

RISK IDENTIFICATION AND ALLOCATION IN UNDERGROUND RAIL CONSTRUCTION JOINT VENTURES: CONTRACTORS' PERSPECTIVE

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Received 14 May 2013; accepted 04 Sep 2013

Abstract. International construction joint ventures (ICJVs) have been widely used in large-scale infrastructure projects all over the world. This study aims to investigate the factors affecting adoption of ICJVs for underground rail construction projects, to identify the critical risks faced by parties that perform the projects under ICJVs, and to examine the obstacles to appropriate risk allocation among the parties under ICJVs. To achieve these objectives, an in-depth literature review was carried out and a questionnaire survey was conducted with 33 contractor firms as well. The survey results reported “sharing of project risks” as the top attractive factor of ICJVs and “differences in culture and working style” as the top negative factor. In addition, both foreign and local contractors considered “partners disagree over some conditions in contract” the most critical risk to the parties involving projects under ICJVs. While risk allocation was perceived to be very important for ICJVs, “unclear division of responsibilities and risks” and “differences in culture and working styles” could be the most significant obstacles against effective risk allocation among the parties. The findings from this study will help improve the implementation of ICJVs and provide valuable information for organizations who intend to participate in ICJVs in Singapore.

Keywords: joint venture, underground rail, risk identification, risk allocation, Singapore.

Introduction

Joint ventures (JVs), which were recognized as temporary arrangements for carrying out projects, especially major projects (Dalle, Potts 1999), have been encouraged in the Singapore construction market. The Singapore government first initiated the preferential margin scheme (PMS) in the 1980s to encourage foreign firms to form international construction joint ventures (ICJVs) with local contractors to bid for public sector projects. This scheme helped enhance the construction and management skills as well as the reputation of indigenous contractors, ultimately facilitating the development of local contractors (Kwok *et al.* 2000).

The construction of large-scale projects tends to require high-level civil engineering technologies and large amount of capital. This is also the case for the Mass Rapid Transit (MRT) system in Singapore (Shimizu 2008). Having commenced since the 1980s, the Singapore MRT construction is still in progress. In addition to the current five operating lines, another three fully underground lines will be in construction till 2020. In the context of Singapore, underground works are very risky due to varying and unpredictable ground conditions,

which makes it difficult to control any ground settlement (Nakano *et al.* 2007). Besides the risks inherent in construction activities, ICJVs are also risky because of the complexity of management issues (Goh, Kwok 2000). Thus, stringent risk management is necessary and crucial to the participants of ICJVs in underground rail projects in Singapore.

Although risk identification and allocation in ICJVs attracted great attention of academia (e.g. Dalle, Potts 1999; Favié *et al.* 2009; Kwok *et al.* 2000; Li, Tiong 1999), few studies have uncovered critical risks and risk allocation issues in the underground rail projects adopting ICJVs. As a result, the objectives of this study are: (1) to investigate the factors affecting adoption of ICJVs for underground rail construction projects; (2) to identify the critical risks faced by parties that perform the projects under ICJVs; and (3) to examine the obstacles to appropriate risk allocation among the parties under ICJVs. The findings from this study will help both practitioners and researchers understand the critical factors affecting ICJV adoption as well as the risk criticalities and allocation under ICJVs, providing valuable information for organizations that intend to take part in ICJVs in Singapore.

1. Background

1.1. International construction joint ventures

ICJVs are formed when a local firm and one or more foreign firms, whose headquarters are outside of the host country where ICJVs operate, decide to make a joint bid (Li 2000). One of the partners involved in an ICJV may act as the managing partner and organize the bidding function with a major control power. The use of ICJVs has become essential to secure large-scale projects or those that are beyond the capability of a firm (Kwok *et al.* 2000). The decision to join an ICJV is usually made during the pre-qualification phase and before submission of the bid (Liu 2002).

Setting up ICJVs can bring about several benefits. The local firms can gain opportunities to obtain new expertise, hence reducing the host country's dependence on foreign expertise and improving the local industry standards in the long run, while the foreign firms can expand into local markets and enjoy benefits such as tax and custom duty concessions (Ofori, Chan 2001; Shimizu 2008). Kwok *et al.* (2000) found that strategic market entry, business diversification, sharing of resources and risk sharing were the most important benefits, which motivated construction firms to enter into ICJVs. However, negative factors should also be considered before forming an ICJV. These include slower cautious decision-making, differences in culture and working style, considerable time and communication required for conflict minimization, tensions arising from the ambiguity on who is in charge, fear on the leak of proprietary technologies, as well as time-consuming and difficult termination process (Li 2000; Liu 2002). Sridharan (1995) found that ICJVs were formed mainly to bid for Singapore MRT projects. Although most ICJVs dismantled after project completion, some have sustained their operations (Ofori, Chan 2000).

1.2. Risks in underground rail ICJVs

Risk identification clarifies risk factors and recognizes potential sources of risks (Zavadskas *et al.* 2010). As an integrative part of risk identification, risk categorization structures the diverse risks that affect a project (Zou *et al.* 2007). Shen *et al.* (2001) identified 58 risks faced by the ICJVs in China. In addition, Li *et al.* (1999) identified 25 risks of the ICJVs in East Asia and categorized them into internal risks, external risks, and project specific risks. Such risk categorization agreed with Zavadskas *et al.* (2010). More specifically, internal risks arise from an ICJV itself and are unique because different organizations are involved, while external risks stem from the competitive macro environment where the ICJV operates. Project specific risks refer to unforeseen events that come from project characteristics and may affect the ICJV performance.

In addition to the risks common to ICJVs, there are risks specific to underground construction, including tunnel construction. Examples of common risks are the high water pressure and water inflow into the screw conveyor in the earth pressure balance (EPB) tunnel boring machine (TBM) (Edalat *et al.* 2010), poor underground condition, and heavy rainfall (Hong *et al.* 2009). In particular, Singapore has a wide range of rapidly varying ground conditions, including tropically weathered sedimentary, low grade metamorphic and igneous deposits. The mixed face conditions are difficult to predict and thus escalate the risk of large volume losses and seepage during tunnelling (Nakano *et al.* 2007). Tunnelling within the urban area is related to interfacing with the built structures. Some tunnelling methods could inevitably induce ground movements and surface settlements, which may cause excessive deformations and damage to existing nearby structures and utilities (Fang *et al.* 2011). Moreover, ground settlement and tunnel collapse would also result from the lack of prompt analysis of the monitoring results and deficient supervision of the work and communication between the different teams (Sousa, Einstein 2012). As the main activities of tunnel construction usually lie in series along the critical time path, the standstill of any activity, for example due to the ground settlement, could lead to a stoppage in construction process and exceptional cost and time (Isaksson, Stille 2005). Under such circumstances, it is also impossible to change the current work site because the tunnel has to be excavated sequentially. Thus, the impact of settlement on built structures and ground settlement control were recognized as pressing issues in underground rail construction (Osborne *et al.* 2008).

1.3. Risk allocation

Risk allocation is the division of responsibility associated with a possible loss or gain (Lam *et al.* 2007), and the procedure of assigning identified risks to the project participants (Li *et al.* 2010). To get started on risk allocation, principles are presented as guidelines on appropriately assigning obligations to the ICJV parties (Mead 2007). A commonly accepted principle is to allocate risks to the party best able to manage it at least cost (Hwang *et al.* 2013a; Xu *et al.* 2010). To ensure proper risk allocation, Mead (2007) suggested distinguishing between risks that are and are not within the control of the parties. If the risk is not within the control of the party, it will be futile even if this party accepts it as the risk may not be mitigated. In addition, Abednego and Ogunlana (2006) claimed that risk allocation strategies were more than just deciding which party should accept the risk and that adopting allocation principles was still inadequate for good risk allocation.

In the context of ICJVs, appropriate risk allocation is difficult because of unclear division of responsibilities and risks among ICJV parties (Favié *et al.* 2009), differences in professional background, knowledge and perspective, as well as problems in communications and

cooperation. In addition, the decision of allocating risk to a party may depend on a number of factors, such as the risk attitude of project participants and the capacity of risk management (Lam *et al.* 2007; Xu *et al.* 2010). Differences in risk attitude among ICJV parties can make risk allocation difficult. Other factors, such as brief JV agreements with limited clauses on risk allocation and differences in culture and working styles, are also likely to hinder appropriate risk allocation in ICJVs.

2. Methodology and data presentation

A comprehensive literature review was conducted to set a foundation for this study and to support the development of a survey questionnaire. Then, a pilot study was conducted with a couple of project managers with experience in underground rail ICJVs in Singapore to filter out relatively insignificant factors and risks. The finalized questionnaire consisted of four main sections. The first section included questions meant to profile the firms that participated in the survey. In the second section, the respondents were asked to rate the attractive and negative factors affecting the adoption of ICJVs. The third section investigated the risk criticalities (RCs) in underground rail ICJVs. In this section, 27 risks collected from the literature review (Kwok *et al.* 2000; Li *et al.* 1999; Osborne *et al.* 2008; Shen *et al.* 2001; Yeo 1995; Zhang, Zou 2007) were presented and classified into external, internal and project specific risks. The respondents were requested to rate the likelihood of occurrence (LO) and the magnitude of impact (MI) of each risk. In the fourth section, the respondents were asked to rate the importance of risk allocation within an ICJV and to assess the negative influence of the obstacles on risk allocation.

A total of 120 questionnaires were randomly sent out to the contractors with experience in underground rail ICJVs in Singapore. The information of these contractors was obtained from the Building and Construction Authority (BCA). The target respondents included middle and top management, who assumed the responsibility of risk management of projects. A total of 33 questionnaires were collected from 33 contractors, representing a response rate of 27.5%, which was in accordance with the norm of 20–30% with most questionnaire surveys on construction management (Akintoye 2000).

Despite the small sample size, statistical analysis could still be carried out because the central limit theorem holds true when the sample size is larger than 30 (Hwang *et al.* 2013b; Ott, Longnecker 2001).

Table 1 presents the summarized profile of the contractors. 57.6% of the respondents were from foreign firms while 42.4% were from local ones. In addition, the majority of the respondents were from the grade A1 (65.65%) and A2 (24.2%). According to the tender limits for each grade, contractors with grade A1 and A2 have higher levels of resources and expertise. As underground rail projects are public projects, the government would prefer to have the best qualified and

Table 1. Profile of contractors

Contractor profiles		Categorization	N	%
Foreign	Registry grades of contractors*	A1	15	45.5%
		A2	4	12.1%
		B1	0	0.0%
		B2	0	0.0%
Local	Registry grades of contractors*	A1	6	18.2%
		A2	4	12.1%
		B1	3	9.1%
Experience of contractors**		B2	1	3.0%
		1	19	57.6%
		2	12	36.4%
		3	2	6.0%

*BCA grading system: A1-unlimited tendering limit; A2-up to S\$85 mil.; B1-up to S\$40 mil.; B2-up to S\$13 mil.

**The number of underground rail ICJVs that a contractor had participated in.

experienced contractors due to the high importance and massive investments involved. In terms of the experience of the firms, 57.6% of them took part in only one underground rail ICJV while only 6% participated in three ICJVs.

3. Data analysis and discussions

3.1. Factors affecting adoption of ICJVs

Seven positive factors and six negative factors were presented in the questionnaire and rated using a five-point Likert scale (1 = least important; and 5 = most important). The perceived importance acted as scores used to calculate the mean score for each factor. Then, the factors were ranked based on their mean scores. The independent samples t-test was used to evaluate the differences in mean scores of all the factors between foreign and local contractors. In addition, the Spearman rank correlation coefficient (r_s) was calculated to measure the degree of agreement on the ranking of these factors. It is a method of computing a correlation between the ranks of scores of two groups rather than the scores themselves (Hwang *et al.* 2009).

Table 2 indicates that the top three attractive factors across both groups are similar. There were no significant differences in the mean scores between local and foreign firms as all the p-values obtained from the independent samples t-test were not significant at the 0.05 confidence level. This was further supported by the r_s of 0.873, showing a strong correlation between the importance rankings of attractive factors of both two firm groups. Hence, both foreign and local respondents shared similar views on the attractive factors of underground rail ICJVs.

Since underground rail construction involves high risks, “sharing of project risks” was ranked first by both groups, indicating that contractors did not wish to undertake such projects alone, especially when they did not

Table 2. Factors affecting adoption of ICJVs

Factors	Foreign		Local		<i>p</i> -value
	Mean	Rank	Mean	Rank	
<i>Attractive factors (r_s = 0.873*)</i>					
Sharing of project risks	4.47	1	4.07	1	0.236
Enhanced technology expertise	1.40	7	1.85	5	0.393
Increased capacity of resources	3.93	2	4	2	0.836
Increase credibility of pre-qualification	2.72	4	2.79	3	0.884
Financial benefits	2.76	3	2.79	3	0.964
To expand into local markets	1.92	5	1	6	0.332
Ability to gain knowledge on local market	1.63	6	1	6	0.292
<i>Negative factors (r_s = 0.943*)</i>					
Slower and more cautious decision-making	3.74	2	3.36	3	0.289
Differences in culture and working style	4.63	1	4.43	1	0.395
Time and communication required to minimize conflicts	3.32	3	3.5	2	0.569
Tensions that arise from ambiguity on who is in charge	2.00	4	2.36	4	0.375
Fear of the other party attempting to usurp own proprietary technology	1.64	5	1.6	5	0.937
Time-consuming and difficult termination process of JV	1.36	6	1	6	0.096

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

have the expertise in geotechnical works. The second top ranked factor “increased capacity of resources” allowed partners to pool their resources together to provide the services, which each participant cannot provide individually (Cushman *et al.* 1992). In addition, “financial benefits” was the third top ranked attractive factor. Cheaper capital and savings can be achieved as specialized foreign contractors have their own labour and equipment. Specialized contractors may prefer to pass the general construction works to the local general contractors as they would be able to bring out a tighter price. It was surprising to note that local firms did not perceive the ability to gain technology expertise as one of the top attractive factors of ICJVs. This differed from what the Singapore government had wished to achieve by introducing the PMS to

improve the skills and management of local contractors. The priority of the local contractors could be mainly to enhance their reputation to bring in more potential projects through ICJVs. By undertaking the project with a more established contractor, the alliance would be able to portray itself as a more technically formidable candidate for pre-qualification (Dalle, Potts 1999).

As for the negative factors of adopting ICJVs, there were no statistically significant differences in mean scores between both groups and there was a strong positive association between the perceived importance rankings. Since ICJVs are formed by construction firms from various countries with different cultures and working environments, both groups recognized “differences in culture and working style” to be the top negative factor. Due to these differences, participants may encounter difficulties in achieving an equitable risk allocation mechanism that should be mutually agreed by all parties. This may in turn lead to “slower and more cautious decision-making” and “time and communication required to minimize conflicts” that were ranked next by both groups. For example, the decision-making process may be stalled when there are different opinions and thus more time and communication is necessary for them to attain a win-win situation as much as possible.

Therefore, before entering into an ICJV, internal and external considerations should be made. As for the internal considerations, a firm should assess whether they are appropriate to work with other contractors in a project. Smaller firms should consider whether they have the resources and ability to manage such projects even on an ICJV basis. External considerations are concerned with selecting a right partner. Besides the qualification, the potential differences in culture and working styles and the possibilities of conflicts should also be considered.

3.2. Risk criticalities

The respondents were required to rate the likelihood of occurrence and impact of each risk that was faced by underground rail ICJVs. Risk criticalities were calculated using the following equations:

$$RC_j^i = LO_j^i \times MI_j^i; \quad (1)$$

$$RC^i = \frac{1}{n} \sum_{j=1}^n RC_j^i, \quad (2)$$

where: n – the number of the respondents; RC_j^i – the risk criticality of the i^{th} risk by the j^{th} respondent; LO_j^i – the LO of the i^{th} risk by the j^{th} respondent; MI_j^i – the MI of the i^{th} risk by the j^{th} respondent; and RC^i – the RC of the i^{th} risk.

Since the evaluation of risk criticalities is complex and vague qualitative linguistic terms are unavoidable (Wang *et al.* 2004), five-point Likert scales were adopted to rate the LO (1 – rarely; 2 – somewhat likely; 3 – likely; 4 – very likely; and 5 – almost definitely) and MI (1 – very small; 2 – small; 3 – medium; 4 – large; and 5 – very large) of each risk. Hence, the final scale

of risk criticality was on a full scale of 25. Risk factors were evaluated within each risk category and across all the categories based on their *RC* values as well as their intra-category and inter-category rankings (see Table 3 and Table 4).

3.2.1. *RC* values and ranks of internal risks

Among all the internal risk factors, the top three risks were the same in both foreign and local contractors. "Disagreement on accounting of profit and loss" was ranked first by both groups. Sharing profits and losses can be a sensitive issue between partners because the issue of profitability is of high concern to the contractors to sustain their operations. The equity share is usually determined by the scope of works. It is common to use the 49:51 equity shares to ensure the smooth progress of the project.

"Distrust between partner employees" was ranked second by both groups. This result revealed that both foreign and local firms emphasized the ability of their potential partners to manage projects as well as the trustworthy relationship. Hence, it is important to select right and trustworthy partners.

"Partner's lack of management competence and resourcefulness" was ranked third by both groups. This result implied that the management competence and resourcefulness of partners was emphasized by both foreign and local companies, which was also concerned with selecting right partners.

In addition, "technology transfer dispute" had low *RC* values and ranks in both foreign and local firms, implying that partners were generally comfortable with sharing technology, knowledge and experiences within an ICJV.

The results of the independent samples t-test indicated significant differences in the *RC* values of two risk factors between foreign and local contractors. Local contractors were less concerned with the financial situation of their foreign partner, which may be due to the established status of foreign contractors entering into the Singapore construction market to form ICJVs. In addition, local firms paid more attention to work allocation than their foreign partners. Such different opinions may result from the smaller size of local firms. In underground rail projects, the splitting of workload was more clear-cut for foreign specialized contractors as they only handled construction regarding tunnelling.

Table 4 shows there was not agreement between foreign and local firms in terms of the internal risk ranks, which was partly caused by the significant differences in the *RC* values of the two risks.

3.2.2. *RC* values and ranks of external risks

Among the external risk factors, "labour, material and equipment import restrictions" was ranked first by local firms and second by foreign firms. In Singapore, the labour, construction material and equipment supply greatly depended on imports. The recent increase in levy fees

for Singapore work permit holders caused a shortage of manpower. Import restriction on material or other countries' ban on material exports can cause skyrocketing material prices. One example is Indonesia's decision to ban exports of sand to Singapore in 2007. Underground rail projects required special equipment, such as TBMs, which were most likely to be available from the foreign specialized firms. Import restriction would make foreign contractors unable to bring their equipment or relevant resources to Singapore, thus preventing them from proceeding with the projects.

"Economy fluctuation" was the second most critical risk in local firms and the third in foreign firms. This risk was dominantly the most critical factor in the economical aspect as an economic slowdown would cause the construction market to shrink, thus impacting the operations of construction firms (Adnan 2008).

"Inconsistency in government policies, laws, and regulations" was ranked third by local firms and fourth by foreign firms. This result revealed that changes in government policies, laws, and regulations were still emphasized by construction firms and was consistent with the finding of Li *et al.* (1999), who found this factor to be the most critical external factor for the ICJVs in East Asia.

There were significant differences in the *RC* values of "language barrier", "security problems at project site", and "different social, cultural and religious background". The values of them in foreign firms were significantly higher than those in local contractors. Although local contractors were well-versed in English, this may not be the case for foreign contractors. For security problems, locals may be more at ease due to their familiarity with the environment, thus did not feel that security problem was a significant risk. In addition, foreign contractors ranked "different social, cultural and religious background" first while local firms ranked it fourth. It was not surprising foreign contractors concerned more about social, cultural and religious background because they may not be familiar with such issues in Singapore and these soft issues would influence the collaboration and communication among partners. The *RC* values of the other eight external risk factors had no significant differences between the two groups.

The Spearman rank correlation analysis indicated a positive correlation. Hence, despite the significant differences in the *RC* values of the three risk factors, there was still a significantly strong agreement on the *RC* ranks between both foreign and local contractors.

3.2.3. *RC* values and ranks of project specific risks

Among all the project specific risks, "partners disagree over some conditions in contract" was ranked first by both foreign and local contractors. A JV contract or agreement tends to indicate how the JV should progress alongside with the project. If JV partners have disagreements and some terms are not clearly defined, conflicts will eventually arise as the project proceeds and project objectives will be threaten.

Table 3. *RC* values and ranks of risk factors: Foreign vs. Local

Risk category	Risk factor	Overall		Foreign			Local			<i>p</i> -value
		<i>RC</i>	Rank	<i>RC</i>	Intra-category rank	Inter-category rank	<i>RC</i>	Intra-category rank	Inter-category rank	
Internal risks	Policy changes in partner's parent company towards ICJV	10.42	13	10.21	5	14	10.71	6	12	0.657
	Partner's parent company in financial problems	7.58	18	9.16	6	16	5.43	9	24	0.000*
	Over-interference by parent company of either partner	11.18	8	11.37	4	10	10.93	5	9	0.563
	Partner's lack of management competence and resourcefulness	11.61	5	11.47	3	9	11.79	3	5	0.71
	Distrust between partner employees	12.06	3	11.84	2	6	12.36	2	3	0.697
	Disagreement on allocation of staff positions in ICJV company/project team	7.36	19	6.68	8	23	8.29	7	15	0.061
	Disagreement on allocation of works	9.55	16	8.37	7	18	11.14	4	7	0.024*
	Disagreement on accounting of profit and loss	12.48	2	12.26	1	4	12.79	1	2	0.583
External risks	Technology transfer dispute	5.94	24	5.84	9	24	6.07	8	21	0.746
	Inconsistency in government policies, laws and regulations	10.39	14	10.11	4	15	10.79	3	11	0.575
	Labor, material and equipment import restrictions	12.00	4	12.05	2	5	11.93	1	4	0.881
	Restrictions on fund repatriation	4.88	26	5.16	11	27	4.5	10	26	0.511
	Economy fluctuation	11.09	9	10.84	3	13	11.43	2	6	0.639
	Inflation	6.61	23	6.84	9	22	6.29	7	20	0.438
	Exchange rate fluctuation	6.70	22	7.26	7	20	5.93	8	22	0.093
	Force majeure	7.00	21	7.21	8	21	6.71	6	19	0.532
	Pollution	7.76	17	7.84	6	19	7.64	5	18	0.768
	Language barrier	7.27	20	8.42	5	17	5.71	9	23	0.000*
Project specific risks	Different social, cultural and religious background	11.58	6	14.11	1	2	8.14	4	16	0.000*
	Security problems at project site	4.15	27	5.79	10	25	1.93	11	27	0.000*
	Partners disagree over some conditions in contract	14.33	1	14.26	1	1	14.43	1	1	0.877
	Client's excessive demands and variations	11.00	10	11.05	5	11	10.93	3	9	0.891
	Client's cash flow problems	5.33	25	5.74	7	26	4.79	7	25	0.314
	Poor relationship between JV team and client or consultant	10.61	11	11.68	3	7	9.14	4	13	0.071
	Incompetence of local subcontractors and material suppliers	11.39	7	11.63	4	8	11.07	2	8	0.486
Ground settlement	10.61	11	12.58	2	3	7.93	6	17	0.001*	
Settlement control (structures)	10.06	15	10.95	6	12	8.93	5	14	0.048*	

* Independent t-test is significant at the 0.05 level (two-tailed).

“Incompetence of local subcontractors and material suppliers” was the second and fourth most critical project specific risk factor for local and foreign contractors, respectively. High *RC* values indicated that uncertainties concerning the technical qualifications, timeliness, reliability, and financial stability of subcontractors and suppliers were very critical to an

ICJV because these risks would lead to time and cost overruns during construction (Akinci, Fischer 1998; Li *et al.* 1999). Hence, it was recommended to use experienced and familiar subcontractors and suppliers (Li *et al.* 1999).

“Client's excessive demands and variation” received the third critical position in local contractors and the fifth

Table 4. *RC* values of risk categories and the Spearman rank correlation

Risk category	<i>RC</i>		Spearman correlation			
	Foreign	Local	Intra-category		Inter-category	
			r_s	<i>p</i> -value	r_s	<i>p</i> -value
Internal risks	9.69	9.95	0.738	0.058	0.742	0.004*
External risks	8.69	7.36	0.818	0.018*		
Project specific risks	11.13	9.60	0.536	0.209		

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

position in foreign firms. It merits attention that the *RC* values of this risk in both groups were high, implying that it was very critical to an ICJV because this risk would result in change of work allocation, disrupt work, and increase claims (Li *et al.* 1999).

“Poor relationship between JV team and client or consultant” was ranked fourth by local firms and third by foreign firms. This revealed that foreign firms attached more importance to the relationship with the client. Since all the MRT projects share the same client in Singapore, namely the Land Transport Authority (LTA), maintaining a good relationship with the client is crucial for foreign contractors and ICJVs to win contracts.

Both foreign and local contractors ranked “client’s cash flow problems” bottom with low *RC* values. As the LTA is a statutory board under the Ministry of Transport, its cash flow can be supported by the Singapore government. Hence, this risk was not critical to an ICJV of underground rail projects.

The results of the independent samples t-test indicated that there were significant differences in the *RC* values of “ground settlement” and “settlement control (structures)” between foreign and local contractors. As it was common in Singapore’s underground rail ICJVs that local contractors were responsible for general works and foreign firms for specialized works, this may result in different viewpoints on risks related to underground works. Since these two risk factors were mainly concerned with geotechnical works and did not lie under the liabilities of local contractors, these two risks were deemed less critical to local firms than to foreign ones.

The analysis results indicated no significant correlation between the *RC* rankings of the two groups. Thus, there was not agreement on the project specific risk ranks between foreign and local firms, partly caused by the significant differences in the *RC* values of the two geotechnical risks.

3.2.4. *RC* values and ranks of all the risks

Risk factors were ranked across risk categories based on their *RC* values assigned by foreign and local firms, respectively (Table 3). The inter-category r_s was 0.742,

indicating significant agreement on the ranking of all the factors between foreign and local contractors.

The *RC* values of the three risk categories were calculated. The risk category *RC* value was the mean value of *RC* values of all the risk factors falling within this category. The results indicated that project specific risks were more critical to foreign firms, and that internal risks were more critical to local firms in underground rail ICJVs. Hence, foreign contractors venturing into the Singapore construction market had to face higher risk exposure. This echoed the viewpoint of Zhi (1995) that inadequate overseas information and experience would lead to a higher risk exposure in the international market.

Furthermore, risk factors were ranked based on the overall *RC* values assigned by all the respondents (Table 3). “Partners disagree over some conditions in contract”, “disagreement on accounting of profit and loss”, “distrust between partner employees”, “labour, material and equipment import restrictions”, and “partner’s lack of management competence and resourcefulness” were the top five critical risk factors for all the contractors in underground rail ICJVs, which implied these five risk factors should be emphasized when setting up ICJVs. By contrast, “inflation”, “technology transfer dispute”, “client’s cash flow problems”, “restrictions on fund repatriation”, and “security problems at project site” were the bottom five risk factors. Hence, these five risk factors were not significant in Singapore underground rail projects.

The two risks related to technical problems, “ground settlement” and “settlement control (structures)” were ranked 11th and 15th, respectively. Their relatively low overall ranks may lend support from the fact that such technical risks can occur regardless of delivery methods and thus are recognized as common and general problems in underground rail projects. Professional engineering contractors can identify these obvious risks early within the project life cycle and thus develop mitigation strategies and emergency plans to deal with them.

3.3. Risk allocation

Both foreign and local contractors rated the perceived importance of risk allocation within an ICJV using a five-point Likert scale (1 – very unimportant; 2 – unimportant; 3 – medium; 4 – important; 5 – very important). The results indicated that all the respondents recognized risk allocation within an ICJV to be important and necessary. Risks should be allocated to appropriate parties in the ICJV. However, appropriate risk allocation is hindered by some factors.

Six obstacles to appropriate risk allocation were presented in questionnaires. The negative influence of the obstacles on risk allocation was assessed using a five-point Likert scale (1 – very small; 2 – small; 3 – medium; 4 – large; 5 – very large).

“Differences in culture and working styles” was ranked first by foreign firms while it was ranked bottom by local firms. Local firms did not feel that it was a

Table 5. Obstacles to appropriate risk allocation

Obstacles	Foreign		Local		<i>p</i> -value
	Mean	Rank	Mean	Rank	
Unclear division of responsibilities and risks among ICJV partners	3.89	3	4.07	1	0.472
ICJV partners could not come to an agreement on allocation of some risks	3.74	5	3.64	5	0.758
No risk allocation standards to follow	3.63	6	3.71	3	0.817
Brief joint venture documents with limited clauses on assignment of risks among partners	4.11	2	3.93	2	0.578
Differences in risk attitude	3.79	4	3.71	3	0.830
Differences in culture and working styles	4.21	1	3.5	6	0.014*

The perceived importance of risk allocation = 4.52;
p-value = 0.000 (one-sample *t*-test, mid value = 3).

The Spearman correlation $r_s = -0.029$.

*Independent samples *t*-test is significant at the 0.05 level.

very significant obstacle to appropriate risk allocation for them due to their familiarity with the construction laws and the operation of construction projects in Singapore. However, foreign firms recognized the influence of this factor to be large because they may be unfamiliar with the Singapore construction market. The difference between the opinions was significant.

“Unclear division of responsibilities and risks among ICJV partners” was ranked top by local firms and third by foreign firms. Some contractors may not be comfortable with sharing the partners’ risks or the risks that they were unclear of.

“Brief JV documents with limited clauses on assignment of risks among partners” received the second position in both foreign and local firms. Hence, JV agreements should be detail enough and include sufficient clauses that clearly and unambiguously state risk allocation among ICJV partners.

The results of the independent samples *t*-test indicated that except “differences in culture and working styles”, both foreign and local firms assigned similar scores to other five obstacles. However, the r_s of -0.029 was close to 0, suggesting that there was not significant agreement on the ranking of the obstacles between the two groups.

Conclusions

ICJVs have been widely used in underground rail projects in Singapore. The adoption of ICJVs is affected by attractive and negative factors. The respondents from both foreign and local firms perceived “sharing of project risks”, “increased capacity of resources” and “financial benefits” as the top attractiveness of adopting ICJVs. Prior to setting up an ICJV, firms should also consider negative factors. “Differences in culture and working

style”, “slower and more cautious decision-making”, and “time and communication required to minimize conflicts” were the top three negative factors of ICJVs for both foreign and local firms, despite differences in their ranks. These three factors made ICJVs less attractive, and there should be a trade-off between the effects of attractive and negative factors.

A total of 27 risk factors were ranked based on their perceived criticalities. At the category level, project specific risks were more critical to foreign firms while internal risks were more critical to indigenous firms. The Spearman rank correlation results indicated the significant agreement on the ranking of external risks. Despite the lack of agreement on the rankings of internal and project specific risks, there was agreement on the overall ranking of all the risk factors between the two groups. In addition, the independent samples *t*-test results indicated no significant differences in the criticalities of 20 risk factors between foreign and local firms.

In addition, although all the respondents recognized appropriate risk allocation as important, obstacles to risk allocation still existed. From the perspective of foreign contractors, differences in culture and working styles had the most negative influence on appropriate risk allocation, while local firms regarded unclear division of responsibilities and risks as the top obstacles. Also, it is necessary to consider differences in culture and working styles prior to setting up an ICJV and to ensure that the ICJV agreement is clear and unambiguous in responsibility division and has adequate and clear clauses relevant to risk allocation. A risk allocation matrix (Wagner 2006) and/or a risk allocation model (Favié *et al.* 2009; Li *et al.* 2010), which elaborates the fundamental steps of risk allocation, can be used to assist risk allocation in ICJVs.

Despite the achievement of the objectives, there were some limitations to conclusions that may be drawn from the results. First, as the sample size in this study was small, cautions should be warranted when the analysis results are interpreted and generalized. Also, the factors affecting the adoption of ICJVs, risk factors as well as obstacles to effective risk allocation would not be exhaustive. Lastly, the findings from this study were well interpreted in the context of Singapore but they may be applicable to underground rail ICJVs in other countries.

Nonetheless, this study still provides an in-depth understanding of ICJVs in underground rail projects in Singapore. This research started from a common and generic knowledge base involving ICJVs and risk management. There are common and geographically specific factors and risks affecting ICJVs no matter where these projects are performed. The implications of this study lie in investigating the attractive and negative factors, critical risks and obstacles to appropriate risk allocation, which are geographically specific to the underground rail ICJVs in Singapore. However, the findings provide valuable information for the international organizations that intend to participate in underground rail construction in Singapore. In addition, this study expands the literature

by investigating the differences in the opinions of local and foreign companies, thus enabling both local and foreign firms to understand the critical risks when they participate in underground rail ICJVs.

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