards safety and the higher safety compliance and lower accident involvement.

2.9.3 Alcohol consumption

Fang et al. (2006) report that employees who drink alcohol at work have a less positive safety climate than those who do not. The study asserts that alcohol may impair the judgment of a person, thereby increasing the chance of an injury. Those who drink at work may not even care about safety of themselves and their colleagues. Other negative working habits usually also accompany alcoholic consumption at work.

2.9.4 Role of employer

Fang et al. (2006) have revealed that employees of subcontractors or joint ventures generally have a less positive view of the safety climate than direct employees do. Excessive subcontracting may lead to lack of control and low commitment towards the company. Indirect labor has low commitment to the company and their workmates.

2.9.5 Personal experience

Zhou et al. (2008) examined the relationship between personal experience and level of safety climate through a Bayesian network based model. Personal experience is conceptualized to have four dimensions: safety knowledge, education experience, work experience and drinking habits. According to their results a joint control of both safety climate factors and personal experience factors is the most effective measure in influencing safety behavior.

2.9.6 Work accident experience

Goncalves et al. (2008) have demonstrated that work accident experience is positively associated with external attribution and unsafe behaviors but negatively associated with internal attributions. People with work accident experience tend to attribute the cause of accident to the external environment, and are likely to have unsafe behaviors.

2.9.7 Employment tenure

Beus et al. (2010a) have determined that worksite tenure is related to safety climate strength such that higher average tenure is associated with stronger safety climates. In other words, if an organization has a high employee turnover rate, safety climate strength tends to be weak because newcomers take time to interact with existing employees to learn about the safety climate of an organization.

2.9.8 Others

The findings of several studies demonstrate that some demographic variables have no significant influence on perceptions of safety climate. The results of Fang et al. (2006) show that gender, work experience with the company, work experience in the construction industry, whether injured or not, and smoking habit have no significant relationship with safety climate. However, as stated by Cooper and Phillips (2004), empirical justification for using personal demographics as a validation technique is required if safety research is to progress.

2.10 PRINCIPLES AND STRATEGIES FOR SAFETY IMPROVEMENT

2.10.1 Basic principles

The traditional paradigm of injury prevention, according to Geller (2001), focuses on three “E”s: (1) engineer, (2) educate, and (3) enforce. These refer to “*engineer* the safest equipment, environmental settings, and protective devices; *educate* people regarding the use of the engineering interventions; use discipline to *enforce* compliance with recommended safe work practices”. These three “E”s help achieve significant improvement in workplace safety. To go beyond the current level of safety excellence, Geller (2001) has put forward a new paradigm with three new “E”s: (1) ergonomics, (2) empowerment, and (3) evaluation. He has further developed ten principles of setting company safety strategies:

- From government regulation to corporate responsibility;
- From failure-oriented to achievement-oriented;
- From outcome focused to behavior focused;
- From top-down control to bottom-up involvement;
- From a piecemeal to a systems approach;
- From fault-finding to fact-finding;
- From reactive to proactive;
- From quick fix to continuous improvement;
- From priority to value; and
- Enduring values.

With these 10 principles in mind, Geller (2001) advocates that companies should perceive safety as part of their corporate social responsibility and not just merely a way to fulfill regulatory obligations. Safety strategies should be achievement-oriented, not merely focused on failure avoidance; focus on behavior rather than injury records; be supported by all managers and supervisors; and be driven by the frontline workers through interdependent teamwork. Geller (2001) suggests adopting a systems approach that is fact-finding, proactive, and committed to continuous improvement.

2.10.2 Safety strategies

Different strategies can be utilized to improve safety; however, deciding whether one strategy is more effective than others may be difficult. Guastello (1993) quantitatively compares the effectiveness of 53 accident-prevention techniques identified from professional journals. These techniques are grouped into 10 approaches by Geller (2001) as follows: (1) behavior-based programs, (2) comprehensive ergonomics, (3) engineering changes, (4) group problem solving, (5) government action, (6) management audits, (7) stress management, (8) poster campaigns, (9) personnel selection, and (10) near-miss reporting. Robson et al. (2007) have reviewed the effectiveness of occupational health and safety management system (OHSMS) interventions on employee health and safety and on associated economic outcomes by analyzing 13 articles meeting both the study's relevance and methodological quality criteria. Their results suggest that OHSMSs have some positive effects; however, insufficient evidence exists to make recommendations either in favor of or against OHSMS. Bottani et al. (2009) have conducted an empirical investigation between adopters and non-adopters of safety management systems (SMSs) to compare their performances in four different aspects: (1) definition of safety and security goals and their communication to employees, (2) risk data updating and risk analysis, (3) identification of risks and definition of corrective actions, and (4) employee training, and find that those companies adopting SMSs achieve significantly better performances in all aspects.

Loosemore and Lam (2004) have conducted an empirical study on construction safety and personal attribute, investigating the role of locus of control as a determinant of opportunistic behavior in construction health and safety. Locus of control is defined as "the self-perceived influence over decision-making" (Loosemore and Lam, 2004, p. 385). Their study concludes that the overall locus of control is high in OHS issues in Australia and suggests addressing the congruent of locus of control between different occupational, gender and ethnic groups to achieve further safety performance improvement.

The study of Mahalingam and Levitt (2007) discusses the effectiveness of safety strategies in terms of enforcement and education. With reference to institutional theory, Mahalingam and Levitt (2007) conclude that coercive safety measures are effective only in the short-term. Although education seems to be ineffective in the short-term, it can change ones' mindset towards safety. Institutional change or mindset change does not occur in a day. Education is often regarded as a key or even the most powerful strategy to improve construction safety; however, according to the findings of Mahalingam and Levitt, this may not be the case. International contractors prefer to employ enforcement strategies that improve safety of global projects because of one-off nature of these projects and because changing safety practices by education takes time. To achieve immediate change in unsafe work practices and long-term safety performance improvement, contractors can adopt a dual approach that employs enforcement strategies together with safety orientation and training.

Ling et al. (2009) have developed and evaluated 41 strategies to minimize fatalities by six safety managers from Singapore and the United States. They identify the top two effective strategies as “site supervisors should also be on a look out for the high risk groups” and “carry out thorough risk assessment of complex projects”. Ling et al. (2009) recommend changing organizational safety culture, enhancing the penalty system, and improving communication between site management and frontline workers. For organizational safety culture, leadership and support from top management are key factors leading to successful safety management systems. To enhance the penalty system, Ling et al. (2009) suggest that the insurers should attach insurance premiums to the safety records of contractors and clients should emphasize safety performance as one of the most important selection criteria of tendering contractors. For communication, the site management staff should communicate effectively with multiple-nationality workers.

Gangwar and Goodrum (2005) have investigated the effect of time on safety incentive programs in the construction industry of the United States. Two types of safety incentive systems exist: injury or illness-based and behavior-based. Injury or illness-based incentives tend to entice the non-reporting of injuries, difficult to discontinue because workers see it as their entitlement, and if it is not administered fairly it can be a de-motivator. For behavior-based incentives, a problem of measurement and monitoring exists because the workers’ behavior is complex and difficult to gauge. Over time, incentives become less viewed as a motivation and perceived more as an entitlement. It must be reinvented through new reward schemes and measures to maintain the interest and motivation of the workforce to improve jobsite safety.

The study of Hinze (2002) discusses the kinds of safety initiatives that would be more effective in driving down injury rates. Safety incentives are more effective when they are given more frequently, to supervisors, as well as to workers. However, incentives of considerable value should be avoided because they may discourage reporting of injuries. Hinze (2002) also notes that injury rates are lower in companies sponsoring safety dinners for workers. Safety performance is particularly magnificent in some cases, such as when the company president and family members are invited to a safety dinner. Although this requires more effort of implementation, safety incentive schemes should be designed to reward the safety behavior of workers during the process of doing the work, rather than the mere absence of injuries. Effects of safety incentive schemes should also be carefully evaluated. Safety performance of workers can be included as a criterion for their job promotion. Negative reinforcement for unsafe behavior through written or verbal sanctions is also useful; however, proper records must be kept of every reprimand.

Anumba et al. (2004) have conducted a closely related study on health and safety in refurbishment involving demolition and structural instability. They recommend a number of strategies to improve safety of refurbishment works. These include selection of suitable procurement routes; demolition design and planning; selection and use of plant and equipment; workforce pre-qualification, selection and supervision; communication of project requirements and health and safety information; and health and safety education and training systems.

2.11 CHAPTER SUMMARY

This chapter has provided a summary of the literature review in respect to causes of accidents; difficulties of implementing safety practices; development of safety management approaches; concepts relating to safety climate; measurement of safety climate; measurement of safety performance; relationships between safety climate and safety performance; demographic variables affecting safety climate; and principles and strategies for safety improvement. Such a review provides a good understanding of the existing literature and further provides a solid basis for developing the research framework of this study.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes and explains the research design and research strategies formulated to achieve the five objectives of this study. A sequential mixed methods research methodology that includes both qualitative and quantitative research strategies is adopted.

3.2 RESEARCH DESIGN

Research design is defined by Creswell (2009, p. 5) as “the plan or proposal to conduct research”. It is affected by the worldview assumptions the researcher brings to the study; procedures for inquiry; and specific methods of data collection, analysis, and interpretation. The selection of a research design is also based on the nature of the research problem or issue being addressed, the researcher’s personal experiences, and the audiences for the study (Creswell, 2009).

Three types of research design are generally utilized. Qualitative research is “a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem” (Creswell, 2009, p. 4). Quantitative research is “a means for testing objective theories by examining the relationship among variables” (Creswell, 2009, p. 4). Mixed methods research is “an approach to inquiry that combines or associate both qualitative and quantitative forms” (Creswell, 2009, p. 4). Rather than viewing qualitative and quantitative research design as polar opposites, they should be viewed as two ends of a continuum, with mixed methods placed in the middle of the continuum.

A framework showing how a research design is formulated is depicted in Figure 3.1. A research design is the resultant decision of three intersecting elements: 1) the philosophical worldview assumptions; 2) the strategy of inquiry, and 3) the methods or procedures of research that operationalize the approach.

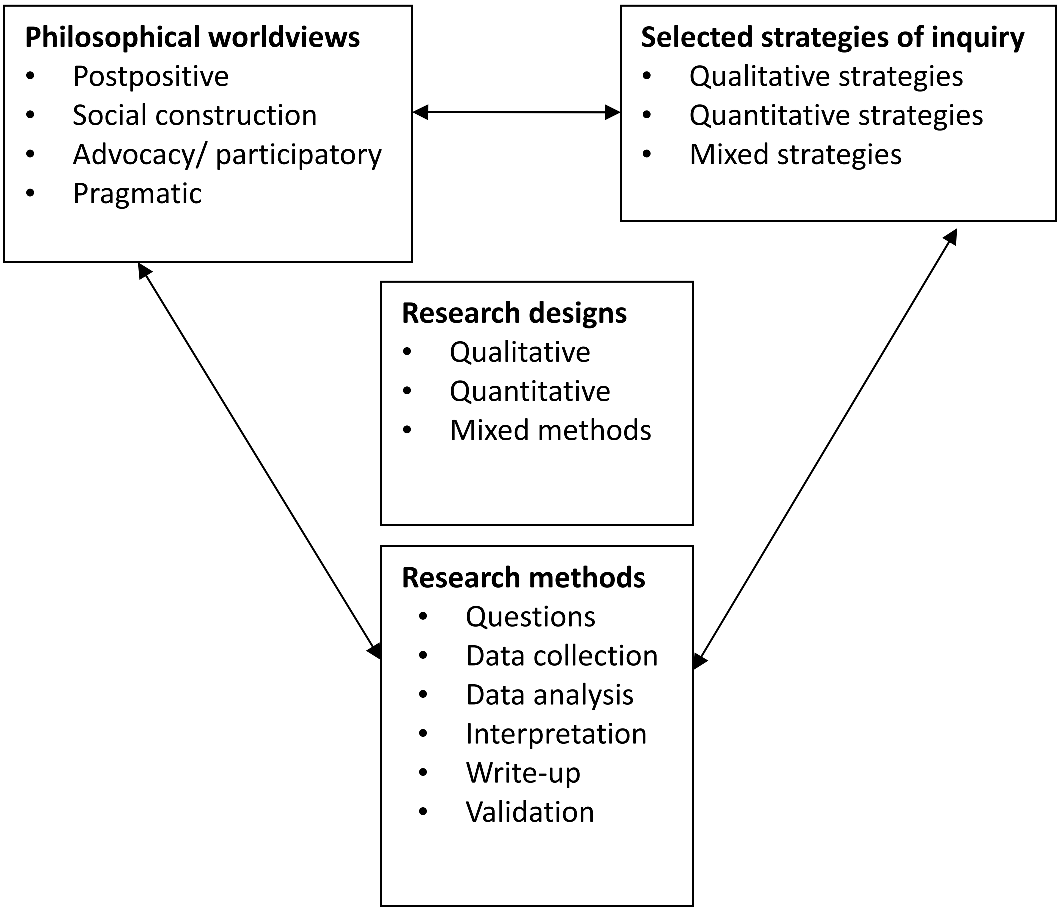

Figure 3.1 Intersected formulating process of research design.
(Adopted from Creswell, 2009, p. 5)

3.2.1 Philosophical worldviews

Worldview means "a basic set of beliefs that guide action" (Guba, 1990, p. 17). It is a general orientation about the world and the nature of research that a researcher holds. The worldview of the researcher underpins the decision to choose a qualitative, quantitative, or mixed methods approach.

Postpositivists hold a deterministic and reductionistic philosophy (Creswell, 2009). They argue that knowledge can be reduced into discrete variables for hypothesis testing. They usually begin their research with a theory and then test the theory with empirical data to support or refute the theory.

Social constructivists assume that individuals seek understanding of the world in which they live and work (Creswell, 2009). Constructivists address the processes of interaction between individuals and adopt qualitative research to generate or inductively develop a theory.

Advocacy and participatory worldviews focus on marginalized individuals in the society or issues of social justice that need to be addressed. The research often contains an action agenda that may change the lives of the participants.

Pragmatists are concerned with applications, what works, and solutions to problems (Creswell, 2009). Instead of focusing on methods, researchers emphasize the research problem and use all available approaches to understand the problem. Pragmatism is a philosophical underpinning for mixed methods studies.

3.2.2 Strategies of inquiry

Strategies of inquiry, or research methodologies, are types of qualitative, quantitative, and mixed methods designs or models that provide specific direction for procedures in a research design (Creswell, 2009).

Common types of qualitative strategy include ethnography, grounded theory and case studies. Survey research being a common type of quantitative strategy, can be cross-sectional or longitudinal. Survey research uses questionnaires for data collection with the intent of generalizing from a sample to a population (Creswell, 2009).

Mixed methods can correct biases inherent in any single method by the biases of other methods. Data can be triangulated and integrated to achieve convergence across qualitative and quantitative methods. Quantitative and qualitative results can support one another to improve validity of the findings (Creswell, 2009).

The three main types of mixed methods are the sequential, concurrent, and transformative methods. Sequential mixed methods involve procedures of qualitative methods to quantitative ones in sequence, and vice versa. Concurrent mixed methods involve collecting both forms of qualitative and quantitative data simultaneously, and then integrating the information in the interpretation of the overall results. Transformative mixed methods involve using a theoretical lens as an overarching perspective within a design that contains both qualitative and quantitative data

(Creswell, 2009).

3.2.3 Research methods

Research methods include data collection, analysis, and interpretation of the findings. Quantitative methods tend to be predetermined. Such methods ask instrument-based questions, use performance data, attitude data, and so on, and perform statistical analysis and interpretation. Qualitative methods tend to be emergent. Such methods ask open-ended questions, use interview data, observation data, document data, and so on, involve text and image analysis, and end up in themes or patterns interpretation. Mixed methods use both predetermined and emergent methods. They ask both open-ended and close-ended questions, collect multiple forms of data, and perform statistical analysis, text analysis and cross-interpretation (Creswell, 2009).

Recalling the research design framework, the worldviews, the strategies, and the methods all contribute to a research design that tends to be quantitative, qualitative, or mixed. A postpositivist tends to adopt the quantitative strategies of inquiry, collect quantitative data, and perform statistical analysis. A constructivist tends to adopt the qualitative strategies of inquiry, collect qualitative data, and perform textual analysis. A pragmatist tends to adopt a mixed methods approach, making use of both quantitative and qualitative data.

3.3 RESEARCH FRAMEWORK OF THE STUDY

Pragmatism is the underpinning worldview of the current study. Pragmatism provides the philosophical foundation to adopt mixed methods as strategy of inquiry (Morgan, 2007). A sequential mixed methods research design was employed in the current study (Teddlie and Tashakkori, 2009). Mixed methods research design is encouraged in construction research because it enhances both the validity and the reliability of the study (Abowitz and Toole, 2010).

After a thorough literature review on safety climate and RMAA works, qualitative and quantitative research methods were employed to achieve the five research objectives sequentially. Research objectives drive the strategies of inquiry. The research process of this study is shown in Figure 3.2. First, interviews were conducted with RMAA contractors to examine the safety problems and safety practices of the RMAA works (Objective 1), and to identify the strategies for improving safety of RMAA works (Objective 5) (the details of interviews can be found in Section 3.4.1). Second, two rounds of Delphi survey were conducted to verify the interview findings (the details of Delphi survey can be found in Section 3.4.2). Third, a questionnaire survey was administered to identify safety climate factors of RMAA works (Objective 2); scrutinize the relationships between safety climate and safety performance of RMAA works (Objective 3); and examine how demographic variables affect the levels of safety climate (Objective 4) (the details of questionnaire survey can be found in Section 3.5.2).

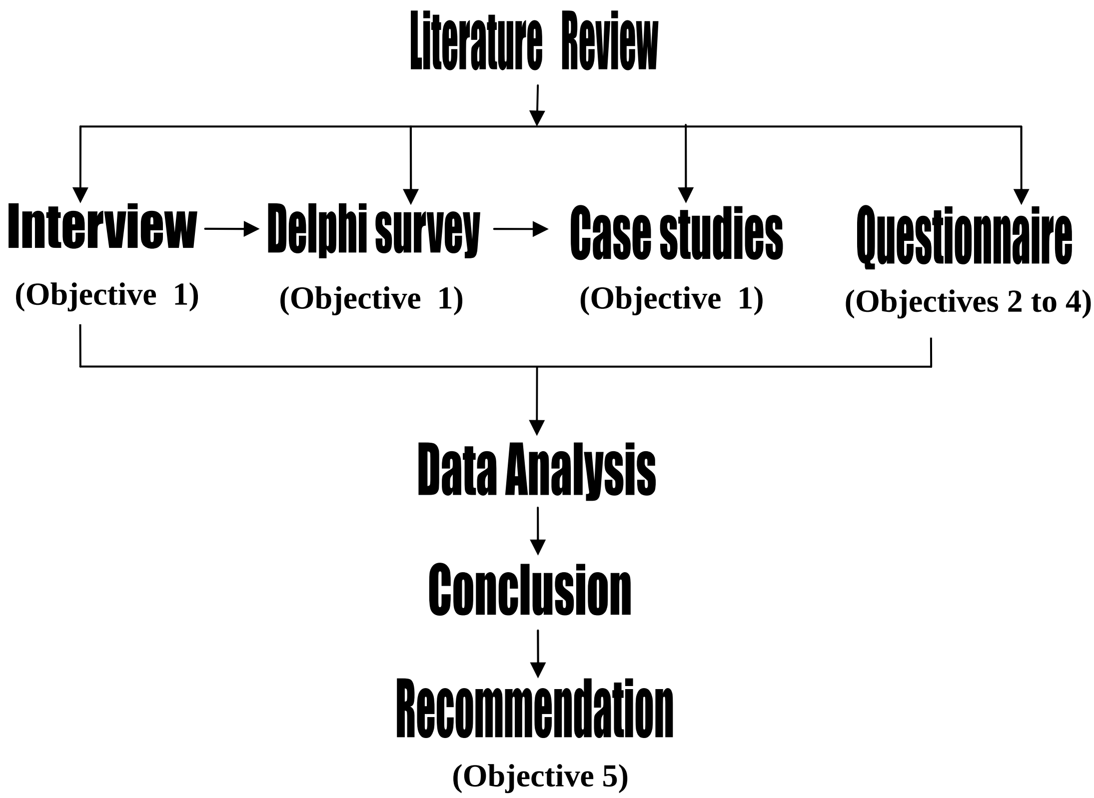

Figure 3.2 Research process of the study.

3.4 RESEARCH STRATEGIES FOR OBJECTIVES 1 AND 5

3.4.1 Interviews

Because there is limited a priori information on RMAA works and safety practices in this sector, adopting a qualitative approach can effectively reveal the reality without stripping away details or imposing a preconceived framework of the researchers.

RMAA contractors with hands-on experience of RMAA work activities were targeted for interviews because they are most likely to be the people in proximity to accidents. Invitations were sent to 17 RMAA contractors on the approved contractors' list of a property management company in Hong Kong. Eight RMAA contracting companies responded favorably to the research interview request. Face-to-face interviews were conducted with senior management representatives of these eight companies between December 2008 and February 2009. Each interview lasted for approximately an hour. Each interview was tape-recorded and transcribed for later coding of data. One invited interviewee (I) chose to provide written answers to the interview questions.

As shown in Table 3.1, the interviews A to C, D to F, and G to H represent views of RMAA contractors undertaking large-, medium-, and small-sized RMAA projects in Hong Kong respectively. Interview questions (Appendix 1) were compiled with reference to CII-HK (2007). Six core questions were asked, with an additional three optional questions when time allowed.

Table 3.1
Background of the Interviewees.

No. of Interviews	Position of interviewees	Project scale/nature
A	Director	HKD 10 million to more than HKD 100 million
B	Project Safety Manager and Project Manager	HKD 10 million to more than HKD 100 million
C	Managing Director and Senior Manager	More than HKD 100 million, term contract
D	Executive Director	Less than HKD 20 million
E	Managing Director	Approximately HKD 10 million
F	General Manager	Approximately HKD 10 million
G	Senior Project Manager	Approximately HKD 10,000 to 2 million
H	Director	Several thousands to HKD 10 million
I	Vice President (Project Development)	Hotel

Qualitative interview data transcribed into narratives were coded by constant comparative method (Grove, 1988; Ryan and Bernard, 2000) in NVivo 8, software for qualitative data analysis. Interview data of common themes and similar semantic meanings were initially coded together as the same category. For example, the concepts of “awareness” and “mindsets” that appeared in transcripts were coded in the same category. Each category was then compared with other categories continuously during the coding process for refinement until each presented a clear and distinct categorization.

3.4.2 Delphi method

The Delphi method is defined by Linstone and Turoff (1975, p. 3) as “a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem”. It allows the experts to think independently, give feedback, and change their opinions after considering the opinions of others. Rather than simply using questionnaire survey, the Delphi method has been proven to be an appropriate method of item prioritization (Okoli and Pawlowski, 2004).

Application of Delphi to rank the relative importance of causes of RMAA accidents is particularly suitable due to a number of reasons. This study specifically requires participation of stakeholders with insights of safety practice of RMAA works. General practitioners in the construction industry may not easily identify and prioritize specific safety problems of the RMAA sector. Instead of evaluating from one single perspective, agreement achieved through a group decision-making process of the client, the contractor, and the OHS consultant/regulatory body of RMAA works is likely to yield a more unbiased and thoughtful result.

A two-round Delphi exercise, which minimizes fatigue and attrition of experts in repeated rounds but still allows feedback and revision of response, was conducted in a focus group meeting through an interactive online survey system. As reviewed by Mullen (2003), two to three rounds of Delphi are preferred and used in most studies. The four questions for the expert panel to answer covered: 1) the causes of RMAA accidents, 2) the difficulties in implementing safety practices in the RMAA sector, 3) the strategies for improving safety performance of the RMAA sector, and 4) the characteristics of RMAA projects with outstanding safety performance. An appended version of the online Delphi survey can be found in Appendix 2. The design of the first round Delphi questionnaire was mainly based on the categories identified from interviews and supplemented by literature (CII-HK, 2007).

After the first round Delphi, the group results were presented to the expert panel in real time. The panel members were then requested to freely adjust and refine their answers in the second round Delphi. Thirteen experts were invited to join the expert panel. As reviewed by Mullen (2003), Linstone (1978) suggests that panel size should not be less than seven, whereas Turoff (1970) claims that it may range from ten to fifty. According to Powell (2003), representativeness of the expert panel is assessed by its qualities, rather than its numbers. A heterogeneous group with diversified background better encapsulates a wide knowledge base.

As shown in Table 3.2, the members comprised experienced senior management taking care of safety in the Hong Kong government, quasi-government organizations, and private organizations. Some experts also served on the board of the construction safety committee of the Hong Kong government.

Table 3.2

Background of the Expert Panel Members.

Expert Panel Member ID	Position/(title)	Organization
1	Safety Manager/(Dr.)	Contractor
2	Technical Manager/(Mr.)	Property management company
3	Deputy Chief Occupational Safety Officer/(Mr.)	Hong Kong government
4	Senior Manager (Safety and Health)/(Mrs.)	Hong Kong government
5	Representative/(Mr.)	Self-regulatory body of insurers
6	Manager/(Mr.)	Contractor
7	General Manager/(Mr.)	Quasi-government body
8	Principle Consultant/(Dr.)	Occupational Safety and Health Council
9	Director/(Dr.)	Construction Industry Institute-Hong Kong
10	Manager/(Mr.)	Private developer
11	Senior Structural Engineer/(Mr.)	Hong Kong government
12	Executive Director/(Mr.)	Electrical and mechanical contractor
13	Safety, Health, Environment and Quality Manager/(Mr.)	Utility service company

Data were analyzed by the software SPSS18.0. Kendall's coefficient of concordance (*W*) was calculated to assess the group agreement of the experts' rankings as follows (Siegel and Castellan, 1988):

$$W = \frac{\sum_{i=1}^{n}\left(\overline{R}_i - \overline{R}\right)^2}{n(n^2-1)/12}$$

n = number of options being ranked

$\overline{R}_i$ = average of the ranks assigned to the i^{th} options

$\overline{R}$ = average of the ranks assigned across all options

The possible value of *W* lies between 0 and 1. The value 0 represents no agreement among the experts at all, whereas 1 represents perfect agreement among the experts in the panel. Because each of the four questions in the Delphi survey (i.e., causes of RMAA accidents; difficulties in implementing safety practices in the RMAA sector; strategies for improving safety performance of the RMAA sector, and characteristics of RMAA projects with outstanding safety performance) consisted of more than seven options for the expert panel to be ranked, further calculation of the chi-square distribution was necessary to test the significance (Siegel and Castellan, 1988). The Delphi technique can improve group consensus, thereby yielding a more reliable ranking of the options.

Spearman's rho correlation between the first and the second-round Delphi ranking exercises assesses the consistency of the expert panel, while Spearman's rho correlation between subgroups assess the similarity of the subgroup rankings. Spearman's rho is calculated as follows (Norušis, 2008):

$$r_s = 1 - \frac{6\sum d^2}{N(N^2 - 1)}$$

d = difference in rank of the two groups for the same option
N = total number of responses concerning that option

The Kruskal-Wallis Test was employed to test the null hypothesis (H_0) that the median scores for three subgroups are the same. The alternative hypothesis (H_1) is that the median scores for three subgroups are not the same. If H_0 is not rejected, the three subgroups have similar rankings towards the options in the question. The Kruskal-Wallis Test Statistic is calculated as follows (Siegel and Castellan, 1988):

$$H = \frac{12}{n(n+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(n+1)$$

H = Kruskal-Wallis Test Statistic
n = total number of observations in all samples
R_i = rank of the sample

3.4.3 Case studies of RMAA fatal accidents

A total of 90 fatal cases of RMAA works for the period between 2000 and 2007 were provided by the Labour Department of the Hong Kong government. Due to the confidentiality of the fatal case reports, the data released were coded into a predetermined classification system in EXCEL format by the Labour Department. Another 29 fatal cases for the period between 2008 up to 31 Oct 2011 were collected from local newspaper archives by the author. The 29 additional cases were then coded in the same classification EXCEL template.

Variables and classification categories were designed with reference to Huang and Hinze (2003) and Chan et al. (2008). Key coding variables include: 1) Time of accident; 2) Day of week of accident; 3) Month of accident; 4) Year of accident; 5) Type of accident; 6) Gender of victim; 7) Age of victim; 8) Trade of worker; 9) Length of experience; 10) Body part injured; 11) Injury nature; 12) Place of accident; 13) Agent involved; 14) Type of work being performed; 15) Safety education and training; 16) Use of safety equipment; 17) Employment condition; 18) Unsafe condition; and 19) Unsafe action.

Data were analyzed with SPSS 18. Descriptive statistics were utilized to analyze the overall pattern of the fatality records. A two-step cluster analysis was employed to derive major clusters of the fall from height fatal cases. The two-step cluster analysis is suitable for this study because it can handle both continuous and categorical variables, determining the optimal number of cluster automatically (SPSS, 2001; Garson, 2010). The two-step cluster analysis firstly pre-clusters the data using a sequential clustering approach. It examines each case and decides if the current record should merge with the previously formed cluster or start a new cluster based on the distance criterion. Fraley and Raftery (1998) proposed utilizing Bayesian information criterion (BIC) as the criterion statistic. The second step takes sub-clusters from the first step as input and then groups them into a number of clusters (Garson, 2010). The literature shows that age, trade, place of accident, and day of accident are distinguishing features of fatalities in construction (Huang and Hinze, 2003; Chi et al., 2005; Chan et al., 2008). Thus, these features were selected to form the clusters. Cross tabulation analyses were then conducted to explore analyses.

3.5 RESEARCH STRATEGIES FOR OBJECTIVES 2 TO 4

3.5.1 Development of research hypotheses

After a thorough literature review in Chapter 2, a research model and three hypotheses were formulated below to achieve Objective 3 (Figure 3.3).

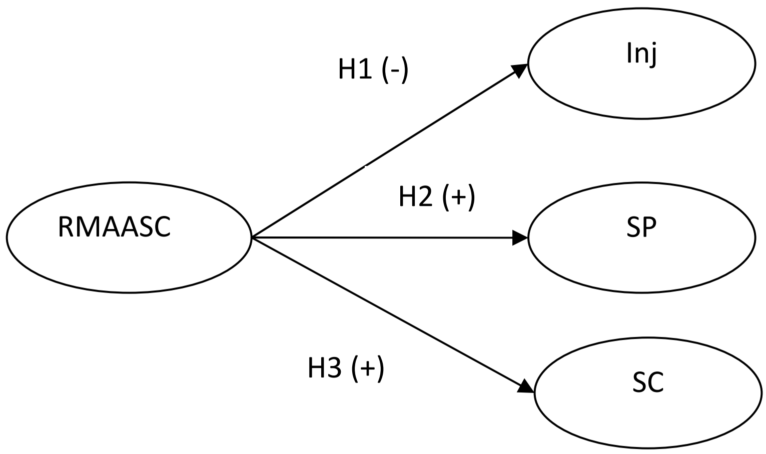

Figure 3.3 Research model and hypotheses.
Note. RMAASC = RMAA safety climate. Inj = Injuries. SP = Safety participation. SC = Safety compliance.

The safety climate largely shows the importance of safety perceived by the employees in an organization. The level of safety climate affects the safety behavior and safety attitudes of people in an organization. When safety perceptions are more favorable, workers are less likely to engage in unsafe acts, resulting in a lower chance of injury. The first hypothesis can thus be generated as follows:

Hypothesis 1 (H1): RMAA safety climate (RMAASC) is negatively related to injuries (Inj).

Safety participation is more on voluntary basis, and, perhaps outside of one's formal role. When managers and supervisors demonstrate their commitment to safety, their subordinates are more likely to reciprocate by participating in safety activities. The more positive the safety climate, the higher level of the safety participation, as hypothesized in Hypothesis 2.

Hypothesis 2 (H2): RMAASC is positively related to safety participation (SP).

A higher level of safety climate may imply better safety management, safety knowledge and awareness of safety within the company. In such a case, people are likely to comply with safety rules and regulations. Thus, Hypothesis 3 can be generated as follows:

Hypothesis 3 (H3): RMAASC is positively related to safety compliance (SC).

The above hypotheses were tested with empirical data. A questionnaire was designed to collect data for hypothesis testing. Details of the design of the questionnaire are discussed in Section 3.5.2.

3.5.2 Design of questionnaire

To date, safety climate research has been predominantly carried out with the survey questionnaires because the questionnaire is an effective instrument to gauge people's perceptions and the resulting information can be used to reveal the inter-correlations of their perceptions (Spector, 1994). Hence, a safety climate questionnaire was designed to collect data for the current study.

The questionnaire was divided into three parts (Appendix 3). Part A consisted of 13 questions concerning personal attributes: 1) working level, 2) work trade, 3) age, 4) gender, 5) marital status, 6) number of family members supported by respondent, 7) education level, 8) direct employer, 9) length of service with the current company, 10) working experience in the construction industry, 11) safety training, 12) smoking habit, and 13) alcohol consumption.

Part B consisted of 38 questions adopted from the Safety Climate Index (SCI) survey of the Occupational Safety and Health Council (OSHC) of Hong Kong which measures safety climate behaviors of workers. These questions were evaluated by the respondents in a five-point Likert scale, with 1 being *strongly disagree* and 5 being *strongly agree*. A number of measurement scales of safety climate are available in the literature (Davies et al., 2001). After evaluation, the SCI survey items of the OSHC were selected for a number of reasons. The SCI survey tool originated from HSE (2001); however, it was shortened and modified to suit the local context of the construction industry of Hong Kong. Validity and practicality of the tool have been proven through prior research of OSHC with local government works departments, private property developers and major contractors. The survey tool was designed and presented in English and Chinese. The Chinese version was provided to potential respondents, especially frontline workers.

Part C consisted of three broad indicators to measure safety performance: injuries, safety participation, and safety compliance. Instead of using objective accident statistics, these subjective measures were used because previous safety climate studies (e.g. Cooper and Philips, 2004; Neal and Griffin, 2004) show that they are reasonably reliable and valid indicators to measure safety performance. They were designed as follows:

Injuries

Four questions were utilized to capture accidents and occupational injuries of the respondents in the last 12 months with a 5-point Likert scale. The questions included near-miss incidents, injuries not requiring absence from work, injuries requiring absence from work not exceeding three consecutive days, and injuries requiring absence from work exceeding three consecutive days. The questions were set in ascending degree of injury severity with reference to the existing injury reporting requirements of the Labor Department.

Safety participation

Two statements from Neal and Griffin (2006, p. 953) were modified to measure safety participation of the respondents with a 5-point Likert scale. Having considered that small RMAA projects may not have formal safety programs, one of the statements listed in Neal and Griffin (2006, p. 953), "I promote the safety program within the organization", was not selected. With examples given to enhance clarity, the two selected statements were posed as questions regarding the frequency of putting extra effort to improve safety of the workplace, and the frequency of voluntarily carrying out tasks or activities to improve workplace safety.

Safety compliance

Two questions were also utilized to measure in terms of time (0% to 100%) the degree of safety compliance with all safety procedures by the respondents and their coworkers, respectively. Two questions were adopted from Mohamed (2002) to measure safety compliance of the respondents. The first question was regarding the percentage of time the respondents followed all of the safety procedures for the jobs or tasks that the respondents perform, whereas the second question was regarding the percentage of time their coworkers followed all of the safety procedures for the jobs or tasks that they perform.

3.5.3 Participants and procedures

Sampling of the questionnaire is important because it affects generalizability of the findings. A sampling frame was set to enlist key stakeholders in the RMAA sector to participate in this study: the private property management companies; the maintenance sections of quasi-government developers and their subcontractors; the RMAA section of general contractors; and the small RMAA contractors, building services contractors and trade unions.

A pilot questionnaire was reviewed by 13 members of the expert panel before dissemination (the background of the expert panel members can be found in Table 3.2). The role of the expert panel was to provide advice and industrial support, ensuring that the research endeavors actually met the needs and concerns of the industry. The questionnaire survey was administered between April and August in 2009. A number of private property management companies, maintenance section of quasi-government developers and their subcontractors, RMAA section of general contractors, small RMAA contractors, building services contractors and trade unions in Hong Kong participated in this study.

The advantage of using questionnaires is to have a large volume of quantitative data, allowing generalization of the findings. The disadvantage is that controlling the quality of the data becomes difficult (Neuman, 2004). For companies or organizations that were willing to administer the questionnaire in their respective

RMAA project sites, their managerial or supervisory staff members were briefed to ensure familiarity with the questionnaire. To enhance the quality of the responses, 14 trained student helpers met with the RMAA workers to provide assistance in completing the questionnaire.

Sampling error can be controlled by drawing samples that are sufficiently large (Hox et al., 2008). To facilitate application of factor analysis and other multivariate statistical techniques, a minimum of five to ten cases per measure is typically recommended (Hair et al., 2010). For the 38 questions of the safety climate measurement scale, a sample size of at least 380 was targeted.

3.5.4 Statistical analysis

Quantitative survey data were analyzed with statistical packages SPSS 18.0 (SPSS Inc., Chicago, IL, USA) for general statistical analysis and LISREL 8.80 (Jöreskog and Sörbom, 2006) for structural equation modeling. Data were randomly split within SPSS into calibration sample and validation sample for data analyses leading to the achievement of Objectives 2 and 3. Statistical analysis selected to achieve research objectives are discussed as follows.

3.5.4.1 Descriptive statistics and analysis of variance

To obtain a general picture of the data collected, descriptive statistics such as mean, standard deviation, frequency, and so on were generated. To achieve Objective 4, RMAA safety climate was analyzed with different referent group such as working level, age, marital status, and so on. Analysis of variance (ANOVA) was employed to determine statistically whether the mean differences of the referent groups were significantly different from one another. ANOVA helped to reveal how demographic variables affect people’s perception to safety. The dependent variable was the RMAA safety climate score, whereas the independent variables were demographic variables such as working level, age, safety training, and so on. The RMAA safety climate score was calculated by averaging the total score of the variables constituting RMAA safety climate as determined in Objective 2.

3.5.4.2 Reliability checking and exploratory factor analysis

Reliability is the degree to which a measure is free from random error, as determined by checking internal consistency. Reliability of safety climate measurement of Part B of the questionnaire was checked by Cronbach's alpha, the most widely used internal consistency reliability coefficient (Netemeyer et al., 2003).

To achieve Objective 2, which identifies the safety climate factors of RMAA works, exploratory factor analysis (EFA) was conducted. EFA is a multivariate statistical technique to reduce a number of variables into underlying constructs (Hair et al., 2010).

Visual inspection of data matrix revealed substantial number of correlations greater than 0.3. The Bartlett test of sphericity, which provides the statistical probability that the correlation matrix has significant correlations among at least some of the variables, was checked. A measure of sampling adequacy (MSA) showed the appropriateness of applying factor analysis. In the Kaiser-Meyer-Olkin measure of sampling adequacy, a value 0.9 or above is generally considered to be marvelous; a value 0.8 or above is meritorious; a value 0.7 or above is middling; a value 0.6 or above is mediocre; a value 0.50 or above is miserable; and a value below 0.5 is unacceptable (Hair et al., 2010).

Two methods can be utilized to obtain factor solutions: component factor and common factor analyses. The component factor model is appropriate when the study aims to examine the minimum number of factors accounting for the maximum portion of the variance in variables, and when information shows that error variance only accounts for a relatively small proportion of the total variance (Hair et al., 2010). Common factor analysis is used when the study aims to identify the latent dimensions or construct represented in the original variables, and when the information of error variance in variables is limited (Hair et al., 2010). However, empirical research shows that these two methods tentatively yield similar results (Velicer and Jackson, 1990). Component factor analysis was selected for this study for its simplicity of interpretation.

Various methods can be used to determine the number of factors to be extracted, including Kaiser's criterion, scree test criterion and Horn's parallel analysis. Kaiser's criterion extracts factors with latent roots or eigenvalues greater than one. All factors with latent roots or eigenvalues less than one are insignificant and disregarded. The scree test is performed by plotting the latent roots against the number of factors. The point at which the curve first begins to straighten out is the maximum number of factors to extract. Horn's parallel analysis compares the size of the eigenvalues with those obtained from a randomly generated data set of the same size (Pallant, 2007). Only the eigenvalues that exceed the corresponding values from the random data set are retained. Horn's parallel analysis has been recognized as the most accurate method to determine the number of factors to retain. Both Kaiser's criterion and scree test tend to overestimate the number of factors to retain (Pallant, 2007). In this study, Kaiser's criterion, scree test, and Horn's parallel analysis were considered when determining the number of factors.

Unrotated factor structure is usually difficult to interpret. To better interpret the factor, rotation is necessary. Rotation of factor matrix redistributes the variance from earlier factors to later ones to achieve a simpler, theoretically more meaningful factor pattern. Orthogonal rotation (e.g., quartimax, varimax, and equimax) maintains the axes at 90 degrees. It is used on the assumption that there is no correlation between factors. Oblique rotation (e.g., oblimin, and promax) does not maintain the axes at 90 degrees. This rotation is used when anticipating that there are relationships between factors in reality. For a construct in social science, assuming that there is no correlation among factors is unrealistic. Because the factors of safety climate are likely to be correlated with one another, this study selected direct oblimin as the method of rotation. Pallant (2007) recommends beginning with direct oblimin and then checking the degree of correlation between the factors. If the factors are not correlated, the result will resemble that of the orthogonal rotation method. Tabachnick and Fidell (2007) suggest that oblique rotation should be selected if factor correlations exceed 0.32.

3.5.4.3 Structural equation modeling

Structural equation modeling (SEM) was employed to achieve Objectives 2 and 3. SEM is a large set of statistical techniques based on general linear model that examines a set of relations between one or more independent variables (IVs) and one or more dependent variables (DVs). IVs and DVs can either be measured variables (directly observed), or latent variables (unobserved) (Ullman, 2006). SEM grows out of and serves similar purposes of multiple regression but in a more powerful way. It has more flexible assumptions than multiple regression, particularly allowing interpretation even in the face of multicollinearity (Garson, 2012). For proper application of SEM, at least three basic assumptions should be met: multivariate normality, selection of covariance matrix, and sufficient sample size (Crowley and Fan, 1997). Maximum likelihood estimate (MLE) is the most common estimation method of SEM. MLE is sensitive to departure of normality. When data are significantly non-normal, other estimation methods which do not require normality should be used or the Satorra-Bentler scaled chi-square which corrects the test statistics to take into account of non-normality should be used. Covariance matrix should be analyzed rather than correlation matrix because statistical theories of estimation methods of SEM are derived from covariance matrix. Sample size should be sufficiently large. Although there is no fixed rule, the number 200 has been suggested as the bottom-line (Crowley and Fan, 1997). Taking into account of the model complexity and number of parameters to be estimated, each estimated parameter should have 5 to 10 participants to support (Crowley and Fan, 1997). All these assumptions were checked and conformed before selecting SEM for this study.

SEM was selected because of its unique features over other multivariate techniques. First, it can examine a series of separate, but interdependent, multiple regression equations simultaneously by specifying the structural model. Second, it can take into account of latent variables. A *latent variable* is a hypothesized and unobserved concept that can only be approximated by observable or measurable variables collected from survey or experiment. Third, it can correct or assess measurement error by providing explicit estimates of error variance parameters. Fourth, it takes a confirmatory rather than an exploratory approach to data analysis (Byrne, 2009). An a priori theoretical model can be tested with empirical data by SEM. In contrast, most other multivariate techniques are descriptive and exploratory in nature, making them less appropriate for model testing (Crowley and Fan, 1997).

3.5.4.4 Application of SEM to this study

Numerous applications of SEM can be found in safety climate research. For example, validating safety climate scale by confirmatory factor analysis (Seo et al., 2004); testing relationships between safety climate dimensions and treatment error in hospitals (Katz-Navon et al., 2005); testing predictive validity of safety climate (Johnson, 2007); testing mediating effect of safety climate on the relationship between leadership and safety performance (Wu et al., 2008); testing mediating role of employee safety control between safety climate and self-reported injury (Huang et al., 2006); and testing safety climate as a moderator of job insecurity and safety performance (Probst, 2004). In addition, SEM has also been employed successfully in safety climate research in the construction industry. Mohmand (2002) first introduced SEM to test safety climate and safety performance relationship in construction site environment, and projected there would be huge potential for a wider application of SEM to safety climate research.

SEM is considered the most appropriate and robust data analysis technique for achieving Objectives 2 and 3 of this study. SEM takes a confirmatory approach to determine the safety climate factors of RMAA works. Confirmatory factor analysis (CFA) was employed to assess the reliability of the factor structure generated by EFA.

SEM also enables multiple factors of safety climate and safety performance to be estimated simultaneously. Safety climate is a latent variable that cannot be directly observed and measured. Because SEM can reveal the interdependencies of observed variables and latent variables simultaneously, interdependencies of safety climate factors and safety performance can be fully modeled and tested. A full structural equation model that consists of both measurement and structural models, was tested to estimate the relationships between safety climate and safety performance.

3.5.4.5 Processes of SEM

SEM applications typically follow a four-step process (Bollen and Long, 1993, as cited in Chin et al., 2008).

Step 1: Model specification

A theoretically based model was formed after conducting the literature review (refer to Figure 3.3). *RMAA safety climate* was the independent variable (IV). Three constructs of safety performance, namely *injuries*, *safety participation*, *and safety compliance* were used as dependent variables (DVs) to form the structural model. CFA, a type of SEM technique, was employed to determine the safety climate factors of RMAA works. SCI questions were the observed variables of safety climate factors, forming the measurement model.

Step 2: Model identification

Model identification considers the question of whether all the parameters are uniquely defined. An unidentified model may have more than one or even an infinite number of set(s) of parameters that can produce the same covariance matrix. Thus, no unique solution to the problem would exist. A check was conducted to determine whether the data points were sufficient for the full structural equation model to be identified.

Step 3: Model estimation

For model estimation, a variety of methods such as maximum likelihood (ML), generalized least squares (GLS), weighted least squares (WLS) or arbitrary distribution free (ADF) and ordinary least squares (OLS) methods can be utilized. The choice depends on the sample size, data distribution, and type of data matrix used as input. ML estimation is the most frequently used estimation method in SEM; however, it requires the data set to be normally distributed.

Results of the normality checking show that data of this study were not normally distributed. For example, the data on injuries were found to be significantly positively skewed. ADF does not require normal distribution; however, it requires a huge data set (> 2,500) to perform well. As suggested by Ullman (2006, p. 43), "in medium (over 120) to large samples the scaled ML test statistic is a good choice with non-normality or suspected dependence among factors and errors". Because the data set of this study is significantly non-normal and reasonably large, the Satorra-Bentler scaled chi-square was utilized. This is an adjusted chi-square statistic that attempts to correct for the bias introduced when data are markedly non-normal in distribution (Satorra and Bentler, 2001).

Step 4: Model evaluation

Many model fit indices are available; however, no single fit index is sufficient for a correct assessment of model fitness (Seo et al., 2004). One of the most widely used fit indices is model chi-square (χ^2) which tests the closeness of fit between the sample covariance matrix and the fitted covariance matrix. A non-significant, small χ^2 value indicates that the observed data are not significantly different from the hypothesized model. However, as formula of computing χ^2 is related to sample size, nearly all models are evaluated as incorrect as sample size increases. For this reason, the ratio of χ^2 to the degrees of freedom (χ^2/df) has been commonly used as an alternative fit index. If this value is less than 2, the model is a good fit (Ullman, 2006).

Another commonly used fit index is root mean square error of approximation (RMSEA). According to Byrne (2009, p. 80), RMSEA is "one of the most informative criteria in covariance structure modeling". RMESA values of less than 0.05 indicate a good fit, whereas values as high as 0.08 represent reasonable errors of approximation in the population.

Other commonly used fit indices include Comparative Fit Index (CFI), Normed Fit Index (NFI) and Non-normed Fit Index (NNFI). CFI, NFI, and NNFI of 0.95 or greater indicate a good fit (Bryne, 2009).

Aside from overall model fitness, internal validity and reliability of the model has to be assessed. To assess the discriminant validity of the CFA, average variance extracted (AVE) should be calculated. Ideally, AVE of a factor should be greater than its squared correlations with other factors. However, if the 95 % confidence interval of factor correlation does not pass the value of 1, that pair of factor still has discriminant reliability (Torkzadeh et al., 2003). To assess the reliability of the CFA, construct reliability index was calculated. A value over 0.7 suggests good reliability (Hair et al., 2010).

Average variance extracted (AVE) was calculated as follows (Fornell and Larcker, 1981):

$$\rho_v = \frac{(\sum \lambda^2)}{[\sum \lambda^2 + \sum(\theta)]}$$

λ = indicator loadings
θ = indicator error variances

Construct reliability was calculated as follows (Fornell and Larcker, 1981):

$$\rho_c = \frac{(\sum \lambda)^2}{[(\sum \lambda)^2 + \sum(\theta)]}$$

λ = indicator loadings
θ = indicator error variances

3.6 CHAPTER SUMMARY

This chapter has described and explained the research methodology adopted in this study. A sequential mixed research methodology was adopted. After a thorough literature review, both qualitative and quantitative research methods were employed to achieve the five research objectives. First, interviews were conducted to reveal the causes of accidents and safety practices in the RMAA sector, and identify the strategies for improving safety of the RMAA sector. Second, two rounds of Delphi survey were conducted to validate the interview findings. Third, a questionnaire survey was administered to examine the safety climate factors of RMAA works, determine the relationships between safety climate and safety performance of RMAA works, and examine how demographic variables affect the levels of safety climate.

CHAPTER 4 SAFETY PROBLEMS AND PRACTICES IN THE RMAA SECTOR

4.1 INTRODUCTION

This chapter reports the qualitative interview findings and the two-round online Delphi survey results relating to Objective 1, which examines the safety problems and practices in the RMAA sector. Specifically, causes of accidents in the RMAA sector and difficulties of implementing safety practices in the RMAA sector are examined.

4.2 CAUSES OF ACCIDENTS IN THE RMAA SECTOR[1]

4.2.1 Interview findings on causes of accidents in the RMAA sector

Table 4.1 shows the eight major categories of accident causes in the RMAA sector. Details of how these categories were derived can be found in interview reports in Appendix 4. Among them, low safety awareness of RMAA workers; low safety awareness of small/medium-sized contractors and property owners in RMAA works; and inadequate safety supervision were the three mostly mentioned causes of RMAA accidents. No interviewee predominantly cited one particular cause of RMAA accidents, which suggests that no single cause can fully explain the occurrence of RMAA accidents.

[1] Published in Hon, C.K.H., Chan, A.P.C. and Wong, F.K.W. (2010). An analysis for the causes of accidents of repair, maintenance, alteration and addition works in Hong Kong. *Safety Science*, 48(7), 894-901.

Table 4.1
Categories of Causes of RMAA Accidents Developed from Interviews.

Categories	Subcategories
1. Low safety awareness of RMAA workers	• Underestimate risk in occupied workplace • Perceive RMAA works to be minute tasks • Demonstrate expertise
2. Inadequate safety supervision	• Scatter in location • Lenient legal requirement
3. Low safety awareness of small/ medium-sized contractors and property owners in RMAA works	• Small contract sum • Limited safety resources • Employ handy man
4. Inadequate site safety planning and hazard assessment	• Ad hoc problems • No standard method statement
5. Inadequate regulatory and monitoring system	• Loophole in reporting system • Less checking
6. Poor housekeeping and congested working environment	• Limited space • Multiple trade of workers
7. Insufficient safety training of RMAA workers for handling multiple tasks	• Multiple skills required • Unskilled workers
8. Hurry to finish the work	• Short project duration

4.2.1.1 Low safety awareness of RMAA workers

As revealed by most of the interviewees, RMAA workers have a relatively low level of safety awareness, and are less cautious than workers of new works. Because RMAA works are conducted in occupied buildings, RMAA workers rarely perceive that they are working in a "site" that is dangerous, and they are hardly able to adopt the stringent safety standards practiced on sites of new works and apply them to RMAA works. Very often, they have the mindset that RMAA works are small tasks that can be finished in a short time. Some workers are over-confident and believe they have the competency to handle any situation.

As cited by representatives of Interview B as an example, some bamboo scaffold workers have the mindset that standing on the inner layer of bamboo scaffold is safe, and their competency allows them not to take any safety precautions. These make them underestimate the potential risks involved. In addition, for small RMAA works, time and effort spent on safety precautions may be even greater than the task itself. For convenience, they are prone to take shortcuts and behave unsafely.

4.2.1.2 Inadequate safety supervision

A vast majority of interviewees advocated that inadequate safety supervision is one of the factors that leads to RMAA accidents. Safety supervision is difficult because locations of RMAA works are widely scattered, particularly for those term contract works. In addition, small to medium-scale RMAA works are exempt from the requirement of employing a full-time site safety officer. That explains why most RMAA works usually do not have full-time site safety officers; instead, they have safety supervisors. That is, there is no staff fully designated to safety supervision. According to a representative of Interview D,

> "A safety officer has better authority to enforce safety on site [than a safety supervisor]. It is because their primary responsibility is to enforce safety; and they have to bear legal responsibility if they fail to perform their duty. For safety supervisors of RMAA works, who perform the dual roles of site foremen and project engineers, safety is only one of the tasks they need to handle. They may be more focused on progress of work rather than safety" (Interview D).

4.2.1.3 Low safety awareness of small/medium-sized contractors and property owners in RMAA works

Most of the interviewees expressed that RMAA works are usually not undertaken by big contractors but small/medium-sized contractors. Management of such small/medium-sized contractors has a relatively low safety awareness and limited resources for safety. With small contract sums, resources for safety such as personal protection equipment (PPE) and safety training are limited. Representatives of Interview C also pointed out that a lack of safety awareness in the public (which includes the clients of the small/medium-sized contractors). The main concern of the public is on cost. People pay little attention to the issue of safety when undertaking simple RMAA works.

4.2.1.4 Inadequate site safety planning and hazard assessment

Many unforeseeable ad hoc problems can arise in RMAA works. Accidents occur because of inadequate or no site safety planning and hazard assessment. For example, representatives of Interview B mentioned that “RMAA works usually depend on experience and the situation rather than following a standard method statement. Field control sheet briefing and workface risk assessment are particularly important for RMAA works”.

This point was echoed by Interviewee I. Inadequate safety planning and hazard assessment are evidenced by accidents arising from unrecorded installation of existing M&E; illegal work done in the past without proper records; poor conditions of the pipework and installation under pressurized condition; concrete spalling and rusty metalwork installation; fire installation malfunction; and inadequate preparation time to understand the work scope before work commencement.

4.2.1.5 Inadequate regulatory and monitoring system

More than half of the interviewees expressed that no regulatory system has been established for RMAA works. RMAA works have less stringent safety requirements than new works. In projects with contract sums of less than HKD 1 million (approximately USD 128,000) the contractor is not required by law to inform the Labor Department regarding the project’s execution. Due to the small scale and short duration of RMAA project, less surveillance of the government regulatory body is required in the RMAA works than in new works.

4.2.1.6 Poor housekeeping and working environment

According to Interviewee G, in his experience, poor housekeeping can easily cause injuries, the most common of which is cuts. For example, piles of building and waste materials next to the working platform pose a danger to the workers. The working environments of RMAA works in occupied buildings are often congested and stuffy, posing potential danger to workers.

Unlike new works, RMAA works have limited space for storage of materials. RMAA works are usually conducted in occupied buildings. Various and numerous trades of workers are packed in a limited space carrying out their own works, usually simultaneously. For example, having more than 100 people, including workers and management team, engaged in an RMAA project in a small renovation site is normal.

In order to reduce the degree of nuisance to other occupants, ventilation is often poor in the enclosed working space of RMAA works. In this hot and stuffy environment, workers can be very reluctant to wear safety helmets, eye goggles or reflective jackets if not strictly required by client and contractor.

4.2.1.7 Insufficient safety training of RMAA workers for multiple tasks

The nature of RMAA works generally requires workers to have multiple skills to perform multiple tasks. RMAA work activities involve many different trades; in this case, work is not done by specialists of a particular trade. An example was cited by Interviewee H; "a painter may be requested to drill a hole on the work which he is not familiar with and this increases the chance of an accident". Despite the fact that most of the RMAA workers possess a *Construction Industry Safety Training Certificate* (commonly known as the "Green Card" in Hong Kong)**,** they are likely to be insufficiently trained to safely undertake multiple tasks in RMAA works.

"Green Card" safety training is very general and does not fully address hazards and dangers encountered by RMAA workers. The effectiveness of a "Green Card" has been challenged in CII-HK (2008). Interviewee C raised the following point:

> "Many RMAA workers are unskilled and without proper safety training. More specific training is required for RMAA workers as RMAA works involve hazards that are different from new works, for example, multiple trade work practices, electricity handling, and so on" (Interviewee C).

4.2.1.8 Hurry to finish the work

Interviewees D, E, and G opined that one of the major reasons for RMAA accidents is the attitude of workers to complete their work hastily. Safety is likely to be neglected when workers are in a hurry to meet deadlines. When the volume of RMAA works increases, project duration may need to be compressed to meet the schedule. RMAA workers would try to finish the work quickly; hence, they would ignore safety, resulting in a higher accident rate.

In addition, some workers may take short cuts and ignore safety measures because of the payment arrangement. As stated by Interviewee D:

> "…Workers of subcontractors may be employed by piece rate [for alteration and addition demolition work]. Time is of essence to them. Without safety supervision, they will not break down a wall piece by piece but let the whole wall collapse quickly by striking at the bottom part of the wall. It is dangerous and may hurt the workers" (Interviewee D).

4.2.2 Relative importance of causes of accidents in the RMAA sector

Reliability of expert ranking was reflected in a moderate level of group agreement. Ranking agreement among the 13 experts improved after two rounds of Delphi. Kendall's coefficient of concordance (*W*) improved remarkably from 0.246 with χ^2 (11, N =13) = 35.210, $p < 0.001$ in the first round to 0.313 with χ^2 (11, N =13) = 44.812, $p < 0.001$ in the second round (Tables 4.2 and 4.3).

Ranking agreement also improved among subgroups of client, contractor, and OHS consultant/regulatory body. Kendall's coefficient of concordance (*W*) of client subgroup increased from 0.414 with χ^2 (11, N =5) = 22.758, $p < 0.05$ in the first round to 0.458 with χ^2 (11, N =5) = 25.217, $p < 0.01$ in the second round; that of contractor subgroup and OHS consultant/regulatory body subgroup increased from 0.517 with χ^2 (11, N =3) = 17.047, *n.s.* at 0.05 significance level in the first round to 0.536 with χ^2 (11, N =3) = 17.693, *n.s.* at 0.05 significance level in the second round, and from 0.360 with χ^2 (11, N =5) = 19.819, $p < 0.05$ in the first round to 0.418 with χ^2 (11, N =5) = 22.974, $p < 0.05$ in the second round. Thus, the employment of the two-round Delphi successfully contributed to improving agreement of the experts and reliability of our findings.

Table 4.2

Round One Delphi Results on Causes of RMAA Accidents.

	Round One Delphi	All experts		Clients		Contractors		OHS consultant/ regulatory body	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1.	Poor safety consciousness of RMAA workers.	4.46	1	4.80	1	4.33	2	4.20	4
2.	RMAA workers underestimate potential risks when performing small tasks for a short period.	4.38	2	3.80	7	4.67	1	4.80	1
3.	Inadequate safety supervision.	3.85	9	4.00	5	3.67	5	3.80	9
4.	Low safety awareness of small/medium-sized contractors on RMAA works.	3.92	8	3.80	7	3.67	5	4.20	4
5.	Low safety awareness of flat owners/tenants on RMAA works.	3.15	12	2.60	12	3.33	9	3.60	12
6.	Inadequate site safety planning and hazard assessment.	4.00	6	4.20	3	3.67	5	4.00	7
7.	Inadequate regulatory control and monitoring system.	3.38	11	3.20	10	3.00	12	3.80	9
8.	Poor housekeeping and congested working environment.	3.62	10	3.20	10	3.33	9	4.20	4
9.	Insufficient safety training of RMAA workers for handling multiple tasks.	4.15	4	4.00	5	3.33	9	4.80	1
10.	Hurry to finish the work.	4.00	6	3.80	7	3.67	5	4.40	3
11.	Lowest bid tendering method without pricing for safety items.	4.23	3	4.40	2	4.33	2	4.00	7
12.	Personal protective equipment not used, incorrectly used, or not provided.	4.08	5	4.20	3	4.33	2	3.80	9
	Number (*N*)	13		5		3		5	
	Kendall's coefficient of concordance (*W*)	0.246		0.414		0.517		0.360	
	X^2	35.210		22.758		17.047		19.819	
	Degrees of freedom (*df*)	11		11		11		11	
	Level of significance	0.000		0.019		0.106		0.048	

Table 4.3

Round Two Delphi Results on Causes of RMAA Accidents.

	Round Two Delphi	All experts		Clients		Contractor		OHS consultant/ regulatory body	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1.	Poor safety consciousness of RMAA workers.	4.54	1	4.80	1	4.00	4	4.60	1
2.	RMAA workers underestimate potential risks when performing small tasks for a short period.	4.31	2	4.20	3	4.67	1	4.20	4
3.	Inadequate safety supervision.	3.69	10	3.80	6	3.67	8	3.60	11
4.	Low safety awareness of small/medium-sized contractors on RMAA works.	3.77	8	3.80	6	3.33	10	4.00	7
5.	Low safety awareness of flat owners/tenants on RMAA works.	3.23	12	1.60	12	3.33	10	3.80	10
6.	Inadequate site safety planning and hazard assessment.	4.00	7	4.00	5	4.00	4	4.00	7
7.	Inadequate regulatory control and monitoring system.	3.46	11	3.60	10	3.33	10	3.40	12
8.	Poor housekeeping and congested working environment.	3.77	8	3.40	11	3.67	8	4.20	4
9.	Insufficient safety training of RMAA workers for handling multiple tasks.	4.08	6	3.80	6	4.33	2	4.20	4
10.	Hurry to finish the work.	4.15	5	3.80	6	4.00	4	4.60	1
11.	Lowest bid tendering method without pricing for safety items.	4.23	4	4.60	2	4.00	4	4.00	7
12.	Personal protective equipment not used, incorrectly used, or not provided.	4.31	2	4.20	3	4.33	2	4.40	3
	Number (*N*)	13		5		3		5	
	Kendall's coefficient of concordance (*W*)	0.313		0.458		0.536		0.418	
	X^2	44.812		25.217		17.693		22.974	
	Degrees of freedom (*df*)	11		11		11		11	
	Level of significance	0.000		0.008		0.089		0.018	

4.2.3 Inter-group comparisons on identified difficulties

As a whole, ranking of the expert panel was consistent. Referring to Table 4.4, Spearman's rho correlation of rankings between the first round and the second round Delphi exercise of the expert panel was highly correlated at a significance level of 0.01 (*Spearman's rho* = 0.938, $p < 0.01$). As for the rankings of subgroups in the two rounds of Delphi, the client subgroup was the most consistent (*Spearman's rho* = 0.886, $p < 0.01$) followed by the contractor subgroup (*Spearman's rho* = 0.630, $p < 0.05$), and finally, the OHS consultant/regulatory body subgroup (*Spearman's rho* = 0.615, $p < 0.05$).

A few noticeable changes of rankings occurred in subgroups, narrowing the difference among subgroups (Tables 4.4 and 4.5). The client subgroup raised the ranking of "RMAA workers underestimate potential risks when performing small tasks for a short period" from the seventh in the first round to the third in the second round. The contractor subgroup lowered the ranking of "Low safety awareness of small/medium-sized contractors on RMAA works" from the fifth in the first round to the tenth in the second round. The OHS consultant/regulatory body subgroup raised the ranking of "Personal protective equipment not used, incorrectly used, or not provided" from the ninth in the first round to the third in the second round. Individual subgroups adjusted their rankings to be more in line with one another.

Table 4.4
Spearman's Rho Correlations of Rankings in Round One and Round Two Delphi on Causes of RMAA Accidents.

Rankings in Rounds One and Two Delphi	Spearman's rho correlation	Sig. (2-tailed)
All experts	0.938**	<0.001
Client subgroup	0.886**	<0.001
Contractor subgroup	0.630*	0.028
OHS consultant/regulatory body subgroup	0.615*	0.033

Note. ** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

As shown in Table 4.5, the client subgroup's ranking was moderately correlated with the contractor subgroup ranking (*Spearman's rho* = 0.668, $p < 0.05$). The contractor subgroup ranking was also fairly correlated with the OHS consultant/regulatory body subgroup's ranking (*Spearman's rho* = 0.647, $p < 0.05$). However, the rankings of the client and OHS consultant/regulatory body were not significantly correlated with one another. This is understandable because they are playing very different roles; the former is monitored by the latter.

Table 4.5
Spearman's Rho Correlations of Client, Contractor and OHS Consultant/ Regulatory Body in Round Two Delphi on Causes of RMAA Accidents.

		Contractors' ranking	OHS consultant/ regulatory body' ranking
Clients' ranking	Spearman's rho correlation	0.668*	0.469
	Sig. (2-tailed)	0.018	0.124
Contractors' ranking	Spearman's rho correlation		0.647*
	Sig. (2-tailed)		0.023

Note. *Correlation is significant at the 0.05 level (2-tailed).

After the second round Delphi, some remarkable ranking variations remained among the subgroups. The client subgroup ranked "Lowest bid tendering method without pricing for safety items" to be the second important cause of RMAA accidents, whereas the contractor subgroup and OHS consultant/regulatory body subgroup ranked it to be the fourth and the seventh, respectively. The client subgroup perceived the safety problem of RMAA sector to be highly attributable to the procurement method and contractual arrangement. This is not surprising because some of the experts in the client subgroup support the implementation of the "Pay for Safety Scheme" by the client to the contractor.

The contractor subgroup ranked "Insufficient safety training of RMAA workers for handling multiple tasks" to be the second most important cause of accidents while other subgroups ranked it as the sixth and the fourth, respectively. From the contractors' perspective, safety competency for multiple task handling is important. The OHS consultant/regulatory body subgroup uniquely attributed the most important cause of RMAA accident to be "Hurry to finish the work". This subgroup consists of experts outside the construction industry. Perhaps this may be the reason this subgroup's ranking differs from client and contractor subgroups of the construction industry. Time constraint is one of the main reasons people work hastily and behave unsafely, thereby causing accidents.

4.2.4 Analysis of RMAA fatal accidents

Analysis of RMAA fatal accidents, which helps to reveal the underlying causes of RMAA accidents, is shown below.

4.2.4.1 Descriptive statistics

As shown in Table 4.6, the fall of person from height (n = 74, 62%) and contact with electricity (n = 20, 17%) were the two major causes for RMAA fatalities between 2000 and 2011. To gain a better understanding of the major causes for RMAA fatalities, the analysis focuses on the 74 cases of fall of person from height.

Table 4.6
Types of RMAA Fatal Accidents in Hong Kong.

Types of RMAA accidents	Frequency	Percentage
Fall of person from height	74	62%
Contact with electricity or electric discharge	20	17%
Contact with moving machinery or object being machined	3	3%
Trapped by collapsing or overturning object	5	4%
Asphyxiation	4	3%
Slip, trip or fall on same level	1	1%
Trapped in or between objects	4	3%
Striking against or struck by moving object	1	1%
Exposure to or contact with harmful substance	1	1%
Struck by falling object	5	4%
Others	1	1%
Total	119	100%

4.2.4.2 Cluster analysis

A cluster analysis was then conducted on 74 fall from height fatal cases. Outlier treatment of noise handling at 25% was selected. After the cluster features (CF) tree was formed, the outliers would be placed in the CF tree if possible, if not, the outliers would be discarded accordingly (SPSS, 2001). Three fall of person from height fatal cases were classified as outliers, the remaining 71 cases were formed into three clusters (Figure 4.1). Average silhouette is 0.3 indicating that the cluster quality is fair (Below 0.2 is poor, 0.2-0.5 is fair, 0.5-1.0 is good). As shown in Figure 4.2, Cluster 1 was labeled as bamboo scaffolders aged between 25 and 34 who fell from external wall/facade in the beginning of weekdays (*n* = 31); Cluster 2 was labeled as miscellaneous workers aged between 45 and 54 who fell from other/unknown places in the end of weekdays (*n* = 27); and Cluster 3 was labeled as manual labour aged between 35 and 44 who fell at floor level/ from floor openings in weekends (*n* =13).

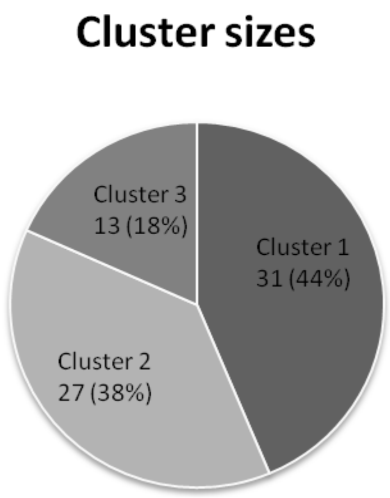

Figure 4.1 Frequency distribution of the three clusters of fall from height fatal cases.

Cluster 1 Bamboo scaffolders aged between 25-34 working at external wall/facade in the beginning of weekdays

This cluster consists of the vast majority of the relatively young bamboo scaffolders. Many accidents happened in the afternoon in the beginning of the week in the summer, that is, Monday and Tuesday afternoons in the summer. Accidents occurred when the bamboo scaffolders were working on the bamboo scaffolding, either erecting or dismantling bamboo scaffolding/ truss-out scaffolding. Most of them were employees.

Cluster 2 Miscellaneous trades of RMAA workers aged between 45-54 working at other/unknown places in the end of weekdays

This cluster mainly consists of miscellaneous trades of RMAA workers including plasterer, plumber, jointer, and others. Accidents occurred in lift shaft/internal work surface, excavation/underground/basement, and others. This cluster of fatalities mostly occurred in the summer afternoon on Thursdays and Fridays.

Cluster 3 Manual labour aged between 35-44 working at floor/floor opening in weekends

Workers in their early middle age undertaking demolition work and others type of works fall at floor level or fall into floor openings. Accidents mostly happened in the afternoon on Saturdays and Sundays in the summer.

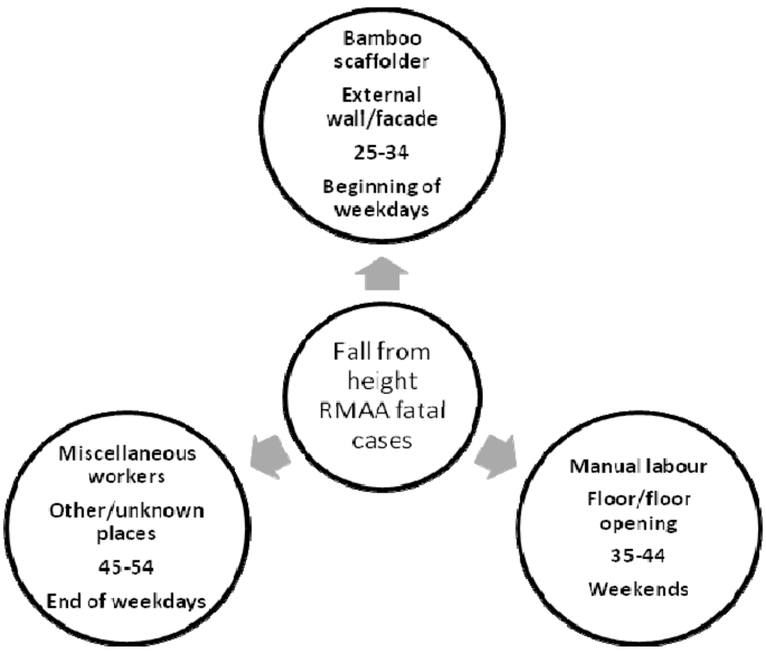

Figure 4.2 Three clusters of fall from height RMAA fatal cases.

Table 4.7 shows the cross-tabulation results of the 71 fall from height fatalities and the three clusters. About 49% of 71 fall from height fatalities (*n* = 35) occurred in the afternoon. Twenty three (*n* = 23) fatalities occurred in the beginning of weekdays and in the end of weekdays respectively whereas far less fatalities occurred in the middle of weekdays (*n* = 13) and weekends (*n* = 12).

Table 4.7

Cross-tabulation Analysis of the Clusters.

Variable	Category	Cluster 1 (*n* = 31)	Cluster 2 (*n* = 27)	Cluster 3 (*n* = 13)	Total (*N* = 71)
Time	08:00-12:00	9	9	3	21
	12:01-14:00	4	3	4	11
	14:01-18:00	***17***	***13***	***5***	35
	Others	1	2	1	4
Day*	In the beginning of weekdays	***13***	10	0	23
	In the middle of weekdays	6	6	1	13
	In the end of weekdays	7	***11***	5	23
	Weekends	5	0	***7***	12
Season	Spring	5	6	1	12
	Summer	***15***	***9***	***6***	30
	Autumn	7	4	3	14
	Winter	4	8	3	15
Age*	≤ 24	5	0	4	9
	25-34	***13***	1	0	14
	35-44	5	2	***6***	13
	45-54	4	***13***	3	20
	≥55	4	11	0	15
Trade*	Labour	2	2	***8***	12
	Painter and decorator	2	3	0	5
	Building services/ E&M worker	2	2	3	7
	Bamboo scaffolder	***24***	0	0	24
	Miscellaneous	1	***20***	2	23
Body part injured	Multiple locations	***23***	***14***	***7***	44
	Skull/scalp	8	13	6	27
Injury nature	Multiple injuries	***23***	***15***	***8***	46
	Contusion and bruise	7	11	5	23
	Concussion	0	1	0	1
	Others	1	0	0	1
Place*	External wall/facade	***31***	8	3	42
	Floor/floor opening	0	8	***6***	14
	Roof/top of building	0	1	4	5
	Others	0	***10***	0	10
Agent	Ladder	2	4	2	8
	Scaffolding/gondola	***24***	5	2	31
	Others	5	***18***	***9***	32
Type of work	Material handling	0	1	1	2
	Manual work	0	4	2	6
	Electrical wiring	0	2	2	4
	Water pipe fitting	0	2	0	2
	Air-conditioner installation	2	2	2	6
	Painting	1	4	0	5
	Demolition work	3	3	***3***	9
	Bamboo scaffolding	***24***	0	0	24
	Others	1	***9***	***3***	13
Safety equipment	Not provided	***20***	***15***	***10***	45
	Provided but not used	0	4	1	5
	Provided and used	9	2	0	11
	Unknown	2	6	2	10
Employment	Employee	***22***	***19***	***9***	50
	Self-employed	8	8	2	18
	Illegal migrants	1	0	2	3

Note. Numbers in bold and italics represent the mode of the categories. *Key features used in the classification of clusters.

Younger workers (aged between 25 and 34) tend to have accidents in the beginning of weekdays (n = 13) whereas the older workers (aged between 45 and 54) tend to have more accidents in the end of weekdays (n = 11). These may be explained by the fact that younger workers tend to have more entertainments during weekends and hence may not get back to working mode when they resume work in the beginning of weekdays whereas older workers tend to get fatigue towards the end of weekdays because of the cumulative effect. The number of fatalities occurred in summer (n = 30) far outweighed other seasons, accounting for about 42% of the 71 fall from height fatalities. Overall speaking, workers aged between 45 and 54 (n = 20) were more prone to accidents. Victims aged 45 or above (n = 35) accounted for about 49% of the 71 fall from height fatalities. It seems that age is a contributing factor for RMAA fall from height fatalities. Most of the victims were injured in multiple locations (n = 44) and had multiple injuries (n = 46). About 59% of fall from height fatalities occurred in external wall/facade (n = 42). Floor/floor opening was the next common place of fall from height fatalities (n = 14). Apart from the category of others, scaffolding/gondola was the most frequently involved agent (n = 31). Bamboo scaffolding was the most accident-prone type of work (n = 24). Shockingly, about 63% of victims were not provided with any safety equipment (n = 45). Most of the fatalities were employees (n = 50).

In terms of trade, bamboo scaffolders accounted for the greatest number of fatal falls (n = 24). Hence, a separate fatality analysis of bamboo scaffolders was conducted and results are shown in Table 4.8. Regarding the bamboo scaffolding trade, young bamboo scaffolders were more prone to accident than their older counterparts. The number of fatalities of bamboo scaffolders in RMAA works aged below 34 was 14, accounting for 58% of total number of fatalities of bamboo scaffolders in RMAA works. However, comparing with the age profile of registered bamboo scaffolders in Hong Kong, the number of bamboo scaffolders aged below 34 was a mere 22% (Construction Workers Registration Authority, 2011). This implies that 22% of the workforce (those aged below 34) accounted for 58% of the total fatalities. The current findings indicate that younger bamboo scaffolders with less experience were more prone to fatal accidents than their older counterparts.

Table 4.8

Comparing the Age Distributions of Bamboo Scaffolders in RMAA Fatalities with Registered Bamboo Scaffolders in Hong Kong.

	Fall from Height fatalities of bamboo scaffolders in RMAA works		Registered bamboo scaffolders in Hong Kong (Construction Workers Registration Authority, 2011)	
Age	Frequency	Percentage	Frequency	Percentage
Below or equal to 24	5	21% *(21%)*	33	2% *(2%)*
25-34	9	37% ***(58%)***	329	20% ***(22%)***
35-44	4	17% *(75%)*	384	23% *(45%)*
45-54	2	8% *(83%)*	580	36% *(81%)*
55 or above	4	17% *(100%)*	306	19% *(100%)*
Total	24	100%	1632	100%

Note. Numbers in italatics refer to cumulative values.

Improper procedure (*n* = 51, 72%) and unsafe process or job method (*n* = 48, 68%) were the top two unsafe conditions (Figure 4.3) whereas failure to use safety belt/harness was the top unsafe action (*n* = 50, 70%) (Figure 4.4) found in the fall from height RMAA fatalities.

Cluster one accounted for most of the improper procedure, unsafe process, and failure to use safety belt/harness, implying that younger bamboo scaffolders tended to pay less attention to the safety practices than the more experienced ones. More safety training and supervision should be given to the younger bamboo scaffolders.

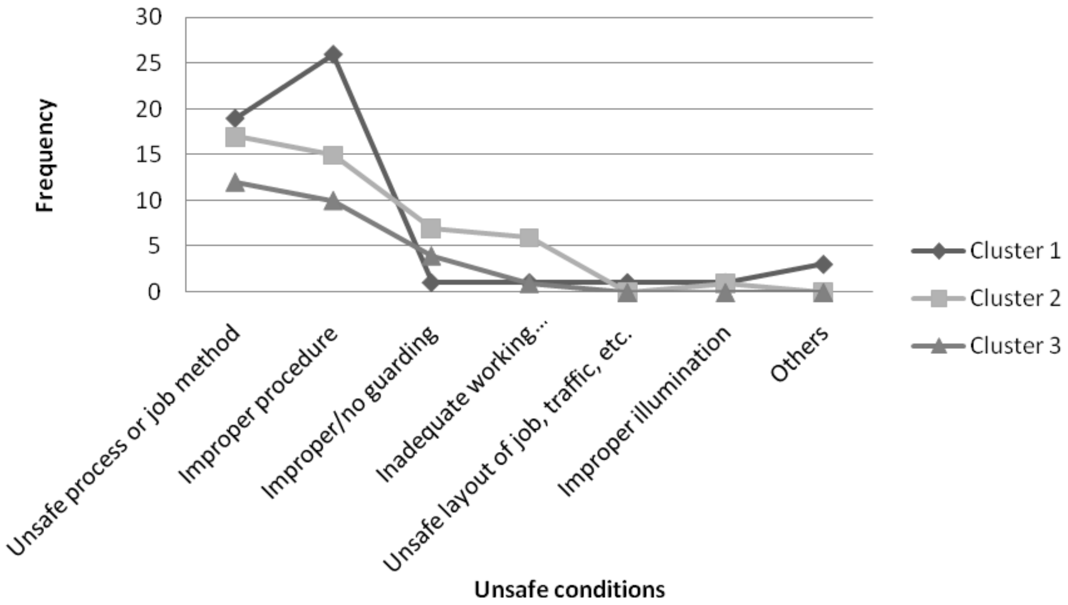

Figure 4.3 Frequency distribution of unsafe conditions with respect to each cluster.

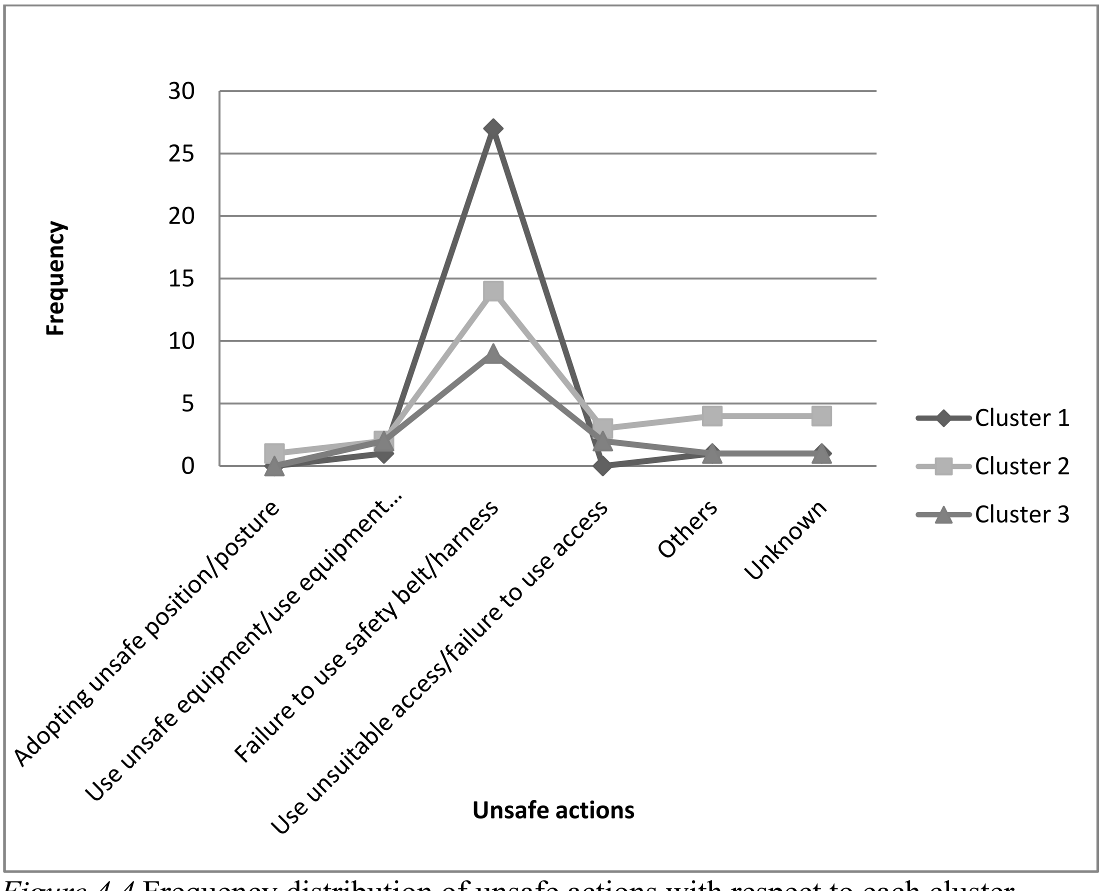

Figure 4.4 Frequency distribution of unsafe actions with respect to each cluster.

4.3 DIFFICULTIES OF IMPLEMENTING SAFETY PRACTICES IN THE RMAA SECTOR[2]

4.3.1 Interview findings on difficulties of implementing safety practices in the RMAA sector

Table 4.9 shows the frequency distribution of difficulty categories mentioned by interviewees.

Table 4.9
Frequency Distribution of Difficulty Categories Mentioned by Interviewees.

Difficulties of implementing safety practices in the RMAA sector	A	B	C	D	E	F	G	H	I	Total
1. Difficulty in changing the mindset of RMAA workers	√	√		√		√	√			5
2. Difficulty in supervision		√	√	√	√	√	√	√		7
3. Limited safety resources	√	√	√		√	√				5
4. Ad hoc site problems		√					√		√	3
5. Shortage of time							√		√	2

4.3.1.1 Difficulty in changing the mindset of RMAA workers

Quite a number of interviewees commented that changing an RMAA worker's mindset is one of the biggest obstacles to carrying out safety measures (Table 4.9). Inadequate safety awareness and low self-motivation of RMAA workers to perform safety is an industry-wide problem. Interviewee A complained that "very often, they [RMAA workers] are only paying lip services to the safety measures". Notably, as pointed out by Interviewee G, the challenge is how to educate them to perform safety measures persistently and wholeheartedly. The mindset of workers towards safety could possibly be changed through safety training and education; however, a high turnover rate of workers in the RMAA sector poses difficulty in providing safety training to them. Interviewee F added, "even for those having attended safety courses,

[2] To be published in Hon, C.K.H., Chan, A.P.C. and Yam, M.C.H. (2011). An empirical study to investigate the difficulties of implementing safety practices in the repair and maintenance sector: a case of Hong Kong. *Journal of Construction Engineering and Management*, doi:10.1061/(ASCE)CO.1943-7862.0000497.

they may not take these courses seriously. Course instructors are too lenient to them", Interviewee D also added that, "to change one's mindset is really hard. Usually when there is an accident, people are more concerned about safety for some time, but this concern will soon die down over time".

4.3.1.2 Difficulty in supervision

Nearly all interviewees agreed that safety supervision in RMAA works is difficult. Difficulties in safety supervision hinder proper implementation of safety practices (Table 4.9). RMAA works are often taken up by subcontractors, which require supervision by the main contractor; however, RMAA works are scattered in various locations. Exercising "close" supervision on a contract with small contract sum and short duration of work is not cost-effective.

Another difficulty of supervision lies on the inadequate provision of safety officers in RMAA works. Under the Factory and Industrial Undertakings Ordinance, only projects with over 100 workers are required by law to employ a safety officer (Labor Department, 2009). RMAA projects seldom employ over 100 workers on site. Safety officers are not mandatorily employed in these projects. Because safety officers are designated solely to enforce safety, they have better authority to uphold safety than safety supervisors in RMAA works. Interviewee D pointed out that a safety officer has better authority to enforce safety on site than a safety supervisor because their primary responsibility is to enforce safety; furthermore, they bear legal responsibility if they fail to perform their duties. For safety supervisors of RMAA works, who also perform the dual roles of site foremen and project engineers, safety is merely one of the tasks they need to handle. They may be more focused on the progress of work, rather than on safety.

To impose proper safety supervision, the ability of safety supervisors to uphold safety is particularly important. As commented by Interviewee E, the enforcement of safety depends on foremen or site agents who perform the dual role of safety supervisors. If supervisors are strict on safety, safety performance would be better. If they are lenient on safety, safety performance would be worse. However, strike a balance between production output and safety can be very difficult.

4.3.1.3 Limited safety resources

Resources for implementing safety practices are scarce. Purchasing personal protective equipment (PPE) and employing safety staff incur additional costs for the project. RMAA contractors, which are mainly SMEs may not have sufficient PPE for every worker due to inadequate resources. Some RMAA works, such as those for maintenance term contracts, take place concurrently in widely dispersed workplaces, thus requiring more safety supervisors than for new works for the same level of safety supervision. However, if the number of foremen acting as safety supervisors increases, additional costs are incurred.

For public construction projects, the Hong Kong government stipulates in the contract that a certain percentage of the total contract sum will be awarded for implementing a list of safety items. However, as expressed by Interviewee C, the Hong Kong government, in some sense, has reduced resources for safety. The same amount of money originally provided for safety in the contract of government projects has been marked to cover environmental protection as well.

4.3.1.4 Ad hoc site problems

Unpredictable and ad hoc site problems of RMAA works hinder proper safety management. The work activities of RMAA projects involve different risks from new construction works. Working environments may vary significantly in RMAA projects. To cite an example, repair of external walls in a new building is quite different from that of an old building because the concrete strength of their external walls is probably different. Very often, there are only generic method statements for general building works available in construction companies. It is difficult to control the potential risks and problems in RMAA works. Safety management faces a challenge to provide adequate instructions on undertaking RMAA works safely.

RMAA works always face the problem of coordination on site. For example, a qualified electrician intuitively understands that electricity supply must be cut-off before the commencement of any electrical work. However, occupants of the building that undertakes RMAA works will usually complain when the electricity supply is cut-off. If no one takes up the role of coordinator between the electrician and occupants, the electrician may have to perform his task under risk (Interviewee B). Upon the execution of RMAA works, the property management company or contractor have to solve unforeseeable ad hoc site problems, take initiatives to liaise with the affected parties, and coordinate the execution of works. They have to make sure that the RMAA project is undertaken in a proper and safe way.

4.3.1.5 Shortage of time

Time is always of the essence to construction projects, and RMAA works are no exception. In some cases, RMAA works can only be carried out at night or in a particular period in order to minimize disturbances to occupants of the premises or the public. When the project duration is short and workers are in a hurry to meet deadlines, full implementation of safety practices becomes difficult.

4.3.2 Relative importance of the identified difficulties

After two rounds of Delphi exercise, the experts ranked the top three important difficulties of implementing safety practices in RMAA works to be "Limited safety resources for RMAA projects undertaken by small/medium-sized contractors", "Difficult to change the mindset of RMAA workers" and "Difficult to conduct safety supervision due to scattered locations".

The Delphi technique successfully improved ranking agreement among the thirteen experts. Kendall's coefficient of concordance (W) improved remarkably from 0.208 with χ^2 (8, N =13) = 21.587, $p < 0.01$ in the first round to 0.234 with χ^2 (8, N =13) = 24.535, $p < 0.005$ in the second round (Tables 4.10 and 4.11).

Ranking agreement also improved among the subgroups of the client, the contractor, and the OHS consultant/regulatory body. Kendall's coefficient of concordance (W) of the client subgroup increased from 0.422 with χ^2 (8, N =5) = 16.882, $p < 0.05$ in the first round to 0.498 with χ^2 (8, N =5) = 19.928, $p < 0.05$ in the second round. The contractor subgroup increased from 0.456 with χ^2 (8, N =3) = 10.974, $p < 0.05$ at

0.05 significance level in the first round to 0.507 with χ^2 (8, N =3) = 12.179, *n.s.* at 0.05 significance level in the second round.

However, the OHS consultant/regulatory body subgroup slightly decreased from 0.346 with χ^2 (8, N =5) = 13.844, *n.s.* at 0.05 significance level in the first round to 0.341 with χ^2 (8, N =5) = 13.643, *n.s.* at 0.05 significance level in the second round. Thus, the employment of the two-round Delphi successfully contributed to improving agreement among the experts and the reliability of our findings.

Table 4.10

Round One Delphi Results on Difficulties of Implementing Safety Practices in RMAA Works.

	Round One Delphi	All experts		Clients		Contractors		OHS consultant/ regulatory body	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1.	Difficult to change the mindset of RMAA workers.	3.54	4	4.00	3	3.00	6	3.40	3
2.	Difficult to conduct safety supervision due to scattered locations.	3.69	2	4.00	3	3.00	6	3.80	2
3.	Limited safety resources for RMAA projects undertaken by small/medium-sized contractors.	4.15	1	4.20	1	3.67	2	4.40	1
4.	Difficult to standardize the operational procedures of RMAA works due to ad hoc site problems.	3.00	8	2.40	9	3.67	2	3.20	5
5.	Shortage of time to deal with safety issues.	3.08	7	3.20	7	3.33	4	2.80	9
6.	High turnover rate of RMAA workers.	3.54	4	3.60	6	4.00	1	3.20	5
7.	Small scale and short duration of RMAA projects.	3.62	3	4.00	3	3.33	4	3.40	3
8.	Influx of illegal workers.	2.85	9	3.00	8	2.33	9	3.00	8
9.	Difficult to control self-employed workers.	3.54	4	4.20	1	3.00	6	3.20	5
	Number (N)	13		5		3		5	
	Kendall's coefficient of concordance (W)	0.208		0.422		0.456		0.346	
	X^2	21.587		16.882		10.974		13.844	
	Degrees of freedom (df)	8		8		8		8	
	Level of significance	0.006		0.031		0.025		0.086	

Table 4.11

Round Two Delphi Results on Difficulties of Implementing Safety Practices in RMAA Works.

	Round Two Delphi	All experts		Clients		Contractor		OHS consultant/ regulatory body	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1.	Difficult to change the mindset of RMAA workers.	3.92	2	4.00	2	3.67	3	4.00	1
2.	Difficult to conduct safety supervision due to scattered locations.	3.77	3	4.00	2	3.33	5	3.80	3
3.	Limited safety resources for RMAA projects undertaken by small/medium-sized contractors.	4.08	1	4.20	1	4.00	1	4.00	1
4.	Difficult to standardize the operational procedures of RMAA works due to ad hoc site problems.	3.08	8	2.60	8	3.67	3	3.20	6
5.	Shortage of time to deal with safety issues.	3.23	7	3.00	7	2.67	9	3.80	3
6.	High turnover rate of RMAA workers.	3.54	5	3.60	6	4.00	1	3.20	6
7.	Small scale and short duration of RMAA projects.	3.62	4	3.80	5	3.00	7	3.80	3
8.	Influx of illegal workers.	2.85	9	2.40	9	3.00	7	3.20	6
9.	Difficult to control self-employed workers.	3.54	5	4.00	2	3.33	5	3.20	6
	Number (*N*)	13		5		3		5	
	Kendall's coefficient of concordance (*W*)	0.234		0.498		0.507		0.341	
	X^2	24.535		19.928		12.179		13.643	
	Degrees of freedom (*df*)	8		8		8		8	
	Level of significance	0.002		0.011		0.143		0.092	

4.3.3 Inter-group comparisons on the identified difficulties

Tests for inter-group comparison were conducted to determine whether any group showed a different perspective towards difficulties of implementing safety practices in RMAA works. As shown in Table 4.12, after testing for all identified difficulties using the Kruskal-Wallis test, the null hypothesis was not rejected. This means that the rankings of the three subgroups were not significantly different from one another. The results of the inter-group comparison indicate that, although the different subgroups play different roles in the industry, they hold similar perceptions towards the difficulties of implementing safety practices. In other words, the difficulties of implementing safety practices in the RMAA sector highlighted in this study are widely recognized across the industry.

Table 4.12
Kruskal-Wallis Test in Round Two Delphi on Difficulties of Implementing Safety Practices in RMAA works.

		Kruskal-Wallis test Asymp. Sig.
1.	Difficult to change the mindset of RMAA workers.	0.189
2.	Difficult to conduct safety supervision due to scattered locations.	0.497
3.	Limited safety resources for RMAA projects undertaken by small/medium-sized contractors.	0.353
4.	Difficult to standardize the operational procedures of RMAA works due to ad hoc site problems.	0.136
5.	Shortage of time to deal with safety issues.	0.182
6.	High turnover rate of RMAA workers.	0.287
7.	Small scale and short duration of RMAA projects.	0.448
8.	Influx of illegal workers.	0.149
9.	Difficult to control self-employed workers.	0.362

Although the differences in rankings across subgroups were insignificant, some ranking variations remained among subgroups after two rounds of Delphi. The client subgroup ranked “Difficult to control self-employed workers” to be the second most crucial difficulty, whereas the contractor subgroup and the OHS consultant/regulatory body subgroup ranked this item to be the fifth and the sixth, respectively. This may reflect the rather unregulated “cow boy” practices among the self-employed RMAA workers in the market. The client subgroup, being the group spending the resources, may find workers difficult to manage because of varied levels of workmanship skills and safety standards.

The contractor subgroup ranked “High turnover rate of RMAA workers” to be the most important difficulty whereas both the client subgroup and the OHS consultant/regulatory body ranked this item to be the sixth most important difficulty. In addition, the contractor subgroup ranked “Difficult to standardize the operational procedures of RMAA works due to ad hoc site problems” to be the third most important difficulty, whereas the client subgroup and the OHS consultant/regulatory body subgroup ranked it to be the eighth and the sixth, respectively. This is understandable because the contractors bear the responsibility of daily site safety management and work execution. The high turnover rate of RMAA workers not only causes chaos in safety management but also makes safety training difficult, if not impossible. Because operational procedures are difficult to standardize, the contractors need to empower safety supervisors to handle ad hoc safety problems. The ability and competence of safety supervisors to handle ad hoc safety problems would greatly affect the safety performance of the RMAA project.

The OHS consultant/regulatory body subgroup ranked both “Shortage of time to deal with safety issues” and “Small scale and short duration of RMAA projects” to be the third most important difficulties, whereas the client subgroup and the contractor subgroup ranked the former as the seventh and the ninth most important difficulty and the latter as the fifth and the seventh most important difficulty, respectively. The OHS consultant/regulatory body subgroup consists of safety experts outside the construction industry; thus, to this subgroup, hasty work practices in the construction industry represent substandard work. To suspect that proper safety procedures may be sacrificed because of time constraints is therefore not unreasonable.

4.4 CHAPTER SUMMARY

This chapter has reported the research findings to achieve Objective 1, which examines safety problems and practices in the RMAA sector. Qualitative interview findings and Delphi survey results were presented. Major causes of RMAA accidents were found to be: 1) poor safety conscientiousness of RMAA workers; 2) RMAA workers underestimate potential risks when performing small tasks for a short period of time; and 3) personal protective equipment not used, incorrectly used, or not provided. Clients highly attributed the cause of RMAA accidents to procurement method and contractual arrangements. Contractors mainly attributed the cause of RMAA accidents to safety competency of RMAA workers. The OHS consultant/ regulatory body distinctly attributed the cause of RMAA accidents to time constraints. The three most important difficulties in implementing safe practices are 1) limited safety resources for RMAA projects undertaken by small/medium-sized contractors; 2) difficulty in changing the mindset of RMAA workers; and 3) difficulty in conducting safety supervision due to scattered locations. Although clients, contractors and OHS consultant/regulatory bodies have different roles to play, they agree regarding the difficulties for implementing safe practices in the RMAA sector.

CHAPTER 5 SAFETY CLIMATE AND SAFETY PERFORMANCE OF THE RMAA SECTOR

5.1 INTRODUCTION

This chapter presents the research findings pertinent to achieving Objectives 2 to 5. The factor structure of the RMAA safety climate is determined. The relationships between RMAA safety climate and safety performance are established. The demographic variables affecting the RMAA safety climate are also identified. Finally, the strategies for improving the safety of RMAA works are evaluated.

5.2 DESCRIPTIVE STATISTICS

In total, 814 completed questionnaires were returned. Although 30 questionnaires from one trade union turned out to be uncollectable, all other questionnaires were promptly returned. The response rate was 96.3%. Univariate outliers with a standard deviation greater than 2 were deleted (Field, 2009). After the deletion of outliers and imputation of missing values, 662 completed questionnaires were deemed valid for analysis. Among the respondents, 60.0% were frontline workers (N = 397), 19.8% were supervisors (N = 131), 19.5% were managers (N = 129), and the remaining 0.6% (N = 5) did not disclose their job position.

Figures 5.1 and 5.2 show the summary of the demographic variables. The majority of the respondents were frontline workers, aged 31 to 50, male, married, without any smoking and drinking habits. Nearly half of the respondents had one to two family members to support. More than half had attained education up to the secondary level or above. Approximately 40% worked in the same company for one to five years. Nearly all of them received Green Card safety training. There was a relatively even distribution of the respondents' working experience in the construction industry. Almost all categories of working experience in the construction industry had approximately 20% of respondents.

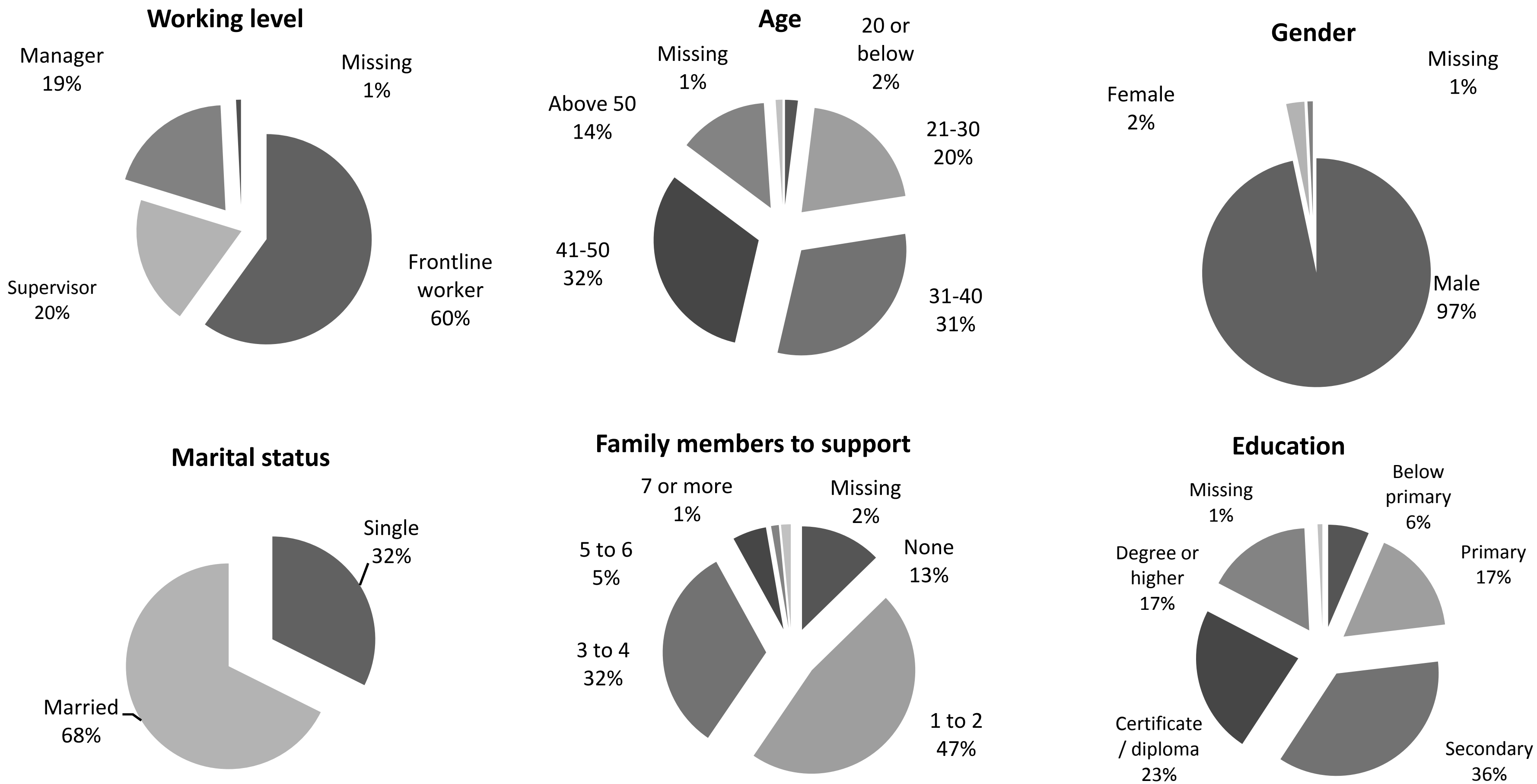

Figure 5.1 Profile distributions of respondents in terms of working level, age, gender, marital status, family members to support, and education.

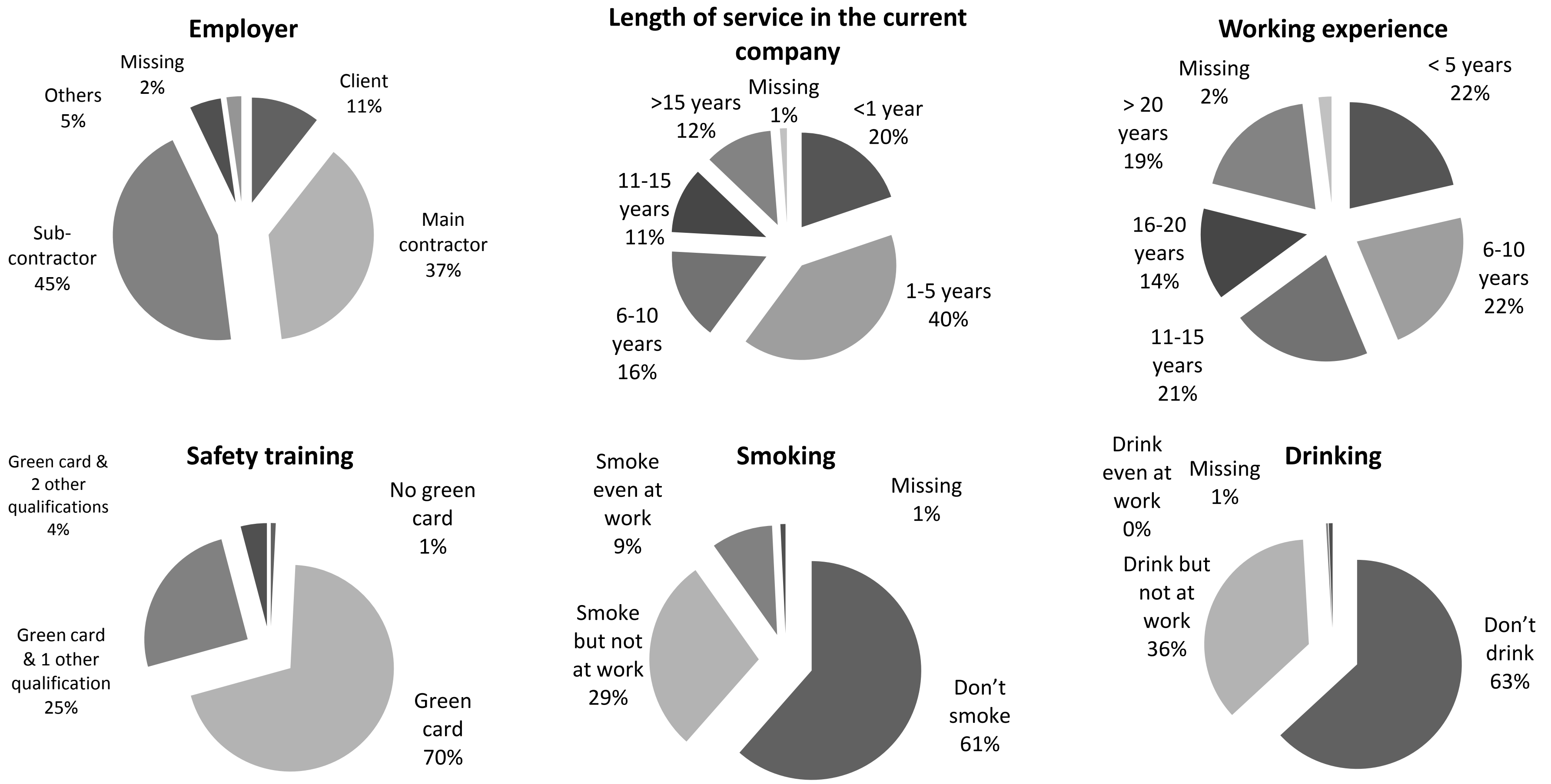

Figure 5.2 Profile distributions of respondents in terms of employer, length of service in the current company, working experience, safety training, smoking habit, and drinking habit.

5.3 SAFETY CLIMATE FACTORS OF THE RMAA WORKS

Using SPSS 18.0, the sample was randomly split into two subsamples: a calibration sample and a validation sample. EFA was conducted on the calibration sample to initially derive the factor structure of the RMAA safety climate. CFA was then conducted on the validation sample to verify the resultant factor structure of the EFA.

5.3.1 EFA of RMAA safety climate on the calibration sample

The 38 items of the SCI were subjected to EFA using the extraction method of principal component analysis (PCA). Before performing PCA, the suitability of data for the factor analysis was assessed. The Kaiser-Meyer-Olkin value was 0.903, indicating superb sampling adequacy (Field, 2009). Barlett's test of sphericity produced an approximation of $\chi^2 = 2{,}496.544$ ($df = 231$, $p < 0.001$), indicating the correlations between variables to be sufficiently large for PCA. The inspection of the correlation matrix revealed the presence of numerous coefficients of 0.3 and above. The factor loading cut-off was fixed at 0.4. In total, 16 items were removed. The communalities of all variables were all above 0.33. The ratio between 331 cases of the calibration data set and the 22 selected variables was 15:1.

PCA revealed the presence of four components with eigenvalues exceeding 1. However, an inspection of the scree plot (Figure 5.3) and the Horn's parallel analysis both supported the three components (Table 5.1). Three underlying components encapsulating 22 variables were generated. The three-component solution explained a total variance of 48.20%. Components 1 to 3 explained 31.78%, 8.76% and 7.65% of the variance, respectively. This result is comparable to that of the study of Choudhry et al. (2009) which yielded a two-component factor structure explaining 43.9% of the total variance.

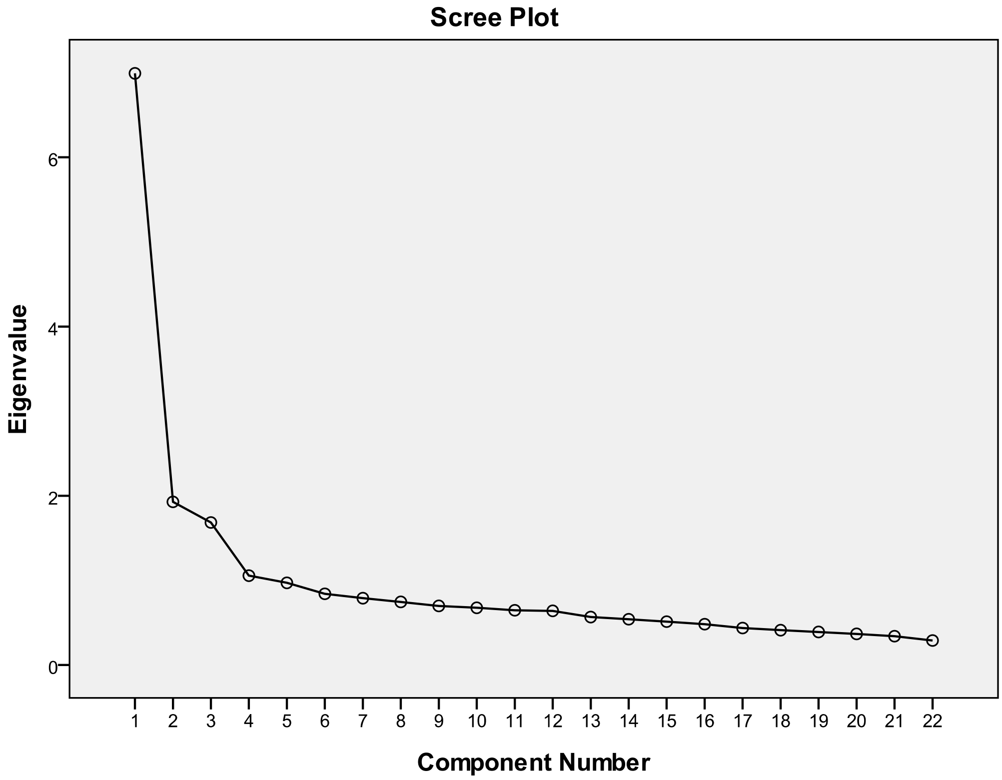

Figure 5.3 Scree plot of EFA.

Table 5.1
Comparison of the Eigenvalues from the PCA and the Criterion Values from the Horn's Parallel Analysis.

Component number	Actual eigenvalue from PCA	Criterion value from parallel analysis	Decision
1	6.992	1.490	Accept
2	1.928	1.409	Accept
3	1.684	1.343	Accept
4	1.056	1.291	Reject

Direct oblimin rotation was performed to enhance factor interpretability. The factor pattern and structure matrix results are shown in Table 5.2. Tabachnick and Fidell (2007) suggest that oblique rotation (e.g., direct oblimin) instead of orthogonal rotation (e.g., varimax) should be selected if factor correlation exceeds 0.32. Table 5.3 shows that the factor correlation between F1 and F2 was 0.351 (i.e., > 0.32), justifying the selection of direct oblimin rotation instead of varimax rotation (Tabachnick and Fidell, 2007). Values of Cronbach's alpha ranged from 0.67 to 0.87 (Table 5.3), which are above the minimum cut-off value 0.6 suggested by Hair et al. (2010).

Table 5.2

Pattern and Structure Matrix for the PCA and Direct Oblimin Rotation of the Three-factor Solution of the RMAA Safety Climate.

	Item	Pattern coefficients			Structure coefficients			Communalities
		1	2	3	1	2	3	
	Factor 1 (F1)- Management commitment to OHS and employee involvement *(Eigenvalue = 6.992; % of variance =31.782; cumulative % =31.782)*							
B8	The company really cares about the health and safety of the people who work here	**.755**	.002	.002	**.756**	.268	.193	.572
B21	There are good communications here between management and workers about health and safety issues	**.705**	.192	-.167	**.730**	.423	.031	.591
B15	The company encourages suggestions on how to improve health and safety	**.701**	.004	-.054	**.708**	.382	.064	.476
B19	I am clear about what my responsibilities are for health and safety	**.690**	-.275	.192	**.688**	.244	.124	.511
B38	I think management here does enough to follow up recommendations from safety inspection and accident investigation reports	**.685**	.154	-.126	**.686**	.304	.120	.536
B13	All the people who work in my team are fully committed to health and safety	**.675**	.073	-.058	**.685**	.381	.011	.478
B16	There is good preparedness for emergency here	**.672**	.163	-.176	**.657**	.202	.367	.521
B30	Accidents which happened here are always reported	**.647**	-.132	.128	**.642**	-.013	.339	.430
B9	Most of the job-specific safety trainings I received are effective	**.615**	-.035	.215	**.633**	.108	.278	.476
B3	I fully understand the health and safety risks associated	**.572**	-.140	.249	**.586**	.086	.380	.418
B28	Safety inspection here is helpful to improve the health and safety of workers	**.529**	.099	.020	**.569**	.287	.164	.332
B34	Staff are praised for working safely	**.473**	.241	-.131	**.525**	.394	.013	.342
	Factor 2 (F2)- Applicability of safety rules and work practices *(Eigenvalue = 1.928; % of variance =8.763; cumulative % =40.545)*							
B29	Some jobs here are difficult to do safely	-.093	**.735**	.147	.202	**.717**	.197	.537
B32	Not all the health and safety rules or procedures are strictly followed here	.081	**.682**	.031	.328	**.714**	.121	.518
B20	Some of the workforces pay little attention to health and safety	.042	**.621**	-.200	.490	**.676**	.270	.416
B11	Some health and safety rules or procedures are difficult to follow	.013	**.600**	.197	.274	**.624**	.261	.429
B35	Supervisors sometimes turn a blind eye to people who are not observing the health and safety procedures	.251	**.573**	.149	.210	**.615**	-.127	.551
B17	Sometimes it is necessary to take risks to get the job done	.222	**.487**	.284	.465	**.594**	.390	.503
	Factor 3 (F3)- Responsibility for health and safety *(Eigenvalue = 1.684; % of variance =7.653; cumulative % =48.198)*							
B10	People are just unlucky when they suffer from an accident	-.042	.125	**.783**	.200	.189	**.785**	.630
B37	Accident investigations are mainly used to identify who should be blamed	.011	-.052	**.612**	.226	.275	**.624**	.374
B26	Work health and safety is not my concern	-.002	.215	**.602**	.148	.013	**.610**	.434
B14	Little is done to prevent accidents until someone gets injured	.311	.214	**.489**	.510	.372	**.589**	.526

Note. Major loadings for each item are shown in bold font.

Table 5.3

Factor Correlation Matrix of the RMAA Safety Climate (Cronbach's Alpha in Diagonal).

	Number of items in scale	1	2	3
(F1) Management commitment to OHS and employee involvement	12	(0.871)		
(F2) Applicability of safety rules and work practices	6	0.351	(0.762)	
(F3) Responsibility for health and safety	4	0.253	0.101	(0.666)

The three factors generated are as follows:

- **F1 – Management commitment to OHS and employee involvement**
  This factor consisted of 12 variables. Variables B8, 21, 15, 16, 30, 28, and 34 were more related to management commitment to OHS whereas B19, 38, 13, 9, and 3 were more related to employee involvement in OHS.

- **F2 – Applicability of safety rules and work practices**
  Six variables were included in this factor. Most of the variables were related to the practicality and enforcement of health and safety procedures (B32, 20, 11, and 35) and work execution practices (B29, and 17).

- **F3 – Responsibility for health and safety**
  This factor was composed of four variables that described both the employee and organization perception of health and safety responsibility. The variables B10 and B26 were reversed statements that explicitly asked whether employees perceive health and safety as part of their responsibilities in the working environment. The variables B37 and B14 asked whether the organization takes responsibility for providing a safe working environment.

5.3.2 CFA of RMAA safety climate on the validation sample

5.3.2.1 Hypothesized CFA model

To confirm the three-factor structure of the RMAA safety climate derived from EFA, CFA was conducted on the validation sample. The hypothesized model is shown in Figure 5.4. The observed variables, comprising the 22 SCI questions, are shown in regular boxes, whereas the latent factors are shown in ellipses. The model hypothesized that RMAA safety climate (RMAASC) accounts for the relationship of the three factors: (F1) *management commitment to OHS and employee involvement*; (F2) *applicability of safety rules and work practices*; and (F3) *responsibility for health and safety*. The model also hypothesized a second-order safety climate factor structure in line with the literature (e.g., Zhou et al., 2011). Hence, both the measurement model and the structural model are involved. The measurement model consists of the hypothesized relationships among 22 variables and the three first-order factors (F1, F2, and F3). The structural model focuses on the relationship between the three first-order latent factors (F1, F2, and F3) and the second-order latent factor RMAASC.

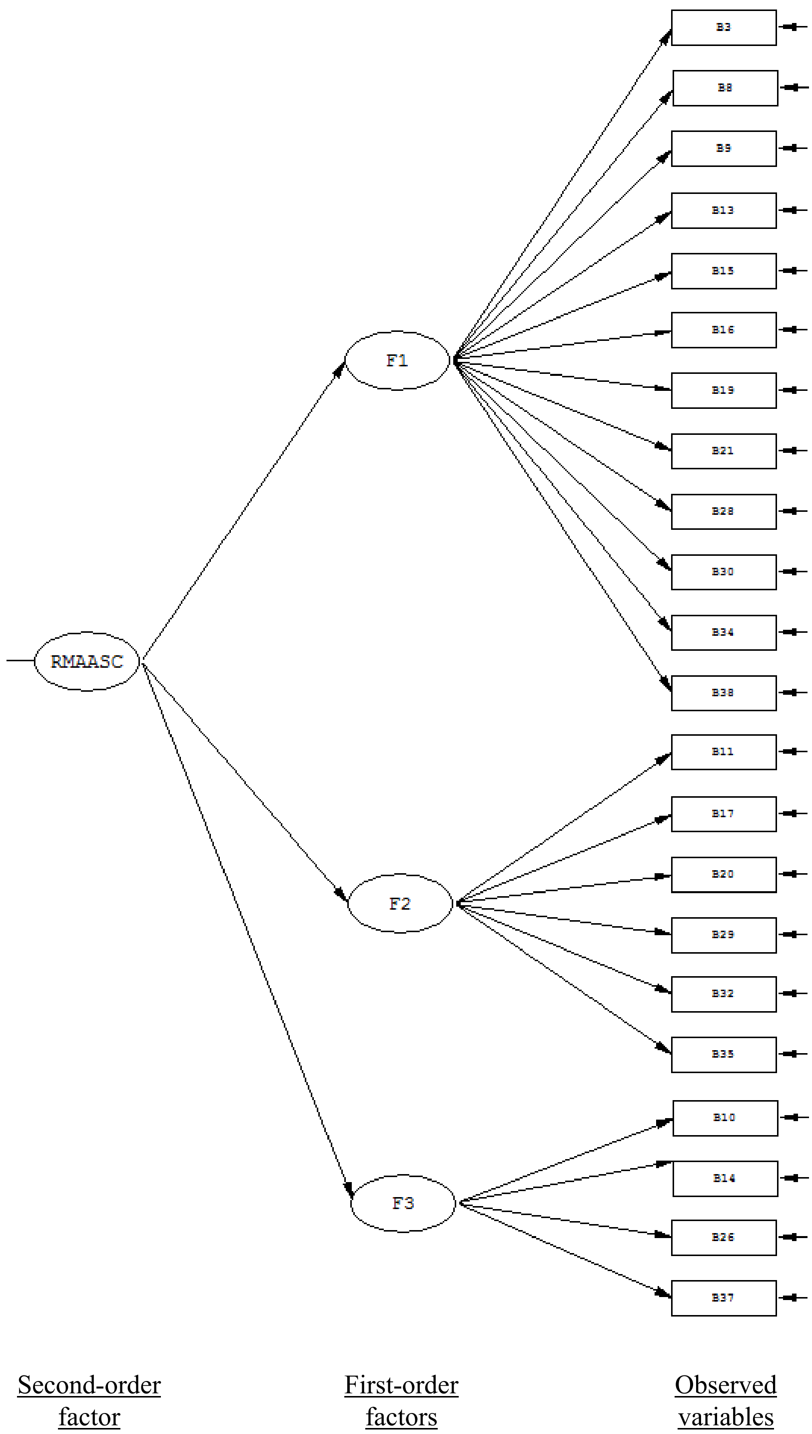

Figure 5.4 Hypothesized CFA model of the RMAA safety climate.

5.3.2.2 Empirically tested CFA model

The empirically tested CFA model of the RMAA safety climate on the validation sample with the standardized parameter estimates is shown in Figure 5.5.

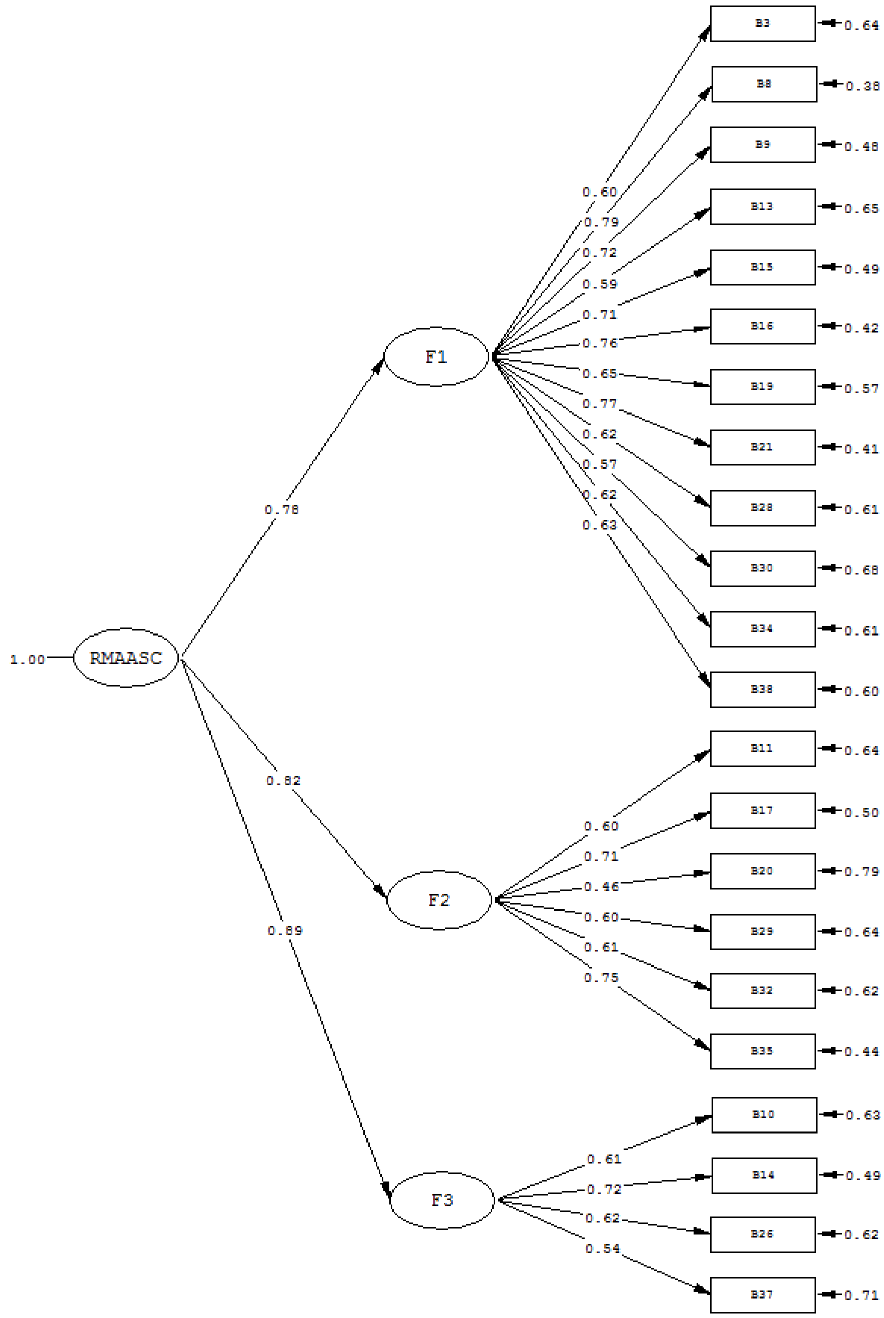

Figure 5.5 RMAA safety climate CFA model tested on the validation sample.

Note. All the paths are significant at 0.05 level.

As a rule, the model fits the data when the χ^2/df is less than 2, the RMSEA is less than 0.05, and the CFI and NNFI are greater than 0.95 (Diamantopoulos and Siguaw, 2000). Results show that the CFA model fits the data well. Satorra-Bentler χ^2 (206, N = 331) = 366.637, $p < 0.05$, $\chi^2/df = 1.780$, RMSEA = 0.049, CFI = 0.983, and NNFI = 0.981.

All the paths from the observed variables to the latent factors were significant. Hair et al. (2010) recommend that standardized factor loading should be greater than 0.5. Except the path from B20 "Some of the workforces pay little attention to health and safety" to F2, which marginally attained 0.5 (standardized path coefficient = 0.46), all standardized factor loadings were greater than 0.5. The face meaning of B20 was less related to F2 than the other variables, accounting for its lower standardized factor loading.

In the first-order factor level, among the 12 observed variables in (F1) *management commitment to OHS and employee involvement*, the variable (B8) "The company really cares about the health and safety of the people who work here" had the strongest standardized path coefficient of 0.79. The strongest standardized path coefficient in (F2) *applicability of safety rules and practices* was (B35) "Supervisors sometimes turn a blind eye to people who are not observing the health and safety procedures" (standardized path coefficient = 0.75), whereas in (F3) *responsibility for health and safety,* it was (B14) "Little is done to prevent accidents until someone gets injured" (standardized path coefficient = 0.72). In the second-order factor level, RMAASC was the underlying latent variable encapsulating F1, F2 and F3. The standardized factor loadings between RMAASC and F1, RMAASC and F2, and RMAASC and F3 were 0.78, 0.82, and 0.89, respectively.

Reliability measures the internal consistency of the latent factors. As shown in Table 5.4, three values of construct reliability (CR) were above the recommended level of 0.7 (Hair et al., 2010). All the factors achieved good internal consistency. Validity is the extent to which the indicators accurately measure what they are supposed to measure (Hair et al., 2010). Construct validity is the extent to which data exhibit evidence of convergent validity and discriminant validity. Convergent validity can be assessed via observable variables that load significantly on their respective latent factors (Anderson and Gerbing, 1988). Figure 5.5 shows that convergent validity was achieved because all the paths in the CFA model were significant. Discriminant validity means dissimilar constructs should differ. Discriminant validity is achieved when AVEs are greater than the squared factor correlations or when all the pairs of 95% confidence interval of factor correlation do not pass the value of 1 (Torkzadeh et al., 2003). Results of the discriminant validity test in Table 5.4 show that the structure has dissimilar constructs for the three factors because all the pairs of 95% confidence interval of factor correlation do not pass through 1.

Table 5.4
Discriminant Validity, Squared Factor Correlation, Confidence Interval and the Composite Reliability of the First-order Factors of the RMAA Safety Climate.

	F1	F2	F3	CR[d]
F1	*0.454*[a]			0.913
F2	0.409[b] (0.572, 0.699)[c]	*0.395*		0.793
F3	0.483 (0.635, 0.747)	0.526 (0.671, 0.772)	*0.390*	0.717

Note. [a]Average variance extracted (AVE) along diagonal. [b]Squared factor correlation. [c]95% confidence interval of factor correlation. [d]CR = Construct reliability.

5.4 RELATIONSHIPS BETWEEN SAFETY CLIMATE AND SAFETY PERFORMANCE

5.4.1 Hypothesized structural equation model

A structural equation model was constructed to explore the relationship between RMAA safety climate and safety performance. The hypothesized model is shown in Figure 5.6, consisting of two measurement models and a structural model. The first measurement model encapsulates the relationship between the three first-order factors of the RMAASC and the 22 observed indicators. The second measurement model depicts the relationship between the three safety performance latent factors, *injuries* (Inj), *safety participation* (SP), and *safety compliance* (SC) and their respective observed variables. The structural model measures the relationships between the RMAASC and the three safety performance latent factors (i.e., Inj, SP and SC). Internal reliabilities of Inj, SP and SC were checked. Cronbach's alpha results are shown in Table 5.5. The observed variable (C1d) "Absence of injury for more than three days" was excluded to improve the internal reliability of the latent factor Inj.

The following hypotheses were tested:

H1: RMAASC is negatively related to Inj.

H2: RMAASC is positively related to SP.

H3: RMAASC is positively related to SC.

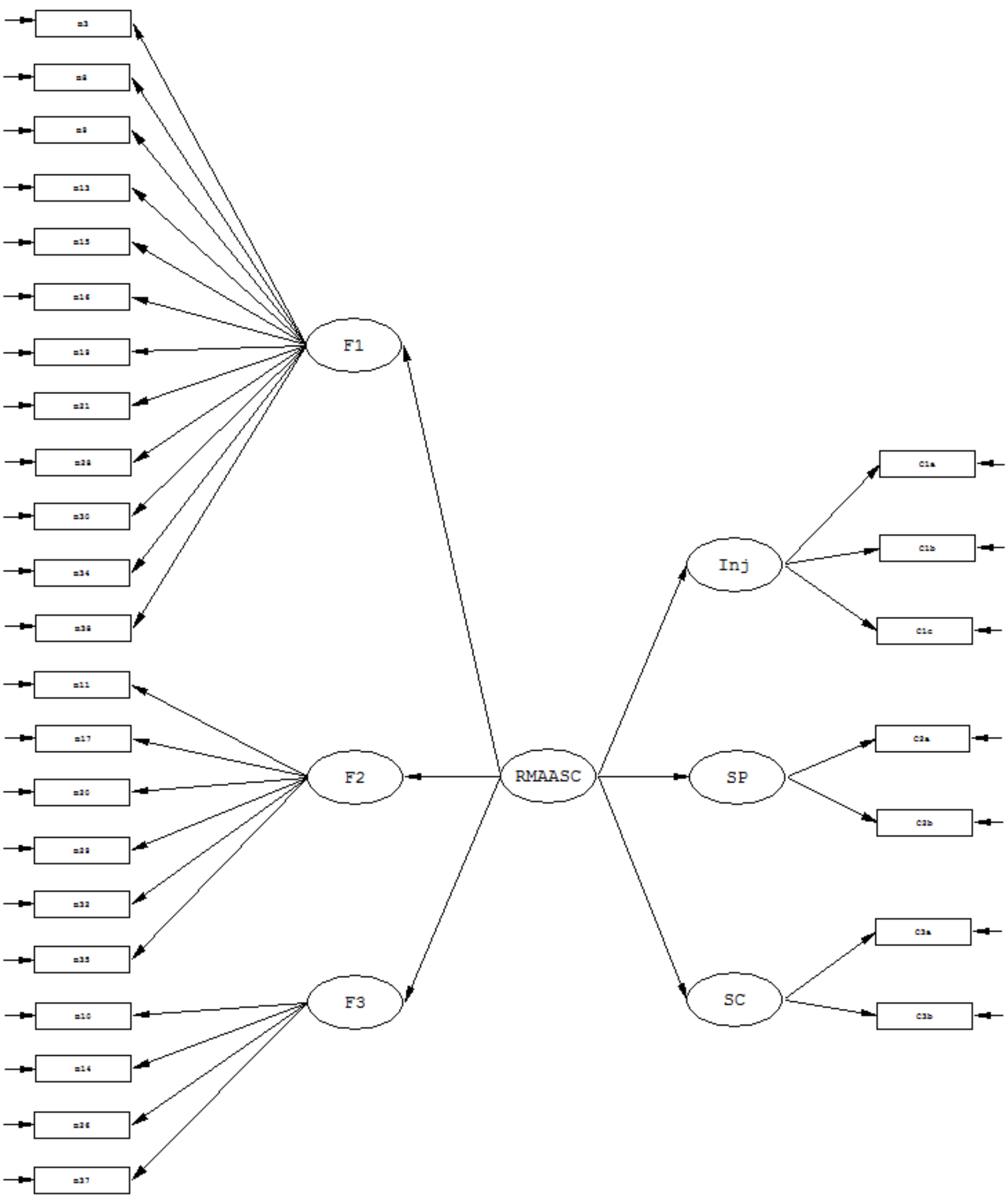

Figure 5.6 Hypothesized structural equation model of the RMAA safety climate and the safety performance.

Table 5.5

Factor Correlation Matrix of Safety Performance (Cronbach's Alpha in Diagonal).

	Number of item in scale	Inj	SP	SC
Injuries (Inj)	3	(0.703)		
Safety participation (SP)	2	0.040	(0.744)	
Safety compliance (SC)	2	-0.262	0.312	(0.737)

5.4.2 Empirically tested structural equation model

As shown in Table 5.6, the goodness-of-fit statistics indicated that the hypothesized model fit the calibration sample and the validation sample well. For the calibration sample, Satorra-Bentler χ^2 (373, N = 331) = 636.667, $p < 0.05$, χ^2/df = 1.707, RMSEA = 0.046, CFI = 0.980, NNFI = 0.978. For the validation sample, Satorra-Bentler χ^2 (373, N = 331) = 666.928, $p < 0.05$, χ^2/df = 1.788, RMSEA = 0.049, CFI = 0.976, NNFI = 0.974.

Table 5.6

Goodness-of-fit of the Structural Equation Model.

Goodness-of-fit measures	Recommended level (Diamantopoulos and Siguaw, 2000)	Calibration sample	Validation sample
χ^2/df	< 2	1.707	1.788
RMSEA	<0.05	0.046	0.049
CFI	>0.95	0.980	0.976
NNFI	>0.95	0.978	0.974

Hypothesis (H1) is supported. The relationship between RMAASC and Inj is significantly negative. The standardized path coefficient from RMAASC to Inj was -0.33 in the calibration sample (Figure 5.7) and -0.32 in the validation sample (Figure 5.8). In other words, one unit of increase in the RMAASC led to an approximately 0.3 unit of decrease in the number of Inj. RMAASC accounted for approximately 11% (R^2 = 0.11) and 10% (R^2 = 0.10) of the variance in injuries in the calibration sample (Figure 5.7) and the validation sample (Figure 5.8), respectively. Although the effect seems to be small, any minute improvement in injuries is still worth striving for because the effect would be a matter of life and death.

Hypothesis (H2) is supported. The relationship between RMAASC and SP is significantly positive. The standardized path coefficient from RMAASC to SP was 0.16 in the calibration sample (Figure 5.7) and 0.22 in the validation sample (Figure

5.8). In other words, one unit of increase in the RMAASC led to an approximately 0.2 unit of increase in SP. RMAASC accounted for 2% (R^2 = 0.02) and 5% (R^2 = 0.05) of the variance in SP in the calibration sample (Figure 5.7) and the validation sample (Figure 5.8), respectively.

Hypothesis (H3) is supported. The relationship between RMAASC and SC is significantly positive. The standardized path coefficient from RMAASC to SC was 0.74 in the calibration sample (Figure 5.7) and 0.65 in the validation sample (Figure 5.8). In other words, one unit of increase in the RMAASC led to an approximately 0.7 unit of increase in SC. RMAASC accounted for 55% (R^2 = 0.55) and 43% (R^2 = 0.43) of the variance in SC in the calibration sample (Figure 5.7) and the validation sample (Figure 5.8), respectively.

F1, F2 and F3 indirectly affected Inj, SP, and SC. The indirect effect between F2 and SC was the strongest (0.84*0.74 = 0.62 in the calibration sample; 0.89*0.66 = 0.59 in the validation sample) amongst all safety climate factors and safety performance. (F2) *applicability of safety rules and practices* was the most important factor affecting the level of Inj, SP, and SC.

When estimating the relationships between RMAASC and safety performance, SC has the highest standardized path coefficient (0.74 in the calibration sample; 0.66 in the validation sample) and the strongest explanatory power (R^2 = 0.55 in the calibration sample; R^2 = 0.43 in the validation sample) when compared with Inj and SP. SC appeared to be the most reliable and valid latent factor of safety performance measurement.

The relationship between RMAASC and SP was the weakest, and was in fact even weaker than Inj. Although the effect of RMAASC on SP was shown to be statistically significant, the RMAASC only exerted a small influence on the level of SP. This indicates that SP may be predominantly affected by variables other than the RMAASC. One possible variable could be personal attitude towards safety.

A general consensus in the RMAA sector is that safety compliance is the safety baseline that needs to be achieved, whereas safety participation is not. Unlike safety compliance, which is considered the obligation of the employee, safety participation involves extra-role activities that are voluntary. More motivation is needed to perform safety participation than safety compliance. The prevailing level of RMAA safety climate successfully motivates RMAA workers to comply with safety rules and regulations; however, the motivation is not sufficiently strong to encourage them to participate in extra safety activities.

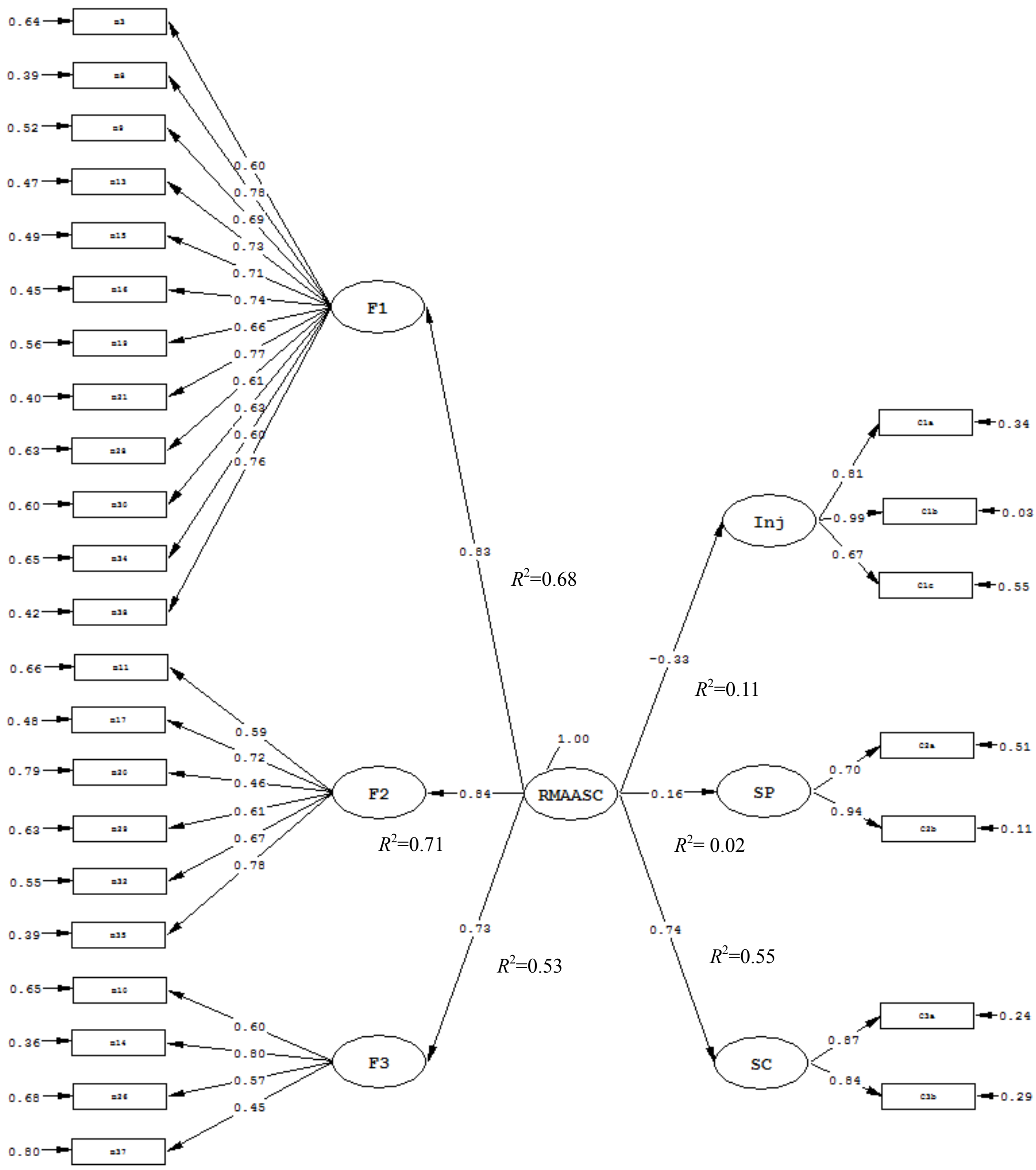

Figure 5.7 Structural equation model of the calibration sample.

Note. All the paths are significant at 0.05 level.

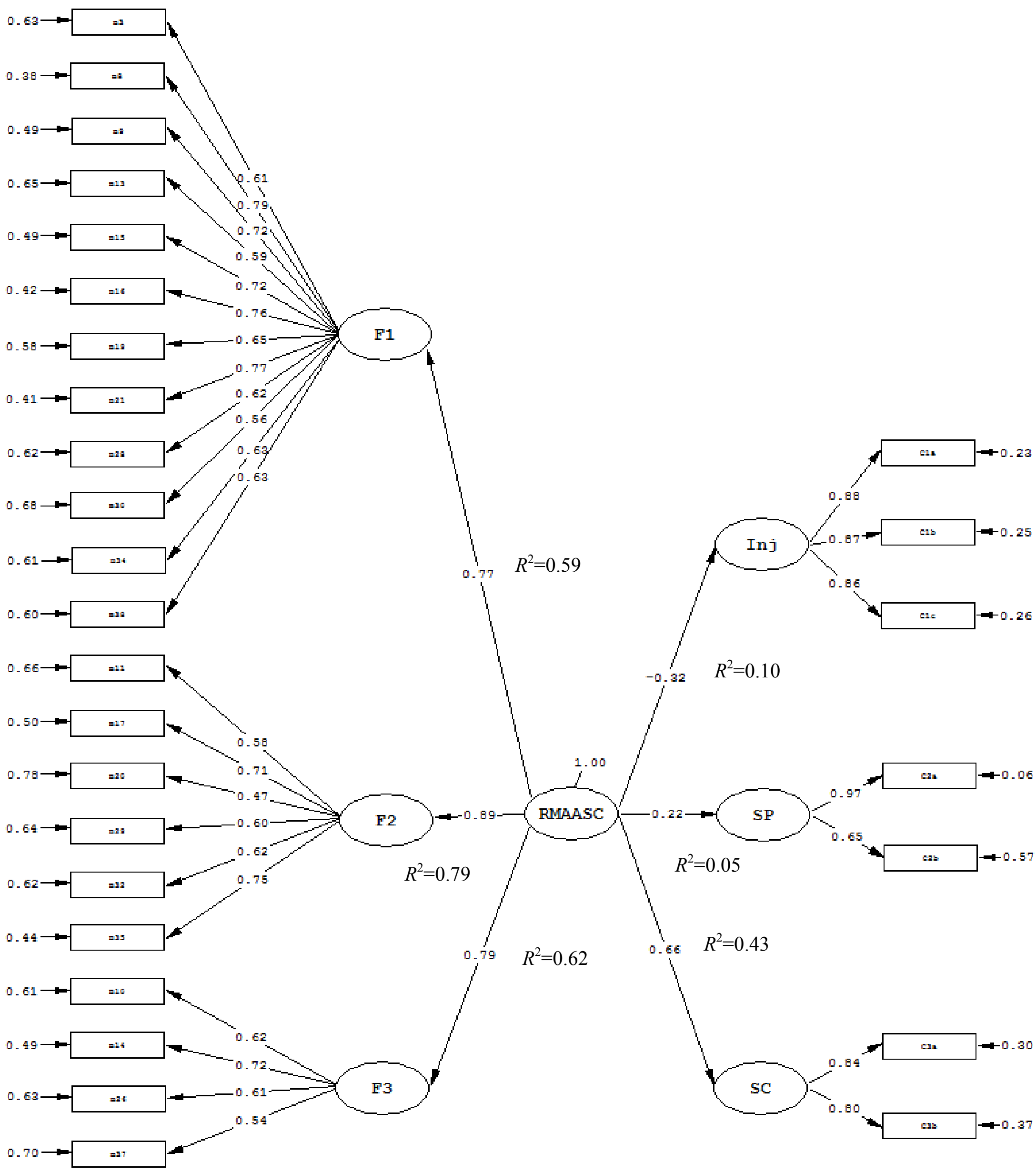

Figure 5.8 Structural equation model of the validation sample.

Note. All the paths are significant at 0.05 level.

5.5 DEMOGRAPHIC VARIABLES AND RMAA SAFETY CLIMATE

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After determining the 22 variables constituting the RMAA safety climate in Section 5.3.1, the RMAA safety climate scores were calculated. Relationships between the RMAA safety climate scores and the demographic variables were analyzed with the help of ANOVA to examine how demographic variables affect the levels of safety climate (Objective 4).

Referring to the ANOVA results in Table 5.7, respondents with different working levels [$F(2,654) = 5.556$, $p = 0.004$], gender [$F(1,655) = 10.778$, $p = 0.001$], marital status [$F(1,653) = 4.476$, $p = 0.035$], education [$F(4,652) = 10.894$, $p < 0.001$], employer [$F(3,643) = 7.650$, $p < 0.001$], length of service in the current company [$F(4,649) = 2.668$, $p = 0.031$], working experience [$F(4,644) = 3.835$, $p = 0.004$], smoking habits [$F(2,654) = 4.112$, $p = 0.017$] and drinking habits [$F(2,655) = 8.154$, $p < 0.001$] had a significantly different level of RMAA safety climate.

With reference to Tables 5.7 and 5.8, the mean RMAA safety climate score of the frontline workers ($M = 3.635$, $SD = 0.454$) was significantly different from that of the managers ($M = 3.791$; $SD = 0.387$). This reflects that while people in the managerial levels perceive high priority of safety in the work environment, such message has not been successfully transmitted to the frontline workers and the supervisors. Females are commonly believed to be more likely to have higher safety climate scores than their male counterparts. Surprisingly, the mean RMAA safety climate score of the females ($M = 3.266$, $SD = 0.321$) was significantly lower than that of the males ($M = 3.684$, $SD = 0.442$). However, because the number of the females in the sample was very small, further studies are needed to warrant this significant relationship.

The mean RMAA safety climate score of married people ($M = 3.698$, $SD = 0.433$) was significantly higher than those who were still single ($M = 3.621$, $SD = 0.465$). This may be due to the increased sense of responsibility and the increased costs of mishaps. People who hold degrees or higher education had significantly higher mean

RMAA safety climate score (*M* = 3.736, *SD* = 0.449) than those who only had primary (*M* = 3.516, *SD* = 0.430) or below primary level of education (*M* = 3.472, *SD* = 0.384). People who worked for the subcontractors had significantly lower mean RMAA safety climate score (*M* = 3.606, *SD* = 0.406) than those who worked for the main contractor (*M* = 3.750, *SD* = 0.473) and the client (*M* = 3.766, *SD* = 0.455). This shows that the safety of the RMAA subcontractors needs much concern.

For those who worked in the current company for less than a year, their mean RMAA safety climate score (*M* = 3.752, *SD* = 0.393) was significantly higher than those with one to five years of experience (*M* = 3.628, *SD* = 0.473). This may indicate that people's alertness towards safety decreases once they become familiar with their tasks. The refreshment of safety training should be provided by the RMAA contracting company on a yearly basis. It is noted that this finding is in contrast to previous research study (Hinze, 2006) that newcomers are more susceptible to accidents. Perhaps, seemingly minute task of RMAA works may undermine the safety alertness of RMAA workers over time; however, this awaits further investigation. For those who had working experience in the construction industry for more than 20 years, their mean RMAA safety climate score (*M* = 3.795, *SD* = 0.413) was significantly higher than those of other groups, except the group having 6-10 years of experience.

The mean RMAA safety climate score of those who smoked even at work (*M* = 3.502, *SD* = 0.511) was significantly lower than those of non-smokers (*M* = 3.692, *SD* = 0.438). For those who drank, but not at work, their mean RMAA safety climate score (*M* = 3.601, *SD* = 0.443) was significantly lower than those of non-drinkers (*M* = 3.716, *SD* = 0.440). Smoking and drinking habits are two variables well known to adversely affect safety. Drinking habit seemed to have a stronger adverse effect on the RMAA safety climate perception of the workers. RMAA workers who get drunk the night before going to work likely cannot perform their tasks well and in a safe manner.

Table 5.7

ANOVA of the Demographic Variables with the Mean RMAA Safety Climate Scores.

Demographic variables	Categories	*N*	*M*	*SD*	ANOVA *F* statistics	Sig.
Working level	Frontline worker	365	3.635	0.454	5.556*	0.004
	Supervisor	126	3.672	0.450		
	Manager	122	3.791	0.387		
Age	20 or below	10	3.522	0.329	1.734	0.125
	21-30	128	3.633	0.471		
	31-40	194	3.694	0.444		
	41-50	198	3.652	0.426		
	51-60	80	3.748	0.449		
	61 or above	3	4.061	0.430		
Gender	Male	598	3.684	0.442	10.778*	0.001
	Female	15	3.266	0.321		
Marital status	Single	194	3.621	0.465	4.476*	0.035
	Married	419	3.698	0.433		
Family members to support	None	81	3.620	0.493	2.103	0.079
	1-2	294	3.683	0.421		
	3-4	199	3.700	0.426		
	5-6	21	3.672	0.553		
	7 or more	8	3.267	0.607		
Education	Below primary	42	3.472	0.384	10.894*	< 0.001
	Primary	100	3.516	0.430		
	Secondary	223	3.769	0.437		
	Cert./diploma	145	3.631	0.427		
	Degree or higher	103	3.763	0.449		
Employer	Client	66	3.766	0.455	7.650*	< 0.001
	Main contractor	236	3.750	0.473		
	Subcontractor	282	3.606	0.406		
	Others	29	3.510	0.390		
Length of service in the current company	< 1 year	118	3.752	0.393	2.668*	0.031
	1-5 years	249	3.628	0.473		
	6-10 years	98	3.719	0.434		
	11-15 years	71	3.651	0.422		
	>15 years	77	3.666	0.445		
Working experience	< 5 years	125	3.616	0.497	3.835*	0.004
	6-10 years	140	3.685	0.351		
	11-15 years	135	3.645	0.468		
	16-20 years	90	3.614	0.475		
	>20 years	123	3.795	0.413		
Safety training	No Green Card	5	3.736	0.494	1.788	0.129
	Green Card	428	3.660	0.442		
	Green Card and trade specific/Silver Card/others	154	3.677	0.433		
	Green Card and any two (trade specific/Silver Card/others)	24	3.854	0.500		
	Green Card and trade specific and Silver Card and others	2	4.091	0.771		
Smoking habit	Don't smoke	380	3.692	0.438	4.112*	0.017
	Smoke but not at work	180	3.687	0.428		
	Smoke even at work	53	3.502	0.511		
Drinking habit	Don't drink	391	3.716	0.440	8.154*	< 0.001
	Drink but not at work	221	3.601	0.443		
	Drink even at work	1	3.050	N.A.		

Note. * $p < 0.05$. *N* = valid number of respondents. *M* = Mean. *SD* = standard deviation.

Table 5.8

Significant Results of the ANOVA Post Hoc Tests.

Demographic variables	Category (I)	Category (J)	Mean difference (I-J)	Sig.
Working level	Frontline worker	Supervisor	-0.025	0.839
		Manager	-0.148*	0.003
Education	Degree or higher	Below primary	0.284*	0.002
		Primary	0.237*	0.000
		Secondary	-0.019	0.995
		Cert./diploma	0.138	0.078
Employer	Subcontractor	Client	-0.163*	0.025
		Main contractor	-0.144*	0.001
		Others	0.102	0.586
Length of service in the current company	< 1 year	1-5 years	0.141*	0.024
		6-10 years	0.037	0.969
		11-15 years	0.114	0.386
		>15 years	0.091	0.605
Working experience	> 20 years	< 5 years	0.179*	0.007
		6-10 years	0.107	0.258
		11-15 years	0.160*	0.023
		16-20 years	0.181*	0.021
Smoking habit	Don’t smoke	Smoke but not at work	0.006	0.986
		Smoke even at work	0.173*	0.013
Drinking habit	Don’t drink	Drink but not at work	0.125*	0.001
		Drink even at work	0.700	0.080

Note. * $p < 0.05$.

5.6 STRATEGIES FOR IMPROVING SAFETY OF THE RMAA SECTOR[3]

The proper management of the RMAA safety climate can improve the safety performance of the RMAA sector. The question now is how can the improvements be made. A number of strategies for improving the safety of the RMAA works were derived from the literature, interviews and analysis of RMAA fatal cases. These strategies were then evaluated by the expert panel using the online two-round Delphi survey.

5.6.1 Strategies and RMAA safety climate factors

These strategies on how to improve safety of the RMAA sector are tabulated in Table 5.9 (with reference to the identified RMAA safety climate factors).

Table 5.9
Strategies for Improving Safety in the RMAA Sector.

		F1	F2	F3
1.	Strengthen site monitoring and safety supervision.			√
2.	Review legislative control.		√	
3.	Have a mandatory licensing system for the RMAA workers.	√		
4.	Provide relevant safety training for the specific trades of RMAA works.		√	
5.	Nurture a good safety culture in the company.	√		
6.	Select the RMAA subcontractors with good track records of safety performance.	√		
7.	Design for safety of RMAA works.		√	
8.	Implement award and penalty scheme.			√
9.	Create clear safe working procedures and guidance for the RMAA workers.		√	
10.	Improve site tidiness and housekeeping.			√
11.	Raise safety awareness of the RMAA workers.	√		√
12.	Provide safety promotion and education towards the RMAA sector.			√
13.	Implement the pay for safety scheme of RMAA works.	√		
14.	Implement technological innovations for better safety.		√	
15.	Provide sufficient safety equipment for the RMAA workers.	√		

Note. (F1) *management commitment to OHS and employee involvement*. (F2) *applicability of safety rules and practices*. (F3) *responsibility for health and safety*.

[3] Published in Hon, C.K.H., Chan, A.P.C. and Chan, D.W.M. (2011). Strategies for improving safety performance of repair, maintenance, minor alteration and addition (RMAA) works. *Facilities - Special Issue on Infrastructure Management*, 29(13/14), 591-620.

To improve the perception of (F1) *management commitment to OHS and employee involvement*, a vision of nurturing a good safety culture in the workplace should be clearly laid down in the company policy. The company can demonstrate steadfast commitment to OHS by selecting RMAA subcontractors with good track records of safety performance; by implementing safety incentive schemes, such as pay for safety of subcontractors; by hiring licensed RMAA workers who have demonstrated previous professional expertise and safety competence; and by providing sufficient safety equipment for the RMAA workers (e.g., PPE). Employee involvement in OHS can be improved by raising the safety awareness of the RMAA workers.

To improve the perception of (F2) *applicability of safety rules and practices*, the current legislative control of RMAA works needs to be reviewed. The company has the responsibility for laying down clear safe working procedures and guidance for the RMAA workers to follow. Government or OHS consultant bodies are advised to provide relevant safety training in handling multiple tasks for the specific trades of RMAA works. Designers or architects are advised to consider maintenance safety in their designs. Unlike new works, the execution procedures of RMAA works are constrained by the original building design. Many accidents could be prevented if maintenance safety is taken into account in the design stage. Simple features such as roof top access and anchor points can be effective in alleviating risks of RMAA works done at heights. Technological innovations can also contribute to the eradication of dangerous work practices, such as, the rapid demountable platform promoted by the Construction Industry Institute of Hong Kong (CII-HK) (Cheung and Chan, 2011), which replaces the traditional bamboo truss out scaffolding that has been the cause of many deaths.

To improve the perception of (F3) *responsibility for health and safety*, raising the safety awareness of RMAA workers and helping to develop in them a sense of responsibility and ownership for safety are important. Undoubtedly, construction activities are high–risk; however, risks are something that can be managed (Reason, 1990). RMAA workers need to be equipped with better safety awareness so that they will know how to manage peculiar risks involved in RMAA works. Notably, management enforcement of safety affects the frontline worker's perception of safety. The enforcement of site safety indicates real company concern regarding safety.

More attainable actions could include the improvement of site tidiness and housekeeping, strengthening of site monitoring and safety supervision, and implementation of an award and penalty scheme. These seemingly simple actions could have profound effects. Government and OHS consultant bodies should put more effort in safety promotion and education towards the RMAA sector and the public, such as launching an RMAA works safety publicity campaign for better awareness.

5.6.2 Relative importance of the strategies

Strategies for improving the safety of RMAA works suggested by the interviewees were then evaluated by the expert panel in a two-round Delphi survey. After the two rounds, the ranking agreement among the 13 experts improved. Kendall's coefficient of concordance (*W*) increased from 0.198 with $\chi^2(14, N=13) = 36.072$, $p < 0.005$ in the first round to 0.210 with $\chi^2(14, N=13) = 38.239$, $p < 0.001$ in the second round (Table 5.10). Thus, use of the two-round Delphi survey successfully contributed to improving expert agreement and the reliability of the findings.

Table 5.10
Kendall's Coefficient of Concordance (W) Results on the Strategies for Improving Safety in the RMAA Sector.

	Round one Delphi survey	Round two Delphi survey
Number of experts (*N*)	13	13
Kendall's coefficient of concordance (*W*)	0.198	0.210
Actual calculated chi-square value (X^2)	36.072	38.239
Critical value of chi-square from table	23.68	23.68
Degrees of freedom *(df)*	14	14
Asymptotic level of significance	0.001	<0.001

Note. H_0 = Respondent sets of rankings are unrelated (independent) to each other within each round.
Reject H_0 if the actual chi-square value is larger than the critical value of the chi-square from the table.

Overall rankings of the expert panel were consistent in the two-round Delphi survey. As shown in Table 5.11, the top three important strategies for improving the safety of RMAA works in both rounds of the Delphi survey are "Raise safety awareness of the RMAA workers", "Select the RMAA subcontractors with good track records of safety performance" and "Provide safety promotion and education towards the

RMAA sector". The two least important strategies in both rounds of the Delphi survey are "Implement technological innovations for better safety", and "Implement the pay for safety scheme of RMAA works".

Some noticeable changes occurred in the second round of the Delphi survey. The strategies "Provide relevant safety training for the specific trades of RMAA works" and "Nurture a good safety culture in the company" emerged to share third ranking with "Provide safety promotion and education towards the RMAA sector". The contractor subgroup changed the ranking of "Review legislative control" from first in the round one of the Delphi survey to tenth in the round two of the Delphi survey.

Referring to Table 5.12, the Spearman's rho correlation of rankings between the first round and the second round Delphi exercises of the expert panel was highly correlated at a significance level of 0.01 (*Spearman's rho* = 0.943, $p < 0.001$). As for the rankings of the subgroups in both rounds of the Delphi survey, the client subgroup was the most consistent (*Spearman's rho* = 0.962, $p < 0.001$) followed by the OHS consultant/regulatory body subgroup (*Spearman's rho* = 0.684, $p < 0.01$). However, rankings of the contractor subgroup in both rounds of the Delphi survey were inconsistent (*Spearman's rho* = 0.312, *n.s.*).

Table 5.11

Two Rounds of the Delphi Survey Results on the Strategies for Improving Safety in the RMAA Sector.

		Round one Delphi survey								Round two Delphi survey							
		All experts		Client subgroup		Contractor subgroup		OHS consultant/ regulatory body		All experts		Client subgroup		Contractor subgroup		OHS consultant/ regulatory body	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1.	Strengthen site monitoring and safety supervision.	4.00	5	3.80	7	4.33	1	4.00	5	4.15	6	4.00	7	4.33	1	4.20	4
2.	Review legislative control.	3.69	10	3.40	13	4.33	1	3.60	13	3.77	13	3.60	12	3.67	10	4.00	10
3.	Have a mandatory licensing system for the RMAA workers.	3.85	8	3.80	7	4.00	4	3.80	9	3.85	10	3.80	8	3.67	10	4.00	10
4.	Provide relevant safety training for the specific trades of RMAA works.	4.23	4	4.20	4	4.33	1	4.20	2	4.23	3	4.40	4	4.00	6	4.20	4
5.	Nurture a good safety culture in the company.	3.92	6	4.00	6	3.67	8	4.00	5	4.23	3	4.20	5	4.33	1	4.20	4
6.	Select the RMAA subcontractors with good track records of safety performance.	4.31	2	4.80	1	4.00	4	4.00	5	4.54	1	4.80	1	4.33	1	4.40	2
7.	Design for safety of RMAA works.	3.85	8	3.60	11	3.67	8	4.20	2	4.08	9	3.80	8	4.33	1	4.20	4
8.	Implement award and penalty scheme.	3.62	12	3.80	7	3.33	11	3.60	13	3.77	11	3.80	8	4.00	6	3.60	14
9.	Create clear safe working procedures and guidance for the RMAA workers.	3.69	10	3.80	7	3.00	13	4.00	5	4.08	7	3.80	8	4.00	6	4.40	2
10.	Improve site tidiness and housekeeping.	3.62	12	3.60	11	3.33	11	3.80	9	3.77	11	3.40	13	3.67	10	4.20	4
11.	Raise safety awareness of the RMAA workers.	4.54	1	4.60	2	4.00	4	4.80	1	4.54	1	4.60	2	4.33	1	4.60	1
12.	Provide safety promotion and education towards the RMAA sector.	4.31	2	4.60	2	4.00	4	4.20	2	4.23	3	4.60	2	4.00	6	4.00	10
13.	Implement the pay for safety scheme of RMAA works.	3.46	14	3.40	13	3.00	13	3.80	9	3.62	14	3.40	13	3.67	10	3.80	13
14.	Implement technological innovations for better safety.	3.23	15	3.20	15	3.00	13	3.40	15	3.54	15	3.40	13	3.67	10	3.60	14
15.	Provide sufficient safety equipment for the RMAA workers.	3.92	6	4.20	4	3.67	8	3.80	9	4.08	7	4.20	5	3.67	10	4.20	4

Table 5.12

Spearman's Rho Correlations of Rankings in Round One and Round Two of the Delphi Surveys on the Strategies for Improving Safety in the RMAA Sector.

Rankings in Round one and Round two of the Delphi surveys	Spearman's rho correlation	Sig. (2-tailed)
All experts	0.943**	<0.001
Client subgroup	0.962**	<0.001
Contractor subgroup	0.312	0.257
OHS consultant/ regulatory body subgroup	0.684**	0.005

Note. ** Correlation is significant at the 0.01 level (2-tailed).

As shown in Table 5.13, after the Kruskal-Wallis test was conducted for all the identified strategies for improving safety of the RMAA works, the null hypothesis was not rejected. This means that the rankings of the three subgroups were not significantly different from one another. The null hypothesis that the medians of the two subgroup rankings are not significantly different from one another was not rejected after the two-round Delphi survey. This inter-group comparison indicates that, although the different subgroups play different roles in the construction industry, they share similar perceptions in terms of the strategies for improving safety performance of the RMAA works.

Table 5.13

Kruskal-Wallis Test in Round Two of the Delphi Survey on the Strategies for Improving Safety in the RMAA Sector.

		Kruskal-Wallis test Asymp. Sig
1.	Strengthen site monitoring and safety supervision.	0.853
2.	Review legislative control.	0.587
3.	Have a mandatory licensing system for the RMAA workers.	0.644
4.	Provide relevant safety training for the specific trades of RMAA works.	0.717
5.	Nurture a good safety culture in the company.	0.892
6.	Select the RMAA subcontractors with good track records of safety performance.	0.517
7.	Design for safety of RMAA works.	0.264
8.	Implement award and penalty scheme.	0.693
9.	Create clear safe working procedures and guidance for the RMAA workers.	0.590
10.	Improve site tidiness and housekeeping.	0.101
11.	Raise safety awareness of the RMAA workers.	0.737
12.	Provide safety promotion and education towards the RMAA sector.	0.202
13.	Implement the pay for safety scheme of RMAA works.	0.692
14.	Implement technological innovations for better safety.	0.737
15.	Provide sufficient safety equipment for the RMAA workers.	0.606

Note. * Null hypothesis rejected at 0.05 Asymp. Sig.

5.7 CHAPTER SUMMARY

The current chapter has presented research findings to achieve Objectives 2 to 5. The safety climate of RMAA works was encapsulated by the 22 statements from the original SCI survey. A three-factor structure was validated by applying confirmatory factor analysis in the validation sample. The three key RMAA safety climate factors include (F1) *management commitment to OHS and employee involvement*, (F2) *applicability of safety rules and practices*, and (F3) *responsibility for health and safety*. The relationship between RMAA safety climate and safety performance was tested with structural equation modeling. RMAA safety climate significantly influences injuries in a negative manner, but it significantly influences safety participation and safety compliance in a positive manner. This study hypothesizes that (H1) RMAA safety climate (RMAASC) is negatively related to injuries (Inj); (H2) RMAASC is positively related to safety participation (SP), and (H3) RMAASC is positively related to safety compliance (SC). All the hypotheses were found to be supported.

Nine demographic variables that influence RMAA safety climate were identified: working level, gender, marital status, education, employer, length of service in the current company, working experience, smoking habit, and drinking habit. Unmarried RMAA workers who worked in the construction industry for less than five years and who have been employed by subcontractors for more than a year who had smoking and drinking habits tended toward lower safety climate scores. This group can be targeted for safety promotion and safety training. Proper management of RMAA safety climate factors helps improve the safety of RMAA works. Fifteen strategies for improving the safety of the RMAA sector were suggested by interviewees, and were evaluated via two-round Delphi survey.

CHAPTER 6 DISCUSSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter discusses the research findings in relation with the existing literature, examines the implications of the qualitative and quantitative research findings and gives recommendations on how to improve safety in the RMAA sector.

6.2 SAFETY PROBLEMS AND SAFETY PRACTICES IN THE RMAA SECTOR

6.2.1 Causes of RMAA accidents

Comparing the current study to that of Brace et al. (2009) in the United Kingdom, quite a number of causes of RMAA accidents share similarities to existing safety research (Table 6.1). Such similarities imply that factors leading to RMAA accidents in Hong Kong are also chronic problems besetting the construction industry in other developed societies. Notably, occupied workplace setting and minute task characteristics of RMAA works tend to magnify some of the common causes that lead to unsafe behavior.

Table 6.1

Similarities and Differences of the Current Study Compared with Brace et al. (2009) Regarding the Causes of Accidents.

The current study	Ranking of current the study	Brace et al. (2009)
Macro Factors		
Low safety awareness of small/medium-sized contractors on RMAA works.	8	Immature corporate systems
Low safety awareness of flat owners/tenants on RMAA works.	12	Not mentioned
Inadequate regulatory control and monitoring system.	11	Inappropriate enforcement
Mezzo Factors		
Lowest bid tendering method without pricing for safety items.	4	Inappropriate procurement and supply chain arrangements
Micro Factors		
Poor safety conscientiousness of RMAA workers.	1	Lack of individual competency and understanding of workers and supervisors
RMAA workers underestimate potential risks when performing small tasks for a short period.	2	Poor behavior
Inadequate safety supervision.	10	Lack of ownership, engagement and empowerment of communication with, and responsibility for workers and supervisors
Inadequate site safety planning and hazard assessment.	7	Site hazards
Poor housekeeping and congested working environment.	8	Not mentioned
Insufficient safety training of RMAA workers for handling multiple tasks.	6	Ineffectiveness or lack of training and certification of competence
Hurry to finish the work.	5	Poor employment practices
Personal protective equipment not used, incorrectly used, or not provided.	2	Poor equipment or misuse of equipment (including PPE)

The importance of safety awareness of RMAA workers is magnified because RMAA works rely heavily on manual labor rather than on machines. The workplace settings of RMAA works in occupied buildings and the minute nature of work tasks also naturally intensify the likelihood of risk underestimation and increase the immediate "benefits" of engaging in unsafe behavior. *Low safety awareness of RMAA workers* is the most important cause category of RMAA accidents. Causes originating from this category are "Poor safety conscientiousness of RMAA workers", "RMAA workers underestimate potential risks when performing small tasks for a short period", and "Personal protective equipment not used, incorrectly used, or not provided". After two rounds of the Delphi survey, the expert panel ranked these three as the most important causes of RMAA accidents. Rather than blaming the RMAA workers, wider organizational factors, such as nature of the job, pressure of productivity, and others, should be considered. The characteristics of RMAA works and the difficulty of supervision aggravate the already unsafe behavior of the workers. The short duration of the job and the minute tasks conducted in an occupied building give the wrong impression to RMAA workers that the job is not risky. Together with the difficulty of supervision of jobs in scattered locations, the unsafe behavior pattern of RMAA workers is further reinforced.

Notably, the two main causes of RMAA accidents identified in the current study, *low safety awareness of flat owners/tenants of RMAA works* and *poor housekeeping and congested working environment* were not identified by Brace et al. (2009). Safety awareness of the public is one of the causes of RMAA accidents identified by the interviewees, although it was ranked the lowest by the expert panel. Households, which are normally inexperienced clients, commonly hire handy men for small RMAA works without considering safety issues and worker qualifications. A congested working environment was found to be a lesser-known hindrance to safety in RMAA works. Unlike new works, RMAA works are limited by the existing building space. The working environment is often so stuffy that workers do not want to wear PPE. Thus, the causes of accidents lean towards human factors at the micro level. Such findings warrant the need for investigation of the safety climate in the RMAA sector.

Causes of RMAA accidents are verified by the case studies analysis of RMAA fatal accidents. Findings of the RMAA fatal accidents analysis are in line with Chan et al. (2008) but provide finer and further analyses. The current study finds that fall from height accidents mostly occurred in the end of weekday afternoons, that is, Thursday and Friday afternoons. Afternoon in the summer is the most accident prone period of fall from height fatalities (n = 35). Hot and humid weather may affect workers' judgment and lapse of attention (Chan et al., 2012).Workers aged between 45 and 54 had the greatest number of fall accidents. This is naturally the case because 55% (i.e.

153,392 out of 277,305) of the total workforce in the construction industry aged 45 and above (Construction Workers Registration Authority, 2011), reflecting that the construction workforce in Hong Kong is ageing rapidly and the industry also experienced difficulties in recruiting youngsters.

In terms of trade, bamboo scaffolders were particularly susceptible to fatal falls. Statistics of registered bamboo scaffolders in Hong Kong as at 14 October 2011 (Construction Workers Registration Authority, 2011) show that those aged below 34 only represented 22% of the total workforce. However, findings of the current study indicate that 58% of RMAA fatalities of bamboo scaffolders occurred in this age group. Younger bamboo scaffolders are more susceptible to fatalities in RMAA works. Being less experienced, they may not be able to identify the risks involved in erecting or dismantling bamboo truss-out scaffold for RMAA works competently. Similarly, the study of Chi et al. (2005) in Taiwan shows that young workers were more susceptible to accidents; and workers with less than one year of experience accounted for about 80% of the fatal falls. The analysis result on fatalities of bamboo scaffolders is particularly noticeable. Such an alarmingly high fatality rate of young bamboo scaffolders in RMAA works may further deter new entrants from joining the bamboo scaffolding trade. If the situation persists, this trade may become obsolete.

It is annoying to find out that 63% (n = 45) of the victims were not provided with safety equipment. Workers were forced to take risk when working at height in these fatality accidents. This is absolutely not tolerable because owners of RMAA contracting companies are legally responsible to provide a safe working environment and necessary safety equipment for their employees. Although small/medium-sized RMAA contracting companies may not have adequate resources for safety, they should not neglect the importance of providing sufficient personal protective equipment to workers. Failure to use safety belt/harness was the most frequent unsafe action. Workers should have objected to risk their life to work at height without any safety protections and refused to work in unsafe condition. This indicates that safety education and compliance of safety practices in the RMAA sector are far from satisfactory. To a certain extent, seemingly safe environment and small/minute task characteristics of RMAA works may have discouraged RMAA workers to use safety belt/harness.

It is noted that nine fatalities occurred even when the deceased wore safety harness. These cases indicate that the workers may not have used the safety harness properly or they may not have chosen the appropriate type of safety harness. According to the guidance notes issued by the Labor Department (2005), safety harnesses available in the market may not have met the European or the American standard. At present, only full body harness is acceptable in the US. OSHA revised the regulations involving fall prevention in 1996. The 1996 revision of regulation stipulates that it is not acceptable to use body belt as a personal fall arrest system (PFAS). Body harness is mandated to provide proper protection to workers (Huang and Hinze, 2003). However, it is not uncommon to see a RMAA worker in Hong Kong using a sub-standard safety belt/semi-safety harness, or even worse a self-made safety belt (Apple Daily, 31 July 2008). Sometimes, a fall accident sadly occurs because the safety belt is loosened and not manufactured to the stipulated standard. Had the victim used a full body harness, the fall accident might have been avoided. Most of the fatal accidents happen because the lanyard of the safety harness is not attached to an independent lifeline or a fixed anchorage point (Huang and Hinze, 2003; OSHC, 2004). Some just attach the lanyard to the bamboo scaffold or the truss-out brackets. These are not reliable anchorage points and often fail to provide rescue to the fall victims. Some bamboo scaffold accidents occur because of unlocking the hook when changing position (Huang and Hinze, 2003).

The first cluster identified was bamboo scaffolders aged between 25 and 34 working at external wall/facade at the beginning of weekdays. Bamboo scaffolders are the most accident-prone workers. This is not surprising because they need to work at height at external wall most of the time. As for RMAA works, truss-out bamboo scaffold has caused many deaths. Truss-out bamboo scaffold should be fixed with three anchor bolts. However, in some circumstances, the truss-out bamboo scaffold supported by three anchorage bolts still collapses because the external facade of the old building is not structurally sound (Apple Daily, 4 July 2008). Weather also contributes to the occurrence of accidents. In rainy days, the truss-out bamboo scaffold fixed to the brick wall is dangerous because the tensile strengths of the anchor bolts are greatly reduced when the bricks expand after absorbing water (Tai Kung Pao, 4 July 2008). There are no fast and fixed rules for erecting a truss-out bamboo scaffold. Precautions have to be taken in response to the specific circumstances.

The second cluster identified was miscellaneous trades of RMAA workers aged between 45 and 54 working at other/unknown places in the end of weekdays. This group of fatalities includes a number of trades, such as plasterer, plumber, jointer, and others. Accidents occurred in lift shaft/internal work surface, excavation/underground/basement, and others. RMAA works are usually multi-tasking, types of works are very diversified. The present categorization system cannot fully reflect all of the work trades. Hence, fatalities of this cluster are relatively unclear which warrant further investigations. However, this cluster suggests that ageing workers are more prone to accidents because of reduced strength and flexibility.

The third cluster identified was manual labour aged between 35 and 44 working at floor/floor opening in weekends. Another major type of fall from height fatalities occurred at floor/floor openings. This is easily overlooked but records show that fall from height from the ladder or working platform has led to a number of deaths (Chi et al., 2005; Chan et al., 2008). The most common causes of this cluster are often the overturning of ladders or inappropriate working platforms and unguarded floor openings (OSHC, 2004). Project works undertaken on weekends are not noticeable and are subject to less surveillance but they could cause serious fatalities. For example, a tragedy involving 6 fatalities occurred on a Sunday in the International Commerce Centre, which is one of the latest landmark constructions in Hong Kong. Six workers fell into the lift shaft when the working platform was overloaded with construction debris (Hong Kong Headline, 14 September, 2009).

6.2.2 Difficulties of implementing safety practices in the RMAA sector

RMAA contractors face particular challenges to safety and health while simultaneously having the greatest potential for improvement in safety management (Wilson and Koehn, 2000). As ranked by the expert panel, RMAA contractors faced difficulties in implementing safety practices due to limited resources. The study of Loosemore and Andonakis (2007) reports similar findings.

At present, many government and quasi-government bodies provide financial aid to the repair and maintenance sector. For example, the Hong Kong government and the OSHC have put forward a set of enhancement schemes applicable to small/medium-sized contractors of RMAA works. Sponsored schemes are available for SMEs to buy fall-arresting equipment, such as temporary anchor devices and safety ladders for renovation and maintenance work. A scheme for SMEs is also available to employ accredited safety consultants to conduct safety inspections and offer recommendations.

Conversely, the top ranking of “Limited resources for RMAA projects undertaken by small/medium-sized contractors” implies that the existing provision of aid and subsidies to alleviate the difficulties of implementing safety practices by SMEs may be inadequate. These findings require a deeper discussion of who should pay for safety and how the government should regulate the construction practices. Safety is the shared responsibility of all stakeholders. Traditionally, safety has been the responsibility of the contractors; however, more and more clients are willing to pay for safety by adopting a pay for safety scheme that sets aside a certain percentage of the contract sum to pay for safety items (Chan et al., 2010).

To improve safety of the RMAA sector, the Hong Kong government could perhaps regulate the safety standards of the RMAA contractors and workers via license registration. Only those with proven safety knowledge and ability to perform repair and maintenance tasks in a safe manner should be eligible to register and take up jobs in the RMAA market. Such license registration requirements would not only give a professional identity to practitioners in the RMAA sector, but would also prevent the market infiltration of unskilled and untrained practitioners (Love et al., 2010).

Inadequate and improper design may result in many difficulties in implementing safety practices in the RMAA works (Yam, et al., 2007). Designers of new works should consider maintenance safety to manage safety and health risks, such as the installation of anchor points on roof top structures. Many accidents could have been prevented if there had been a certain design change (Hare et al., 2006; Cameron et al., 2007; Cooke et al., 2008).

Halse et al. (2010) argue that authorities and professional bodies have extreme difficulty in reaching out to small enterprises when it comes to preventive safety measures. Halse et al. (2010) suggest using occupational health and safety intermediaries. Although the debate as to who should take up the role of upholding safety and health issues in SMEs continues, the idea of assigning a safety intermediary to individually disseminate updated safety aids and assistance to SMEs seems plausible.

Another important obstacle in implementing safety practices is the passive mindset that RMAA workers have towards safety. Workers are notoriously difficult to motivate to care for safety and comply with safety procedures when they experience role overload. Quoting Jones and James (1979), which is also cited in the work of Mullen (2004), "Perceptions of work overload are defined as being the degree to which performance is affected by inadequate resources, training, and time to perform one's role". Workers experiencing role overload are pressured to work under unsafe conditions. Although time is always a constraint in any construction project, project managers should utilize every means to keep a reasonable schedule and should keep reminding workers about the overriding importance of safety over performance to minimize worker perception of role overload.

Widely scattered locations of RMAA work projects make safety supervision difficult, inefficient and costly. Numerous RMAA projects exist in the construction market. The Labor Department of Hong Kong, being the only regulatory authority of the government for safety, lacks the manpower to monitor all projects. Small-scale

RMAA works are exempt from reporting their project commencements to the Labor Department; hence, such projects do not attract much attention unless an accident occurs.

In light of such safety inspection difficulties, the government can perhaps divert its efforts to particularly raise the safety standards of the RMAA workers. The ultimate goal is to help the RMAA workers actively care for their own safety. These RMAA workers need education and training to make them knowledgeable in handling ad hoc situations and multiple tasks in a safe manner. Safety supervisors also need education and training to make them competent in safety procedures and in the maintenance of project progress. The government and the safety training providers may need to review their courses to better suit the practical needs of the RMAA workers and the safety supervisors. Should a license system be implemented in the RMAA sector, it would require a new series of RMAA works safety training courses that are tailored for both the safety supervisors and the workers.

6.3 SAFETY CLIMATE FACTORS OF RMAA WORKS

The three key factors of RMAA safety climate encapsulating 22 variables have been determined. The hope is that these 22 variables can better reflect the core factors of the safety climate in RMAA works. Notably, the RMAA safety climate of the current study and other safety climate studies (e.g., O'Toole, 2002; Fang et al., 2006; Choudhry et al., 2009) could only explain less than 50% of the total variance. This may imply that safety climate is a multifaceted concept that cannot be easily grasped.

The RMAA safety climate factors identified in this study are (F1) *management commitment to OHS and employee involvement*; (F2) *applicability of safety rules and work practices*; and (F3) *responsibility for health and safety*. F1 and F2 have been most commonly identified in the literature (Dedobbeleer and Béland 1991; Mohamed, 2002; Fang et al., 2006; Choudhry et al., 2009; Zhou et al., 2011). *Management commitment to OHS and employee involvement* is an important factor because effective OHS management needs promotion from the top and support from the bottom. Applicable safety rules and work practices prevent potential hazards from endangering the RMAA workers.

For (F3) *responsibility for health and safety,* it has been identified in safety climate studies conducted in industrial gas production (Cox and Cox, 1991), manufacturing (Cheyne et al., 1998), and offshore oil and gas production (Mearns et al., 1998). This is one of the dominant themes in safety climate factors identified by Clarke (2000). The study has succinctly revealed the factor of responsibility for safety and health, which may have been undermined or ubiquitously scattered across several factors in previous construction safety climate studies.

Surprisingly, the three-factor structure of the RMAA safety climate revealed in the current study shares commonalities with other safety climate studies in construction and other industries. Despite the commonalities in factor labeling, subtle characteristics and peculiar challenges in the management of these safety climate factors in the context of RMAA works were noted.

As for management commitment to OHS and employee involvement, most RMAA contracting companies are small/medium-sized companies which may have inadequate awareness and resources for safety (Hon et al., 2010). RMAA worksites are usually scattered in various locations, making it particularly difficult for management to carry out safety supervision, demonstrate commitment to OHS and enlist employee involvement (Hon et al., 2011).

For applicability of safety rules and practices, because most RMAA projects are small in scale and short in duration, some safety rules applicable to new construction works may not be applicable to RMAA works. For example, the law of Hong Kong requires construction projects with over 100 workers to employ a safety officer; however, this requirement usually does not apply to RMAA projects because they seldom employ more than 100 workers on site (Hon et al., 2011). RMAA works also face many ad hoc problems that differ from the new construction works. For example, the risks involved in RMAA works undertaken at the external wall of an old building is different from that of a new building because concrete strength of their external walls are likely to be different. Although most construction companies have generic method statements for general building works, they cannot directly address the potential risks and problems in RMAA works (Hon et al., 2011). The challenge now is to design a set of safety rules and good practices for the common types of RMAA works.

As for the responsibility for health and safety, this sense of responsibility for RMAA workers may be undermined by the working environments and the nature of tasks of the RMAA projects. RMAA workers working in occupied buildings and handling minute tasks may easily underestimate the importance of safety. RMAA projects undertaken by SMEs may not have a comprehensive safety system, or may be lacking in terms of transparency and communication. Workers can easily develop a mindset that takes safety for granted, or to care only when an accident actually occurs. This can lead to a subsequent negative impression on accident investigation.

6.4 RELATIONSHIPS BETWEEN THE SAFETY CLIMATE AND THE SAFETY PERFORMANCE OF RMAA WORKS

In contrast to the study of Griffin and Neal (2006) on hospital employees, which has revealed a significant relationship between safety climate and safety participation, but not safety compliance, the current study has identified significant relationships between RMAA safety climate and both safety participation and safety compliance. The relationship between RMAA safety climate and safety compliance is particularly strong. Because (F2) *applicability of safety rules and practices* is the strongest factor of RMAA safety climate, RMAA safety climate clearly has the greatest predictability of safety compliance.

Perhaps, such discrepancy can be attributed to the different research design and the industrial settings used. The 2006 research of Griffin and Neal was a longitudinal study in a hospital setting, whereas the current study is a cross-sectional study in the RMAA sector of the construction industry. Generally, a higher standard of safety compliance can be found in a hospital setting. Safety compliance cannot be compromised. It is less sensitive to any change in the safety climate. Safety participation behavior, which involves extra-role activities, is more sensitive to the change in the safety climate. Safety participation is also likely to have a longer time lag in response to any change in the safety climate. Thus, safety participation behavior is better grasped in a longitudinal study. However, the case is different in the RMAA sector. Safety compliance in RMAA works can only be achieved when a positive safety climate exists. In an RMAA project with a low level of safety climate, the level of safety compliance is likely also going to be very low.

In Choudhry et al. (2009), the safety climate factor *management commitment and employee involvement* was found to exert greater influence on perceived safety performance than the other safety climate factor *inappropriate safety procedures and work practices.* The current study on RMAA works; however, has found that (F2) *applicability of safety rules and practices* slightly outperforms other factors to exert the greatest influence on safety performance particularly safety compliance, reflecting the peculiar situation of the RMAA sector.

Although the construction industry generally has clear existing safety rules and best practice guidelines, the RMAA sector urgently needs a set of safety rules and practice guidelines that can better meet the specific needs of the RMAA works. Despite the presence of some practice guidelines for implementation of property management companies, such efforts are yet to be comprehensive. Moreover, many small/medium-sized RMAA contracting companies may not even be aware that they exist. Proper RMAA safety rules and safety practices should be laid down and promoted in the RMAA sector.

Managing safety climate factors can result in better safety performance. Deficiencies in management procedures and safety system can be detected in the measurement of safety climate (Choudhry et al., 2009). *Management commitment to OHS* stems from genuine concern for the well-being of the employee. Such management commitment only occurs when top management truly believes that good safety performance is not a random occurrence but a calculated result of specific management actions (Hinze, 2006). Transparent and good communication with workers and supervisors is necessary. Safety should be integrated with other company goals. To enlist *employee* *involvement*, workers need to have a clear understanding of their OHS responsibilities and the health and safety risks they will face. They should also be assessed and praised for working safely.

The factor *applicability of safety rules and work practices* contributes significantly to safety performance. Safety rules and work practices must be up-to-date, technically correct, and clear (Choudhry et al., 2009), and should help the RMAA workers avoid potential risks and hazards, and conduct tasks safely. They also need to be upheld and properly enforced.

To have a positive perception of *responsibility for health and safety*, RMAA workers must have a correct assessment of risk and a locus of control for accidents (Hinze, 2006). Accidents can be avoided if the workers demonstrate a concern for safety and behave safely. In addition, the contracting companies also need to properly bear the responsibility for health and safety. Accident investigation should identify the root causes of accidents, not who should be blamed. Proactive safety measures should be performed on a daily basis, not be delayed until someone is injured.

6.5 DEMOGRAPHIC VARIABLES AFFECTING THE SAFETY CLIMATE

Among nine demographic variables that significantly affect the level of people's RMAA safety climate, five were in line with Fang et al. (2006): gender, marital status, education level, drinking habits, and direct employer. As pointed out by Fang et al. (2006), social responsibility and the propensity to take risks are the reasons people with different demographic variables tend to have significantly different safety climate perceptions. People who are older, married, and support more family members are likely to have higher mean scores of safety climate.

Based on the findings of the current study, unmarried RMAA workers who have worked in the construction industry for less than five years but have been employed by their subcontractors for more than a year, and who have smoking and drinking habits, are likely to have lower safety climate scores. Subcontractors are usually small in scale, and may not have the resources to provide safety training and safety supervision. This group of people tends to be young and have acquired basic craftsmanship skills. When they become familiar with their tasks, they easily lose their alertness towards work safety. They are more prone to accidents; however, their propensity to take risks will change when they mature and have more social responsibility to bear. Effective safety measures should be tailored in a way that would change this group's propensity to take risks.

6.6 STRATEGIES FOR IMPROVING SAFETY IN THE RMAA SECTOR

The strategies derived from the literature, interviews and analysis of RMAA fatal cases were verified by two rounds of the Delphi survey. Results highlighted the importance of the human aspects involved in developing strategies for improving safety performance of RMAA works. Although the importance of enforcement and education was well recognized by the interviewees, the Delphi survey findings also point to the importance of ergonomics, empowerment, and evaluation.

6.6.1 Raise safety awareness of RMAA workers

"Raise safety awareness of RMAA workers" was ranked the most important strategy in both rounds of the Delphi survey exercise. This item is interrelated with "Nurture a good safety culture in the company" and can be discussed together with "Provide relevant safety training for the specific trades of RMAA works" and "Provide safety promotion and education towards the RMAA sector". As revealed in the interviews, RMAA workers need to have a higher level of safety standard and self-regulation because safety supervision of widely dispersed RMAA works is difficult.

Safety awareness is intrinsic and incubated in one's mindset and attitude towards safety. As suggested by Geller (2001), changing an extrinsic behavior is easier than changing intrinsic attitude. Mahalingam and Levitt (2007) point out that education and training can change one's mindset and attitude towards safety, thereby enhancing safety awareness; however, this takes time. A reward and penalty scheme immediately changes one's safety behavior; however, the effect may not last.

The most effective strategy is to carry out dual approaches that target change in both extrinsic behavior and intrinsic attitude. The resultant change in either behavior or attitude directly or indirectly leads to a change in the other (Geller, 2001). A comprehensive safety management system together with an empowered culture throughout all worker levels is vital.

Successful safety strategies require management leadership and commitment, and worker empowerment to engage workers in the process of safety management. Apart from raising the safety awareness of RMAA workers, a good culture of company safety should also be established. Safety should be regarded as the basic value and social responsibility of any key project stakeholders in the RMAA sector (Smallwood and Lingard, 2009).

6.6.2 Select the RMAA subcontractors with good track records of safety performance

"Select the RMAA subcontractors with good track records of safety performance" is considered to be another important strategy in improving safety of RMAA works. This finding is comprehensible because it is one of the important strategies recommended by the Report of the Hong Kong Construction Industry Review Committee to improve the existing safety performance of the whole construction industry (HKCIRC, 2001).

The strategy of selecting RMAA subcontractors with good safety performance implies an impact on the consideration of procurement arrangement and tenderer selection. Similarly, Anumba et al. (2004) have pointed out the importance of choosing competent contractors and the implementation of an appropriate procurement strategy to achieve good safety performance. Rather than adopting the practice of "the lowest bid gets the job", safety performance should be a key assessment criterion when awarding contracts. According to Smallwood and Lingard (2009), safety should gain equally important status as time, cost and quality in terms of project performance.

This strategy, however, seems to be particularly important to the RMAA sector. Because many RMAA subcontractors in Hong Kong are small/medium-sized companies with varied levels of safety competency, and are loosely regulated (Hon et al., 2010), the selection of RMAA subcontractors with good track records of safety performance is particularly essential to the RMAA contractor.

Smallwood and Lingard (2009) suggest incorporating OHS into the supply-chain management where there is socially responsible buying and contracting. These authors advance the claim that socially responsible construction organizations should look beyond their own workers and consider the OHS performance of their key suppliers and contractors. OHS can be incorporated into the supply-chain by promulgating approved lists of suppliers and subcontractors and implementing mentoring schemes that assist small/medium-sized suppliers and subcontractors in developing their OHS competency (Smallwood and Lingard, 2009).

As revealed in the interviews, some large RMAA contractors have already implemented the policy of working and building a partnership only with subcontractors who have good safety performance records. Safety performance should be properly evaluated so that it gains the same status as the other aspects of project performance (Smallwood and Lingard, 2009).

6.6.3 Implement technological innovations for better safety

"Implement technological innovations for better safety" is perceived to be the least important strategy. Technological innovation was considered very important in earlier days and in new construction sites when many accidents resulted from machinery failure. With rapid technological advancement, the design and quality of construction equipment and machinery have been improved and are now better suited for various construction purposes. More importantly, RMAA projects are likely to rely more on handicraft and workmanship, and less on heavy equipment. Hence, technological innovation may not be that important in the context of RMAA works.

6.6.4 Implement the pay for safety scheme of RMAA works

The second least important strategy is "Implement the pay for safety scheme of RMAA works". The pay for safety scheme [now Pay for Safety and Environment Scheme (PFSES)] is one of the important strategies implemented by the government to take the lead in improving safety performance of the overall construction industry (Hong Kong Government, 2003). It has been mostly adopted in government or quasi-government new capital construction projects. This is a client-driven safety strategy in which a certain percentage of the contract sum is set aside as an incentive for the contractor to observe safety; however, this scheme may be unsuited or insignificant for RMAA projects with small contract value and short project duration.

PFSES now applies to all public capital works contracts (Works Branch, Development Bureau, 2008), electrical and mechanical (E&M) contracts, and design-and-build contracts with an estimated contract sum of HKD 20 million (approximately USD 2.6 million); and term contracts with an estimated expenditure of HKD 50 million or above (approximately USD 6.4 million). Regardless of the contract value, term contracts solely for maintenance works (e.g., some E&M maintenance contracts) and contracts with duration of six months or less need not be included in PFSES.

Due to the small contract values and short project durations, many government RMAA projects are exempt from the scheme. Private sector clients are unlikely to consider PFSES as an important strategy for their RMAA projects. PFSES, being a type of monetary incentive for safety, only induces short-term safety motivation (Gangwar and Goodrum, 2005). Safety motivation will eventually become watered down as people gradually regard such incentive as part of their usual entitlement.

6.6.5 Review legislative control

The third least important strategy for improving safety performance of RMAA works is "Review legislative control". This strategy was highly favored by the contractor subgroup in the first round of the Delphi survey; however, in the second round, its ranking was adjusted in line with the other subgroups.

Currently, the contractor subgroup bears most of the legal liability and responsibility for giving compensation to the injured party. They naturally want to resort to coercive means. This may seem to be a quick fix to unsafe behavior and may mitigate the safety supervision effort of the contractor; however, it also has adverse effects on the workers and the government. On one hand, the Labor Department may experience difficulty in tracing and justifying the causes of worker injury or death in a negligent accident. On the other hand, to blame the workers for negligence when there may be some other underlying causes leading to the accident would be unfair.

6.6.6 Strategies and safety climate factors

Referring back to Table 5.9, "Raise safety awareness of RMAA workers" is the strategy proposed to improve (F1) *management commitment to OHS and employee involvement* and (F3) *responsibility for health and safety,* whereas "Select the RMAA subcontractors with good track records of safety performance" is the strategy for improving (F1) *management commitment to OHS and employee involvement.* As evaluated by the experts, these two strategies were the two most important strategies for improving RMAA works in Hong Kong. This shows that to further improve safety performance of RMAA works, more efforts should be put on (F1) and (F3). If the levels of climate factor (F1) and (F3) become higher, it is likely that the level of safety participation will become higher. Moving beyond baseline safety compliance to active safety participation is the future direction for further safety improvement of the RMAA sector.

To improve the safety performance of RMAA works, effective safety management strategies should be established by the management and supported by the RMAA workers. The project characteristics of small scale and short duration of RMAA works greatly hinder safety supervision and law enforcement. Hence, raising the safety awareness of RMAA workers so that they actively care for their workplace health and safety is crucial.

To raise the safety awareness of RMAA workers, a dual approach of safety strategy that includes a reward and penalty mechanism complemented with safety education and training should be adopted. A reward and penalty system should be encouraged in RMAA contracting companies with support from frontline safety supervisors and commitment from top management. Moreover, the procurement method should be carefully considered. OHS should be integrated into the company supply-chain management by implementing mentoring schemes or establishing partnering relationships between the RMAA contractors and the subcontractors.

Safety performance should be properly evaluated and regarded to be equally important as time, cost, and quality. To cultivate a strong culture of safety in the RMAA sector, workers need to be empowered throughout the overall safety management process and involved in the evaluation of safety performance. Key stakeholders of the RMAA sector should recognize safety as one of the core values of their business and accept it as part of their social responsibility.

6.7 CHAPTER SUMMARY

This chapter has interpreted the research findings presented in Chapters 4 and 5. It has integrated the interview, Delphi survey, and safety climate questionnaire survey findings with the existing literature. It has also discussed and revealed the practical implications of the safety findings in the RMAA sector.

CHAPTER 7 CONCLUSIONS

7.1 INTRODUCTION

This chapter presents a summary of the research findings and highlights the significance, contributions, and limitations of the current study. It also provides suggestions for future research directions.

7.2 SUMMARY OF THE MAJOR FINDINGS

The current study aims to establish a model that explains and predicts the relationship between the safety climate and the safety performance of RMAA works in the construction industry of developed economies. The specific objectives are to examine the safety problems and practices, identify the factor structure of the safety climate, scrutinize the relationships between the safety climate and the safety performance, examine how demographic variables affect the levels of safety climate, and recommend strategies for improving safety within the RMAA sector.

7.2.1 Safety problems and safety practices of the RMAA sector

Accidents occur in RMAA works due to inter-related reasons. Accidents are caused by unique factors of the RMAA workplace setting and task characteristics that, at the same time, share certain similarities with common safety problems of the whole construction industry. Poor safety conscientiousness of RMAA workers; underestimation of RMAA workers of potential risks in performing small tasks for short periods of time; and non-use, incorrect use, or lack of personal protective equipment were found to be the three most important causes of accidents. These commonly point to the phenomenon of low safety awareness of RMAA workers, which is in line with the research results of previous studies. Efforts should be made to raise the safety awareness of RMAA workers and their employers, as well the public, considering their role as clients. All stakeholders need to raise their safety awareness and be aware of the potential risks involved in RMAA works.

The major difficulties hindering the implementation of safety practices in the RMAA sector are limited safety resources for SMEs, difficulty in changing the mindset of RMAA workers, and difficulty in performing safety supervision. These difficulties reflect long-term malpractices in the industry. Time is required to correct such errors. If these difficulties are successfully removed, safety practices in the RMAA sector can be better implemented, thereby leading to an improvement in safety performance.

7.2.2 Safety climate factors of the RMAA sector

Three safety climate factors of the RMAA works were derived by exploratory factor analysis of the calibration sample. A three-factor second-order RMAA safety climate model was then validated by applying a confirmatory factor analysis on the validation sample. The RMAA safety climate factors include (F1) *management commitment to OHS and employee involvement*; (F2) *applicability of safety rules and work practices*; and (F3) *responsibility for health and safety*. These safety climate factors share some commonalities with other safety climate studies in the construction industry; however, they reflect subtle characteristics of the RMAA sector.

7.2.3 Relationship between safety climate and safety performance

A structural equation model encapsulating the relationship between safety climate and safety performance was tested and validated. All the hypotheses were supported. A significant negative relationship exists between RMAA safety climate and injuries. A significant positive relationship exists between RMAA safety climate and safety participation, and safety compliance respectively. A higher level of RMAA safety climate results in higher levels of safety participation and safety compliance.

7.2.4 Demographic variables affecting safety climate

Nine demographic variables significantly affect the level of RAMA safety climate: working level, gender, marital status, education, employer, length of service in the current company, working experience, smoking habit, and drinking habit. Unmarried RMAA workers who worked in the construction industry for less than five years but who have been employed by subcontractors for more than a year and who have smoking and drinking habits are likely to have significantly lower safety climate scores.

7.2.5 Strategies for improving safety of RMAA works

A number of strategies for improving safety of RMAA works were offered and evaluated by the expert panel. “Raise safety awareness of the RMAA workers” and “Select the RMAA subcontractors with good track records of safety performance” were the top two most important strategies. The strategy “Implement technological innovation for better safety” and “Implement the pay for safety scheme of RMAA works” were regarded as the least important strategies.

7.3 SIGNIFICANCE AND CONTRIBUTIONS

7.3.1 Identifying a new area of safety improvement and research interest

The construction industry has long been an accident-prone industry. Despite past leapfrog improvements of construction safety in many developed countries, many of these countries have reached a plateau in safety improvement. To strive for continuous safety improvement, the worsening safety performance and the rising importance of the RMAA sector should be the new areas of focus. While the safety performance of new construction projects of large contractors has largely improved, remarkable room for improvement remains for small/medium-sized contractors in the RMAA sector.

In view of the rising concern for sustainability of existing structures, renovation, retrofitting, and remodeling works have continuously increased. This, along with aging buildings in many developed cities, indicates that, RMAA works are becoming increasingly important to the construction industry. Statistics indicate that RMAA safety problems have been worsening in recent years. Surprisingly, the RMAA sector has been overlooked, and literature discussing safety of RMAA works remains scarce.

The current study contributes to fill in a rather untapped body of knowledge in construction safety. It not only sheds light on further improvement in construction safety beyond the “plateau” but also sparks research interest in the RMAA sector. Although the current study was conducted in Hong Kong, findings can be extrapolated to any other developed society with aging buildings or a surging RMAA sector.

7.3.2 Robust research design and model validation

The use of mixed methods research design in the current study combines the strengths of both qualitative and quantitative research strategies. The qualitative findings allowed an in-depth investigation of the nature of safety problems and practices found in the RMAA sector, whereas the quantitative findings of the Delphi survey and the subsequent safety climate questionnaire survey results allowed statistical analysis for generalization.

Validate a structural equation model with demonstrated goodness-of-fit with another sample of data is a good practice; however, this is often difficult, if not impossible, because of time and resource constraints. Because a considerable questionnaire survey data were collected, the data set was randomly split into a calibration and a validation sample. In light of this, RMAA safety climate and the safety performance structural equation model was tested with the calibration sample and then validated using the validation sample to increase consistency and credibility.

7.3.3 Deriving safety climate factors of the RMAA works with demonstrated reliability and validity

RMAA works differ from new works in terms of scale, duration, nature of tasks, teams of workers and others. Because safety climate tends to vary between different industrial settings, the unique characteristics of the RMAA works may render different safety climate factors from those in new works. The existing safety climate studies in the construction industry cannot fully reflect the RMAA sector. An independent study to reveal the safety climate of RMAA works was thus needed. The current study contributed to identifying the three-factor safety climate structure of the RMAA sector, which encapsulates 22 items of SCI.

The current study has derived an RMAA safety climate measurement scale with proven construct reliability, validity, and predictability of safety performance. This scale can be employed in future research studies in the RMAA sector in other places. Practitioners in the RMAA sector can easily employ this three-factor RMAA safety climate to periodically gauge the safety climate of their own RMAA projects, which would act as a leading indicator of safety performance.

7.3.4 Constructing a safety performance measurement of RMAA works

A multifaceted safety performance measurement has been developed. Injuries, safety participation and safety compliance are assigned to measure safety performance. "Near-misses" has been added to the scale of injury measurement, thereby increasing the sensitivity of safety climate variation. Rather than simply asking the respondents regarding their perceived safety performance, the three factors consisting of seven items can provide a more reliable and valid safety performance measurement.

7.3.5 Proffering a safety climate and safety performance model of RMAA works

With the help of SEM, the intricate relationships of RMAA safety climate, and its safety climate factors and multifaceted safety performance have been simultaneously estimated. To the author's knowledge, this is the first study of its kind in the RMAA sector of the construction industry to successfully test the theoretical model of second-order safety climate and safety performance using SEM techniques. The successful determination of the statistically significant relationship between RMAA safety climate and safety performance in terms of injuries, safety participation, and compliance has been accomplished. Thus, the RMAA safety climate demonstrates the capacity to have predictive validity of safety performance of the RMAA sector.

Perhaps the most significant contribution of this research is the demonstration of a significant relationship between RMAA safety climate and safety performance. A positive safety climate was proven to result in fewer injuries, and higher levels of safety participation and safety compliance. These results confirm that safety climate can be a useful leading indicator of safety performance. Safety performance of RMAA works can be improved by better managing the following RMAA safety climate factors: management commitment to OHS and employee involvement, applicability of safety rules and practices, and responsibility for health and safety.

7.3.6 Well-founded strategies for improving the safety of RMAA works

Recommended strategies for improving the safety of RMAA works were substantiated by interviews of the RMAA contracting companies. Their relative importance was evaluated by an independent expert panel that included clients, RMAA contractors, and OHS consultant/regulating bodies. With valuable input from the industry and other stakeholders, these recommended strategies are believed to be highly practical and valid for consideration of the RMAA sector.

7.4 LIMITATIONS OF THE STUDY

The current study faced the challenge of reaching those RMAA workers who are casually employed or are self-employed. To a certain extent, data were collected primarily from RMAA workers of more established contracting companies, despite the utmost effort of reaching out to all types of RMAA workers through the trade unions.

Methodologically, the design of the questionnaire survey relied on self-reported measures to gauge respondent perceptions on safety climate and safety performance, which may have led to the problem of common method variance (i.e., the variance attributable to the measurement method rather than the constructs that the measures represent) (Podsakoff et al., 2003). The common method of measurement may have overestimated the strength of relationships among safety climate and safety performance.

7.5 FUTURE RESEARCH DIRECTIONS

Further research could be conducted on safety of the RMAA sector in other developed cities with expanding RMAA works. Intriguing comparisons can be made with this study in Hong Kong to examine the safety problems and safety practices. In addition, a benchmarking of RMAA safety climate can be built by administering a safety climate survey to RMAA works in other places. This is particularly important for the RMAA sector in Hong Kong because the RMAA sector does not have the “accidents per 1,000 workers” statistic as a yard stick of safety performance, and because benchmarking of the safety climate may serve to be a proxy of comparison.

In addition to a cross-sectional questionnaire research design, further study on safety climate of RMAA works can be conducted with different research methods that have stronger ability to confer causality, such as, a quasi-experiment or a longitudinal questionnaire study. Behavior observations can also replace the measurement of self-reported injuries, safety participation and safety compliance to avoid the problem of common method variance.

Another direction for future research would be an investigation of safety climate strength. Climate strength is a variable moderating the relationship between safety climate and safety performance. The stronger the climate strength, the stronger the relationship between safety climate and safety performance, and vice versa. Further investigation can also be extended to the antecedents of safety climate in the construction industry. For example, investigating the effect of supervisor leadership behaviors on group level safety climate and group safety performance would be of great interest.

7.6 CHAPTER SUMMARY

To conclude, this chapter has summarized the major findings, has highlighted the significance and contributions, and has acknowledged the limitations of the current study. Directions for future research have also been proposed. The information shared herein should be able to shed light on how to improve safety in the RMAA sector, and spark further research interest in the topic.

APPENDICES

APPENDIX 1: RESEARCH INTERVIEW QUESTIONS

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

Research Interview Questions

1.	What do you think are the major causes of accidents in the RMAA sector?	你認爲導致 RMAA 領域意外事故的主要原因是什麼？
2.	Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?	請你簡單描述貴公司的安全措施或者 RMAA 領域的主要安全措施。
3.	What are the difficulties of implementing safety practices in the RMAA sector?	在 RMAA 領域推行安全措施的主要障礙是什麼？
4.	Do you have any suggestions on how to improve the safety performance of the RMAA works?	對於改善 RMAA 領域安全狀況你有何建議？
5.	Please assess the safety climate of the RMAA works of your company with the following dimensions (1= 'Least satisfactory' to 5= 'Most satisfactory'): • Commitment and concern for OSH by organization and management • Resources for safety and its effectiveness • Risk taking behavior and perception of work risk • Perception of safety rules and procedures • Personal involvement in safety and health • Safe working attitude and workmates' influence • Safety promotion and communication	請從以下角度評估貴公司的在 RMAA 領域的安全氣候 (1= '最不滿意' 至 5= '最滿意')： • 組織及管理方面對於職安健的重視與實行力度 • 安全措施之資源及其有效性 • 風險行為及風險意識 • 對安全規定及措施的認識 • 個人對於職安措施的參與情況 • 安全作業態度及同事間之相互影響 • 安全意識的交流及推廣
6.	How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?	你如何解決管理層，監管部門及操作人員在安全問題態度上的分歧。
Optional questions:		
7.	How do you assess the safety performance of the RMAA works?	你如何評估 RMAA 領域的安全狀況？
8.	Do you assess the safety performance of the RMAA works differently from the new works?	在評估 RMAA 領域安全狀況時，你是否採用與新建工程領域不同的評估方法。
9.	Please think of an RMAA project which has 'outstanding' safety performance and one 'ordinary' project. What are the key features/ characteristics to distinguish them in terms of safety performance?	請給安全狀況'出色'及'一般'的建築工程各舉一個實例。你認爲區分這兩個工程安全狀況的主要標準是什麼？

APPENDIX 2:APPENDED VERSION OF ONLINE DELPHI SURVEY

Online Delphi Survey

Q1. Your Name: ___________________

Q2. Causes of RMAA accidents To what extent do you think the followings are important causes of RMAA accidents? *Please indicate your opinions by clicking on the appropriate boxes.*		1 = Not important at all 2 = Somewhat important 3= Moderately important 4 = Very important 5 = Extremely important				
1.	Poor safety conscientiousness of RMAA workers.	1	2	3	4	5
2.	RMAA workers underestimate potential risks when performing small tasks for a short period.	1	2	3	4	5
3.	Inadequate safety supervision.	1	2	3	4	5
4.	Low safety awareness of small/medium-sized contractors on RMAA works.	1	2	3	4	5
5.	Low safety awareness of flat owners/tenants on RMAA works.	1	2	3	4	5
6.	Inadequate site safety planning and hazard assessment.	1	2	3	4	5
7.	Inadequate regulatory control and monitoring system.	1	2	3	4	5
8.	Poor housekeeping and congested working environment.	1	2	3	4	5
9.	Insufficient safety training of RMAA workers for handling multiple tasks.	1	2	3	4	5
10.	Hurry to finish the work.	1	2	3	4	5
11.	Lowest bid tendering method without pricing for safety items.	1	2	3	4	5
12.	Personal protective equipment not used, incorrectly used, or not provided.	1	2	3	4	5

Q3. Difficulties in implementing safety practices in the RMAA sector To what extent do you think the followings are important difficulties in implementing safety practices in the RMAA sector? *Please indicate your opinions by clicking on the appropriate boxes.*		1 = Not important at all 2 = Somewhat important 3 = Moderately important 4 = Very important 5 = Extremely important				
1.	Difficult to change the mindset of RMAA workers.	1	2	3	4	5
2.	Difficult to conduct safety supervision due to scattered locations.	1	2	3	4	5
3.	Limited safety resources for RMAA projects undertaken by small/medium-sized contractors.	1	2	3	4	5
4.	Difficult to standardize the operational procedures of RMAA works due to ad hoc site problems.	1	2	3	4	5
5.	Shortage of time to deal with safety issues.	1	2	3	4	5
6.	High turnover rate of RMAA workers.	1	2	3	4	5
7.	Small scale and short duration of RMAA projects.	1	2	3	4	5
8.	Influx of illegal workers.	1	2	3	4	5
9.	Difficult to control self-employed workers.	1	2	3	4	5

Q4. Suggestions for improving safety performance of RMAA sector To what extent do you think the followings are important suggestions for improving safety performance of RMAA sector? *Please indicate your opinions by clicking on the appropriate boxes.*		1 = Not important at all 2 = Somewhat important 3 = Moderately important 4 = Very important 5 = Extremely important				
1.	Strengthen site monitoring and safety supervision.	1	2	3	4	5
2.	Review legislative control.	1	2	3	4	5
3.	Have a mandatory licensing system for the RMAA workers.	1	2	3	4	5
4.	Provide relevant safety training for the specific trades of RMAA works.	1	2	3	4	5
5.	Nurture a good safety culture in the company.	1	2	3	4	5
6.	Select the RMAA subcontractors with good track records of safety performance.	1	2	3	4	5
7.	Design for safety of RMAA works.	1	2	3	4	5
8.	Implement award and penalty scheme.	1	2	3	4	5
9.	Create clear safe working procedures and guidance for the RMAA workers.	1	2	3	4	5
10.	Improve site tidiness and housekeeping.	1	2	3	4	5
11.	Raise safety awareness of the RMAA workers.	1	2	3	4	5
12.	Provide safety promotion and education towards the RMAA sector.	1	2	3	4	5
13.	Implement the pay for safety scheme of RMAA works.	1	2	3	4	5
14.	Implement technological innovations for better safety.	1	2	3	4	5
15.	Provide sufficient safety equipment for the RMAA workers (e.g. personal protective equipment (PPE)).	1	2	3	4	5

Q5. Characteristics of RMAA projects with outstanding safety performance To what extent do you think the followings are important characteristics of RMAA projects with outstanding safety performance? *Please indicate your opinions by clicking on the appropriate boxes.*		1 = Not important at all 2 = Somewhat important 3 = Moderately important 4 = Very important 5 = Extremely important				
1.	Low accident rate.	1	2	3	4	5
2.	Few number of summons from the Labor Department.	1	2	3	4	5
3.	Few non-compliance items in company weekly reports.	1	2	3	4	5
4.	Availability of safety resources (e.g. PPE).	1	2	3	4	5
5.	Proactive safety supervisor to enforce safety.	1	2	3	4	5
6.	Concern safety of the public as well as the workers.	1	2	3	4	5
7.	Good housekeeping.	1	2	3	4	5
8.	Learn from previous accidents and come up with innovative safety measures.	1	2	3	4	5
9.	Strong safety commitment of client.	1	2	3	4	5
10.	Strong safety commitment of RMAA contractor.	1	2	3	4	5

~ The End. Thank you for your participation! ~

APPENDIX 3: QUESTIONNAIRE

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

DEPARTMENT OF BUILDING & REAL ESTATE
建築及房地產學系
INTERNATIONAL • COLLABORATIVE • CONSTRUCTION

Questionnaire

Instruction: Please answer this questionnaire with reference to an RMAA project you have been involved.

Section A: Personal Particulars

Please answer this section by ticking the most appropriate boxes.

1. Your working level: □ Frontline worker □ Clerical staff □ Supervisor □ Manager

2. Your work trade: □ Laborer □ Plumber □ Bamboo scaffolder □ Plasterer
□ Concretor □ Metal worker □ Joiner □ Bar bender & fixer
□ Building services/ E&M worker □ Demolition worker
□ Painter & decorator □ Plant & equipment operator
□ Carpenter (formworker) □ Others _________
□ Construction/Mechanical plant mechanic or fitter

3. Your age: □ 20 or below □ 21-30 □ 31-40 □ 41-50 □ 51-60 □ 61 or above

4. Your gender: □ Male □ Female

5. Your marital status: □ Single □ Married

6. Number of family members supported by you (excluding yourself): □ None □ 1-2 □ 3-4 □ 5-6 □ 7 or more

7. Your education level: □ Below primary □ Primary □ Secondary □ Certificate/ Diploma □ Degree or higher

8. Your direct employer: □ Client □ Main Contractor □ Subcontractor □ Others ___________

9. Length of service with the current company: □ < 1 yr □ 1-5 yrs □ 6-10 yrs □ 11-15 yrs □ > 15 yrs

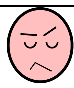
10. Working experience in the construction industry: □ < 5 yrs □ 6-10 yrs □ 11-15 yrs □ 16-20 yrs □ >20 yrs

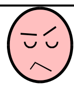
11. Safety training you received: □ No Green Card □ Green Card □ Trade specific safety training
□ Silver Card
□ Others ________________ (You may tick more than 1 box, if applicable)

12. A habit of smoking (at least 1 cigarette per day in the last 12 months): □ I don't smoke
□ I smoke, but not at work
□ I smoke even at work (including lunch time & break)

13. A habit of alcohol consumption (drink at least 3 times per week): □ I don't drink
□ I drink, but not at work
□ I drink even at work (including lunch time & break)

Section B: Safety Climate of RMAA Works (Adopted from the "Safety Climate Index (SCI) in the Construction Industry" of Occupational Safety and Health Council.)

Please circle the appropriate number to show your level of agreement with each of the following statements.	 *Strongly Disagree*	*Disagree*	*Neither Agree nor Disagree*	*Agree*	 *Strongly Agree*
1. Productivity is usually seen as more important than health and safety by the company	*1*	*2*	*3*	*4*	*5*
2. People can always get the equipment which is needed to work according to the health and safety procedures	*1*	*2*	*3*	*4*	*5*
3. I fully understand the health and safety risks associated with the work for which I am responsible	*1*	*2*	*3*	*4*	*5*
4. Some health and safety rules or procedures do not reflect how the job is now done	*1*	*2*	*3*	*4*	*5*
5. I feel involved in the development and review of health and safety procedures or conduct risk assessment	*1*	*2*	*3*	*4*	*5*
6. People here always work safely even when they are not being supervised	*1*	*2*	*3*	*4*	*5*
7. Suggestions to improve health and safety are seldom acted upon	*1*	*2*	*3*	*4*	*5*
8. The company really cares about the health and safety of the people who work here	*1*	*2*	*3*	*4*	*5*
9. Most of the job-specific safety trainings I received are effective	*1*	*2*	*3*	*4*	*5*
10. People are just unlucky when they suffer from an accident	*1*	*2*	*3*	*4*	*5*
11. Some health and safety rules or procedures are difficult to follow	*1*	*2*	*3*	*4*	*5*
12. People here always wear their personal protective equipment (e.g. eye protectors, masks, ear protectors, etc.) when they are supposed to	*1*	*2*	*3*	*4*	*5*
13. All the people who work in my team are fully committed to health and safety	*1*	*2*	*3*	*4*	*5*
14. Little is done to prevent accidents until someone gets injured	*1*	*2*	*3*	*4*	*5*
15. The company encourages suggestions on how to improve health and safety	*1*	*2*	*3*	*4*	*5*
16. There is good preparedness for emergency here	*1*	*2*	*3*	*4*	*5*
17. Sometimes it is necessary to take risks to get the job done	*1*	*2*	*3*	*4*	*5*
18. I know that if I follow the safety rules or procedures, I will not get hurt	*1*	*2*	*3*	*4*	*5*
19. I am clear about what my responsibilities are for health and safety	*1*	*2*	*3*	*4*	*5*
20. Some of the workforces pay little attention to health and safety	*1*	*2*	*3*	*4*	*5*

Please circle the appropriate number to show your level of agreement with each of the following statements.	 Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	 Strongly Agree
21. There are good communications here between management and workers about health and safety issues	1	2	3	4	5
22. There are always enough people available to get the job done according to the health and safety procedures	1	2	3	4	5
23. Health and safety procedures are much too stringent in relation to the risks	1	2	3	4	5
24. Sufficient resources are available for health and safety here	1	2	3	4	5
25. It is important for me to work safely if I want to keep the respect of others in my team	1	2	3	4	5
26. Work health and safety is not my concern	1	2	3	4	5
27. Time pressures for completing jobs are reasonable	1	2	3	4	5
28. Safety inspection here is helpful to improve the health and safety of workers	1	2	3	4	5
29. Some jobs here are difficult to do safely	1	2	3	4	5
30. Accidents which happened here are always reported	1	2	3	4	5
31. My workmates would react strongly against people who break health and safety procedures	1	2	3	4	5
32. Not all the health and safety rules or procedures are strictly followed here	1	2	3	4	5
33. My immediate boss often talks to me about health and safety matters on site	1	2	3	4	5
34. Staff are praised for working safely	1	2	3	4	5
35. Supervisors sometimes turn a blind eye to people who are not observing the health and safety procedures	1	2	3	4	5
36. The risk controls do not get in the way of doing my job	1	2	3	4	5
37. Accident investigations are mainly used to identify who should be blamed	1	2	3	4	5
38. I think management here does enough to follow up recommendations from safety inspection and accident investigation reports	1	2	3	4	5

Section C: Measures of Safety Performance

Please answer this section by circling the most appropriate numbers.

1. Number of accidents and occupational injuries in the **last 12 months** (1 = Never; 2 = 1 time; 3 = 2-3 times; 4 = 4-5 times; 5 = Over 5 times)					
a) How many times have you exposed to a near miss incident of any kind at work?	1	2	3	4	5
b) How many times have you suffered from an accident/ injury of any kind at work, but did NOT require absence from work?	1	2	3	4	5
c) How many times have you suffered from an accident/ injury, which require absence from work NOT exceeding 3 consecutive days?	1	2	3	4	5
d) How many times have you suffered from an accident/ injuries, which require absence from work exceeding 3 consecutive days?	1	2	3	4	5

2. Safety Participation (1 = Never; 2 = Yearly; 3 = Monthly; 4 = Weekly; 5 = Daily)					
a) How frequent do you put in extra effort to improve safety of the workplace (e.g. reminding coworkers about safety procedures at work)?	1	2	3	4	5
b) How frequent do you voluntarily carry out tasks or activities that help to improve workplace safety (e.g. attending safety meeting, receiving safety training)?	1	2	3	4	5

3. Safety Compliance

Please circle on a scale of 0–100% the percentage of time:

a) You follow all of the safety procedures for the jobs that you perform.

0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

b) Your coworkers follow all of the safety procedures for the jobs that they perform.

0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

Occupational Safety and Health Council (OSHC)'s permission to allow the research team to adopt the "Safety Climate Index (SCI) in the Construction Industry" in Section B of this study is gratefully acknowledged.

End of the questionnaire. Thank you for your contribution!

Please return as soon as possible by post using prepaid envelope to Ms Carol Hon, Dept. of Building & Real Estate, The Hong Kong Polytechnic University; by fax at 2764 5131; or by email to carol.hon

THE HONG KONG POLYTECHNIC UNIVERSITY 香港理工大學

DEPARTMENT OF BUILDING & REAL ESTATE 建築及房地產學系

INTERNATIONAL • COLLABORATIVE • CONSTRUCTION

問卷

指引: 請按照一個您曾參與的維修、保養、小型改建及加建工程回答此問卷。

A 部分: 受訪者資料 (請在合適的選項前"√"。)

1. 公司職位: □工人 □ 文員 □ 管工 □ 管理層

2. 工種: □ 雜工 □ 水喉工 □ 竹棚工 □ 泥水工 □ 木工（釘板工） □ 混凝土(石矢)工 □ 金屬工 □ 裝修木工 □ 紮鐵工 □ 機械設備操作員 □ 屋宇設備工人 □ 拆卸工 □ 油漆及裝飾工 □ 建築機械維修工 □ 其他 __________

3. 年齡: □ 20 或以下 □ 21-30 □ 31-40 □ 41-50 □ 51-60 □ 61 或以上

4. 性別: □ 男 □ 女

5. 婚姻狀況: □ 單身 □ 已婚

6. 需要供養的家庭成員數（不包括自己): □ 無 □ 1-2 □ 3-4 □ 5-6 □ 7 或以上

7. 教育程度: □ 小學以下 □ 小學 □ 中學 □ 證書或文憑 □ 大學或以上

8. 您的直接雇主: □ 業主 □ 主承建商 □ 分判商 □ 其他 _______________

9. 於當前所屬公司之就職時間: □ < 1 年 □ 1-5 年 □ 6-10 年 □ 11-15 年 □ > 15 年

10. 從事建築業之工作經驗: □ < 5 年 □ 6-10 年 □ 11-15 年 □ 16-20 年 □ >20 年

11. 曾接受之安全培訓: □ 無綠卡 □ 綠卡 □ 特定工種安全培訓 □ 銀卡 □ 其他 _______________ (可選多項)

12. 吸煙習慣（過去 12 個月每日最少食一支煙): □ 我不吸煙 □ 我只在非工作時間吸煙 □ 我在工作時間也吸煙（包括午餐和休息時間）

13. 飲酒習慣（每週最少飲酒三次): □ 我不飲酒 □ 我只在非工作時間飲酒 □ 我在工作時間也飲酒（包括午餐和休息時間）

B 部分: RMAA 工程之安全氣候 （引用職業安全健康局之建造業安全氣候指數）

按照閣下對以下每個項目的意見，在其右方圈出適當的同意程度。	 極不同意	不同意	沒有意見	同意	 非常同意
1. 公司通常認為工程進度比安全更重要	1	2	3	4	5
2. 工友可以隨時拿到安全程序上所註明需要使用的工具	1	2	3	4	5
3. 我完全瞭解自已工作上的風險	1	2	3	4	5
4. 有些安全守則或程序現在已過時了	1	2	3	4	5
5. 公司於進行風險評估或制定及修改安全程序時，曾讓我們參與或徵求過我們的意見	1	2	3	4	5
6. 就算管工不在場，這裏的工友都會安全地工作	1	2	3	4	5
7. 這裏很少實行工友提出的安全改善建議	1	2	3	4	5
8. 公司是真正關心這裏工友的安全	1	2	3	4	5
9. 有關我工作的安全訓練是有用的	1	2	3	4	5
10. 工友是因為「唔好彩」才受傷的	1	2	3	4	5
11. 有些安全守則或程序很難遵守	1	2	3	4	5
12. 當有需要時，工友會佩戴個人防護裝備(例如：眼罩、口罩、耳塞等)	1	2	3	4	5
13. 同組人員都完全地承擔安全上的責任	1	2	3	4	5
14. 除非有人受傷，否則這裡很少執行防止意外的措施	1	2	3	4	5
15. 公司鼓勵我們提出安全改善的建議	1	2	3	4	5
16. 這裏有充分的準備以應付緊急情況	1	2	3	4	5
17. 有時需要冒險才可以完成工作	1	2	3	4	5
18. 我只要遵守安全守則或程序，便不會受傷	1	2	3	4	5
19. 我清楚自己的安全職責	1	2	3	4	5
20. 有些工友不太注重安全	1	2	3	4	5
21. 這裏的管理層和工友就有關安全的問題有良好溝通	1	2	3	4	5
22. 為了確保安全，這裏的工作經常有安排足夠人手	1	2	3	4	5
23. 相對於風險的程度，安全程序是過於嚴謹了	1	2	3	4	5
24. 公司有提供足夠的資源來做好安全	1	2	3	4	5

按照閣下對以下每個項目的意見，在其右方圈出適當的同意程度。	極不同意	不同意	沒有意見	同意	非常同意
25. 施工要安全，才可以得到同組工友的認同	1	2	3	4	5
26. 工作安全與健康不是我的事	1	2	3	4	5
27. 我被給予合理的時限去完成工作	1	2	3	4	5
28. 這裏的安全巡查可以幫助改善工友的工作安全及健康	1	2	3	4	5
29. 這裏有些工作很難安全地進行	1	2	3	4	5
30. 這裏發生的意外都有向上級報告	1	2	3	4	5
31. 這裏的同事很不喜歡違反安全程序的工友	1	2	3	4	5
32. 這裏有些安全守則或程序沒有被嚴格遵守	1	2	3	4	5
33. 我的直屬上司經常同我談論地盤的安全事項	1	2	3	4	5
34. 工友會因安全工作而被讚賞	1	2	3	4	5
35. 管工有時對不遵守安全程序的工友會「隻眼開，隻眼閉」	1	2	3	4	5
36. 風險控制措施沒有阻礙我的工作	1	2	3	4	5
37. 意外調查的主要目的是找出哪位工友需要負責任	1	2	3	4	5
38. 我想這裏的管理層已有效地跟進安全檢查或意外調查報告所提出的改善措施	1	2	3	4	5

C 部分: 安全狀況 (請於下列問題右方圈出合適的選項。)

1. **過去 12 個月內**安全事故及工傷數目 (1 = 無; 2 = 1 次; 3 = 2-3 次; 4 = 4-5 次; 5 = 超過 5 次)					
a) 在工作中，您有多少次險些遭遇安全事故或工傷?	1	2	3	4	5
b) 在工作中，您有多少次遭遇安全事故或工傷，但傷勢輕微無須請假?	1	2	3	4	5
c) 在工作中，您有多少次遭遇安全事故或工傷，需請假但不超過三天?	1	2	3	4	5
d) 在工作中，您有多少次遭遇安全事故，需請假超過三天?	1	2	3	4	5

2. 職安參與情況 (1 = 無; 2 = 每年; 3 = 每月; 4 = 每週; 5= 每天)					
a) 請描述在改善工作場所安全方面，您付出額外努力的頻繁程度 (例如: 在工作中提醒工友安全程序):	1	2	3	4	5
b) 請描述在改善工作場所安全方面，您自願參與相關活動的頻繁程度 (例如: 參加安全會議，接受安全培訓):	1	2	3	4	5

3. 職安遵守情況																				
a) 於0–100%間, 您有多少百分比的時間在工作中遵守所有的安全程序?																				
0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
b) 於0–100%間, 您的工友有多少百分比的時間在工作中遵守所有的安全程序?																				
0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

經香港職業安全健康局許可，是次問卷得以於B部分採用建造業安全氣候指數(SCI)，特此表示衷心感謝。

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APPENDIX 4: RESEARCH INTERIVEW REPORTS

Research Interview Report A

Interviewee: Interviewee A (Director of Company A)
Date: 16/12/2008
Time: 4:30p.m.-5:30p.m.

1. Background information

Company A expedites one-off RMAA projects instead of term-contract. It is because the company perceives term contract to be risky, unit rate is not realistic and the company doesn't have the experience on this type of work. Examples of their works, include design and build of shop front, RMAA projects of The Link Management Ltd. RMAA works have higher profitability than new works when comparing costs per square meter.

Private sector RMAA works have higher accident rate because the placement of clerk of works and other supervisory staff all depends on the contract sum. Safety initiatives of the project are market driven. For public sector RMAA works, supervision does not decrease. Safety awareness and supervision is better in the government works.

2. What are the major causes of accidents in the RMAA sector?

Mentality of RMAA workers. They do not perceive RMMA works as construction work. Although risk is the same, they tend to underestimate it. They have less safety awareness for RMAA works. In new works, they know very well that they have to wear safety helmets because they are within the area of construction site. However, in an occupied area, such as a theatre, they may not have the awareness to wear safety helmets. Actually, the theatre has high headroom, working at height is also dangerous. For alteration and addition works, they involve more demolition, workers are more aware for their safety because demolition is regarded as dangerous. The Buildings Department also poses strict control on demolition. When there is high risk, workers have higher safety awareness and fewer accidents.

RMAA contractors are, mainly, small/medium-sized companies. Safety awareness of the management, not only the workers, is not strong. Safety management levels and qualities in such companies are low. As for Company A, its safety management system is attached to its parent company's Safety Department. In terms of safety management, the same level is expected for the RMAA works as compared to the new works.

3. Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?

There is standard safety practice and company safety plan to follow. A set of practice notes on working at height is issued by Company A because RMAA works involve lots of working at height. Disciplinary actions will be taken if practice notes are violated, no matter by worker, subcontractor, site agent, foreman, or project manager. There will be verbal warning; written warning and the heaviest disciplinary action would be dismissal.

Other than civil and new project works, all fitting-out renovation (non-new project) works are expedited by Company A. RMAA works are not necessarily to be small in contract sum. For example, Pacific Place Atrium Hotel amounts to HKD 0.4 billion. The Link Management Ltd. has a project in Lok Fu to change and install new escalator which amounts to more than HKD 0.2 billion. Another upcoming renovation project of the Link Management Ltd. in Stanley Bay amounts to more than HKD 0.1 billion.

4. What are the difficulties of implementing safety practices in the RMAA sector?

Workers' safety awareness is low. They promise to do verbally but not in action. Environments of RMAA works affect workers' safety awareness. They do not feel that RMAA work environments are as dangerous as construction sites.

For SMEs, PPE is not enough. Repair and maintenance work for a single building block is usually done by sub-subcontractors. From the boss to the workers, they do not have enough safety awareness. Duration of RMAA works is short and some work scale is very small. Workers do not want to follow the safety practices for such a small scale project and short time work.

In Company A, all workers are registered and have Green Cards. Usually, workers of new builder's works do not cross over to take up RMAA works. RMAA works have occupants' restrictions which new works workers do not like. RMAA workers also do not like to take up new works because RMAA works have less competition and have higher profitability. For E&M works, no matter new works or RMAA works, more or less are the same group of subcontractors.

5. Do you have any suggestions on how to improve the safety performance of the RMAA works?

Supervision. More frequent and more regular inspection. Legislation. It is a passive means. Too much legislation may not be good but still possible. For example, penalty for not wearing safety helmet. At the moment, workers registration is not separated into new works or RMAA works. According to the definition of construction work, all construction activities such as fitting out, maintenance, road work, and port work are included. There is no need to separate workers' registration. Otherwise, the RMAA works may have the impression that RMAA can have less safety awareness.

6. Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):

Safety climate factors	Scores
Commitment and concern for OSH by organization and management	5
Resources for safety and its effectiveness	5
Risk taking behavior and perception of work risk	4 (Supervisor) 3 (Worker)

Perception of safety rules and procedures	4 (Supervisor) 3 (Worker)
Personal involvement in safety and health	4
Safe working attitude and workmates' influence	4
Safety promotion and communication	5

7. How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?

Conflict would be on the level of importance but not on right or wrong. There are workshops to identify safety problems. In-house case sharing. Workshops held on site with supervisors and subcontractors. For example, workshops are held in the site offices of projects with the Link Management Ltd. In the workshop, specific safety issues to pay attention are pinpointed under a particular type of work in a particular circumstance.

8. How do you assess the safety performance of the RMAA works?

Safety performance of RMAA works is rated at 3 to 4 out of 5 scale. Safety record of Company A is very good. However, the Labor Department sometimes finds out safety problems that should not be found in new works. E.g. not wearing safety helmet, not enough kicking plate or work platform. These potential safety problems are more easily to be found in the RMAA works rather than in new works.

For Company A, there is a full time site engineer talking up safety issues in every project. The company keeps one full time safety officer to oversee all the projects at hand. So far there is no RMAA project involves more than 100 workers, project safety officer is not required by law.

9. Do you assess the safety performance of the RMAA works differently from the new works?

The same.

10. Please think of an RMAA project which has ‘outstanding’ safety performance and one ‘ordinary’ project. What are the key features/ characteristics to distinguish them in terms of safety performance?

An example of an outstanding safety performance RMAA project:
A&A works in a shopping arcade to have a leveled slab for retailing. Company A suggested a design change because the original plan was too dangerous. First level of the shopping arcade was a cinema; ground floor level was a market. The original work was to take away the slab and lower the floor level. From the as built drawings, there was double slab but actually not. In that case, the A&A work would be very dangerous and affect business of the shops at the ground level. Suggestions were given to raise the floor and use up the excessive headroom. This project is outstanding because it has considered safety of users (shops and customers in the market) and at the same time achieved the original purpose with ad hoc savings.

Ordinary safety performance RMAA project does not involve any work that affects the existing users. Characteristics that distinguish outstanding from ordinary safety performance RMAA project are: Concern for users (shops in the market and customers), not affect original purpose; and ad hoc saving.

Research Interview Report B

Interviewees: Interviewee B1 (Project Safety Manager, Company B)
Interviewee B2 (Project Manager, Company B)
Date: 19/12/2008 (Fri)
Time: 11:00 a.m.- 12:00 p.m.

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1. Background information

Examples of RMAA works undertaken by the Construction Services Department of Company B include: Renovation of Pacific Place Mall and Alteration to the Hong Kong International Airport. Scale of works would range from HKD 10 million to more than HKD 100 million. For large-scale RMAA works like the Renovation of Pacific Place Mall of Swire Properties, safety-related expenditure has been included in overhead to cover the cost of engineers/foremen required.

2. What do you think are the major causes of accidents in the RMAA sector?

Lack of proper site supervision. RMAA works are usually small in scale and scattered in location. RMAA works usually depend on experience and situation rather than following a standard method statement. For small-scale RMAA works, there may be no consultant supervision at all. There are different types of working environment and types of works involved. For example, concrete components used for new buildings are quite different from old buildings.

For those one-man band RMAA contractors, safety training and PPE are not enough. They do not have the necessary safety helmet and they often use wooden ladder rather than aluminum ladder while working at height.

RMAA works always face the problem of coordination. For example, a qualified electrician intuitively understands that he cannot undertake any tasks without cutting off the electricity supply. However, shops will usually complain when the electricity

supply is cut-off. Because of the lack of coordinators between the electricians and tenants, this task is always conducted at risk.
Simple small-scale RMAA works do not need to inform the Labor Department of their commencement because the duration of such works are often too short.

3. Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?

Our company is primarily involved in large-scale RMAA works rather than small-scale. RMAA works also follows the same safety policy of the company as for new works. Safety officers or supervisors will be assigned on site to conduct pre-work safety briefing towards the workers and risk assessment.

4. What are the difficulties of implementing safety practices in the RMAA sector?

The difficulties are minor works have short duration, rely on subcontractors, not cost effective to have "close" supervision, and work activities change frequently on site. RMAA works involves different levels of risks and work types; however, there are only generic method statements available. Field control Sheet briefing and workface risk assessment are needed. Naturally, workers care for their lives. The company faces a challenge to inform the workers how to do it safely. A qualified electrician knows that it is dangerous to work without cutting off the electricity supply; however, when coming to the RMAA work site he may find that he cannot cut-off the power supply because shops around will complain. Then the company has to decide whether ask him to take a short cut and finish the work in time; or provide mechanism for him to communicate with the safety officer of the company.

Mindset of the workers is also another obstacle. For example, based on the experience and expertise, scaffolders perceive that standing on an inner layer of bamboo scaffolds is rather safe. They may take short cut. For example, workers think of some quick but dangerous ways to transport materials from one place to the other. The company must communicate with them that unsafe practice is not acceptable.

Scattered RMAA works make supervision difficult. For new works, 10 foremen may be assigned to supervise 100 workers on a site. However, the case for RMAA works is not. One foreman may be assigned to supervise an RMAA work site in Causeway Bay and another one in TKO simultaneously. If the number of foremen required increases, it will incur extra money.

Company B will select preferred partners which put safety as their priority. Company B also provides safety training to workers of the subcontractors just as their own direct labor. Direct laborer of Company B, having received sufficient safety training, act as gangers or leaders of their peer workers employed by the subcontractors. When unsafe behaviors are observed, they can supplement supervision by informing the management or stopping those unsafe behaviors immediately. They can be promoted to foremen based on their good track records of performance.

5. Do you have any suggestions on how to improve the safety performance of the RMAA works?

Strengthen work site supervision and standardize work method of individual tasks. Assuming that workers do not take short cut, the company faces the challenge to provide proper communication channels for workers to reflect the potential risks. Management needs to set up a better safety-related communication mechanism. Keep close to the near-miss reports for further safety improvement. Change the mindset of workers towards safety and select subcontractor partners with good safety track records.

Safety is still an industry-wide problem. In order to change unsafe behaviors, we provide sufficient safety training should be provided and a safety mechanism for workers to develop commitment and sense of belonging to company should be set up. For example, promotion, stable workforce and learning opportunities. As stated in the employment contract, award or bonus of HKD 1,000 will be given to the direct laborer if he/she doesn’t have any injuries within 6 months. There are also safety management practices at site level. For each site, Safety Officer or Project Manager will assess the safety performance of different work groups. For the group with the best safety performance, HKD 1,000 will be rewarded in every three months for each person of the winning group and HKD 2,000 for the group leader to have lunch with the whole group. Not limited to the above, other safety incentives are implemented, such as lucky draw. At company level, the best subcontractor award for the year has been set up.

6. Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):

Safety climate factors	**Scores**
Commitment and concern for OSH by organization and management	5
Resources for safety and its effectiveness	3
Risk taking behavior and perception of work risk	4
Perception of safety rules and procedures	4
Personal involvement in safety and health	3
Safe working attitude and workmates' influence	4 (3 or 2 at workers level)
Safety promotion and communication	4

7. How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?

Communicating and coaching to bridge the misalignment, and preferably have mutual discussions to resolve any conflicts or discrepancies before the commencement of site works. The management has responsibility to enforce safety because of the significant consequence.

8. How do you assess the safety performance of the RMAA works?

New works has the number of accidents occurred per 1,000 people to measure safety performance. However, the number of people engaged in the RMAA sector is unknown. To regulate or monitor RMAA safety performance, the government needs to require the RMAA contractors to register. The government should then assess the safety performance of the construction projects undertaken by an RMAA contractor on a yearly basis. Works involving different levels of risks may need to take into consideration. Currently, no proper measurement statistic of safety performance of RMAA works is available.

9. Do you assess the safety performance of the RMAA works differently from the new works?

Assuming there is data available, assessment can be done on the company basis; for example, measure safety performance of a number of projects undertaken by a company within a specific period of time.

10. Please think of an RMAA project which has ‘outstanding’ safety performance and one ‘ordinary’ project. What are the key features/ characteristics to distinguish them in terms of safety performance?

Proper site supervision and safety inspection. These indicate whether the RMAA contractor cares about safety of the workers and the public. Not only look at accident rate but also look at the site set-up, machinery maintenance, PPE and other resources. The government should come up with effective measures to help those small/medium-sized RMAA contractors with good safety conduct to survive.

Research Interview Report C

Interviewees: Interviewee C1 (Managing Director, Company C)
Interviewee C2 (Senior Manager (Compliance), Company C)
Date: 18/02/2009 (Wed)
Time: 2:30 p.m.- 3:30 p.m.

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1. Background information

For RMAA works, Company C undertakes maintenance, fitting out, and some term contracts. For example, term contract of the Housing Authority in Sham Shui Po District.

2. What do you think are the major causes of accidents in the RMAA sector?

Unskillful workers without sufficient safety training join the RMAA sector. RMAA workers in general have the mindset that they are not working in a dangerous construction site. Contractor has supervision difficulty because RMAA works are dispersed in location. For term contract, daily RMAA work activities may spread as widely as some in Kowloon and some in the New Territories, making supervision very difficult. Works Bureau has suggested assigning a supervisor for every ten number of workers. The supervisor gives briefing to the workers at the beginning and at the end of the day respectively; and the supervisor keeps contact with the workers by phone during the day.

As the mandatory workers registration scheme is becoming more mature, it is anticipated that RMAA workers should register under the RMAA category in the future. Self-discipline to work safely is especially important for the RMAA workers because supervision by contractor is difficult. RMAA workers should acquire extra safety training other than the Green Card. Without close safety supervision of the contractor, the RMAA workers need to have a higher standard of safety awareness so that they can be self-monitored.

Legal responsibility rests on the main contractor. It is extended to the subcontractor in some cases but not yet to the worker. May be when there is a well-established system, workers should bear the responsibility if accident is proved to be caused by their negligence.

New works have morning safety briefing but it is not easy to implement in RMAA works. Company C tried to gather small groups of RMAA workers in different locations to have morning briefing sessions. For example, workgroup briefing sessions were held in five different locations in Sham Shui Po. This strategy, however, was not very effective.

The RMAA works, for example in the Housing Authority's project, use the same conditions of contract as the new works. Some of the terms do not fit for the RMAA works. The Construction Workers Registration Authority (CWRA) does not provide registration to RMAA workers. In recent years, the government has reduced resources in safety. In the past, 2% of the contract sum is provided in the contract for safety. Now, the 2% of the contract sum covers safety and environmental protection. Resources for safety have been reduced for about 40%. The conditions of contract should reflect the safety needs of the RMAA works. Because more supervision is needed in the RMAA works, the existing conditions of contract, if used in RMAA works, may need to be revised from assigning a safety supervisor for every 20 workers to every 10 workers.

More specific training should be provided to the RMAA workers because they involve specific hazards that are different from the new works; for example, multiple trade work practices, electricity handling, and etc. For RMAA workers, they may underestimate risks involved and neglect safety because of short duration of the tasks and working in occupied buildings. RMAA works in the private sector do not need to inform the Labor Department about their commencement. General citizens and building owners have little safety awareness. They employ some handy-men around the corner to do small RMAA works without concerning whether they are competent or qualified to do the job. They need to be educated to choose qualified workers to undertake RMAA works.

3. **Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?**

Share resources with the subcontractor. For example, HKD 10 out of HKD 20 received from toolbox talks will be given back to the subcontractor as motivation. The pay for safety scheme should be extended to the subcontractors' level. When accidents occur or receive summons from the Labor Department, there will be a panel enquiry to find out the possible ways of safety improvement, rather than fault finding.

Safety performance is linked to project bonus and safety bonus of the subcontractors and the site team. Safety bonus to the site team is calculated by a formula comprising of accident rate, danger occurrence, safety audit (by third party) and summons of the Labor Department. Safety bonus given to the site team staff is around HKD 1 million a year.

Legal and contractual terms are only minimum requirements. Company C invests more on safety according to the actual needs. For example, 2 safety officers are required by law for every 200 workers. When needed, Company C will assign 2 safety officers when there are only 150 workers. Similarly, assign 5 safety supervisors even when 3 are required by the contract.

Company safety principles are the same for the new works and the RMAA works but there is flexibility upon implementation to make it fit for purpose. Upon commencement of a project, specific safety needs of the project are identified. There is specific project safety plan highlighting physical needs of different hazards and identifying the focal point of safety precautions.

Resident safety officer operationally reports to the project manager and functionally reports to the Senior Management. Project manager and resident safety officer produce a 3-month forecast to identify high hazard activities in detail. After identifying the activities, method statement, risk assessment, and safety precaution measures will be designed, and finally pre-work meeting will be held. In the meeting, the safety officer, the project team and the subcontractors will sit together to make out how the work should be conducted. The work process is monitored during implementation. If the work process is deviated from the plan, the work process will be fine tuned.

Overall accident rate of the company is 11. Accident rate of the RMAA works is 15-16. The most common type of accident is body injury during material handling.

A safety meeting between the director, the general manager, the safety officer and the senior officer is held every three months. Safety bulletins are regularly circulated to all management levels to highlight safety issues.

Develop partnership with the subcontractor to share safety responsibility and profit. Before awarding a contract, the safety department participates in the tender interview with the subcontractors, explaining to them the safety standard required by Company C. Subcontractors can then revise their tender prices. If accident happens, there will be a panel enquiry. The panel will urge the subcontractor to submit improvement plan. If the safety performance in the second quarter is still bad, the subcontractor will be suspended from future tendering.

4. What are the difficulties of implementing safety practices in the RMAA sector?

Refer to answers in question 2.

5. Do you have any suggestions on how to improve the safety performance of the RMAA works?

Establish good safety culture right at the beginning of the project by putting extra resources. For example, in the first three months, a resident safety officer is assigned to the project to assist project manager and another resident safety officer to establish good safety culture.

6. **Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):**

Safety climate factors	**Scores**
a) Commitment and concern for OSH by organization and management	4
b) Resources for safety and its effectiveness	4
c) Risk taking behavior and perception of work risk	4
d) Perception of safety rules and procedures	5
e) Personal involvement in safety and health	4
f) Safe working attitude and workmates' influence	4
g) Safety promotion and communication	5

7. **How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?**

Senior management is very committed to safety. Safety is the first priority. No project manager will argue with the importance of safety.

8. **How do you assess the safety performance of the RMAA works?**

There is a director overseeing all projects and he can take disciplinary action. If safety performance is unsatisfactory, causes of near misses and accidents will be identified and people are to be held responsible. For internal staff, senior management will urge project team to improve. If the situation is still not rectified, a warning will be given. If two warnings have been given, there will be dismissal of the responsible staff.

9. **Do you assess the safety performance of the RMAA works differently from the new works?**

Basically the same. Use 17 elements for safety performance assessment. The first 1-13 elements are the same for the new works and the RMAA works. The 14th element on physical situation is different.

10. Please think of an RMAA project which has 'outstanding' safety performance and one 'ordinary' project. What are the key features/ characteristics to distinguish them in terms of safety performance?

Housekeeping is the first example. Good housekeeping leads to a good project management. Innovation is another. For example, a site team analyzed accident records of the last project, finding that material handling caused injuries. The site team then used small trucks for material handling to avoid similar incidents in the next project. Thirdly, construction method. For example, use system formwork and precasting method rather than traditional formwork and falsework. For demolition works, use hydraulic crusher to grip instead of manual striking.

Research Interview Report D

Interviewees: Interviewee D (Executive Director and General Manager, Company D.)
Date: 6/2/2009 (Fri)
Time: 11:00 a.m.- 12:00 p.m.

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1. Background information

Company D undertakes fitting out, building maintenance, renovation and alteration and addition work. One of the clients is Town Gas. Company D undertook renovation and fitting out work of the restaurants and the cooking centres of Town Gas. Company D is listed as license C contractor of a property management company. Apart from those contractors undertake both the new works and the RMAA works, such as Shui On and Gammon, Company D is considerably big in the RMAA market.

Company D mainly undertakes RMAA works of contract size under HKD 20 million; for example, renovation of an industrial building which amounts to around HKD 8 million. It mainly tenders for projects of Sino Land, Cheung Kwong, Henderson, Hong Yip, and etc. However, it does not tender for repair and maintenance project of a single building and project of unknown property management companies. It works for companies which pay on time. For a single building project, the Owners' Incorporation may not be able to collect enough money from owners to pay for the project. For RMAA works, the client does not give deposit. Consultant certifies work done monthly. Money will then be given in 1 to 3 months' time in arrears.

2. What do you think are the major causes of accidents in the RMAA sector?

For new works, there must be a safety officer in a site with 100 workers. In RMAA works, usually there is no safety officer but safety supervisor. These safety supervisors are usually playing the dual roles of site foremen and project engineers. They may be experienced site staff with qualifications of Bachelor Degree or CITA safety supervisor certificate. Safety officers have better authority to enforce safety on site. This is because their primary responsibility is to enforce safety; and they have to bear legal responsibility if they fail to perform their duty. For safety supervisors of RMAA works, who perform the dual roles of site foremen and project engineers, safety is only one of the duties they need to handle. They may be more focused on the progress of work rather than on safety. Safety supervisors will properly submit safety report to the management but it is unlikely that rectification of unsafe behavior/condition is as immediate as the safety officers in the new works.

Alteration and addition works involve a lot of demolition activities. Workers of the subcontractors may be employed by a piece rate. Time is an essence to them. Without safety supervision, they will not break down the wall piece by piece but let the whole wall collapses quickly by striking at bottom part of the wall. It is dangerous and may cause injury. For small RMAA contractors not on the list of property management companies, they may not have high safety awareness.

3. Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?

There are safety supervisors. Most workers on sites are mainly employed by the subcontractors. Company D mainly plays the role of supervision. Penalty is imposed on individual worker for unsafe behavior. For example, there is a penalty of HKD 100 for smoking on site and a penalty of HKD 500 for not wearing safety harness. (Daily wage of a worker is around HKD 700). Penalty on individual worker is found to be effective for raising workers' safety awareness.

4. What are the difficulties of implementing safety practices in the RMAA sector?

Workers, in general, are not well-educated. Some of them may conduct their works in a convenient but unsafe way, believing that they have the skills to handle the situation. They have Green Cards and some have attended a 32-hour safety course. However, they do not take the safety course seriously and course instructors are lenient to them. Very often, when there is an accident, people are more aware of safety for some time. With passage of time, people begin to forget.

5. Do you have any suggestions on how to improve the safety performance of the RMAA works?

At present, the contracting company bears most responsibility of an accident. However, educating the frontline workers to change their unsafe behaviors is the most important. Suggestion can be suspension of the workers' license and thus not allow them to work on site for a period of time.

6. Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):

Safety climate factors	**Scores**
a) Commitment and concern for OSH by organization and management	5
b) Resources for safety and its effectiveness	3
c) Risk taking behavior and perception of work risk	3
d) Perception of safety rules and procedures	4
e) Personal involvement in safety and health	3
f) Safe working attitude and workmates' influence	4
g) Safety promotion and communication	3

7. How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?

Senior management plays site visits frequently. Site staff members come back to office to have regular meetings once every two weeks. In the meeting, senior management reminds supervisors of safety problems on site. With penalty on individual workers, they are forced to behave safely although they may not be willing to do so. An effective way to enforce safety is frequent site visit by senior management. Company D has been established for more than 10 years, there have been less than 10 non-fatal accidents and zero fatal accident.

8. How do you assess the safety performance of the RMAA works?

As the volume of RMAA works increase, it is anticipated that the number of RMAA accidents will increase. More contractors with varied qualities will join the market and they may not have good safety awareness. Time is money for them to compete for more projects. Inexperienced workers are also employed and they have to undertake activities which they don't have the expertise. New immigrants enter the RMAA market because they think that RMAA works are easy to take up and underestimate the risks involved. All these will lead to an increase in the number of RMAA accidents in the construction industry.

9. Do you assess the safety performance of the RMAA works differently from the new works?

Yes. Unlike the new works, the RMAA works are conducted in occupied buildings. Safety precautions are needed not only for workers but also for existing occupants. When erecting hoarding or fencing, we consider the safety of the existing occupants as well.

10. Please think of an RMAA project which has 'outstanding' safety performance and one 'ordinary' project. What are the key features/ characteristics to distinguish them in terms of safety performance?

An outstanding project can borrow good practices of the new works. For example, put signage beneath a scaffold, penalize unsafe behavior, and avoid platform overload with waste materials. For ordinary project, there was once a school renovation project which involved installation of HVAC air duct in hall ceiling. The worker erected a working platform without fencing. Sometimes non-electricians have to handle temporary electric supply in RMAA works.

Research Interview Report E

Interviewees: Interviewee E (Managing Director, Company E)
Date: 17/12/2008 (Wed)
Time: 2:30 p.m.- 3:30 p.m.

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1. Background information

Company E has 8 to 10 direct labor and foreman. There is also safety officer in charge of safety supervision. It undertakes repair and maintenance works, as well as alteration and addition work at around HKD 10 million.

2. What do you think are the major causes of accidents in the RMAA sector?

There are several reasons. The first cause is carelessness. RMAA workers tend to underestimate the risks involved in the RMAA works. Workers have higher safety awareness in the new works because they expedite the work in a construction site. RMAA workers have lower safety awareness because the working environment is an occupied area but not a construction site.

Safety culture/climate is better in the construction site than in the RMAA works. RMAA workers do not see the importance of safety as equal to that of the new works. Some small RMAA works do not have a site office. Small/medium-sized RMAA contractors are less aware of safety. For projects with contract sum less than HKD 1 million it is not necessary for the contractors to report to the Labor Department.

Safety performance of the RMAA works heavily depends on the supervision of the foreman. Most foremen intuitively know about safety but they need to put effort in reminding the workers about safety. If the foreman enforces close safety supervision and keep reminding the workers to act safely, the safety performance would be better. For example, the project in Wai Lee Building, workers do not always wear safety helmets. For another cladding work project in Wyndham Street (contract sum more than HKD 10 million), there is a safety officer on site and workers are more aware of safety because bamboo scaffolds are erected which resemble a construction site.

In the past, suggestions of the Labor Department that a working platform should be used instead of wooden A ladder is not feasible. Nowadays, better designed products meet the safety requirement of the legislation. Aluminum ladder is now widely available in the market at a reasonable price. Property management companies also have a higher awareness of safety and they play a role in reminding RMAA workers to perform the work safely. When the volume of RMAA works increases, there may be short project duration. RMAA workers try to finish the work quickly and ignore safety, resulting in a higher accident rate.

3. Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?

Fulfill requirements of the legislation. In addition, there are also safety meeting, site safety plan and site risk assessment for individual project but very depend on the site agent. For every 20 workers, there should be a safety supervisor, actually every foremen is qualified to be safety supervisor. Foreman, however, may not be able to fully take up the duties of safety supervisor at the same time. Of course, it would be the best to have a safety officer but this is only feasible for large scale project. Function of the safety officer is to deal with the Labor Department, preparing documents for surveillance; and to safeguard the interest of the company. The cost is huge for the company to have an accident.

Company E has just settled a case which lasted for two years. One worker, after having performed the work for four days, claimed that she fell down from the ladder twisting her waist. The company then underwent a long process of outside court settlement. Life is very important, even a small injury is not tolerable by the society. When workers have safety awareness, they know how to avoid risk.

4. What are the difficulties of implementing safety practices in the RMAA sector?

Execution depends on foremen and site agents. If they are strict on safety supervision, then safety performance would be better. If they are lenient on safety supervision, then safety performance would be worse. However, it is really difficult for them to strike a balance between production and safety. If too strict, production would be hindered. Implementation also depends on scale of project. For small scale job, facilitates and planning for safety are not enough. Management's attitude is important, emphasize on safety or emphasize on production disregarding safety. For subcontractors, there should be penalty of safety violation. The greatest obstacle is the mindset and attitude of workers on safety.

5. Do you have any suggestions on how to improve the safety performance of the RMAA works?

As safety has been promoted in the construction industry for years, most companies have good safety awareness. However, workers may not have the same safety awareness. At present, when accident happened, the employer has to bear the legal liability for not providing a safe working environment. It is suggested that worker has to bear part of the responsibility. In foreign countries, workers respect their job and are proud of their work. They are more aware of their safety. PPE is well-designed and properly kept. Accident rate is much lower. Fast and convenient culture of Chinese is also a reason to explain unsafe behavior. In China, however, the situation may not be worse than in Hong Kong because labor is cheap and abundant in China, and project duration is not as tight as in Hong Kong. Accident rate may be lower.

6. Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):

Safety climate factors	**Scores**
a) Commitment and concern for OSH by organization and management	4
b) Resources for safety and its effectiveness	4
c) Risk taking behavior and perception of work risk	3
d) Perception of safety rules and procedures	4
e) Personal involvement in safety and health	4
f) Safe working attitude and workmates' influence	3
g) Safety promotion and communication	3

7. How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?

It depends on attitude of the boss, whether the boss emphasizes safety or production.

8. How do you assess the safety performance of the RMAA works?

Safety performance of RMAA works is ok and is improving. In general safety awareness has been improving. Accident rate may not truly reflect the situation because in the past, injuries may not be reported but now people are more aware of safety and report to the Labor Department, making the figure higher. For example, in the past, the company had a project which was painting work of a 6-storey building. The company is convicted because of a worker climbing the scaffold without wearing a safety belt. At that time, no one looks at safety regulation and ordinance. The mindset was not to bother with safety and thought that it was ok to follow the traditional practice. Now, everyone accepts that safety is important. More and more foremen and supervisors have qualification of safety officer.

9. Do you assess the safety performance of the RMAA works differently from the new works?

Depend on scale of project. Safety needs money resources. For RMAA works with small contract sum, we need to decide how much we can spend on safety. For new works, safety requirements are more rigid. There are well-established guidelines and standard requirements but this is not the case for RMAA works. In general, activities in RMAA works involve relatively lower risks than new works, for example, plunge a nail itself involves low risk. However, RMAA works still have risks that one should not overlook.

Sometimes if the RMAA project is small, say HKD 50, 000 to fix a signboard and the insurance costs HKD 3,900. The contractor may take risk not to buy insurance if the property management company overlooks. Company E has bought an open policy of insurance whenever there is a new project, fax the information to the insurance co. and the procedures are done.

10. Please think of an RMAA project which has 'outstanding' safety performance and one 'ordinary' project. What are the key features/ characteristics to distinguish them in terms of safety performance?

Availability of resources on safety is the key factor. With adequate resources, there can be safety officer to supervise and buy more proper PPE.

Another factor is company safety culture. Work with a subcontractor which has better safety awareness. Supervisor and foreman need to be proactive on safety.

Research Interview Report F

Interviewees: Interviewee F (General Manager, Company F)
Date: 17/2/2009 (Tue)
Time: 2:15 p.m.- 3:15 p.m.

1. Background information

Company F undertakes large scale repair, maintenance, alteration and addition work. For example, repair and maintenance of 2-3 residential building blocks in Shatin managed by Hong Yip, shopping mall alteration and addition work in Maritime Square (Tsing Yi) and Telford. Other projects include alteration and addition work of the City University and the Chinese University of Hong Kong. Typical project contract sum is around HKD 10 million. Duration of projects ranges from several months to more than a year.

2. What do you think are the major causes of accidents in the RMAA sector?

RMAA works are usually not undertaken by big companies. There is no well-established regulatory system. Some RMAA main contractors directly sublet the whole project to subcontractors. RMAA works are difficult for main contractor to supervise because RMAA works are undertaken in different locations. For a small RMAA work, only a few workers are allocated to the work without much supervision. For new works, there is a safety officer for every 100 workers. However, a small RMAA project is not required to have a safety officer. Safety supervisors in RMAA works are at the same time site foremen or site agents. There is no full-time staff designated for safety.

High turnover of RMAA workers poses difficulty of providing safety training to them. One trade of RMAA workers may work in a project for only a few days and then another trade of workers comes in. Safety awareness of RMAA workers is not enough. RMAA workers in general underestimate the risk and have the perception that it is not worthy of taking safety measures because tasks are small and last for only a short duration, e.g. repair water leakage outside the building for 2 hours. Sometimes, some activities involved in RMAA works are so minor that the effort put on observing safety would be greater than the amount of work to be done. For convenience, they may take risk not to take necessary safety action. It is also difficult for the government to monitor as well. The Labor Department may check once a week. It is difficult for the Labor Department to monitor RMAA works that finish in a few days' time or in several hours. Workers' low safety awareness, undertaking small tasks in short duration, less safety supervision and difficulty of providing safety training to RMAA workers are key causes of accidents.

3. Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?

Company F is a subsidiary of a big contracting company. Its parent company has a Safety Department of 20 to 30 people. Two to three are assigned to look after Company F's projects. There is regular site visit and training. Safety walk will be done in large scale project. Senior management is very committed to safety. Safety officer directly reports to the head office. Adverse safety appraisal will be done on subcontractors with safety problems. This assessment affects subcontractor's chance of being selected in future tendering. Motivation is also given at site level. Safety Department evaluates site safety performance every year. Award with money will be given to site manager, site team and subcontractor with good safety performance.

4. What are the difficulties of implementing safety practices in the RMAA sector?

Contracting company is usually very willing to do safety. Safety equipment only costs small amount of money. The difficulty lies on tackling safety problems arising from workers' inadequate safety awareness and self-motivation because safety supervision in RMAA works is particularly difficult. Unlike new works, RMAA workers in general have less safety awareness. For new works, project scales are big and have more resources on safety supervision. For small RMAA works, there is no site office. RMAA workers are remote to stringent safety requirements of new works.

SMEs undertaking RMAA works have limited resources on safety. Although personal safety equipment is provided, no one checks whether the worker has used or not.

5. **Do you have any suggestions on how to improve the safety performance of the RMAA works?**

Self-motivation to perform safety comes from training. CITA (now CICTA) can provide tailor made training course to RMAA workers on safety. For example, other than Green Card, RMAA workers need extra safety training to be qualified to work in RMAA sector. The most dangerous activity of RMAA works is external repair work in an occupied building. RMAA workers may neglect safety when performing external repair work because of convenience sake and short duration of the task. Sometimes, safety equipment is provided to RMAA workers but there is nobody or inadequate manpower to check whether they have really used the safety equipments properly. Education and training is especially important to raise RMAA workers' safety awareness. Mandatory workers' registration assesses workers' skill on a particular trade but has nothing to do with safety. Create a trade category for RMAA works in the mandatory workers' registration may address the issue. Safety problems of RMAA works are different from new works. RMAA workers need safety training to perform RMAA works. For example, it is more difficult to erect a truss out scaffold with steel brackets than scaffold in new works.

Pay for safety scheme may not be effective in RMAA works. For new works, considerable amount of money spent on safety goes to hoarding etc. Contractor may want to save money by not erecting proper hoarding. For RMAA works, amount of money spent on safety goes to personal equipment such as safety belt which is reusable for three years. Contractor is unlikely to save money by not providing safety belts to workers. For RMAA works, safety problems often arise from inadequate safety awareness of the workers and lack of self-motivation rather than from the contractor cutting safety measures to save money. To increase worker's safety awareness and self-motivation, training and more supervision are needed.

6. Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):

Safety climate factors	**Scores**
a) Commitment and concern for OSH by organization and management	4
b) Resources for safety and its effectiveness	3
c) Risk taking behavior and perception of work risk	3
d) Perception of safety rules and procedures	4
e) Personal involvement in safety and health	2
f) Safe working attitude and workmates' influence	3
g) Safety promotion and communication	4

7. How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?

Senior management does not encourage the site team to skip safety for production. Safety officer or supervisor should have anticipated necessary safety precaution and made good safety planning. Money spent on safety equipment and setting (e.g. illumination) is not a problem, instead communication is of utmost importance. Site team should produce the method statement when the project starts. Company F has standard safety planning/practices for A&A work, renovation work of commercial buildings and residential buildings respectively. Subcontractors have to follow.

8. How do you assess the safety performance of the RMAA works?

Number of summons from the Labor Department, safety audit report, items of non-compliance (weekly). Company F has set an internal safety target to meet for benchmarking purpose, for example, less than certain no. of accident per 1000 workers.

9. Do you assess safety performance of RMAA works differently from new works?

Same as new works. No other good methods of measurement.

10. Please think of an RMAA project which has 'outstanding' safety performance and one 'ordinary' project. What are the key features/ characteristics to distinguish them in terms of safety performance?

Not only rely on whether have summons from the Labor Department but rely on weekly report indicating items of non-compliance. If only a few items of non-compliance, safety performance is outstanding.

Research Interview Report G

Interviewees: Interviewee G (Senior Project Manager, Company G)

Date: 14/02/2009 (Sat)

Time: 9:00 a.m.- 10:00 a.m.

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1. Background information

80% of minor A&A works undertaken by Company G are offices and the remaining 20% are shopping malls. Project sum ranges from HKD 10,000 to HKD 2 million. For example, there was a project which renovated an industrial building to data centre. Contract sum was HKD 6 million. Company G also undertakes repair and maintenance term-contract of government departments, such as fire services of EMSD.

2. What do you think are the major causes of accidents in the RMAA sector?

When working at height, workers may not aware of the surrounding environment. Accidents may occur when coming down from a wooden ladder. Workers usually use wooden ladders which may have been used for many years and have structural problems. Workers do not like to use aluminum ladders because they are not as high as wooden ladders and would easily be stolen.

Poor housekeeping causes cutting injuries. As compared to new works, RMAA works have limited space for storage. RMAA works are conducted in occupied buildings and many trades of workers conduct their works in a limited space at the same time. For example, RMAA work in a building of 20, 000 sq fit, more than 100 workers are working at the same time. RMAA works have less stringent safety requirements.

Safety of RMAA works heavily depends on the requirement of client and main contractor. For large alteration and addition work, for example, Atrium Hotel, the developer and the main contractor require wearing safety helmets and having assigned a safety officer to the project. Unless required by the client or the main contractor, RMAA workers normally do not need to wear safety helmets, reflective vests, and safety boots. Small RMAA works are of short duration, usually last for several days to less than a month. RMAA workers have less safety awareness as they perceive that they are doing something very small. They are then careless not to perform the work safely especially when they are in hurry to meet deadline.

3. Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?

Post safety notices. Safety supervisors monitor RMAA workers. Provide safety helmets and goggles. There is strict safety requirement that a fire extinguisher must be placed nearby when RMAA workers conduct welding work. Smoking is also strictly prohibited. If an RMAA worker is found smoking on site, Company G will penalize the subcontractor by filing them a debit note. Subcontractor will then penalize the worker. If safety is not strictly enforced on site, workers will repeat their unsafe behavior.

Company G's direct labor is mainly engaged in testing and commissioning. Their work nature has fewer chances of accident as compared to the workers of the subcontractors. Safety award is given to the subcontractor with the best safety performance throughout the year. Company G has safety officer who oversees all the projects. To guarantee safety training quality, Company G provides free half-day safety training to the workers of the subcontractors to renew their Green Cards every three years.

4. What are the difficulties of implementing safety practices in the RMAA sector?

Working environment of the RMAA works. For example, stuff and waste materials put next to the working platform endanger the workers.

Bad influence by others. Many trades of work are conducted at the same time. Some workers may not behave safely and they set a bad example. Those behave safely would follow their workmates.

RMAA works are of short duration. There is no safety officer but safety supervisor. Safety supervisor is actually the foreman.

All workers have Green Card. They should have adequate knowledge of safety. The problem would be how to educate them to perform safety persistently. Workers tend to have low self-requirement for safety. They are only concerned for their job opportunities.

Safety of RMAA works depends on whether the main contractor assigns safety supervisor to strictly enforce safety. They may underestimate the risk of RMAA works because RMAA works are conducted within a building. In an enclosed building, the working environment is very stuffy, deterring workers from wearing safety helmets.

5. Do you have any suggestions on how to improve the safety performance of the RMAA works?

More safety supervision. Check PPE. Provide mask to workers. Everyone (e.g. engineer) can take the role as safety supervisor, not only safety supervisor, reminding others to perform safely. Penalize workers and subcontractors if they are found to have violated safety requirements.

6. Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):

Safety climate factors	**Scores**
a) Commitment and concern for OSH by organization and management	5
b) Resources for safety and its effectiveness	5

c) Risk taking behavior and perception of work risk	5
d) Perception of safety rules and procedures	5
e) Personal involvement in safety and health	5
f) Safe working attitude and workmates' influence	5
g) Safety promotion and communication	5

7. **How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level and the operation level?**

Operative Supportive Department is responsible for safety. If there are discrepancies, relevant departments will have meeting together. Top management is very committed to safety. Director checks safety on site every month.

8. **How do you assess the safety performance of the RMAA works?**

From information of the Labor Department and company assessment information. In general, safety performance of RMAA works is ok.

9. **Do you assess the safety performance of the RMAA works differently from the new works?**

No.

10. **Please think of an RMAA project which has 'outstanding' safety performance and one 'ordinary' project. What are the key features/ characteristics to distinguish them in terms of safety performance?**

For example, the client of the Hong Kong Island East No. 1 project requires workers to wear safety helmets. The main contractor is willing to improve safety and health by improving ventilation. The client and the main contractor's requirements on safety distinguish an outstanding project from an ordinary project.

Research Interview Report H

Interviewees: Interviewee H (Director, Company H)

Date: 19/12/2008 (Fri)

Time: 4:00 p.m.- 5:00 p.m.

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1. Background information

Company H has about 12 permanent staff, including project manager, foreman, quantity surveyor, designer and coordinator, and etc. It has an 'A' license and is a listed contractor of Hong Yip, MTRC, Cheung Kwong, New World Development. New works and RMAA works account for about 50% of the company's business respectively.

Project value ranges from several thousand Hong Kong dollars, such as fixing several electrical sockets; to ten million Hong Kong dollars. For example, lobby renovation of MTRC head office in Fo Tan, Sai Kung Market, covered walkway in Fung Tak Estate, design and build for lobby of Chun Fat Industrial Building in Hung Hom (HKD 1 million).

2. What do you think are the major causes of accidents in the RMAA sector?

Lack of proper supervision. Many RMAA works are small in scale. Duration of these projects is usually very short. Work activities involve many different trades; in this case, work is not done by a specialist of a particular trade. For example, a painter may also be requested to drill a hole on the work which he is not familiar with and this increases the chance of accident. Surveillances of the Labor Department for RMAA works are fewer than new works.

3. Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?

Company H has its own direct labor. For a large project, there is a supervisor on site to ensure safety. For a very small project, safety largely depends on the self-regulation of workers. The supervisor only visits the site infrequently.

Safety is the first priority of the senior management because life is valuable. Although safety is not explicitly priced in the tender, a site supervisor is normally assigned to a RMAA project and a safety officer will be assigned to a new works project. Sometimes, a safety officer is assigned to an RMAA project because of the client's requirement. For example, the renovation work of MTRC head office lobby in Fo Tan (approximately HKD 5 million) required Company H to put a safety officer in the project. Safety equipment such as safety helmet, safety harness, spectacles and even team uniform are provided to the workers to improve safety. All workers must have Green Card.

4. What are the difficulties of implementing safety practices in the RMAA sector?

New works are easier to control because the geographical location is concentrated. Unlike new works, RMAA works spread widely. For RMAA works, the Owners' Incorporation also plays a role to uphold safety. Safety statistics of the RMAA works of Company H is much better than that of the new works. Roughly, the ratio of number of times being convicted by the Labor Department for the new works and the RMAA works are 90:10. A project with a contract sum greater than HKD 1 million needs to report to the government. However, there is less surveillance of the Labor Department on RMAA works. Supervision is basically relied on the company. Company H being a registered contactor cares about safety of its workers and the public.

5. **Do you have any suggestions on how to improve the safety performance of the RMAA works?**

Pay for safety scheme is difficult to take effect in the RMAA works. Private clients and developers often ask for a discount of contract sum after having awarded the contract, not to mention set aside money for safety. Pay for safety scheme may work better for public/quasi-government clients, such as the ASD and the MTRC.

6. **Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):**

Safety climate factors	**Scores**
a) Commitment and concern for OSH by organization and management	3
b) Resources for safety and its effectiveness	3
c) Risk taking behavior and perception of work risk	3
d) Perception of safety rules and procedures	3
e) Personal involvement in safety and health	3
f) Safe working attitude and workmates' influence	3
g) Safety promotion and communication	3

7. **How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?**

First of all, carefully select subcontractors and workers with good safety performance track records. Work with a few partnered subcontractors and workers. Safety awareness of workers is now stronger. Sometimes, Company H employs workers well-trained for safety from the big construction companies, such as Hsin Chong or Gammon.

8. How do you assess the safety performance of the RMAA works?

Visit the site and check the safety of the scaffolding, the safety fencing, the safety well, the hoarding, and etc. Rather than launching a safety campaign, Company H rewards good safety performance of the workers by bonus.

9. Do you assess the safety performance of the RMAA works differently from the new works?

N/A

10. Please think of an RMAA project which has 'outstanding' safety performance and one 'ordinary' project. What are the key features/ characteristics to distinguish them in terms of safety performance?

N/A

Research Interview Report I

Interviewees: Interviewee I (Vice President of Project Development, Company I)
Date: 19/12/2008 (Fri)
Time: 4:00 p.m.- 5:00 p.m.

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1. Background information

N/A

2. What do you think are the major causes of accidents in the RMAA sector?

Unknown installation of existing M&E, illegal work done in the past without proper records, poor conditions of the pipework and installation under pressurized condition, concrete spalling and rusty metalwork installation. Fire installation malfunction.

3. Can you describe the safety practices of your company or the predominant safety practices in the RMAA sector?

Congested working environment and short time frame for the work. Inadequate preparation time to understand the work scope before start. Limited knowledge of the existing condition.

4. What are the difficulties of implementing safety practices in the RMAA sector?

Congested working environment and short time frame for the work. Inadequate preparation time to understand the work scope before start. Limited knowledge of the existing condition.

5. **Do you have any suggestions on how to improve the safety performance of the RMAA works?**

Provide sufficient lead time prior to work commencement, more detailed site investigation to the existing building and the work environment. Supervisors on site must be fully experienced and be able to observe any potential safety hazards. Structural engineer should check the existing structure if alteration to structure is involved.

6. **Please assess the safety climate of the RMAA works of your company with the following dimensions (1 = least satisfactory; 5 = most satisfactory):**

Safety climate factors	**Scores**
a) Commitment and concern for OSH by organization and management	N/A
b) Resources for safety and its effectiveness	N/A
c) Risk taking behavior and perception of work risk	N/A
d) Perception of safety rules and procedures	N/A
e) Personal involvement in safety and health	N/A
f) Safe working attitude and workmates' influence	N/A
g) Safety promotion and communication	N/A

7. **How would you solve the conflict if there are discrepancies towards safety attitude from the management level, the supervisory level, and the operation level?**

No compromise and the contractor's staff would be asked to leave the job site if no improvement is seen after warning.

8. **How do you assess the safety performance of the RMAA works?**

N/A

9. **Do you assess the safety performance of the RMAA works differently from the new works?**

N/A

10. **Please think of an RMAA project which has 'outstanding' safety performance and one 'ordinary' project. What are the key features/ characteristics to distinguish them in terms of safety performance?**

N/A

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