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Risk management in small construction projects in Singapore: Status, barriers and impact

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Abstract

Risk management (RM) should be implemented in construction projects to assure the achievement of project objectives, regardless of project size. This study aims to investigate RM in small projects in Singapore in terms of status, barriers and impact of RM on project performance. To achieve the objectives, a questionnaire survey was conducted and data were collected from 668 projects submitted by 34 companies. The analysis results indicated a relatively low level of RM implementation in small projects, and that “lack of time”, “lack of budget”, “low profit margin”, and “not economical” were prominent barriers. Also, the results reported the positive correlation between RM implementation and improvement in quality, cost and schedule performance of small projects, respectively. The findings of this study can provide an in-depth understanding of RM in small projects in Singapore and make benefits of RM convincing to the participants of small projects.

Keywords: Risk management; Small projects; Implementation; Barriers; Impact; Project performance

1. Introduction

The construction industry has become one of the sectors that significantly contribute to Singapore's economy. According to the Building and Construction Authority (BCA, 2012), Singapore's construction demand, measured by total value of construction contracts awarded, increased by 16% year-on-year from S $27.6 billion (US$1.00 ≈ S$1.25) in 2010 to S$32 billion in 2011. It is worth noting that more than half of construction tenders in 2011 were for smaller projects with value up to £6.5 million (≈ S$12.85 million) (UKTI, 2011). Thus, it is important to ensure the successful deliveries of small construction projects in Singapore.

At any stage of a life cycle, a project is plagued with various risks due to the complex and dynamic nature (Zhao et al., 2010). Thus, risk management (RM) should be emphasized and implemented in construction projects, regardless of the project size, to assure the achievement of project objectives. According to the Project Management Institute (PMI, 2008), project risk is an uncertain event that, if it occurs, impacts at least one project objective (e.g. quality, cost, time, etc.), and project RM intends to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project. Thus, project RM implementation would improve project performance through assuring the achievement of project objectives and pursuing opportunities to increase the positive impacts on these objectives. The project RM process consists of RM planning, risk identification, qualitative and quantitative risk analysis, risk response planning, and risk monitoring and control. In addition, project RM has been considered as one of the nine project management knowledge areas (PMI, 2008) and enables stakeholders to understand risk impacts on project performance (Chapman and Ward, 2003).

Like other management approaches, RM implementation needs the investment of various resources. However, previous studies (Griffith and Headley, 1998) indicated that, in small projects, the time spent on management would be disproportionate

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to the project costs. In addition, small and medium contractors (SMCs) may not be capable of effectively managing risks in their small projects due to the lack of internal knowledge (WSHC, 2011). Nonetheless, RM implementation in small projects should be emphasized and improved. Thus, to make the benefits of RM convincing to the participants of small projects, the impact of RM on project performance should be investigated.

The objectives of this study are: (1) to investigate the status quo of RM implementation in small projects in Singapore; (2) to identify the barriers to RM implementation; (3) to capture the perceived importance of RM in improving project performance; and (4) to explore the perceived impact of RM on project performance. Thus, the findings of this study provide practitioners, especially the participants of small projects, with a clear understanding of the status quo of RM implementation in these projects and confirm the benefits of RM in terms of the positive impact on project performance. Also, as few studies have focused on RM in small construction projects, this study contributes to the body of knowledge relating to the management of small projects.

Following the introduction to this study, the second section provides the background information relating to the characteristics of small projects and RM in this type of projects. In the third section, research methodology and a profile of the respondents are presented. Then, data concerning the RM status quo, barriers to RM implementation and impact of RM on project performance are analyzed, and the results are discussed in the fourth section. Finally, the fifth section draws conclusions of this study and recommends further research.

2. Background

2.1. Small projects

Despite no consensus on the definition of small projects, previous studies have provided some characteristics of these projects. The Construction Industry Institute (CII) indicated that judging whether a project was small mainly depended on intuition that reflected the firm size, type of work, current work volume and management approach (CII, 1991). Also, the CII (2001) revealed that small projects would have less staff and formal controls, higher project contingency, and more standardized process and use of checklists. In addition, Griffith and Headley (1998) believed that small projects were likely to have short duration, higher uncertainty and limited formal documentation, and considered the disproportion between the management investment and the project costs as the main problem in small projects. Moreover, Dunston and Reed (2000) recognized that small projects were those with the following characteristics: repetitive or routine work; simple or uncomplicated construction process; maintenance projects; renovations, remodeling or upgrades; and total project costs less than US$1 million. Furthermore, based on the previous studies, Liang (2005) believed small projects should have at least one of the following characteristics: project costs between US$0.1 million and US $5 million; project duration of 14 months or less; project site work-hours up to 100,000; and projects do not need full-time project management resources or a significant percentage of firm resources. With the reference to Liang (2005), the scope of this study is limited to the projects worth from US$0.1 million to US$5 million or those lasting less than 14 months.

2.2. Risk management in small projects

Small projects are prone to more risks as they face more challenges than large projects due to their innate characteristics such as resource constraints, tight project schedule, competition and low profit margin (Smith and Bohn, 1999). Hence, small projects should be managed diligently to prevent schedule and cost overruns. However, RM is often overlooked because RM is a tedious and costly strategy involving intensive information gathering and analysis (Mubarak, 2010). In Hong Kong, Mok et al. (1997) found that only 35% of project players emphasized RM in projects costing less than HK$10 million while more than 90% recognized the importance of RM in projects worth more than HK$100 million.

Previous studies indicated that the SMCs mainly contracting small projects did not attach adequate importance to RM in small projects because these contractors lacked sufficient internal knowledge on RM (Ho and Pike, 1992; Smith and Bohn, 1999), especially on the application of risk analysis techniques (Frey and Patil, 2002). Also, due to the disproportion between the resources required to conduct RM and the low profit margin of small projects, many SMCs were discouraged from investing in RM (Griffith and Headley, 1998). Moreover, intense competition forces SMCs to price their bids so low that they cannot have excess budget for contingency (Smith and Bohn, 1999).

Various studies revealed that the benefits of RM were tremendous in construction projects. For example, RM could improve the quality of cost estimate and decision-making (Mills, 2001; Mok et al., 1997), help projects completed on time and within budget (Ali, 2000), lower transaction costs and facilitate better risk allocation (Klemetti, 2006). However, few studies have indicated the benefits of RM in small projects and the impact of RM on project performance, such as project quality, costs and schedule. Given the innate characteristics, the benefits and impact of RM in small projects may be different from those in larger projects and are worth investigation.

As only a limited number of studies have focused on RM in small construction projects, this study expands the existing literature by investigating the implementation status and impact of RM on project performance in small construction projects in Singapore. It merits attention that this study focuses on formalized and standardized RM rather than implicit RM. This is because a formalized and standardized risk management process has been widely seen as a critical attribute to measure the risk management capability or maturity in previous studies (e.g. Hillson, 1997; Hopkinson, 2011; Ren and Yeo, 2004; Zou et al., 2010). Also, a formalized and standardized risk management process facilitates the cultivation of strong risk awareness and the flow of risk management information throughout the entire project life cycle.

3. Methodology and data presentation

The literature review conducted aided in having a better understanding of small construction projects and RM in them and collecting information to develop the survey questionnaire used for this study. A pilot study was conducted with four project managers from consultants and contractors to validate the questionnaire.

The finalized survey questionnaire consisted of four sections. Prior to the main body, the introduction letter provided the definition of small projects and the objectives of this study. The first section captured the basic profile of respondents and their companies. The second section was designed to identify the status quo of RM implementation in companies. The respondents were asked to provide the number of projects that their companies had been engaged in during the past three years as well as the number of projects with formalized RM implementation. The amount of projects was stratified according to project type, nature, cost and duration. In the third section, 10 barriers to RM in small projects identified from the literature review were presented. The respondents were requested to rate the negative impact of these barriers on RM implementation in the small projects that they had participated in according to a 10-point scale (1 = least impactful and 10 = most impactful). The last section consisted of questions that solicited the perceived importance of RM in a five-point Likert scale (1 = very unimportant; 2 = unimportant; 3 = neutral; 4 = important; and 5 = very important), and that explored the impact of RM on project performance (i.e. quality, cost and schedule) in small projects in terms of the percentage of improvement achieved.

A total of 200 survey questionnaires were sent out via email to consultants and contractors. The contractors in the sample were those with the BCA Contractors Registry Grades of B1 (tendering limit up to $40 million), B2 (tendering limit up to S$13 million), C1 (tendering limit up to S$4 million), C2 (tendering limit up to S$1.3 million), and C3 (tendering limit up to S$0.65 million). Contractors of these grades were selected due to the characteristics of small projects that are associated with SMCs. As contractors with A1 (no tendering limit) and A2 (tendering limit up to S$85 million) do not usually engage in small projects due to their ability to bid for projects with higher contract value, these large contractors were excluded from the sample.

A total of 34 complete questionnaires were returned, representing a response rate of 17%. The low response rate could be due to the confidentiality and sensitivity of information which companies were unwilling to divulge. Also, despite the small sample size, statistical analysis could still be conducted as the central limit theorem holds true with a sample size greater than 30 (Ling et al., 2009; Ott and Longnecker, 2001; Zhao et al., 2012).

While Likert scale data have been considered as ordinal scale data, a great number of papers in international journals using Likert scales in their questionnaire surveys have adopted parametric statistical methods. Meanwhile, the results from parametric methods with ordinal data were recognized as reasonably reliable (Nunnally, 1975). These parametric methods included, but are not limited to: *t*-test (Baker et al., 1966; Binder, 1984), multiple regression (Carifio and Perla, 2008), factor analysis (Carifio and Perla, 2008) and Pearson correlation (Carifio and Perla, 2008; Norman, 2010). In addition, some previous studies argued that parametric methods for interval variables could be used for ordinal variables because the power and flexibility obtained from parametric methods can outweigh the small biases that they may entail (Allan, 1976; Kim, 1975; Labovitz, 1971; O'Brien, 1979), and conclusions and interpretations of parametric methods might be easier and provide more information (Allen and Seaman, 2007). Also, Zumbo and Zimmerman (1993) believed that "there is no need to replace parametric statistical tests by nonparametric methods when the scale of measurement is ordinal and not interval" (p. 390). Furthermore, Norman (2010) argued that parametric statistics can be used to analyze Likert data with unequal variances and non-normal distributions, without fear of coming to wrong conclusions. Therefore, this study adopts one-sample *t*-test, independent *t*-test and Pearson correlation to analyze the data.

Table 1 presents the profile of the data collected from the questionnaire. Among the companies of the respondents, consultants and contractors represented 44.1% and 55.9%, respectively. Specifically, six out of the 15 consultants were design consultants while the remaining nine were project management consultant. Also, 14 (73.7%) out of the 19 contractors had the BCA registry grades of C1, C2 and C3. In addition, 61.8% of the companies have more than 21 years of experience in the construction industry, which would ensure that the responses collected were accurate and trustworthy. In terms of the respondents, 20.6% of them were senior management while 79.4% were project

Table 1
Profile of companies, respondents, and projects.

Characteristics			N	%
Companies (N = 34)	Consultants	Design	6	17.6%
		Project management	9	26.5%
	Contractors	B1	2	5.9%
		B2	3	8.8%
		C1	5	14.7%
		C2	2	5.9%
		C3	7	20.6%
	Years of experience	<10	3	8.8%
		10–20	10	29.4%
		21–30	17	50.0%
		>30	4	11.8%
Respondents (N = 34)	Job title	Senior management	7	20.6%
		Project management	21	61.8%
		Project engineer	6	17.7%
	Years of experience	<5	4	11.8%
		5–9	6	17.7%
		10–20	17	50.0%
		>20	6	17.7%
Project (N = 668)	Project type	Public	256	38.3%
		Private	412	61.7%
	Project nature	New construction	214	32.0%
		RMAA	454	68.0%
	Project cost (S$)	<0.1 million	74	11.1%
		≥0.1 but <1 million	312	46.7%
		≥1 but <5 million	213	31.9%
		≥5 but ≤10 million	69	10.3%
	Project duration	<6 months	375	61.7%
		≥6 but <14 months	195	29.2%
		≥14 months	98	9.1%

management or engineers. In addition, 66.7% of them have more than 10 years of experience in the construction industry, which could affirm the reliability and quality of data.

Furthermore, Table 1 summarizes the number of projects in which the companies had participated in the past three years. Among the 668 projects surveyed, 61.7% were private projects, which may be due to the fact that the criteria of contractor selection for public projects were more stringent than those for private projects and thus it appeared easier for SMCs to win the tender of private projects. Also, in terms of project nature, repair, maintenance, addition and alteration (RMAA) works accounted for 68.0% of all the projects. This was consistent with Hon et al. (2010), which indicated that the RMAA sector constituted a considerable size of the construction market in developed countries and that these projects were mostly done by small contractors. Additionally, projects worth less than $5 million accounted for 89.7% of all the projects performed by the companies, while projects with duration of less than 14 months made up 90.87%, implying that most projects surveyed were small projects.

4. Data analysis and discussions

4.1. Status of risk management implementation

4.1.1. Status of risk management implementation: Company level

To identify the status quo of RM implementation, the respondents were asked to provide project RM implementation in their companies. Thus, the RM implementation index (RMII), which describes the extent of RM implementation in a company, can be calculated using the following equation:

$$\text{RMII} = \text{No. of projects with RM implementation} / \text{Total no. of projects of a company} \times 100\%$$

In this study, the denominator of this equation was the total number of the projects that a company had participated in during the past three years. Thus, the RMII of each company surveyed was calculated (see Table 2). The results indicated that only four companies (two consultants and two contractors) did not implement RM (RMII = 0%) in all their projects, while none obtained a RMII over 90%. Also, this study recognizes the RMII of 50% as the medium level of RM implementation. The companies with the RMII less than 50% and those with the RMII of 50% or more accounted for half of all the companies surveyed, respectively.

The overall mean RMII was 45.4%, implying that the RM implementation in the companies that mainly participated in small projects was at a slightly low level because the RMII was lower than 50%. The mean RMII of design and project management consultants was 40.4% and 39.0%, respectively. These values were lower than those of contractors, suggesting that contractors that were mainly responsible for project execution attached more importance to RM than consultants. Moreover, B1 and B2 contractors obtained a mean RMII of 56.5%, higher than that (RMII = 47.4%) of contractors with registry grades of C1, C2 and C3. This result indicated that larger contractors, which were better equipped with resources, experience, advanced technology and professionals with expertise (Hwang and Low, 2012), were more likely to implement RM in their projects.

Table 2
Status of RM implementation: Company level.

RMII	Consultant		Contractor		Overall	
	Design	Project management	B1, B2	C1, C2, C3	N	%
0%	1	1	0	2	4	11.8%
1–9%	0	1	0	0	1	2.9%
10–19%	0	1	1	2	4	11.8%
20–29%	1	2	0	1	4	11.8%
30–39%	2	0	1	0	3	8.8%
40–49%	0	0	0	1	1	2.9%
50–59%	0	0	0	1	1	2.9%
60–69%	1	0	0	3	4	11.8%
70–79%	1	4	3	3	11	32.4%
80–89%	0	0	0	1	1	2.9%
90–100%	0	0	0	0	0	0.0%
Total	6	9	5	14	34	100.0%
Mean	40.4%	39.0%	56.5%	47.4%	45.4%	

4.1.2. Status of risk management implementation: Project level

Table 3 presents the number and proportion of the projects with RM implementation. In terms of project type, 72.3% of public projects had RM implementation while the proportion of private projects was only 26.5%. This was probably because the public sector tended to place higher emphasis on the overall quality than the tender price (BCA, 2005) and RM would increase the quality of the tender, thus contributing to higher scores during the tender evaluation of public projects. On the other hand, the private sector usually award the contract to the tender with the lowest price (Wong et al., 2000), which may not have sufficient resources for RM implementation.

In addition, the results indicated that the percentage (56.6%) of RMAA works with RM was much higher than that (17.3%) of new construction. As RMAA works tended to involve higher uncertainty and risks than newly built projects (Boothroyd and Emmett, 1996; Flanagan and Norman, 1993), RM implementation would help the project team to better prepare for the

Table 3
Status of RM implementation: Project level.

Project characteristics		No. of projects	No. of projects with RM	% of projects with RM
Project type	Public	256	185	72.3%
	Private	412	109	26.5%
Project nature	New construction	214	37	17.3%
	RMAA	454	257	56.6%
Project cost (S$)	<0.1 million	74	30	40.5%
	≥0.1 but <1 million	312	125	40.1%
	≥1 but <5 million	213	95	44.6%
	≥5 million	69	44	63.8%
Project duration	<6 months	375	139	37.1%
	≥6 but <14 months	195	89	45.6%
	≥14 months	98	66	67.3%
Total		668	294	44.0%

potential risks. However, newly built projects also encountered diverse and complex risks in their life cycle. The greatest degree of uncertainty is usually encountered at the early phase in the project life cycle (Perry and Hayes, 1985). If major risks are not addressed early in the life cycle, they would magnify their effects in the later project phases (Pennock and Haimes, 2002). Thus, more attention should be drawn to the RM early in the life cycle of small-size newly built projects.

Moreover, 40.5% and 40.1% of the projects costing less than S$0.1 million and between S$0.1 million and S$1 million implemented RM, respectively. For those worth between S$1 million and S$5 million, the proportion was a little higher, reaching 44.6%. However, it appeared that the management teams of larger projects attached more importance to RM implementation and RM was implemented in 63.8% of the projects worth more than S$5 million. This suggested that the RM implementation level in small projects was relatively low, and that RM was more likely to be implemented in the projects with higher costs. This result agreed with the viewpoint of Smith and Bohn (1999) that the low profitability of small projects would result in insufficient additional budget for contingency planning.

Lastly, 37.1% of the projects, whose duration was below 6 months, were found to have RM implementation, while 45.6% of those lasting 6 to 14 months adopted RM. However, the percentage reached 67.3% in the projects lasting more than 14 months. This implied that RM implementation in small projects lasting less than 14 month was inadequate, and that the projects with longer duration were more likely to implement RM. This result echoed Griffith and Headley (1998) who revealed that it was not economical to manage small projects due to the disproportion between the project duration and the time spent on RM. Thus, inadequate resource investment would be a major barrier to RM implementation. The next section identifies the critical barriers to RM implementation in small projects.

4.2. Barriers to risk management implementation

A total of 10 probable barriers to RM implementation in small projects were presented and the respondents were requested to rate the negative impact of these barriers on RM implementation in the small projects that they had participated in using a 10-point scale (1 = least impactful and 10 = most impactful). As Table 4 indicates, "lack of time", "lack of budget", "low profit margin", and "not economical" are the top four impactful barriers to RM implementation in small projects based on their overall mean scores. Also, the one-sample *t*-test result implied that these four factors significantly hindered RM implementation in small projects at the 0.05 significance level.

"Lack of time" was considered as the most impactful barrier by both consultants and contractors. This result confirmed the finding from Table 3 that the lower proportion of projects with RM implementation tends to go with the shorter project duration. As small projects are restricted by tight schedules (Smith and Bohn, 1999) and the development of a RM framework is tedious and time-consuming (Mubarak, 2010), project players are reluctant to implement RM. Also, the result supported the argument of Griffith and Headley (1998) that time spent in managing small projects would be disproportionate to project cost. Actually, "lack of time" could be seen as a common barrier to RM implementation as Akintoye and MacLeod (1997) and Lyons and Skitmore (2004) found that this factor was a critical reason for not using RM in the UK and Australia, respectively.

"Lack of budget", "low profit margin", and "not economical", which were all related to the expense of RM implementation, were the remaining three impactful barriers. These three barriers were also ranked second to fourth in the groups of consultants and contractors, respectively. The results implied that the respondents did not believe that RM implementation in small projects was worth the expense involved, and that money spent in RM in small projects would also be disproportionate to project cost. This extended the viewpoint of Griffith and Headley (1998). As low profit margin is one of the innate characteristics of small projects (Smith and Bohn, 1999) and these projects should be managed in a cost-effective manner to increase the profit margin (Stephenson and Thurman, 2007), RM implementation would not be prioritized by project management teams. Also, management needs to consider the balance between the cost and benefits of RM implementation. In some cases, a slight

Table 4
Barriers to RM implementation in small projects.

Barriers to RM implementation	Overall			Contractors		Consultant		p-Value
	Mean	p-Value	Rank	Mean	Rank	Mean	Rank	
Competition among SMCs	4.82	0.007 [a]	7	5.00	7	4.60	7	0.410
Complexity of analytical tools	2.85	0.000 [a]	9	3.11	9	2.53	9	0.469
Lack of potential benefits	5.53	0.929	5	5.95	6	5.00	5	0.154
Lack of budget	7.91	0.000 [a]	2	7.79	2	8.07	3	0.620
Lack of government legislation	1.44	0.000 [a]	10	1.53	10	1.33	10	0.555
Lack of knowledge	3.85	0.000 [a]	8	4.32	8	3.27	8	0.101
Lack of manpower	5.50	1.000	6	6.16	5	4.67	6	0.020 [b]
Lack of time	8.79	0.000 [a]	1	8.42	1	9.27	1	0.116
Low profit margin	7.24	0.000 [a]	3	6.37	4	8.33	2	0.005 [b]
Not economical	7.06	0.001 [a]	4	6.37	4	7.93	4	0.047 [b]
Spearman's rank correlation	0.967 [c]							

[a] The one-sample *t*-test result was significant at the 0.05 level (test value = 5.50).
[b] The independent *t*-test result was significant at the 0.05 level.
[c] The Spearman's rank correlation was significant at the 0.05 level.

increase in expected cost could significantly reduce risk (Ward and Chapman, 1991).

In addition, "lack of potential benefits" and "lack of manpower" were ranked fifth and sixth. Although their mean scores were not lower than the test value, the one-sample *t*-test results revealed that there were not significant differences between these two scores and the test value. Thus, the impact levels of these two barriers were medium. Moreover, the remaining four barriers obtained scores lower than the test value and the one-sample *t*-test results indicated that they were significantly different from the test value. Thus, they were not impactful barriers to RM implementation in small projects. Although previous studies indicated that lack of sufficient knowledge would hinder RM implementation in small projects (Ho and Pike, 1992; Smith and Bohn, 1999), this was not the case in Singapore construction industry, as "lack of knowledge" obtained a low mean score and overall rank.

The independent *t*-test was also used to examine whether there were significant difference in the mean scores between contractors and consultants. The results implied that only three barriers obtained significance. "Lack of manpower" obtained significantly different mean scores from contractors and consultants (p-value = 0.020). A contractor needs to input staff specifically in one project while a consultant can simultaneously use the same group of staff in the management of multiple projects. Thus, in contractors, the human resource invested in RM would be limited and thus RM implementation was hindered, while consultants did not consider this barrier impactful. In addition, despite the significant differences in the mean scores of "low profit margin" and "not economical" between contractors and consultants, both groups of respondents recognized these two factors highly impactful.

Furthermore, the Spearman rank correlation coefficient was calculated and statistically tested to measure the degree of agreement associated with the ranks of the barriers between contractors and consultants. The correlation coefficient was 0.967 in this study, significant at the 0.05 level, indicating that contractors and consultants agreed with the overall ranking of the barriers to RM implementation in small projects.

4.3. Perceived importance of risk management

The respondents were also asked to provide their perception on the importance of RM in improving project performance based on their experience relating to management of small projects using a five-point Likert scale (1 = very unimportant and 5 = very important). Project quality, cost and schedule have been recognized as primary objectives of small projects (Griffith and Headley, 1997), which can be associated with project performance indicators (Ling et al., 2009). Thus, project performance was divided into project quality, cost and schedule performance. Table 5 indicates the overall mean scores of the perceived importance of RM and compares the views on the importance of RM between the companies with the RMII below 50% and those with the RMII of 50% or more. The independent *t*-test was used to test whether the differences in the perceived importance between the two groups were significant at the 0.10 significance level.

In terms of overall performance, 61.8% and 14.7% of all the respondents perceived that RM was important and very important, respectively, while none considered it unimportant. The overall mean score of 3.91 suggested that RM was significantly important for the overall performance of small projects. Also, the independent *t*-test results indicated that the companies with the RMII of 50% or more perceived that RM was significantly more important than those with the RMII below 50% (p-value = 0.052). This was probably because none of the companies with the RMII below 50% perceived that RM was very important while the percentage in companies with the RMII over 50% was 29.4%.

For project quality performance, only 14.7% and 11.8% of all the respondents believed that RM was important and very important, respectively, and the overall mean score of the perceived importance of RM was only 2.82. Also, 76.5% of the companies with the RMII below 50% revealed that RM was unimportant or very unimportant, while this proportion was only 23.5% in those with the RMII of 50% or more. As the one-sample *t*-test result indicate that the overall mean score was not significantly different from the test value (p-value = 0.347), the importance of RM to quality improvement in small projects was neutral. However, the independent *t*-test result showed significant difference in the importance of RM between the companies with the RMII below 50% and those with the RMII of 50% or more (p-value = 0.000).

In the case of cost performance, 61.8% and 23.5% of all the respondents perceived that RM was important and very important, respectively, while none considered that RM was unimportant. The overall mean score of perceived importance reached 4.09, suggesting that RM was recognized significantly important for cost savings in small projects. In addition, both groups of companies recognized importance of RM and the companies with the RMII over 50% considered that RM was significantly more important than the other group (p-value = 0.052), according to the independent *t*-test result.

Lastly, 50.0% and 41.2% of companies reported that RM was important and very important for project schedule improvement, respectively, while none considered it unimportant. The overall mean score of 4.09 suggested that RM was recognized significantly important for schedule reduction in small projects. Also, the difference between the companies with the RMII over and below 50% was significant (p-value = 0.059), suggesting that the importance of RM in time savings was more prominent from the perspectives of the companies with the RMII above 50%.

Therefore, RM was perceived significantly important for improvement of overall, cost and schedule performance of small construction projects, and companies with higher-level RM implementation were more likely to recognize its importance for project performance improvement than those with lower-level RM practice. Besides the importance of RM, it is also worth exploring the impact of RM on performance of small projects, which is presented in the next section.

4.4. Perceived impact of risk management on project performance

The respondents were requested to estimate the percentage of cost and time savings and quality improvement in the small

Table 5
Perceived importance of RM in improving performance of small projects.

Performance	Scale	Overall (N=34)				RMII<50% (N=17)			RMII≥50% (N=17)			p-Value
		N	%	Mean	p-Value	N	%	Mean	N	%	Mean	
Overall performance	3	8	23.5%	3.91	0.000 [a]	5	29.4%	3.71	3	17.6%	4.12	0.052 [b]
	4	21	61.8%			12	70.6%		9	52.9%		
	5	5	14.7%			0	0.0%		5	29.4%		
Quality performance	1	2	5.9%	2.82	0.374	2	11.8%	2.18	0	0.0%	3.47	0.000 [b]
	2	15	44.1%			11	64.7%		4	23.5%		
	3	8	23.5%			3	17.6%		5	29.4%		
	4	5	14.7%			1	5.9%		4	23.5%		
	5	4	11.8%			0	0.0%		4	23.5%		
Cost performance	3	5	14.7%	4.09	0.000 [a]	4	23.5%	3.82	1	5.9%	4.35	0.011 [b]
	4	21	61.8%			12	70.6%		9	52.9%		
	5	8	23.5%			1	5.9%		7	41.2%		
Schedule performance	3	3	8.8%	4.32	0.000 [a]	2	11.8%	4.11	1	5.9%	4.52	0.059 [b]
	4	17	50.0%			11	64.7%		6	35.3%		
	5	14	41.2%			4	23.5%		10	58.8%		

[a] The one-sample *t*-test result was significant at the 0.05 level (test value=3.0).
[b] The independent *t*-test result was significant at the 0.10 level.

projects they had participated in. For the four respondents who indicated that RM was not formally implemented in their projects, the responses were based on their perceptions, while the 30 respondents with RM implementation in their projects responded based on their project data. Table 6 presents the analysis results of the impact of RM on project quality improvement, cost savings and schedule savings.

In terms of quality performance, 41.2% of the companies with the RMII of 50% or more reported that RM had an impact on quality improvement by 4% to 6% and none felt RM had no impact, while 64.7% of the companies with the RMII below 50% revealed that RM improved quality by only 1% to 3% and 11.8% reported that RM had no impact. Thus, the independent *t*-test result showed the significant mean difference between the two groups (p-value=0.001).

In the case of cost performance, none of the two groups reported that the impact of RM on cost savings was 0% or 1% to 3%. This result was along with the result presented in Table 5 that none felt that RM was unimportant for cost performance improvement. In addition, 52.9% of the companies with the RMII above 50% reported that cost savings of 7% to 9% could be obtained from RM, and 47.1% of this group felt that the cost savings reached 10%, which was consistent with the perceived important role of RM in improving cost performance (see Table 5). In the other group, 70.6% and 17.6% of companies indicated that the impact of RM on project cost savings was 7% to 9% and 10%, respectively. The difference in cost savings between the two groups was statistically significant (p-value=0.030).

For schedule performance, none reported that the impact of RM on cost savings was below 3%, which echoed result in Table 5 that none considered that RM was unimportant for time savings. Also, the companies with the RMII above 50% reported the benefits of schedule reduction by an average of 9.1%, and 64.7% of this group mentioned that RM can reduce time by 10%. In contrast, 70.6% of the companies with the RMII below 50% felt that time savings produced by RM were 7% to 9%, and only 17.6% reported schedule reduction of 10%. Thus, the independent *t*-test result showed significant difference in time savings between the two groups (p-value=0.025).

It merits attention that the quality improvement by RM was lower than cost and time savings, which was probably because quality improvement could not be measured as explicitly as cost and schedule savings (Hwang and Low, 2012). Also, the companies with the RMII of 50% or more reported higher project performance improvement than those with the RMII below 50%. Thus, it could be hypothesized that higher-level RM implementation was positively associated with project performance improvement. The RMII was used to measure the RM implementation level and the Pearson correlation was performed to test this hypothesis (see Table 7). The correlation coefficients implied that the RMII values were significantly correlated with the improvement of project quality, cost and schedule at the 0.05 significance level, respectively. Thus, the RMII values were positively associated with project performance improvement and the hypothesis was tested. In addition, the Pearson correlation results reported that quality improvement, cost savings and time savings were significantly correlated with each other, which confirmed the findings of Ling et al. (2009). Hence, improvement in one project performance indicator would be related to improvement in other indicators.

5. Conclusions and recommendations

This study investigates the RM in small projects in Singapore in terms of the current implementation status, barriers and the impact of RM on project performance. The RMII was proposed to measure the status quo of RM implementation in a company. The analysis results implied that half of the companies surveyed had the RMII below 50%, and that the RM implementation of these companies was at a relatively low level (overall RMII=45.4%). Also, among the 668 projects surveyed, the majority of which were small projects, higher proportion of public and RMAA projects had RM implementation than that of private and new construction. In addition, less than 50% of the small projects

Table 6
Impact of RM on performance of small projects.

Performance improvement		RMII < 50% (N = 17)			RMII ≥ 50% (N = 17)			p-Value
		N	%	Mean	N	%	Mean	
Quality performance	0.0%	2	11.8%		0	0.0%		
	1–3%	11	64.7%		4	23.5%		
	4–6%	3	17.6%	2.7%	7	41.2%	5.5%	0.001 [a]
	7–9%	1	5.9%		5	29.4%		
	10.0%	0	0.0%		1	5.9%		
Cost performance	4–6%	2	11.8%		0	0.0%		
	7–9%	12	70.6%	8.0%	9	52.9%	8.9%	0.030 [a]
	10.0%	3	17.6%		8	47.1%		
Schedule performance	4–6%	2	11.8%		1	5.9%		
	7–9%	12	70.6%	8.0%	5	29.4%	9.1%	0.025 [a]
	10.0%	3	17.6%		11	64.7%		

[a] The independent *t*-test result was significant at the 0.05 level.

surveyed implemented RM, which confirmed the finding that RM implementation in small projects in Singapore was relatively low. In an attempt to investigate the reasons for the low-level RM implementation, "lack of time", "lack of budget", "low profit margin", and "not economical" were the prominent barriers that should be overcome by practitioners to appreciate more benefits of RM in small projects. Also, the results showed that contractors and consultants agreed with the overall ranking of the barriers, despite some differences in the mean scores between these two groups. It terms of the importance of RM, respondents recognized significant importance of RM in improving overall, cost and schedule performance of small projects while the importance to project quality was perceived at the neutral stand. As for the perceived impact of RM on project performance, the cost and time savings was higher than the quality improvement and the RMII values were positively associated with project performance improvement. Some SMCs may just emphasize the cost involved in risk management but overlook the potential benefits. Actually, in the long run, risk management implementation in small projects would bring about benefits that outweigh the costs.

In the context of Singapore, the government plays a key role in ensuring the healthy development of the construction industry. SMCs are enterprises with limited liquid assets and do not have the capabilities to allocate extra funds for RM. To encourage SMCs to adopt RM, the government may provide financial incentives (e.g. tax rebates or grants), which would have a direct impact on profits and cover the costs related to RM implementation. Thus, SMCs would not experience substantial increase in costs and would be more willing to implement RM. In addition, the government can provide training programs to the management staff in SMCs, thus introducing good RM practices that would help these companies to deal with risks and ensure the performance achievement.

Table 7
Pearson correlations between project performance and RMII.

Indicators	Quality improvement	Cost improvement	Schedule improvement	RMII
Quality improvement	1.000			
Cost improvement	0.612 [a]	1.000		
Schedule improvement	0.583 [a]	0.558 [a]	1.000	
RMII	0.517 [a]	0.459 [a]	0.533 [a]	1.000

[a] Correlation is significant at the 0.05 level (2-tailed).

Although the findings provide an understanding of the status, barriers and impact of RM in small projects in the Singapore construction industry, there are some limitations. First, as the sample size in this study was small, cautions should be warranted when the analysis results are interpreted and generalized. Also, due to the lack of a consensus on the definition of small projects, this study identified the scope of small projects through two characteristics, i.e. project cost and schedule. Thus, the small projects investigated in this study may not be exhaustive. Lastly, the impact of barriers to RM, the importance of RM and the impact of RM on project performance were assessed by the respondents based on their experience and perception. Thus, the data inevitably involved subjectivity. Actually, this is a common problem for most studies using questionnaire survey to collect data, and most assessment relating to RM was based on the experience and subjective judgment (Raz and Michael, 2001; Wiguna and Scott, 2006).

Future studies would be conducted to examine RM implementation in small projects and SMCs in other countries, and to investigate the relationship between the resources invested in RM and improvement in performance (e.g. quality, cost, schedule, safety, productivity and customer satisfaction) in small projects, as well as the underlying causal relationship between RM implementation and performance improvement. Also, it is interesting to compare the RM implementation and impact in small projects with that in larger projects.

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