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Publisher: Routledge
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Construction Management and Economics
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rcme20

Risk management framework for construction projects in developing countries

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Published online: 13 May 2010.

To cite this article: Shou Qing Wang , Mohammed Fadhil Dulaimi & Muhammad Yousuf Aguria (2004) Risk management framework for construction projects in developing countries, Construction Management and Economics, 22:3, 237-252, DOI: 10.1080/0144619032000124689

To link to this article: http://dx.doi.org/10.1080/0144619032000124689

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Construction Management and Economics (March 2004) **22**, 237–252

Spon Press
Taylor & Francis Group

Risk management framework for construction projects in developing countries

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It is important to manage the multifaceted risks associated with international construction projects, in particular in developing countries, not only to secure work but also to make profit. This research seeks to identify and evaluate these risks and their effective mitigation measures and to develop a risk management framework which the international investors/ developers/ contractors can adopt when contracting construction work in developing countries. A survey was conducted and twenty-eight critical risks were identified, categorized into three (country, market and project) hierarchical levels and their criticality evaluated and ranked. For each of the identified risks, practical mitigation measures have also been proposed and evaluated. Almost all mitigation measures have been perceived by the survey respondents as effective. A risk model, named Alien Eyes' Risk Model, which shows the hierarchical levels of the risks and the influence relationship among the risks, is also proposed. Based on the findings, a qualitative risk mitigation framework was finally proposed which will benefit the risk management of construction project in developing countries.

Keywords: Risk management, risk identification, risk mitigation, risk model, international construction project, developing countries

Introduction

Prevalent 1997 recession which stagnated Singapore's economy and created a saturated construction industry has compelled Singapore's investors, developers and contractors to explore new vistas globally. It is clear that competing in a small domestic market offers very little opportunities for the industry to grow. The Construction 21 Report (C21 Steering Committee, 1999) has therefore firmly put the issue of 'building the external wing of the construction industry' on the agenda to promote and encourage Singaporean construction firms to venture overseas. However, the same report recognizes that to perform well in the international construction market especially in developing countries will not be easy as the risk of working in a foreign environment is multifaceted.

Nonetheless, demands for infrastructure and services in developing countries have created much greater opportunities compared to the stagnant domestic construction industry and motivated Singaporean firms to venture overseas. China is one of such developing countries in which the opportunity for Singaporean firms is likely to be great especially after China's admission to WTO in 2001 and China's success in bidding for the 2008 Olympic Games.

The aim of this research is to help international construction firms, especially Singaporean construction firms, identify the risks foreign construction firms may face in operation in developing countries and to develop a risk management framework to aid their effort in mitigating such risks. The research objectives are:

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Construction Management and Economics
ISSN 0144-6193 print/ISSN 1466-433X online © 2004 Taylor & Francis Ltd
http://www.tandf.co.uk/journals
DOI: 10.1080/0144619032000124689

- to develop a model for identifying, categorizing and representing the risks associated with international construction projects;
- to validate the model through an international survey to identify and evaluate the critical risks associated with construction projects in developing countries with emphasis on China;
- to identify and evaluate the practical measures for mitigating these risks;
- to formulate a risk management framework that can be adopted by international construction firms, including Singaporean firms, seeking work in developing countries.

Concepts of risk and risk management

Risk is a multi-facet concept. In the context of construction industry, it could be the likelihood of the occurrence of a definite event/factor or combination of events/factors which occur during the whole process of construction to the detriment of the project (Faber, 1979), a lack of predictability about structure outcome or consequences in a decision or planning situation (Hertz and Thomas, 1983), the uncertainty associated with estimates of outcomes – there is a chance that results could be better than expected as well as worse than expected (Lifson and Shaifer, 1982), etc. This research has adopted the more general and broad definition of risk as presented by Faber (1979).

In addition to the different definitions of risk, there are various ways for categorizing risk for different purposes too. For example, some categorize risks in construction projects broadly into external risks and internal risks while others classify risk in more detailed categories of political risk, financial risk, market risk, intellectual property risk, social risk, safety risk, etc (Songer *et al.*, 1997).

The typology of the risks seems to depend mainly upon whether the project is local (domestic) or international. The internal risks are relevant to all projects irrespective of whether they are local or international. International projects tend to be subjected to the external risk such as unawareness of the social conditions, economic and political scenarios, unknown and new procedural formalities, regulatory framework and governing authority, etc. These risks gain predominance when the consideration is solely given to international projects alone (Flanagan and Norman, 1993).

Hastak and Shaked (2000) classified all risks specific to whole construction scenario into three broad levels, i.e. country, market and project levels. The research has found this classification useful in portraying the influence of one risk on the others and in prioritizing the mitigation measures for each of the risks. Country level risks are seen as a function of the political and macroeconomic stability. They materialize when the authorities of the country expropriate property, introduce foreign currency exchange or trade restrictions or change trade legislation, etc. Macroeconomic stability is partly linked to the stance of fiscal and monetary policy, and to a country's vulnerability to economic shocks. Construction market level risks, for a foreign firm, include technological advantage over local competitors, availability of construction resources, complexity of regulatory processes, and attitude of local and foreign governments towards the construction industry while project level risks are specific to construction sites and include logistic constraints, improper design, site safety, improper quality control and environmental protection, etc (Thobani, 1999).

Risk is inherent and difficult to deal with, and this requires a proper management framework both of theoretical and practical meanings. Risk management is a formal and orderly process of systematically identifying, analysing, and responding to risks throughout the life-cycle of a project to obtain the optimum degree of risk elimination, mitigation and/or control. Significant improvement to construction project management performance may be achieved from adopting the process of risk management (Flanagan and Norman, 1993).

The types of exposure to risk that an organization is faced with are wide-ranging and vary from one organization to another. These exposures could be the risk of business failure, the risk of project financial losses, the occurrences of major construction accidents, default of business associates and dispute and organization risks. It is desirable to understand and identify the risks as early as possible, so that suitable strategy can be implemented to retain particular risks or to transfer them to minimize any likely negative aspect they may have.

A systematic approach to risk management in construction industry consists of three main stages: a) risk identification; b) risk analysis and evaluation; and c) risk response. The risk management process begins with the initial identification of the relevant and potential risks associated with the construction project. It is of considerable importance since the process of risk analysis and response management may only be performed on identified potential risks. Risk analysis and evaluation is the intermediate process between risk identification and management. It incorporates uncertainty in a quantitative and qualitative manner to evaluate the potential impact of risk. The evaluation should generally concentrate on risks with high probabilities, high financial consequences or combinations thereof which yield a substantial financial impact. Once the risks of a project have been identified and analysed, an appropriate method of treating risk must be adopted. Within a framework of risk management, contractors should decide how to handle or treat each risk and formulate suitable risk treatment strategies or mitigation measures. These mitigation measures are

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generally based on the nature and potential consequences of the risk. The main objective is to remove as much as possible the potential impact and to increase the level of control of risk. The more control of one mitigation measure on one risk the more effective the measure is. The process of risk management does not aim to remove completely all risks from a project. Its objective is to develop an organized framework to assist decision makers to manage the risks, especially the critical ones, effectively and efficiently (Perry and Haynes, 1985).

Past research on risk management

There is extensive literature in the field of risk management of construction projects. For example, Bajaj *et al.* (1997) identified, investigated and evaluated the process of risk identification. They found that the most frequently used method of risk identification is the top-down approach technique, where the project is analysed from an overall point of view. Baker *et al.* (1999) believed personal and corporate experience, engineering judgement, and brainstorming to be effective ways for identifying new risks and for qualitative use. Ramcharran (1998) identified the risks usually faced by the engineering/construction service providers in a foreign country, while Kalayjian (2000) identified further the risks that are specific to the developing countries. Haarmeyer and Mody (1997) explained the critical risks by focusing on specific developing countries such as Guinea and Mexico. Jaselskis and Talukhaba (1998) described the main characteristics of developing countries and identified the top information requirements in 15 key areas for architectural, engineering, and construction firms. Thobani (1999) discussed the proper risk allocation in developing countries arguing that investors should bear the exchange and interest rate risks. Many researchers also draw lessons of risk management from international construction projects in developing countries (Raftery *et al.*, 1998; Li *et al.*, 1999; etc).

In the context of China, Silk and Black (2000) proposed several mitigation strategies for the risks in China and strongly recommended the joint venture (JV) type of vehicle. Luo (2001) concluded further that share control is the most favorable method of JV management in China. Wang *et al.* (2000a, 2000b) identified and evaluated the unique and critical risks associated with the build-operate-transfer (BOT) projects in China. Cheng and Chung (2001) found that the monopoly in China power projects lends itself to major corruption and proposed several mitigation measures.

Other researchers have examined the different approaches to risk management in some developing countries, for example, the risk of differences between enterprise stake holders in several projects (Yeo and Tiong, 2000), the risk management of a power project in India (Gupta and Sravat, 1998), the risks in a hydro power project in Turkey (Ozdoganm and Birgonul, 2000) and the common risks in Kazakhstan (Munns *et al.*, 2000).

Research method

To meet the research objectives four research tasks have been carried out mainly through literature review, interviews and discussions as well as an international survey, as graphically presented in Figure 1.

As shown in Figure 1, the research began with a heavy literature review to compile the list of risks of construction project and the list of mitigation measures for each of the risks identified as well as to examine existing risk models. Then the risks and their mitigation measures identified were filtered and a risk model and a risk management framework proposed after discussion among the research team members together with some experienced academicians. To validate the proposed risk model and risk management framework, it needs to understand well the criticality of the identified risks and the effectiveness of the mitigation measures. Therefore, an international questionnaire survey was carried out. After analysing the survey results, the risk model and risk management framework were improved and documented.

The questionnaire was designed based on the knowledge obtained from literature review, interviews and discussions. Hastak and Shaked's (2000) three-level (country, market and project) risk categorization has been adopted for this questionnaire. The questionnaire encompasses all major risks that are likely to be encountered in international construction projects especially those in developing countries (Table 1) as well as all the practical mitigation measures for each of the risks identified (Table 2). The questionnaire was amended several times while conducting review and discussion sessions with five local academics and professionals and its final version is represented in Table 1 and Table 2 (Wang and Dulaimi, 2002).

As the evaluation of the criticality of risk is a complex subject shrouded in uncertainty and vagueness, such vague terms are unavoidable since project managers find it easier accessing risks in qualitative linguistic terms. To improve the preciseness and reliability of the survey, a seven-degree rating system for the criticality of risks and the effectiveness of mitigation measures, as shown in Table 3, have been adopted.

The survey was carried out from September to December 2001 targeting project sponsors, developers, investors and contractors from all over the world who have experience in the initiation, funding, planning and construction of international construction projects in developing countries. In total 400 hardcopy questionnaires were sent out by post to selected companies which are filtered from various lists, e.g. CNR of international investors, developers and contractors, and softcopy was also sent by email to the

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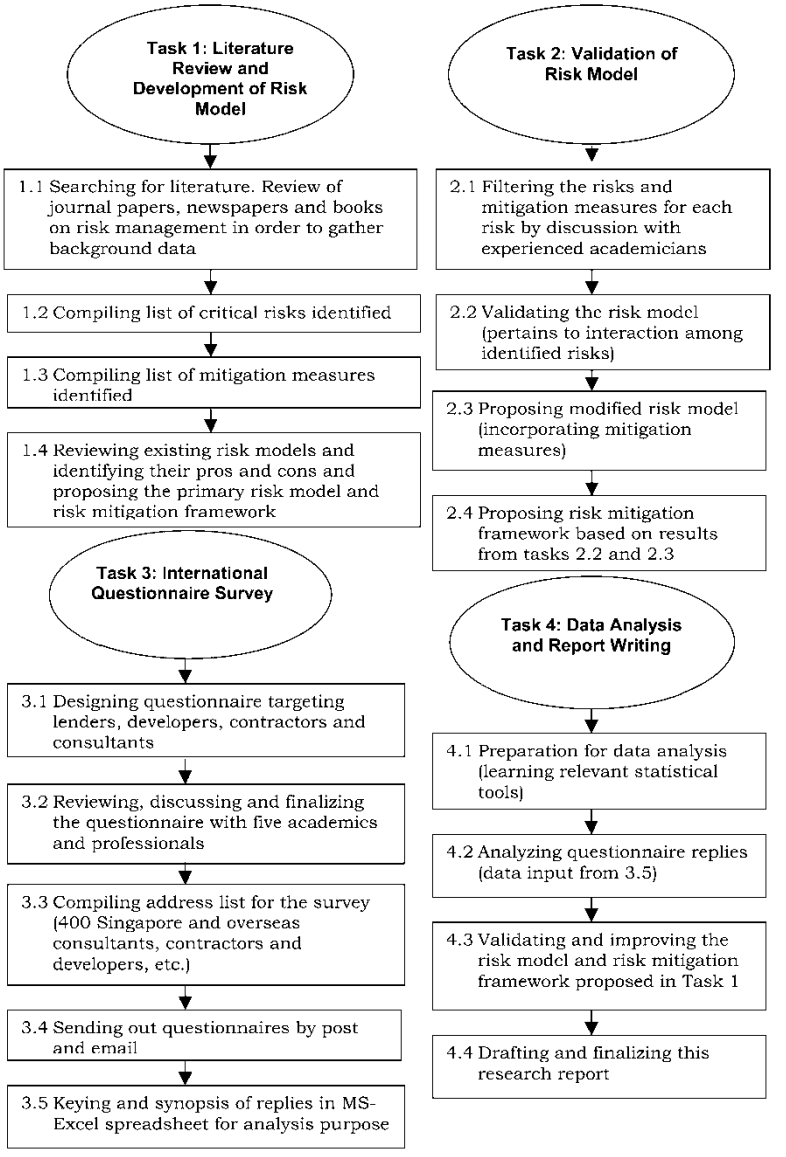

Figure 1 Research tasks

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CNBR (Co-operative Network for Building Researchers) members asking them to help disseminate the questionnaire to suitable practitioners. However, the respondent rate was unexpectedly low and only 31 valid replies (7.75%) were received although an incentive that survey participants will get the research report was stated in the questionnaire. One of the reasons may be that the questionnaire is very comprehensive consisting of 10 A4 pages, which may discourage some potential respondents from participating the survey. This low response rate would limit the generalization of the findings of the study. Nevertheless, the survey results are still meaningful as the 31 respondents are all at high management level in their respective companies and have concrete experience in international construction projects in developing countries. In addition, they have all shown great interests in the research, have filled in the questionnaire carefully and provided a lot of valuable comments. The following summarize the key findings of the survey. For more details, please refer to Wang and Dulaimi (2002).

The risk criticality and mitigation measure effectiveness

Criticalities of risks and risk levels

The criticality of the identified risks as shown in Table 4 is listed along with statistical indicators, the mean and standard deviation (SD), sorted by criticality ranking.

Table 1 Risks under hierarchy levels and their definitions

ID	Level
	Level I: country level
A1	Approval and permit: Delay or refusal of project approval and permit by local government
A2	Change in law: Local government's inconsistent application of new regulations and laws
A3	Justice reinforcement: Lack of legal judgment reinforcement
A4	Government influence on disputes: Unnecessary and unjust influence by local government on court proceedings regarding project disputes
A5	Corruption: Corrupt local government officials demand bribes or unjust rewards
A6	Expropriation: Due to political, social or economic pressures, local government takes over the facility run by foreign firm without giving reasonable compensation
A7	Quota allocation: Failure in obtaining fair import/export quota allocation from local government
A8	Political instability: Frequent changes in government; agitation for change of government or disputes between political parties or different organs of the state
A9	Government policies: Government policies on foreign firms, e.g. mandatory joint venture (JV); mandatory technology transfer; differential taxation of foreign firms, etc.
B1	Cultural differences: Differences in work culture, education, values, language, racial prejudice, etc., between foreign and local partners.
E1	Environmental protection: Stringent regulation which will have an impact on construction firms' poor attention to environmental issues
E2	Public image: Victim of prejudice from public due to different local living standards, values, culture, social system, etc
G1	Force majeure: The circumstances that are out of the control of both foreign and local partners, such as flood, fires, storms, epidemic diseases, war, hostilities and embargo
	Level II: market level
B2	Human resource: Foreign firms face difficulties in hiring and keeping suitable and valuable employees.
B3	Local partner's creditworthiness: Information on local partner's accounts lucidity, financial soundness, foreign exchange liquidity, staff reliability
B4	Corporate fraud: Unexpected increases in turnover, unexpected resignation of financial adviser, letter of credits with 'unreasonably round figures', intentional or unintentional negligence either by auditors, bankers or creditors
B5	Termination of Joint Venture (JV): Unfair dividends, e.g. assets, shares and benefits, to foreign firm by local partner upon termination of JV contract
C1	Foreign exchange and convertibility: Fluctuation in currency exchange rate and/or difficulty of convertibility
C2	Inflation and interest rates: Unanticipated local inflation and interest rates due to immature local economic and banking systems
H1	Market demand: Inadequate forecast about market demand
H2	Competition: Competition from other international investors/developers/contractors.
	Level III: project level
C3	Cost overrun: Unavailability of sufficient cash flow, improper measurement and pricing of Bill of Quantities (BOQ), ill planned schedule and client's delay in payment
D1	Improper design: Unanticipated design changes and errors in design/drawings resulting from the difference in local design custom and practices.
D2	Low construction productivity: Obsolete technology and practices by local partner; or low labour productivity of local workforce owing to poor skills or inadequate supervision
D3	Site safety: High rate of accidents during construction or operation phases
D4	Improper quality control: Local partner tolerance of defects and inferior quality
D5	Improper project management: Improper project planning, budgeting; inadequate project organization structure; and incompetence of local project team
F1	Intellectual property protection: Former local employees, partners and/or third parties steal company's intellectual property, commercial secrets or patent formulae

The Total Criticality Index is the sum of all rated indexes (1 to 7) for each risk by all respondents while the Mean Criticality Index is the average index for each risk obtained by dividing the Total Criticality Index by total number of respondents. The ranking of risks is directly based on the Mean Criticality Index.

It could be seen from Table 4 that 22 out of 28 risks having mean criticality index between 4 (i.e. Critical) and 6 (i.e. Very Much Critical). It follows that respondents perceive about 78% of identified risks within critical to very critical range.

It could also be seen from Table 5 that out of the top

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Table 2 Mitigation measures for each of the risks identified

ID	Mitigation measures
	Mitigation measures for risk #A1: approval and permit
M1	Ensure the project is complying with local planning commission's development plan
M2	Ensure the feasibility study report and contract depict local government, local partner and foreign party's actual intentions (like anticipated profits, risk sharing)
M3	Prepare and submit all necessary documents and feasibility study report in a timely manner to local government departments
M4	Establish JV with renowned local partners, especially the central government agencies or state owned enterprises
M5	Maintain good relationship with local government and higher officials
M6	Ask local government to establish one stop agency for all approvals
M7	Pre-package all approvals when signing contract with project client
M8	Obtain support of foreign firm's home government and international monetary institutions like World Bank and Asia Development Bank (ADB) against delay in approval and permit
	Mitigation measures for risk #A2: change in law, and for risk #A3: justice reinforcement
M1	Obtain local government guarantee to adjust tariff or extend concession period (for Build-Operate-Transfer (BOT) projects)
M2	Maintain good relationship with local government and higher officials
M3	Obtain insurance for political risks
M4	Include clauses for delays and additional payments in contract, which occur due to new rules or change in law
M5	Seek support from international developers/contractors' home government
M6	Rely on combination of international consortium, joint international convention and insurance policies (especially political insurance) to protect investment in the project
M7	Obtain support of international monetary institutions like World Bank and ADB against discrimination and harassment by local government in legal procedures
	Mitigation measures for risk #A4: government influence on disputes
M1	Provide dispute settlement clauses in the contract
M2	Ensure the approval is sought at the right local government departments
M3	Maintain good relations with concerned local government officials and concerned authorities
M4	Establish JV with local partners especially the central local government agencies or state owned enterprises
	Mitigation measures for risk #A5: corruption
M1	Establish JV with renowned local partners, especially the central local government agencies or state owned enterprises
M2	Enter into contract with local government authorities to prevent corruption
M3	Set aside a budget for unavoidable spending
M4	Cultural and commercial awareness training to management and key personal who may have to deal with corrupt officials
M5	Try to work directly with the business connections, i.e. do not hire broker or middleman
M6	Obtain all necessary approvals in timely manner to minimize chance for corrupt individual to obstruct work
M7	Obtain support from foreign firm's home government and international monetary institutions like World Bank and ADB against misuse of power by local government or its agencies
M8	Maintain good relations with concerned local government officials and concerned authorities
	Mitigation measures for risk #A6: expropriation
M1	Be informed of political developments by making use of information sources like international security and risk assessment companies
M2	Develop contingency plans and obtain insurance for expropriation possibility
M3	Establish JV with local partners especially the central local government agencies or state owned enterprises
M4	Rely on combination of international consortium and insurance policies (especially political insurance)
M5	Maintain good relations with concerned local government officials and concerned authorities
M6	Obtain support from foreign firm's home government and international monetary institutions like World Bank and ADB against expropriation by local government or its agencies
	Mitigation measures for risk #A7: quota allocation
M1	Establish good relations with officials in concerned ministries
M2	Prepare and submit all necessary reports and feasibility study on time
M3	Establish JV with local partners especially the central local government agencies or state owned enterprises
M4	Obtain support from foreign firm's home government and international monetary institutions like World Bank and ADB against unfair quota allocation
	Mitigation measures for risk #A8: political instability
M1	Develop own contingency plans for possible political instability, such as plan for emergency evacuation
M2	Seek incorporation of termination or delay clauses in contract

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Table 2 (cont'd)

M3	Obtain insurance for political risks from international finance and risk assessment agencies
M4	Be informed of political developments by using information sources like international security and risk assessment companies
M5	Rely on combination of international consortium
M6	Establish JV with local partners especially the central local government agencies or state owned enterprise
M7	Maintain good relationship and connections with higher local government officials, local power sources like opulent persons and politicians
M8	Obtain support from foreign firm's home government during anticipated insurgency
	Mitigation measures for risk #A9: government policies
M1	Establish JV with local partners especially the central local government agencies or state owned enterprise
M2	Maintain good relationship and connections with higher local government officials, local power sources like opulent persons and politicians
M3	Obtain support from foreign firm's home government during anticipated insurgency
M4	Transfer ordinary technology only but keep the key ones
M5	Seek reasonable compensation scheme (lump sum, share in JV, profit) for technology transfer
M6	Study carefully the differential taxation and find legal and reasonable measures to reduce taxes
	Mitigation measures for risk #B1: cultural differences
M1	Undertake comprehensive negotiations and agreement with local government and partners
M2	Devise unambiguous and agreed risk sharing code at the time of contract
M3	Try to have as large an equity share as possible thus ensuring control of Board of Directors
M4	Insist on having trustworthy people on key places within the JV
M5	Hire company's own competent native language-speaking employee, even though some of the staff understand native language
M6	Provide dispute settlement clauses in the contract
	Mitigation measures for risk #B2: human resource
M1	Only take over the local partner's competent staff when merging with the partner or during the contract process
M2	Sign formal employment contract with every staff
M3	Employ staff on a contract through one local partner who is more familiar with one local set-up than foreign firm
M4	Decide on recruitment and selection criteria in consultation with one local partner
M5	Foreign firm should insist on having trustworthy people on key places within the JV
M6	Offer training to new and existing staff
M7	Offer better remuneration/incentive packages to staff
	Mitigation measures for risk #B3: local partner's creditworthiness
M1	Gain accurate financial and other information from international and independent security and risk evaluation agencies
M2	Examine the target company's financial viability, technical and management competence and connections with local government
M3	Maintain good relationships with top local government officers at state or provincial level to gain more information about prospective local partner
M4	Insist on having trustworthy people on key places within the JV
M5	Obtain guarantees or other credit support from reliable and credit worthy local and international entities
M6	Have clear contractual terms and conditions, agree on one accounting standard and define clear authority and responsibility in contract
M7	Pay careful attention to contract translation
M8	Hire company's own competent native language-speaking employee, even though some of the staff understand native language
M9	Insist that bilingual (English and local language) documents are prepared simultaneously and agreed in final form by all parties
M10	Define clearly the merging scope of assets, employees, shares, organization, strategies, etc. when merging with a local partner
	Mitigation measures for risk #B4: corporate fraud
M1	Get information about local partner's credibility from its present and past business partners
M2	Insist on having trustworthy people on key places within the JV
M3	Monitor present status and par/face value of share dealings of the JV
M4	Visit/check the factory or business regularly and irregularly
M5	All parties should agree on one accounting standard and hire one independent accountant
	Mitigation measures for risk #B5: termination of Joint Venture
M1	Choose to establish a cooperative JV and partnership

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Table 2 (cont'd)

M2	Provide comprehensive terms of default in the contract
M3	Try to have larger share of profit as early as possible
M4	Maintain good relationship and connections with higher local government officials, local power persons like opulent persons and politicians
M5	Insist on having trustworthy people on key places within the JV
	Mitigation measures for risk #C1: foreign exchange and convertibility
M1	Obtain local government guarantees of exchange rate and convertibility, e.g. fixed rate for long period or less fluctuation etc
M2	Use dual-currency contracts with certain portion to be paid in local currency and others in foreign currency
M3	Use other money transfer tools e.g. forward and swap that can hedge exchange rate
	Mitigation measures for risk #C2: inflation and interest rates
M1	Get Letter of Credit from local government
M2	Client to secure standby financing (i.e. more than 100% financing commitments when needed)
M3	Obtain payment and performance bonds from local and international banks
M4	Ensure that a reputable owner through international institute, e.g. ADB or World Bank, finances the project
M5	Adopt alternatives to contract payment, e.g. land development rights, resource swap
M6	Specify extension or compensation clauses in contract for payment
	Mitigation measures for risk #C3: cost overrun
M1	Secure standby cash flow in advance
M2	Measure and price Bills of Quantities properly during bidding stage
M3	Develop a clear and appropriate plan and control schedule and cost
M4	Incorporate escalation clauses for interest, inflation rates and delays in contract
M5	Obtain payment and performance bonds from local and international banks
M6	Ensure that a reputable owner through international institute, e.g. ADB, WORLD BANK, finances the project
M7	Sell foreign firm's shares to local public and local government to get their help
M8	Specify extension or compensation clauses in contract for payment
M9	Enter into fixed rate loan contract with lending banks
M10	Adopt as much as possible domestic product/labour to reduce cost
M11	Sign fixed or pre-determined prices with material and accessory facilities suppliers
	Mitigation measures for risk #D1: improper design
M1	Undertake pre-project planning to minimize design errors
M2	Adopt Design & Build option which enables contractor to design in harmony with site conditions thus minimizing design/drawing disputes
M3	Introduce adjustment clauses in contract to review plan and constructability
M4	Get Design liability insurance
M5	Arrange and undertake comprehensive site investigation before construction phase
M6	Specify construction extension clause in contract
M8	Organize for appraisal/vetting of drawings and design criteria by at least one independent engineering/architect consultant
	Mitigation measures for risk #D2: low construction productivity
M1	Adopt proper quality control procedures
M2	Organize site properly for maximum productivity
M3	Undertake probability and sensitivity analysis
M4	Adopt proper safety control programme
M5	Review plans jointly with local partner to determine changes
M6	Incorporate weather impacts into project schedule
M7	Apply innovative production concepts/philosophies like Lean Construction, Just In Time and Total Quality Management, to decrease variability and rework during construction
M8	Benchmark and monitor construction activities properly
	Mitigation measures for risk #D3: site safety
M1	Ensure that construction and operation are as per examination and concerned approving authority's expectation
M2	Get Third Party Insurance for compensation to general public and staff
M3	Study and implement the local accident regulations stringently and effectively
M4	Adopt proper safety control programme, management system, supervision, incentives and preventive measures
	Mitigation measures for risk #D4: improper quality control
M1	Adopt proper quality control procedures, supervision and incentives
M2	Review plans jointly with local partner to determine changes
M3	Implement ISO9000 and get certification

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Table 2 (cont'd)

	Mitigation measures for risk #D5: improper project management
M1	Hire competent project management team
M2	Employ local staff with bilingual ability
M3	Clear definition of each staff's scope of work
M4	Conflict resolution clause in contract and specify construction extension clause in contract if client causes the delay
M5	Provide notice provision and notice period in contract
M6	Provide clauses on schedule delay and additional payment if caused by client
	Mitigation measures for risk #E1: environmental protection
M1	Adopt strict pollution control measures
M2	Engage both local and international pollution control specialists
M3	Comply with international and/or local environmental laws, standards and regulations
M4	Include disclaimer in contract for present pollution level (conduct survey to see clear picture)
	Mitigation measures for risk #E2: public image
M1	Comply with local and international civil laws and standards, local social and cultural values
M2	Maintain good reputation and image to the public
M3	Give donations to renowned non-governmental organizations, which are involved in elevating the living conditions of poor
M4	Participate actively in public relation activates and charity
	Mitigation measures for risk #F1: intellectual property protection
M1	Place restrictive covenants (promises) in the contracts of employees
M2	Exploit local legislation to get protection against unauthorized use of confidential information
M3	Ensure that the local partner appreciates the advantages of having exclusive rights to that property i.e. shareholding in protection of intellectual property
M4	Limit the duration of technology transfer contract
M5	Negotiate on amount and speed of technology transfer
M6	Confirm whether a good local intellectual property protection scheme is in place for the key intellectual property like trademark, patent or copyright law
M7	Insist on having trustworthy people on key places within the JV
M8	Intellectual property rights training to all key employees by sending them to seminars
	Mitigation measures for risk #G1: force majeure
M1	A party which fails to meet his contractual obligation due to force majeure must notify the other one within a reasonable time
M2	Obtain local government guarantee to adjust tariff or extend concession period (for BOT projects)
M3	Insure all of the insurable force majeure risks
M4	Obtain local government's guarantee to provide financial help when needed
M5	Include delay clauses for contingency plan in contract
	Mitigation measures for risk #H1: market demand
M1	Employ reputable third party consultant to forecast market demand
M2	Maintain good relationship and connections with higher local government officials, local power sources like opulent persons and politicians
	Mitigation measures for risk #H2: competition
M1	Conduct market study and obtain exact information of competitive projects
M2	Adopt as much as possible domestic product/labour to reduce cost
M3	Establish agreement with local government agency to reduce/exempt from import formalities
M4	Maintain good relationship and connections with higher local government officials, local power sources like opulent persons and politicians

Table 3 Rating system for risk criticality and mitigation measure effectiveness

Rating	Risk criticality	Mitigation measure effectiveness
1	Not critical at all	Not effective at all
2	Slightly critical	Slightly effective
3	Somehow critical	Somehow effective
4	Critical	Effective
5	Very critical	Very effective
6	Very much critical	Very much effective
7	Exceptionally critical	Exceptionally effective

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Table 4 Statistical results on the criticality of risks

Risk ID	Risk description	Total criticality index	Mean index	Risk rank	Standard deviation
A1	Approval and permit	181.5	5.85	1	1.30
A2	Change in law	161.5	5.21	2	1.42
A3	Justice reinforcement	161.5	5.21	2	1.42
B3	Local partner's creditworthiness	154	4.97	4	1.36
A8	Political instability	150.5	4.85	5	1.98
C3	Cost overrun	150.5	4.85	5	1.58
A5	Corruption	148	4.77	7	1.36
C2	Inflation and interest rates	143.5	4.63	8	1.39
A9	Government policies	142.5	4.60	9	1.39
A4	Government influence on disputes	141.5	4.56	10	1.37
B5	Termination of JV	141.5	4.56	10	1.55
B4	Corporate fraud	141	4.55	12	1.46
H2	Competition	141	4.55	12	1.36
C1	Foreign exchange and convertibility	140.5	4.53	14	1.27
H1	Market demand	140.5	4.53	14	1.64
D1	Improper design	140	4.52	16	1.43
D5	Improper project management	140	4.52	16	1.54
D4	Improper quality control	138.5	4.47	18	0.92
A6	Expropriation	136.5	4.40	19	2.01
B2	Human resource	129.5	4.18	20	1.43
D2	Low construction productivity	127.5	4.11	21	1.28
A7	Quota allocation	126	4.06	22	1.48
G1	Force majeure	123	3.97	23	1.91
D3	Site safety	122.5	3.95	24	1.38
B1	Cultural differences	114	3.68	25	1.71
E2	Public image	110.5	3.56	26	1.37
F1	Intellectual property protection	107	3.45	27	1.54
E1	Environment protection	106	3.42	28	1.26

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11 most critical risks, seven risks (A1, A2, A3, A8, A5, A9 and A4) are in Country Level and this confirms that the Country Level is the most critical risk group. As Quartiles are often used to divide populations into groups and the third Quartile value is of important meaning which means that 25% of the populations are having values greater than it, the third Quartile values of each risk levels are also shown in Table 5. The third Quartile value of Country Level Criticality is 4.85, the highest of the three levels, confirming again that the Country Level is the most critical risk group. The next most critical group of risks is the Market Level as it contains two out of 11 most critical risks (B3 and C2) with the 3rd Quartile value of 4.58 of Level Criticality. While the Project Level represents only one risk (C3) in the top 11 most critical risks and with the lowest third Quartile value of 4.52 of Level Criticality.

Effectiveness of mitigation measures

Table 6 shows the mean effectiveness, rated by the respondents using the rating system in Table 3, of the mitigation measures for each of the risks. It is understandable that mitigation measures which are perceived to be of higher effectiveness value should be implemented with higher priority than that with less effectiveness one, i.e. the effectiveness dictates the implementation sequence of mitigation measures.

Table 6 also shows that all mitigation measures have been rated between 3.7 and 5.7. Hence all respondents have perceived the proposed measures as effective or very effective.

Proposed risk model

Risk influence matrix

Based on the above as well as literature review, interview and discussion, general wisdom and logical deduction, it could be drawn that there is relationship among risks at different levels (Flanagan and Norman, 1993; Thobani, 1999; Hastak and Shaked, 2000). The country level risks are influencing both the market and project levels risks, while the market level risks are influencing the project level risks (Table 7). The country level risks are therefore most dominant and at the highest hierarchical level while the project level risks are relatively the most dormant and

Table 5 Risk level criticality based on third Quartile value (75th percentile)

ID	Level	Criticality index (1, 2, . . . , 7)	Risk rank	Level criticality (3rd Quartile)
	Level I: Country Level			4.85
A1	Approval and permit	5.85	1	
A2	Change in law	5.21	2	
A3	Justice reinforcement	5.21	2	
A4	Government influence on disputes	4.56	10	
A5	Corruption	4.77	7	
A6	Expropriation	4.40	19	
A7	Quota allocation	4.06	22	
A8	Political instability	4.85	5	
A9	Government policies	4.60	9	
B1	Cultural differences	3.68	25	
E1	Environmental protection	3.42	28	
E2	Public image	3.56	26	
G1	Force majeure	3.97	23	
	Level II: Market Level			4.58
B2	Human resource	4.18	20	
B3	Local partner's creditworthiness	4.97	4	
B4	Corporate fraud	4.55	12	
B5	Termination of joint venture (JV)	4.56	10	
C1	Foreign exchange and convertibility	4.53	14	
C2	Inflation and interest rates	4.63	8	
H1	Market demand	4.58	13	
H2	Competition	4.50	18	
	Level III: Project Level			4.52
C3	Cost overrun	4.85	5	
D1	Improper design	4.52	16	
D2	Low construction productivity	4.11	21	
D3	Site safety	3.95	24	
D4	Improper quality control	4.47	18	
D5	Improper project management	4.52	16	
F1	Intellectual property protection	3.45	27	

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are in the lowest hierarchical level, just as were confirmed by the survey results summarized in Table 5.

Table 8, a much more comprehensive risk influence matrix, portrays the detailed influences of risks at one higher level, the dominant risks, on the risks at one lower level, the dormant risks (Flanagan and Norman, 1993; Thobani, 1999; Hastak and Shaked, 2000). It follows that the risk mitigation strategy should prioritize the risks with respect to dominance, i.e. the dominant risks should be mitigated before or with higher priority over the dormant ones. The goal is not only to mitigate the dominant risks but also their influence on subsequent dormant risks, which will ultimately minimize the dormant risks as well.

Take for example the influence of the human resources risk (B2, at the Market Level) on the cost overrun risk (C3, at the Project Level). 'B2→C3' means Risk B2 is influencing Risk C3. As suitable, competent and valuable employee ensure availability of proper measurement and pricing of Bill of Quantities (BOQ), and proper schedule. Another example, 'C1, C2→C3' means Risk C1 (foreign exchange and convertibility) and Risk C2 (inflation and interest rates) both influencing Risk C3 (cost overrun). This is true as fluctuation in currency exchange rate and/or difficulty of convertibility brings out cost overrun. And unanticipated local inflation and interest rates due to immature local economic and banking systems put forward unavailability of sufficient cash flow, improper pricing of BOQ and client's delay in payment, etc., all of which will result in cost overrun.

Alien eyes' risk model

Based on the above, if symbol A→B is used to represent the influence relationship of one event on the other, e.g. Risk A on Risk B, then the relationship among risks at the three levels could be represented in the proposed risk model as illustrated in Figure 2.

Apropos to consideration for the proposed risk model shown in Figure 2, some unique conceptual analogies were found between an Alien (extraterrestrial beings) and a risk's impact and interaction as discussed above. This

Table 6 Effectiveness of mitigation measures for each risk

Risk	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
A1	5.28	4.80	4.60	5.10	5.65	4.38	4.53	4.67			
A2/A3	4.98	5.32	4.52	4.70	4.15	4.67	4.23				
A4	4.97	4.82	5.08	5.07							
A5	4.25	3.87	4.83	4.80	4.27	4.15	4.05	4.92			
A6	4.20	4.45	4.92	4.40	4.80	4.35					
A7	4.92	5.00	4.92	4.18							
A8	4.60	4.63	4.90	4.52	4.28	4.73	4.78	4.20			
A9	4.73	5.00	4.20	4.20	4.62	4.90					
B1	4.50	4.65	4.73	5.28	4.85	4.87					
B2	4.40	4.75	4.40	4.93	5.45	5.28	5.28				
B3	5.05	5.22	4.73	5.30	4.97	5.42	5.33	4.83	5.08	5.13	
B4	4.92	5.37	4.78	5.25	5.53						
B5	4.83	4.92	4.38	4.68	5.03						
C1	4.65	4.98	4.77								
C2	4.27	4.68	5.12	5.03	4.20	4.87					
C3	5.10	5.38	5.40	5.02	4.75	5.00	3.72	4.45	4.45	4.70	5.05
D1	4.88	5.22	4.57	4.40	5.25	4.70	4.58				
D2	5.05	5.32	4.70	4.75	4.80	4.60	4.77	4.93			
D3	4.90	5.18	4.98	5.30							
D4	5.40	4.92	4.68								
D5	5.40	4.62	5.12	5.02	4.77	4.92					
E1	5.28	4.70	5.33	4.73							
E2	4.98	5.28	4.02	4.25							
F1	4.62	4.42	4.78	4.47	4.64	4.78	5.03	4.03			
G1	5.07	4.68	5.03	4.62	5.00						
H1	4.60	4.73									
H2	5.25	4.90	4.65	4.73							

Note: Refer to Table 1 and Table 2 for risk and mitigation measure IDs.

Table 7 Synopsis of risk influence among risk hierarchy levels

	Country level risks	Market level risks
Market level risks	<	
Project level risks	◀	←

Note:
< Influence of Country Level Risks on Market Level Risks
◀ Influence of Country Level Risks on Project Level Risks
← Influence of Market Level Risks on Project Level Risks

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is analogous to an Alien with two eyes. Secondly alien and risk share same nature as they both are uncertain, ambiguous, hard to understand, and may bring loss or danger. Therefore, to better reflect the characteristics of the proposed risk model, it is referred to as the Alien Eyes' Risk Model.

Proposed risk mitigation framework

Prioritizing mitigation measures

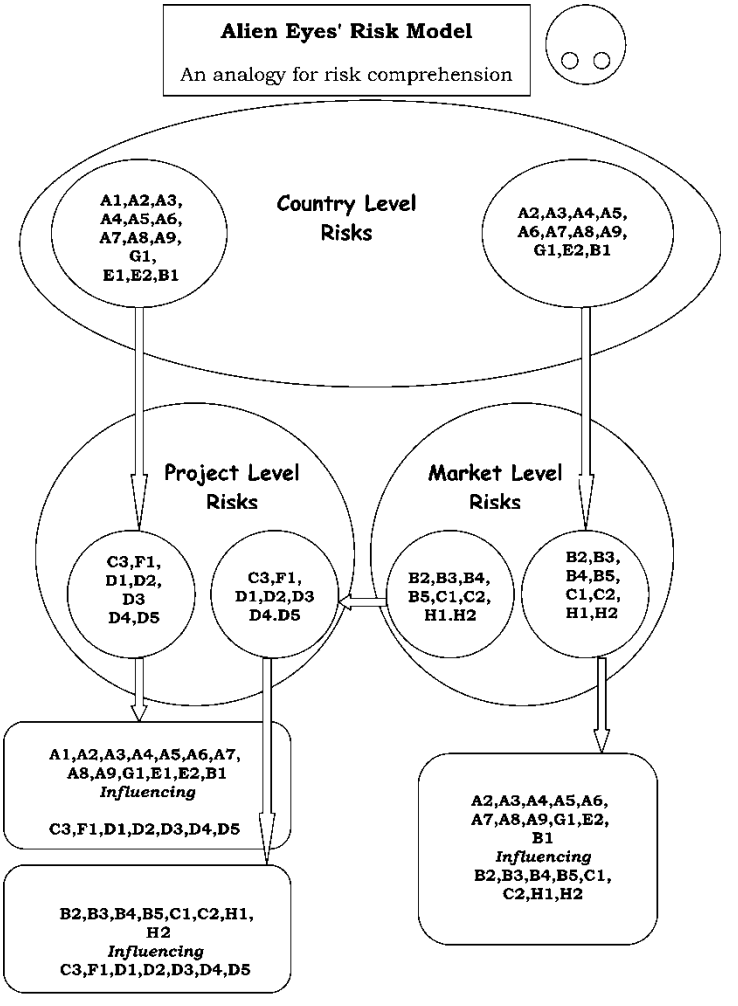
As discussed earlier, the mitigation measures for one risk should be prioritized with their effectiveness as summarized in Table 6 when they are implemented to mitigate the risk. Furthermore, as there is influencing relationship among risks under the three hierarchy risk levels, the prioritizing of mitigation measures should also take into account the risk hierarchy levels. This could be illustrated further by following example.

Let Risk A's Mitigation Measure 1 = A1M, Risk B's Mitigation Measure 1 = B1M and also assume the relationship between Risk A and Risk B is 'A→B' (i.e. Risk A is influencing Risk B or Risk B is influenced by Risk A), then there is 'A1M→B1M', which means that Risk A's Mitigation Measure 1 has to be implemented before the Mitigation Measure 1 for Risk B. This is because that Risk A is influencing Risk B and therefore prioritizing the Mitigation Measure 1 for Risk A will help to reduce the possible occurrence of Risk B.

Table 8 Risk influence matrix

		Country level risks												Market level risks							
		A1	A2/A3	A4	A5	A6	A7	A8	A9	G1	E1	E2	B1	B2	B3	B4	B5	C1	C2	H1	H2
Market level risks	B2		<						<			<	<								
	B3				<			<	<				<								
	B4		<	<	<			<					<								
	B5		<	<	<	<	<	<	<	<			<								
	C1		<				<	<	<	<											
	C2				<		<	<	<	<											
	H1									<											
	H2									<											
Project level risks	C3	◀	◀	◀		◀	◀	◀	◀	◀				←	←	←	←	←	←	←	
	D1		◀										◀	←						←	←
	D2	◀							◀			◀	◀	←							
	D3		◀		◀						◀			←							
	D4		◀		◀						◀		◀	←							
	D5		◀	◀	◀									←							
	F1		◀	◀	◀				◀			◀	◀	←	←	←		←			

Note: Refer to Table 1 for risk IDs and definitions
< Influence of Country Level Risks on Market Level Risks
◀ Influence of Country Level Risks on Project Level Risks
← Influence of Market Level Risks on Project Level Risks



Note: Refer to Table 1 for risk IDs and definitions

Figure 2 Proposed risk model – Alien Eyes' Risk Model

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Table 9 Prioritizing mitigation measures for risks

Risk group	Risk code	Implementation sequence (I . . . . XI) of mitigation measures based on their effectiveness and the risk level										
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Country level risks	A1	M5	M1	M4	M2	M8	M7	M3	M6			
	A2/A3	M2	M1	M4	M6	M3	M7	M5				
	A4	M3	M4	M1	M2							
	A5	M8	M3	M4	M5	M1	M6	M7	M2			
	A6	M3	M5	M2	M4	M6	M1					
	A7	M2	M3	M1	M4							
	A8	M3	M7	M6	M2	M1	M4	M5	M8			
	A9	M2	M6	M1	M5	M3	M4					
	B1	M4	M6	M5	M3	M2	M1					
	E1	M1	M2	M4	M3							
	E2	M3	M1	M4	M2							
	G1	M1	M3	M5	M2	M4						
Market level risks	B2	M6	M6	M7	M4	M2	M1	M3				
	B3	M6	M7	M4	M2	M10	M9	M1	M5	M8	M3	
	B4	M5	M2	M4	M1	M3						
	B5	M5	M2	M1	M4	M3						
	C1	M2	M3	M1								
	C2	M3	M4	M6	M2	M1	M5					
	H1	M2	M1									
	H2	M1	M2	M4	M3							
Project level risks	C3	M3	M2	M1	M11	M4	M6	M5	M10	M8	M9	M7
	D1	M5	M2	M1	M6	M7	M3	M4				
	D2	M2	M1	M8	M5	M7	M4	M3	M6			
	D3	M4	M2	M3	M1							
	D4	M1	M2	M3								
	D5	M1	M3	M4	M6	M5	M2					
	F1	M7	M3	M6	M5	M1	M4	M2	M8			

Note: Refer to Table 1 and Table 2 for IDs and definitions of risk and mitigation measure.

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Therefore, for the example discussed in above section, since Risk C1 (foreign exchange and convertibility) and Risk C2 (inflation and interest rates), both at Market Level, are influencing another Risk C3 (cost overrun), at Project Level, mitigation measures M1, M2, M3 for Risk C1 and M1, M2, M3, M4, M5, M6 for Risk C2 are prerequisites, and M1, M2, M3, . . . , M11 for Risk C3 must be the successor mitigation activities. (Refer to Table 2 for details of the respective mitigation measures M1, M2, . . . , M11 for the risks C1, C2 and C3.)

Table 9 summarizes the prioritizing results of the mitigation measures for risks at different risk levels based on their effectiveness (Table 6) obtained from the survey.

Qualitative risk mitigation framework

Based on the risk criticalities (Table 4), the risk hierarchy levels (Table 5), the influence relationship among risks (Table 8 and Figure 2), the mitigation measure effectiveness (Table 6) and the prioritized mitigation measures (Table 9), a qualitative risk mitigation framework as shown in Figure 3 is proposed. This framework contains the following steps.

Step 1 Define the nature of any identified risk, i.e. whether the risk is close in definition and scope to a risk listed in Table 1 and which hierarchical level the risk falls in.

Step 2 Find the risk's criticality from Table 4 and its proposed mitigation measures' effectiveness from Table 6.

Step 3 Find the risk's influence relationship with other risks from the Risk Influencing Matrix shown in Table 8.

Step 4 If the risk falls in the Level I, only the mitigation measures (referred as group X) specific to this risk should be implemented but the mitigation measures with higher effectiveness as shown in Table 6 with higher priority, if the measures are applicable.

Step 5 If the risk falls in Level II, implement Group X mitigation measures first followed by Group Y measures which are specific to this level of risk. For the mitigation measures of one risk, implement the measures with higher effectiveness first.

Step 6 If the risk falls in Level III, the implementation

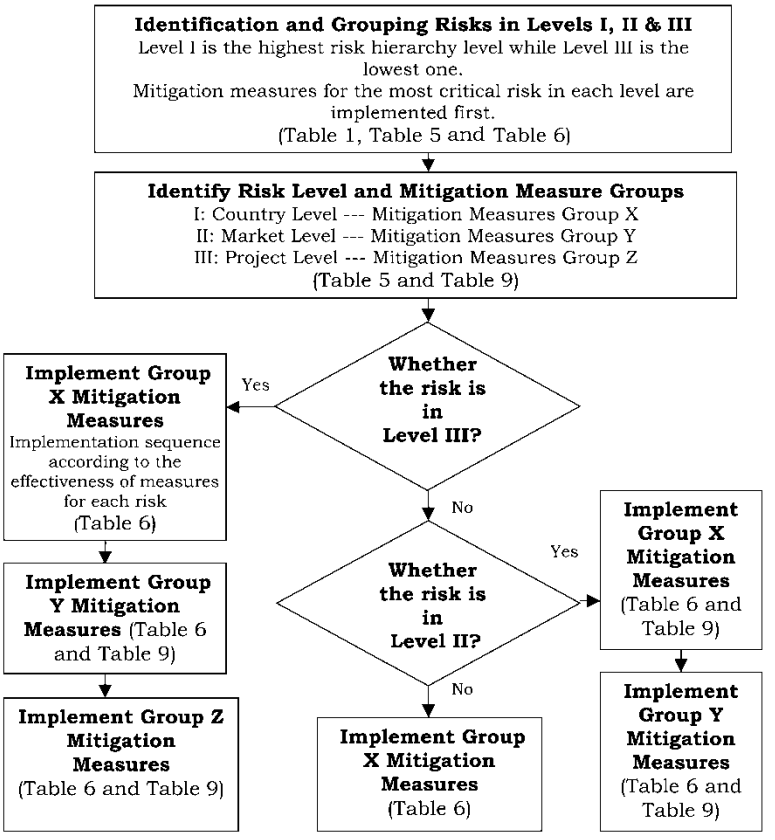

Figure 3 Proposed qualitative risk mitigation framework

sequence would be first Group X, second Group Y and lastly Group Z mitigation measures. For the general implementation sequence of mitigation measures, Table 9 needs to be used.

Conclusions

Twenty-eight critical risks associated with international construction projects in developing countries were identified and categorized into three hierarchy levels (Country, Market and Project). Of which, 22 were evaluated as Critical or Very Much Critical based on a 7-degree rating system. The top 11 critical risks are: Approval and Permit, Change in Law, Justice Reinforcement, Local Partner's Creditworthiness, Political Instability, Cost Overrun, Corruption, Inflation and Interest Rates, Government Policies, Government Influence on Disputes and Termination of JV. The risks at Country level are more critical than that at Market level and the latter are more critical than that in Project level.

For each of the identified risks, practical mitigation measures were provided and evaluated. Almost all of the mitigation measures were perceived by the respondents to the survey as effective using a 7-degree rating system. It is suggested that when mitigating a specific risk, the measures with higher effectiveness should be given a higher priority.

Taking into account the higher criticalities of higher risk hierarchy levels, the mitigation measures should also be prioritized by the higher risk hierarchy level, i.e. the risks at higher hierarchy level should be mitigated first with higher priority with their respective more effective mitigation measures.

A risk model, named Alien Eyes' Risk Model, was proposed which shows the three risk hierarchy levels and the influence relationship among risks. This model will enable better categorizing of risks and representing the influence relationship among risks at different hierarchy levels as well as revealing the mitigating sequence/priority of risks.

A qualitative risk mitigation framework integrating the key findings of the research was also proposed providing detailed risk management strategies and procedure that international especially Singaporean firms, could adopt. The proposed framework is practical and relatively easy to apply.

Although the survey sample is relatively small, the authors believe that the survey results are still meaningful. Nevertheless, more survey samples could be included so as to make the results more valid.

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Acknowledgements

The authors would like to thank the National University of Singapore (NUS) for sponsoring this research; Prof George Ofori, Department of Building, NUS, for providing feedback on the draft questionnaire; all the interviewees and respondents of the survey for their valuable opinions, comments and responses; and all the four reviewers of this paper, for their valuable comments and suggestions.

References

Bajaj, D., Oluwoye, J. and Lenard, D. (1997) An analysis of contractor's approaches to risk identification in New South Wales, Australia. *Construction Management and Economics*, **15**, 363–9.

Baker, S., Ponniah, D. and Smith, S. (1999) Risk response techniques employed currently for major projects. *Construction Management and Economics*, **17**, 205–13.

C21 Steering Committee (1999) *Construction 21 Report*. Singapore.

Cheng, A.T. and Chung, Y. (2001) Power corrupts. *Asiaweek*, 9 February, 24–26.

Faber, W. (1979) *Protecting Giant Projects: A Study of Problems and Solutions in the Area of Risk and Insurance*, Willis Faber, England, Ipswich, UK.

Flanagan, R. and Norman, G. (1993) *Risk Management and Construction*, Blackwell Scientific, Oxford, UK.

Gupta, J.P. and Sravat, A.K. (1998) Development and project financing of private power projects in developing countries: a case study in India. *International Journal of Project Management*, **16**, 99–105.

Haarmeyer, D. and Mody, A. (1997) Private capital in water and sanitation. *Finance and Development*, **34**(1), 34–7.

Hastak, M. and Shaked, A. (2000) ICRAM-1: model for international construction risk assessment. *Journal of Management in Engineering*, **16**(1), 59–67.

Hertz, D.B. and Thomas, H. (1983) *Risk Analysis and Its Applications*, John Wiley & Sons, Inc., New York.

Jaselskis, E.J. and Talukhaba, A. (1998) Bidding operations in developing countries. *Journal of Construction Engineering and Management*, **124**(3), 185–93.

Kalayjian, W.H. (2000) Third world markets: anticipating the risks. *Civil Engineering*, **70**(5), 56–7.

Li, B., Tiong, R.L.K., Wong, W.F. and Chew, D.A.S. (1999) Risk management in international construction joint ventures. *Journal of Construction Engineering and Management*, **125**(4), 277–84.

Luo, J. (2001) Assessing management and performance of Sino–foreign construction joint ventures. *Construction Management and Economics*, **19**, 109–17.

Munns, A.K. Aloquili, O. and Ramsay, B. (2000) Joint venture negotiations and managerial practices in the new countries of former soviet union. *International Journal of Project Management*, **18**, 403–13.

Ozdoganm, I.D. and Birgonul, M.T. (2000) A decision support framework for projects sponsors in the planning stage of BOT projects. *Construction Management and Economics*, **18**, 343–53.

Perry, J.G. and Hayes, R.W. (1985) Risk and its management in construction projects. *Proceedings of Institution of Civil Engineers, Part 1*, **78**, 499–521.

Raftery, J., Pasadilla, B., Chiang, Y.H., Hui, E.C.M. and Tang, B.S. (1998) Globalization and construction industry development: implications of recent developments in the construction sector in Asia. *Construction Management and Economics*, **16**, 729–37.

Ramcharran, H. (1998) Obstacles and opportunities in international engineering services. *Journal of Management in Engineering*, **14**(5), 38–46.

Silk, M.A. and Black, S. (2000) Financing options for PRC water projects. *The China Business Review*, July/August (http://www.chinabusinessreview.com/0007/black.html).

Songer, A.D., Diekmann, J. and Pecsok, R.S. (1997) Risk analysis for revenue dependent infrastructure projects. *Construction Management and Economics*, **15**, 377–82.

Thobani, M. (1999) Private infrastructure, public risk. *Finance and Development*, **36**(1), 50–3.

Wang, S.Q., Tiong, R.L.K.R., Ting, S.K. and Ashley, D. (2000a) Evaluation and management of political risks in China's BOT projects. *Journal of Construction Engineering and Management*, **126**(3), 242–50.

Wang, S.Q., Tiong, R.L.K.R., Ting, S.K. and Ashley, D. (2000b) Evaluation and management of foreign exchange and revenue risks in China's BOT projects. *Construction Management and Economics*, **18**(2), 197–207.

Wang, S.Q. and Dulaimi, M.F. (2002) Building the External Wing of Construction: Managing Risk in International Construction Projects. Research Report R-296-000-044-112, Dept of Building, National University of Singapore.

Yeo, K.T. and Tiong, R.L.K. (2000) Positive management of differences for risk reduction in BOT projects. *International Journal of Project Management*, **18**, 257–65.

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