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Effectiveness of Policies and Difficulties in Improving Safety Performance of Repair, Maintenance, Minor Alteration, and Addition Works in Hong Kong

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Abstract

The Repair, Maintenance, Minor Alteration, and Addition (RMAA) sector accounted for 50% of all fatalities in the Hong Kong construction industry in 2016. In spite of the different policies launched in recent years, the casualty rate has held constant, raising doubts over the effectiveness of current measures for improving safety performance in RMAA works. Against this backdrop, this study is aimed at identifying and evaluating the 1) effectiveness of prevailing policies; 2) potential difficulties in improving safety performance in Hong Kong; and 3) best ways to improve the safety performance of RMAA. Following an extensive literature review, 15 existing policies and 10 common difficulties are established. Based on the solicitation of experts having rich experience in the area of RMAA, the analytical hierarchy process (AHP) is employed to prioritize the identified policies and Likert-scale-based survey to establish the relative importance of the identified difficulties. The 'award of encouragement' is found to be the most effective policy category, whereas the 'lack of self-regulation of workers' appeared as the most significant hurdle. In order to further validate the results obtained from the study, a number of interviews using highly experienced professionals were conducted. It is recommended that strategies such as registration of RMAA workers, intensifying monitoring and enforcement, and provision of loan services for safety can overcome the difficulties. The hindsight provided from this study can pave the way for the concerned parties towards improving the occupational safety and health (OSH) of such projects by improving the effective policies concurrently with improving the status quo of critical hampering.

Keywords: Safety performance, RMAA, Industrial Fatalities, Construction safety

Introduction

Hong Kong has earned quite a reputation as a 'concrete jungle'. The number of private buildings alone has reached over 40 thousand in the metropolis (HAD, 2017). Since buildings degrade with time, refurbishment and maintenance constitute an important part of the building life cycle (Murthy et al., 2002). In Hong Kong, nearly 21,000 buildings have exceeded the age of 30 years (URA, 2017) and more than 60% of the private buildings have been constructed at least twenty years ago (Rating and Valuation Department 2009). It is estimated that the number of aged buildings will reach 40,000 in 2046, leading to a growing demand for maintenance services. In addition to affecting the cityscape, such buildings also pose safety threats to occupiers and pedestrians.

The renovations of existing buildings contribute to reduced operation costs, minimized environmental impact, increased building resiliency, improved living standards, and most importantly, enhance the safety of the users. The Hong Kong government has implemented a number of schemes in recent years to ameliorate the safety of aging buildings such as Operation Building Bright (OBB), Mandatory Window Inspection Scheme (MWIS), and Mandatory Building Inspection Scheme (MBIS). Under these schemes, thousands of private buildings exceeding certain age-limit are selected by the Building Department (BD) for regular statutory inspections and renovations. Besides government schemes, sustainability initiatives, which advocates for cost-retrofitting of existing buildings instead of constructing new ones, are likely to drive the future growth of the repair, maintenance, alteration, and Addition (RMAA) industry in Hong Kong (Hon & Chan, 2013a; 2013b; Chan & Hon, 2016).

RMAA is a huge money-making sector in Hong Kong. For instance, in 2007, RMAA projects were responsible for more than half of the construction market (Wong et al., 2009) and reached one-third of the total construction market in 2016 (HKEX, 2017). Due to the RMAA industry boom, the RMAA workforce has increased manifolds, which, in turn, has elevated the magnitude of workplace incidents in this sector. However, the poor safety performance of RMAA works has been reflected to be a grave concern for public authorities over the past decade. According to the Census and Statistics Department and Labor Department (2017), the number of fatal accidents in RMAA works has fluctuated between 4 to 12 in the past ten years

(please see Figure 1). Despite the downward trend in the overall industrial fatality rate from 2013 in Hong Kong, the high-risk RMAA industry still recorded a noticeable number of fatalities in the construction industry. Accidents occur due to different reasons and can cause serious injury or even death. For instance, Figure 2, developed by tracking accidents through newspapers such as Sing Tao Daily (*https://std.stheadline.com/*) and Ming Pao Daily News (*https://news.mingpao.com/*), showed 5 serious accidents related to RMAA works in 2017. This included a fall from a 3-meter ladder, a fall from the third floor, a fall from an "illegal work platform", gas exploding due to accidentally destroying an LPH pipe, and a fall from a 3-meter Working Platform. These accidents demonstrate the challenges to occupational safety in the RMAA industry.

[Insert Figure 1]

[Insert Figure 2]

Many researchers have explored the area of improving safety performance for new construction projects (Mohandes and Zhang 2019; Zhang and Mohandes 2020). For example, Mahalingam and Levitt (2007) discussed the role of education and enforcement on the improvement of safety performance in global construction projects. Similarly, Ling et al. (2009) developed and analyzed 41 approaches that can be used in minimizing construction fatalities. Gangwar and Goodrum (2005) investigated the effectiveness of two incentive-based safety measures, namely: injury-based incentives and behavior-based incentives. However, the safety of RMAA works is different from that of new works owing to the nature of the activities involved. In spite of huge research on construction safety, studies on reviewing the employed policies and tackling the safety problems of RMAA works are still limited. For instance, Anumba et al. (2004) carried out research on safety improvement for renovation projects involving demolition and structural strengthening. Hon et al. (2011), Hon et al (2014), and Hon and Liu (2016) delved into the safety climate associated with RMAA-related activities and came up with some tangible solutions to improve the safety culture within the respective firms. In another study undertaken by Chan et al. (2008), a scrupulous investigation into the

causes and rates of fall-related injuries in relation to RMAA activities was carried out using observed data over a five-year period.

Lack of RMAA consideration not only leads to incurring costs to the respective stakeholders (resulting from the expenses to be spent on insurance or the delays caused to the projects) but also the safety and health of workers involved in the related tasks are significantly debilitated. Despite this importance, limited and scattered studies have focused on the viable strategies to improve the status quo and the difficulties existing in the related process in one holistic frame. Thus, with a view to improving the OSH of related operations, there is a need to undertake strong studies on this fecund ground. Considering the mentioned necessity for conducting more insightful research, this study aims to meticulously realize the following objectives: (1) evaluate the effectiveness of the current policies and (2) identify the difficulties in implementing safety measures that hinder further safety performance improvement. The insights provided from this study are intended to benefit the concerned safety professionals dealing with the RMAA-related activities, leading to improving the OSH of such operations for the involved crew members.

Background

According to the Labour Department (2005) in Hong Kong, RMAA works can be defined as the works that involve minor alterations, repairs, maintenance, interior decoration of existing buildings as well as construction projects in the New Territory (one of three geographical territories of Hong Kong) for village-type houses. Similarly, the report on the Quarterly Survey of Construction Output (2011) indicates that RMAA works refer to 'the construction works at locations other than sites, including general trades and special trades.' General trades comprise repair, maintenance, decoration, and construction work at minor work locations while special trades comprise the installation and maintenance of carpentry, electrical equipment, ventilation, gas and water fitting, etc.

More often than not, RMAA projects are being carried out by SMEs, whereas SMEs are referred to as any manufacturing/non-manufacturing company in Hong Kong that employs fewer than 100 and 50 people, respectively (Hong Kong Government, 2012). The RMAA sector in Hong Kong is on the rising side as the

Department of Minor Works Control System has registered more than 14,300 contractors for RMAA projects by 2012 (Hon & Chan, 2013b). The sector is expected to grow further as the issue of sustainability and aging buildings is of great importance to the government.

RMAA works have distinctive characteristics in terms of scale, duration, location, participants involved, and work nature, which creates some safety issues for the workers involved in the related activities. Reviewing the government's effort in recent years, particularly, the number of industrial fatalities in RMAA works has not been falling significantly. This 'not-so-significant fall' can be attributed to some inadequacies in the government's regulations for construction safety. For instance, RMAA work that has six weeks' duration for its completion is not required to be monitored by the Commissioner for Labour (Cap 59I Regulations in Factories and Industrial Undertakings Ordinance). Therefore, the safety aspect of this kind of project will not be given optimum attention by the contractors. Furthermore, only one safety supervisor is required to monitor an RMAA work that might comprise 100 or more workers on a construction site, while only one safety supervisor is required on new construction sites when the total number of workers is 20 or more (Cap 59Z Regulations in Factories and Industrial Undertakings Ordinance). This shows the deficiency in the construction safety supervision regulations under the RMAA works. It is noteworthy that the number of fatal accidents in RMAA works occupies a considerable proportion of the total fatal accidents of the construction industry i.e. 44% of the overall fatal accidents between 2013 and 2016 (Labor Department 2017). Reflected by the accident case information issued by the Labour Department (2017), the fatality cases in the RMAA sector between 2011 and 2016 identified the "fall of a person from a height" to be the most frequent cause and "electrocuting" to be the second most frequent cause. In the same period, 71% of RMAA fatal accidents were related to falling from height and 17% were related to electrocution. The current policies and difficulties in implementing RMAA works are given in Table 1. The explanation is given in the coming sections.

[Insert Table 1]

Current Policies on Improving Safety Performance in RMAA Works

The major policies are as follows.

Enforcement of Regulations

- Inspection by Labour Department (LD)

-Factories and Industrial Undertakings Ordinance (F&IUO), Chapter 59: Both new construction and RMAA works are under this regulation.

-Occupational Safety and Health Ordinance (OSHO), Chapter 509: This ordinance applies to both industrial & non-industrial workplaces where the employers or occupiers should satisfy basic safety requirements in order to guarantee the safety of the worker.

- Inspection by Authorized Persons from Construction Industry Council (CIC)

-Construction Workers Registration Ordinance (CWRO), Chapter 583: This ordinance is responsible for the registration of every construction worker in Hong Kong.

- Inspection by Building Department (BD)

-Minor Works Control System (MWCS) & Building (Minor Works) Regulation, Chapter123N: This regulation is responsible for the registration of minor work contractors in Hong Kong.

Safety Initiatives for Construction Projects

- Safety Management System (SMS)

SMS, a system to provide safety management in an enterprise, has been widely promoted in construction projects by the government. SMS is intended to prevent improper behavior that possibly leads to accidents, detect and report potential problems, and report and handle the accidents properly. Bottani et al (2009) found that the companies that adopt SMS exhibit higher safety performance than the companies that do not give attention to the SMS (Bottani et al., 2009).

- Pay for Safety Scheme (PFSS)

The government introduced the PFSS for government construction contracts in 1996. The objective of PFSS is to develop a fair and equitable environment for the contracting parties under a construction

project to manage site safety matters, thus enhancing the standard of the safety performance of contractors.

Award for encouragement

- Construction Industry Safety Award Scheme

In 1999, the construction industry safety award scheme was launched by the labor department, aiming at raising the safety and health awareness of construction practitioners, thus, fostering a positive safety culture, and recognizing the good occupational safety and health performances of awardees. It is hoped that such award may motivate the construction workers to give more attention to the safety practices while working (Hon et al., 2011). While the research conducted by Hon et al., (2011) discussed 15 strategies to improve current policies relating to safety in the RMAA industry, it should be noted that the researchers did not discuss the various difficulties in implementing the safety measures in the RMAA industry.

- Considerate Contractors Site Award Scheme

Development Bureau and CIC have been jointly organizing the Considerate Contractors Site Award Scheme since 2011 for fostering a considerate attitude and encouraging good site safety, health, and environmental practices in both Public Works and non-Public Works sites.

- OSH Star Enterprise - RMAA Safety Accreditation Scheme

LD and OSHC jointly launched the "OSH Star Enterprise Safety Accreditation Scheme" for the RMAA industry in 2012. This includes the provision of safety training, subsidies for the purchase of fall arresting devices, and safety audits for the applied small-and-medium-sized RMAA contractors.

Financial Subsidies for Safety Items

- SME Sponsorship Scheme for Fall Arresting Equipment for Renovation & Maintenance Work and Construction Industry

This scheme, launched by LD and OSHC in 2005, aims to enhance the safety of work at height by

149 providing subsidies for RMAA SMEs to purchase safety equipment such as torque wrench, transportable
150 temporary anchor devices, full-body harness, metal detector, and truss-out-metal bracket.

151 • Mobile Working Platform Sponsorship Scheme for SMEs & Light-Duty Working Platform
152 Sponsorship Scheme for SMEs

153 The two schemes were launched by LD and OSHC in 2013 and 2015, respectively, to enhance the use of
154 safer equipment when working at a great height by providing some financial subsidies to the contractors in
155 order to purchase safer equipment.

156 *Safety Training and Promotion*

157 • RMAA Safety Training Courses

158 Launched by OSHHC, RMAA Ambassador Training help establish the safety culture among RMAA
159 employees and promote the proper safety procedures.

160 • RMAA Safety Publicity and Promotion

161 LD, OSHC, and CIC have put great efforts into the safety promotion regarding RMAA work to raise
162 public awareness of the risks associated with RMAA works. The publicity activities include TV/ Radio
163 broadcasts, display of publicity banners and posters, publications, open seminars, and exhibitions for
164 members of the public.

165 ***Difficulties of Implementing Safety Measures in RMAA Works***

166 *Worker*

167 • Difficult to Change the Mindset owing to the Nature of Work

168 RMAA works are often carried out in enclosed building environments that are deemed as non-dangerous
169 workplaces relative to the construction site, resulting in the low self-motivation of workers to perform
170 safely (Enshassi et al., 2014). Thus, the RMAA workers might tend to have a carefree attitude to safety
171 and might not take the safety of RMAA works seriously as they would do for new works (Chaw, 2011).

172 ➢ Shortage of Time

173 Under the tight schedule and the pressure from their supervisor, workers would attempt to finish the

works in a rushed manner and disregard safety. Another possible reason for this is that the workers tend to rush the job and finish before their allocated break time so that they do not end up working when they are expected to be off (Ling et al., 2009). The full implementation of the safety practices tends to be more difficult in such an environment (Hon et al., 2010).

While the research conducted by Ling et al. (2009) discussed strategies to reduce fatal accidents and some recommendations on how to improve the current policies to mitigate fatality rate in the construction industry, the research did not focus on RMAA works in specific and also left other safety aspects apart from fatality.

- Insufficient Experience and Training

As there is no clear and definite scope for RMAA works, it is a tough task to provide effective safety training for the itinerant workforce (Hon et al., 2011). Out of the 23 stated factors affecting safety performance in RMAA works by Enshassi et al. (2014) in their research, insufficient experience and training of RMAA workers were ranked second. This means that special attention needs to be given to this area so as to protect the lives of construction workers. Furthermore, the study carried out by Enshassi et al. (2014) only focused on the difficulties in implementing safety measures in RMAA projects and did not discuss the current policies in implementing RMAA work safety. It should also be noted that the current construction safety scheme does not contain appropriate training in the area of RMAA works.

- Unfavorable Work Condition

Since workers of different trades need to work in a congested area at the same time, the space for material storage and waste accommodation is also limited which leads to poor tidiness on-site (Enshassi et al., 2014). For instance, the workers in a poorly ventilated area might be forced to remove their personal protective equipment, which leads to compromising the safety practices.

Contractor

- Limited Resources on Safety

Small-medium-sized subcontracting companies with relatively poor safety consciousness are commonly

employed for RMAA works (Hon et al, 2010). Because of their small scale of business, safety resources such as personal protection equipment (PPE) and safety training may be rare (Chan & Hon, 2016).

- Difficulty in Safety Supervision;

RMAA work spots are widely dispersed in an occupied building, precipitating inadequate site safety planning and difficult safety supervision (Hon & Chan, 2013a). Importantly, RMAA workplace safety is typically supervised by experienced technicians in the field of construction technology but less knowledgeable in the field of construction safety (Hon & Chan, 2013b).

- Unpredictable and Ad Hoc Site Problems;

Safety management is usually hindered by ad hoc site problems and the varied working environment of RMAA projects (Hon et al., 2011). Contractors do not care much for safety planning and risk assessment before the work commencement for unforeseen events, failing to minimize the on-site risks for workers (Hon, 2012).

Client

- Low Safety Awareness;

Hon et al. (2010) indicated that clients may employ a contractor/worker without verifying his qualification or may employ the RMAA contractor with the lowest bid without considering its past safety performance. These poor employment practices have a domino effect on on-site safety and pose a risk in operations. Research conducted by Enshassi et al. (2014) and Tam et al., (2012) showed that low safety awareness is a critical factor that contributes to low safety performance in the RMAA industry and ranked this factor first among other relating factors in their research.

Research Methodology

This research adopted a mixed-methodology-based approach (Figure 3). Following background study, a quantitative approach in the form of a questionnaire survey and sequential qualitative research in the form of a structured interview were employed for further research. The effectiveness of the existing policies for

RMAA work safety and the difficulties in implementing safety practices in RMAA works figured out from the literature review were investigated through the AHP-based (1-9) and Likert scale-based (1-5 with 1 being strongly disagree to 5 being strongly agree) questions in the questionnaire, respectively. The data extracted from AHP-based questions were statistically analyzed by Analytic Hierarchy Process (AHP). Whereas, the data extracted from Likert scale-based questions were analyzed using Cronbach's Alpha Reliability Test, Mean Score Ranking Technique, and Kendall's Concordance Analysis.

[Insert Figure 3]

Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is an effective tool for prioritizing the alternatives (Chung et al. 2020; Rong et al. 2020; Zhang et al. 2021), which was applied to determine the relative weights of the effectiveness of different types of employed policies. A hierarchical structure was established to conduct a questionnaire survey (Figure 4). AHP was adopted for the questionnaire survey because of its effectiveness in sorting elements into smaller groups for easier analysis (Yeung et al., 2020; Tsz Wai et al. 2021). AHP works on the principle of pairwise comparison based on the fact that human has the capacity to attach more importance to a factor over the other alternative. Furthermore, Darko et al. (2019) and Zhang et al. (2021) stated that a sample size that is greater than 30 could be considered sufficient for AHP analysis. AHP method can be summarized in three steps (Pachemska et al., 2014): (i) the development of a hierarchical model in solving a decision problem, consists of three levels, namely, the objective level (goal), the criteria & sub-criteria level, and the alternative level (ii) pairwise comparison of the structural elements using Saaty' scale, and (iii) calculation of weightage of each structural element and the overall priorities of the alternatives. In this study, the elements in the 5 criteria were pairwise compared with each alternative and sequenced for preference. The principle was simple i.e. the higher the weight, the more effective the policy is. The priority weights of alternatives were calculated based on the pairwise comparison matrix using the formula:

$$Aw = \lambda maxw, \quad = (w1, w2, \dots, wn)T \qquad (1)$$

Where A = n-dimensional comparison matrix.
λmax= the maximum eigenvalue of A .
w= the eigenvector of λmax.

The consistency index (C.I.) and consistency ratio (C.R.) were computed for checking the individual consistency and rationality of the judgmental data collected from respondents, respectively. C.R. was expected to be <0.1 (Chung et al. 2020). The equations for computing C.I. and C.R. are shown below:

$$C.I = \frac{(\lambda max - n)}{n-1} \quad (2)$$

Where λ_{max}= the maximum eigenvalue
n= the dimension of the matrix.

$$C.R = \frac{C.I}{R.I} \quad (3)$$

Where R.I.= the random consistency index which is related to the dimension of the matrix**.**

[Insert Figure 4]

Cronbach's Alpha Reliability Test

Reliability refers to the repeatability/reproducibility of survey results and affects the trustworthiness and validity of the research. As an index of reliability, Cronbach's alpha is calculated for measuring the internal consistency amongst the responses on a set of measurement scales. The acceptable value of alpha should be greater than 0.70 (Tariq and Zhang 2020). This test was adopted to test the reliability of the measurement scale of the difficulties in improving safety performance in RMAA works.

Mean Score ranking and agreement analysis (Kendall's Coefficient of Concordance)

The mean score ranking technique (Tariq and Zhang 2020; Lee et al. 2020) was used to compute the effectiveness of common difficulties from the Likert scale-based questionnaire data. Besides, Kendall's coefficient of concordance (W) was used to measure the agreement of different groups of experts (i.e. consultants' group, supervisory personnel group, and frontline staff group) on the rankings of difficulties (Tariq and Zhang 2020; Yevu et al. 2021). The value of W can vary from 0 to 1, with 0 implying total disagreement and 1 implying total agreement. Thus, the larger the value of W, the higher level of consensus between the respondents inside each group. The equation for computing W is shown below.

$$W = \sum_{i=0}^{n} (\bar{R}i - \bar{R}) / (\frac{n(n-1)}{12}) \quad (4)$$

where n = Number of difficulties being ranked.

$\bar{Ri}$= Average of the ranks assigned to the difficulties.

$\bar{R}$ =Average of the ranks assigned across all difficulties.

Data Collection

Questionnaire Survey

A questionnaire survey was undertaken for collecting views of different stakeholders regarding the effectiveness of existing strategies for RMAA safety improvement and the difficulties in implementing safety practices at the site level. A convenient sampling technique was adopted to invite RMAA workers, RMAA contractors listed under the Register of Minor Works Contractors of BD, safety officers or supervisors, RMAA scholars, and government safety officers to participate in this questionnaire survey through face to face and online survey forms. The two survey methods were adopted to facilitate the questionnaire survey process. Online survey forms sent to participants through email were used to solicit the views of different stakeholders as it is cost-effective, convenient for respondents, and enables large amounts of data from participants to be collected with less error (Regmi et al., 2016). Despite the advantages of the online survey, the response rate from participants was low and hence was complemented using face-to-face questionnaire delivery. This approach was costly and time-consuming, however, the general response rate was satisfactory. Judging from the diverse nature of stakeholders involved in RMAA works, the participants were categorized into three groups; (i) consultants; (ii) Supervisory personnel; (iii) Frontline Staffs. All these three categories of workers perform different roles regarding construction site safety and as such their responses to the effectiveness of existing strategies for RMAA safety improvement and difficulties in implementing safety practices at the site represented diversity and thus better representation of the overall situation. The questionnaire survey consisted of five sections:

1)The first section collected the general information of respondents, e.g. company, position, years of experience in RMAA works, etc.

300 2)The second section survey collected the respondents' experience of accidents related to RMAA works,
301 e.g. details of accidents.

302 3)The third and fourth section survey acquired views of respondents on how they think the pairwise
303 effectiveness of the existing strategies and the significance of common difficulties of improving safety
304 performance for RMAA works on AHP and Likert scales, respectively.

305 4)The fifth section survey requested recommendations on further improving the safety performance for
306 RMAA works from respondents.

307 A total of 100 research questionnaires were distributed by hand or emailed to the three target groups. 46
308 valid questionnaires were received, out of which 11, 19, 16 respondents were from the group of consultants,
309 supervisory personnel, and frontline staff, respectively. The overall response rate was 46%. Although a
310 sample size of 100 was comparatively small, a 46% response rate was deemed satisfactory for AHP analysis
311 (Darko et al. 2019; Ott and Longnecker 2015; Mcclave and Sincich 2006). The small sample size can be
312 ascribed to the fact that only experienced professional was targeted, which is evident from the fact that
313 about 83% of the respondents had more than ten years of working experience in the RMAA industry and
314 only less than one-fifth (11%) of respondents had less than 4 years' experience in RMAA works (Figure 5).
315 Moreover, Ott and Longnecker (2015) and Mcclave and Sincich (2006) asserted that results from the survey
316 could be generalized if the sample size exceeds 30 as the central limit theorem is held valid, given that the
317 respondents constitute a good mix of diversified individuals in the same field, thus ensuring the reliability
318 of the responses to represent the whole population of RMAA workers in Hong Kong. Furthermore, small
319 sample sizes are not uncommon in construction/architectural management-related research. For instance,
320 32 responses in Ameyaw and Chan (2015) and 32 respondents in (Zhao et al. 2016).

321 [Insert Figure 5]

322 ***Structured Interviews***

323 As a valuable and effective data collecting method, interview gathers in-depth information through verbal

conversations with people to provide detailed insights on the research focus area (Gill et al., 2008). Because of the limited a priori information on RMAA works, employing such a qualitative approach can effectively reveal the reality and show the opinions of participants at the same time. Structured interviews were carried out with predetermined respondents who had extensive experience in RMAA works as a follow-up to the questionnaires for further eliciting their responses (McNamara, 1999). The desirability and deficiency of existing measures implemented, the potential difficulties on enhancing safety in RMAA works from their real practice as well as the possible corresponding solutions were investigated from the interviews. Their valuable opinions can possibly contribute to the further improvement of safety performance in RMAA works. The background of the interviewees is tabulated in Table 2.

[Insert Table 2]

Results

Experience of RMAA related Accidents

Among the 46 survey participants, as mentioned previously, respondents with more than ten years of working experience in the RMAA industry accounted for a large proportion (83%) while less than a fifth (11%) of the respondents had less than 4 years of experience in RMAA business. This means that the participants were knowledgeable in the field of this study and were able to provide important insight into the safety-related RMAA industry. Besides, 27 (58%) of the respondents witnessed accidents during their work in recent years. Among these 27 respondents, 24 (89%) and 22 (81%) believed that contractors and workers were responsible for the accidents that occurred, respectively. For instance, most of these responses categorized the lack of worker self-regulation, low level of safety awareness among workers and contractors, and the limited resources contractors placed on safety as major causes of RMAA-related accidents. On the other hand, a small proportion of respondents considered that the government department and client/developer were responsible for the incidents as they didn't enforce the necessary regulations.

The Effectiveness of Existing Policies for RMAA Work Safety

AHP was used to evaluate the effectiveness of existing policies for RMAA work safety. All the responses were valid as CR was less than 0.1. This showed the consistency of the pairwise comparison matrix and the reliability of the survey data. The weights of policies were analyzed through the pairwise comparison matrix of the five policy categories i.e. "Enforcement of Regulations", "Different Safety Initiatives for Construction Projects", "Award for Encouragement", "Financial Subsidies for Safety Items", and "Safety Training and Promotion". The weights of each policy category were multiplied by the relative weight of the sub-policies to calculate the overall weight of sub-policies. The weights and rankings of policies and sub-policies are shown in Table 3.

[Insert Table 3]

According to the weight of the policies, the top two effective policy categories for RMAA work safety were "Award for Encouragement" (0.3044) and "Financial Subsidies for Safety Items" (0.2723) while the relatively ineffective policy categories were "Different Safety Initiatives for Construction Projects" (0.0989) and "Enforcement of Regulations" (0.1608). The result revealed that incentivizing contractors and workers is a more effective approach to improve safety performance in RMAA works. This result is in line with the discovery of Hinze and Harrison (1981) as they pointed out that safety award campaigns for contractors and workers are the most effective tools for promoting safety awareness, thereby mitigating site casualties. Although "Enforcement of Regulations" was not among the top two ineffective policies found by Hon et al. (2011) in their study, however, the policy – "Enforcement of Regulations" was one of the top five ineffective policies. Technology innovation was found as the most ineffective strategy by Hon et al. (2011), probably because RMAA work usually relies on handicraft rather than advanced technological equipment. According to the weights of the sub-policies, the survey participants regarded the "Construction Industry Safety Award Scheme" (0.1247) as the most effective policy, followed by "SME Sponsorship Scheme for Fall Arresting Equipment for RMAA Industry" (0.1116) and "OSH Star Enterprise - RMAA Safety Accreditation Scheme" (0.0949). A possible interpretation for the first ranked sub-policy is that the

provision of monetary incentives and support are the key drivers for contractors and workers to perform safely. With the prizes including a trophy and a cash coupon for safe sites and safe workers, "Construction Industry Safety Award Scheme" not only can motivate the workers to take practicable safety measures, but also can recognize an individual for their efforts toward safety yearly (Legislative Council, 2016). The respondents believed that this monetary incentive scheme could improve safety performance in the RMAA industry effectively. However, the monetary incentive should not be too large so that the construction workers will be tempted not to report any safety lapses or injury to the appropriate stakeholders in order not to be at a disadvantage in receiving the monetary incentive.

"SME Sponsorship Scheme for Fall Arresting Equipment for RMAA Industry", which was ranked in the second position, provides both hardware i.e. a maximum amount of $9500 sponsorship, and software i.e. the safety courses to promote the use of proper safety equipment when working at height (Labour Department, 2015). The results in the pairwise comparison matrix of "financial subsidies for safety items" implied that the effectiveness of such policies depends on the amount of sponsorship i.e. the larger amount of subsidy the more effective the policy is.

"OSH Star Enterprise-RMAA Safety Accreditation Scheme", the only award scheme solely for SME RMAA contractors, was ranked the third most effective policy. Under this scheme, the applicants are not only provided safety training, financial subsidies, and safety audits for their company, but also the alternative prizes of discount on premiums if the specific requirements are fulfilled (OSHC, 2012b).

Besides, it is surprising that "RMAA Safety Courses" (0.0605) was ranked lower at 8th, maybe due to the voluntary nature of participation. Wilkins (2011) asserted that non-mandatory safety training is unengaging for workers to participate. These courses are only provided to a small proportion of RMAA workers, thus reducing its effectiveness in improving RMAA safety performance. "Promotional Activities" (0.0222) have the lowest order, showing that safety publicity activities e.g. TV/ Radio broadcasts could not raise the safety awareness of RMAA workers effectively. The less effective policies also included "Inspection by Authorized Persons from CIC" (0.0289), "Safe Working Guideline by LD" (0.0334), "Pay for Safety

Scheme in RMAA contract" (0.0430), and "Safety Forums and Seminars" (0.0478), thereby indicating the agreement of the respondents to the existence of some inadequacies in the implementation of these measures. For instance, the "Pay for Safety Scheme" in Hong Kong is designed in such a way to only favor the new construction projects as the scheme applies to a project with an estimated contract sum of HK$20M (Hon et al., 2011). The results also reflected that the respondents, in general, agree that the voluntary-based measures without incentive have limited effectiveness in improving RMAA work safety.

Difficulties in RMAA Safety Performance Improvement

Cronbach's alpha coefficient came out to be 0.707, as shown in Table 4, which was higher than the threshold value of 0.7 according to Santos (1999). It inferred that the use of a five-point Likert scale for determining the difficulties on safety performance improvement in RMAA works was reliable and internally consistent (Tariq and Zhang 2020).

The Kendall's coefficient of concordance (*W*) came out to be 0.099, 0.491, 0.327, and 0.223 for "All respondents group", "Consultant group", "Supervisory personnel group" and "Frontline staff group", respectively. All calculated *W*s were regarded as statistically significant with a significance level of 0.000. Since the number of attributes considered was greater than 7, the use of the chi-square value would be more preferable to the use of the *W* value. With the degree of freedom (9) and the allowable level of significance (5%), the calculated chi-square values for each group were higher than the critical value of the chi-square (16.919). Hence, the concordance test showed the validity and consistency of the survey data.

The mean score (MS) for these common difficulties as assessed by "All respondents" ranged from 2.70 to 3.50. The results revealed that the respondents from the frontline staff group rated these difficulties in general much lower than that of respondents from other groups, which means the frontlines were less agreeable to the difficulties than the other groups.

[Insert Table 4]

The difficulties related to workers were generally scored higher than the others. The two greatest difficulties confronting the RMAA industry in the safety aspect regarded by "All respondents" were "Lack of Self-

regulation of Workers" with an MS of 3.50 and "Low Safety Awareness of Workers" with an MS of 3.39. Although the research conducted by Hon et al. (2011) only investigated the effectiveness of some safety policies in RMAA projects and did not investigate the difficulties in RMAA safety improvement, however, they found "Safety Awareness and Self-regulation of Workers" as the most effective approach of mitigating fatalities in RMAA works. Furthermore, the safety performance of the RMAA industry highly depends on the attitude and behavior of workers. The results reinforce the research findings stated by Hon et al. (2011) in both inadequate self-motivation and low safety awareness of RMAA workers to perform safety were found to be the biggest challenges in improving RMAA work safety. Very often, the workers with a risk-taking attitude tend to take a shortcut and ignore safety precautions for the sake of convenience. They just implement safety practices only in the presence of supervisors. These factors were also considered as the root causes of accidents in RMAA works (Hon, et al., 2010).

"Limited Resources Put on Safety by Contractors" was ranked in the third position by "All respondents" with an MS of 3.22. Hon et al. (2014) pointed out the contractors for RMAA works, who are usually small to medium-sized companies, are prone to give the safety issues a lower priority due to financial constraints. Resulting from the limited resources on safety, not only the workers may have insufficient safety equipment and safety training for undertaking the works, but also the level of safety supervision for the works may be lowered because of the lack of supervisors (Aboagye-Nimo, et al., 2012). It was also identified by Hon et al. (2010) as one of the indirect causes of accidents in the RMAA sector.

However, "Low Safety Awareness of Workers" and "Lack of Self-regulation of Workers", which were ranked as the top two difficulties from all respondent groups, consultant group, and supervisory personnel group, were ranked as the 7th and 8th by frontline staff group. The results reflected that the workers disagree with the perceived poor behaviors of them. They believed and ranked "Unfavorable Working Condition" with an MS of 3.31 and "Shortage of Time" with an MS of 3.19 to be the two greatest difficulties. The unfavorable working environment and tight work schedule resulting from the site constraints in RMAA works could be the barriers for workers to perform safety practices, posing a higher risk for workers (Chan

448 & Hon, 2016). Similarly, the lack of ventilation/poor housekeeping or time-limit of projects can indeed
449 discourage the workers from fully implementing safety measures as indicated by the workers in the survey.
450 This observation corroborates the findings of Hon et al. (2010), which illustrates the hazardous nature of
451 RMAA works due to the existence of limited space provided for the respective workers involved in
452 undertaking the related tasks.

453 Besides, "Inexperience of Clients" and "Low Safety Awareness of Contractors" were ranked lower by all
454 the respondent groups and both have a mean score lower than 3.0. The results showed that the respondents
455 generally believe that the low safety awareness of contractors and clients could not be serious hindrances
456 to improve the RMAA work safety which is in line with the observations obtained from a study undertaken
457 by Hon et al., (2011).

458 **Discussion**

459 ***Current policies for improving RMAA works***

460 Discussions on each policy using interviews and excerpts from literature are made in this section as follows.

461 *Enforcement of Regulations*

462 Nearly all interviewees considered that enforcement of regulations has not made a significant contribution
463 to the safety performance of RMAA works which conforms to the questionnaire results. The legislation is
464 a passive means to control safety issues on the construction site (Hon et al., 2011). There are also some
465 noticeable loopholes in the law enforcement and inspection by the Labour Department, resulting in limited
466 effectiveness in preventing unsafe acts in RMAA job sites. Interviewee D complained that the improper
467 enforcement strategy of the inspection is the main cause of undermined effectiveness. He further explained
468 that a suspension of work during the inspection period and "preparations for safe workplaces" are the
469 common coping strategies for the site inspection with prior notice. Workers are unlikely to comply with the
470 safety regulations other than the day of inspection. However, an unannounced inspection (without prior
471 notice to the workers) might be effective in mitigating such a problem. Notably pointed out in Interview B
472 and E, in many offending cases, a fine of several thousand dollars would be the penalty of the malpractices,

which cut no ice with offenders. Also, the shortage of manpower in the labor department, excessive RMAA work sites, and the short duration of the RMAA project greatly increase the difficulty for law enforcement. Even though a complaint is received, the persons concerned are unlikely to be prosecuted as the work may be finished before the arrival of labor department inspectors, according to Interview A. Aside from site inspection by the Labor Department, CIC has rarely undertaken inspections on RMAA job sites while the Building department has inspected for the compliance of work processes and the qualification of project operators but not the compliance of safety regulations, based on Interview C. This finding shows that the impact of law enforcement has been mostly limited by insufficient enforcement efforts and lenient sentences.

Different Safety Initiatives for Construction Projects

To improve the standard of safety performance in construction works, different safety initiatives such as SMS and PFSS are adopted in both public and private sectors (Choi et al., 2011). Interviewee B regarded PFSS as the most effective policy for ensuring the appropriate allocation of resources on safety. Under PFSS, the claimable expenses for safety equipment and safety management encourage the contractors to put more effort into safety issues which can easily be overlooked in RMAA projects with smaller contract value (Chan et al., 2010). However, Interviewee A indicated that this scheme is preferred to be applied in RMAA projects which are relatively larger in scale and involve a higher contract sum. Such a restriction on the application of this scheme with good intention weakens its actual effectiveness in improving RMAA work safety, as echoed by the findings of Tam et al. (2006). It should be noted that many of the interviewees did not comment on the safety initiatives probably because they are not aware of them in relation to RMAA projects; this can emphasize the questionnaire results that suggest the safety initiatives as the most ineffective policy.

Award for Encouragement

Quite a large number of the interviewees coincidently deemed that award for encouragement helps enhance the safety performance in the RMAA industry by encouraging both companies and workers to have more

concerns about workplace safety. This finding is consistent with the results in the questionnaire survey. Interviewee B stated that the awardees are usually found to work harder on safety precautions and measures. Among these schemes, the actual contribution of the RMAA Safety Accreditation Scheme to RMAA work safety has given rise to controversies. As commented by Interviewee A, this scheme not only provides hardware like safety equipment and software training to the applicants but also enhances the safety culture of their companies by offering consultancy services and safety audits. The premium discounts are also given to the awarded company which is listed in the "OSH Star Enterprise List" for preferential appointments by the supporting organization. Such incentives would encourage RMAA contractors to have better safety performance. Although the three-pronged approach is adopted, this scheme is still criticized by some of the construction practitioners as there are only 38-star enterprises out of four thousand RMAA contractors. Interviewee B further explained that the excessively high threshold of application for this scheme (i.e. awarded company should have zero accident record in the past two years) and the unattractive reward discourages some of the contractors to participate in it. Owing to the lack of support from the industry, Interviewee B and C believed that this scheme has given less contribution to safety improvement in RMAA works. The policy with a stronger incentive would have more significant achievement in dealing with safety issues.

Financial Subsidies for Safety Items

Having good intentions, these schemes aim at providing sponsorships for RMAA contractors who have limited safety resources to purchase necessary safety equipment for strengthening the protection offered to workers. However, Interviewee C questioned the actual effectiveness of these schemes on reducing accident rates in RMAA works because of the failure in seeking the applicants in need. As expressed by him, the companies in greater need do usually not benefit due to the lack of promotion for these schemes. He added that the inconvenient application procedures and unfavorable arrangements would also lower the participation rate. A common practice in the application was illustrated by him:

"The companies generally apply for the platform before the commencement of work. When the notice of redemption for the platform is issued by OSHC, the applicants are required to redeem it from the nominated

suppliers within a certain period, otherwise, the application will be canceled. For the small companies which may have insufficient space for storage, the wrong timing often takes away the sponsorship for them." Hence, it can be inferred that the application procedures for these schemes are always uncomfortable for small scall RMAA companies.

Safety Training and Promotion

As emphasized by Interviewee E, instead of the reward and penalty system, educating the RMAA workers is an effective approach in the long term. Through education, the positive attitude towards the safety of workers which is a key to prevent unnecessary incidents and injuries can be nurtured and good safety culture can then be established in this industry. The created safety culture would be passed down to future generations, thus improving the safety performance continuously. Nevertheless, the lack of safety training courses solely for RMAA workers and the voluntariness of attendance at the existing training courses make effective safety education for the RMAA industry more difficult. Interviewee B notably pointed out that most workers tend not to participate in these courses as they consider them unnecessary for their works. The compulsory safety training for RMAA workers would be essential for creating a positive safety culture in the industry. For the safety promotion, Interviewee B and C criticized that organizing safety activities is just a superficial act without a satisfactory result. Regardless of the advertisements and seminars, the safety awareness of workers has been made no sign of enhancement owing to the ineffective message delivery, which is coherent with the quantitative findings. Further commented by Interviewee C, the unimpressive content of these broadcasts was unable to draw the attention of the workers to the importance of safety.

Difficulties in Improving Safety Performance in RMAA works

Difficulties in improving safety performance mentioned by interviewees are summarized in Table 5. A comparison of top difficulties from interview and survey analyses is provided in Figure 6. A further discussion on each difficulty using interviews and excerpts from literature are made in this section as follows.

549 [Insert Table 5] & [Insert Figure 6]

550 *RMAA Workers*

551 *Negative Safety Culture in RMAA Industry.* As stressed by Interviewee E, safety culture has a great
552 influence on the on-site behavior of workers. Most of the interviewees reconciled that the negative safety
553 culture in the RMAA industry is the greatest barrier confronting the safety performance improvement in
554 RMAA works. With the transmitted poor safety culture, the risk-taking mindset of workers and the unsafe
555 customs are fostered and ingrained in the working culture of the industry, which even passes down to new
556 entrants. Interviewees A and D expressed that pretending to wear safety belts and relocating the ladders
557 without getting down for expediency and shortening the processing time are the common unsafe practices
558 when working at height, which reveals that the deficiency of self-regulation of workers as highlighted in
559 the questionnaire survey. Adding that the self-complacency of workers on experience usually discourages
560 them from fully implementing safety regulations, and accidents would be more likely to occur when they
561 finish the works in a rush manner. Despite the informal risk assessments and site management carried out
562 by experienced workers, the underlying risks may probably be overlooked, resulting in ineffective
563 prevention of accidents, according to Interview C. Such deep-rooted mindsets and industry customs are
564 difficult to be shifted within a short period, which would be the obstacles for improving safety performance
565 in RMAA works. The workers' vigilance on safety at work could be heightened for a while only in case of
566 an accident.

567 *Insufficient Safety Training and Education.* The high salary in the RMAA industry has attracted more
568 and more inexperienced entrants over the past decade, which makes the training more important for
569 preventing casualties. Although, the questionnaire survey ranked "insufficient safety training and education"
570 as the fourth difficulty in RMAA safety improvement the majority of the interviewees accepted
571 "insufficient safety training and education" to be one of the biggest challenges facing RMAA safety
572 improvement. As complained by Interviewee C, with the extra cost and the disadvantageous course
573 schedules, the smaller-scale contractors tend not to provide training to workers because of the limited

resources and the affected productivity. Interviewee E further pointed out that the tight working schedule ordinarily strips off the educational opportunity for workers.

"*Even if the training courses are held other than the working hours, they would rather take a rest than having lessons since they are physically exhausted due to high-intensity physical activity."* Interviewee B stated that the high mobility of RMAA workers also poses a challenge in providing effective training.

Site Constraints. Interviewees A and C believed that the unfavorable constraints in job sites are the major hindrance for workers to implement safety measures, impeding improvement in safety performance. This result corresponds to the findings addressed in the literature review and questionnaire survey. In most cases, the workers are required to work under poor conditions due to the site limit and the need for reducing influence on the occupiers (Li et al., 2015). An example was demonstrated by Interviewee C: "*In the projects of renovation in a commercial building with a curtain wall, the renovated areas are usually isolated by physical barriers like hoarding and the air-conditioning inside cannot be turned on during the work to avoid introducing the construction pollutants into the occupied areas. Adding that the curtain wall allows sunlight penetration and cannot be opened for ventilation, the hot, stuffy, and dusty area impels the workers to remove the PPE and be in a rush to finish the work. The contractors usually provide blowers instead of portable air-conditioner due to its lower cost*." Interviewee A supplemented that even if the workers are willing to adopt the standard safety equipment, it sometimes cannot be applied because of the restriction of the site. The common difficulty encountered by workers is to find a secure anchorage for attaching safety belts in a limited area. The case for the use of Anchor Devices in home maintenance and repair projects were shared by him:

"*Normally, door jamb metal bar, which is a transportable temporary anchorage device, is used when working at height. It would be inapplicable if the site does not have a suitable anchor point like the door frame. Rather than that, the use of a structural anchors device which includes an eye bolt secured to vertical, horizontal, and inclined surfaces inside the home is preferable. However, it would be thwarted by the client owing to the damage to the ceiling or wall*." Such kind of unfavorable working environment and site

restrictions present a challenge to workers to take all the safety measures when carrying out the RMAA works.

Unfavorable Safety Equipment. Interviewee D elaborated that the ceiling work can be finished five times faster if using a timber ladder instead of a step platform, which implies that the productivity would be greatly reduced by the use of safer equipment. Moreover, the safety harness with only 1.5m suspension rope also hinders the work process by limiting the working area. With those disadvantages, the workers are unlikely to use it under forgiving supervision, thus worsens the safety performance.

RMAA Contractors

Difficulty in Site Supervision. The difficulty in safety supervision in RMAA works impedes the implementation of safety practices mentioned by Interviewees C and D. The main contractor is generally required to oversee the RMAA works taken up by subcontractors. Interviewee C found that the workers from the subcontractor are not obedient to comply with the safety regulations unless the top management from the main contractor is present, showing the low motivation of self-regulation of workers and the importance of close supervision to safety. The higher cost of the project incurred from the close supervision would weaken the competitiveness of the company, posing a challenge to contractors on adequate supervision.

Limited Resources for Safety. The workers without a full set of PPE and sufficient training are found more likely to be injured. The limited resources for safety in RMAA projects can be linked to the small nature of RMAA projects compared to new construction projects. Apart from the small nature of its contract sum, another challenge is the unwillingness of the company to spend any amount on safety. Further expressed by Interviewee C, the contractors who are profit-minded tend to put 0% resource on safety in the projects through the additional cost is affordable. Their money mindsets would not be conducive to the improvement of RMAA work safety.

Limited Commitment to Safety by Top Management. As pointed out by Interviewee E, the employers or managers in smaller companies tend not to put effort into the establishment of a safety culture within the

organization which the top management often considered as a time-consuming and cost-intensive process. Yet, the perspective of management is likely to influence frontline employee decisions that relate to at-risk behaviors (Jitwasinkul & Hadikusumo, 2011). The low management commitment to safety would probably be the barrier to achieving better safety performance in RMAA works.

Government

Difficulty in Providing Safety Promotion and Training for Workers. Providing Safety Promotion and Training for Workers was Complained by Interviewee B, there is a lack of RMAA workers' registration system, posing difficulties to the government for finding out the RMAA workers for providing education. In particular, the workers for small-scale works like painting do not necessarily have a registration card. Adding that quite a few practitioners in RMAA work play a dual role of workers and bosses of contractors, the presence of 'unknown' workers limits the effectiveness of safety promotion and training launched by the government**.**

Difficulty in Inspection. According to Interview B, some types of RMAA work sites in private properties that do not require notification of works bring difficulties to the government department with insufficient manpower.

Recommendations on Enhancing Safety Standards in RMAA Projects

Some recommendations for improving the effectiveness of existing policies and overcoming the difficulties identified suggested by the interviewees are summarized in Table 6.

[Insert Table 6]

Law Enforcement

Interviewee D suggested that the government should recruit more inspectors for frequent site inspections and should carry out spot checks instead of the checks with prior notice. The sufficient human resources and changed strategy is believed to provoke the workers to implement the safety practices while working, thus improving the RMAA site safety.

Legislation

Implementing Computerized Registration System for RMAA Workers

The imperfect tracing system for workers' identity leads to difficulties in the provision of safety training. As recommended by Interviewee B, an additional computerized registration system for RMAA workers should be implemented for collecting their personal information and managing the daily attendance records of their works. Under this system, the contractors or workers are required to record the daily works they are involved in, the location of works, and the number of workers for the works through the internet for monitoring. This information facilitates not only the site inspection of the government but also the provision of safety knowledge and safety education.

Launching Compulsory Specialized Training Program

Interviewees B, C, and D concurred that a compulsory specialized training program solely for RMAA workers should be launched for raising their awareness on safety and developing a positive safety culture, thereby reducing the accident rate. Such training should be held outside of working hours avoiding the impediment of their work processes.

Implementing 'Five-Day Work Week"

For the problem of lack of educational opportunity for workers, the government is suggested to implement 'five-day work week' for the construction employees and the contractors should act in concert over this work arrangement. With two days off weekly, the workers can easily strike a balance between rest and training. Interviewee E believed that this arrangement would definitely help to inculcate the right safety attitude for workers through effective education.

Enforcing the Property Management Companies to Sign the Charter on Preferential Appointment of OSH Star Enterprise

The actual effectiveness of the RMAA Safety Accreditation Scheme has been suspected due to the low level of industry support Interviewee A recommended that all property management companies should be enforced to sign the Charter on Preferential Appointment of OSH Star Enterprise for ensuring that the contractors who carry out RMAA works has implemented effective safety management system and passed

675 OSHC's stringent safety audit. This implementation would probably encourage more contractors to enhance
676 the safety standard of the companies for participating in the scheme, thus mitigating the accident rate in the
677 RMAA sector.

678 ***Provision of Support***

679 *Providing Financial Subsidies and Rental Services for Safety items to RMAA contractors*

680 Regarding the insufficient safety resources for contractors as one of the main difficulties to improve RMAA
681 works safety, the sponsorship given from existing financial subsidy schemes is found insufficient.
682 Interviewees A and C expected that government should increase the amount of sponsorship and provide
683 rental services on safety items for RMAA contractors. These supports help alleviate the financial burden of
684 contractors, hence they are more likely to implement adequate safety practices.

685 *Providing On-Site Social Service to Contractors and Workers*

686 Interviewee C suggested that the government should provide on-site social services for the workers and
687 contractors encountering difficulties in implementing safety measures. By taking care of the financial and
688 psychological needs of the frontline staff, the social workers can establish mutual understanding and
689 enhance communication among them. He believed that a good relationship would be instrumental in
690 instilling in the workers the proper safety attitude.

691 *Providing Safety Promotion and Education to the Stakeholders in RMAA Industry*

692 In view of the limited effectiveness of the past safety promotional activities, Interviewee B and C
693 recommended that the government should cooperate with the employees' union which have given workers
694 a stronger sense of belongings to organize the promotional activities to the at-risk worker groups like the
695 workers involved in working at height and electricity and even their relatives. In these activities, the victim's
696 family in construction accidents should be invited to share about their miserable life after losing their
697 breadwinner. Such events are perceived to impress the participants and remind them of the importance of
698 workplace safety. Apart from educating the practitioners, the safety education for clients who may be
699 property owners is likely to be overlooked, hence, the government is suggested to educate the clients by the
700 safety promotion in Owners' Corporations and open seminars, according to Interview A. Through the

promotional activities, the clients would understand their responsibility and the importance of safety in RMAA works.

Providing Universal Education for Occupational Safety

Interviewee B suggested that universal education for occupational safety should be provided in the senior secondary curriculum by adding safety courses or promotional activities. Such courses could help teenagers develop safety knowledge and a sense of workplace safety. Having those pre-employment safety training, the students could not only prevent injuries and hazards in the work environments in the future but also exert an influence on the safety attitude of their parents.

Improvement in Management

Establishment of Safety Culture in Companies

As advocated by Interviewee E, the top management should put not only the resource but also their heart into the establishment of a positive safety culture for improving the safety performance of the company effectively. A top-down approach is required for this culture to necessitate the commitment of senior employees, subsequently, the commitment of all employees. It is essential to set the tone for the importance of work safety within an organization.

Conducting Preliminary Site Inspection

The site constraints have previously been identified as the greatest difficulty encountered by workers. Based on Interviewee A, since the applicability of some safety equipment can be affected by the location of the site, a preliminary site inspection is preferred for deciding the most suitable equipment for the particular tasks, thus lower the probability of injury of workers

Conducting Workgroup Briefing Session

Interviewees C and D suggested that the contractor should have a workgroup briefing session about the possible hazards in the site and the corresponding precautions with workers before the commencement of work. They believed that the possible risks imposed on workers could be foreseen by the experienced

supervisors. Such short briefing could enhance the alertness of workers on potential and foreseeable risks, thereby preventing accidents.

Setting Up the Proactive Maintenance Plan

Advised by Interviewee E, the proactive maintenance plan which involves scheduled checks over regular intervals and continuous condition monitoring should be developed for preventing the degradation of items. As early treatment is usually good for recovery, the early detected defects might be smaller in scale and easier to be fixed. The less serious defects are believed to impose less risk on workers due to their reduced exposure to potential safety hazards.

Conclusions

This study investigates the efficacy of policies and guidelines playing role in the RMAA-related operations in Hong Kong. In doing so, a two-step methodology approach, which is based on the exploitation of AHP and Likert-based survey together with structured interviews, was considered. For the sake of data collection in this research, qualified experts who had the relevant working experience and degree were considered throughout the whole research. The followings are the observed contributions of this study made to the body of existing knowledge:

(1) The existing strategies together with the common difficulties of improving safety performance related to RMAA operations are prudently prioritized. It is witnessed that the award of encouragement and Construction Industry Award Scheme are the most effective policy, while enforcement of regulations and promotional activities are the less effective ones. In the follow-up interviews, the contribution of the award schemes to safety performance was emphasized by 3 out of the 5 interviewees and the loopholes in law enforcement were noticed by most of the interviewees. When it comes to the prioritization of setbacks that are extant for safety improvement in RMAA projects, the lack of self-regulation of workers and low safety awareness of workers are witnessed to be the most crucial barriers.

(2) A bunch of fruitful recommendations towards further improvement in the safety performance related to RMAA operations is garnered as follows.

a) Intensifying monitoring and enforcement by conducting more inspections to RMAA workplaces and increase penalties against offenders as part of the strategic plan.

b) Launching the Mandatory Registration System of RMAA Workers through launching the Mandatory Registration System of RMAA Workers. To spot the workers involved in the RMAA industry, this system should record not only the personal information and qualification of registered RMAA workers but also the daily works they are involved in.

c) Launching a Compulsory Training Program for RMAA Workers. With the aid of the Mandatory Registration System of RMAA Workers, the safety training solely for RMAA works can be given to the registered workers to ensure their quality. The participants in this program should be offered extra days off for allowing a balance between work, rest, and training.

d) Providing Loan Services for Safety Items for the contractors who are in need. Such equipment centers should be centrally located in different districts in Hong Kong, and provide protective equipment and safety gear for a loan.

e) Establishing Safety Culture in Companies by the contractors, to commit more resources in promoting and creating a safety culture and set the safety tone within the organization.

f) Establishing a Proactive Maintenance Plan by clients through conducting scheduled and regular inspections as well as continuous condition monitoring.

g) Providing Universal Education of Occupational Safety by introducing pre-employment safety education into the RMAA industry, leading to facilitating the establishment of safety culture within the industry in the future.

h) Developing New Technology for RMAA Work Safety through devoting more resources to new research of technologies and skills for reducing the needs of RMAA services and the risks involved in RMAA works.

Despite the various policies that have been implemented in mitigating the safety problems in the RMAA industry, the casualty rate remains constant. Hence, this research will help various stakeholders in the

777 industry to get themselves acquainted with the most effective policies that can be used to mitigate the
778 lingering safety problem. This research work can serve as reference material for developing safety training
779 manuals for RMAA workers.

780 Like every research, this research has some limitations. Firstly, the sample size was small, therefore, the
781 rankings of the top policies and difficulties might vary in the opinion of concerned public sector officials.
782 However, care has been taken to ensure sufficient reliability and validity of results with the help of mixed-
783 method and various statistical approaches, therefore, substantial deviations are not expected. Secondly, this
784 research was conducted from the Hong Kong perspective and might not be applicable to the RMAA industry
785 in other countries, however, experiences and research framework can be used. Future research will be
786 carried out for 1) designing a special short safety course for workers/contractors involved in RMAA related
787 works, and 2) the development of a mobile-based application for safety monitoring of RMAA workers.

788 **Disclosure Statement**

789 There is no conflict of interest.

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Figure 1 Industrial Fatalities in RMAA work (2007-2016). Source: Data from Labour Department of Hong Kong (2008b, p. 3; 2010) and Legislative Council (2011a, 2011b); Hon & Chan (2013a). Statistics for fatal RMAA accidents from 2012-2016 were collected from Newspapers archives

Figure 2. Serious RMMA related accidents in 2017. Tracked from Sing Tao & Ming Pao Daily News.

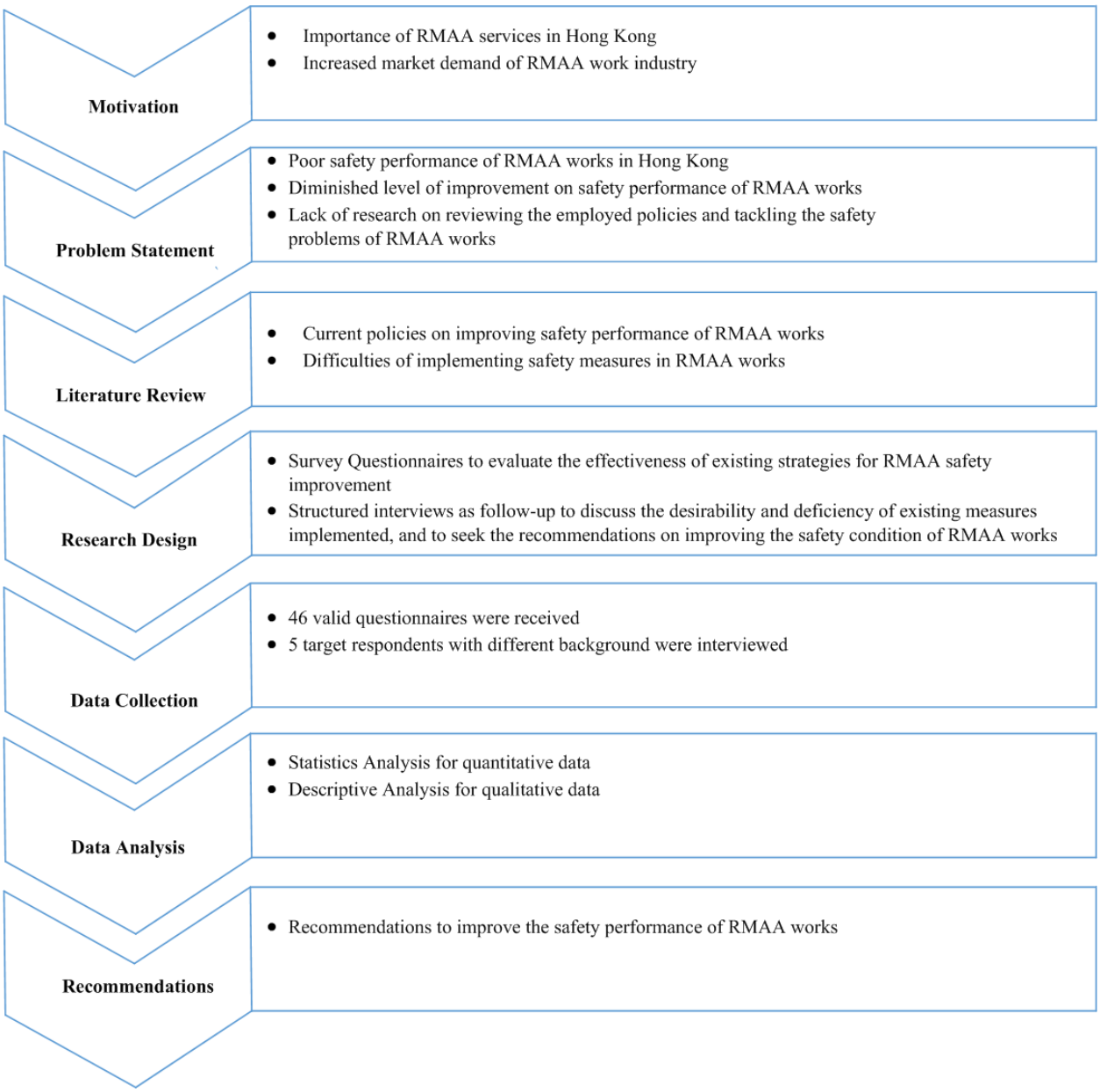
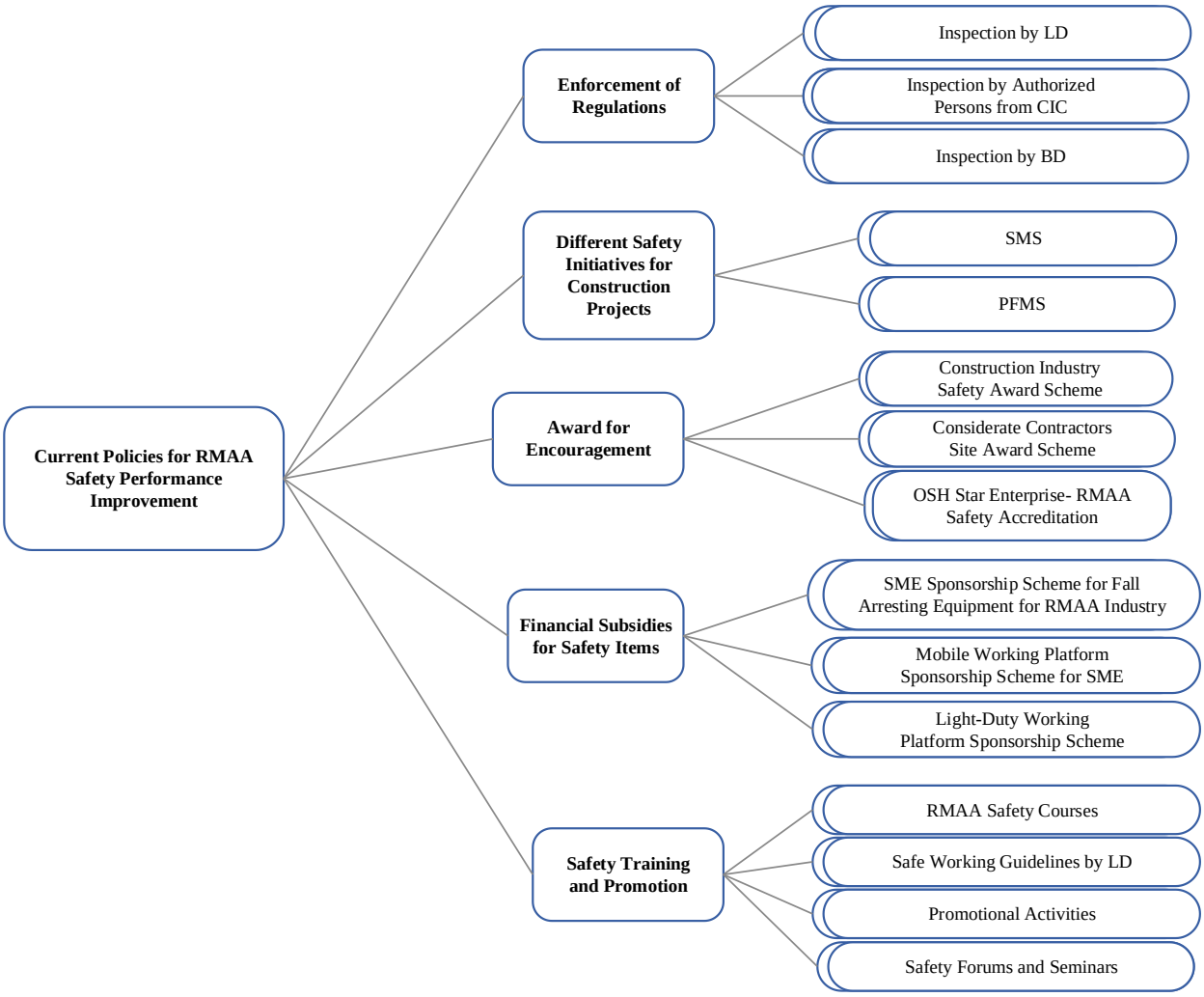


Figure 3. Research flow



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960 **Figure 4.** AHP hierarchy structure

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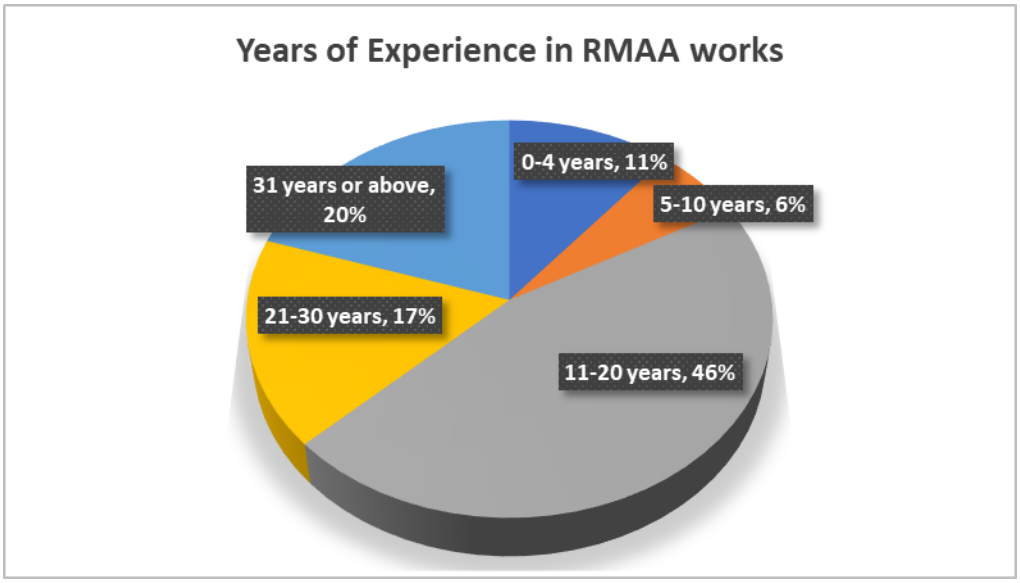

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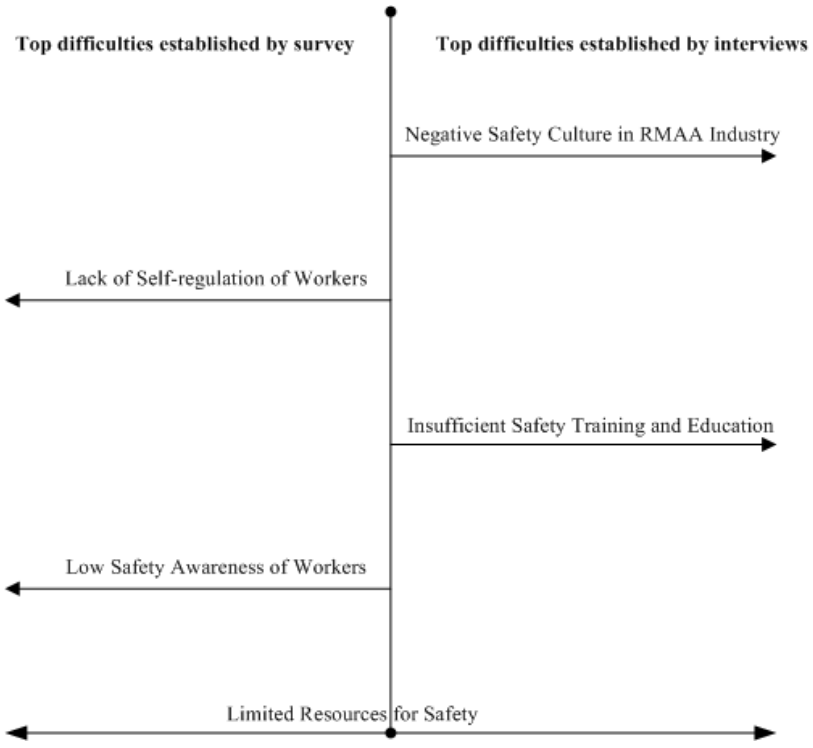
963 **Figure 5.** Respondents' experience



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965 **Figure 6.** Comparison of top difficulties in RMAA safety improvement from survey and interview

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969 **List of Tables**

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971 **Table 1.** Current policies and difficulties in implementing safety measures with respect to Hong Kong

Current Policies on Improving Safety Performance in RMAA Works				
Enforcement of regulations	**Safety Initiatives for Construction Projects**	**Award for encouragement**	**Financial Subsidies for Safety Items**	**Safety Training and Promotion**
Inspection by LD[1] (Department of Justice, 1955)	Safety Management System (Hon et al., 2011; Bottani et al., 2009)	Construction Industry Safety Award Scheme (Hon et al., 2011)	SME[1] Sponsorship Scheme (Occupation Safety and Health Council, 2017)	RMAA[1] Safety Training Courses (Hon et al., 2011)
Inspection by Authorized Persons from CIC[1] (Department of Justice, 2004)	Pay for Safety Scheme (Hon et al., 2011)	Considerate Contractors Site Award Scheme (Development Bureau and Construction Industry, 2017)	Mobile Working Platform Sponsorship Scheme (Occupation Safety and Health Council, 2015)	RMAA Safety Publicity and Promotion (Hon et al., 2011)
Inspection by BD[1] (Department of Justice, 2012)	-	OSH Star Enterprise Safety Accreditation Scheme (Occupation Safety and Health Council, 2012)	-	-
Difficulties of Implementing Safety Measures in RMAA Works				
Worker	**Contractor**	**Client**		
Difficult to Change the Mindset Owing to the Nature of the Work (Enshassi et al., 2014; Hon et al., 2010)	Limited Resources on Safety (Chan &Hon, 2016; Hon et al., 2010)	Low Safety Awareness (Hon et al., 2010; Enshassi et al. 2014 and Tam et al., 2012)		
Shortage of Time (Hon et al., 2020; Ling et al., 2009)	Difficulty in Safety Supervision (Chan &Hon, 2016; Hon & Chan, 2013)	-		
Insufficient Experience and Training (Enshassi et al., 2014; Hon et al., 2011)	Unpredictable and Ad Hoc Site Problems (Chan & Hon, 2016; Hon et al, 2011; Hon, 2012)	-		
Unfavorable Work Condition (Enshassi et al., 2014; Hon et al., 2010)	-	-		

972 [1]BD – Building Department; LD – Labour Department; CIC – Construction Industry Council; OSH –
973 Occupational Safety and Health; SME – Small and Medium Enterprises
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Table 2. Background of interviewed experts

NO. of interviewee	Position held (title)	Organization	Experience
A	Senior consultant (Mr.)	Hong Kong Occupational Safety & Health Council	More than 15 years
B	Chairman (Mr.)	Hong Kong Construction Industry Institute	More than 30 years
C	President (Mr.)	Registered Minor Works Contractor Signatory Association	More than 30 years
D	Senior artisan (Mr.)	Private developer	More than 35 years
E	Academician (Dr.)	High ranked local university	More than 15 years

1009 **Table 3.** Relative importance and rankings of employed policies

Policies	Weight	Rank	Sub-policies	Weight	Rank	Overall weight	Rank
Enforcement of regulations	0.161	4	Inspection by labor department	0.506	1	0.081	6
			Inspection by authorized persons from CIC	0.18	3	0.029	14
			Inspection by Building Management	0.315	2	0.051	10
Different safety incentives for construction projects	0.099	5	Safety Management System	0.565	1	0.056	9
			Pay for Safety Scheme in RMAA Contract	0.435	2	0.043	12
Award for encouragement	0.304	1	Construction industry safety award scheme	0.41	1	0.125	1
			Construction contractor site award scheme	0.279	3	0.085	5
			OSH star enterprise – RMAA safety accreditation scheme	0.312	2	0.095	3
Financial subsidies for safety items	0.272	2	SME sponsorship scheme for all arresting equipment for RMAA industry	0.41	1	0.125	1
			Mobile working platform sponsorship scheme for SME	0.33	2	0.085	5
			Light duty working platform sponsorship scheme	0.26	3	0.095	3
Safety training and promotion	0.164	3	RMAA safety course	0.369	1	0.061	8
			Safe working guideline by Labor department	0.204	3	0.033	13
			Promotional activities	0.135	4	0.022	15
			Safety forums and seminars	0.292	2	0.048	11

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Table 4. Ranking of Difficulties in RMAA Safety Performance Improvement

Difficulty Encountered	All Respondents		Consultants Group		Supervisory Personnel Group		Frontline Staffs Group	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Low Safety Awareness of Workers	3.39	2	4.36	1	3.58	2	2.5	7
Lack of Self-regulation of Workers	3.5	1	4.18	2	4.05	1	2.38	8
Insufficient Experience and Training of Workers	3.13	4	3	6	3.37	3	2.94	3
Low Safety Awareness of Contractors	2.7	9	2.45	8	2.74	7	2.81	5
Limited Resources Put on Safety by Contractors	3.22	3	3.45	3	3.11	4	3.19	2
Experience of Clients	2.76	8	2.91	7	2.68	8	2.75	6
Difficult for Safety Supervision	2.93	7	3.36	4	2.79	6	2.81	5
Shortage of Time	3.11	5	3	6	3.11	4	3.19	2
Unpredictable and ad hoc site problems	2.93	7	3.09	5	2.89	5	2.88	4
Unfavorable Working Condition	2.98	6	2.91	7	2.74	7	3.31	1
Number of respondents	46		11		19		16	
Kendall's Coefficient of Concordance (W)	0.099		0.491		0.327		0.223	
Calculated Chi-square	41.038		48.631		55.904		32.041	
Critical Value of Chi-Square	16.919		16.919		16.919		16.919	
Degree of Freedom (df)	9		9		9		9	
Level of Significance	0		0		0		0	

Table 5. Difficulties in Improving RMAA Work Safety by interviewees.

Aspects and related difficulties	A	B	C	D	E	Total
1. RMAA Workers						
• Negative safety culture in RMAA industry	X		X	X		3
• Insufficient safety training and education		X	X		X	3
• Site constraint	X		X			2
• Unfavorable safety equipment				X		1
2. RMAA Contractors						
• Difficulty in site supervision			X	X		2
• Limited resources for safety	X		X	X		3
• Limited commitment to safety by top management				X		1
3. Government						
• Difficulty in providing safety promotion for workers		X				1
• Difficulty in inspection		X				1

Table 6. Summary of the Recommendations for Improving RMAA Work Safety

Recommendations	
Law Enforcement	• Recruiting more Inspection Staffs and Changing the Enforcement Strategy
Legislation	• Implementing Computerized Registration System for RMAAWorkers • Launching Compulsory Specialized Training Program • Implementing 'Five-Day Work Week" • Enforcing the Property Management Companies to Sign the Charter on Preferential Appointment of OSH Star Enterprise
Provision of Support	• Providing Financial Subsidies and Rental Services for Safetyitems to RMAA contractors • Providing On-Site Social Service to Contractors and Workers • Providing Safety Promotion and Education to the Stakeholdersin RMAA Industry • Providing Universal Education for Occupational Safety
Improvement in Management	• Establishment of Safety Culture in Companies • Conducting Preliminary Site Inspection • Conducting Workgroup Briefing Session • Setting Up the Proactive Maintenance Plan