STAKEHOLDER-ASSOCIATED RISK NETWORKS IN GREEN BUILDINGS: CHINA VERSUS AUSTRALIA

Rebecca J. Yang[1], Patrick X.W. Zou[2] and Jiayuan Wang [3]

[1] *School of Property, Construction and Project Management, RMIT University, Melbourne, Australia*
[2] *Building and Construction Management and Institute of Governance and Policy Analysis, University of Canberra, Canberra, Australia*
[3] *College of Civil Engineering, Shenzhen University, Shenzhen, China*

The aim of this research is to model stakeholder-associated risk networks and gain understanding of the differences and similarities of green building risks in China and Australia, given the different political, social-cultural and legal systems. This paper builds on the authors' previously published research (Yang and Zou 2014). Case studies of green star accredited recently constructed major office buildings were undertaken in both countries. Data were collected through desktop studies, focused workshops and face-to-face interviews with key project participants, and analysed by using Social Network Analysis (SNA) methods which aims to analyse the characteristics and interdependencies of risks-stakeholders relationships. The research finds that while reputation risks are important for project players in both countries, the ethical risk 'assessment experience and fairness' has been highlighted as crucial in the Chinese green practice due to potential corruption issues. In the Chinese case, relatively higher attention was paid on the quality / technical issues and the government plays more important role to develop rigorous policy systems, as well as improve societies' knowledge and awareness levels on green technology and energy saving. From stakeholder management perspective, communications between internal stakeholders can contribute to a smooth green building design and construction in both countries. The main contribution of this research is the development and application of an integrated method of SNA and stakeholder management in project risk assessment in green buildings in differing political, technical, social and cultural settings. The outcomes of this research have an implication in theoretical development and practical application for both green building risk management and international construction.

Keywords: green building, risk, stakeholder, social network analysis, Australia, China.

INTRODUCTION AND RESEARCH AIMS

With the rapid rates of economic development and urbanization, the property development and construction industry in China has become a pillar of its national economy, and they are proposing to develop 10 million affordable green buildings every year in the next 10 years (Guo and Su, 2011). All buildings in China, including new developments and existing buildings, are required to achieve a reduction of energy consumption of a minimum of 50% compared to the nineteen-eighties (MOHURD, 2011). This is a massive undertaking, particularly when it is

[1] rebecca.yang@rmit.edu.au

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acknowledged that China is still in its infancy in terms of experience in the adoption of 'green building' expertise (Wang, 2010).

The Australia in the Asian Century White Paper (Australian Government, 2011) has clearly emphasised the vital importance to identify the actions that Australia governments and business sectors should seize the opportunities and meet the challenges arising from China which is already unfolding. While opportunities may be attractive, there are many risks when working in different business environments where the institutional and economic developments, as well as the legal, political and sociocultural settings are quite different from the host countries (Kytle and Ruggie, 2005). Most of the risks are associated with various project or business stakeholders, from the government, to the building development lifecycle supply chain members, because of the different claims, interests, and culture backgrounds (Zhang, 2011). This requires an in-depth understanding of the Chinese construction market operation and management mechanism, their relevant policies, and market demand force together with the opportunities, stakeholders and associated risks for Australian governments and firms.

This study aims to understand the differences and similarities of the green building risks in different political, social and cultural settings, by using China and Australia as case examples to demystify complex stakeholder and risk networks. Two office buildings with one in each country were selected as case studies for comparison. A Social Network Analysis (SNA) model, improved based on the one proposed by the authors of this paper (refer to Yang and Zou (2014)) was chosen to assist the case study analysis process. This paper starts with an explanation of the theoretical background on use of the SNA model, which standardises the case study process. Then the results of the two case projects are explained, compared, and discussed to assist researchers' and industry practitioners' understanding of stakeholder associated risk networks and international green building practice.

THEORETICAL BACKGROUND

Yang and Zou (2014) developed a SNA-based 'green' risk & stakeholder analysis model by combining the classical risk management process and the generic SNA steps. Rather than focusing on risks'/stakeholders' attributes, the social network views characteristics and interdependencies of risks-stakeholders as arising out of the social structural environment in order to better understand the decision-making process. By identifying the directions of influence in the entire network, project managers can conduct systemic analysis, communicate with internal and external stakeholders about the influential risks, and develop risk response or mitigation strategies accordingly. In essence, the application of the social network perspective to stakeholder and risk analysis investigates the patterns of stakeholder-associated risk networks as well as the forces which shape these patterns, and unlocks risk interactions inside the whole relationship network. All of these are intended to provide a rationale for stakeholder communication and risk response strategies and facilitate the decision-making process in green buildings. There are five major steps in this model, listed as below:

4. Identification of stakeholders and their risks
   The stakeholder and risk groups were proposed. Risk categories include: time (risks related to time management), cost (risks related to cost increase and return), quality and technical issues (risks related to the product quality, including technical barriers, material availability and work quality), organization and management (risks related to organizational structure, knowledge, and relationship

management), policy and standards (risks related to regulations and standards), safety (risks related to occupational health and safety), ethics and reputation (risks related to social and ethical issues), and environment (risks related to environment protection). The stakeholder groups include: client, consultant, contractor, subcontractor/supplier, end user, financial organization, government, environmental organization, professional association, media, public, labour union, assessor/certifier, researcher/educator, and others.

5. Determination of risk interrelations
   This step defines the links in the risk network, which represent the impact between two nodes. The link is defined by the impact from one risk to the other, and the likelihood of the interaction between the risks.
6. Visualisation of risk network
   In the network, different shapes of the nodes represent risks associated with different stakeholders, while different colours of the nodes represent different risk categories. The arrows with values in the network are the interrelations among the risks, of which the thicknesses indicate the degrees of influence degrees (i.e. impact * likelihoods) of the interrelations.
7. Decipherment of risk network
   Three types of measures are useful for network analysis: Network measures, Node/link measures, and Partition measures.
8. Identification and simulation of risk mitigation actions
   The critical risks and interrelations are identified based on the results in the last step. The critical risks will be removed from the network, and the network measures can be recalculated.

The SNA-based model presented by Yang and Zou (2014) has been demonstrated as a useful tool for assessing risk interactions and risk mitigation actions in green building projects. The case study analysis in this research will follow the steps in this SNA model. For detailed information about the model, please refer to their paper.

RESEARCH METHODS

Why Case Study Method

This research has adopted a case study approach. The research aims to obtain an in-depth understanding of the stakeholder-associated risks and their interactions in green buildings under different legal, political, social and cultural settings, namely China and Australia. The emphasis here is more on 'how' and 'why' than 'what'. Green building development is relatively new and still in its infancy stage. Such new development involves application of new technology and new sets of skills, which are not applied to general building design and construction. Furthermore the collection of the data that is required to develop the risk network requires interactive interactions with project team rather than a single round of 'tick and flip' exercise. As such it would not be feasible or suitable to use population-wide or sample-sized questionnaire surveys. Instead case study methods are more suitable. Case study analysis is a preferred technique when 'how' and 'why' questions are considered (Yin, 2009). This research addresses a 'how' type of question in order to understand how risks are connected in large-scale complex green building projects. Given the above mentioned reasons, the case selection was not random but based on theoretical/selective sampling. The case projects were chosen because they have high level project complexities, which make stakeholder and risk analysis more meaningful, due to the complex relationships in the projects, and the project managers had challenges managing them. The data was collected by workshops and interviews, with more details in the following section.

Case Selection

The Chinese Case

The Chinese case selected for this research was a multi-storey office building located in Shenzhen city, the southern China. The building occupies 3000 m^2 of land, and has 14 storeys including 2 underground basement levels. The total indoor area is 18,114 m^2. The total cost is $80+ millions Chinese Renminbi (RMB). It implements a design principle of 'localisation, low cost, low energy consumption, and scalability'. The total energy saving achieved the goal of 65.9%. It has achieved significant economical environmental and social benefits and exceeded the national saving targets set by the Chinese central government. The finance and occupancy of the building all belong to the same organisation, which is a research and design institute whose core business is undertaking research to improve building performance in terms of energy, water, indoor air, etc. To this end, it is like 'leading by example'. The building has been granted the US LEED golden prize and a number of the Chinese national green ratings and awards.

A workshop, which has 8 project team members attended including project managers, consultants, contractors and end users, was organised to identify the internal and external stakeholders and their associated risks in the project with reference to the stakeholder and risk categories specified by Yang and Zou's study (2014). The workshop participants also contributed to the development of risk interrelationship matrix in which the possibility and consequence of the impact between risks were determined with five-point values (5 meaning extremely high, 1 meaning extremely low). A number of interviews with the team members were conducted at a later stage to obtain further information and clarify any ambiguities. The researchers (i.e. the authors of this paper) also had a site visit to the built facility, to gain first hand impression and understanding of the technologies applied to the building and the built environment.

The Australian case

The Australian case project selected here was adopted from a previous study by the authors Yang and Zou (2014), for comparison purpose. While more details of the project can be referred to their paper, a brief summary of the project case is provided here. It is a three-storey office building, which has a contract sum of over $10 million Australian dollars. It was constructed using a World Leading practices as required by the Green Building Council of Australia to target a 6 Stars rating in both *"As Design"* and *"As Built"*. The case project presented considerable challenges and difficulties to the project management team, requiring the adoption of a relationship based collaborative approach to project management and project delivery. A number of new technologies have been designed and applied to this building.

The data was collected through surveys and interviews with key project participants together with desktop-studies on the project information provided by the design-and-construct head contractor. The stakeholder and risk information were collected in a first round survey, based on which the risk relationship matrix was developed in the second round surveys and interviews. The researchers (i.e. the authors) visited the building at its near-completion stage accompanied by the project director. For more details readers are referred to Yang and Zou (2014).

RESULTS AND ANALYSIS

Comparison of risk and stakeholder groups

In SNA, density and cohesion are two network measures: The higher the density, the more risk interrelations are there in the network; and the higher the cohesion, the more complexity of the risk network is. Figure 1 shows the risk networks in both projects. The network density and cohesion value are (0.338, 0.624) in the Chinese case and (0.37, 0.703) in the Australian case, which show that the networks in both projects are relatively dense and complex compared to networks in other studies such as Fang *et al*.'s work (2012).

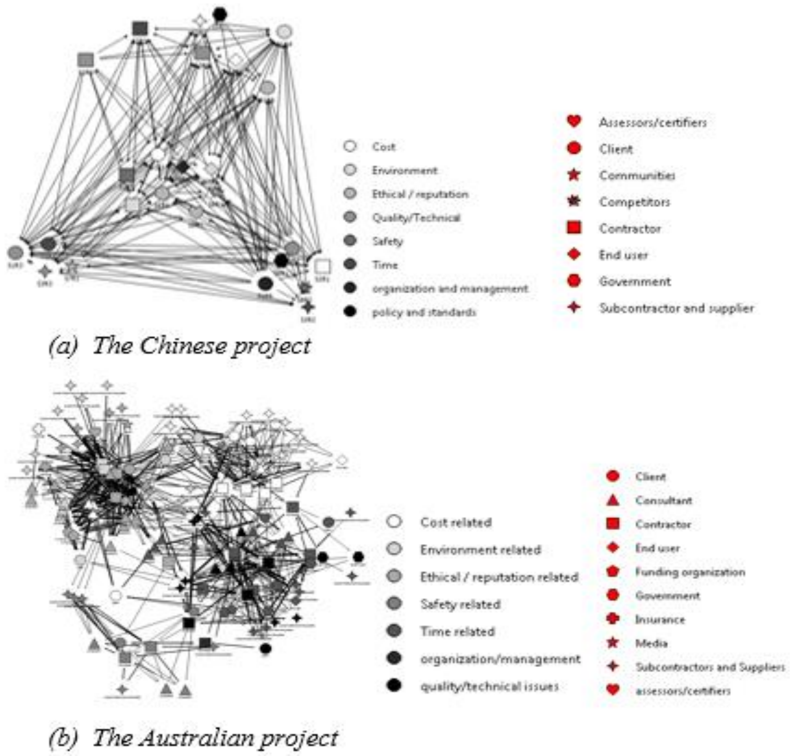

Figure 1 Stakeholder-associated green risk networks

In the Chinese case, in total, 9 stakeholders were identified with 26 'green related' risks and 220 risk interactions (Table 1). Comparing with the Australian case which has 127 'green-related' risks associated with 20 stakeholders, and 867 risk interactions, the numbers of stakeholders, risks and their interactions are much less. This can be explained from two perspectives:

- **Project contract types**: The Australian building is a Design-Build project, in which the head contractor subcontracts the design work to several consultants, and most construction activities to specialised subcontractors or trades; while the Chinese building is a combination of force account and traditional procurement type, in which the client has its own team for design, and only contracts the construction work to a major firm who may have its own workforce (including trades and labourers). Since the design work was completed by themselves staff, the Chinese client does not have a consultant stakeholder group, which reduced the project environment complexity significantly.
- **Construction practices**: There is a major difference between Australian and Chinese construction firms: Usually in Australia, the head contractors do not

have their own labours, so they have to subcontract most construction works to subcontractors. In contrast, most of the Chinese construction firms have permanent employees working on different trades on sites, and only subcontract sporadic works to external firms. This not only reduces the labour cost, but also minimises the coordination works, thereby mitigates risks. However, for international contractors in China, they have to be aware of the dispute risk with local construction labours (Zhang, 2011), as well as labour restrictions and cost to use sources of labour from inside/outside the host country (Ashley and Bonner, 1987).

Table 1: Summary of risks and stakeholder groups identified in the Chinese project

Stakeholder category	Stakeholder	Number of risks	Risk ID	Risk	Risk category
Client	IBR	8	S1R1	Cost risk if budget found to be inadequate	Cost
			S1R2	On time design, construction and occupation of building	Time
			S1R3	Failure of achieving green building standards targets	Quality/ Technical
			S1R4	Higher than expected energy use	Environment
			S1R5	Demonstration of social responsibilities	Ethical / reputation
			S1R6	Enterprise awards	Ethical / reputation
			S1R7	Experience on green building project management	Quality/ Technical
			S1R8	Tender selection mechanism to choose experienced green building contractor and suppliers	Organization and management
Contractor	FTJA	6	S2R1	Responsible to ensure project is delivered within budget	Cost
			S2R2	On time deliver the building	Time
			S2R3	Responsible to ensure project is delivered to green building quality standard	Quality/ Technical
			S2R4	Waste minimisation	Environment
			S2R5	Ensuring construction safety when working on some green features	Safety
			S2R6	Experience on green building construction	Quality/ Technical
Subcontractor and supplier	Subcontractor and supplier	3	S3R1	Responsible to ensure the building component is delivered within budget	Cost
			S3R2	On time deliver the building	Time
			S3R3	Green products and the final work satisfy green building quality standards	Quality/ Technical

Comparing with the Australian case, relatively higher attention was paid on the quality / technical issues (risks) in the Chinese case which mainly refer to the green building design, construction and assessment experiences in China. Although the Chinese government launched a series of green programme since 2004, there still is a shortage of green building skills in the Chinese construction industry (Andrews-speed, 2009). Two risks in the Chinese case are related to policy and standards; while policy risks were not proposed in the Australian project. This indicates the importance of Chinese government in green building development. Apart from the above mentioned differences, the Chinese industry also concerns more on the organisation and management issues, but less on the ethical/reputation, cost, and time risks. However, since the striking difference of risk numbers in the two projects, it is more meaningful to compare the critical risks instead of quantities.

Comparison of critical risks

The comparison of critical nodes and links are based on the calculation of out-degree, degree difference, and betweenness values.

The out-degree shows the direct impact from a risk to the others, and the higher the degree difference, the stronger impact of the risk to the others comparing to the impact received by the risk. Figure 2 shows the out-degree and degree difference in the Chinese case. S1R8 (Tender selection mechanism to choose experienced green building contractor and suppliers) has the highest out-degree of 283; S6R1 (Transparent green building assessment standards) has the highest degree difference of 270 with no direct impact from the others, followed by S1R7 (Experience on green building project management). These three risks basically have high direct impact on the others. Comparing with the Australian case in which the reputation related risks associated with contractors and consultants have higher direct impact, the Chinese practitioners viewed the management process (as S1R8), policy issue (as S6R1), and industry capacity (as S1R7) are critical in the current green building practice.

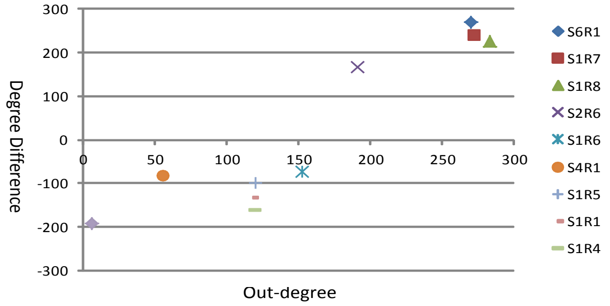

Figure 2 Distribution of risks with high degree values in the Chinese case

Betweenness centrality indicates the incidence with which a given node/link falls between two other nodes/links. A node/link with a high value of betweenness centrality has a high level of control over the impact passing through it, and the node is somehow taking the gatekeeper role. Table 2 displays the top ten ranked risks and the interrelations with the highest betweenness centrality in the Chinese project. Different from the Australian case in which most high betweenness centrality risks are associated with contractor, in the Chinese project client plays more connection 'hub' roles in a project environment. A risk related to end users within the 'organisation and management' risk category (S4R3 - Appropriate user behaviour) also has high betweenness centrality. This finding shows the important impact of user behaviour on energy consumption in occupation stage in China.

Table 2: The key risks and links according to the betweenness centrality

Rank	Risk ID	Node Betweenness Centrality	Link ID	Link Betweenness Centrality
1	S1R5	0.067	S1R7→ S1R8	40.00
2	S1R3	0.067	S1R6→ S4R3	12.55
3	S1R6	0.056	S1R5→ S4R3	11.29
4	S1R4	0.046	S9R1→ S1R3	8.177
5	S1R8	0.042	S4R3→ S1R4	7.78
6	S4R3	0.037	S1R3→ S1R5	7.61
7	S1R1	0.034	S1R3→ S4R2	7.38
8	S1R2	0.028	S4R1→ S1R4	7.38
9	S2R3	0.022	S5R1→ S1R8	7.20
10	S2R4	0.019	S9R1→ S1R6	6.39

All of the important links are related to the key risks in Table 2. As Yang and Zou (2014) stated, the source risks of the links in betweenness centrality results should be treated with caution because by controlling these risks, the links can be cut off. Comparing with the Australian project in which the contractor, consultants and subcontractors are the main sources of critical risk links, in the Chinese case, the client, assessor, end user and government are owners of key risk connections. This shows an interesting difference between the two countries. In a mature green building market such as Australia, the risk network is connected by the green 'constructors' who are responsible for the design and construction works; whereas in a developing market such as China, the risk network is mainly shaped up because of client and external stakeholders although most risks are caused by internal stakeholders. This means that risk network segmentation mainly relies on builders and consultants in Australia, while in China clients, government and end users take more responsibilities on the reduction of risk network complexity.

In Table 2, another risk worth mentioning is S9R1 (assessment experience and fairness) related to the assessors' ethics, which is the sources of two important links. This shows that in China, the bidders view assessors' experiences and fairness as a critical risk, due to the immature policy systems and corruption issues in China. Severe measures against bribery have been implemented nationally by the new Chinese government leading by President Xi Jinping since 2013. Nevertheless, international firms should understand the potential ethical risks in the construction industry.

Comparison of interfaces between stakeholders

Partition measures compute the interfaces between each pair of stakeholder groups. Table 3 shows the interfaces of stakeholder categories in the Chinese case. The important impacts are highlighted in bold. As shown in Table 3(a), S1 (Client) receives high impacts from the internal stakeholders (contractor, subcontractors and end users). This is similar with the Australian case with suggestions to increase communication activities between internal stakeholders. The Chinese also is impacted significantly by S6 who is the green building assessment government body. Considering the propagated consequences in Table 3(b), the communication between end users should be enhanced in the Chinese project mainly due to staff energy using behaviour affecting the building operation and maintenance cost significantly. This was not considered in the Australian project.

Table 3 Interfaces between stakeholders in the Chinese case

	S1	S2	S3	S4	S5	S6	S7	S8	S9
(a) Immediate interface									
S1	507	353	239	193	0	0	0	110	0
S2	369	317	0	37	0	0	0	0	0
S3	156	0	37	32	0	0	0	0	0
S4	126	0	0	54	0	0	0	14	0
S5	41	0	0	0	0	0	0	0	0
S6	97	0	0	0	0	0	0	24	16
S7	36	0	0	32	0	0	0	0	9
S8	18	0	0	0	0	0	0	25	0
S9	4	0	0	0	0	0	0	20	0
(b) Global interface									
S1	0.57	0.41	0.15	0.12	0.04	0.00	0.03	0.02	0.00
S2	0.39	0.32	0.04	0.03	0.01	0.02	0.01	0.00	0.00
S3	0.22	0.06	0.04	0.02	0.01	0.01	0.01	0.00	0.00
S4	0.19	0.08	0.04	0.05	0.00	0.01	0.02	0.00	0.00
S5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S6	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S8	0.01	0.03	0.01	0.02	0.00	0.02	0.00	0.02	0.01
S9	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00

CONCLUSIONS

In conclusion, this research has achieved its aim of providing an in-depth understanding of the risk-stakeholder interactions in green building in international markets, by undertaking two case studies. The results show a number of key differences between China and Australia due to the different political, social and cultural differences and the different level of technology and technique uptake and application in green building development process. While reputation risks are important for project players in both countries, the ethical risk ‘assessment experience and fairness’ has been highlighted as crucial in the Chinese green practice due to potential corruption issues. In the Chinese case, relatively higher attention was paid on the quality / technical issues and the government plays more important role to develop rigorous policy systems, as well as improve societies’ knowledge and awareness levels on green technology and energy saving. From stakeholder management perspective, communications between internal stakeholders can contribute to a smooth green building design and construction in both countries. It is anticipated that the risk analysis process and results presented in this research will be useful to researchers and practitioners, not only about risk in green building projects but also their interactions in an international construction arena. In future more cases should be studied to provide a more comprehensive understanding of the similarities and differences between the two countries. In short, risk–stakeholder interaction analysis is an important area requires further research, and the use of SNA-based approach is an appropriate modelling method for such purpose.

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REFERENCES

Andrews-Speed, P (2009) China's ongoing energy efficiency drive: Origins, progress and prospects. *Energy Policy*, **37**(4), 1331-1344.

Ashley, D. B. and Bonner, J. J. (1987). Political risks in international construction, *Journal of Construction Engineering and Management*, **113**(3), 447-467.

Australian Government (2011) *Australia in the Asian century*. Retrieved June 2012 from: http://asiancentury.dpmc.gov.au/

Guo, H. and Su M. (2011) Green construction in real estate development in China, *Energy Procedia*, **13**, 2631-2637.

Kearins, K. and Pavlovich, K. (2002) The role of stakeholders in Sydney's green games, *Corporate Social Responsibility and Environmental Management*, **9**(3), 157-169.

Mohurd (2011) *Notification of promoting the heating management and energy-efficiency retrofit of existing residential buildings in northern regions with heating* (in Chinese). Retrieved June 2012 from www.mohurd.gov.cn/lswj/tz/t20110128_202232.htm.

Wang, G. T. (2010) The implementation of 'four efficiencies' is the key to building up a frugal society: reflections of the construction of energy-efficient and land-saving housing and public buildings. *The third International Conference on Intelligent and Green Building Technologies*, 2010, Beijing.

Yang, R. J. and Zou, P. X. W. (2014) Stakeholder-associated risks and their interactions in complex green building projects: A social network model. *Building and Environment*, **73**, 208-222.

Yin, R. K. (2009) *Case Study Research: Design and Methods*, 4thed, 484. Sage Publications.

Zhang, X. (2011) Social risks for international players in the construction market: A China study, *Habitat International*, **35**(3), 514-519.