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Stakeholder-associated risks and their interactions in complex green building projects: A social network model

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ABSTRACT

Previous research on risks in complex green building projects has been mainly focused on what the risks are and how they may impact on project objectives. Such studies have tended toward an inward looking perspective that treats risks in isolation from one another. In reality, most risks are interrelated and associated with internal or external project stakeholders. To address this research gap, this current research developed a Social Network Analysis (SNA) based stakeholder-associated risk analysis method to assess and analyse the risks and their interactions in complex green building projects. A case study was conducted to highlight the green-specific risks and their profiles, together with the proposed mitigation actions. The research results presented in this paper may broaden researchers and construction professionals' awareness of influential risks in green building projects and enhance their ability to perceive, understand, assess, and mitigate the risks in an effective and efficient way; thereby achieving higher performance in strategic risk management and stakeholder communication in green building project management.

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1. Introduction and research aims

Human activities have adapted to more sustainable and "green" habits over the last two decades, drawing on lessons learnt from the world's natural ecosystem. The "green" actions in the construction industry are urgent when viewed through the lens of energy consumption statistics: according to the Green Building Council Australia [16], "buildings consume 32% of the world's renewable and non-renewable resources, 12% of available water, 40% of energy consumption, produce 40% of CO2 emissions" [30]. In line with other industries, the implementation of green building project development encounters the same, if not more risks due to the traditional conservative and reactive behaviour of parties/stakeholders in the built environment [4,23], and the transient relationship of project teams and stakeholders [26].

Several previous research have studied the identification and assessment of risks in green building projects. Dewlaney et al. (2012) [67] interviewed contractors and designers regarding safety risks and safety performance of green and non-green buildings to test for the presence of a difference in OSHA-recordable incident rates and lost time case rates between the two project types. Bianchini and Hewage (2012) and Zhang et al. (2012) [2,63] focussed on cost risk by analysing the cost/benefit of green building development, and proposed strategies for delivering a green project within acceptable cost constraints and enhanced economic value. These studies provided valuable information/evidence for the industry to integrate green concepts into business operation. Limitations of these researches are inevitably related to single-perspective investigations, which neither analysed the cause–effect relationships exits in complex systems, nor considered the entire supply chain as a whole for performance evaluation.

With the boom in stakeholder analysis and engagement research in the last decades it is not surprising that quite a few papers (Refs. [10,59]) investigated the stakeholders' roles in green building development. Examining the risks identified in the previous studies, it is clear that most, if not all are associated with project stakeholders. As stated by Prum and Del Percio (2009) [38], risk sources should be analysed and each stakeholder in a green building project should assess their risks and take measures to mitigate the possible impacts. Stakeholder–Risk analysis is important not only for developing a comprehensive risk list and recognising the causes of risks, but also contributing to effective decision-making and efficient communication in green building project management. Van Bueren and Priemus (2002) [60] pointed out institutional factors, not technological difficulties are key

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barriers to sustainable construction. Here, the concept of institution refers to nontechnical barriers, which range from legal regulations, to behavioural patterns such as habits and traditions. They discussed several gaps (i.e., between location development and building project development, between construction and management, and between construction and in-use) that hinder stakeholder decisions to apply sustainable construction measures. These gaps highlighted the risks associated with fragmented decision-making and lack of stakeholder communication during the green building development process. Robichaud and Anantatmula (2011) [44] emphasised the importance of stakeholder analysis: they considered the most significant challenge to delivering a successful green building project to be "communication and coordination across a multidisciplinary team" to accommodate specific user, regulatory, or community needs and therefore mitigate the risks.

Studies of stakeholders in green building development confirmed the undeniable responsibility of stakeholders to foster and create a more sustainable local and global community in the construction industry. However, the interactions of stakeholders in green initiatives and market promotion were not clearly analysed. This was critiqued by scholars with 'network' perception. Yang et al. (2011) and Pryke (2012) [54,37] believed a construction project takes place in a non-linear, complex, iterative and interactive environment, in which the impact of stakeholders cannot be easily identified when discussion is limited to two parties. They pointed out that analysis of the impact of stakeholders acting through 'the network of relationships' is important, especially as it can highlight the importance of different stakeholders.

As pointed out above, the majority of previous research were limited to the use of linear impact analysis when assessing the impact of risks or stakeholders on green building development without consideration of the associated risks and stakeholders, and the interrelationship between risks and stakeholders. The reality is that most green-related risks are associated with different stakeholders in the construction projects [6] and risk source analysis is an indispensable component in risk management planning/registers [36] to facilitate the risk response and mitigation actions. The stakeholder-associated risks could be far more unpredictable and difficult to manage than first thought. Jing and Qin (2011) [21] revealed that an evaluation of the influence of stakeholders and the risks associated with them should be considered as a necessary and important step in the planning, implementation, and completion of any construction project. Furthermore, risks and stakeholders do not exist in vacuum. Ren (1994) [41] pointed out that risks in construction projects "affect, magnify or diminish each other and have mutual influence on a project". After that, several scholars, including Glickman and Khamooshi (2005), Allan and Yin (2011), and Yildiz et al. (2012) [1,14,56], emphasised when assessing risks, to take risk interdependencies into consideration to achieve a better simulation of project conditions. Nevertheless, in the area of green building research, limited research has been conducted into demystifying the risk-stakeholder interrelationships.

Discussion about stakeholder interdependency is not a new topic. Rowley [45] in 1997 considered multiple and interdependent interactions to simultaneously exist in stakeholder environments. However, in green building projects, imperative questions are "who associates with whom and in what ways do these stakeholders depend on each other" for green-related decisions [60]. In this paper, a Social Network Analysis (SNA) model is developed, to answer these questions, together with a case study to demonstrate the application of this method.

The aim of this research is to develop a method for analysing stakeholder-associated risks in complex green building projects from a network perspective. It is in this context that a SNA method is used. The paper is organised as follows: in Section 2 a literature review is conducted to identify the risk and stakeholder categories; Section 3 discusses and describes the process of SNA-based method; in Section 4 a complex green building project case is studied and analysed to demonstrate the application and validation of the proposed method. It is anticipated that the research presented here will provide an innovative risk and stakeholder analysis method for researchers and practitioners to simulate and manipulate the green reality.

2. Risks and stakeholders in green building projects

The number of studies on the barriers, risks and critical success factors in delivering green buildings has grown significantly in recent years. Both researchers and practitioners accept the fact that green building projects are more complex and problematic because the construction industry is "extremely conservative, and subject to slow rates of change due to regulatory, liability and limited technology transfer from other sectors of society" [23]. Therefore, an understanding of the risks and barriers in green building design and construction is critical for industry players to analyse risks, thresholds and develop responding strategies proactively. Table 1 summarises green-related risks identified in previous studies. It should be noted that green-related risks are those risks that have arisen specifically through the introduction of sustainable materials, concepts or practices in building development.

Current risk identification literature usually classifies risks into different categories, including: financial, political, and technical [53]; internal and external [55]; elemental and global (Walker and Smith, 1995 [68]); general/country and specific project [58]; project-related, government-related, client-related, design-related, contractor-related, consultant-related, and market-related [48]; project and general [34]; technical, commercial, political and regulatory, and economic and financial [33]; time, cost, quality, safety, and environmental [65]; as well as supply chain [66].

Although there is no standard classification of risks, this paper groups the risks into seven categories, with each category named to help industry practitioners identify risks for the proposed SNA-based method. These 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), organisation and management (risks related to organisational 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). It should be noted that this categorisation does not cover all the risk groups, but rather is designed to facilitate risk identification for the practitioners and researchers.

To mitigate risks, it is important to identify the risk sources. However, the difficulties of using the risks identified in the literature to track the risk sources are that: (1) many risks are too general and related to different stakeholders, thus increasing the difficulties for practitioners to develop risk response strategies; (2) the stakeholder groups used by previous studies were not comprehensive, so many risks associated with external project stakeholders (except government bodies) were not identified. There are many more stakeholders in construction projects than those identified in Table 1. External stakeholders, such as communities, competitors, NGOs and the media can also cause complications (and hence risks) to green building projects [7]. Therefore, it is worthwhile to review the stakeholder groups in order to help practitioners to identify the possible risk sources.

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