A NETWORK-THEORY BASED MODEL FOR STAKEHOLDER ANALYSIS IN MEGA CONSTRUCTION PROJECTS

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A Network-theory Based Model for Stakeholder Analysis in Mega Construction Projects

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CERTIFICATE OF ORIGINALITY

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ABSTRACT

Mega construction projects (MCPs) are highly uncertain and volatile in nature. They involve numerous stakeholder groups who have discrepant issues and expectations, and are interrelated by various social interactions in the project. MCP development can positively or negatively impact the vested interests of stakeholders; who are making their best endeavour, in different ways, to raise the project team's salience in safeguarding their interests. In addition, stakeholder issues arising from the same MCP are interconnected. When an issue is not properly addressed, its presence can be the source of occurrences of other interrelated issues in the same project environment, producing chain effects of more stakeholder issues that can further result in conflicts and project resisting forces. This complex MCP nature requires a set of systematic methods and procedures to analyse and manage MCP stakeholders, issues and relationships. Stakeholder management is an effective approach for doing this by bringing stakeholder issues to the surface and building robust stakeholder relationships; and stakeholder analysis is an essential element of this process to interpreting the complex stakeholder environment, for formulating proper stakeholder management strategies.

Notwithstanding the recent growth of project stakeholder analysis theories and approaches, the performance of stakeholder management in MCPs has still been criticized as being unsatisfactory (Pryke and Smyth, 2006). This can be attributed to several reasons. First, the conventional stakeholder analysis practice has some methodological constraints when applied in MCPs – it disregards stakeholder relationships, stakeholder issue interdependencies, and the propagating impacts produced by these network systems on the project. These methodological limitations confine the accuracy and effectiveness of MCP stakeholder analysis. Besides, stakeholder analysis is more complex in MCPs than in

ordinary projects, but some practitioners may not possess sufficient skills and knowledge to undertake this task, and the various methods available have led them to confusion in practice (Jepsen and Eskerod, 2009). More importantly, there is a lack of a systematic and holistic model for MCP stakeholder analysis and management. The existing models, in construction project context, have been criticized as being spontaneous and not entirely coherent and formal. A fragmented and informal stakeholder analysis process is not sufficient to address and manage the complex stakeholder interfaces in mega developments. As such, a systematic and holistic model is in need of development for analysing and managing stakeholder complexities in MCPs.

With the above background, this research aims to develop a systematic and holistic model for stakeholder analysis and management in MCPs, specifically investigating stakeholder interactions and stakeholder-related issue interdependencies from a network perspective. The three main objectives of this research are: (1) to develop and refine a social network approach for analysing stakeholders and their interactions in MCPs, (2) to develop and refine a social network approach for analysing stakeholder-related issues and their interdependencies in MCPs, and (3) to develop and validate a systematic and holistic model, and its application guideline, building upon the network perspective, for stakeholder analysis and management in MCPs.

The research objectives have been fulfilled mainly through literature review, case studies, interviews and questionnaire survey, conducted in Hong Kong. Findings of the research can be summarized into four main areas: (1) the development and validation of a social network approach for analysing stakeholders and their relationships in MCPs, with an emphasis on stakeholder information exchange interactions; (2) the development and validation of a network approach for analysing stakeholder-related issues and issue interdependencies in MCPs; (3) the development and validation of a social network model and its associated application guideline for stakeholder analysis in MCPs; and (4) the identification of practical insights on MCP stakeholder management from four case studies representing different MCP types.

This study has contributed to the body of knowledge. This research contributes to a new angle, the network perspective, of analysing both stakeholders and stakeholder-related issues in mega project developments. Building upon the network theory, this study develops a model to identify and decipher the underlying networks of both stakeholders and stakeholder-related issues in MCPs; as well as recognize and examine the critical stakeholders, issues and interdependencies which play crucial roles in structuring the network systems. Compared to the conventional stakeholder analysis practice, this network perspective brings higher accuracy and more effective evaluation on the propagating effects between stakeholders and between their associated issues on MCP development. This research study has also improved understanding of MCP stakeholder analysis and management in four aspects:

1. The social network approach for assessing stakeholders and their interrelationships in MCPs can improve the traditional MCP stakeholder analysis practice, which has often regarded stakeholders as staying in a hub-and-spoke environment and relied too heavily upon individual stakeholder attributes when assessing stakeholder impacts.
2. The network-theory based approach for analysing stakeholder-related issues and issue interdependencies in MCPs can improve the conventional MCP stakeholder issue analysis practice; which has often ignored the sources or origins of stakeholder issues, considered issues as being independent and stationery in project environment, and

overlooked the propagating effects of these issue interdependencies on project development.

3. The social network model and its associated application guideline can serve as a systematic and generic reference for MCP leaders, to design and conduct a network-theory based stakeholder management process which suits the characteristics and needs of their MCPs.

4. The stakeholder analysis results in the four case studies which can be useful to practitioners who are involved or take the lead in managing similar MCPs. The major project challenges, possible causes and recommendations identified can bring them practical insights when dealing with similar problems in future mega developments.

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LIST OF ABBREVIATIONS

AI	Abbreviated form of the case project name in Case Study IV
CWD	Chinese White Dolphins
DEVB	Development Bureau
ER	Employer’s Requirements
IEC	Independent Environmental Checker
PCC	Public and Community Consultation
PMI	Project Management Institute
MCP	Mega Construction Project
SNA	Social Network Analysis
SP	Abbreviated form of the case project name in Case Study II
TD	Abbreviated form of the case project name in Case Study III
XC	Abbreviated form of the case project name in Case Study I

Chapter 1 – Introduction

1.1 Research Background

1.1.1 Why analysing stakeholders in mega construction projects (MCPs)

Mega construction projects (MCPs) are substantial investment, that are often wholly or partly initiated and funded by the government; to provide building, infrastructural or communal facilities essential for boosting economic growth as well as enhancing the environment and societal quality of life (Zeng et al., 2015). MCPs are characterized by being dimensionally huge and human-oriented (Yeo, 1995); having extreme complexity, high risks and long lead time (Fiori and Kovaka, 2005); involving multiple stakeholders; and producing considerable impacts to the society, economy and natural environment (Zhai et al., 2009). The cost of a MCP is huge where the governments and researchers worldwide have accepted the range of US$500 million-1 billion as the cost threshold per project (DEVB, 2002; FHA, 2005; Hu et al., 2015). Based on this description, MCPs involve numerous stakeholder groups who have discrepant concerns and expectations, and are interrelated by various social interactions in the project. MCP development can readily produce positive and negative impacts to the vested interests of stakeholders; who are making their best endeavour, in different ways, to raise the project team's salience in avoiding their interests from being put in peril (Olander and Landin, 2008). Stakeholders can even be allied to build a stronger force in safeguarding their interests. Ineffectively addressing stakeholder needs often harms the project and leads to failures. This complex MCP nature requires systematic approaches and proper skills of project managers to assess stakeholders and accommodate their issues, thereby achieving the best project outcome. *Stakeholder management* is regarded an effective approach for doing this by bringing stakeholder concerns to the surface and building robust stakeholder relationships; and *stakeholder analysis* is an essential element of this process to interpreting the complex stakeholder environment, for formulating proper management strategies (Bourne and Walker, 2005).

Previous research, in the construction project management domain, has devoted great efforts to developing stakeholder analysis theories and practical approaches. However, obstacles of engaging and managing stakeholders in MCPs have been reported by many practitioners. For instance, MCP stakeholder identification is often incomplete where the issues and controversies of hidden stakeholders are overlooked (Yang, 2014). The engagement process in MCPs has also been criticised as one-sided, where only a few major players are involved in the project decision-making; without adequate consultation with external stakeholders on their needs and preferences (Li et al., 2012). In fact, many project problems are sourced from or related to the project stakeholders. One local example is the development of Hong Kong-Zhuhai-Macao Bridge. Due to underestimating the influences of affected vicinity and their emphasis on environmental issues, the project commencement was delayed for one year by a legal dispute about ecological impacts of the bridge (MDT, 2011). The dispute and associated delay aroused vigorous controversies from politicians, pressure groups, media and the public. The government has ended up spending extra efforts and resources to catching up project progress, and handling negative responses from the public.

Mega project developments are often ‘human-driven’ and ‘human-oriented’. Every MCP involves a wide range of stakeholders who have diverse backgrounds and interests, and are interdependent owing to intricate relationships and interactions. In fact, stakeholders are the central figures of a MCP, as well as chief determinants of its successful delivery (Lin, 2014). However, the extreme complexity of project stakeholders has been a hurdle in establishing stakeholder common ground and collaborations, leading to many challenges and problems that are actually emerged from or related to stakeholders. As such, analysing and addressing the complexities of stakeholders is vital to improve MCP management and outcomes.

1.1.2 What are the complexities of stakeholders in MCPs

In the context of MCPs, stakeholder complexity can be viewed from three aspects. The first aspect considers *'who the stakeholders are'*. According to Li et al. (2012), stakeholders refer to any groups or individuals "who can influence the project process and/or final results, whose living environments are positively or negatively affected by the project, and who receive associated direct and indirect benefits and/or loss". It is vital to identify as complete as possible all involved project stakeholders. However, 'hidden' stakeholders who have little apparent impacts or being remote from core project team are often discarded to the edge of stakeholder analysis process.

The second aspect is '*stakeholder relationships and interactions'*. In MCPs, stakeholders are connected directly or indirectly by various relationships across functional and organisational borders, they are embedded in networks instead of being isolated in vacuum. Earlier research paid much attentions on the formal relationships of stakeholders; such as the contractual links between project organisations concerning resources sharing and construction services supply (Pryke, 2004), and the hierarchical relationships between intra-organisational project participants (Lin, 2014). Recent studies shift focus towards informal stakeholder relationships, e.g. information exchange, trust, and emotional support; and emphasise on improving relationship management strategies (Cross and Parker, 2004). Stakeholders do not exist independently in a project environment. These relational structures are where the values and perceptions of stakeholders emerge, and also key factors shaping stakeholders' behaviors and influencing strategies. As such, a systematic method is needed to examine the interactions of stakeholders, and their roles and impacts in these relational structures.

The third aspect considers '*stakeholder issues and their interdependencies'*. The development of MCPs can readily attract and influence the vested interests of various stakeholder groups. Stakeholder issues, being described as the vested interests or concerns of project stakeholders, are often discrepant and dynamic. New stakeholders and issues often emerge in response to the changing project environment; priorities of issues may also vary among different stakeholder groups. The conflicting stakeholder issues may result in project threats and failures if they are insufficiently accommodated. Comprehensive identification and prioritization of stakeholder interests have attracted attentions in previous studies. Li et al. (2012) identified the main stakeholder concerns in the planning and design of large public infrastructure projects and investigated their different priorities among the government, public, pressure groups and affected vicinity. Zeng et al. (2015) identified the key stakeholder issues in major engineering projects which relate to the fulfilment of social responsibility. Existing publications have enriched our understanding about stakeholder issues in MCPs. Nonetheless, the evaluation and prioritization of issue importance have relied heavily on the subjective judgment of individual stakeholders; while overlooking the interdependencies between stakeholder issues and the propagating impacts produced by the issue network. As such, a rigorous method is in need to analyse stakeholder issue interdependencies and assess their proliferating effects on MCP development.

1.1.3 Why existing analysis methods are inadequate for application in MCPs

MCPs are highly uncertain, volatile and complex in nature, their stakeholder environment is also highly complicated. This requires a set of systematic methods and procedures to analyse the three aspects of MCP stakeholder complexity (mentioned in Section 1.1.2), and formulate the appropriate management strategies. In the past decades, researchers have developed various stakeholder analysis models; but they have some methodological limitations which confine their effectiveness in addressing MCP stakeholder complexity, as explained below.

The conventional stakeholder analysis models can include three major types. The first type is *attribute-based stakeholder classification*. Stakeholder Salience Model is an attribute-based classification method widely used in the construction management field (Mitchell et al., 1997). Power, legitimacy and urgency are three key attributes forming the classification basis. By considering stakeholder possession of these attributes, project teams can categorize the stakeholders, determine the degree of salience paid on them, and assess their impacts. This model is time-efficient, but the attribute assessment and classification process is perception-driven and may easily lead to bias; for example, the same stakeholder may be put into different classes by different respondents. The second type is *impact-probability matrices*. In this kind of approach, project teams assess stakeholder influences and predict their likely behaviours by grouping stakeholders from two dimensions (Olander and Landin, 2008): (1) the level that a stakeholder can impact the project; and (2) the likelihood for this impact to occur. This approach has many variations, such as power/predictability or power/interest matrices, and the stakeholder vested-interest impact index. The last type is *Stakeholder Circle methodology*. Comparing with the above two types, this model is considered more holistic by incorporating stakeholder visualisation, engagement, and evaluation of communication effectiveness into the process (Bourne, 2005). It analyses stakeholders in a more structured way by indicating the directions of stakeholder impacts to the project team, as well as the scope and degree of impacts. However, this model relies heavily on the dyadic relationships between stakeholders and focal organisation in its assessment. It is noted that, in reality, stakeholders are linked by multiple social interactions and embedded in relationship networks. This model, building upon two-way stakeholder relationships, are thus inadequate to address stakeholder complexities in MCPs.

The above background indicates that the conventional stakeholder analysis methods are linear and subjective for application in MCPs. Additionally, they have disregarded some important aspects of MCP stakeholder complexities, such as stakeholder relationships, stakeholder issue interdependencies, and the propagating impacts produced by these network systems (i.e. the stakeholder network and issue network); resulting in limited accuracy and effectiveness in MCP stakeholder analysis. A rigorous and innovative approach is in need to analysing and addressing the high complexities of stakeholders in MCPs.

1.1.4 Why network perspective has the potential

The network perspective provides a way forward for analysing and addressing stakeholder complexities in MCPs. The network theory was firstly introduced in 1930s; this methodology systematically analyses the relational structures of a definite set of actors, by visualising these structures with sociographs and quantitatively deciphering the structural pattern with network indices (de Nooy et al., 2005). According to Wasserman and Faust (1994), the performance and robustness of a network system are readily affected by the interconnected elements within this system, as well as the ways that these elements are linked together. As such, using network-theory based approach for stakeholder analysis in MCPs can help to understand the interactions of stakeholders, cause-and-effect relationships between stakeholder issues, as well as the resultant impacts of these on project delivery.

To improve the traditional stakeholder analysis practice, a network perspective can be applied to analyse two important aspects of MCP stakeholder complexities: ‘stakeholder interactions’ and ‘stakeholder issue interdependencies’. MCP stakeholders are embedded in relationship networks, within which their values, expectations and behaviors emerged. It is therefore vital to analyse interactions and impacts of stakeholders from a network perspective. Stakeholder issue interdependencies is another key aspect to be analysed because issues emerging from a MCP are interrelated. The presence and incidence of an issue can trigger the other issues to occur, and affect their perceived importance under propagating effects. The issues of a MCP are under direct, indirect or mutual impacts from each other. Overlooking these interdependencies will compromise the accuracy and completeness of stakeholder impact assessment. Despite of the above, there are only limited research investigating stakeholder relationships, issues interdependencies and their effects with a network perspective. The full potential of using network-theory based approach for analysing and addressing stakeholder complexities in MCPs is yet to be exploited.

1.1.5 Why a model is needed

Stakeholder analysis has been regarded an essential element of MCP management to interpreting the complex stakeholder environment (Karlsen, 2002; Li et al., 2012; Olander and Landin, 2008; Yang and Zou, 2014). Notwithstanding the recent growth of project stakeholder analysis theories and practical approaches, the performance of stakeholder management in MCPs has still been criticized as unsatisfactory (Pryke and Smyth, 2006). As Rowlinson et al. (2010) stated, “the issue of stakeholders and their management was paid scant regard”; the study by Li et al. (2012) in Hong Kong also added that, “numerous project failures resulting from insufficiently addressing their concerns and meeting their expectations throughout the project lifecycle are detailed”. The conventional stakeholder analysis practice has put obstacles on project teams to fully identifying stakeholders and their issues, and accurately evaluating their relationships and impacts. Besides, stakeholder analysis is more complex in MCPs than in ordinary projects, but some practitioners do not possess sufficient skills and knowledge to undertake this task, the various methods available have led them to confusion in practice (Jepsen and Eskerod, 2009).

Apart from the above, Karlsen (2002) pointed out one more reason to explain the unsatisfactory MCP stakeholder management record – the lack of a systematic and holistic model. The existing stakeholder management process models, in construction project context, have been criticized as not entirely coherent and formal (Yang and Shen, 2014). As Karlsen (2002) described, the process is "characterized by spontaneity and casual actions" (Karlsen, 2002). It is obvious that, a fragmented and informal stakeholder management process is not sufficient to address and manage the complex stakeholder interfaces in mega developments. As such, a systematic and holistic model is in need of development for analysing and managing stakeholder complexities in MCPs.

In this research, stakeholder analysis in MCPs is considered as a process; comprising the activities to identify stakeholders and their associated issues, analyse stakeholder relationships and issue interdependencies, assess stakeholder and issue importance, and develop stakeholder engagement and issue treatment strategies, towards successful project delivery. With the above background, this research aims to develop a systematic and holistic model for stakeholder analysis and management in MCPs, specifically investigating stakeholder interactions and stakeholder-related issue interdependencies from a network perspective.

1.2 Research aim and objectives

This research systematically reviews previous studies on stakeholder management in MCPs. In the scope of existing research, three knowledge gaps are identified as follows:

Gap 1. The full potential of using network perspective to analyse and manage stakeholder relationships in MCPs needs to be further explored. A systematic approach to analyse stakeholder interactions and assess stakeholder importance in MCPs has yet to be developed.

Gap 2. Most studies consider stakeholder issues as being independent, and overlook the origins of issues and the interdependencies between issues. A systematic approach to analyse stakeholder-related issue interdependencies and assess issue importance in MCPs has yet to be developed.

Gap 3. A systematic and holistic model for stakeholder analysis and management in MCPs needs to be further developed. To enhance current MCP stakeholder management practice in Hong Kong, an application guideline of the model is in need.

In the context of the above knowledge gaps, the main proposition of this research is:

> *The development of a systematic and holistic model for MCP stakeholder analysis and management, building upon the network perspective, can contribute to the body of knowledge in the construction stakeholder management domain. An improvement in the accuracy and effectiveness of MCP stakeholder analysis requires the investigation of stakeholder interactions and stakeholder-related issue interdependencies from a network perspective.*

Following the above research proposition, the aim of this research is:

To develop a systematic and holistic model for stakeholder analysis and management in MCPs, specifically investigating stakeholder interactions and stakeholder-related issue interdependencies from a network perspective.

To achieve the above aim, three objectives of this research are designed:

Objective 1. To develop and refine a social network approach for analysing stakeholders and their interactions in MCPs, and validate the proposed approach by using real-life MCPs (corresponding to Gap 1).

Objective 2. To develop and refine a social network approach for analysing stakeholder-related issues and their interdependencies in MCPs, and validate the proposed approach by using real-life MCPs (corresponding to Gap 2).

Objective 3. To develop and validate a systematic and holistic model, and its application guideline, building upon the network perspective, for stakeholder analysis and management in MCPs (corresponding to Gap 3).

1.3 An overview of the research methodology

This research study is designed to accomplish the three objectives described in Section 1.2. Figure 1.1 outlines the research design. This study is carried out in four phases.

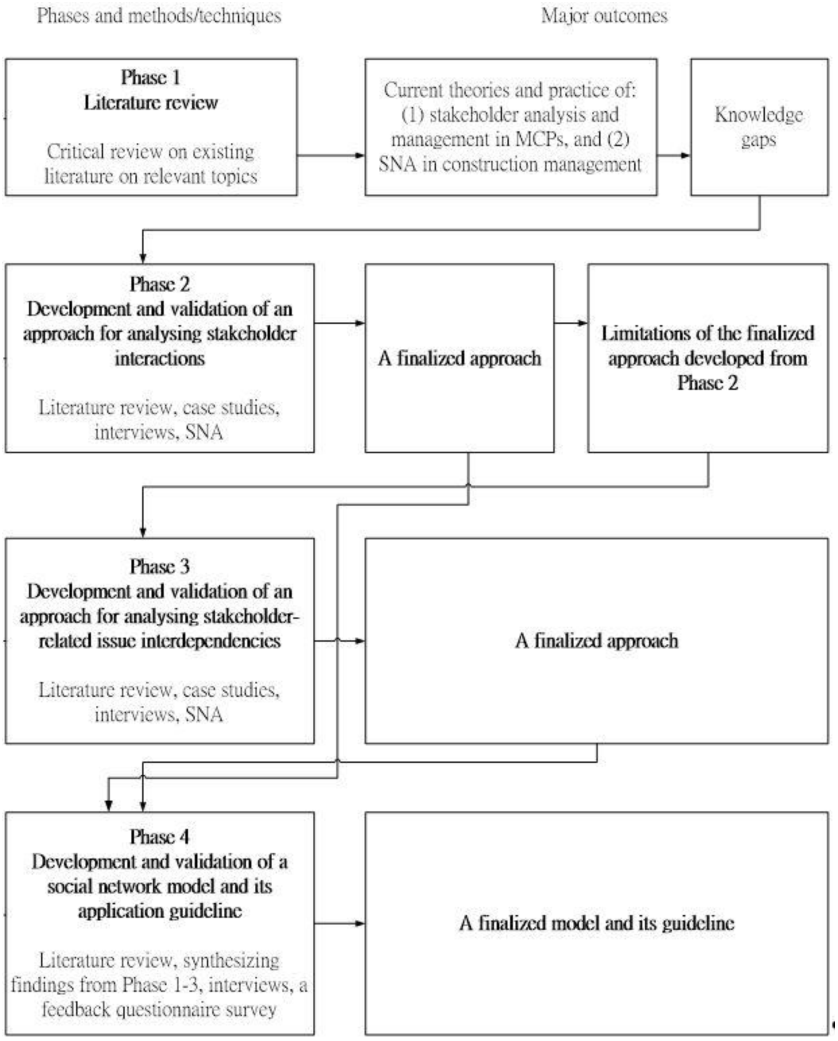


Figure 1.1: An outline of the research process and interim deliverables

Phase 1 is a literature review process. Previous studies on stakeholder management in MCPs and SNA in the construction management field are examined. This process aims to observe the current trends of these research topics, identify the knowledge gaps, and build a strong theoretical foundation upon which the research study is based (refer to Chapter 2).

Phase 2 is the development, refinement and validation process of a social network approach for analysing stakeholders and their interactions in MCPs, based on findings from the literature review and two case studies in Hong Kong (refer to Chapter 4 and 5). The case studies in this phase involves several research methods and techniques for data collection and analysis, including literature review, chain referral sampling, interviews, and SNA. The finalized approach is a major outcome of this phase. The findings from this phase also revealed the needs to identifying the sources of stakeholder issues, and analysing the interdependencies between issues, leading to Phase 3.

Phase 3 is the development, refinement and validation process of a network-theory based approach for analysing stakeholder-related issues and their interdependencies in MCPs (refer to Chapter 6 and 7). The research flow and methods taken in Phase 3 are basically similar to those of Phase 2. The findings are mainly based on the literature review and two case studies in Hong Kong. The finalized approach is a major outcome of this phase.

By synthesizing findings from the empirical studies (Phase 2 and 3) and groundworks from the literature review (Phase 1, 2 and 3), a social network model and its application guideline for stakeholder analysis and management in MCPs are developed. Phase 4 delivers the synthesis, refinement and validation process of the model and guideline. The validation is done by semi-structured interviews and a feedback questionnaire survey with relevant experts from the industry and academia.

1.4 Structure of the thesis

There are nine chapters in this thesis. The contents of each chapter are briefly described below. Chapter 1 is an introduction to this research and thesis. It presents the research background, identified knowledge gaps, research aim and objectives, an overview of the research methods used, and the thesis structure.

Chapter 2 is a literature review on stakeholder management in MCPs. It firstly describes mega projects in general and MCPs, then presents the development of stakeholder theory and stakeholder concept in MCPs. After the background, an overview of literature on stakeholder management in MCPs is carried out, and three research gaps are subsequently identified. The identified gaps reveal the potential of using network perspective. Thus, the chapter ends with a discussion on the development of network theory, and an overview of network studies in the construction project management field.

Chapter 3 discusses and justifies the research design and methods employed to accomplish the research objectives presented in Chapter 1. This chapter firstly explores the nature of this research study by scrutinizing ten considerations relating to research design; namely purpose of the research, types of investigation, research setting, level of researcher interference, time span, methodological approach, selection of data collection methods, sampling design, quality of research, and ethical considerations. The research methods selected for retrieving knowledge in this study are described. The research process is explained in detail.

Chapter 4 presents a social network approach for analysing stakeholders and their interactions in MCPs, with an emphasis on the project information exchange relationships of stakeholders. The chapter explains the rationale of the approach, SNA metrics applied, detailed procedures, and the main principles for identifying and engaging the critical stakeholders.

Chapter 5 is to illustrate the application of and validate the proposed social network approach (in Chapter 4) by using two real-life MCPs in Hong Kong. The two case projects include a major cultural building project and a large-scale green building development. The major outcome of the chapter is a finalised social network approach for analysing stakeholders and their social interactions in MCPs.

Chapter 6 presents a social network approach for analysing stakeholder-related issues and their interdependencies in MCPs. The chapter explains the rationale of the approach, network metrics and techniques applied, detailed procedures involved, main principles for identifying critical stakeholders, associated issues and links; as well as the immediate simulation process.

Chapter 7 is to demonstrate the application of and validate the proposed network approach (Chapter 6) by using two real-life MCPs. The two case projects include a major public office building development and a large-scale reclamation works. The main outcome of the chapter is a finalised network-theory based approach for analysing stakeholder-related issues and their interdependencies in MCPs.

Chapter 8 presents a social network model for stakeholder analysis in MCPs for Hong Kong, and an application guideline for practical use of the model. The proposed model is developed by consolidating the findings from Chapter 2, 4, 5, 6 and 7. Following these, the chapter presents the results of model and application guideline validation by a number of relevant experts and industry practitioners, through face-to-face discussions and questionnaire.

Chapter 9 is the final chapter of the thesis. It summarizes the main research findings obtained for fulfilling the research objectives, and describes how this work contributes to construction stakeholder management domain. The chapter ends with an explanation on the limitations of research, and the recommendations for future research and practice.

1.5 Chapter summary

This chapter is an introduction to the thesis. The main argument of the research is that, a systematic and holistic model for MCP stakeholder analysis and management, building upon the network perspective, can contribute to the body of knowledge in the construction stakeholder management domain. Analysing stakeholder interactions and stakeholder-related issue interdependencies with the network perspective can improve the overall effectiveness of MCP stakeholder analysis practice.

This chapter introduces the background of research, identifies the research gaps, presents the research aim and objectives, and briefly describes the research process and methods. The next chapter is a literature review which serves as a theoretical foundation of this research study.

Chapter 2 – Literature Review

2.1 Introduction

This chapter presents a comprehensive review on stakeholder management studies in MCPs. This chapter firstly introduces the background of mega projects in general and MCPs, then explains the development of stakeholder theory and stakeholder concept in MCPs. Following these, an overview of previous studies relating to stakeholder management in MCPs is carried out. Through the review on existing publications in the defined scope, three research gaps are identified for further investigation. These identified research gaps reveal the potential of applying a network perspective to analysing stakeholder relationships and stakeholder issue interdependencies in MCPs. As such, this chapter finally discusses the development of network theory, and provides an overview on network studies in the construction project management domain.

2.2 Background of mega construction projects and stakeholder management

1.2.1 Mega projects in general

Mega project is described as a substantial capital project, of several billion dollars, which requires concerted efforts from major participants in terms of resources, skills and expertise (Flyvbjerg, 2007; Sykes, 1990). There are various types of mega projects, including transport infrastructures, oil and gas extraction, defence and aerospace, water and dams, power supply and urban development (Flyvbjerg, 2007; Gellert and Lynch, 2003). Research of mega projects has become an increasingly widespread interest in the engineering and project management domains. The fast pace of mega project development can be attributed to the advanced construction technology and rapid globalization. Table 2.1 summarises the definitions, types and examples of mega projects, mega infrastructure projects and mega construction projects in some relevant literatures.

Table 2.1: Definition, categorization and examples of mega projects, mega infrastructure projects and mega construction projects

	Researcher(s)	Definition	Categorization	Examples
Mega project	Gellert and Lynch (2003)	"Projects which transform landscapes rapidly, intentionally, and profoundly in very visible ways, and require coordinated applications of captial and state power" (p.15).	Infrastructure	Ports, railroads, urban water systems
			Extraction	Minerals, oils, gas
			Production	Industrial tree plantations, manufacturing parks
			Consumption	Massive tourist installations, malls, theme parks, real estate developments
	Flyvbjerg (2007)	"The most-expensive infrastructure projects that are built in the world today, typically at costs per project from around a hundred million to several billion dollars" (p.578).	Transportation	San Francisco-Oakland Bay Bridge, the Copenhagen metro, the Channel Tunnel, Eurotunnel, Denver International Airport
			Defence and aerospace	the Pentagon spy-satellite program, the International Space Station, NASA space shuttle, the Eurofighter military jet, the Astute attack submarine
			Information technology	the FBI's Trilogy information system
			Urban development	the Quebec Olympic stadium, the Scottish parliament building, the Millennium Dome, the Guggenheim Museum Bilbao, the Iraq reconstruction effort
			Water and dams	India's Sardar Sarovar Dam, the Animas-La Plata water project
			Oil and gas extraction	Russia's Sakhalin-1 oil and gas project,
			Power supply	the Washington Public Power Supply System, Ontario's Pickering nuclear plant
	Genus (1997)	Projects which "have the following characteristics: long lead time; high capital intensity; large unit size; and dependence upon specialized infrastructure" (p.169).	Water	Irrigation schemes
			Aerospace	Space shuttle
			Power supply	the development of nuclear energy
	Skyes (1990)	"Any collaborative or capital project which requires knowledge, skills or resources that exceed what is readily or conventionally available to the key participants" (p.159). The definition covers both macro-engineering projects and massive non-engineering projects.		

	Researcher(s)	Definition	Categorization	Examples
Mega infrastructure projects	Salet et al. (2013)	"A loosely coherent accumulation of single elements framed as a single unitary package" (p.1985).	Projects with a primary infrastructural function and organised as a single project	the Regional Metro System in Naples
			Project which serves as part of an assemblage of different projects under a multipurpose development strategy	the Cultural Forum in Barcelona, the urban development projects of Erdberger Mais in Vienna
	El-Gohary et al. (2006)	Projects which raise different levels of contention among various stakeholders, and where stakeholder involvement is a crucial factor of project success.	Transportation	Highway and bridge construction, transit planning, transportation planning
			Water	Water resources, water supply, water treatment
			Mining	
			Solid waste management	
			Hazardous waste disposal	
			Land development	
	Yeo (1995)	Projects which can be seen as large scale systems and are characterized by being dimensionally large, being human-activity centered, being capable of growth, and having stringent multiparty control structure.	Transportation	Seaports, airports, mass rapid transit system, the network of expressways
			Utilities	Electricity, water and gas utilities
			Telecommunication	telecommunication systems

	Researcher(s)	Definition	Categorization	Examples
Mega construction projects	Sun and Zhang (2011)	Projects which are "described as substantial investment (more than 1 billion dollars), long schedule (over two years) public infrastructures, which usually have long life time of 50 years and more, and generate multiple social impact, and invested or commissioned by governments" (p.828).	Energetics, oil industry	Underground civil engineering projects, industry plant construction
	Zhai et al. (2009)	Construction projects which cost US$100 million or above, and are characterized by having "extreme complexity, substantial risks, long duration, a large number of participants and extensive impacts on the community, economy, technological development and environment of the region or even the whole country" (p.99).	Municipal infrastructure projects	
	Han et al. (2009)	Projects which cost US$1 billion or above, require duration of more than five years, and are characterized by involving many activities and complex procedures.	Transportation	Korea Train Express, the Channel Tunnel, the Central Artery/Tunnel project in USA, the Oil Sands Projects in Canada
	Fiori and Kovaka (2005)	"A construction project, or aggregate of such projects, characterized by: magnified cost, extreme complexity, increased risks, lofty ideals, and high visibility, in a combination that represents a significant challenge to the stakeholders, a significant impact to the community, and pushes the limits of construction experience" (p.3).	Transportation, Commercial/Residential, Urban redevelopment	Bridge, highway, skyscraper, urban riverbed development

Mega projects are often initiated with a single primary objective of serving human, economic and societal needs (Jia et al., 2011). The huge size and high complexity of mega projects bring about some major challenges in their planning and management: (1) the involvement of numerous stakeholders and vested interests resulting in intricate stakeholder interactions and issue interdependencies, thus requiring integrated efforts in coordination to achieve project goals; (2) the dynamics and growing capacity leading to high project uncertainty (Yeo, 1995), for example, cost and time uncertainties due to changing project scope; and (3) their governance by a stringent multi-role administrative structure leading to high public attention and controversies (Yeo, 1995). The following section focuses on mega constructions.

1.2.2 MCPs

MCPs are massive investments of infrastructure, often initiated by the government, which have long schedule, huge lifespan, extreme complexity and significant social impacts (Sun and Zhang, 2011). Salet et al. (2013) divided MCPs into two major groups according to their project function. The first group considers one new single project or an aggregate of projects which are initiated to serve a primary infrastructural function. They comprise project components of the same sector. For example, the Hong Kong-Zhuhai-Macao Bridge involves project components (bridge, highway, and tunnel) of a single sector, transportation. The second group considers a combination of new projects, each serving different functions, but integrated under the single umbrella of a strategic development plan. Kai Tak Development in Hong Kong is an example where it comprises project components from the residential, educational, and leisure sectors. MCPs play three major roles in the strategic development of a society: (1) satisfying human, economic and societal needs; (2) elevating a country's social image; and (3) delivering leading international events (Jia et al., 2011). Notwithstanding the significance of mega project developments, many difficulties are encountered in their stakeholder management process. Rose and Manley (2010) indicated that late involvement of major stakeholders and discrepancy in their relationship intentions were two major negative drivers in aligning the work motivation of contractors and consultants. Emuze and Smallwood (2011) revealed that in developing countries, the skills of public sector departments in collaborating stakeholders were inadequate which consequently compromised project performance. Iyer and Jha (2006) stated that the schedule performance of MCPs could be significantly hindered due to conflicts, indecisiveness and inadequate coordination of project stakeholders.

The definition of MCPs in the literature varies. Despite the different foci of these studies, they generally define MCPs as substantial investment, which are initiated and funded by the government, to provide communal facilities essential for boosting economic growth as well as enhancing the environment and societal quality of life (DEVB, 2002; Zeng et al., 2015). MCPs are characterized by being dimensionally huge and human-oriented (Yeo, 1995); having extreme complexity, high risks and long lead time (Fiori and Kovaka, 2005); involving multiple stakeholders at different levels; and producing considerable impacts to the society, economy and natural environment (Zhai et al., 2009). The cost of MCP is huge where the governments and researchers worldwide have accepted the range of US$500 million-1 billion as the cost threshold per project (FHA, 2005; Hu et al., 2015). Failures of MCPs have been discussed in many studies, where the complexities of stakeholders, stakeholder issues and their interactions are highlighted as major factors adding difficulties to MCP management (Olander and Landin, 2005). The following section discusses the development of stakeholder theory and the stakeholder concept in MCPs.

1.2.3 The origin of stakeholder theory

The stakeholder theory was originated from strategic management in 1963 when the Stanford Research Institute primarily defined stakeholders as individuals whose existences are vital to organisational survival (Freeman, 1984). Following its origin, the stakeholder notion diverged into four key directions concerning organisational studies: *corporate planning*, *systems theory*, *corporate social responsibility* and *organisational theory*. The stakeholder concept was given wider recognition since Freeman (1984) elaborated on stakeholder definition as any entities "who can affect or is affected by the achievement of the firm's objectives" in his classic: *Strategic Management: a Stakeholder Approach*. Thereafter, scholars enriched the stakeholder theory to enhance its position. For example, Donaldson and Preston (1995) proposed three approaches to look into stakeholder theory: (1) *descriptive*, which explores stakeholder management process and develops methods; (2) *instrumental*, which investigates how stakeholder management influences the accomplishment of organisational goals; and (3) *normative*, which considers moral guidelines to manage stakeholders. Freeman (1984) proposed the concepts of stakeholder dynamics, and Mitchell et al. (1997) proposed stakeholder salience and the typology. Following the advancement of stakeholder theory, scholars have realized its potential to be implemented in other domains including construction management. Extensive research efforts have been devoted on managing project stakeholders in recent years, in particularly stakeholder management in MCPs. A critical review of previous studies on stakeholder management in MCPs is presented in Section 2.3.

1.2.4 The concept of stakeholder in MCPs

In project management context, the Project Management Institute (PMI) (1996) describes project stakeholders as any "individuals and organisations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion". In this study, PMI's definition is adopted to conceptualize stakeholders in MCPs.

MCPs comprise a wide range of stakeholders. Various methods are available to identify who they are. Classifying stakeholders into groups is a commonly used approach to stakeholder identification; while stakeholders' contractual relationships with the project, their degree of engagement in project decision making, and their position in project environment are some broadly used basis for stakeholder classification in MCPs (Nguyen et al., 2009). In the study of Tuman (2006), project stakeholders include four groups: (1) *project champion*, who make the project come into existence (e.g. project proponents, developers, financiers, and end users); (2) *project participants*, who have responsibilities in project planning, execution and management; (3) *community participants*, whose stakes are directly influenced by project implementation (e.g. the local community and natural environment in the vicinity of project); and (4) *parasitic participants*, who bring about challenges or controversies even they do not possess any direct interests in the project (e.g. the media and pressure groups). Based on stakeholders' legal relationships with the project, Charkham (1992) and Li et al. (2012) categorized MCP stakeholders into two types: (1) *internal stakeholders*, who are engaged contractually with the client for the demand/supply of resources, services and/or end products in project delivery (e.g. contractors, engineers, suppliers, consultants and end-users); and (2) *external stakeholders*, who do not have contractual relationships but are collaborated in the project as owning a stake (e.g. local community, environmentalists, public authorities). There are many other ways to classify stakeholders in MCPs, such as internal/external interests (Huang and Kung, 2010), direct/indirect environmental impacts (Darnall et al., 2010), as well as the direction of stakeholder influences on the project and its outcomes (Bourne, 2011). Generally, MCP stakeholders include: *publicly-funded project proponent*, *contractors*, *designers*, *consultants*, *suppliers and subcontractors*, *regulatory agencies*, *financers*, *media*, *environmentalists*, *politicians*, *local community*, *the public*, *end users*, and *professional institutions*. It is worth noting that this list does not aim to cover all stakeholder entities in MCPs, but it provides initial insights on which stakeholder groups are to be focused in this study.

2.3 Overview of previous studies on stakeholder management in MCPs

2.3.1 The review process

Paper retrieval

This critical review was undertaken by an intensive comparison of peer-reviewed journals of the stakeholder management domain in MCPs. A set of search criteria were established for paper retrieval. Firstly, only academic journals were selected for review, in consideration of their impact positions in the research community in terms of SCImago Journal Rank and H-index. Book reviews, industry reports, editorials and papers in conference proceedings were eliminated. This is to ensure that all retrieved publications could be investigated using an identical analytical construct in terms of research aims and methodologies. Three academic databases: ISI web of knowledge, Scopus and ABI/INFORM complete, were searched for relevant publications. Secondly, some keywords were used for literature search. The search rule used was (“stakeholder”, “project participant” OR “project environment”) AND (“mega”, “major”, “complex” OR “large”) AND (“construction project”, “infrastructure project”, “engineering project”, “building project” OR “development”). These keywords were applied because they contain meanings alike but appear in different research disciplines and countries (Feliu, 2012; Manowong and Ogunlana, 2006; Toor and Ogunlana, 2010). Thirdly, the scope of publication search was scaled down to starting from 1997/1/1. This starting point was selected because the relevant publication appeared since 1997 (Genus, 1997), while earlier studies were not analysed specifically from the perspective of stakeholder management in MCPs. It is expected that, the state-of-the-art of stakeholder management research in MCPs could be clearly depicted by reviewing academic journals of this time span. To ensure a comprehensive literature search, some references from the initially retrieved papers were also followed up. A total of 442 articles were retrieved. Despite the rigorous search rule, some retrieved publications appear to be less relevant. Therefore, in the subsequent step, this review applied the filtering process previously adopted by Olander (2006) and Yang et al. (2011b) in their literature reviews. This process comprised two stages. In the first stage, publications which do not contain the abovementioned keywords in their titles and abstracts were screened out. In the second stage, after a brief review of the paper contents, the less relevant and irrelevant papers were excluded, leaving a total of 113 publications for further analysis. The selected publications covered various perspectives of managing stakeholders in MCPs, for example stakeholder interests and influence strategies, stakeholder participation, as well as the theories and practical approaches of handling stakeholder issues in MCPs.

Statistics of relevant publications

Figure 2.2 shows the annual number of publications, indicating a sharply increasing research interest since 2005. This can be explained by the globally rising trend of MCPs, and the real-life problems encountered by MCP leaders and managers in balancing and addressing diverse project stakeholder claims (Li et al., 2012).

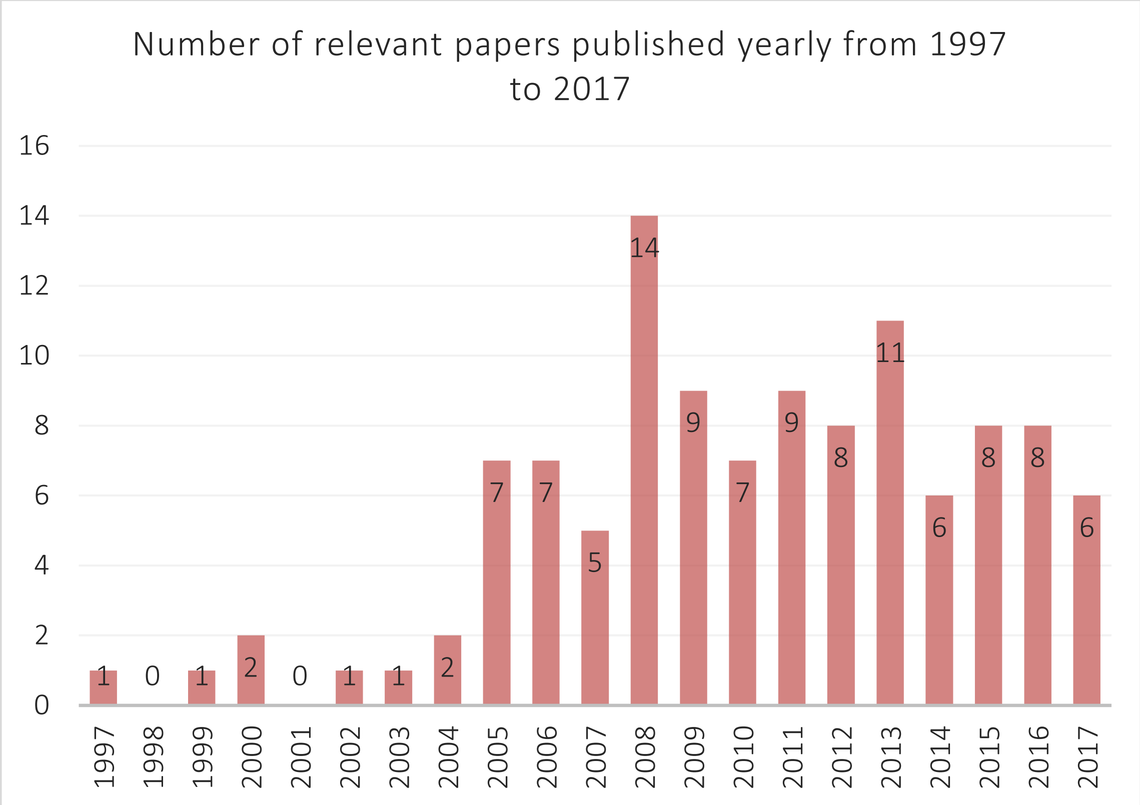


Figure 2.1: Number of relevant articles published yearly from 1997 to 2017

Table 2.2 presents the distribution of selected publications in different journals. Two journals, *International Journal of Project Management* and *Construction, Management and Economics*, have published the largest number of articles on stakeholder management in relation to MCPs; counting 23% and 13% of the retrieved papers respectively.

Table 2.2: Distribution of selected articles for review

Journal title	**Number of selected papers**	**Percentage (%)**
International Journal of Project Management	26	23
Construction Management and Economics	15	13
Journal of Construction Engineering and Management ASCE	7	6
Project Management Journal	5	4
Building Research and Information	3	3
Automation in Construction	3	3
Engineering, Construction and Architectural Management	3	3
Facilities	2	2
Habitat International	2	2
Journal of Management in Engineering ASCE	2	2
Land Use Policy	2	2
Management Decision	2	2
Research Policy	2	2
AACE International Transactions	1	1
Architectural Engineering and Design Management	1	1
Architectural Science Review	1	1
Baltic Journal of Management	1	1
Building and Environment	1	1
Computer-aided Civil and Infrastructure Engineering	1	1
Cities	1	1
Civil Engineering and Environmental Systems	1	1
Construction Economics and Building	1	1
Desalination	1	1
Disaster Prevention and Management	1	1
Ecological Economics	1	1
Engineering Management Journal	1	1
Environmental Impact Assessment Review	1	1
European Journal of Environmental and Civil Engineering	1	1
European Journal of Industrial Engineering	1	1
International Journal of Construction Management	1	1
International Journal of Technology	1	1
Journal of Architectural Engineering	1	1
Journal of Civil Engineering and Management	1	1
Journal of Environmental Management	1	1
Journal of Facilities Management	1	1
Journal of Infrastructure Systems	1	1
Journal of Transport Geography	1	1
Journal of Urban Planning and Development ASCE	1	1
Journal of Water Resources Planning and Management ASCE	1	1
KSCE Journal of Civil Engineering	1	1
Proceedings of the Institution of Civil Engineers Civil Engineering	1	1
Proceedings of the Institution of Civil Engineers Municipal Engineer	1	1
Research in Transportation Economics	1	1

Scandinavian Journal of Management	1	1
Structural Survey	1	1
Supply Chain Management-an International Journal	1	1
Sustainability	1	1
Sustainable Development	1	1
Systems Research and Behavioral Science	1	1
Transportation Research Part A Policy and Practice	1	1
Technological and Economic Development of Economy	1	1
The TQM Magazine	1	1
Total	113	100

Regarding their geographical jurisdiction, 68% of the selected articles examined a single domestic market. This could be attributed to the variances of social, cultural and economic systems of different countries (Hofstede, 1991). Therefore, MCP stakeholder management practice is subject to the national or regional context of the project; and to certain extent, generalizing findings across national borders may produce limited practical implications. Among these studies, the majority investigated the markets of Asia (25%), Europe (23%) and America (10%). In addition, 13% of the articles were considered multi-country since multi-national MCPs or stakeholder organisations were their subject of study, and 19% were unspecified in terms of country. Table 2.3 presents the distribution of selected publications by geographical jurisdiction.

Table 2.3: Distribution of selected articles by geographical jurisdiction

Geographical jurisdiction	No. of papers	Percentage (%)
Asia	28	25
Europe	26	23
America	11	10
Australia	8	7
Africa	3	3
The middle east	1	1
Multi-country	15	13
Unspecified	21	19
Total	113	100

Content analysis

Content analysis, a structured and systematic technique to "compressing many words of text into fewer content categories based on explicit rules of coding" (Stemler, 2001), was adopted to identify the key research themes in this literature review. Content analysis can facilitate researchers to examine huge amount of textual data in an organised manner, to identify the focus of subject matter, and to observe emerging patterns in literatures (Elo and Kyngäs, 2008; Krippendorff, 2004; Weber, 1990). This technique was applied by Laplume et al. (2008) in their review of stakeholder theory-related publications, where they discovered some major research themes by coding and analysis using an inductively developed but standardized codebook. Laplume et al.'s (2008) codebook was adapted and used in this critical review.

2.3.2 The current status

By content analysis, it is observed that, stakeholder management research in relation to MCPs is categorized under four major themes, namely (1) *stakeholder management process*, (2) *stakeholder analysis methods,* (3) *stakeholder issues and influence strategies,* and (4) *stakeholder relationships*. Some articles discussed more than one identified theme but they are classified according to the main research interest examined in the papers. Table 2.4 presents the distribution of publications by period and identified research themes. It indicates that scholars have given the least attention to "stakeholder issues and influence strategies", but made relatively even research efforts on the other three identified themes. It is notable that the research interest on "stakeholder relationships" has been rising rapidly since 2006. One limitation is that, under the limited search scope, the selected publications may not cover all relevant studies of this domain, but they can reflect its overall development and research trend.

Table 2.4: Distribution of selected articles by period and identified research themes

Research theme	Period (Year)					Total	Percentage (%)
	1997-2000	2001-2005	2006-2010	2011-2013	2014-2017		
Stakeholder management process	3	4	13	8	2	30	27%
Stakeholder analysis methods	2	5	8	3	11	29	26%
Stakeholder issues and influence strategies	2	0	7	6	6	21	19%
Stakeholder relationships	0	1	13	10	9	33	29%
Total	7	10	41	27	28	113	100%

2.3.2.1 Stakeholder management process

The procedures and process of MCP stakeholder management have been widely discussed in literatures (El-Gohary et al., 2006; Jepsen and Eskerod, 2009). The main purpose of MCP stakeholder management is to gain stakeholder support in project development and to make project activities "issue driven rather than stakeholder driven" (Jergeas et al., 2000). To achieve this, education, communication, mitigation and compensation are four key activities that the project team should continuously undertake in the entire stakeholder management process (Jergeas et al., 2000). The six-step stakeholder management process model established by Karlsen (2002) is another model frequently cited in construction and project management literature (Aaltonen, 2011; Jepsen and Eskerod, 2009; Yang et al., 2009). These steps include defining objectives, resources and operational details; identifying stakeholders; evaluating their interests and impacts; reporting evaluation results; formulating stakeholder management strategies; and monitoring effectiveness. Summarizing these previous studies, *stakeholder identification*, *stakeholder analysis*, *strategy development* and *performance control* appear to be four essential stages in the MCP stakeholder management process. However, the existing stakeholder management process models of MCPs are not entirely consistent. The performance of MCP stakeholder management is criticized as unsatisfactory (Pryke and Smyth, 2006); its process is "characterized by spontaneity and casual actions" (Karlsen, 2002), but the fragmented and informal process is insufficient to manage the complicated interfaces in mega developments. As such, there is an acknowledged need for a complete, systematic and formal stakeholder management process model for application in MCPs (Yang et al., 2011b).

Some scholars focus on spatial dynamics of MCP stakeholder management process. Spatial distance has been considered as a significant factor of stakeholder interaction and influence in some stakeholder research of the business and ecological domain (Driscoll and Starik, 2004; Hein et al., 2006). This concept has been applied in the context of infrastructure planning, for example, Doom et al. (2013) examined the link between spatial dynamics and stakeholder impacts in seaport planning and development. Stakeholder structure and interests vary with their spatial distance from the project, with stakeholders gaining higher salience when they become geographically closer to the project (Dooms et al., 2013). This concept of spatial dynamics can be useful in MCPs with transnational involvement. The interests and actions of stakeholders at different spatial scales are influenced by locational factors like local culture, media, political systems and regulations. Disregarding the spatial dimension in MCP stakeholder management may lead to incomplete stakeholder boundaries and unexpected negative effects on project execution.

Some literatures pay more attention to the stakeholder management process of early project phases. For example, scrutinizing alternative solutions and communicating project values are found to be crucial when managing stakeholders at the planning stage (Olander and Landin, 2008). The process of integrating council stakeholders during project planning, inception and design phases were also investigated (Heywood and Smith, 2006). However, MCPs are characterized by long lifecycles and complicated interfaces (Chou and Yang, 2012), placing focus solely on the stakeholder management process of early project phases is insufficient to address stakeholder claims in complex MCP environments. Fully illustrating the stakeholder management process at every stage along the entire MCP lifecycle is needed.

2.3.2.2 Stakeholder analysis methods

Stakeholder analysis in MCPs is a process of interpreting the project stakeholder environment, which refers to a project setting composing of "all organisations, and relationships between them, that can affect or be affected by the project" (Aaltonen, 2011). Various stakeholder analysis methods have been developed in previous studies and they serve three main purposes: *stakeholder identification, classification* and *assessment*. Mitchell et al. (1997) established stakeholder salience model to determine the classes of stakeholders based on their possession of one, two or all the three attributes: power, legitimacy and urgency. This classification system can gauge the amount of attention that project team should give when addressing stakeholder needs (Mitchell et al., 1997). Another classification method considers stakeholder attitude towards a project by distinguishing whether a stakeholder is an advocate or adversary of the project in five levels: “active opposition”, “passive opposition”, “not committed”, “passive support” and “active support” (McElroy and Mills, 2000). These methods can help determining the direction of stakeholder influences on MCP decision making (Olander, 2007), but classifying stakeholders is only part of the identification process. It helps distinguishing stakeholders in general case, yet of little help in quantitatively assessing their actual impacts on MCP development.

Bourne (2005) developed the Stakeholder Circle methodology, which offers a systematic and effective means of visualising the project stakeholder community and picturing their patterns of influences. Nonetheless, a weakness of this method is lacking the indication of stakeholder attitudes – it shows the directions of stakeholder forces towards project team, but does not reflect whether they perceive the project positively or negatively (Nguyen et al., 2009). Olander (2007) developed the stakeholder impact index to quantitatively assess stakeholder influences by integrating: (1) Mitchell et al.'s (1997) stakeholder attributes; (2) Bourne and Walker's (2005) stakeholder vested interest-impact index; and (3) McElroy and Mills's (2000) stakeholder position towards the project. This method is said to be comprehensive because it considers the nature, probability, intensity of stakeholder influences; as well as stakeholder attitudes. Based on Olander's (2007) stakeholder impact index, Nguyen et al. (2009) propose a similar method to evaluate stakeholder influences but incorporating one more variable: stakeholder knowledge. They emphasize the importance of this variable by stating that, stakeholders with inadequate project knowledge can only exert limited influences even if they have the power and, in addition, stakeholders can be more influential if they gain concrete project information instead of relying on rumours and anecdotes.

It can be seen that, the above traditional stakeholder analysis methods categorize stakeholders and evaluate their impacts based on individual attributes, attitudes, roles and predictability. However, for application in MCPs, these methods are constrained by cognitive limitation of project team members and incomplete stakeholder boundary, as the project grows in size and complexity (Yang et al., 2009). A social network approach can comprehend the stakeholder environment by considering the interactions among multiple stakeholders and the structural characteristics of stakeholder networks (Rowley, 1997). SNA was built upon the assumptions that network members are interdependent and their behaviours are confined by relationship patterns within the network structures, thus it is a useful way to examine the "simultaneous influence of multiple stakeholders" and to forecast the corresponding response and management strategies (Rowley, 1997). Analysing project stakeholders with SNA bring two major benefits: (1) the quantitative diagnosis of relational ties and overall network structure provides more rigor analysis of stakeholder impacts; and (2), it enables the visualisation of complex and abstract stakeholder relationships using socio-grams in different project stages (Chinowsky et al., 2008). Recent stakeholder research in the construction management field is increasingly applying SNA, as every construction project is eventually a network of social interactions and collaboration (Chinowsky et al., 2008). For example, Yang et al. (2011a) examined stakeholder influence relationships with SNA in a small school building project; and Lienert et al. (2013) analysed, using SNA, how stakeholder collaboration and decision-making relationships can influence their priorities of interests in a water infrastructure project.

The existing stakeholder analysis methods, together with their strengths and weaknesses, are summarized above. Stakeholder analysis is more complex in MCPs than in ordinary projects. However, many practitioners do not possess sufficient skills and knowledge to undertake MCP stakeholder analysis (Jepsen and Eskerod, 2009); these various methods available can lead project leaders and managers to confusion in practice. There is a need to understand the features of stakeholder management in MCPs, the current stakeholder analysis methods and their pros and cons; and to develop a suitable approach for specific application in MCPs.

2.3.2.3 Stakeholder issues and influence strategies

Conflicts often arise in the development of MCPs due to the diverse interests, perceptions and expectations of the numerous stakeholders. Li et al. (2012) consolidated a list of seventeen stakeholder issues in public infrastructure and construction projects; their issues are multidimensional such as improving international reputation, maintaining construction sustainability and enhancing infrastructural facilities in the society. In many cases, stakeholders seek to prevent their vested interests from being jeopardized; consequently, an issue that is very important to one stakeholder group may be in the lowest priority of other groups. The different priorities that major stakeholder groups placed on their issues have been investigated in an infrastructure project in Hong Kong. The findings revealed that the government emphasizes potential economic benefits generated by the development; while the community focuses on sustainable land use, pressure groups are concerned with maintaining ecological and environmental sustainability, and the project-affected groups mainly consider tangible compensation (Li et al., 2012).

To satisfy individual vested interests, stakeholders often apply strategies to influence project decision making in a way matching their specific objectives. Understanding these strategies can help project teams to forecast stakeholders' likely behaviours and manage the stakeholder environment more systematically (Frooman, 1999). Aaltonen et al. (2008) classified eight influencing strategies that stakeholders adopt during project execution: "resource building", "credibility building", "direction action", "coalition building", "communication", "conflict escalation", "direct withholding" and "indirect withholding". By using the right strategy, stakeholders can raise the attention of project managers to satisfying their claims and thereby influencing project outcomes. They further suggested that stakeholder influencing strategies are dynamic over the entire project lifecycle as stakeholders take different roles and actions to cope with the changing project environment (Aaltonen and Kujala, 2010). Instead of taking the stakeholder perspective, influencing strategies have been investigated from the viewpoint of focal organisation who takes a leading role in project implementation. Regarding the responses of core project team to stakeholder claims, five strategies are identified: "adaption", "compromise", "avoidance", "dismissal" and "influence" (Aaltonen and Sivonen, 2009). One limitation of these studies is that, their basis is built upon the dyadic interactions between project team and individual stakeholders, but overlooking stakeholder interrelationships and their resultant impacts on shaping these influencing strategies (Aaltonen and Sivonen, 2009).

2.3.2.4 Stakeholder relationships

Many studies have contributed to conceptualizing and understanding the various types of stakeholder relationships in MCPs, e.g. trust, commitment, communication, conflict, coalition and cooperation. Pinto et al. (2009) conceptualise three kinds of trusting stakeholder relationships in MCPs and examine their importance from the perspectives of clients and contractors. Khalfan et al. (2007) identify project size and complexity as two influential factors affecting the strength of trusting stakeholder relationships; concluding that MCPs require more time and efforts in trust building than ordinary sized projects, because they involve complex interfaces between multiple stakeholder organisations and specialised trades. Leung et al. (2004) conceptualise three forms of goal commitment from project stakeholders; their results indicating that affective, instead of continuous commitment, can enhance project performance and stakeholder satisfaction in MCPs. Through an industry-wide survey, Leung et al. (2005) suggest that a moderate degree of conflict can increase stakeholder satisfaction of project performance, and project team should adopt proper strategies to stimulate conflicts at the goal establishment stage and maintain conflicts at an optimal level. Lizarralde et al. (2013) examine the different perceptions and roles of informal stakeholder communications in different project contexts of developed and developing countries. Their findings indicate that, informal communication in developed countries can help to generate shared values and maintain good contractual stakeholder relationships, but it only serves as a management tool to accelerate administrative procedures and reduce bureaucratic obstacles in developing countries.

MCPs require active participation and strong collaboration among key project stakeholders (Rose and Manley, 2010). Adversarial stakeholder relationships weaken collaborations and are likely to result in poor project performance. Significant research has been conducted to establish measures for promoting and improving MCP stakeholder relationships (Feliu, 2012, Rowlinson and Cheung, 2008). For example, Karlsen et al. (2008) suggest three strategies for trust building in large public cultural building projects, e.g. open and bona fide information sharing, creating informal stakeholder relationships, and early and clear communication of project responsibilities. In a cross-country railway project, Genus (1997) investigate the drawbacks of early centralised decision making on stakeholder collaboration, and recommend a flexible and incremental participatory approach to reducing stakeholder conflicts. Heywood and Smith (2006) promote early stakeholder involvement by exploring its benefits in mega project delivery, such as positive project image, greater political support, minimisation of community resistance and higher stakeholder satisfactions. To achieve these benefits, Valdes-Vasquez and Klotz (2013) suggest some methods to encouraging MCP stakeholder participation, such as early identification of stakeholder expectations, clear communication of project benefits and constraints to stakeholders, and increasing public transparency in project planning and design processes. Some studies pay more attention to public participation in MCPs. Ng et al. (2013) create a conceptual framework to promote public engagement by transferring decision-making power to the public, and encouraging public input in planning stage. Manowong and Ogunlana (2006) indicate the unsatisfactory performance of public hearing exercise in MCPs and recommend improvement measures, e.g. increasing flexibility in the hearing procedures, simplifying technical information before dissemination to the public, and providing the public with open access to the hearing results.

To date, existing research has largely focused on conceptualising and promoting the various stakeholder relationships involved, but this is not adequate to manage the extreme complexity of stakeholder relationships in MCPs. As Yang et al. (2009) note, the dynamic and intricate nature of project stakeholder relationships can affect how stakeholders perceive, behave and create value concerning the project. The patterning and characteristics of these relationship structures can also affect how effective the stakeholders are to be engaged. MCPs involve large and complex stakeholder relationship networks. This necessitates a systematic approach to accurately and objectively analysing the network structures and their associated impacts on project management and implementation. It appears that, a structured and holistic approach to analysing stakeholder relationship networks in MCPs is still in need of development. Further studies are needed to bridge this gap.

2.3.3 Research gaps

The previous section presents an overview of existing stakeholder management research relating to MCPs. With the above background, several areas have emerged as being in need of further research, as illustrated in Figure 2.3 and explained in the following discussion.

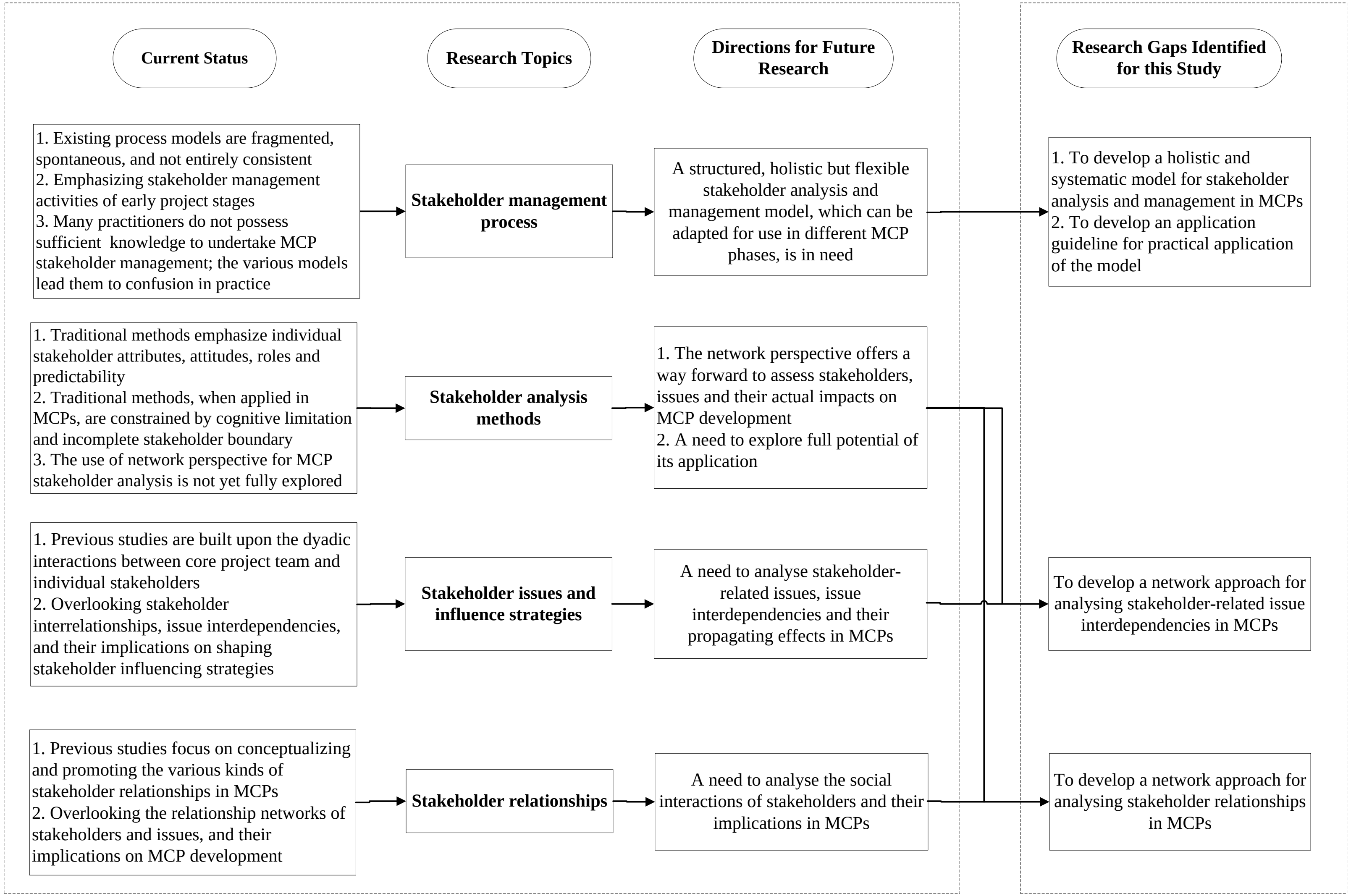


Figure 2.2: Current status and future directions of stakeholder management studies

2.3.3.1 Need to analyse stakeholder relationships from network perspective

Stakeholders in a MCP are connected across organisational and functional borders by various interactions, such as power and influence, communication, information exchange, and knowledge sharing (Chinowsky et al., 2008; Meese and McMahon, 2012). Stakeholders' roles, values, expectations and behaviours emanate from their relational structures; besides, these structural patterning can affect the way that stakeholders are engaged and influencing each other. Analysing the relationships of stakeholders and their impacts through these relationship networks can enhance stakeholder communication, realisation of actual stakeholder needs, and project decision making.

Despite the above, existing MCP stakeholder analysis methods have overlooked stakeholder relationship networks and their implications on project development. As noted in the review, current methods have paid too much emphasis on individual stakeholder attributes, as well as the two-way interactions between core project team and stakeholders. Taking a similar view to Jergeas et al. (2000), assessing individual stakeholder attributes and salience is no longer adequate to cope with the extreme stakeholder complexity in MCPs; but an examination of "how value is created in stakeholder relationships" would help (Myllykangas et al., 2010). Some researchers have taken a network perspective in their stakeholder management studies (Rowley, 1997; Yang et al., 2009); but the size of projects and their stakeholder relationship networks were quite small, and their investigations were confined to early project stages. It appears that, empirical studies which take a network perspective to analyse stakeholder interactions in MCPs, have been lacking. A structured approach to capturing, interpreting and managing stakeholder relationship networks is also in need of development, for application in MCPs. Bridging these gaps will help project team in understanding the underlying causes and consequences of stakeholder behaviours, identifying the critical and under-engaged project stakeholders, monitoring their network dynamics, formulating appropriate management strategies; and ultimately improving MCP performance.

2.3.3.2 Need to analyse stakeholder issue interdependencies from network perspective

Based on previous research, this study conceptualizes 'stakeholder issues in MCPs', extends the idea and develops a definition of this term. As mentioned above, stakeholders are any individuals or groups who have a 'stake' in the project. These stakes can be favourably or unfavourably affected due to the project, and the stakeholders would try to influence project execution or decision making, so as to prevent their stakes from being jeopardized (Olander and Landin, 2005). As such, this study defines stakeholder issues in MCPs as *the concerns or vested interests of stakeholders in a MCP, which could be positively or negatively affected due to project execution or completion* (Li et al., 2012; PMI, 1996). They are the interests that a stakeholder strives to safeguard by increasing its salience level in the eyes of other powerful stakeholders and influencing their decision making. They are also important considerations of a stakeholder whenever it makes decisions or takes actions in a MCP. Previous studies classified stakeholder issues into different groups such as: cost, time, safety, relationships, social, environmental, and economics (Guo et al., 2013); investment, resources allocation, responsibility, and coordination (Zeng et al., 2015); system performance, environmental, safety, social, economic, political, and travel (El-Gohary et al., 2006); time, cost, quality, technical, safety, and disputes (Toor and Ogunlana, 2010); also social, economic, environmental, technical, and institutional (Takayanagi et al., 2011). In fact, there is no universal categorization of stakeholder issues, yet this study attempts to classify stakeholder issues in MCPs into thirteen types, namely: *cost* (project cost control); *economic* (indirect cost and benefits due to associated economic activities); *environmental* (environmental protection); *ethical* (e.g. corporate reputation); *legal* (legislation compliance and enforcement); *organisational* (e.g. organisational members, structures and relationships); *political* (e.g. political interference); *procurement and contractual* (e.g. labor productivity and resources allocation); *quality* (e.g. quality standards and tests); *safety* (occupational health and safety); *social* (social and cultural issues); *technological* (technological systems, processes and diversity); and *time* (project time management). It is worth noting that this list does not intend to cover all stakeholder issues in MCPs, but it gives initial insights on which types of issues are to be focused in this study.

Stakeholder issues are often multidimensional and conflicting since stakeholder backgrounds, expectations and objectives are diverse. Besides, stakeholder issues in a MCP are interdependent – the occurrence of an issue can result in the incidence of other related ones. The interactions and propagating effects of stakeholder issues can increase uncertainties in stakeholders' behaviours and project decision making. When the issues and issue interactions are not properly addressed, they can become the causes or consequences of various challenges and problems confronted by stakeholders in project implementation. Even so, the existing stakeholder analysis methods have overlooked issue interdependencies and their propagating effects – they have perceived stakeholder issues as being isolated and stationary in vacuum. This limitation may compromise the accuracy and completeness of stakeholder analysis; resulting in misalignment between stakeholder needs and project objectives, uninformed project decision making, and poor stakeholder satisfaction on MCP performance. As such, a network perspective is needed to examine stakeholder issues and issue interdependencies in MCPs. This will help depicting the cause-and-effect relationships among stakeholder issues, identifying the key issues and interactions, as well as developing the right response and management strategies.

2.3.3.3 Need to develop a holistic model

As discussed in the overview, many researchers acknowledged the importance of continuous stakeholder management in the entire project lifecycle, and have established frameworks for the project stakeholder management process (Eskerod and Jepsen, 2013; Huemann and Zuchi, 2014; Trentim, 2015). Notwithstanding their research efforts, empirical studies illustrating a complete stakeholder management process at every stage of a MCP appears to be inadequate; and the recent studies has placed much attention on managing stakeholders in early project phases. This may be attributed to the relatively higher uncertainties and changeability in early MCP phases, which allow greater flexibility to incorporating stakeholder issues into project requirements. Consequently, many empirical studies have focused on discussing stakeholder analysis toolkits and management measures for application in the briefing, planning or design stages of MCPs (Doloi, 2011; Lienert et al., 2013; Valdes-Vasquez and Klotz, 2013).

A typical MCP comprises many stages, including: feasibility study, safety and environmental impact assessment, project appraisal, project alternative identification, application for government approvals, design, tendering, construction, handover, operation and maintenance (van Marrewijk, 2007). Every project phase involves specific objectives, various activities and complex interfaces in between; besides, the composition, issues, and relationship patterns of stakeholders are dynamic as a project proceeds (Windsor, 2010). As such, a holistic and flexible stakeholder analysis and management model, which can be adapted for application in different MCP phases, is in need. Also, application guideline of the model can be developed to, firstly, support its practical use by industry practitioners; and secondly, to enhance the overall effectiveness of MCP stakeholder management practice in Hong Kong.

2.3.3.4 Summary of the findings in the overview

As noted above, current stakeholder analysis methods applied in MCP research emphasise the assessment of individual stakeholder attributes and the dyadic interactions between project team and stakeholders; while overlooking the interrelationships between stakeholders, the interdependencies among stakeholder issues, as well as the impacts on MCP development through these relationship networks. When applying in mega developments, these methods are also constrained by cognitive limitation of human and incomplete stakeholder boundary, as the project increases in size and complexity. To bridge these gaps, it is necessary to take a step beyond traditional stakeholder analysis approaches. This calls for a systematic model to completely identifying all stakeholders and their associated issues; objectively and accurately analysing stakeholder interactions and issue interdependencies; interpreting their implications on project development and formulating appropriate management strategies, for application in MCPs. The network-theory based analysis method offers a way forward. The next section discusses the development of network theory and provides an overview on network studies in the construction project management field.

2.4 Network-theory based analysis

Evolving from the network theory, network analysis is a quantitative tool to identify the interdependencies between a group of elements, and analyse the features and implications of these relational fabrics, by integrating mathematical and computational applications (Dogan et al., 2013). As defined by Wasserman and Faust (1994), elements (nodes) of a system can be joined by different kinds of relationships (links) (e.g. influence or resources sharing) in various manners (e.g. directly or indirectly in a loop), forming unique network structures. This method accentuates network and relational measures instead of the elements' individual attributes, due to the conception that: (1) the existence of an element can influence the presence of other interrelated elements in the same system; and (2) the system's strength and behaviours can be readily affected by how its elements are interconnected (Fang et al., 2012).

Following its earlier use in sociometry (Moreno, 1960), network analysis has been applied in other research domains including construction and engineering management. These studies can be broadly divided into two types. The first type primarily analyses interpersonal, intra- or inter-organisational ties in project contexts, *considering human actors as nodal elements of the network*. Pryke's study (2004) has been regarded ground-breaking as it explored the feasibility of network analysis in interpreting construction project coalitions, and proposed a network perspective to understand relationships between project participants. Another pioneering study is the work of Chinowsky et al. (2008). They recognized the importance of project network and developed a social network model to improve knowledge sharing, as the bedrock of achieving effective team and project performance. In recent years, network studies of this type have extended to cover more topics, such as the investigation of command transmission (Lin, 2014), spatial proximity between construction trades (Wambeke et al., 2012), online stakeholder discussions (Williams et al., 2015), stakeholder relationships and their effects on project social sustainability outcomes (Almahmoud and Doloi, 2015), and integrating network analysis with jobs-to-be-done tool to increase team performance (Solis et al., 2013). These studies show the capability of network analysis for interpreting stakeholder relationships to improve construction project performance. However, the potential of using this network perspective in analysing stakeholder interactions of MCPs and their implications on MCP management has not yet been thoroughly explored. A systematic and holistic approach for the said purpose is also in need of development.

The second type of network studies in the construction and engineering field *considers the interconnected but non-human objects, in a project, as nodal elements; and analyses their interdependencies*. Eusgeld et al. (2009) and Sen et al. (2003) studied the underlying networks of infrastructure systems (power transmission and railway systems respectively), their vulnerability and structural properties; by taking power/railway stations as nodes, and power/railway lines between stations as links. Zhang et al. (2015) investigated the salience and protection arrangement of railway infrastructure by modelling the network of their train stations (nodes) and railway lines (links) according to the strength of passenger flow. Fang et al. (2012) analysed the risk network in a large engineering project to identify the key risks and risk interactions affecting the project objectives. They surveyed members of the risk management process to determine the project risks (nodes) and their influence relationships (links). Yang et al. (2016) examined stakeholder-related risks (nodes) and their relationships in green buildings projects in Australia and China, to explore the differences of their green building practice. Similarly, Li et al. (2016) identified the key schedule risks in prefabrication housing production by analysing their networks in supply chain. These studies show the methodological viability of network-theory based analysis in exploring relational structures of interrelated non-human objects, and giving insights into the central network components. However, the potential of using this network perspective in analysing stakeholder issues and issue interdependencies of MCPs has not yet been thoroughly explored; a structured approach for the said purpose seems to be lacking.

2.5 Chapter summary

This chapter provides a comprehensive review on stakeholder management research in MCPs. This chapter begins with a background description of mega projects in general and MCPs, followed by an explanation on the development of stakeholder theory and stakeholder concept in MCPs. After these, an overview of existing publications relating to stakeholder management in MCPs is undertaken.

The stakeholder theory was originated from strategic management in 1963. In view of the globally rising trend of mega project developments but an unsatisfactory stakeholder management record, researchers have been showing a growing interest on MCP stakeholder management in the past decades. Stakeholders in a MCP are individuals or groups who have an 'issue' in the project, while these 'issues' are their concerns and vested interests that could be positively or negatively affected by the project. Existing publications about stakeholder management in MCPs are systematically reviewed in this chapter, serving as a theoretical foundation of the research.

Through an overview of previous studies on stakeholder management in MCPs, a conclusion can be drawn – *a systematic model, to be built upon the network perspective; for completely identifying project stakeholders and their issues, analysing stakeholder interactions and issue interdependencies, interpreting their implications on project development, and formulating corresponding management strategies, is in need of development for application in MCPs*. This can contribute to the current body of knowledge, and help improving the accuracy and effectiveness of MCP stakeholder analysis. Following the review, an overview on network studies in the construction project management field is also conducted. This overview shed lights on the methodological viability of using network analysis to assess stakeholder interactions and issue interdependencies in complex project environment.

The next chapter will present the research design, and the research methods applied in the development of the social network model for stakeholder analysis in MCPs.

Chapter 3 – Research Methodology

3.1 Introduction

This chapter discusses the research design, process and methods applied in this investigation for accomplishing the research objectives described in Section 1.2. This chapter starts with a presentation on the considerations relating to this research design. Then, the research methods used for obtaining stakeholder knowledge in this study are described, and the logic behind the selection of methods in the context of this study is justified. At last, the research process is explained in detail.

3.2 Considerations relating to research design

Research is a search for knowledge. Slesinger and Stephenson (1930) in their Encyclopaedia of Social Sciences defined research as "the manipulation of things, concepts or symbols for the purpose of generalising to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of an art". Research design is an orderly and logical blueprint guiding the investigator in this searching and manipulation process (Appannaiah et al., 2010). To develop this blueprint, the investigator should scrutinize certain issues carefully concerning the nature of research. According to Appannaiah et al. (2010) and Kothari (2004), these issues include: (1) purpose of the research, (2) types of investigation, (3) research setting, (4) level of researcher interference, (5) time span, (6) methodological approach, (7) selection of data collection methods, (8) sampling design, (9) quality of research, and (10) ethical considerations. These ten considerations of research design are also shown in Figure 3.1.

Figure 3.1: Considerations of research design

3.2.1 Purpose of the research

Every research study is a voyage of discovery and has its own specific objective. Even so, the purpose of research can be largely categorized into five groups: exploratory, descriptive, explanatory, diagnostic, and hypothesis-testing. An exploratory study is conducted when the researcher has limited scientific knowledge about a phenomenon or process yet believing that, with justifications, it "contains elements worth discovering" (Stebbins, 2008). The main goal is to get familiar with a situation, or to develop proposition for acquiring further insights; and the outcomes are usually based on inductive and/or empirical generalisations (Kothari, 2004; Stebbins, 2008). Descriptive research is a study that goes beyond exploration and attempts to depict the characteristics of a specific phenomenon or process; the outcomes produce a more whole theoretical picture to the research problem (Kothari, 2004). Explanatory research goes one step further from descriptive studies. While descriptive research only observes a situation, explanatory studies focuses on 'why' and explains the reasons for its occurrence (Jonker and Pennink, 2010). Lastly, diagnostic research diagnoses the frequency that a situation happens; and hypothesis-testing establishes the causal relationships between variables (Kothari, 2004).

A mixed approach of exploration, description and explanation is adopted in this research. The aim of this study – exploring a holistic and systematic social network model for stakeholder analysis and management in MCPs, is exploratory. Using descriptive approach, this research describes: (1) components in the social network model, (2) procedures of the network-theory based approaches for analysing stakeholder relationships and issue interdependencies, and (3) the critical stakeholders, issues and interactions in MCPs. Besides, the underlying reasons for the major challenges in the four case projects and the cause-and-effect relationships between stakeholder-related issues are also explained, using an explanatory approach.

3.2.2 Types of investigation

The types of investigation should be well determined in research design since they are closely related to the choices of research methods and setting. Two dimensions can be used to define the types of investigation: applied vs. fundamental, and qualitative vs. quantitative (Dhawan, 2010). Table 3.1 explains the types of investigation for this research study.

3.2.3 Research setting

Research setting, referring to the environment in which the study is conducted, can be either non-contrived or contrived (Sekaran, 2003). The type of investigation has an influence on the study setting. For example, the setting of experimental research is often contrived because the investigator intends to take full control on the conditions of study in laboratory setting; while qualitative research often requires a non-contrived setting to observe the natural flow of the subject phenomenon and serve the main purpose of "meaning-making" (Bhattacharya, 2008). This study has a non-contrived setting due to two reasons: (1) it is interested in investigating the underlying motives of stakeholder concerns and project challenges in MCPs, and (2) the researcher follows the normal flow of project stakeholder management and network analysis in the development of the proposed social network model and application guideline.

Table 3.1: Types of investigation for this research study

Basic type of research	Brief description	Type of investigation for this study
Applied vs. Fundamental	Applied research aims at identifying solutions for a practical and compelling problem facing the society at large or a particular institution, business, policy or project (Kothari, 2004). It is designed to involve people and organisations, with the decision makers informed of the outcomes (Brodsky and Welsh, 2008). Fundamental research, in contrast to applied, focuses on the generalisation of theory (Dhawan, 2010). It is designed to collect and analyse data from a physical environment or respondents, and aims at developing a theoretical model for broad use in a general domain (Easterby-Smith et al., 2008; Stokes, 2011).	This study is a mixture of applied and fundamental research, but directing more towards the 'fundamental' side. This research aims at developing a social network model for stakeholder analysis and management in MCPs, for broad application in the construction stakeholder management domain, based on the stakeholder theory and the social network theory. It is thus a fundamental research. Besides, this study is also interested in understanding the challenges faced by stakeholders in a MCP, and the ways to tackling them. This objective is of an 'applied' nature.
Qualitative vs. Quantitative	Qualitative research aims at discovering the qualitative aspects of a phenomenon (Donmoyer, 2008). Two major types of qualitative research are 'opinion studies' and 'motivation studies' (Kothari, 2004). The former looks at how people feel on a specific topic, while the latter finds out the underlying motives of human thoughts or behaviours (Dhawan, 2010). Constructivist approaches are often used, e.g. interviews and case studies (Stokes, 2011). Quantitative research refers to empirical inquiry which uses measurement or numbers of statistics to gather, examine and draw conclusions on data (Stokes, 2011). Positivist approaches, e.g. survey, are often used (Donaldson, 1996).	This study is a mixture of qualitative and quantitative research. This study addresses several research questions, e.g. 'how to systematically analyse and manage stakeholders in a MCP taking into account the network perspective?', 'what are the critical stakeholders, issues and interactions in a MCP? Why are they important? How to manage them well?'. These questions concern with human thoughts/behaviors and their underlying motives, and thus are qualitative aspects of phenomena. This research used both qualitative and quantitative methods to study the qualitative aspects of social phenomena. Numbers of SNA and survey statistics play an important role in collecting and analysing data and drawing conclusions.

3.2.4 Level of researcher interference

The level of researcher interference is determined by the objective of study and the type of investigation. To fulfil the specific purposes stated in Section 3.2.1 and 3.2.2, the researcher places minimal interference, and conducts the study in the natural environment of MCPs and stakeholder entities. When developing the social network model and guideline, the researcher does not alter an entity's normal operations of stakeholder management; because the research outcomes are only intended to offer a generic reference for practitioners in their future MCP stakeholder analysis process. Besides, the researcher does not interfere the natural flow of activities in the case projects. This research is interested in explaining the reasons for critical stakeholders and issues and major challenges in the projects. As indicated by Dhawan (2010), studies discovering "the underlying motives of human behaviours" or 'what makes human concern a specific thing' should be conducted in a natural environment with a normal flow of events.

3.2.5 Time span

Time span refers to the period of time that a research study includes. From the perspective of time, a research can either be one-time (also called cross-sectional) or longitudinal (Dhawan, 2010). A cross-sectional study analyses data obtained at single moment in time, investigating a snapshot of the subject phenomenon; while a longitudinal study involves a few observations of the same phenomenon over an extended time period, depicting and explaining the changes (Kothari, 2004). Descriptive and exploratory research is often one-time; data can be collected by interviews or surveys carried out during a short period of time (Saunders et al, 2006). This research adopts the one-time approach to examine snapshots of: (1) stakeholder relationships and issue interdependencies in MCPs, and (2) the respondents' viewpoints regarding project concerns and the social network model.

3.2.6 Methodological approach

A sound research requires investigators being able to justify the logic behind their choices of research approach and make rational choices in the context of their specific research problem. Figure 3.2 shows a research pyramid which comprises four levels, steering investigators throughout the knowledge-searching process towards a justifiable research design. Paradigm concerns with how the researcher views the nature of ‘reality’, and defines his basic approach of enquiry (Jonker and Pennink, 2010). Methods and methodology are different, often leading to confusion. While the former refers to “the specific steps of action that need to be executed in a certain (stringent) order” of performing research operations; the latter is the way, tailored to the research paradigm, of obtaining knowledge of this reality (Jonker and Pennink, 2010). Methodology shapes the investigator’s basis for deciding which methods and procedures are applicable and which are not (Dhawan, 2010). There are two methodological approaches. The first one is inductivism which begins with some samples of data, then develops and generates concepts or theoretical frameworks from the data (Stokes, 2011). The other is deductivism – it begins with concepts or theoretical framework whose key components have been developed in an initial phase of research, and the framework is then applied to the data collected to draw conclusion (Stokes, 2011). This study uses a mixed approach of inductivism and deductivism. Inductive reasoning is used when drawing practical insights on the major project challenges of MCPs and developing the social network model for MCP stakeholder analysis because the findings are synthesized. In the meantime, deductive reasoning is applied in the development process of the network-theory based approaches for analysing stakeholder relationships and issue interdependencies in MCPs.

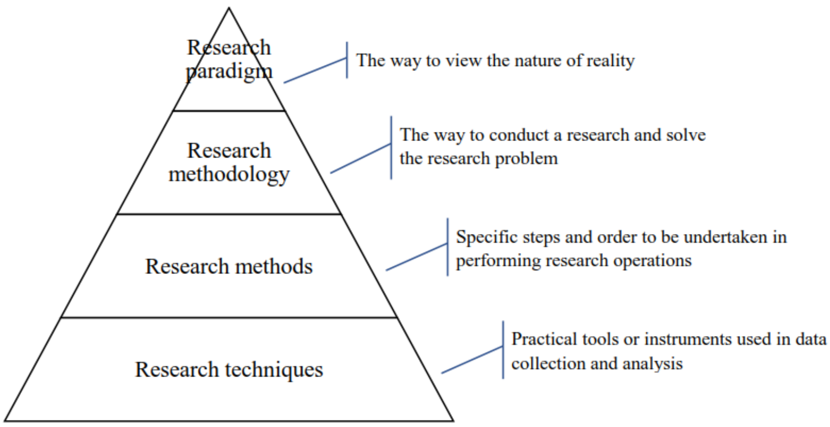


Figure 3.2: Research pyramid (Adapted from Jonker and Pennink, 2010)

3.2.7 Selection of data collection methods

Research methods can comprise but not limited to survey, case study, interview, focus group and observation. The research paradigm taken by investigator in an inquiry, i.e. positivism or constructivism, determines which research methods to be applied when performing research operations (Easterby-Smith et al., 2002; Yang, 2010). Positivism focuses on "explaining phenomena typical in the natural sciences" (Costantino, 2008). It believes that knowledge of the reality is gained independently from the investigator (Stokes, 2011), through objective methods such as hypothesis testing, experiments, generalization, and causal study using statistical analysis (Bryman and Bell, 2007). In contrast, constructivism, which views the world as socially constructed and inherently subjective, emphasizes the understanding of human dimension in social phenomena (Costantino, 2008). It asserts that, what we know about the world is co-created by researcher and the participants experiencing the subject phenomena "through their mutual interaction within the research setting" (Costantino, 2008). To achieve the research aim, this study requires the participants' social constructs on mega project development and stakeholder management for data generation, and both quantitative and qualitative analyses of the data obtained. Table 3.3 describes some commonly used research methods and their applicability to this study.

Table 3.2: Selection of data collection methods for this research study

Research method	Brief description	Applicability in this research study
Survey research	Deriving from positivism, survey research has two main purposes. It can be used to capture the general understanding from a large group of respondents on a related set of issues, or to confirm the generalizability of results obtained from a small sample using interviews (Julien, 2008). Data collected from survey research may not be solely quantitative; survey can generate textual or narrative data when it is conducted in an interview or consisting of open-ended questions (Julien, 2008).	An appropriate method to efficiently and systematically collect the large amount of relational data from project stakeholders for network analysis. It can also be used to obtain quantitative feedbacks from practitioners about the research findings. *Applicable to this study.*
Case study	An approach of studying in-depth one or several instances in a real-life phenomenon (Stokes, 2011). Various methods, e.g. interviewing, survey or focus groups, can be used in a case study to obtain qualitative and quantitative data (Stokes, 2011). Compared with other positivist approaches (e.g. survey and experiment), case study investigates a real and natural instance, instead of a case created and controlled by the researcher; also it emphasizes the 'depth', rather than the 'breadth', of investigation (Blatter, 2008).	An appropriate method to describe and interpret in-depth the development and stakeholder management of the real-life MCPs. Taking into account the confidentiality and sensitivity issues in the case projects, case study is considered more suitable than action research and participant observation in this study. *Applicable to this study.*
Interview	This method can explore the respondents' views and interpretations about a specific issue, as well as the constructs they adopted as a basis for their perceptions (Daymon and Holloway, 2001). When compared with the fixed questions and response formats in survey research, interviewing can: (1) obtain data that are established within the respondents' social context (expressed in their own words), and (2) allow higher flexibility since data are produced from the evolving dialogue between the researcher and respondents (Daymon and Holloway, 2001).	This study involves many confidential and sensitive issues of the case projects. Many stakeholders are unwilling to share their thoughts unless in a confidential and one-on-one setting. Interviewing is thus an appropriate method to elicit the facts and opinions from stakeholders about the development of case projects. This method is also suitable for obtaining practitioners' views about the practice of construction stakeholder analysis and management. *Applicable to this study.*
Focus group	Focus group is similar to interviewing except that it is conducted on a researcher-led and group basis. In a focus group, participants with a similar background are engaged to discuss a specific topic; data are generated from their conversations; the extent of researcher control, e.g. 'what to be discussed' and 'how freely the participants discuss', depends on the purpose of research (Morgan, 2008).	Focus groups bring the advantage of generating new insights through meaningful discussion of the participants. However, this research involves controversial case projects and sensitive issues of the projects. Many stakeholders are reluctant to meet other participants in occasions other than their work routines, they consider individual interviews as more 'carefree'. Besides, it

		is practically infeasible to arrange a focus group which fits all stakeholders' schedules. *Not applicable to this study.*
Qualitative observational research	A constructivist approach where the researcher understands a phenomenon by systematically and purposively capturing the events occurred in a natural setting, as if they are experienced by the participants; rather than based on those narrated or generalized by the participants themselves (Daymon and Holloway, 2001). It involves mutual interactions between the researcher and participants (McKechnie, 2008). Often used in conjunction with interviews for data generation.	The rich description generated by this method about the subject phenomenon is an attractive data source. It is theoretically possible to undertake participant observation in a stakeholder organisation at one time. However, a MCP involves many stakeholder groups or organisations which are geographically dispersed. The resources and logistical constraints make the method practically infeasible in this study. *Not applicable to this study.*

Summarising the above, survey research, case study and interview will be used in this study for data collection.

3.2.8 Sampling design

All items, people, events or things of interests in any field of inquiry compose a 'population', while items or respondents selected from the population form a 'sample' (Kothari, 2004). Probability sampling and non-probability sampling are two basic kinds of sample design (Kothari, 2004). In the former, each item of the population shares an equivalent chance of being included in the sample; while in the latter, items constituting the sample are selected purposively by the investigator of inquiry, on the basis that the chosen items are representative of the entire population (Dhawan, 2010). Different sample designs are applied in different parts of this research study to suit specific objectives. In the case study part (refer to Chapter 5 and 7), the population of each case comprises all stakeholders who are actively involved in the case project, or whose interests may be favourably or unfavourably influenced due to project execution or completion. Non-probability sampling is used herein. In each case study, the investigator purposively includes representatives from every stakeholder role into the sample, with an attempt to constitute a ‘representative sample’. The selected respondents are either invited by the investigator or referred by participants who have already taken part in the study. In the part of social network model development and validation (refer to Chapter 8), the population includes practitioners who possess adequate experiences and knowledge in construction stakeholder management and mega project management. Probability sampling is used herein. The practitioners are chosen randomly to participate in the interviews and survey.

3.2.9 Quality of research

A researcher should determine a set of criteria for evaluating the quality of research and make sure the study meeting these criteria. Reliability and validity are two commonly used criteria, but they have quite different meanings in quantitative and qualitative research (Daymon and Holloway, 2001). Table 3.3 summarises these criteria and explains the strategies used in this study for ensuring the quality of research.

Table 3.3: Evaluation criteria and strategies for quality of research

<table>
<tr><th>Criteria</th><th>Brief description</th><th>Strategies for ensuring the quality of study</th></tr>
<tr><td>Reliability in quantitative research</td><td>The extent that a research instrument will re-generate approximately similar results when it is used again or by another researcher (Maylor and Blackmon, 2005; Stokes, 2011).</td><td>Appropriate design of the survey instruments, which are used for network data collection in the case studies (refer to Chapter 5 and 7) and social network model validation (refer to Chapter 8), respectively.</td></tr>
<tr><td>Reliability in qualitative research</td><td>Qualitative inquiries embrace constructionism and subjectivity in their data collection, analysis and interpretation; so it is hard to yield the same results even conducted in similar conditions with the same methods (Daymon and Holloway, 2001).</td><td>A detailed record of the data, methods, procedures and decisions taken in the entire research process. This allows other researchers to trace, understand, evaluate or even repeat the process. It therefore ensures reliability of the study in some extent.</td></tr>
<tr><td>Validity in quantitative research</td><td>The extent that a research can accurately and insightfully measure the truth or concept it purports to measure (Cameron and Price, 2009; Stokes, 2011).</td><td rowspan="2">Participant validation (Lincoln and Guba, 1985) during data collection and interpretation in the case studies and interviews. For instance, during interviews, the researcher summarises and paraphrases the respondents' words and checks their responses. From time to time, the interim findings (e.g. stakeholder and issue lists, interview transcripts, stakeholder and issue priorities, SNA results in case studies; and interview transcripts in model development and validation) are sent back to participants for feedbacks. Participants' responses help to ensure credible interpretation of data.

Adequately relating the network-theory based approaches to relevant literatures (refer to Chapter 2, 4 and 6).

Clearly explaining how the network-theory based approaches are applied in the four case studies which are of different settings (refer to Chapter 5 and 7).

Methodological triangulation in the development of the social network model. The proposed model is developed by an intensive literature review and case studies in four MCPs, its practicality and applicability are validated by practitioners and academia in the field.</td></tr>
<tr><td>Validity in qualitative research</td><td>It concerns with "the credibility of description, conclusion, explanation, interpretation, or other sort of account" (Maxwell, 1996).

It can be described from three aspects (Daymon and Holloway, 2001): (1) internal validity, the extent that the findings can truly reflect the research aim and portray the reality; (2) theory-based generalizability, the extent that the theoretical idea developed in one setting can be transferred and applied in other context; and (3) relevance, the extent that the research findings provide useful insights for solving practical problems in the field.</td></tr>
</table>

3.2.10 Ethical considerations

To maintain the integrity, professionalism and holistic nature of a research, ethical issues must be given full consideration and handled carefully in the entire research process. For carrying out this research ethically, four basic principles of ethics have guided the researcher throughout the initial access, data analysis, reporting and publication phases.

The first principle is "the right of free and informed choice" (Daymon and Holloway, 2001). When recruiting participants, all invited people have the right to freely decide whether to take part in this study or not, without pressure. Even after accepting invitation, they also have the right to withhold participation at any time of the course of research. The second principle is protecting participants from harm (Daymon and Holloway, 2001). Adhering to this principle, the researcher paid attention to the welfare of all participating individuals and organisations throughout the research process by; for instance, ensuring that the research procedures were fair to them, honouring the privacy of their ideas and viewpoints, and avoiding them from unnecessary risks (where the projects under case studies were controversial and sensitive). The third principle is to protect privacy by promising anonymity and confidentiality (Daymon and Holloway, 2001). The researcher kept anonymous the identities of participating individuals, stakeholder organisations, and projects. For instance, interview transcripts were stored securely. When disseminating the research findings, labels were used to substitute the project and stakeholder names; also, demographic information which can make readers easily recognising the participants were not disclosed. As Daymon and Holloway (2001) defines, confidentiality means "you do not disclose issues or ideas that participants wish to keep confidential". In this research, the participating individuals and stakeholder organisations (in the case studies, interviews and questionnaire survey) were sent a cover letter and a 'Letter of Confidentiality Undertaking'. Apart from guaranteeing confidentiality, these documents had several other purposes: (1) it explains clearly the nature of research project so all participants understand; (2) it represents a written consent from participants that they agreed to take part in the study, and that the data they provided are to be used for academic purpose; (3) it makes clear the participants' rights to freely take part in or withdraw from the study; and (4) it states clearly that the researcher should respond to the queries raised by participants about the study. The last principle is to ensure autonomy by obtaining informed consent from participants (Daymon and Holloway, 2001). As mentioned, the cover letter and 'Letter of Confidentiality Undertaking' sent from the researcher to participants have served this purpose.

3.3 Research methods

Which research methods to employ is a question of the depth and scope of the study (Knight, et al., 2008). After scrutinizing the research design considerations (Section 3.2), five research methods are considered suitable and thus applied in this study for data collection and analysis, including literature review, case study, interview, survey, and SNA.

3.3.1 Literature review

Literature review is regarded as a useful method to gain in-depth understanding on a research topic (Littau et al., 2010), it helps researchers to identify the current body of knowledge and stimulate inspirations for future works. Despite the importance, it appears that limited review has been conducted on stakeholder management research in MCPs until the study of Mok et al. (2015). For example, Yang et al. (2009) reviewed stakeholder literature in general domain and identified practical implications for the construction industry. Littau et al. (2010) carried out a meta-analysis of stakeholder publications and found that project evaluation and strategy played an important role in stakeholder theory development. Yet, the previous reviews seem to be generic whose research foci were not specific on MCPs. In this research, existing publications on stakeholder management in MCPs were critically examined. Previous studies on SNA in construction management were also reviewed. The groundwork laid by literature review established a solid theoretical foundation for this research, guided the development of social network approaches for analysing stakeholder interactions and issue interdependencies, also shaped the development of the social network model and its application guideline.

3.3.2 Case study

Case study is an in-depth investigation of the process and outcomes, as well as the uniqueness and complexity, of a contemporary real-life phenomenon (Thomas, 2011; Tellis, 1997). This method is considered applicable when: (1) the phenomenon contains various relationships or elements whose interactions are the research interest (Fidel, 1984); (2) the research focus concerns ‘why’ and/or ‘how’ questions (Yin, 2009); (3) the examination of phenomenon becomes meaningless without its embedded context (Baxter and Jack, 2008); and (4) context-dependent knowledge can only be generated with a minimum intervention of the investigator (Yin, 2009). Case study was used in the development and refinement processes of the social network approaches for analysing stakeholder relationships and issue interdependencies. This method is selected since the research setting fits the above considerations. There are different kinds of case study such as descriptive, evaluative and interpretative (Merriam, 1988); or intrinsic, instrumental and collective (Stake, 1995). Four case studies of the instrumental and interpretative nature were undertaken since the research intended to gain comprehensive and in-depth understanding of the unique project settings, and the findings were expected to bring insights for other MCPs of similar contexts.

Case selection is a rigorous process because “case study is not a methodological choice but a choice of what to be studied” (Stake, 2005). Information-oriented sampling is used for case selection (Flyvbjerg, 2006). The case selection criteria and the backgrounds of chosen cases were described in Section 5.2.1, 5.3.1, 7.2.1 and 7.3.1. The four case projects are of different MCP types, including a cultural building project, a green Research and Development office and laboratory building, a design-and-build public office building development, and a large reclamation works. To ensure reliability of the collected data and objectiveness of the case analyses, the researcher maintained a neutral relationship with the core project teams and stakeholders — the researcher played an impartial role and did not favour any sides in the case studies. In addition, the researcher maintained independent from the situations under exploration, so as to ensure a minimum intervention to the research contexts. The case study findings help to: (1) refine the details, illustrate the application, and validate the applicability of the two social network approaches; and (2) identify the critical stakeholders, issues and relationships in MCPs, thus revealing the major project challenges, their possible causes and management measures from the stakeholder perspectives.

3.3.3 Interview

Interviewing is an interactive research method where the investigator gains knowledge on some human experiences or a specific topic through his/her conversations with interviewees (Brinkmann, 2008). This method is commonly used in the social science discipline and can exist in three main forms: structured, semi-structured or unstructured. In a structured interview, the researcher raises a set of definite questions in a precise sequence, and obtains responses in standardized formats "that are amendable to quantitative procedures" (Brinkmann, 2008). Structured interviews are considered suitable when the researcher intends to obtain key data in a coherent format from some informants and does not require extensive narrative details (Stokes, 2011). An unstructured interview needs not to follow an agenda but to start with a general theme or an opening question set by the researcher – the interview is to evolve from this starting point and generate in-depth insights through conversations (Stokes, 2011). An intermediate form between standardized and unstructured interview is the semi-structured interview. It follows a predetermined agenda and some key questions, but leaving rooms for interviewees to elaborate and give spontaneous narratives (Brinkmann, 2008).

Interviewing is a major research method in this study due to several reasons: (1) this research involves many confidential and sensitive issues of the case projects, where the participants were reluctant to share unless in a one-on-one setting; (2) to accomplish the research aim, this study requires the participants' social constructs on mega project development and stakeholder management for data generation. Interview is useful because data are established within the respondents' social context, i.e. the respondents' interpretations articulated in their own terminologies (Daymon and Holloway, 2001); and (3) interviews allow the researcher a high degree of flexibility – he/she may adjust the level of control to suit the interview purpose. Interviewing is used in different phases of this research study to serve different purposes. The aims and details of interviews were presented in the detailed research process in Section 3.4.

3.3.4 Questionnaire survey

Questionnaire survey is a series of questions carefully designed, phrased, and ordered by the researcher, in order to gather useful data from respondents about their perceptions, behaviors, experience or knowledge on a specific topic (Stokes, 2011). Data gained from a questionnaire can be wholly quantitative, mainly qualitative or a combination, depending on the purpose of survey. When a questionnaire intends to gather standardized responses for statistical analysis, it often contains close-ended questions. For questionnaires containing open-ended questions, textual or narrative data can be obtained to "contextualize more quantitative responses and to add depth and richness to the data set" (Julien, 2008). A questionnaire can be used to capture the general perceptions of a large sample on an issue and guide the development of interview questions for further study, it can also be used to confirm the qualitative findings generalized from interviews with a small sample (Julien, 2008).

When developing the two social network approaches for analysing stakeholder relationships (Chapter 5) and issue interdependencies in this research (Chapter 7), two questionnaires were designed to facilitate the collection of relational data from targeted project stakeholders (refer to Appendix A and B). To ensure comprehensibility of the questionnaires, pilot studies were conducted with a small sample of respondents prior to distribution. The obtained quantitative data were analysed mainly by NetMiner 4.0 for deciphering the network structures, while the collected qualitative data were examined to enrich the quantitative dataset and corroborate the network analysis results.

A feedback questionnaire was also designed to validate the social network model under five criteria, namely 'degree of comprehensiveness', 'degree of practicality', 'degree of objectivity', 'degree of replicability', and 'degree of adaptability for application in different MCP types' (refer to Appendix F). These five criteria had been used in the similar research of Yeung (2007) and Cheung (2009) for model validation, relevant adjustments were made to suit the purpose of this study. A pilot test was conducted prior to distribution to ensure the questionnaire was understandable.

3.3.5 Social Network Analysis

Building upon the social network theory, SNA is a method which combines mathematical and computational tools to visualise interactions and analyse their relational structures (Solis et al., 2013). According to the social network theory, the behaviours and roles of a social actor are readily affected by other actors connecting to it within the same system environment; and the way these actors connect is influential to the robustness and performance of the entire system (Wasserman and Faust, 1994). Based on this perspective, since stakeholders and issues in a MCP are interconnected, stakeholder behaviours or issue occurrence/impacts can be affected directly/indirectly by their neighbours in the relationship networks. Applying SNA to analyse stakeholder interactions or issue interdependencies is therefore useful – it helps assessing the roles and impacts of stakeholders and issues, and developing proper measures to deal with the issues and facilitate stakeholder engagement. With its capabilities in relational analysis, SNA has high potential to be used in complex project environment, making a step forward from the traditional MCP stakeholder analysis practice. There are five main steps in the general SNA process: (1) setting up the network boundary, (2) determining and assessing the meaningful interactions, (3) visualising the network, (4) deciphering the network structures, and (5) presenting the network analysis results (Yang and Zou, 2014). Table 3.4 presents some terms and concepts commonly used in network analysis.

Table 3.4: Some terms and concepts in network analysis

Term/concept	Interpretation/mathematical expression	Reference
Graph	Any networks can be denoted by a *graph*. A graph comprises a set of *nodes* and a set of *edges* or *ties* joining pairs of nodes.	Freeman (1978)
Geodesic distance	Two nodes are said to be *adjacent* when they are directly linked by an edge. *Geodesic distance* is the shortest path, or the minimal number of edges connecting a pair of nodes.	Freeman (1978); Lin (2014)
Density	*Density* reflects the extent that how densely the nodes in a network are linked. It is calculated as the proportion of existing relationships in the entire network to the largest number of possible ties when all nodes are joined together. It can be expressed mathematically as: $$Density = \frac{L}{N(N-1)\frac{1}{2}}$$ Where L = number of existing relationships, and N = number of existing nodes.	Park et al. (2010); Yang and Zou (2014)
Direct and indirect links	*Direct links* are the number of directly connected edges that a node has, while *indirect links* are the number of edges reachable by a node through its neighbouring nodes in the network. Direct and indirect links can reflect the degree of power of a node in the network.	Ahuja (2000); de Nooy et al. (2005); Park et al. (2010)
Degree centrality	*Degree centrality* reflects the level of importance of a specified node in the network. It can be calculated by a count of the number of edges to other nodes in the network. Mathematically, it can be expressed as: $$Degree\ centrality = \frac{\sum_{b=1}^{N}(L_{ab} + L_{ba})}{\sum_{a=1}^{N}\sum_{b=1}^{N} L_{ab}}$$ Where L_{ab}= number of ties that a node *a* receives from a node *b*, and N = number of existing nodes.	de Nooy et al. (2005); Dogan et al., (2013); Lu et al. (2015); Park et al. (2010)
Betweenness centrality	Betweenness centrality measures the extent in which a specific node falls on the geodesic distance between other pairs of nodes. Mathematically, it can be expressed as: $$Betweennes\ centrality\ (of\ node\ b) = \sum_{u,v:u\neq v\neq b} \frac{\beta_b\,(u,v)}{\beta(u,v)}$$ Where $\beta_b\,(u,v)$ = the number of shortest paths from node *u* to node *v* that passing through node *b*, and $\beta(u,v)$ = total number of shortest paths from node *u* to node *v*.	de Nooy et al. (2005); Dogan et al., (2013); Park et al. (2010)
Closeness centrality	Closeness centrality is the distance, or the number of intermediaries, of a specified node to every other nodes in the network on the basis of shortest path. Mathematically, it can be expressed as: $$Closeness\ centrality\ (of\ node\ b) = \frac{N-1}{\sum_{j\in M} d(b,j)}$$ Where *N* = number of nodes, *M* = total number of nodes, *j* = *j*th node in the network, and *d(b,j)* = the length of the shortest path between node *b* and *j*.	de Nooy et al. (2005); Dogan et al., (2013); Park et al. (2010)

3.4 Research process

As stated in Section 3.2 and 3.3, this study uses a mixed approach of exploration, description and explanation; selects a non-contrived setting; puts a minimal researcher interference; takes a cross-sectional perspective of time; and uses both inductive and deductive reasoning. Five research methods are applied for data collection and analysis including literature review, case study, interview, survey and SNA. This study is carried out in four phases with three research objectives. Phase 1 reviews existing literature on stakeholder management in MCPs and SNA in construction management. Phase 2 and 3 are the development, refinement and validation processes of two network-theory based approaches: one for analysing stakeholders and their interactions, the other for analysing stakeholder-related issues and their interdependencies, in MCPs, respectively. Phase 4 synthesises and develops a systematic model and its application guideline for stakeholder analysis and management in MCPs, and validates them by relevant experts and practitioners through interviews and feedback questionnaire. Figure 3.3 illustrates the detailed research process.

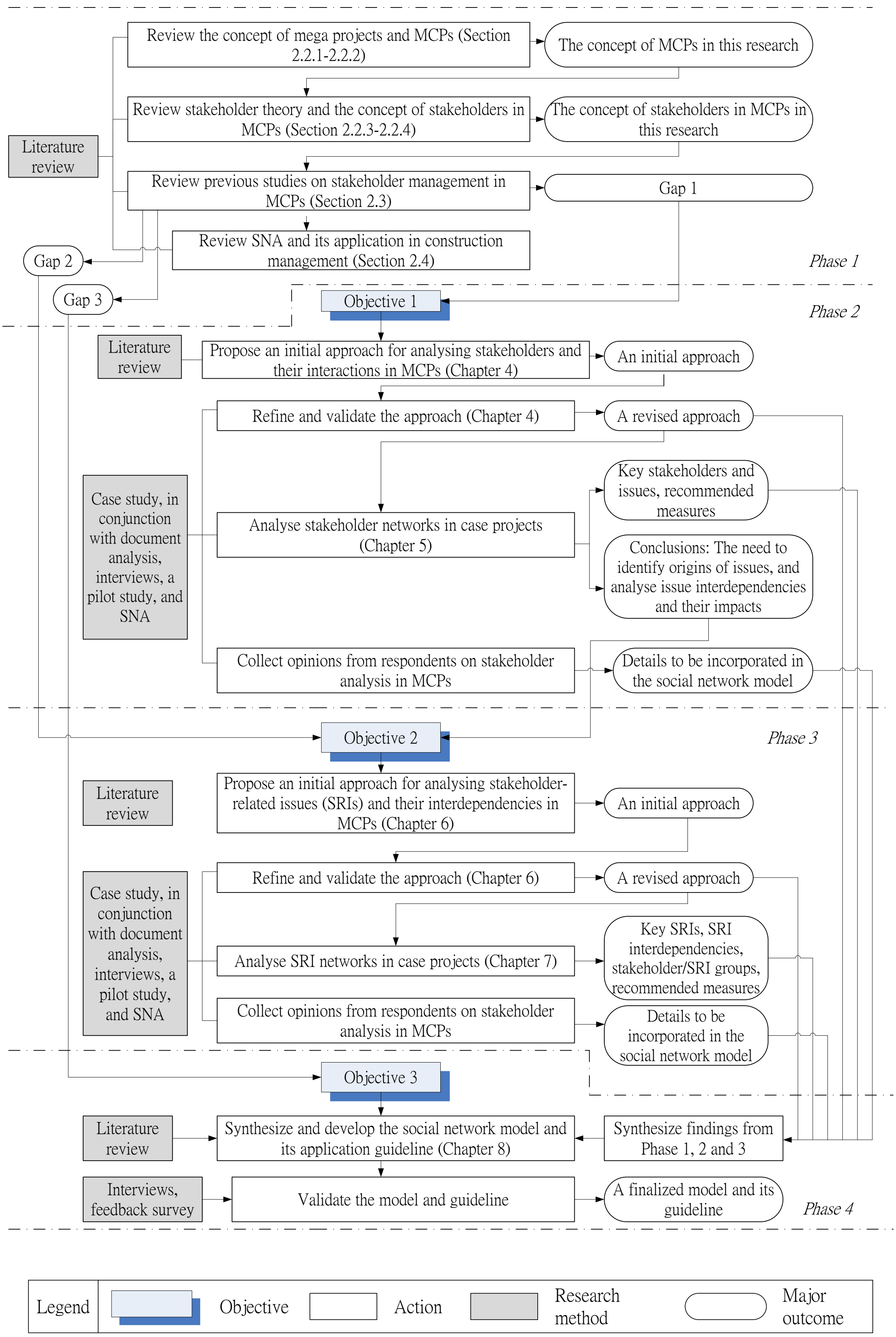


Figure 3.3: The detailed research process and interim deliverables

Phase 1 is a literature review process. Previous studies on stakeholder management in MCPs and SNA in construction management are reviewed. This process helps to observe the current trends of these research topics, identify the knowledge gaps, and establish a strong theoretical foundation upon which this research is based.

This phase begins by conceptualising a MCP and stakeholders in MCPs based on background information in Section 2.2. For the purpose of this study, a MCP is described as: a substantial investment often initiated and funded by the government to provide communal facilities for enhancing economic growth and the environmental and societal quality of life; with a widely accepted cost threshold of US$500 million-1 billion per MCP; and with the characteristics of being huge; extremely complex, having high risks and long lead time; involving a wide range of stakeholders; and exerting considerable impacts to the society, economy and environment. In this study, stakeholders in a MCP refer to individuals or groups who are actively involved in the MCP, or whose interests may be affected due to MCP execution or completion (PMI, 1996).

Following this, an overview of previous studies relating to stakeholder management in MCPs was carried out. In the scope of existing literature, three research gaps are identified for further examination (Section 2.3.3). These gaps reveal the potential of applying a network perspective to analysing stakeholder relationships and stakeholder-related issue interdependencies in MCPs. They also bring about a conclusion that, a systematic and holistic model for MCP stakeholder analysis and management, building upon the network perspective, can contribute to the body of knowledge in the construction stakeholder management domain. Diagnosing stakeholder interactions and stakeholder-related issue interdependencies from a network perspective is crucial to coping with the high stakeholder complexities in MCPs, and improving the accuracy and effectiveness of MCP stakeholder analysis practice. In the final stage of Phase 1, the development of network theory was presented, an overview on network studies in the construction project management domain was also provided.

To accomplish the research aim, three objectives (as described in Section 1.2) will have to be fulfilled in Phase 2, 3 and 4:

- To develop and refine a social network approach for analysing stakeholders and their interactions in MCPs, and validate the proposed approach by using real-life MCPs (corresponding to Gap 1);
- To develop and refine a social network approach for analysing stakeholder-related issues and their interdependencies in MCPs, and validate the proposed approach by using real-life MCPs (corresponding to Gap 2); and
- To develop and validate a systematic and holistic model, and its application guideline, building upon the network perspective, for stakeholder analysis and management in MCPs (corresponding to Gap 3).

Phase 2 is to develop, refine and validate a social network approach for analysing stakeholders and their interactions in MCPs by using several research methods or techniques: (1) literature review, (2) case studies, (3) chain referral sampling, (4) interviews, and (5) SNA.

This phase begins by proposing an initial framework for analysing project stakeholders and their interactions in MCPs based on the earlier groundwork built up from literature review. The initial framework comprises five components: (1) identifying stakeholders and general concerns; (2) determining stakeholder interactions; (3) visualising stakeholder network; (4) analysing the network; and (5) prioritising stakeholders and general concerns. Case study method is applied to demonstrate the application, further develop and refine the details, and confirm the applicability of the proposed approach. Two case projects of different MCP types and contexts were chosen. Case selection criteria were described in Section 5.2.1 and 5.3.1.

The initial approach was applied in the two case studies to identify stakeholders and general concerns, analyse stakeholder relationships, assess stakeholder roles in the stakeholder network, prioritise stakeholders and concerns according to their impact/importance level. The approach involves various research methods and techniques for data collection and analysis, as explained below:

- Chain referral sampling and empirical-knowledge based method were used to identify the stakeholders.
- Semi-structured interviews, document analysis and literature review were applied to understand the case project backgrounds, identify general concerns of stakeholders, and the challenges they encountered in the case project. In the interviews, the questions below regarding the general practice of stakeholder analysis and management in the respondents' organisations or MCPs were also asked, for example (see Appendix E):
    - what methods are used to identify stakeholders and their concerns in the project?
    - what methods are used to analyse stakeholder relationships and assess stakeholder influences in the project?
    - what methods are used to engage stakeholders and enhance communication?
    - what strategies are used to striking an appropriate balance between the conflicting interests of multiple stakeholders?
    - in which project stage(s) stakeholder analysis is most critical and gives the greatest impacts on project delivery?

  - when evaluating the effectiveness of a stakeholder analysis method in terms of its process and outcomes, what performance criteria are important?
  - what are the key factors for effective application of a stakeholder analysis method?
  - What are the limitations in the current MCP stakeholder analysis practice? What are the suggested solutions?
  - Do the respondents' organisations provide institutional guidelines and procedures for undertaking stakeholder analysis in practice? If yes, what are they?

- Standardized interviews and a pilot study were used to collect relational data for the subsequent SNA. A survey instrument was designed to facilitate network data collection.
- SNA was applied to analyse stakeholder information exchange networks. As Cross and Parker (2004) indicated, communication, information exchange, knowledge sharing, and power/influence are four important kinds of relationships to be studied. The case studies focus on information exchange because analysing stakeholders' information transfer can uncover their mechanism of interactions, as well as who sit in the project communication hub (Chinowsky et al., 2008). Two network-level and six node-level metrics are selected for network analysis (Section 4.3).
- The impacts of stakeholders and the importance levels of general concerns were evaluated based on the SNA results.
- Semi-structured interviews were conducted for several purposes: (1) collecting feedbacks from the respondents on the social network approach and the analysis results (see Section 5.2.4); (2) asking for practical recommendations to handle the critical concerns; and (3) collecting opinions on practical issues for applying the network-theory based stakeholder analysis and management framework (e.g. responsibilities, schedule for implementation). These feedbacks are to be synthesized and incorporated in the development of the social network model.

Based on findings from the two case studies, the initial social network approach for analysing stakeholders and their interactions was refined, its applicability was illustrated and confirmed. The finalised approach was presented in Chapter 4. The empirical findings revealed two limitations of the approach: (1) neglecting the origins of stakeholder issues, (2) overlooking the interdependencies between stakeholder-related issues and their propagating impacts in the project; while an issue can govern the existence of another. These two important conclusions lead to the development of a network-theory based approach for analysing stakeholder-related issues and their interdependencies in MCPs. The approach is developed in Phase 3.

Phase 3 fulfils the second objective. This is a development, refinement and validation process of an approach for analysing stakeholder-related issues and their interdependencies in MCPs, by applying the research flow and methods similar to Phase 2.

An initial approach is proposed based on the findings from literature review and the empirical studies (Chapter 2, 4 and 5). Case study method is employed to refine the details and confirm the applicability of the approach. Several research methods are involved in the case studies, including chain referral sampling, document analysis, SNA, semi-structured and standardized interviews, and a survey instrument for collecting relational data. This approach deciphers the influence network of stakeholder-related issues; where the issues sourced from stakeholders are the nodes, and the influence relationships (in terms of impact intensity and likeliness) of the associated issues are the links. Ten SNA metrics (including two at the network level, six at the node-/link-level, and two at the interface level) are selected for network analysis.

The findings from Phase 3 are threefold. First, the initial approach was further developed and refined. Chapter 6 presents the finalized approach, which consists of five major components (identifying stakeholders and stakeholder-related issues; determining issue interdependencies; network visualisation; network analysis; identifying critical issue and issue interdependencies) and an immediate simulation. Secondly, the applicability of the social network approach was illustrated and confirmed, notwithstanding some practical concerns such as ethical challenges in data collection and availability of network analysis expertise. Lastly, a list of critical issues, issue interdependencies, and closely connected stakeholder/issue groups in MCPs (one major office development and one reclamation works) were identified. Practical recommendations to treat these critical network elements and reduce the project stakeholder complexities were given in the findings. During the case studies, viewpoints on the practical use of the network-theory based stakeholder analysis and management model were also collected, they are to be synthesized in the development of the social network model in Phase 4.

A systematic and holistic model, which specifically deciphers stakeholder interactions and stakeholder-related issue interdependencies from a network perspective, for MCP stakeholder analysis and management is presented in Chapter 8. This model is developed by synthesizing findings from the empirical studies (Chapter 4-7) together with groundwork established from the literature review. An application guideline is developed to aid practical use of the model. The validation of the social network model and its guideline is delivered in *Phase 4* by using semi-structured interviews and a feedback questionnaire.

The social network model, comprising seven blocks, is presented graphically to ease understanding. Each block is further broken down into components for zooming into specific details. The application guideline, comprising ten chapters, intends to provide potential users with detailed descriptions to the procedures and components of the model, as well as practical instructions and management tools for using the model.

The model is validated by nine experts from the industry and academia using semi-structured interviews and a feedback questionnaire with five validation aspects. Opinions obtained from interviews are presented in Section 8.4.2. The model presented in Chapter 8 is the finalized model with experts' feedbacks incorporated. According to the validation questionnaire results, the experts reflected that the model was holistic to cover all essential elements for carrying out MCP stakeholder analysis, it was also considered objective and adaptable for application in different MCP types. The findings concluded that, the model and its guideline provided a systematic and effective management tool for project teams of MCPs to identify, analyse and address stakeholders, issues, and relationships (i.e. stakeholder interactions and stakeholder-related issue interdependencies) throughout the MCP development; with the ultimate goals to improving project decision making and stakeholder management effectiveness.

3.5 Chapter Summary

This chapter is an overview of the research methodology. It presents and justifies the research design and methods employed to accomplish the research objectives. This study uses a mixed approach of exploration, description and explanation; has a non-contrived setting; places a minimal researcher interference; with a cross-sectional timespan; and adopts both inductivism and deductivism for reasoning. Five research methods are primarily used for data collection and analysis, including literature review, case study, interview, survey and SNA.

Chapter 4 – A Social Network Approach for Analysing Stakeholders in MCPs

4.1 Introduction

As discussed in the earlier chapters, there is a need for analysing stakeholders and their social interactions in complex MCP environments. As such, this chapter presents a social network approach for analysing stakeholders and their interrelationships, with a particular focus on their project information exchange interactions. This approach involves the use of chain referral sampling technique, SNA, and a network visualisation and analysis software package (e.g. *NetMiner*). This proposed approach enables the project management team to identify a complete boundary of project stakeholders and their general issues, visualise stakeholder information exchange interactions, decipher characteristics of these connectivity structures, explore opportunities for improving project information exchange, and identify the influential stakeholders and important general issues.

4.2 Need for a social network approach to analysing stakeholders

As mentioned in Chapter 3, it is crucial to assess stakeholder interactions and their impacts on project development through these relationship networks. Every MCP occurs in an interactive and dynamic environment (Pryke, 2012), where stakeholders are interrelated instead of staying in a hub-and-spoke system. Stakeholders' roles, values and behaviours emerge from their relational structures; in addition, the patterning and characteristics of these structures can affect how effective the stakeholders are to be engaged. Therefore, a thorough analysis on stakeholders and their interactions is essential to facilitate project decision making and communication.

Although various practical stakeholder analysis methods have been developed in the past decades (Chapter 2 summarised those methods), a major drawback of the existing methods is that they cannot breakthrough the cognitive limitations of core stakeholders when a MCP possesses extremely high complexity and complicacy. Instead of analysing stakeholders based on the core project team's empirical knowledge and perceptions, a social network approach, which focuses on stakeholder relationships by completely engaging all stakeholders and examining their real interactions, can bring the benefits of higher objectivity, accuracy and effectiveness.

Rooting in the Social Network Theory, the proposed social network approach perceives a MCP as a complex system of social interactions connecting a defined set of stakeholders; and the arrangement of these links can affect social behaviours of stakeholders, as well as the robustness of the entire system (Rowley, 1997; Wasserman and Faust, 1994). The purposes of the proposed approach are to map stakeholder interactions, diagnose how the connectivity structures and patterning affecting stakeholder behaviours, recognize important stakeholders, and identify opportunities for improving stakeholder engagement.

Stakeholders in a MCP are connected across organisational and functional borders through various interactions (Meese and McMahon, 2012); among which communication, information exchange, knowledge sharing, and power/influence are four important kinds to be studied (Chinowsky et al., 2008; Cross and Parker, 2004). The proposed approach focuses on information exchange of project stakeholders. According to Chinowsky et al. (2008), every project task requires information transfer; and in the social context, stakeholders are engaged through effective information transmissions. Examining stakeholders' information exchange can therefore uncover their mechanism of interactions, as well as who sit in the project communication hub. In the proposed social network approach, information exchange between stakeholders is defined as the provision or receipt of information which facilitates them in understanding or addressing stakeholder issues in the project. Accordingly, information refers to: (1) any information relating to the general issues of project stakeholders; and (2) any information whose transmission can help or is essential for stakeholders to understand or accommodate their general issues in the project. The means of information exchange can cover face-to-face meetings, tele-/video-conferences, phone calls, emails, letters, memos, and discussions on e-platforms, etc., depending on the actual project situations.

4.3 Social Network Analysis metrics

In the proposed approach, eight SNA metrics are computed to investigate the structural characteristics and patterns embedded in the stakeholder information exchange network at both the network-level and node-level. At the *network-level*, two metrics, namely *density* and *cohesion*, are calculated to quantitatively examine the overall network structure. At the *node-level*, six metrics, namely *in-degree centrality*, *out-degree centrality*, *degree difference*, *power centrality*, *betweenness centrality*, and *closeness centrality* are computed to assess the roles of individual stakeholders (e.g. central connector, information broker, and peripheral actor) and their influences in the network. Table 4.1 presents the theoretical definitions and practical interpretations of these SNA metrics in analysing stakeholder information exchange network. The application details of these SNA metrics in the proposed social network approach are described in the following section.

Table 4.1: SNA metrics, their theoretical definitions and practical interpretations for stakeholder information exchange network

(a) Network level metrics

Metrics	Theoretical definition	Practical interpretation	Implication for overall network structure	References
Density	The ratio of actual ties in a network to the greatest number of possible ties when all nodes are interconnected.	The overall network connectivity.	A higher density value represents a higher occurrence of information exchange in the whole project.	Wasserman and Faust (1994)
Cohesion	The number of ties, or the length of path, to reach nodes in a network.	The time taken for information to be diffused in the network.	A lower cohesion value benefits information flow, as it represents a shorter time or path for information to be disseminated among stakeholders.	Wasserman and Faust (1994)

(b) Node level metrics

Metrics	Theoretical definition	Practical explanation	Implication for central stakeholders		References
			Role	Description	
In-degree centrality	The number of direct incoming ties transmitted to a specific node.	The degree to which a stakeholder receives information from its direct neighbours in the network.	Information recipient	A stakeholder with high in-degree has high accessibility to information in the project.	de Nooy et al. (2005); Freeman (1979);
Out-degree centrality	The number of direct outgoing ties emitted by a particular node.	The degree to which a stakeholder provides information to its direct neighbours in the network.	Information transmitter	A stakeholder with high out-degree is influential as it can quickly disseminate one's information to a large population.	Wasserman and Faust (1994)
Degree difference	The difference between out-degree and in-degree scores of a specific node.	Degree difference is calculated by deducting the out-degree from in-degree of a stakeholder to identify peripheral actors.	Peripheral actor	A stakeholder with larger in-degree than out-degree is considered peripheral, i.e. less influential, in the project as it is an information receiver more than provider.	
Power centrality	The degree of which a node's immediate neighbours are dependent on this node. In degree measure, a node's centrality is determined by the number of its direct	The extent to which a stakeholder is being relied on by its connected others for information access.	Powerful stakeholder	A stakeholder is powerful (i.e. with high power centrality score) if its interacting others are not themselves well connected. In contrast, if the interacting others are already well connected to other stakeholders, they would be less dependent on this stakeholder for information access, thus	Bonacich (1987); Meese and McMahon (2012)

	ties/neighbours. In power measure, a node's centrality is a function of the centrality scores of its immediate neighbours.			this stakeholder is less powerful.	
Betweenness centrality	The incidence in which a specific node falls on the geodesic distance between other pairs of nodes.	The extent to which a stakeholder acts the role of broker/gatekeeper in the communication between other stakeholders by controlling or filtering the information flow between them.	Information broker	This role facilitates communication by diffusing information to stakeholders which may otherwise be disintegrated from the network. This role may also interfere communication if it transmits information in a poor quality or untimely manner.	Freeman (1979)
Closeness centrality	The distance, or the number of intermediaries, of a particular node to every other nodes in the network on the basis of shortest path.	An indication of how the entire network is proximate to or rivet on a stakeholder. It also reflects a stakeholder's independence in the relational activities in the network.	Focal actor	This role enjoys a higher quality of communication (e.g. lower chance of information distortion, and shorter information transmission time) due to their shorter distance with other stakeholders. However, it is difficult for this stakeholder to act alone without drawing others' attention.	Freeman (1979)

4.4 Procedures

Figure 4.1 shows the procedures for analysing stakeholders in MCPs using a social network approach. The entire process aims to map the information exchange interactions of stakeholders, assess stakeholders' roles and influences through these relationships, identify the important, intermediary and under-engaged stakeholders, and prioritise the general issues of stakeholders. The whole procedure comprises five main steps: (1) identifying stakeholders and general issues; (2) determining stakeholder relationships; (3) visualising stakeholder network; (4) analysing stakeholder network; and (5) prioritising stakeholders and general issues. It is acknowledged that the details of the proposed approach were adapted from two published/prepared papers with the candidate as the first author, as shown in the footnotes below[1][2].

4.4.1 Identifying stakeholders and general issues

Step 1 aims to completely identify project stakeholders and issues which may be affected due to MCP development or the achievement of project objectives. Two methods for stakeholder and issue identification can be used, namely empirical knowledge-based method and chain referral sampling. These two methods can be employed separately or in combination, depending on the actual project situation.

[1] Mok, K.Y., Shen, G.Q., Yang, R.J. Addressing stakeholder complexity and major pitfalls in large cultural building projects. International Journal of Project Management. (Under Review)

[2] Mok, K.Y., Shen, G.Q., Yang, R.J. Analysing stakeholder relational structures and concerns in large scale green building projects. Engineering, Construction and Architectural Management. (Under Review)

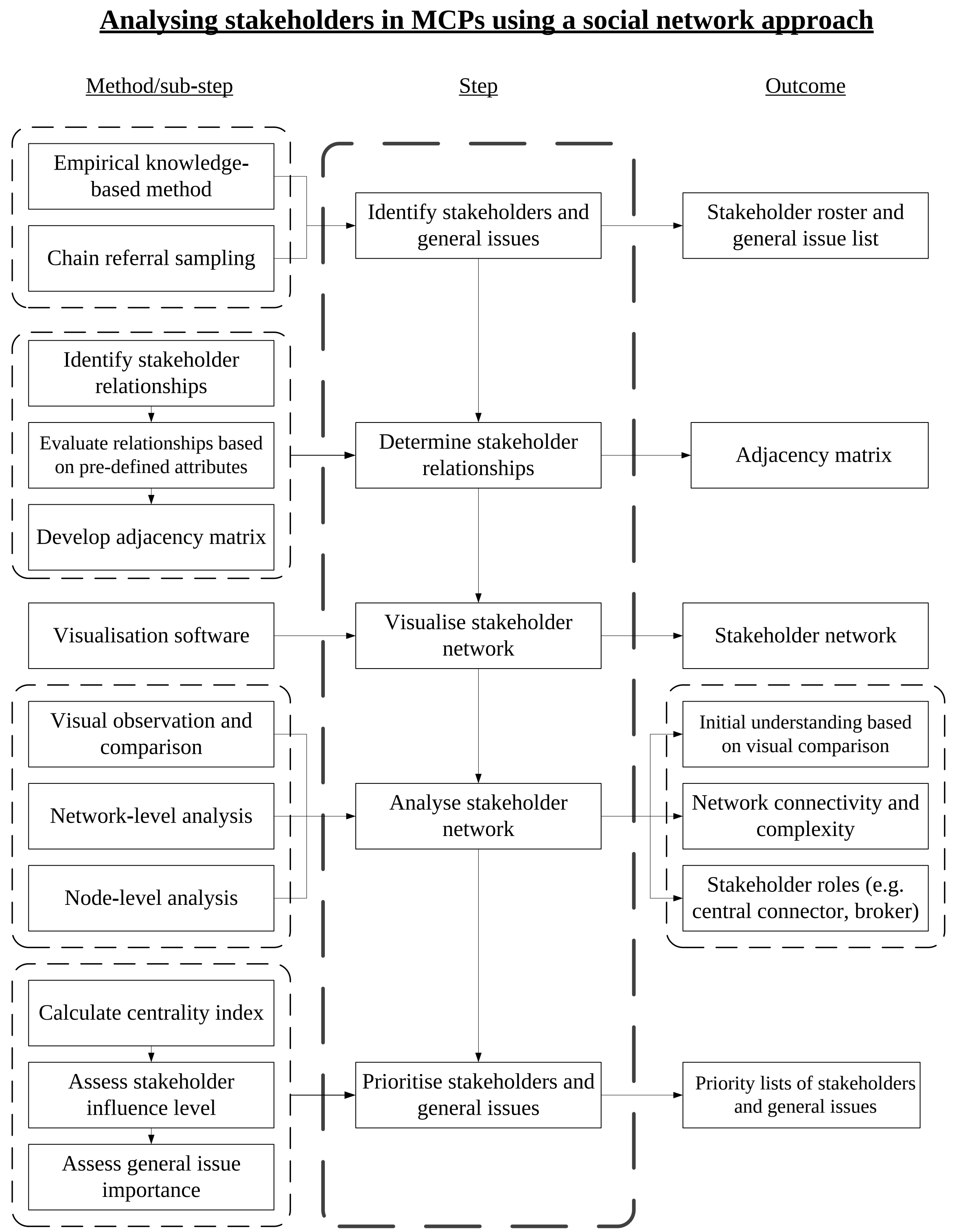


Figure 4.1: Procedures for analysing stakeholders in MCPs using a social network approach

Empirical knowledge-based method

Empirical knowledge-based method is a commonly used means for identifying stakeholders and issues, and gathering the relevant information. This method is to engage a representative group of project participants from the core project team and other stakeholders via workshops, interviews or surveys; and to collect their opinions on a few questions such as ‘who are the project stakeholders’ and ‘what are the issues or concerns of these stakeholders in the project’, and ‘why these issues are at stake’. This method is described as ‘empirical’ because stakeholders and issues are identified based on the experience, professional and/or project-specific knowledge of core stakeholders. To facilitate the identification process, a reference list of possible stakeholders and issues deriving from literature review and project document analysis can be provided to the stakeholders. All identified stakeholders and issues should be well recorded to avoid missing information. In comparison with interviews and surveys, workshop is a preferred means since workshop participants can effectively reach consensus on a set of stakeholders and issues to be analysed. The advantages of empirical knowledge-based method include: (1) it is relatively time efficient, (2) it can be easily implemented, and (3) the experience of core stakeholders can be well utilised. However, this method has two drawbacks: (1) a complete stakeholder and issue identification is difficult due to cognitive limitations of core stakeholders, and (2) the accuracy of identification results may decrease when the project grows in complexity

Chain referral sampling

Chain referral sampling is a commonly used technique in qualitative sociological research for engaging nearly all project stakeholders (Berg, 1988; Biernacki and Waldorf, 1981). While the empirical knowledge-based method identifies stakeholders based on a small group of stakeholders’ experiences, chain referral sampling generates an almost complete stakeholder list through referrals directed by people who know the potentially relevant others. Chain referral sampling identifies stakeholders in three steps: (1) the core project team members are invited to appoint internal stakeholder groups; (2) these nominated parties are then invited to provide referrals of external stakeholders who may impact or be impacted by the project; and (3) these designated parties are required to appoint any conceivably impacting or impacted groups who are still absent in the chain. This method produces a complete stakeholder roster. Interviews, workshops or surveys can then be conducted with the identified stakeholders to identify issues in the project. The advantages of chain referral sampling include: (1) it enables a complete and accurate stakeholder identification, (2) the identification is not restrained by cognitive limitations of core stakeholders, and (3) it is particularly suitable when the data collection involves insiders' knowledge and sensitive information (Biernacki and Waldorf, 1981). However, this method has two drawbacks: (1) it is relatively time consuming, and (2) practical difficulties exist, e.g. people might concern about anonymity and are declined to provide referrals.

Step 1 yields a stakeholder roster and an issue list of the project. All identified stakeholders and general issues are coded numerically as S_a (where a = 1…n; n is the number of identified stakeholders) and I_b (where b = 1…k; k is the number of identified issues) respectively, for subsequent data processing and analysis. The identified project stakeholders are the nodes of the stakeholder information exchange network.

4.4.2 Determining stakeholder relationships

Step 2 determines the links in the stakeholder network, which represents the information exchange interactions between project stakeholders. This step firstly identifies and assesses the links based on pre-defined relationship attributes and numerical scales, then develops an adjacency matrix for subsequent network visualisation and analysis.

Relationship identification and assessment

Information is exchanged in two directions – in one direction, one obtains information from a set of stakeholders to help in understanding or addressing various stakeholder issues; in the opposite direction, one provides information to a set of stakeholders to facilitate them in understanding or addressing the issues. This step firstly requires each identified stakeholder (from Step 1) to identify its information providers and recipients among the *n* identified project stakeholders. After that, respondents were asked to evaluate each identified link based on three relationship attributes, namely *frequency*, *timeliness* and *information quality*, using five linguistic-based levels. ‘Frequency’ and ‘information quality’ are two relationship attributes widely used in SNA studies (Lin, 2014; Meese and McMahon, 2012; Solis et al., 2013), while ‘access’ is also an important factor to differentiate between effective and ineffective relationships (Cross et al., 2001). Table 4.2 presents the definitions of these relationship attributes and the descriptions of numerical scale. Questionnaire survey is a useful means to solicit responses in the relationship identification and assessment process. A sample questionnaire is attached in Appendix A. After collecting all relational data via the survey, a sanity check should be conducted to identify any mismatches in the data, e.g. S1 declares to give information to S2, but S2 does not identify S1 as an information provider. In such occasion, the mismatch should be investigated and resolved by seeking viewpoints from relevant stakeholders on the contradicting stories, and inquiring their particular information exchange habits and interactions from different angles; in an attempt to achieve consensus about the specific links. Workshop with the core project team and stakeholder representatives is an effective means to sort out data mismatches.

Table 4.2: Relationship attributes for identifying and assessing stakeholder information exchange interactions

Relationship attribute	Definition	Numerical scale	
Frequency	The frequency of information transmission	1	Fewer than once a month
		2	Biweekly to monthly
		3	Weekly
		4	Several times a week
		5	At least once per day
Timeliness	The level of timeliness in which information is obtained from or provided to stakeholders	1	Very untimely access
		2	Untimely access
		3	Fairly timely access
		4	Timely access
		5	Very timely access
Information quality	The quality of information in terms of correctness, completeness and comprehensibility	1	Very low quality
		2	Low quality
		3	Fair quality
		4	Good quality
		5	Very good quality

Developing adjacency matrix

After determining the links, an *adjacency matrix*, which forms part of the input data required for network visualisation and analysis, is developed. Table 4.3 presents a sample adjacency matrix. The first row and column denote the identified stakeholders representing in their numerical codes S_a. The numbers in the cells represent the frequency of information transfer from the 'column' stakeholder to the 'row' stakeholder. This matrix indicates the stakeholder information exchange network.

Table 4.3: An example of adjacency matrix representing the stakeholder information exchange network

	S1	S2	S3	S4	S5
S1		3		5	2
S2	1		3	3	
S3		2		5	1
S4	4	4			1
S5	5	2		3	

4.4.3 Visualising stakeholder network

Step 3 applies a network visualisation and analysis software package (e.g. NetMiner) to visualise the stakeholder information exchange network. The node list, link list and adjacency matrix compose the major input data. A sociogram G(N, M) is developed to represent the stakeholder information exchange network, where the *n* identified stakeholders are drawn as the N nodes joined by the M valued edges. Node shape indicate the stakeholder types, and edges represent the information flow from one stakeholder to another.

4.4.4 Analysing stakeholder network

Step 4 is broken down into three sub-steps: (1) *visual observation* – the stakeholder network was differentiated into three sociographs based on the three relationship attributes, then the sociographs were visually inspected and compared to obtain initial insights regarding the effectiveness of stakeholder information exchange; (2) *descriptive analysis* – two network-level metrics, namely *density* and *cohesion*, are calculated to quantitatively examine the overall network structure; and (3) *stakeholder role assessment* – six node-level metrics, namely *in-degree*, *out-degree*, *degree difference*, *power*, *betweenness*, and *closeness*, are computed to assess the roles of individual stakeholders (e.g. central connector, information broker, and peripheral actor) and their influences in the network

Visual observation

A sociogram G of the stakeholder network, in terms of information exchange frequency, has been developed in Step 3 (please refer to Section 4.4.3). This network graph can be differentiated into two more sociograms based on the relationship attributes of timeliness and information quality. Removing the links of fair and poor information quality (i.e. those scoring ‘≤3’ in the attribute ‘information quality’) yields the network G'. Further eliminating the links of fair and poor information access timeliness (i.e. those scoring '≤3' in the attribute 'timeliness') from G' produces G". In these three sociograms, nodes denote the stakeholders, and links represent the existence of information flow between stakeholders. The more links a stakeholder has, the more central location it occupies. Observing the variations of these three sociograms (G, G' and G") in terms of network structure and central node distribution can render initial understanding to stakeholder interaction patterns.

Regarding the network structure, particular attentions should be paid to the network connectedness and cut-points. Cut-points refer to nodes who connect the otherwise isolated stakeholders through weak ties. For example, if many stakeholders can mutually reach each other in G but G" contains many one-way interactions and cut-points, this scenario indicates that the relational structure of stakeholders is vulnerable to disruption when access timeliness and information quality are taken into consideration. The weak ties should be protected from attacks to maintain stakeholder communication. Regarding the central node distribution, if the central stakeholders in G occupy peripheral locations in G' and G", this scenario reflects that there is a need for these stakeholders to improve their information quality and access timeliness because they frequently interact with others.

Descriptive analysis

Density and cohesion are two useful network-level metrics to quantitatively analyse the overall network structure. Density measures the network connectivity, where a higher density represents a higher incidence of information flows. Cohesion indicates the time taken for information to be diffused in the network. A lower cohesion favours information transmission because it implies a quicker dissemination. A cohesion value of 2 can be regarded reasonable for information network (Cross and Parker, 2004). The theoretical definitions and practical meanings of the network-level metrics in stakeholder information exchange network have been explained in Table 4.1. The descriptive analysis results of the three networks (G, G' and G") can be compared to yield useful findings. For example, if there is a sharp decrease between the density values of G and G', it implies that many links in G are rated fair and poor regarding information quality; indicating a need for stakeholders to improve the correctness, completeness and comprehensibility of information.

Stakeholder role assessment

In-degree, out-degree, degree difference, power, betweenness and closeness centrality are six useful node-level metrics to analyse stakeholder roles in information exchange and assess their influences. The theoretical definitions and practical meanings of the node-level metrics in stakeholder information exchange network have been explained in Table 4.1. Based on these calculations, three stakeholder roles, namely *central connector*, *information broker*, and *peripheral actor*, are identified. Table 4.4 explains the meanings of these roles and the specific metrics applied.

Table 4.4: Stakeholder roles and the specific node-level metrics applied

Stakeholder role	Description	The metrics applied
Central connector	Directly responsible for many information provisions in the network; the information source heavily relied on by its neighbours because these neighbours are not well connected to others else	Out-power centrality; out-degree centrality
Information broker	The gatekeeper; having high power in controlling or filtering information to stakeholders who may otherwise be disconnected from the network	Betweenness centrality
Peripheral actor	Relatively less influential because it is an information receiver more than provider	Degree difference; in-degree centrality

Power and degree are two distinct centralities to measure an actor's power and influence respectively. Out-power indicates the extent that a stakeholder is being relied on by its connected others for information access. The higher the out-power, the more powerful a stakeholder is since its neighbours are not well connected and thus become dependent on the actor to obtain information. Out-degree measures the extent that a stakeholder provides information to its direct neighbours. The higher the out-degree, the more influential a stakeholder is because its information can quickly reach a large population. Plotting out-power against out-degree helps to identify *central connectors* who are respectable and influential in the information exchange network. Figure 4.2 shows an example of the plot. As shown in Figure 4.2, stakeholders outside the pink cluster are considered central connectors, who are the direct information sources that many others have heavily relied upon.

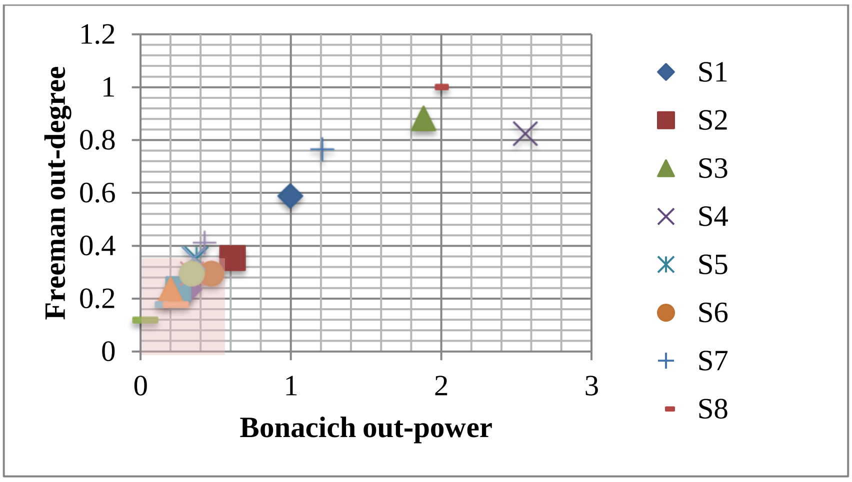


Figure 4.2: An example plot of out-power against out-degree

Betweenness centrality measures the extent that a stakeholder lies between two non-adjacent others in the network. Stakeholders with high betweenness score are considered *information brokers*, as they control the information flow to others who may otherwise be disintegrated from the network. Information brokers take a leader role in the network as well, by urging their neighbours to devote more to solutions for tackling project problems.

Degree difference and in-degree help to identify *peripheral actors* who have more incoming than outgoing links. There are two potential reasons of these stakeholders being peripheral: (1) they possess specialised skills and knowledge which are peripheral in nature, so they are relatively less perceived by others as useful information sources; and (2) they may not be eager to share what they know. Regardless of reasons, these peripheral actors represent the under-utilised resources, implying high potential to explore new information from them.

4.4.5 Prioritising stakeholders and general issues

Step 5 aims to assess stakeholders' influence and issues' importance in the project based on the node-level results.

Assessing stakeholder influences

This process assesses stakeholders' influence levels in the project based on the node level results, and it includes three steps. Calculating the centrality index of each stakeholder is the first step. The degree, betweenness and closeness centrality values are normalized to avoid the effect of network size, and thus ranged between 0 and 1 (Beauchamp, 1965). Then, the three centrality scores of each stakeholder are averaged to obtain its centrality index (Dogan et al., 2013). The second step is to prioritize stakeholders according to their centrality index, and obtain their ranking. The last step is to evaluate stakeholder influence in the project. The influence level of each stakeholder can be calculated by Eq. (1)[3]:

$$S_q = \frac{R+1-r(q)}{\sum_{p=1}^{n}[R+1-r(p)]} \tag{1}$$

where S_q denotes the influence level of a stakeholder q in the project; R is the maximum rank among all project stakeholders; $r(q)$ is the fractional rank of stakeholder q; and n is the total number of project stakeholders (Lim and Finkelstein, 2012). A lower rank implies a greater stakeholder influence, therefore this expression deducts a stakeholder's rank from the upper limit of R+1, to invert the rank value (Lim and Finkelstein, 2012). This is then divided by the

[3] Eq. (1) assesses the actual influence of each stakeholder among all project stakeholders. For this purpose, the calculation firstly inverts a stakeholder's rank value (by subtracting it from 'R+1'), then performs normalization (i.e. dividing the obtained value by the sum of all stakeholders' influence levels).

sum of all stakeholders' influence levels for normalization, so as to reflect the actual impact of a stakeholder among all n stakeholders.

Assessing stakeholder issue importance

This process assesses issue importance in the project and prioritises the issues accordingly. First, the importance level of each identified issue (identified from Step 1) in the project is evaluated using Eq. (2):

$$I = \sum_{m=1}^{n} (S_m \times C_m) \tag{2}$$

where I represents the importance level of a stakeholder issue in the project, S_m denotes the influence level of a stakeholder m; C_m is the rating given by stakeholder m on the corresponding issue; and n is the total number of project stakeholders (Lim and Finkelstein, 2012). Stakeholders' ratings on an issue, C_m, are elicited from representatives of all identified stakeholders through the aforementioned questionnaire survey (please refer to Section 4.4.2 and Appendix A). In the survey, respondents are required to rate the importance of each issue based on their empirical knowledge using a five-point scale (where '1' and '5' meaning the least and the highest importance respectively, and 'N/A' indicates the issue being unrelated to the stakeholder).This calculation assesses how critical an issue is, by taking into account both *stakeholders' perception on an issue's importance in the project*, and *the actual influences of corresponding stakeholders in the real relationship situation*. Next, all identified issues are prioritised based on their importance levels. The output was a ranked list of issues, with those of greater importance ranked higher. Basically, the top issues represent those which are perceived as the most critical and are most frequently communicated by stakeholders in the project. The project team should pay particular attention in handling them

4.5 Identification and engagement of critical stakeholders

This proposed social network approach prioritises project stakeholders and issues based on their importance levels. In addition, it helps to identify critical stakeholders who worth particular attention from the project team or whose communications and engagement ought to be enhanced. The main principles to engage the identified critical stakeholders are discussed below.

Central connector

Stakeholders with high out-power and out-degree are central connectors. They are influential and powerful because they can quickly disseminate information to a large population; and at the same time, being relied upon by their information receivers as important information sources. The project team should pay particular attention on their actual influences in project information flow, and put more efforts in monitoring their information quality and timeliness in information provision.

Information broker

Stakeholders with high betweenness centrality are information brokers. They can control and filter information to others who may otherwise not be able to get access to the information. Although weak ties may not be favourable for transferring complex information, the project team should protect these weak ties from attack so as to maintain stakeholder communication.

Peripheral actor

Stakeholders with large degree difference and in-degree are peripheral actors. They might represent under-utilised sources of knowledge, or they may not be willing to share what they know. The project team should improve communications and engagement with them, so as to explore new information and knowledge.

4.6 Chapter summary

This chapter presents a social network approach for analysing stakeholders and their relationships in MCPs, with an emphasis on stakeholder information exchange interactions. This approach involves the application of chain referral sampling, SNA, a software package for network visualisation and exploration (e.g. *NetMiner*), as well as the calculations of two network-level and six node-level SNA metrics. The entire procedures of the proposed approach comprise five main steps, namely ‘identifying stakeholders and general issues’, ‘determining stakeholder relationships’, ‘visualising stakeholder network’, ‘analysing stakeholder network’, and ‘prioritising stakeholders and general issues’.

With the use of the proposed approach, the project team would be able to identify completely all project stakeholders and issues, map the stakeholder information exchange interactions, identify the critical stakeholders (e.g. central connectors, information brokers and peripheral actors) and key issues, and spot opportunities for improving project information exchange. The analysis outcomes would help the project team to formulate appropriate stakeholder engagement measures, for instance, monitoring the information quality of and timeliness in information provision by central connectors; protecting the weak ties with information brokers which might be more vulnerable to disruptions; and improving the engagement with peripheral actors whose information or knowledge might be under-utilised.

The next chapter will present two case studies of different MCP types, including a major cultural building project and a large-scale green building development. These case studies are used to demonstrate the application of the proposed social network approach for analysing stakeholders and their interactions. The findings will provide useful insights on the important stakeholders and issues in major cultural and green building projects. In addition, the lessons learnt will offer valuable insights on the further development of the social network model for stakeholder analysis in MCPs.

Chapter 5 – Validation of the Approach for Analysing Stakeholders

5.1 Introduction

A social network approach for analysing stakeholders and their information exchange interactions in MCPs has been developed and introduced in Chapter 4. Case study is used to illustrate the application of and validate the proposed approach. Two real case projects of different MCP types, including a major cultural building project and a large-scale green building development, are used for the said purposes. This chapter presents the validation of the approach by the two case studies. Abbreviated forms of the two project names, namely XC project (for the cultural building project) and SP project (for the green building development), are adopted in this chapter for confidential consideration. Case Study I on the XC project is presented in Section 5.2, while Case Study II on the SP project is described in Section 5.3. Lessons learnt from the two case studies are discussed in Section 5.4 with an aim of exploring the applicability of the proposed social network approach.

5.2 Case Study I – the XC project

5.2.1 Description of the XC project

The XC project is a HK$2.7 billion arts venue particularly constructed for the performance, production, education and research of Chinese opera in Hong Kong. This building has seven storeys and two underground basement levels, with a footprint of 13,800 square meters on site. The project scope comprises four main parts: (1) two auditorium for 1,100 and 400 seats, (2) a 280-seat tea house theatre for traditional recitals and Chinese tea tasting, (3) training and educational facilities (such as rehearsal rooms and studios) of 2,000 square meters, and (4) an atrium for public leisure.

The XC project is selected for case study due to four reasons. First, this project is considered a MCP according to the definition on MCPs previously described in Chapter 2. Secondly, this project involves a wide range of stakeholders with complex relationships and diverse interests, which contribute to high complexity in its stakeholder management. Thirdly, this project is an ongoing development instead of a completed works. The researcher considers ongoing projects as more appropriate because comprehensive information can be collected; while in past projects, there is often information missed. Lastly, this project is a performing arts centre, which is the most preferable kind of cultural buildings considered by the researcher among the various kinds (e.g. museums and theatres). According to Woronkowicz et al. (2014), performing arts centre is the largest and most costly type of cultural building project in comparison with museum and theatre. Its project nature is also complex since it often incorporates multifunctional facilities such as theatre, concert hall, user amenities and public space.

The unique nature and high complexities of the XC project necessitate a social network approach for stakeholder analysis and issue prioritisation. For instance, there are rare local and overseas examples of art venues specially built for Chinese opera, the project team lacks ‘role models and benchmarks’ for reference in the design and delivery process. There are over 200 genres of Chinese opera while each of which has unique requirements on stage, instruments and costumes; presenting a great diversity in end users’ requirements. The venue is lantern-shaped with the 1,800-tonne main theatre structure (made of structural steel) situated at the building top; requiring the use of heavy lifting method whose operation is technically complex. The construction is adjacent to an established shopping district whose congested traffic has added difficulties to the site vehicular access. The budget and schedule are both tight, any cost and time overruns may result in huge controversies as the project is of high profile. To understand the background of the XC project, document review was conducted on the below: project profile, public engagement reports and development plan prepared by the client; project brief by the design consultants; environmental impact assessment report by consultancies; relevant articles by local Chinese opera organisations; relevant discussion papers by the legislative council, etc. The information was analysed under four themes: project background; stakeholders; stakeholder issues; and information flow of stakeholders.

Since stakeholder relationships and issues evolve with time, a definite time span should be determined (Baxter and Jack, 2008; Stake, 1995). When the researcher entered the selected case, the construction stage of the XC project had commenced for a few months. The stakeholder network herein captures relational structures at a point-in-time in the construction phase. In addition, all stakeholders that were interviewed and surveyed in this case study have full knowledge about the issues and problems throughout the project from its beginning to the construction stage. To ensure the reliability of collected data and the objectiveness of case analysis, the researcher maintained a neutral relationship with the core project team and stakeholders – the researcher played an impartial role and did not favour any sides in the entire case study. In addition, the researcher maintained independent from the situation under exploration, so as to ensure a minimum intervention from the investigators to the research context. The outcomes of literature review and project document analysis help the researcher to assemble two tentative lists of stakeholders and issues of the case. These two lists had served as reference to assist the subsequent stages of stakeholder and issue identification.

5.2.2 Development of the stakeholder information exchange network

Chain referral sampling was used to identify stakeholders, i.e. the nodes, in the XC project. Four representatives from the client, main contractor and lead design consultant were reached to start the chain, and they all have full responsibilities in project development. To facilitate the identification process, all participants were given a reference list of stakeholders; this list had been previously created through project document analysis and literature review, with feedbacks obtained from the core project team. When stakeholders were nominated, the researcher would approach them to confirm/clarify their role, responsibility and involvement in the project; and to gain their consent to participate in the subsequent survey. Eventually, 18 stakeholders were identified and coded numerically from S1 to S18, as shown in Table 5.1. This stakeholder list and the brief description had been sent back to the core project team for feedbacks and were subsequently confirmed after minor amendments.

A combination of document analysis, literature review and interviews were conducted to identify stakeholder issues in the XC project. Initially, project documents (such as public engagement reports and the government's discussion papers) and relevant literature (about 'stakeholders' and 'cultural facility projects') were reviewed and analysed; a reference list of stakeholder issues was developed. Subsequently, interviews were conducted with key project participants from the initially approached stakeholders, to have deeper understanding on the issues and to gain feedbacks on the issue list. The issue list was further revised according to the core project team's feedbacks and was confirmed with all stakeholder representatives. Finally, 54 issues were identified, as shown in Table 5.2. This list formed a part of the questionnaire survey, and assisted the link identification and issue prioritisation tasks in the later stages.

Table 5.1: Stakeholders identified in the XC project

Stakeholder		Description
S1	Client project delivery division	A division in the client organisation who oversees the overall planning, construction and management of the case project
S2	Client performing arts division	A division in the client organisation who engages the end users (e.g. opera performers, operators, specialists and advisors of different art forms), consolidate end users' requirements and develop the design brief
S3	Lead design consultant	A consultancy firm to undertake architectural design and contract administration; it won the design competition launched by the client for the case project and is subsequently appointed as lead design consultant
S4	Main contractor	A contractor company to construct the performing arts venue and manage the project programme
S5	Quantity surveying consultant	A consultancy firm appointed by the client to provide cost management and advisory services
S6	Structural engineer	A consultancy firm appointed by the client to provide façade and structural engineering design and solutions
S7	MEP design engineer	A consultancy firm appointed by the client to provide MEP design and engineering solutions including sustainability, security, specialist lighting, audio visual, etc.
S8	Theatre design consultant	A consultancy firm appointed by the client to undertake theatre planning and design
S9	Fit-out subcontractor for timber works	A subcontractor company jointly selected by S1 and S4 to carry out fit-out works (timber works)
S10	Fit-out subcontractor for metalwork	A subcontractor company jointly selected by S1 and S4 to carry out fit-out works (metal works)
S11	Structural steel subcontractor	A subcontractor company employed by S4 to undertake structural steel works
S12	Electrical subcontractor	A subcontractor company employed by S4 to carry out electrical installation works
S13	Theatre system subcontractor	A subcontractor company employed by S4 to supply and install theatre system
S14	MVAC subcontractor	A subcontractor company employed by S4 to supply and install MVAC system
S15	Fire services and plumbing subcontractor	A subcontractor company employed by S4 to supply and install fire services and plumbing & drainage works
S16	ELV subcontractor	A subcontractor company employed by S4 to supply and install ELV system
S17	District council	A consultative body (supervised by the government) who gathers opinions from the public and local community concerning the development, and reflects their views to the client
S18	End users	Performing arts organisations who are potential end users of the facilities in the performing arts venue

Table 5.2: Issues identified in the XC project

Issue code	Issue description	Issue category
I1	Communication and engagement with the public and local community	Community/Social
I2	Disruption to the neighbourhood and local community (e.g. changes to traffic conditions)	Community/Social
I3	Enhancing the image of local community and society	Community/Social
I4	Prevention and mitigation measures against disruption to the neighbourhood	Community/Social
I5	Provision of public amenities and open space	Community/Social
I6	Safety of the neighbourhood	Community/Social
I7	Adequacy and stability of project finance	Cost
I8	Inflation of construction price including labour, material and plant costs	Cost
I9	Ensuring the project to be completed within budget	Cost
I10	Increased job opportunities to the construction industry	Economic
I11	Indirect economic benefits brought by associated economic activities, e.g. more pedestrian flow	Economic
I12	Pollution brought by construction works to the neighbourhood (e.g. air, noise, odour)	Environment
I13	Sustainability achievement (e.g. LEED, BEAM)	Environment
I14	Visual impacts to the neighbourhood (e.g. view blockage)	Environment
I15	Building a positive image of the project	Ethical/Reputation
I16	Company image and reputation	Ethical/Reputation
I17	Information disclose to the media, general public and NGOs	Ethical/Reputation
I18	Compliance with statutory provisions	Legal
I19	Processes and policies of getting statutory approvals and permits to carry out construction works	Legal
I20	Building common language, effective communication and mutual understanding between the project team and end users	Organisational
I21	Mechanisms and procedures to manage changes	Organisational
I22	Effective decision making and maturity of the core leadership team	Organisational
I23	Coordination with interfacing construction projects	Organisational
I24	Accommodating cultural variations between project team members (e.g. national culture)	Organisational
I25	Establishing trust, common understanding and mutual goals between client, contractors and consultants	Organisational
I26	Previous experience of the project team in undertaking similar construction projects	Organisational

I27	Clear and sufficient government policies to support project development	Political
I28	Controversies from the public and politicians on project quality and performance	Political
I29	Coordination and communication between government departments	Political
I30	Availability and allocation of specialized labour, materials and plants	Procurement/contractual
I31	Contract strategy and administration	Procurement/contractual
I32	Contractual disputes and claims	Procurement/contractual
I33	Fairness of risk sharing between client and contractors	Procurement/contractual
I34	Alignment between design uniqueness, aesthetics, budget, end users' requirements and the actual project programme	Quality
I35	Clear specification, drawings and work instructions	Quality
I36	Performance and attitudes of contractors and consultants	Quality
I37	Performance of works affecting future business opportunities	Quality
I38	Project design accurately reflecting the requirements of client and end users	Quality
I39	Project performance meeting client's satisfaction	Quality
I40	Quality/performance of workmanship, materials and plants meeting the required standards	Quality
I41	Meeting the different expectations of various stakeholders on project quality and performance	Quality
I42	Sustainability and reliability of the development after project completion (e.g. maintenance complexity)	Quality
I43	Construction safety performance	Safety
I44	Proper implementation of safety measures on site	Safety
I45	Adapting technological processes and systems to changes	Technological
I46	Adopting innovative and leading-edge construction technology	Technological
I47	Clear government testing procedures and quality standards of new construction materials	Technological
I48	Green and sustainable construction methods and engineering solutions	Technological
I49	Risk mitigation	Technological
I50	Site logistic and storage arrangement	Technological
I51	Technological complexity	Technological
I52	Value engineering solutions and the associated design changes arising in the construction stage	Technological
I53	Sequencing and progress of construction works	Time
I54	Tightness of project programme	Time

After recognising the stakeholders and issues, stakeholder information exchange relationships were identified and assessed. For the purpose of this case study, information refers to: (1) any information relating to the 54 identified stakeholder issues, and (2) any information whose transmission can help or is essential for the stakeholders to understand or address these issues. The means of information exchange include face-to-face meetings, tele-/video-conferences, phone calls, emails, letters, memos and e-platform discussions, etc. The reason for considering a variety of means is that they have been widely used by all identified stakeholders in the project. A questionnaire survey was conducted with representatives of the 18 stakeholders, who had taken part in stakeholder and issue identification, for determining and evaluating the links (refer to Appendix A). All respondents (except S17 and S18) were at senior management level, with over 10 years work experience in their field, and fully responsible in the project. In the survey, respondents were asked to identify their information providers and recipients among the 18 stakeholders. Next, the respondents were asked to assess each identified link based on three relationship attributes, namely ‘frequency’, ‘timeliness’, and ‘information quality’, using five linguistic-based levels (Chapter 4 described these relationship attributes and numerical scale). The survey data collection lasted for about two months, and the questionnaire design included a piloting cycle to minimize ambiguities and errors in the instrument. A confidentiality statement was included in the survey to alleviate respondents’ concerns on data anonymity and ethical issues. After collecting all relational data, a sanity check was conducted to identify any data mismatches Finally, 129 links connecting 18 stakeholders were defined. The information exchange frequency provides the basis of creating adjacency matrix. Accordingly, the matrix representing the stakeholder information exchange network G (18,129) was developed.

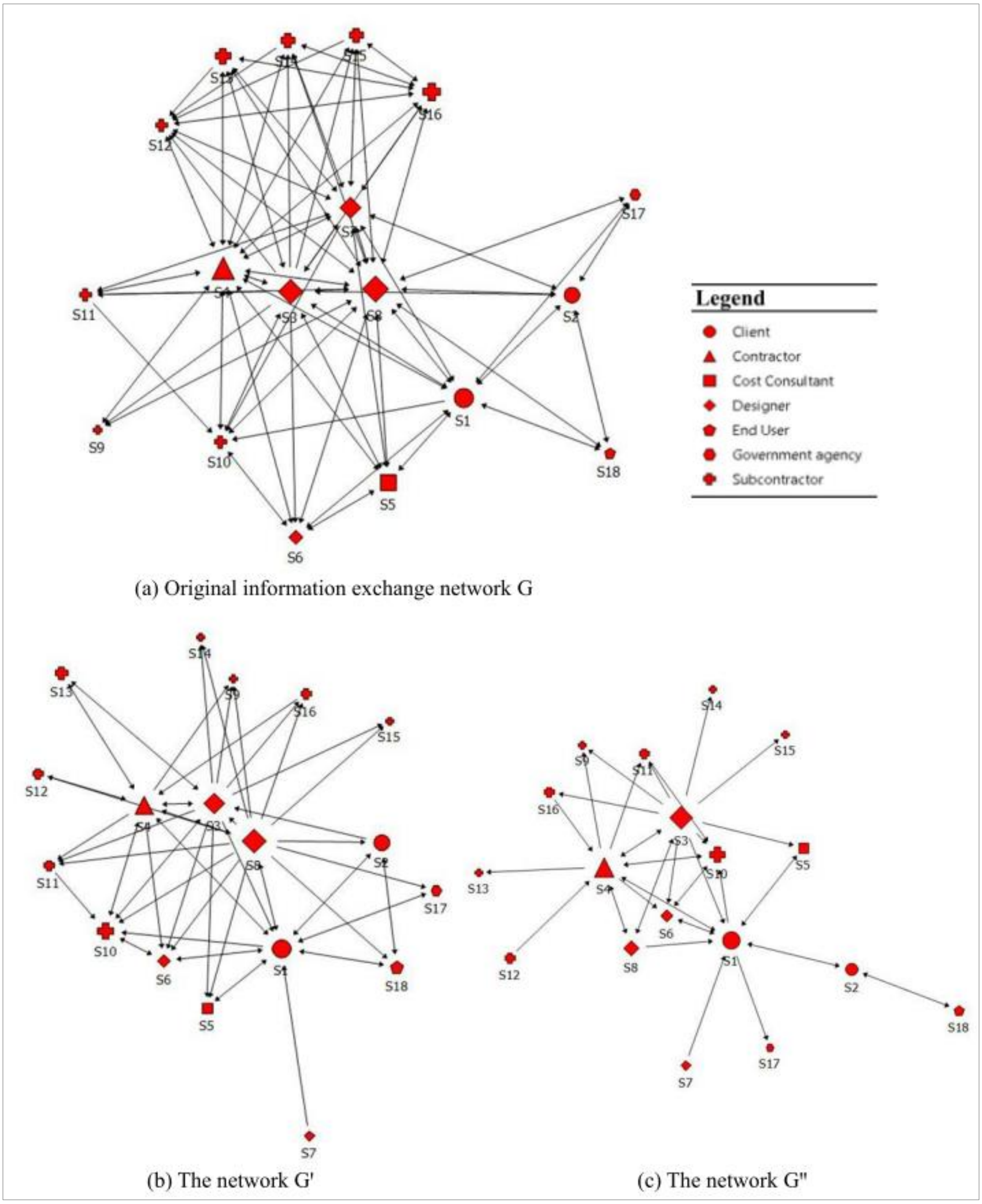
5.2.3 Results of network analysis and discussion

This section discusses the SNA results in three parts: (1) structure and properties of the stakeholder information exchange network based on visual observation and descriptive analysis; (2) stakeholder roles and priorities based on node measure results; and (3) issue prioritisation based on their weighted importance.

Stakeholder information exchange network

Sociograms of the stakeholder network, in terms of information exchange frequency, are shown in Figure 5.1. Nodes denote the stakeholders, while lines represent the existence of interactions between stakeholders. Stakeholders with more interactions occupy a more central position, while those with fewer ties are located more peripheral. The network is differentiated into three sociograms based on relationship attributes. Figure 5.1(a) shows the original network G(18, 129), comprising 18 stakeholders linked by 129 interactions. Removing poor/fair quality links (i.e. those scoring '≤3' in the attribute 'information quality') yields the network G'(18, 61), as shown in Figure 5.1(b). Further eliminating links of poor/fair information access timeliness (i.e. those scoring '≤3' in the attribute 'timeliness') from Figure 5.1(b) forms the network G''(18, 41), as seen in Figure 5.1(c). G'' shows the interaction pattern when information of good quality is transmitted in a timely manner. Observing variations of the three sociograms in terms of network structure and central nodes yields interesting findings. First, stakeholders are more interconnected in G than in G''. The original network has a high connectedness since stakeholders in all node pairs can mutually reach each other. In contrast, G'' has more one-way interactions and cut points. Cut points refer to nodes who connect the otherwise isolated actors through weak ties. This observation indicates that the relational structure of stakeholders is vulnerable to disruption when timeliness and quality are taken into consideration. Although weak ties are not favourable for transmitting complex information, they should be protected from attacks to maintain stakeholder communication. Second, S3 (lead design consultant), S4 (main contractor), S7 (MEP design engineer) and S8 (theatre design consultant) occupy central positions in G. However, S7 and S8 are peripheral in G'', reflecting a need for these two stakeholders to improve their quality and timeliness as they interact frequently with others.

Two network-level metrics, namely density and cohesion, are used to analyse the network structure quantitatively. Density measures the network connectivity, where the higher density represents the higher incidence of information exchange. Cohesion indicates the time taken for information to be diffused in the network. A lower cohesion favours information flow as it implies a quicker dissemination. The density and cohesion values of G, G' and G'' are (0.422, 1.578), (0.199, 2.066) and (0.134, 2.335) respectively. The sharp decrease of density implies that many interactions in the original network are rated poor/fair regarding information quality; indicating a need for stakeholders to improve the correctness, completeness and comprehensibility of information. Cohesions in all three structures are less than 2.5, which are considered acceptable (Cross and Parker, 2004).



(a) Original information exchange network G

(b) The network G'

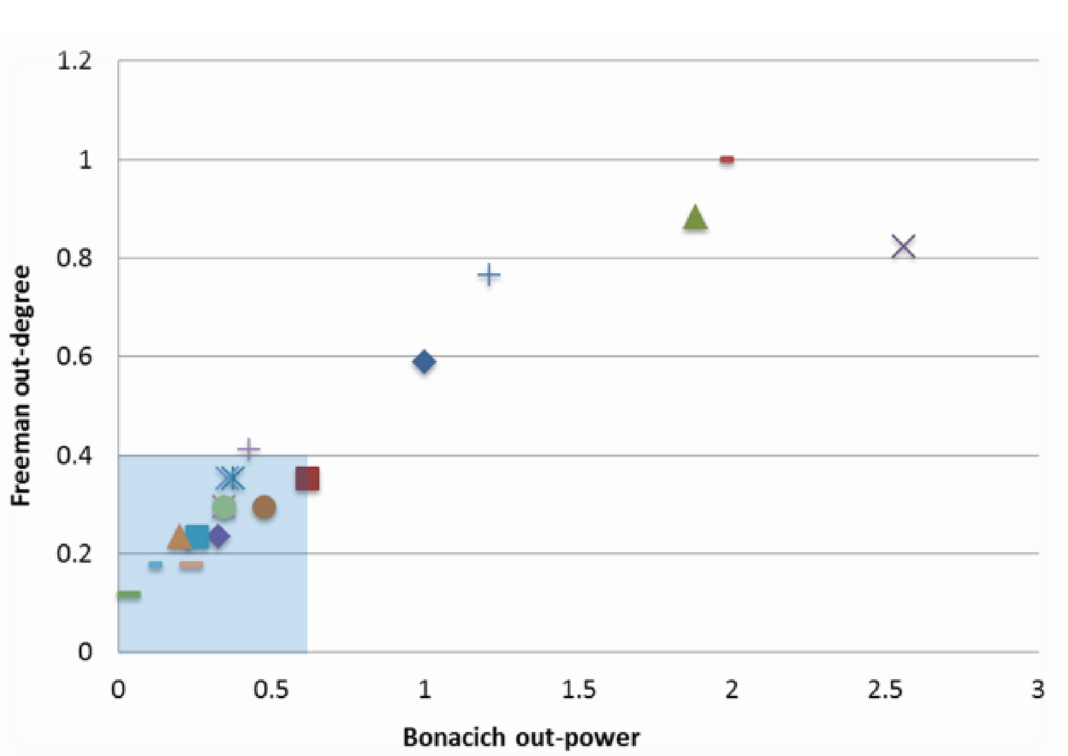
(c) The network G''

Figure 5.1: Stakeholder information exchange network(s) in the XC project

Stakeholder roles and priorities

Six node-level metrics, namely in-degree, out-degree, degree difference, power, betweenness, and closeness centrality, are used to analyse stakeholder roles in information exchange and assess their impacts. It should be noted that the calculation builds upon the original network G, as the researcher intends to decipher stakeholder relational structure based on their actual interaction patterns.

Figure 5.2 plots the out-power against out-degree centrality of stakeholders. Power and degree are two distinct centralities to measure an actor's power and influence respectively. Out-power indicates the extent that a stakeholder is being relied on by its connected others for information access. The higher the out-power, the more powerful a stakeholder is since its neighbours are not well connected and thus become dependent on the actor to obtain information. Out-degree measures the extent that a stakeholder provides information to its direct neighbours. The higher the out-degree, the more influential a stakeholder is because its information can quickly reach a large population. As Meese and McMahon (2012) highlighted, it is "subjective and fuzzy" to distinguish between central connectors and non-central connectors. Plotting out-power against out-degree helps to identify central connectors who are respectable and influential in the information network. As shown in Figure 5.2, all stakeholders are clustered in the blue shaded region except S1 (client project delivery division), S7, S3, S8 and S4. Accordingly, these five stakeholders are considered central connectors who are the direct information sources that many others have heavily relied upon.



	Out-Power Centrality	Out-Degree Centrality
S1	0.9971	0.5882
S2	0.6147	0.3529
S3	1.8840	0.8824
S4	2.5604	0.8235
S5	0.3745	0.3529
S6	0.4746	0.2941
S7	1.2109	0.7647
S8	1.9665	1.0000
S9	0.0335	0.1176
S10	0.3253	0.2353
S11	0.2540	0.2353
S12	0.2016	0.2353
S13	0.3546	0.3529
S14	0.3432	0.2941
S15	0.3432	0.2941
S16	0.4276	0.4118
S17	0.1031	0.1765
S18	0.2381	0.1765

Figure 5.2: Scatter plot of stakeholders in the XC project showing their Bonacich out-power against Freeman out-degree

Table 5.3 shows the top five information brokers and peripheral actors in the XC project based on betweenness and degree difference respectively. Betweenness centrality measures the extent that a stakeholder lies between two non-adjacent others in the network. Stakeholders with high betweenness are considered information brokers, as they control the information flow to others whom may otherwise be disintegrated from the network. They play a leader role in the network as well by urging their neighbours to devote more to solutions for tackling project challenges (Hossain, 2009a; Hossain, 2009b). As shown in Table 5.3, the top five information brokers are S8, S4, S7, S3 and S1 who are also central connectors in the case, indicating their criticality in project communication. As mentioned earlier, the proportion of ties with fair/poor quality and timeliness for S7 and S8 is quite high. The simultaneous roles of central connector and information broker for S7 and S8 raise urgent needs for them to improve their information quality and timeliness in information provision.

Degree difference and in-degree help to identify peripheral information-seeking actors who have more incoming than outgoing links. Table 5.3 shows that the top five peripheral actors are S12 (electrical subcontractor), S10 (fit-out subcontractor for metalwork), S9 (fit-out subcontractor for timber work), S6 (structural engineer) and S16 (ELV subcontractor). It is not surprising that majority of them are subcontractors; as they possess specialized skills/knowledge which are peripheral in nature, they are relatively less perceived by others as useful information or knowledge sources. Another reason of being peripheral is that these stakeholders may not be eager to share what they know (Solis et al., 2013). Regardless of reasons, peripheral actors signify the underutilized resources, implying high potential to explore new information from them.

Table 5.3: The top five information brokers and peripheral actors in the XC project

Rank	(a) Information broker		(b) Peripheral actors			
	Stakeholder	Betweenness centrality	Stakeholder	In-degree centrality	Out-degree centrality	Degree difference
1	S8	0.3107	S12	0.4706	0.2353	0.2353
2	S4	0.1297	S10	0.4118	0.2353	0.1765
3	S7	0.0793	S9	0.1765	0.1176	0.0589
4	S3	0.0532	S6	0.3529	0.2941	0.0588
			S16	0.4706	0.4118	0.0588
5	S1	0.0485	--	--	--	--

Note: Degree difference is calculated by "Degree difference$_{Sa}$ = In-degree$_{Sa}$ - Out-degree$_{Sa}$" to identify peripheral stakeholders in the XC project. These stakeholders act as information receiver more often than information provider.

Table 5.4 shows the priorities of stakeholders and their influence level in the project based on their centrality index. Centrality index is the average of degree, betweenness and closeness of a stakeholder (Dogan et al., 2013). While degree and betweenness were explained earlier, closeness centrality measures the extent that an entire network is proximate to a stakeholder. The higher the closeness value, the closer a network is to the stakeholder. As Table 5.4 displayed, the top five stakeholders according to centrality index are again S8, S3, S4, S7 and S1; stressing their critical roles in the information network. S8 is ranked the first, with the highest degree, betweenness and closeness scores. This result can be attributed to the responsibilities and expertise of S8. Since the XC project is the first-ever purpose-built arts venue for Chinese opera with world standard in Hong Kong, S8 (as a theatre planning and design specialist engaged early in the project) possess more specialized knowledge than other key stakeholders; leading to its higher control and influence on information flow than S1, S3, S4 and S7. The centrality index result shows that these five stakeholders control and contribute to the majority of information transmissions in the project. In addition, these five stakeholders are also the most economic information sources since they have the shortest communication paths to other stakeholders, therefore information can be obtained from them easily and economically (Dogan et al., 2013; Wasserman and Faust, 1994). Based on the centrality index result, the influence levels of stakeholders in the project are calculated using

Eq. (1) introduced in Chapter 4 (please see Section 4.4.5). The obtained results, as shown in Table 5.4, are used in the next part to calculate the weighted importance of the identified stakeholder issues.

Table 5.4: Priorities and influence levels of stakeholders in the XC project according to their centrality index

Priority	Stakeholder	Degree centrality	Betweenness centrality	Closeness centrality	Centrality index	Influence level in the project
1	**S8**	**1.0000**	**0.3107**	**1.0000**	**0.7702**	**0.1053**
2	**S3**	**0.8824**	**0.0532**	**0.8947**	**0.6101**	**0.0994**
3	**S4**	**0.8235**	**0.1297**	**0.8500**	**0.6011**	**0.0936**
4	**S7**	**0.7647**	**0.0793**	**0.8095**	**0.5512**	**0.0877**
5	**S1**	**0.5882**	**0.0485**	**0.7083**	**0.4484**	**0.0819**
6	S16	0.4118	0.0079	0.6296	0.3498	0.0760
7	S2	0.3529	0.0123	0.6071	0.3241	0.0702
8	S5	0.3529	0.0023	0.6071	0.3208	0.0643
9	S13	0.3529	0.0009	0.6071	0.3203	0.0585
10	S6	0.2941	0.0025	0.5862	0.2943	0.0526
11	S14	0.2941	0.0000	0.5862	0.2934	0.0439
--	S15	0.2941	0.0000	0.5862	0.2934	0.0439
13	S10	0.2353	0.0035	0.5667	0.2685	0.0351
14	S11	0.2353	0.0000	0.5667	0.2673	0.0263
--	S12	0.2353	0.0000	0.5667	0.2673	0.0263
16	S17	0.1765	0.0000	0.5484	0.2416	0.0146
--	S18	0.1765	0.0000	0.5484	0.2416	0.0146
18	S9	0.1176	0.0000	0.5313	0.2163	0.0058

Stakeholder issue priorities

Table 5.5 shows the top ten stakeholder issues, among all the 54 issues, in the XC project according to their weighted importance. The importance of an issue is calculated based on stakeholders' rating on the issue weighted by the influence level of each stakeholder, using Eq. (2) introduced in Chapter 4 (please see Section 4.4.5). These ten issues worth particular attention from the project team because they are perceived as the most important and being most frequently communicated by stakeholders in the project. Among these top ten issues, the issues which yield interesting insights for major cultural building projects are further discussed below.

I26 ("Previous experience of the project team in undertaking similar construction projects"), which has the importance value of 4.5556, was ranked the third in Table 5.5. According to the stakeholders, the core project team has insufficient experience in executing projects of similar nature and scale. There are rare examples of purpose-built performance arts venues for Chinese opera in both Hong Kong and overseas. In addition, the project team cannot simply take reference from the existing typical opera houses worldwide because the art forms of Western and Chinese opera are substantially different. It is also difficult to engage contractors and designers with such experiences. All these factors have added difficulties to the stakeholders in the project planning, design and construction.

I38 ("Project design accurately reflecting the requirements of client and end users") and I20 (Establishing trust, common understanding and mutual goals between the project team and end users") are ranked the fourth and the tenth in Table 5.5. In the XC project, performing arts organisations (including the opera performers, resident operators and technicians) are the major end users. Developing an accurate end users' requirements and creating a common understanding between the project team and end users are important yet challenging tasks in the XC project. The stakeholders suggested two main reasons. First, the opera performers lacked sophisticated thoughts about their specific needs and requirements for the facilities. For example, neither do they realize the concept of acoustic design, nor do they recognize what settings are considered optimal for large-scale Chinese opera theatres. This might be ascribed to the history and art forms of Chinese opera. Unlike the Western ones, early forms of Chinese opera greatly emphasise singing and costumes, they have simple stage setting and accompaniment, and do not have orchestra. Despite the evolution of Chinese opera during these centuries (e.g. being publicly staged in Chinese opera theatres and incorporating more different kinds of instrumental accompaniment), many performers still have vague ideas when it comes to ‘what they actually need in this modern purpose-built arts venue’. Secondly, the resident operator has not yet been identified at the design stage, i.e. the actual main end user and its requirements are unknown. It adds extra difficulties to the design team in creating the right end users’ requirements since there are numerous forms of Chinese opera (e.g. Kunqu, Beijing opera) – each having unique concerns on backstage facilities and venue setting. Although S2 engaged local organisations from various genres of Chinese opera and attempted to establish a common ground among all end users, some stakeholders opined that, it is challenging to consolidate the diverse needs of different art forms; as well as to decide a single voice as their representative. These reasons have added great difficulties to the project team in understanding the right end users’ requirements and accurately reflecting them into the project design.

I22 (“Effective decision making and maturity of the core leadership team”) was ranked the sixth in Table 5.5. A successful MCP, from initiation to operation, requires the core leadership team to effectively exercise its decision making power. According to

Woronkowicz et al. (2014), many major cultural building projects adopt an approach of ‘cross-sector collaboration within a single organisation’ for core leadership team make up and project governance. In the XC project, the focal organisation is a new enterprise particularly established to deliver the subject development – its core leadership is formed by assembling experts from various sectors into a team, with an intent that their cross-sectoral collaboration can effectively oversee different aspects of the project and strive towards successful project delivery. This mechanism has been described in previous studies, where Kania and Kramer (2011) named it *collective impact* and defined it as “the commitment of a group of important actors from different sectors to a common agenda for solving a specific social problem”. However, a potential drawback of this mechanism is that, conflicting views and disconnection might easily arise among the leadership board members due to their discrete backgrounds and expertise. It is therefore vital to have a ‘charisma’ or ‘central figure’ in the core leadership to consolidate the diverse views of board members, and to make final judgment when necessary. Without an actual leading head, the project leadership group can hardly exercise its decision-making power in an effective way, and steer the project towards a successful end.

I34 (“Alignment between design uniqueness, aesthetics, budget, end users’ requirements and the actual project programme”) was ranked the ninth in Table 5.5. Many vast-scale cultural facilities are constructed in aesthetic and unique appearances. Striking an appropriate balance between design uniqueness, aesthetics, functionality and project resources (e.g. cost and time) is vital to successful project development. If misalignment occurs, it can have substantial practical implications on other key issues such as I9 (“ensuring the project to be completed within budget”), I19 (“processes and policies of getting statutory approvals and permits to carry out construction works”), and I52 (“value engineering solutions and the associated design changes arising in the construction stage”). As stated by Woronkowicz et al. (2012), the client’s initiatives behind large cultural facilities are often more than simply meeting the community’s demand for having permanent sites to accommodate cultural aspirations. Many cultural building projects are commissioned to serve as the emblems of civilization for how a city exhibits itself on the national and international stages; besides, being packaged as new landmarks to revive the sluggish local community and attract more visitors. As such, the client and funders often have a strong desire towards remarkable and aesthetic architectural design. Sometimes, the client selects project design by means of design competition. In order to win, contestants often put greater emphases on design uniqueness and aesthetics than on practicality and buildability; resulting in designs that are creative but hard to be implemented. If the core leadership is over-optimistic in its design selection and project planning, mismatch between the budget, time, functionality and aesthetics will easily occur at the project outset; and this discrepancy is often not realised until the construction stage. Consequently, to maintain cost effectiveness and the value for money, many value engineering solutions and associated change orders will arise after the construction starts, e.g. cutting off some planned components which are found to be too costly or impractical to build. Finally, these will result in extra cost and time to accommodate design changes in construction, with the building’s aesthetics being compromised somehow. For successful project development, the project team should ensure the design is functionality-driven, fully reflect the design uniqueness in the cost plan and programme at the outset, as well as staying alert to the likely cost impacts of variation orders.

Table 5.5: The top ten stakeholder issues in the XC project according to their weighted importance values

Priority	Issue code	Issue	Weighted issue importance
1	I9	Ensuring the project to be completed within budget	4.6433
2	I19	Processes and policies of getting statutory approvals and permits to carry out construction works	4.6345
--	I40	Quality/performance of workmanship, materials and plants meeting the required standards	4.6345
3	I26	Previous experience of the project team in undertaking similar construction projects	4.5556
--	I43	Construction safety performance	4.5556
4	I38	Project design accurately reflecting the requirements of client and end users	4.5439
5	I52	Value engineering solutions and the associated design changes arising in the construction stage	4.5088
--	I7	Adequacy and stability of project finance	4.5088
6	I22	Effective decision making and maturity of the core leadership team	4.5058
7	I36	Performance and attitudes of contractors and consultants	4.5029
8	I25	Establishing trust, common understanding and mutual goals between client, contractors and consultants	4.4444
--	I35	Clear specification, drawings and work instructions	4.4444
9	I34	Alignment between design uniqueness, aesthetics, budget, end users' requirements and the actual project programme	4.4415
10	I20	Building common language, effective communication and mutual understanding between the project team and end users	4.4298

5.2.4 Validation of the case study results

The case study findings (including the network analysis and issue prioritisation results) were disseminated to the core project team. Through semi-structured interviews, the project team was asked to provide feedbacks on the results and the proposed social network approach. To be more specific, the project team was asked to give opinions on the questions below.

1. Regarding the SNA and issue prioritisation results:

(a) Do you agree with the analysis results?

(b) Are the results (e.g. stakeholder network maps, stakeholder priorities and issue priorities) easy to follow and understand?

2. Regarding the proposed social network approach:

(a) Can the information exchange interactions of stakeholders be appropriately defined and analysed by the proposed approach?

(b) Can the importance of stakeholders and their issues be appropriately assessed by the proposed approach?

(c) What are your comments or suggestions to improve the proposed approach?

Basically, the core project team agreed with the SNA and issue prioritisation results; they opined that the network maps and analysis results were easy to follow and understand. In addition, the project team considered that the proposed social network approach is useful in analysing the information exchange interactions of stakeholders, as well as their roles in these relational structures in the project. However, the project team suggested a potential limitation of the approach – overlooking the sources/origins of stakeholder issues in issue identification and prioritisation. The details of this suggestion are described in Section 5.4.

5.3 Case Study II – the SP project

5.3.1 Description of the SP project

The SP project is a HK$2 billion large-scale green building development, which spans 6 hectares of land with a construction floor area of 105,000 m2, in Hong Kong. The project scope comprises three 8 to 9-storey Research and Development Office and Laboratory buildings and a transport terminus. The development uses a 'back-to-basic' design approach to shun overprovision of redundant building services; and follows a design principle of 'reduction, efficiency, and generation' to meet the various targets in energy conservation, water saving, waste reduction, use of sustainable materials, and outdoor planting.

The SP project is selected for case study as it comprises a wide range of stakeholders who possess disparate interests and complicated interactions, presenting challenges to the project and its stakeholder management. This project is considered a MCP according to the definition on MCPs previously described in Chapter 2. The unique nature and high complexities of the SP project necessitate a social network approach for stakeholder analysis and issue prioritisation. For example, as a role model to promote sustainable building practice in the local industry, the SP project adopts many green technologies. The building envelope is energy efficient with the use of high performance glazing, insulated façades, shading panels and green roofs. The air-conditioning system is efficient with the use of district cooling system chilled water supply, total heat recovery wheel and thermal storage tanks. Rainwater is harvested and recycled for irrigation. Other green features include dynamic solar tracking louvres, photovoltaic panels and solar tubes. The SP project is semi-public – the client, who implements the development, operates and manages the buildings, is a statutory body. The constructed area is to be leased to technology-based enterprises whose core businesses focus on telecommunications, green technology, electronics, or biotechnology; yet the exact tenants are unknown during the project planning, design and construction. One building within the development has been granted the LEED (Leadership in Energy and Environmental Design) platinum rating, and all three buildings have won local green building awards and green platinum ratings. Document review was conducted to grasp the background of the SP project. Documents reviewed include: project profile and sustainability reports by the client; project brief by designers and consultants; discussion papers by the legislative council; articles by professional institutions and green-building-related non-profit organisations regarding sustainability features of the project. Information on the project background, stakeholders, their issues and information flows were gathered and synthesized.

Similar to Case Study I, the researcher should specify a time span of the Case Study II since stakeholder interactions and issues change over time. The SP project was in its late construction stage at the time the researcher entered the case, therefore this case study only captured a screenshot of the stakeholder network in the construction stage.

5.3.2 Development of the stakeholder information exchange network

Similar to the previous case study, chain referral sampling was applied in Case Study II to identify stakeholders of the SP project (i.e. the nodes). Thirteen stakeholders were identified and Table 5.6 summarises their profiles. All stakeholders were interviewed to define and understand their issues in the project. The interviews, which lasted 1-2 hours, were transcribed with manuscripts sent back to stakeholders for feedbacks. Accordingly, 43 stakeholder issues were identified, as shown in Table 5.7. This issue list was included as part of a questionnaire survey instrument (which was used for subsequent link determination and issue rating). After stakeholder and issue identification, a questionnaire survey (Appendix A) was conducted with all stakeholders who have also participated in the interviews. This survey required stakeholders to firstly identify and assess their information exchange interactions in terms of ‘frequency’, ‘timeliness’ and ‘information quality’ using a five-point scale (Chapter 4 explained these relationship attributes and numerical scale); then to rate their perceptions on the importance of the 43 issues. To ensure data representativeness, all interviewed and surveyed stakeholder representatives (except S13) were at or above senior management level, possessed ≥10 years work experience in their professions, and were directly involved in the development with in-depth knowledge on stakeholder issues throughout the project. The researcher undertook a sanity check of the relational data to spot and clarify data mismatches. Eventually, 99 information exchange relationships (i.e. the links) were identified between the 13 stakeholders. The information exchange frequency provides the basis for creating an adjacency matrix, which represents the stakeholder information exchange network N(13,99) of the SP project.

Table 5.6: Stakeholders identified in the SP project

Stakeholder		Description
S1	Client project development team	A team in the client company who runs the case project, sets the project objectives and develops the Client's Brief.
S2	Client commercial team	A team in the client company for business development, leasing and tenancy. In the project, S2 represents future tenants. S2 consolidates ideas from potential end users on their requirements and needs, and convey the end user's requirements to S1 for incorporation into Client's Brief.
S3	Executive project manager	A consultancy and construction company appointed by the client to act as project manager/administrator in the case project. On behalf of the client, S3 oversees the cost, programme, project administration, and performance of contractors and consultants.
S4	Lead design consultant	An architectural firm hired by the client to provide lead design consultancy services.
S5	Main contractor	A contractor company hired by the client to construct the building development.
S6	Structural engineer	A consultancy company to provide structural, civil and geotechnical consultancy services.
S7	MEP design engineer	A consultancy company to provide building services design and engineering solutions.
S8	Quantity surveying consultant	A consultancy company to provide cost management services and contractual advices.
S9	Sustainability specialist	A consultancy company to provide sustainable building design and consultancy services on green building certification (e.g. LEED, BEAM Plus).
S10	Landscape designer	A consultancy company for landscape design and advisory services.
S11	Subcontractor and supplier	Subcontractor and supplier companies including curtain wall, specialized architectural product supply, raised floor system, etc.
S12	Local government for innovation and technology	A government agency to support innovation, technology, applied research and development. Apart from the client, S12 also monitors the overall project development and management.
S13	District councils	Government bodies on district administration and affairs. The client regularly updates S13 about the project progress and potential implications to local communities.

Table 5.7: Issues identified in the SP project

Issue code	Issue description	Issue category
I1	Communication and engagement with the public and local community	Community/Social
I2	Disruption to the neighbourhood and local community (e.g. changes to traffic conditions)	Community/Social
I3	Enhancing the image of local community and society	Community/Social
I4	Prevention and mitigation measures against disruption to the neighbourhood	Community/Social
I5	Provision of public amenities and open space	Community/Social
I6	Safety of the neighbourhood and the site users	Community/Social
I7	Adequacy and stability of project finance	Cost
I8	Inflation of construction price including labour, material and plant costs	Cost
I9	Project cost control	Cost
I10	Increased job opportunities to the construction industry	Economic
I11	Indirect economic benefits brought by associated economic activities (e.g. more pedestrian flow)	Economic
I12	Pollution brought by construction works to the neighbourhood (e.g. air, noise, odour)	Environment
I13	Achieving sustainability goals set in the project objectives	Environment
I14	Visual impacts to the neighbourhood	Environment
I15	Company image and reputation	Ethical/Reputation
I16	Information disclose to the media, general public and NGOs	Ethical/Reputation
I17	Approval process, statutory requirements and policies on green building design and implementation	Legal
I18	Creating common language and understanding between project team and end users in developing the end user's requirement	Organisational
I19	Mechanisms and procedures to manage changes in construction stage	Organisational
I20	Building common understanding and mutual goals between stakeholders when developing and implementing sustainable building design	Organisational
I21	Previous experience of contractors and consultants in undertaking similar projects	Organisational
I22	Stability of project governance structure	Organisational
I23	Clear and sufficient government policies to support project implementation	Political
I24	Coordination and communication with government departments	Political
I25	Public controversies on project quality and performance	Political

I26	Availability and allocation of labour, materials and plants	Procurement/contractual
I27	Contractual disputes and claims	Procurement/contractual
I28	Contract strategy and administration	Procurement/contractual
I29	Practicality and value for money of some green building design features	Quality
I30	Attitudes of contractors and consultants when designing and working on some green building features	Quality
I31	Performance of works affecting future business opportunities	Quality
I32	Allowing design flexibility to cater the requirements of client and end users	Quality
I33	Quality of workmanship, materials and plants meeting the required standards	Quality
I34	Balancing the different expectations of stakeholders on project quality and performance	Quality
I35	Sustainability and reliability of the development after project completion (e.g. maintenance complexity)	Quality
I36	Implementation of safety measures and the performance of safety when working on some green building design features on site	Safety
I37	Adaptability of technological processes and systems to changes	Technological
I38	Adopting innovative and leading-edge construction technology	Technological
I39	Adopting and showcasing the latest green technologies and sustainability features to promote green building developments	Technological
I40	Site logistic and storage management	Technological
I41	Technological complexity	Technological
I42	Sequencing and progress of construction works	Time
I43	Tight project programme	Time

5.3.3 Results of network analysis and discussion

Similar to the previous case study, this section discusses the SNA results of Case Study II in three parts: (1) structure and properties of the stakeholder information exchange network based on visual observation and descriptive analysis; (2) stakeholder roles and priorities based on node-level results; and (3) issue prioritisation based on their weighted importance.

Stakeholder information exchange network

Figure 5.3(a) shows the original network N(13, 99) which was built based on information exchange frequency. Figure 5.3(b) and 5.3(c) shows N'(13, 47) and N''(13, 29) respectively, they are variations of the original network N when taking into account two relationship attributes: 'information quality' and 'timeliness'. Cutting off interactions of fair and poor information quality (i.e. scoring '≤3' in this attribute) obtains N', while further excluding interactions of fair and poor information access timeliness (i.e. scoring '≤3' in this attribute) from N' produces N''. Visual observation of the three networks renders initial understandings. The more links a stakeholder has, the more central place it occupies. In the original network N, S4 (lead design consultant), S1 (client project development team), S3 (executive project manager) and S5 (main contractor) are located centrally. However, in N'', S5 is located at the network boundary with only incoming links. It indicates an urgent need for the main contractor, who interacts closely with many stakeholders and plays an important role in implementing sustainability design, to improve its information quality and timeliness in information provision. In addition, in N'', S4 moves to the periphery and S11 (subcontractor and supplier) becomes isolated; implying a problem that they cannot enjoy timely access to correct, complete or comprehensible information when they need.

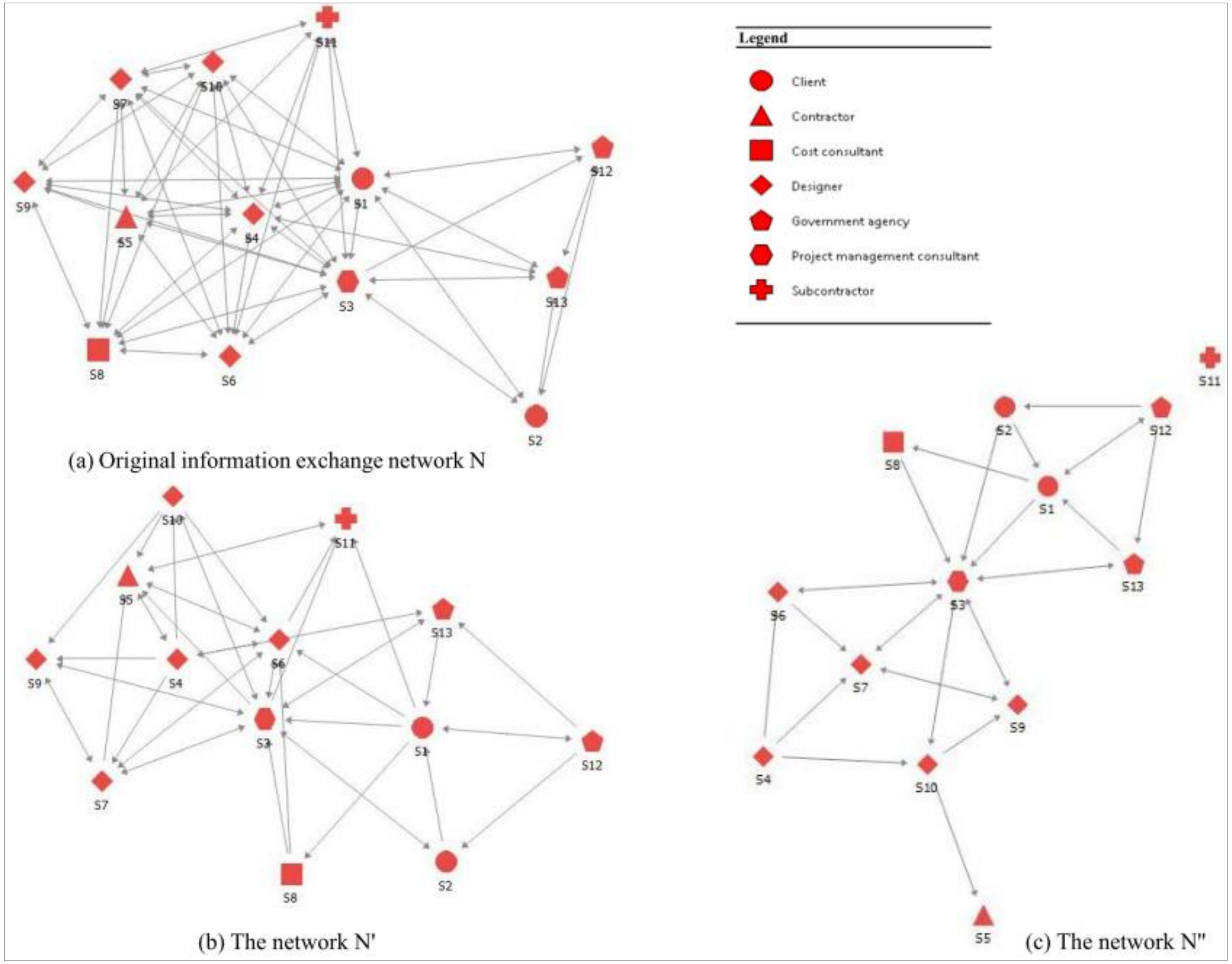


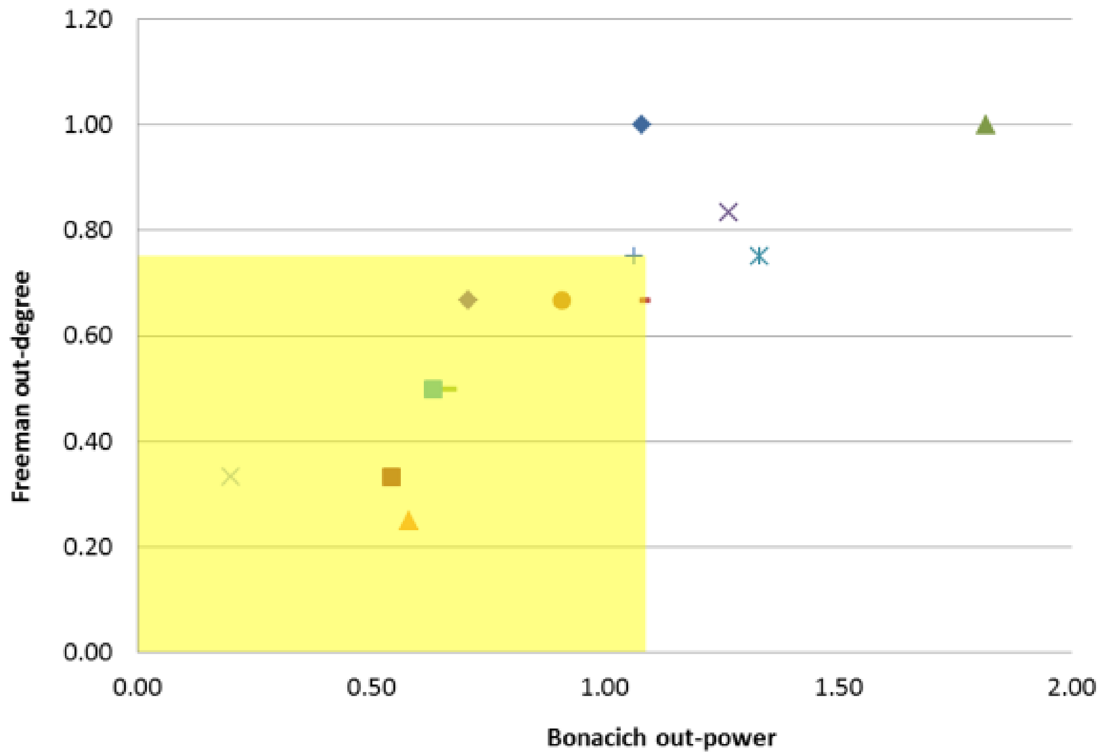
Figure 5.3: Stakeholder information exchange network(s) in the SP project

Quantitative analysis of the overall network structure requires the calculation of two network-level metrics: density and cohesion. The network density and cohesion of N, N' and N" are (0.635,1.365), (0.301, 2.064) and (0.186, 2.171) respectively. Comparing N and N", the density value has dropped by 70.71%; indicating that many information flows in the project are perceived unsatisfactory in terms of information quality and timeliness of access. There is a need to improve this situation for more effective stakeholder communications. A shorter diffusion time favours information flows and a cohesion value of ≤2 is preferable (Cross and Parker, 2004). The cohesion results show that good-quality information requires a longer time to be synthesized and disseminated between stakeholders, but still the cohesion of N" (2.171) can be regarded acceptable. The analysis of stakeholder roles, priorities and issues in the following sections are based on the original network N because the researcher intended to examine stakeholders' actual interactions in the SP project.

Stakeholder roles and priorities

Similar to the previous case study, six node-level metrics, namely in-degree, out-degree, degree difference, power, betweenness, and closeness centrality, are used in Case Study II to examine stakeholder roles in information exchange and assess their influences.

Out-degree measures how active a stakeholder is by directly sending information to others, and out-power indicates how much a stakeholder is counted on by others as information source. Figure 5.4 clearly demarcates all stakeholders into central and non-central connectors by plotting out-power against out-degree. In Figure 5.4, all stakeholders cluster in the yellow shaded region other than S1, S3, S4 and S5. These four stakeholders are central connectors in the network. As indicated by their high out-degree and out-power values, S1, S3, S4 and S5 are powerful and influential stakeholders since: (1) a majority of information are contributed and released by them, and (2) their neighbours are unlikely to find other substitute information sources as they are not well connected themselves.



	Out-Power Centrality	Out-Degree Centrality
S1	1.0812	1.0000
S2	0.5438	0.3333
S3	1.8184	1.0000
S4	1.2657	0.8333
S5	1.3333	0.7500
S6	0.9096	0.6667
S7	1.0642	0.7500
S8	1.0790	0.6667
S9	0.6648	0.5000
S10	0.7093	0.6667
S11	0.6346	0.5000
S12	0.5807	0.2500
S13	0.2003	0.3333

Figure 5.4: Scatter plot of stakeholders in the SP project showing their Bonacich out-power against Freeman out-degree

Betweenness centrality measures how capable a stakeholder is in controlling information flows between two non-adjacent stakeholders. Table 5.8 shows the betweenness values of all stakeholders in descending order. S1, S3 and S4, who ranked at the top three, are information brokers. In the network, they take the roles as: (1) controller, who can easily facilitate or interrupt the interactions between two non-adjacent stakeholders; and (2) leader, who can effectively urge others in dedicating more to project problem solving. It is not surprising that, the executive project manager S3 has the second highest betweenness, and scores higher than the main contractor and design consultants (e.g. S4, S5, S6 and S7) who have direct and substantial inputs in designing/constructing sustainability features in the SP project. As appointed by the client, S3 is the project administrator to oversee various aspects such as cost, programme, contractors' and consultants' performance, on behalf of the client. The project responsibilities of S3 as assigned by the client in the contract justifies its high score in the betweenness result.

Table 5.8: Betweenness centrality scores of stakeholders in the SP project

Stakeholder	Betweenness centrality
S1	**0.1977**
S3	**0.1383**
S4	**0.0474**
S7	0.0121
S13	0.0114
S5	0.0076
S6	0.0051
S8	0.0036
S10	0.0036
S2	0.0025
S12	0.0025
S9	0.0000
S11	0.0000

Figure 5.5 plots the in-degree against degree difference to identify peripheral stakeholders in the SP project. Stakeholders with high degree difference are considered less influential since they seek information far more than contributing information. According to Figure 5.5, S9 (sustainability specialist), S12 (local government for innovation and technology) and S13 (district council) are the three peripheral actors in the network. The high degree differences of S12 and S13 indicate their advisory role and passive involvement in the project – they are regularly updated by the project team for work progress and potential implications, but have limited direct inputs in the design and construction. It is surprising that the sustainability specialist S9 is peripheral. This may be attributed to two reasons: (1) the specialised knowledge/ideas of S9 on innovative sustainability design was somehow deemed impractical or inessential, so they were overlooked and underutilised; and (2) S9 was not sufficiently engaged in stakeholder communications and information sharing.

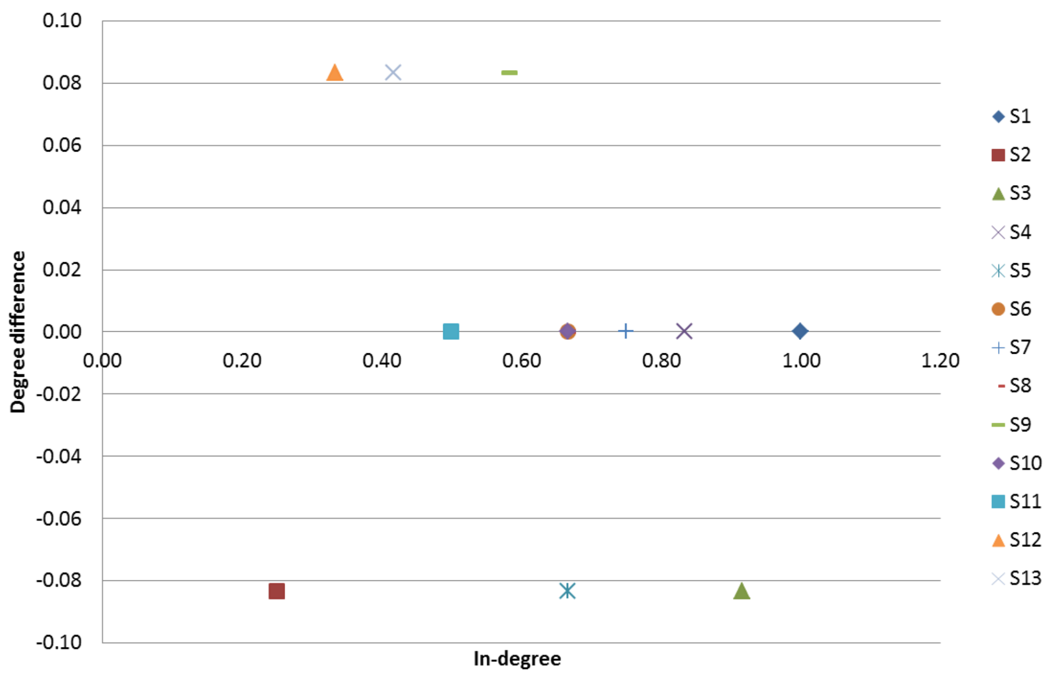


Figure 5.5: Scatter plot of stakeholders showing their in-degree against degree difference

Table 5.9 presents the influence levels of stakeholders, as calculated using Eq. (1) introduced in Chapter 4 (please see Section 4.4.5). The influence levels of stakeholders are computed based on their centrality indices, which are the averages of their degree, betweenness and closeness scores (Dogan et al., 2013). This calculation takes into account the direct impact, controlling power and proximity to the whole network of a stakeholder when assessing its influence level. As shown in Table 5.9, the top three stakeholders are S1, S3 and S4. In addition, the client's project development team S1 and the executive project manager S3 have the maximum score of 1 in both degree and closeness centralities, re-emphasising their critical roles in the information exchange network. The results of stakeholder influence levels in Table 5.9 are used in the next section to evaluate the weighted importance of the 43 identified stakeholder issues.

Table 5.9: Priorities and influence levels of stakeholders in the SP project according to their centrality index

Priority	Stakeholder	Degree centrality	Betweenness centrality	Closeness centrality	Centrality index	Influence level in the project
1	**S1**	1.0000	0.1977	1.0000	**0.7326**	**0.1429**
2	**S3**	1.0000	0.1383	1.0000	**0.7128**	**0.1319**
3	**S4**	0.8333	0.0474	0.8571	**0.5793**	**0.1209**
4	**S7**	0.7500	0.0121	0.8000	**0.5207**	**0.1099**
5	S5	0.7500	0.0076	0.8000	0.5192	0.0989
6	S6	0.6667	0.0051	0.7500	0.4739	0.0879
7	S8	0.6667	0.0036	0.7500	0.4734	0.0714
--	S10	0.6667	0.0036	0.7500	0.4734	0.0714
9	S9	0.5000	0.0000	0.6667	0.3889	0.0495
--	S11	0.5000	0.0000	0.6667	0.3889	0.0495
11	S13	0.3333	0.0114	0.6000	0.3149	0.0330
12	S2	0.3333	0.0025	0.6000	0.3119	0.0220
13	S12	0.2500	0.0025	0.5714	0.2746	0.0110

Stakeholder issue priorities

Table 5.10 lists the top ten stakeholder issues, among all the 43 issues, in the SP project based on their weighted importance. The importance of an issue is calculated using Eq. (2) introduced in Chapter 4, by considering stakeholders' ratings on the issue weighted by each stakeholder's influence level in the project. The project team should be cautious in addressing these issues which are regarded as the most critical among all stakeholders' objectives.

I17 ("Approval process, statutory requirements and policies on green building design and implementation"), which has the highest importance of 4.7363, is identified as the most critical issue in the project. The government plays a significant role on policies and standards, yet the stakeholders encountered great challenges in obtaining statutory approvals for green design and drawing submissions in the project. As opined by the stakeholders, standardised requirements and approval processes for large-scale lab-enabled Research and Development projects are not sufficiently available and comprehensive in Hong Kong. In addition, it lacks effective communication and coordination between various government departments who involve in statutory approvals. For example, officers of different departments have different interpretations to the same provision, they lack coordination and fail to reach consensus. It causes the project team extra time and efforts to address these inconsistencies and ambiguities in the design and statutory procedures.

I29 ("Practicality and value for money of some green building design features") is ranked the fifth in Table 5.10. Environmental sustainability is a prime objective of the project. As the stakeholders stated, they come up with two key questions in the sustainability design of this project: (1) what innovative and leading-edge green features to be adopted, and (2) what sustainability goals (e.g. green certifications and energy saving) to be targeted. In addition, the applicability and value for money of the green features are their main concerns in answering these questions. However, the stakeholders encountered great challenges to build common understanding and mutual goals in developing sustainability design (Table 5.10, I20). They suggested two main possible causes: (1) sustainability performance of some green technologies is hard to be quantified or predicted at the early project stage, yet they are the key considerations of the client and investors in exploring sustainability opportunities for the design; and (2) it lacks a direct and systematic stakeholder analysis approach to identify comprehensively the issues of all stakeholders, as well as to determine and reach consensus on priorities of these often conflicting issues.

I32 (“Allowing design flexibility to cater the requirements of client and end users”) is ranked the sixth in Table 5.10. Leaving design flexibility is an important but challenging task in the project, and unknown end user’s requirement is one of the main causes. In the design stage, the ratio of office to laboratory area is available; but future tenants are unknown, so as their actual needs and the exact locations of offices and laboratories within the building. Since offices and laboratories are substantially different regarding their architectural and structural requirements, the project team has allowed adequate design flexibility for future tenants to plan their space utilisation, such as minimizing services height, maximizing headroom for occupancy, and maximising floor loading for equipment.

I30 (“Attitudes of contractors and consultants when designing and working on some green building features”) and I39 (“Adopting and showcasing the latest green technologies and sustainability features to promote green building developments”) are ranked the eighth and the ninth respectively in Table 5.10. The stakeholders indicated that, a ‘can-do’ (instead of claim-conscious or contractual) attitude of contractors and consultants are crucial to achieving and promoting sustainability in large green building developments. It is particularly important when state-of-the-art technologies are to be adopted but the project team lacks previous experience in carrying out similar works.

I18 ("Creating common language and understanding between project team and end users in developing the end user's requirement") is also identified as critical. Since future tenants are unknown, the client commercial team S2 represents future tenants in the design development, and consolidates ideas from potential end users on their needs. According to the stakeholders, communication between project team and S2 is ineffective due to a lack of common language and understanding. For example, the project team requires S2 to reflect end user's requirements using exact figures in terms of civil parameters (e.g. the required pressure in kPa). However, S2 and end users lack the engineering background and are unable to express their real thoughts; leading to gaps between 'what the project team expects end users to answer', 'what the end users answer', and 'what the end users actually need'. Scenario-based discussion is a potential solution to the communication problem, e.g. the project team can provide end users with a few scenarios of possible laboratory settings for their discussions, comparison and selection. More technical advices provided by the project team during discussions (e.g. regarding the compliance to statutory provisions) may also help.

Table 5.10: The top ten stakeholder issues in the SP project according to their weighted importance values

Priority	Issue code	Issue	Weighted issue importance
1	I17	Approval process, statutory requirements and policies on green building design and implementation	4.7363
2	I36	Implementation of safety measures and the performance of safety when working on some green building design features on site	4.5714
3	I13	Achieving sustainability goals set in the project objectives	4.5385
4	I19	Mechanisms and procedures to manage changes in construction stage	4.4505
5	I29	Practicality and value for money of some green building design features	4.4341
6	I32	Allowing design flexibility to cater the requirements of client and end users	4.4121
7	I20	Building common understanding and mutual goals between stakeholders when developing and implementing sustainable building design	4.3681
8	I30	Attitudes of contractors and consultants when designing and working on some green building features	4.3462
9	I39	Adopting and showcasing the latest green technologies and sustainability features to promote green building developments	4.2418
10	I18	Creating common language and understanding between project team and end users in developing the end user's requirement	4.2308

5.3.4 Validation of the case study results

At the end of the case study, the findings (including the SNA and issue prioritisation results) were disseminated to the core project team. Interviews were conducted with the project team to collect their feedbacks on the results and the proposed social network approach. Similar to Case Study I, the core project team of the SP project was asked to provide their opinions on the two questions described in Section 5.2.4 (Q1(a-b) and Q2(a-c)). In general, the project team agreed with the network analysis and issue prioritisation results. They considered that the network figures and analysis results were easy to follow, and the proposed approach has effectively analysed stakeholder information exchange relationships in large and complex projects. Despite of the above, the project team suggested a potential limitation of the approach – a stakeholder issue can and should exert influence on another issue, but the proposed approach has overlooked the interdependencies between stakeholder issues when assessing the issue importance. The details of this suggestion are described in Section 5.4.

5.4 Lessons learnt from Case Study I and II

5.4.1 Comments on the approach for analysing stakeholders in MCPs

The core project teams in the two case studies confirmed that the proposed social network approach (introduced in Chapter 4 and demonstrated in Chapter 5) is useful in analysing stakeholders and their information exchange interactions in large and complex construction projects. They considered that the approach helped to identify stakeholders as complete as possible; has visualised and systematically examined stakeholder interactions; identified influential, mediating and peripheral stakeholders in these actual relationship situations; spotted opportunities to improve information exchange; and identified issues which worth particular attentions from the project teams. They commented that the proposed approach was a useful evaluation tool of stakeholder relationships and influences, and the analysis results could provide useful references for them to improve stakeholder engagement. Despite of the above, the two project teams suggested two limitations of the proposed approach in assessing issue importance. First, they considered that the approach has overlooked the origins of stakeholder issues in the issue identification process. They suggested that, in real situations, many issues in MCPs are sourced from or associated to different stakeholders because stakeholders often come from disparate backgrounds and possess diverse interests. Without identifying the right origins of issues, the project team might not be able to accurately evaluate issue importance and formulate proper measures for addressing the key issues. Secondly, they consider that the proposed approach has overlooked the interdependencies between stakeholder issues and their proliferating impacts on the project when assessing the issue importance. They suggested that, issues arising from a project are often interdependent. The existence of an issue can and should influence the occurrence and impact of another issue. Without taking the issue interactions into account, the importance levels of stakeholder issues might not be accurately evaluated. These comments are considered to further develop the social network model for MCP stakeholder analysis, and the details are described in Chapter 6 and 8.

5.4.2 Practical insights from Case Study I and II

The findings from Case Study I and II revealed some critical issues of the projects from stakeholder perspectives, and provided useful practical insights for practitioners who manage or take the lead in similar future MCPs.

Case Study I is related to major cultural building projects, it is a large performing arts centre purposely built for the production and education of Chinese Opera. According to the case study findings, achieving an alignment between design uniqueness, end users' requirements, aesthetics, budget and actual programme is crucial to successful project development. Large cultural building projects are often built in aesthetic and remarkable design, and therefore might be exposed to higher cost and schedule risks than typical construction projects. Inadequately acknowledging the design uniqueness and technology complexity in cost plan and programme would lead to project failures. Accurately reflecting the requirements of client and end users into the project design is also a critical issue. However, inadequate similar experience of the project team and lacking a common language between the project team and end users (e.g. opera performers) have added extra difficulties in achieving this. In addition, core leadership team makeup and charisma are also vital to the effective decision making, governance and administration of large cultural building projects.

Case Study II is related to green building projects, it is a large-scale development of Research and Development office and laboratory buildings. The case study findings show that fulfilling statutory requirements and obtaining relevant approvals for green building features are onerous processes in Hong Kong. The situation can be improved by the government providing more comprehensive green standards and enhancing the communications between the involved government departments. The practicality and value for money of green building features are also critical concerns of stakeholders in major green building projects. Building common understanding and mutual goals between stakeholders regarding what sustainability targets (e.g. green certifications, energy saving targets) to be achieved would help to increase stakeholder satisfaction towards the project outcomes. Besides, a ‘can-do’ attitude of the project team is essential, particularly when the project aims to adopt and showcase leading-edge green design and technologies.

Despite of the above practical insights, the researcher encountered several limitations in the case studies. First, notwithstanding the use of chain referral sampling in the network building process, it was practically and ethically infeasible to engage all stakeholders; some of them concerned the confidentiality and anonymity issues, and were disinclined to provide data. Secondly, the two case studies analysed only screen-shots of the stakeholder information exchange networks at a point in time during the construction phase. Due to time limitation, longitudinal network studies are not undertaken to explore the dynamics of stakeholder relationships throughout the whole project lifecycle. Thirdly, although the findings presented here offer practical insights on key issues in large cultural and green building projects, they are each derived from a single case and the context may therefore be limited.

5.5 Chapter summary

This chapter presents the validation of the social network approach for analysing stakeholders and their social interactions in MCPs (which has been proposed in Chapter 4). Two research methods are applied in this chapter, namely case study and interviews (for collecting feedbacks on the case study results and the proposed approach).

Two case studies from Hong Kong are presented in this chapter. The two cases are of different building types. Case Study I is related to major cultural building projects, it is a large performing arts centre purposely built for the production and education of Chinese Opera. Case Study II is related to green building projects, it is a large-scale development of Research and Development office and laboratory buildings. Both cases involve a wide range of stakeholders and show high project complexities, necessitating a relational approach for stakeholder analysis and issue prioritisation.

The two case studies have demonstrated the applicability of the proposed social network approach in analysing stakeholders and their relationships in MCPs. The detailed analytical variables and procedures of the stakeholder analysis process are clearly illustrated. At the end of the two case studies, the two project teams confirmed that the proposed approach is effective in analysing stakeholders and their information exchange interactions in MCPs. The analysis results are beneficial to the project teams by providing them insights to improve stakeholder engagement, and identifying key issues which worth their particular attentions. Finally, the project teams suggested two limitations of the proposed approach in assessing issue importance, namely: (1) overlooking the origins of stakeholder issues, and (2) overlooking issue interdependencies and their proliferating impacts on the project. These two comments are used to further develop the social network model for MCP analysis as described in Chapter 6 and 8.

Chapter 6 – A Social Network Approach for Analysing Stakeholder-related Issues in MCPs

6.1 Introduction

This chapter presents a social network approach for analysing stakeholder-related issues and their interdependencies in MCPs. As suggested by the findings of Chapter 5, there are two limitations in the analysis approach introduced in Chapter 4 (i.e. the social network approach for analysing stakeholders and their social interactions), namely '*overlooking the origins of stakeholder issues*' and '*overlooking issue interdependencies and their proliferating impacts on the project*'. The social network approach proposed in this chapter can tackle the aforementioned limitations. This approach involves the use of chain referral sampling, SNA, and a network visualisation and analysis software package (e.g. *NetMiner*). This approach enables the project management team to identify completely all project stakeholders and their associated issues, map the cause-and-effect relationships between stakeholder-related issues, examine their structural properties and propagating effects on project development, as well as to identify the critical stakeholders and issues which worth particular attention.

6.2 Need for a social network approach to analysing stakeholder-related issues

The lessons learnt of Chapter 5 reveals that, the analysis approach introduced in Chapter 4 has two limitations in 'overlooking the sources of stakeholder issues' and 'overlooking the stakeholder issue interdependencies and their propagating effects on the project development'. To tackle these limitations, a network perspective should be taken to accommodate two essential aspects of effective MCP stakeholder analysis. The first aspect is to *identify the sources or origins of stakeholder issues*. In reality, many issues in MCPs are sourced from or associated to different stakeholders owing to their diverse backgrounds, interests, and project expectations (Yang and Zou, 2014). To develop proper stakeholder management strategies, it is vital for the project team to recognise the right sources of stakeholder issues, that is, identifying stakeholder-related issues. The second aspect considers *the interdependencies between stakeholder-related issues* in a project system. Stakeholder issues springing from a MCP are bonded with strong and dynamic interdependencies. The presence of an issue can evoke or govern the existence as well as incidence of other directly or indirectly related issues in the same project environment (Fang et al., 2012). The interactions and chain effects between stakeholder issues increase uncertainties in stakeholder behaviours and project decision making, therefore posing great challenges to both stakeholder management and the delivery of MCPs. In fact, a MCP can be considered as a network of interrelated stakeholder issues. A network perspective to analyse stakeholder issues, their interdependencies and proliferating impacts on the project is essential; without which the stakeholder analysis process might compromise in completeness and accuracy, resulting in poor stakeholder satisfaction, uninformed project decision making and unsatisfactory MCP performance.

Notwithstanding that various practical stakeholder analysis methods have been developed in the past decades (Chapter 2 summarised those methods), a major drawback of the current methods is that they are insufficient in addressing the complexities brought by stakeholder-related issues, issue interdependencies and their chain effects on the project. The existing methods perceive stakeholder issues as being independent and stationary in vacuum. Consequently, they are not able to help in answering two key questions: (1) How are the issues of different stakeholders interconnected? (2) What are the practical implications of these issue interdependencies on stakeholder management and project implementation? To tackle these limitations, a network perspective to analyse stakeholder issue interdependencies in MCPs is of theoretical and practical importance.

Network analysis is a potential method to investigate stakeholder issue interdependencies in MCPs by visualising the relationship fabrics and examining quantitatively their structural properties (Wasserman and Faust, 1994). Stakeholder issues exist in a form of network in each MCP, however the existing stakeholder analysis methods have overlooked issue interdependencies and their proliferating impacts. Using a social network approach can help the project team to capture the cause-and-effect relationships between stakeholder issues, and to identify the key issues and interactions which worth particular attention.

As mentioned in Chapter 2, network analysis has been applied in various research domains including construction, engineering and project management. These network studies can be broadly divided into two types. The first type primarily analyses interpersonal, intra- or inter-organisational ties in project contexts, considering human actors as nodal elements of the network. The second type considers the interconnected but non-human objects, in a project, as nodal elements, and analyses their interdependencies (Chapter 2 summarized those previous studies). These studies show the methodological viability of network-theory based analysis in exploring relational structures of interrelated non-human objects, and giving insights into the central network components. However, the potential of using this network perspective in investigating stakeholder issues of MCPs has not yet been thoroughly explored. As such, this chapter presents a specific social network approach for analysing stakeholder-related issues and their interdependencies in MCPs.

6.3 Social Network Analysis metrics

In the proposed approach, ten SNA metrics are used to decipher the structural characteristics and patterns embedded in the stakeholder-related issue influence network at the network-, node-/link-, and interface-levels. At the *network-level*, two metrics, namely *density* and *cohesion*, were computed to quantitatively analyse the overall network structure in terms of connectivity and complexity. At the *node-/link-level*, five node-level metrics including *nodal degree*, *ego network size*, *node betweenness centrality*, *status centrality*, and *brokerage*; and one *link-level* metric, the *link betweenness centrality*, are calculated to assess the roles and characteristics of individual stakeholder-related issues and issue interdependencies, as well as to measure their importance in the network. At the *interface-level*, two metrics, namely *direct connectivity* and *global connectivity*, are computed to measure the interactions and accessibility between different pairs of divisions (i.e. stakeholder types or issue categories). Table 6.1 presents the theoretical definitions and practical interpretations of these SNA metrics in examining stakeholder-related issue influence network. The application details of these metrics in the proposed social network approach are described in the following section.

Table 6.1: SNA metrics, their theoretical definitions and practical interpretations for stakeholder-related issue influence network

(a) Network level metrics

Metrics	Theoretical definition	Practical interpretation	Implication for overall network structure	References
Density	The proportion of existing relationships in the entire network to the largest number of possible ties when all nodes are joined together. Density ranges from zero (all nodes are isolated) to one (all nodes are interconnected to each other else).	The overall network connectivity.	A dense network implies that many stakeholder issues are interrelated to each other.	Wasserman and Faust (1994)
Cohesion	The length of path, or the number of ties, to reach nodes in a network based on the shortest path.	The overall network complexity.	A greater cohesion implies a more complicated network, since more number of walks are needed for a node to reach the others.	Wasserman and Faust (1994)

(b) Node level metrics

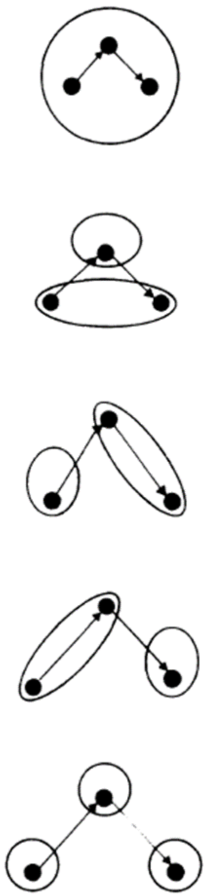
Metrics	Theoretical definition	Practical interpretation	Implication for overall network structure	References
Nodal degree	The weight sum of relationships directly occurred at a specified node. According to the direction of links, in-degree considers incoming relationships transmitted to a node; and out-degree considers outgoing relationships radiated from a node. Nodal degree difference is obtained by subtracting the in-degree from the out-degree of a particular node. To spot out influential nodes, out-degree can be plotted against degree difference.	The direct impact of a stakeholder issue by considering its immediate connectivity to other issues. In-degree indicates the direct impact received by an issue. Out-degree reflects the direct impact given out by an issue. Degree difference measures the net direct influence level of an issue to the others.	Issues with high out-degree and high degree difference magnitude both worth particular attention from the project team. An issue with high degree difference magnitude implies that it can readily impact or be impacted by others.	Freeman (1979); Yang and Zou (2014); Wasserman and Faust (1994)
Ego network size	The number of nodes located in the direct neighbourhood of a focal node.	The number of immediate successors or predecessors of a stakeholder issue.	Large egonet size implies a great extent of influence of a stakeholder issue.	Wasserman and Faust (1994)

Betweenness centrality	The extent to which a particular node is located upon the geodesic distance between all combinations of other pairs of nodes.	The power of a stakeholder issue in controlling the influences passing through it.	An issue with high betweenness centrality is critical. First, it takes a broker role to join different parts of a network which may otherwise be segregated. Second, it acts as a gatekeeper to influence the impact flowing through it to others.	Pryke (2004)
Status centrality	The number of nodes adjacent to or from a focal node, plus the number of secondary nodes which indirectly connect to the focal node through its direct neighbours.	The relative impact of a stakeholder issue in the whole network. According to the direction of impacts, in-status considers relative impact received by an issue; and out-status refers to relative impact emitted from an issue. To identify key issue, out-status is adopted in the analysis.	An issue with high out-status value worth special attention because it can readily impact the entire network.	Katz (1953)
Brokerage	The incidence that a specified node (i.e. the intermediary or broker) acts in each of the five types of brokerage relations: *coordinator, liaison, itinerant, representative, and gatekeeper*, in linking different subgroups of nodes, under a chosen node partition. In this analysis, node partition can either be the stakeholder types or issue categories as previously identified. Figure 6.1 shows the five types of broker relationships (Gould and Fernandez, 1989).	The roles and ability of a stakeholder issue in connecting different subgroups of issues. When (partition = 'stakeholder type'), brokerage indicates an issue's role in connecting issues associated with various stakeholder types. When (partition = 'issue categories'), brokerage reflects an issue's role in connecting issues of different categories.	An issue which scores high brokerage is critical, because it plays special roles in generating the chain effects between issues, and increase the network complexity.	Gould and Fernandez (1989)

(c) Link level metric

Metrics	Theoretical definition	Practical interpretation	Implication for overall network structure	References
Betweenness centrality	The extent to which a particular link is situated upon the geodesic distance	The power of an issue interdependency in controlling the	A link with high betweenness centrality is critical since it acts as a gatekeeper to control	Pryke (2004);

	between all combinations of other pairs of links.	influences passing along it.	the influences passing along it.	Yang and Zou (2014)
(d) Interface level metric				
Metrics	Theoretical definition	Practical interpretation	Implication for overall network structure	References
Direct connectivity of stakeholder types	The number of direct links between every pair of stakeholder types.	The interactions between various stakeholder types from a local perspective.	When a pair of stakeholders is highly connected, the communication between them should be enhanced.	Fang et al. (2012); Yang and Zou (2014)
Direct connectivity of issue categories	The number of direct links between every pair of issue categories.	The interactions between various issue categories from a local perspective.	When a pair of issue categories is highly connected, the coordination between issues of relevant groups should be strengthened.	
Global connectivity of stakeholder types	The number of both direct and indirect connections between every pair of stakeholder types.	The interactions between various stakeholder types from a global point of view.	When a pair of stakeholders is highly connected, the communication between them should be enhanced.	
Global connectivity of issue categories	The number of both direct and indirect connections between every pair of issue categories.	The interactions between various issue categories from a global point of view.	When a pair of issue categories is highly connected, the coordination between issues of relevant groups should be strengthened.	



Coordinator

- The broker, the initiator and the receiver all belong to the same partition. The broker facilitates relationship between the initiator and receiver (Gould and Fernandaz, 1989; Yang and Zou, 2014).

Itinerant

- The initiator and receiver are under the same partition. The broker, who come from another partition, facilitates the relationship between them (Gould and Fernandaz, 1989; Yang and Zou, 2014).

Gatekeeper

- The broker and the receiver are under the same partition, while the initiator comes from another. The broker acts as a gatekeeper because it can control the receiver's access to the link sending from the initiator of another partition (Gould and Fernandaz, 1989; Yang and Zou, 2014).

Representative

- The broker and the initiator are under the same partition, while the receiver comes from another. The broker sends a tie to the receiver on behalf of the initiator. Therefore, the broker plays a representative role (Gould and Fernandaz, 1989; Yang and Zou, 2014).

Liaison

- The broker, the initiator and the receiver all come from different partitions. The broker facilitates relationship between the initiator and the receiver who might otherwise have no alliance formed between them before (Gould and Fernandaz, 1989; Yang and Zou, 2014).

Note: In each figure, the node at the top represents the broker; while the bottom left node represents the initiator, and the bottom right node represents the receiver. The circles indicate the partitions in which the nodes belong to;

Figure 6.1: The five kinds of brokerage relations
(Source: Gould and Fernandaz, 1989)

6.4 Procedures

Figure 6.1 shows the procedures for analysing stakeholder-related issues in MCPs using a social network approach. The whole process aims to analyse stakeholder-related issues, their interdependencies and proliferating impacts on the project. It helps to identify the critical issues and issue interactions which require particular attention from or specific treatments by the project team. The entire procedure comprises five main steps: (1) identifying stakeholders and stakeholder-related issues; (2) determining stakeholder-related issue interdependencies; (3) visualising the issue network; (4) analysing the issue network; and (5) identifying critical issue and issue interdependencies. It is acknowledged that the details of the proposed approach were adapted from two published papers with the candidate as the first author, as shown in the footnotes below[4][5].

[4] Mok, K.Y., Shen, G.Q., Yang, R.J., Li, C.Z. (2017). Investigating key challenges in major public engineering projects by a network-theory based analysis of stakeholder concerns: A case study. International Journal of Project Management, 35(1), 78-94 (DOI: 10.1016/j.ijproman.2016.10.017).

[5] Mok, K.Y., Shen, G.Q., Yang, R.J. (2016). A network-theory based analysis of stakeholder issues and their interrelationships in large construction projects: a case study. International Journal of Construction Management, 1-18 (DOI: 10.1080/15623599.2016.1187246).

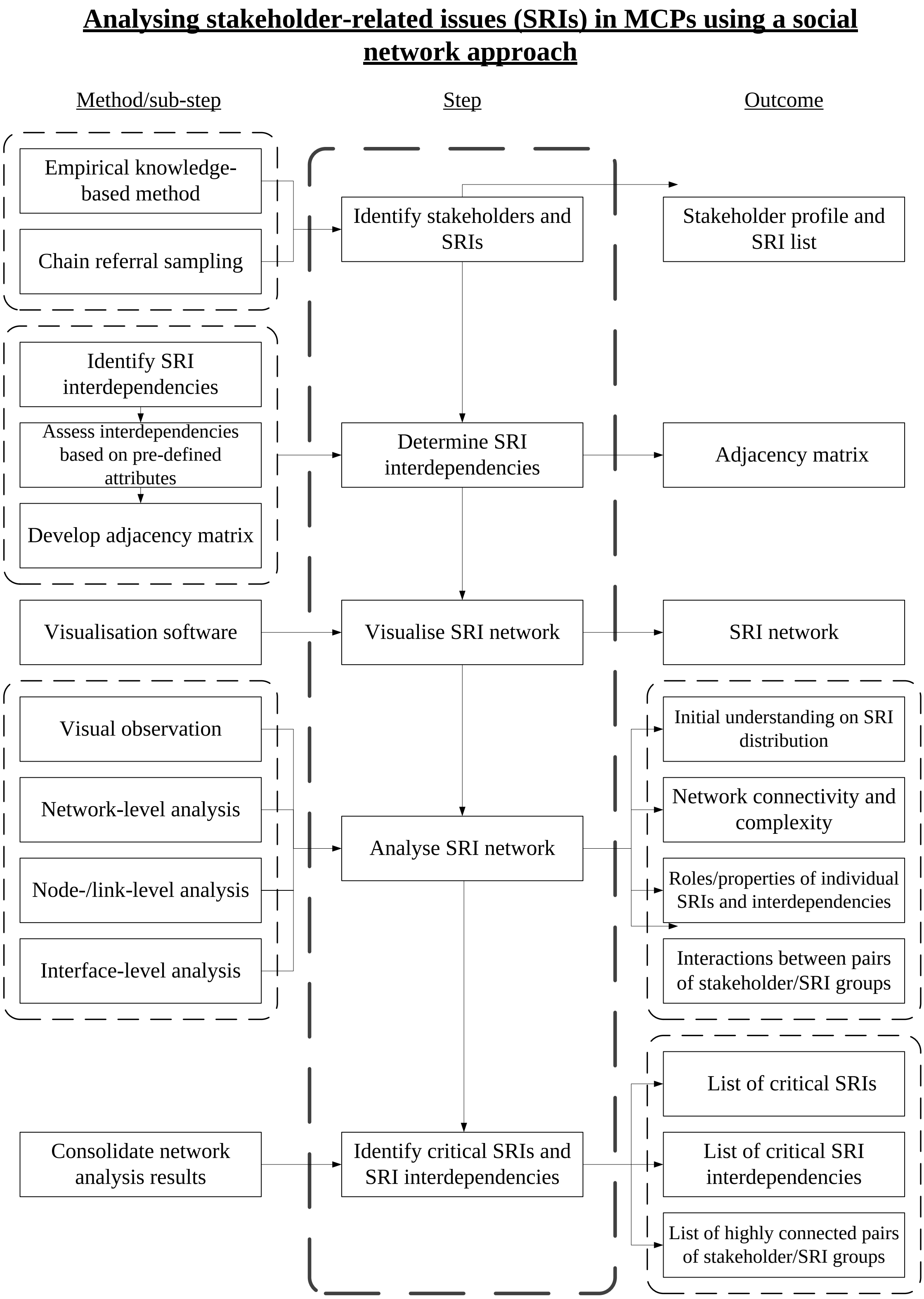


Figure 6.2: Procedures for analysing stakeholder-related issues in MCPs using a social network approach

6.4.1 Identifying stakeholders and stakeholder-related issues

Step 1 aims to completely identify project stakeholders and their associated issues which may be affected due to MCP development or the achievement of project objectives. This process involves two sub-steps as described below.

Identifying stakeholders

This sub-step is to identify the stakeholders who are sources of the nodes (i.e. stakeholder issues) of the network. Chain referral sampling is used for the said purpose (Chapter 4 explained this method), in an attempt to fully recognize stakeholders and their associated issues in the project. In the stakeholder identification process, the core project team members are firstly invited to appoint internal stakeholder groups, then these nominated parties are invited to provide referrals of external stakeholders who may impact or be impacted by the project, lastly these designated parties are required to appoint any conceivably impacting or impacted groups who are still absent in the chain. A provisional stakeholder roster (deriving based on literature review and project document analysis) can be provided to stakeholders as reference in the chain referral process. This sub-step yields a complete stakeholder profile. All identified stakeholders are coded numerically as Sa (where a = 1…n; n is the number of identified stakeholders) for subsequent data processing.

Identifying stakeholder-related issues

The second sub-step is to determine the nodes, i.e. stakeholder-related issues in the project. Empirical knowledge-based method (e.g. interviews and workshops) is the primary means for the said purpose (Chapter 4 explained the method). This method is used since a large amount of information can be elicited from targeted samples according to the predetermined orders but without sacrificing flexibility (Longhurst, 2003). The stakeholders (identified from the previous sub-step) can be interviewed and asked to provide opinions, based on their project knowledge and experience, on three main questions: (1) What are their key issues in the project? (2) Why these issues are at stake? (3) What are the cause-and-effect relationships between these issues? Similar to stakeholder identification, a provisional list of stakeholder-related issues can be provided as reference to assist the issue identification task. All obtained information should be well documented. This sub-step yields a complete list of stakeholder-related issues. For network data processing, these nodes are coded numerically as S_eI_f, where *f* represents the issue number of a particular stakeholder *e*. It should be noted that, the same issue identified by different stakeholders should be distinguished as different issues, and are assigned with different numerical codes. This is because the nodes in this network analysis refer to stakeholder-related issues, i.e. the issues concerned by or sourced from a particular stakeholder. If stakeholders tell contradicting stories about an issue, the contradictions should be investigated and sorted out, e.g. by seeking opinions from relevant stakeholders on the contradictions and raising questions about these issues from different angles, in an attempt to reaching consensus. Workshop with key project participants and stakeholder representatives is a potential method to resolve contradictions. The identified issues can be further classified into different categories (Chapter 2 summarised the possible issue categories) for subsequent network data processing and analysis.

6.4.2 Determining stakeholder-related issue interdependencies

Step 2 is link determination and assessment. In the proposed approach, a link refers to the influence that a stakeholder issue exerts on another issue. In this process, all identified stakeholders (who had previously participated in node determination) are asked to consider all possible combinations of issue pairs, and to decide whether a link exists in each pair based on their empirical knowledge. Since relationships can be reciprocal, stakeholders should make explicit the link directions. For example, the influence exerted by S_aI_b on S_cI_d is treated as a distinct relationship from the influence that S_cI_d has on S_aI_b. Next, the stakeholders quantify each identified link by assigning two scores, namely the *intensity of impact* given by an issue on the other, and the *likeliness for this impact to happen*; with a five-point scale (where "1" indicates the lowest level and "5" denotes the highest level). Multiplying the impact intensity and likeliness serves as a basis for evaluating the influence level of a pair of stakeholder issues. If no influence presents between two issues, the influence level becomes nil. These relational data can be collected from each identified stakeholder using interviews, in conjunction with a questionnaire survey of a matrix format, to facilitate the link assessment process. Workshop with the identified stakeholders is also a potential means, during which the participants can identify and assess the links through the survey. Appendix B presents a sample survey instrument. Accordingly, a complete list of interdependencies connecting all identified stakeholder-related issues is determined. Lastly, an adjacency matrix is created to represent the issue network. In this matrix, stakeholder-related issues are listed at the head row and first column. Influence levels of the links are inputted into the cells accordingly, with zero on the diagonal because an issue is not considered to give impact on itself. This matrix represents the stakeholder-related issue influence network.

6.4.3 Visualising stakeholder-related issue network

Step 3 applies a network visualisation and analysis software package (e.g. NetMiner) to visualise the stakeholder-related issue influence network. The node list, link list and adjacency matrix are the major input data. A sociogram H(N,Z) is developed to represent the stakeholder issue network, where the *n* identified stakeholder-related issues (S_eI_f) are drawn as the N nodes joined by the Z valued edges. The stakeholder types and issue categories can be denoted by different node shapes and node colours respectively. The edges indicate the influence from one stakeholder-related issue to another.

6.4.4 Analysing stakeholder-related issue network

Step 4 aims to investigate the structural characteristics of stakeholder issue network, as well as the roles and propagating effects of individual issues and links. It can be further divided into four stages: (1) visual observation, (2) descriptive analysis, (3) node-/link-level analysis, and (4) interface-level analysis.

Visual observation

Visual observation enables the project team to acquire initial understanding on the key issues and their distribution in the network. Particular attention can be paid to the network connectedness, clustering of issues, and isolated issues. In theory, isolated issues can be addressed more easily because they can be considered as independent problems.

Descriptive analysis

Density and cohesion are two useful network-level metrics to uncover structural properties of the overall stakeholder issue network. Density indicates the network connectivity, where a high density implies that many stakeholder issues are interrelated to each other. Cohesion measures the network complexity. A greater cohesion implies a more complicated network, since more number of walks are needed for a node to reach the others. The theoretical definitions and practical meanings of the network-level metrics in stakeholder issue influence network have been explained in Table 6.1.

Node-/link-level analysis

Five node-level metrics are computed to investigate the direct and/or propagating impacts, properties and functions of individual nodes; and to determine key stakeholder-related issues in the network. These five metrics include nodal degree, ego network size, node betweenness centrality, status centrality, and brokerage. The outcome of this process is a list of critical stakeholder-related issues of the project.

Following the node-level analysis, link betweenness centrality is computed to measure the extent that an issue interaction plays a gatekeeper role in governing the influences passing through it. The theoretical definitions and interpretations of these node-/link-level metrics when applied to the issue network have been explained in Table 6.1. This process yields a comprehensive list of key issue interactions of the project.

Interface-level analysis

Two interface-level metrics, namely direct connectivity and global connectivity, are calculated to measure the interactions and accessibility between different pairs of divisions (i.e. stakeholder types or issue categories). In the stakeholder management process, 'who possesses the issues' and 'what are the issues' are two fundamental considerations. According to Fang et al. (2012), in project management, stakeholder issues are often categorized into different domains, e.g. technical, financial, managerial, etc. From the core project team's point of view, different stakeholder entities of different expertise would be assigned to handle issues of one or several categories. Therefore, stakeholder-related issues can be classified into different divisions based on their associated stakeholders and issue nature; and it would be useful to analyse the connectivity between different division pairs of issues.

Direct connectivity refers to the number of direct links between every division pair of issues. It represents the reachability between various division pairs from a local perspective. It can be computed by sorting all issues based on the selected division vector (i.e. either stakeholder types or issue categories), followed by counting the number of direct ties between the various division pairs. Similarly, global connectivity measures the number of both direct and indirect interactions between every division pair of issues. It indicates the reachability of various division pairs from a global perspective. Its computation is based on the adjacency matrix of direct connectivity between various division pairs. The theoretical definitions and practical meanings of the interface-level metrics in stakeholder issue network have been explained in Table 6.1.

6.4.5 Identifying critical stakeholder-related issues and issue interdependencies

Step 5 aims to identify critical network actors in the issue network, and develop appropriate stakeholder management strategies for alleviating these critical network actors. This process can be further divided into three parts: (1) identifying critical stakeholder-related issues by consolidating the node-level results, (2) identifying critical issue interdependencies based on the link-level results, and (3) identifying the highly connected stakeholder/issue division pairs based on the interface-level results. It should be noted that, in identifying the critical network actors, the cut-off points of analysis results would be case-specific. The project team should give particular attentions to the identified critical network actors and treat them with high urgency, since they play important roles in producing immediate and/or propagating impacts to the entire issue network. The main principles to identify and alleviate the critical network actors are discussed below.

Critical stakeholder-related issues

Based on the node-level results, critical stakeholder-related issues can include the followings:

(i) Issues with high nodal out-degree, which can exert high direct impact on the other issues;

(ii) Issues with large magnitude of nodal degree difference, which can either give high direct impact on or receive high direct impact from the other issues;

(iii) Issues with large ego network size, which can impact or be impacted by a large number of adjacent issues;

(iv) Issues with high betweenness centrality, which can possess high control on the influences passing through them;

(v) Issues with high out-status centrality, which can produce high overall impact on the entire network;

(vi) Issues with high brokerage, which play important roles in generating propagating effects between issues, thus increasing the network complexity;

The above issues are considered critical because they play important roles in producing direct and/or proliferating impacts to the whole issue network. The project team should handle these issues with high priority and attempt to alleviate them.

Critical issue interdependencies

Based on the link-level results, issue interdependencies with high link betweenness centrality are considered critical because they connect many issues which may otherwise be segregated from the issue network. Theoretically, eliminating these critical links can disconnect a large number of issues, and disentangle the 'hairball' structure of network into less complicated clusters. As such, the project team should develop appropriate strategies for enhancing the communication and coordination between stakeholders associated with the sourcing issues and targeting issues of the identified critical links; in an attempt to get the links resolved.

Highly connected stakeholder/issue division pairs

Based on the interface-level results, for the highly connected pairs of stakeholders, the project team should enhance communications between the relevant stakeholders; while for the highly connected pairs of issue categories, the project team should strengthen coordination between the issues of relevant categories.

6.5 Immediate simulation

An immediate simulation can be conducted to test the likely effectiveness of the suggested issue and issue interdependency treatment strategies. This section explains the assumptions, procedures and tools used in the simulation.

Purpose

The purpose of immediate simulation is to measure the likely effectiveness of the suggested management actions. The project environment represents a network system comprising a definite set of stakeholder-related issues and issue interdependences. The more complex the network system, the more challenging the stakeholder management process. The issues and interdependencies are the origins giving rise to the complexity of network system. This is because the issues and links do not simply exist in the form as they are – the issues and links together can produce direct and proliferating effects, impacting the entire network system in different extents. Therefore, the immediate simulation intends to predict: *Theoretically, in what extent, the complexity of network system will decrease after enforcing the suggested issue and interdependency treatment actions*.

Tools

The complexity level of the whole network system can be measured by two network-level metrics: density and cohesion. These two metrics are the main tools used in the simulation.

- *Density* is defined as the proportion of existing relationships in the entire network to the largest number of possible ties when all nodes are joined together (Wasserman and Faust, 1994). This metric indicates the overall network connectivity.
- *Cohesion* refers to the length of path, or the number of ties, to reach nodes in a network based on the shortest path (Wasserman and Faust, 1994). This metric indicates the overall network complexity.

Assumptions

In Step 5 of the proposed social network approach (Section 6.4.5), appropriate stakeholder management strategies are developed for resolving the critical network actors. Therefore, this immediate simulation makes an assumption:

- *It is assumed that all suggested issue and issue interdependency treatment actions have been fully implemented, thus all critical issues and links are resolved and to be eliminated from the network.*

Procedures

Under the above assumption, the immediate simulation comprises the following steps:

1. Eliminating all identified key issues and links from the issue influence network (assumed that they are all resolved after undertaking the suggested management actions);
2. Re-calculating the network density and cohesion;
3. Comparing the density and cohesion results of the resultant network with those of the initial network, and to observe how much the values have been decreased.

Theoretically, the decrease of density and cohesion values can reflect the potential reduction in the overall network connectivity and complexity, after enforcing the management actions. The greater the decrease of the network-level metric values, the more effective the measures are likely to be. This simulation process can help the project team to early predict the likely effectiveness of the measures, before their actual implementation. Yet, the simulation is only theoretical. Periodic tests are needed to measure the actual effectiveness of the measures. The entire network-theory based issue analysis process should be carried out again at regular intervals of the project, so as to observe and monitor the stakeholder and issue dynamics.

6.6 Chapter summary

This chapter presents a social network approach for analysing stakeholder-related issues and their interdependencies in MCPs. This approach can overcome two limitations of the analysis approach introduced in Chapter 3 (i.e. the social network approach of analysing stakeholders and their social interactions); by taking into account the sources/origins of stakeholder issues, as well as modelling stakeholder issue interdependencies and their proliferating effects on the project development. The proposed approach involves the use of chain referral sampling, SNA, a software package for network visualisation and exploration (e.g. *NetMiner*); as well as the calculations of two network-level, six node-/link-level, and two interface-level SNA metrics. The entire procedures of the approach comprise five main steps, namely ‘identifying stakeholders and stakeholder-related issues’, ‘determining issue interdependencies’, ‘visualising the issue network’, ‘analysing the issue network’, and ‘identifying critical issue and issue interdependencies’.

With the application of the proposed approach, the project team would be able to identify completely all project stakeholders and their associated issues, visualise the issue interdependencies, decipher their structural characteristics and propagating effects on project development, as well as to identify the critical stakeholders and issues which worth particular attentions. The analysis outcomes would help the project team to develop appropriate key issue and interdependency treatment actions and stakeholder engagement strategies. An immediate simulation is also introduced to test the likely effectiveness of the suggested stakeholder management measures.

The next chapter will present two case studies of different MCP types, including a large public office building development and a large-scale reclamation project. These case studies are used to illustrate the application of the proposed social network approach for analysing stakeholder-related issues and their interdependencies. The findings will offer useful insights on the critical stakeholders and their associated issues in major building and civil engineering projects. In addition, the proposed approach and case study findings will provide a solid foundation for developing a social network model for MCP stakeholder analysis. The details of the social network model will be discussed in Chapter 8.

Chapter 7 – Validation of the Approach for Analysing Stakeholder-related Issues

7.1 Introduction

A social network approach for analysing stakeholder-related issues and their influence relationships in MCPs has been proposed and introduced in Chapter 6. Case study is applied to demonstrate the application of and validate the proposed approach. Two real case projects of different MCP types, including a major public office building development and a large-scale reclamation works, are used for the said purposes. This chapter describes the validation of the approach by the two case studies. Abbreviated forms of the two project names, namely TD project (for the office building development) and AI project (for the reclamation works), are used in this chapter due to confidentiality consideration. Case Study III on the TD project is described in Section 7.2, while Case Study IV on the AI project is presented in Section 7.3. Lessons learnt from the two case studies are discussed in Section 7.4, in an attempt to explore the applicability of the proposed social network approach.

7.2 Case Study III – the TD project

7.2.1 Description of the TD project

The TD project is an iconic public office building development in Hong Kong, procured under a design-and-build contract with a contract sum of HK$5 billion. The project scope embodies three office towers with a total gross floor area of 130,000 m2 and an open space of nearly 20,000 m2 for public enjoyment. This project is considered a MCP according to the definition on MCPs previously described in Chapter 2. The project involves a wide range of stakeholders and shows high project complexities, imposing a need of an effective stakeholder-related issue analysis. For example, this development was the first project in Hong Kong adopting seismic-resistant measures for building structures. Without previous experiences and relevant local code of practice, the client spent extra time and resources than expected in developing the building standards and scrutinising the detailed design. Accommodation and security requirements of the client and end users were also not clearly reflected in the employer’s requirements (ER). Additionally, owing to public accountability and political interference, this public development attracted huge attentions from the general public and pressure groups pertaining to project cost and value for money.

Stakeholder-related issues and their interdependencies are dynamic throughout the project lifecycle, so as the assessment of impacts of the issues on each other. Due to time limitation, the network analysis in this case study is only a one-off. Therefore, the network in this case only captures a snapshot of the stakeholder-related issues and their interactions at a single point in time during the design-and-construction stage. The following section explained the network development process.

7.2.2 Development of the stakeholder-related issue influence network

Before defining nodes and links of the stakeholder issue network, stakeholder identification is an initial task in the data collection process as the origins of stakeholder-related issues are the stakeholders themselves. Chain referral sampling were applied to identify stakeholders in the TD project. To start the referral process, five representatives from the project proponent organisation were initially engaged. They were invited to nominate internal stakeholder entities in the supply chain, these identified parties were then asked to nominate external stakeholders who were deemed influential or being influenced in project execution. Accordingly, 18 stakeholder groups were identified and they were each assigned a numerical code S_n (where n = 1 to 18). Table 7.1 summarises the stakeholder profile.

Table 7.1: Stakeholders identified in the TD project

Stakeholder	Stakeholder description	Issue no.
S1: Project proponent	A public agency who initiates the proposed office building development	31
S2: Design-and-build contractor	A private contractor company (appointed by S3) to design and construct the proposed development	33
S3: Project manager	A government department who works on behalf of S1 to oversee the cost, programme and administration of the proposed development	30
S4: Subcontractor and supplier	Subcontractor and supplier companies including curtain wall, raised floor system, etc.	14
S5: Lead designer	An architectural firm (hired by S2) to provide lead design consultancy services	18
S6: Quantity surveying consultant	A consultancy company (appointed by S3) to provide cost management services and contractual advices	6
S7: Lead structural designer	A consultancy company (engaged by S2) to provide structural consultancy services	5
S8: Lead building services designer	A consultancy company (engaged by S2) to provide building services design and engineering solutions	13
S9: Local government for planning and development	A government bureau in charge of land use planning and development, building safety and maintenance, and public works	7
S10: Media	--	16
S11: Politician	--	8
S12: NGO (social welfare-related)	A NGO which is social welfare- and rehabilitation services-related	4
S13: NGO (environmental-related)	A green group	4
S14: General public	--	19
S15: End users of Office Tower A	--	26
S16: End users of Office Tower B	--	8
S17: End users of Office Tower C	--	4
S18: Professional organisation	A professional body in surveying	7

Node identification was the second task. Semi-structured interviews were conducted with representatives from each of the 18 stakeholders. Respondents were invited to identify their issues in the project based on their empirical knowledge. A reference list of stakeholder issues and issue categories, which had been developed based on desktop studies and literature review, was provided to respondents to facilitate their issue identification process. Feedbacks on the issue reference list had been sought from the core project team prior to the issue identification. Accordingly, 253 issues associated with 18 stakeholders were identified. These 253 stakeholder-related issues (i.e. the nodes) were each assigned a numerical code S_nI_j for subsequent data processing, where *j* denotes the issue number sourced from a specific stakeholder *n*. Table 7.2 shows the issue categories in the TD project. As shown in Table 7.2, 'technical', 'social', 'project management and governance' and 'cost' were the top four issue categories in descending order; accounting for 70% of all identified issues.

Table 7.2: Summary of stakeholder-related issue categories in the TD project

Issue category	Issue no.
Cost related	28
Economic related	18
Environmental related	22
Ethical and reputational related	11
Political related	11
Project management and governance related	30
Social related	45
Technical related	75
Time related	2
Others	11
Total	253

Notes: The 'Others' category includes stakeholder-related issues such as ' information access by the public and pressure groups'; 'relationship between the government and construction industry', etc.

Link determination was the third task. Respondents from the 18 stakeholders, who had previously identified the nodes, were asked to identify and evaluate the links. When a stakeholder-related issue influences another issue, a link is said to exist between these two issues. The respondents then quantified each identified link by assigning two scores: the *intensity of impact* given by an issue on the other, and the *likeliness for this impact to happen*, with a five-point scale (where '5' denotes the highest degree and '1' indicates the lowest degree). Since links can be reciprocal, respondents were asked to make explicit the directions of the identified links. These relational data were obtained from respondents using interviews, in conjunction with a survey instrument of matrix format (Appendix B) to facilitate the link assessment process. Each interview lasted around three to five hours. Interview was used to gather relational data because the researcher can provide clear explanations and instructions of the link assessment method to respondents, while the respondents can give elaborations on the identified links and their scores. Accordingly, 1,822 links connecting 253 nodes were identified. The influence level of each issue interdependency was then calculated by multiplying the impact and likelihood scores. Finally, an adjacency matrix which represents the stakeholder-related issue influence network H (253, 1822) was developed.

7.2.3 Results of network analysis

Descriptive analysis results

Figure 7.1 shows the stakeholder issue network of the TD project, with the stakeholder and issue categories denoted by different node shapes and node colours respectively. The network density and cohesion values were 0.029 and 0.082 respectively, while the average distance between stakeholder issues was 2.66 walks of length 1. These figures show that the current network was dense and complicated, and the issues were relatively proximate to each other in comparison with the network properties of previous network studies (Fang et al., 2012; Yang and Zou, 2014).

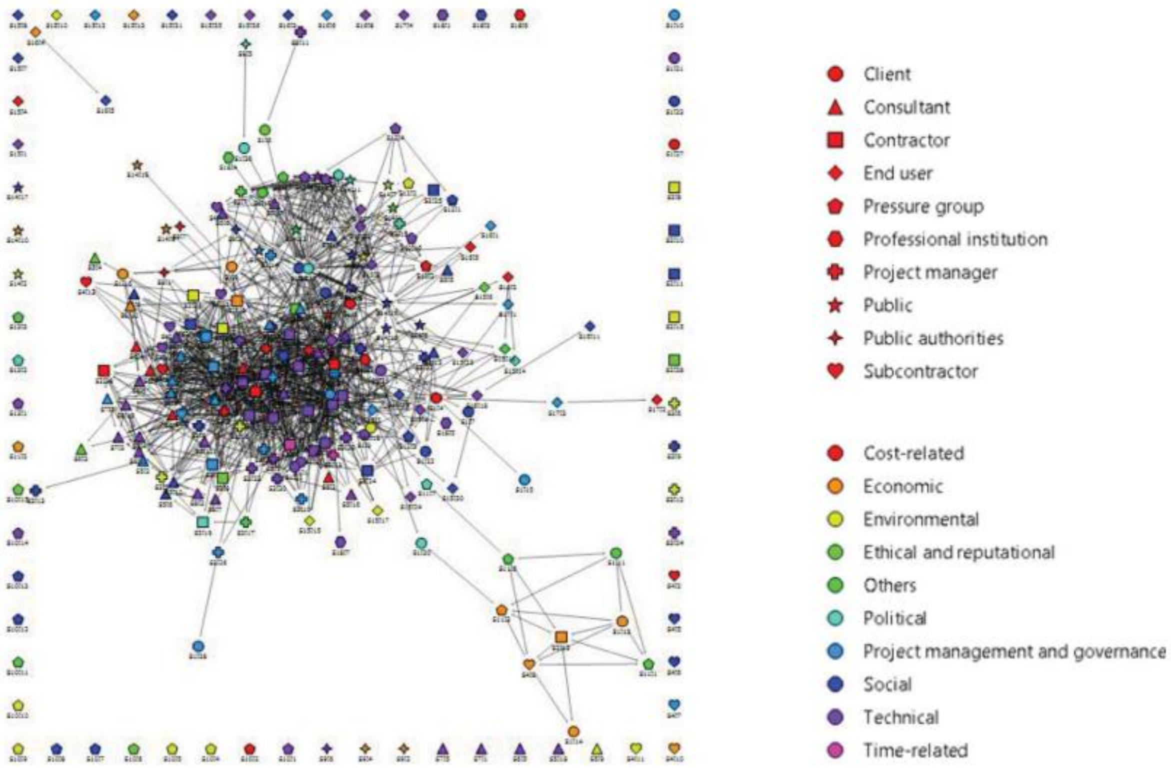


Figure 7.1: Stakeholder-related issue influence network in the TD project

Note:
(1) Node shapes and colours denote stakeholder and issue categories respectively;
(2) Stakeholders (S1-S18) are categorised into ten groups to reflect their positions in the stakeholder community; namely client, consultant, contractor, end user, pressure group, professional institution, project manager, public, public authorities, and subcontractor.

Node-/link-level results

After descriptive analysis, this section investigates the roles of meaningful stakeholder issues and links taking into account their positions and relationships in the network. Figure 7.2 visualises the distribution of twenty stakeholder-related issues based on their out-degrees and degree differences. These twenty issues deserved considerable attention since they either had a great weighted sum of out-links or a high value of degree difference. S2I5 ("Delivering the project within budget" sourced from contractor) has the largest out-degree and in-degree simultaneously, in respective values of 528.96 and 546.12. S15I22 ("Provision of tight security measures and facilities" sourced from end users of office tower A) has a high degree difference of 241.50, owing to its large number of immediate successors and comparatively slight direct impacts from other stakeholder issues. The issue, S1I2 ("Accommodating the requirements of various end users" sourced from project proponent), is most heavily impacted by direct predecessors in view of its high in-degree of 400.13. In this network, most of the issues are categorised as ordinary nodes. The network also contains 11 'receiver' nodes as listed in Table 7.3. 'Receiver' nodes refer to issues which only has incoming ties but no outgoing ties, these issues are unlikely to affect the network complexity since no immediate impacts were sourced from them.

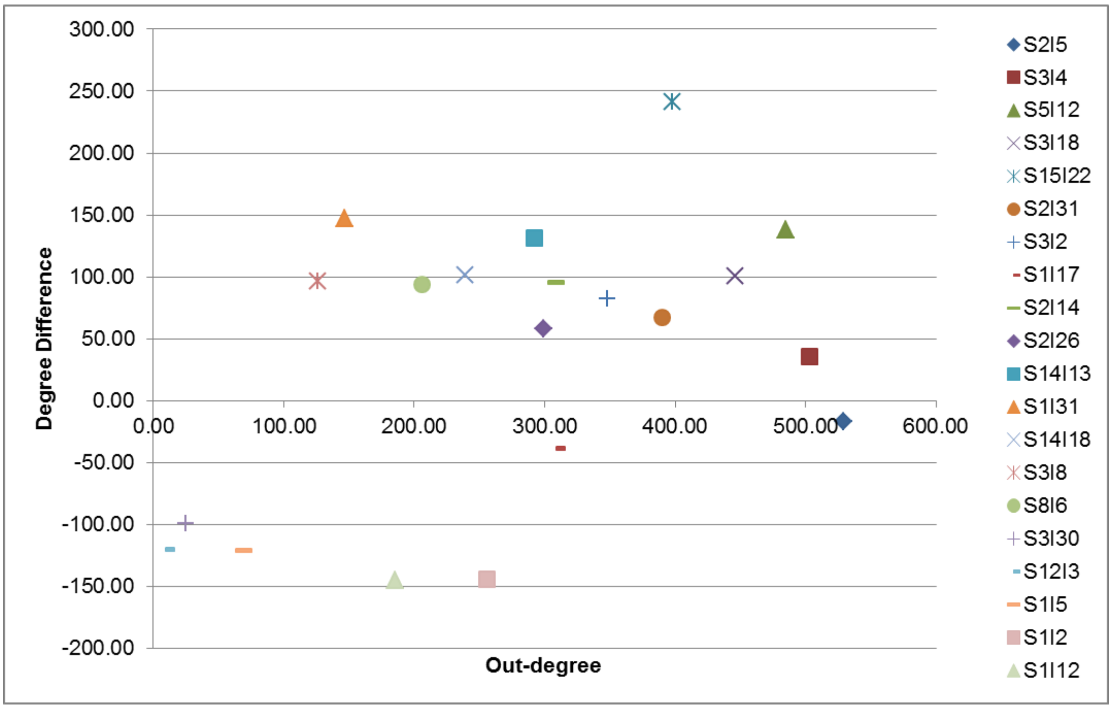


Figure 7.2: Distribution of stakeholder issues with high out-degrees and degree differences in the TD project

Table 7.3: Receivers in the stakeholder issue network of the TD project

Issue code	Issue	Related stakeholder
S1I7	Creation of a convenient and comfortable pedestrian circulation	Project proponent
S1I8	Disruption to the daily life or social network of affected vicinity	Project proponent
S1I14	Increase in indirect economic benefits (e.g. tax income)	Project proponent
S1I20	Pressure in dealing with controversies from the public and media	Project proponent
S1I30	Morale and the spirit of unity of civil servants	Project proponent
S6I3	Enhancing company image	Quantity surveying consultant
S11I1	Harmonious relationship between the government and the local construction industry	Politician
S14I9	Increase in land value and supply of Grade A office land	General public
S14I19	New job opportunities	General public
S15I20	Provision of facilities to increase social awareness of gender equity	End users of Office Tower A
S18I4	Access to project relevant information by professional bodies	Professional organisation

The top fifteen stakeholder issues and interdependencies according to their betweenness centrality are presented in Table 7.4. As shown, S1I17 (“Political interference to project implementation” sourced from project proponent), S1I2, S2I5, S3I18 (“Project design in terms of design concept, aesthetics and visual permeability” sourced from project manager) and S2I31 (“Technical complexity in structural design and construction” sourced from contractor) are the top five issues with the highest betweenness centrality. The results indicate that these five issues are important junctions in bonding many issue pairs and in exerting high degree of control over the interactions passing through them. Ten of the key interdependencies identified in Table 7.4 are passing through these five issues. Among these ten key links, “S1I2→S2I5” and “S2I5→S1I17” should be heeded with alertness since both of their sourcing and targeting nodes are the issues with the highest betweenness centrality. By comparing the stakeholder issues in Figure 7.2 and Table 7.4, six issues are recognised as important due to their roles as major junctions in the network, notwithstanding their relatively low number of direct successors. These six issues include: S1I24 (“Provision of good incentives and clear instructions to support project implementation” sourced from project proponent), S1I29 ("Sufficiency and effectiveness of public consultation" sourced from project proponent), S3I27 ("Sufficiency and effectiveness of public consultation" sourced from project manager), S3I29 ("Using innovative and efficient construction methods and technology" sourced from project manager), S14I15 ("Provision of barrier-free facilities for the disabled" sourced from general public) and S14I16 ("Provision of public space and amenities" sourced from general public).

Table 7.4: Important stakeholder issues and links in the TD project based on the betweenness centrality

Rank	Issue code	Node betweenness centrality	Link code		Link betweenness centrality
1	S1I17	0.0392	S1I2	→ S2I5	433.30
2	S1I2	0.0360	S3I4	→ S17I3	318.00
3	S2I5	0.0355	S1I17	→ S3I27	251.91
4	S3I18	0.0295	S2I31	→ S1I5	250.57
5	S2I31	0.0286	S2I5	→ S1I17	200.45
6	S3I4	0.0268	S3I18	→ S1I29	192.53
7	S3I29	0.0260	S1I12	→ S2I14	191.79
8	S1I29	0.0215	S1I12	→ S3I18	183.39
9	S1I24	0.0206	S14I15	→ S1I17	182.86
10	S1I5	0.0197	S3I18	→ S14I15	182.65
11	S14I16	0.0189	S14I6	→ S1I17	168.30
12	S1I12	0.0154	S16I1	→ S14I16	163.00
13	S14I15	0.0140	S3I30	→ S1I24	162.00
14	S2I14	0.0127	S15I3	→ S2I31	156.38
15	S3I27	0.0115	S14I15	→ S3I29	147.73

Table 7.5 shows the top fifteen stakeholder issues based on their out-status centrality. S3I4 ("Delivering the project within budget" sourced from project manager), S2I5, S5I12 ("Project design in terms of design concept, aesthetics and visual permeability" sourced from lead designer) and S3I18 are the top four issues giving the greatest impacts to other issues from a global view of network connections. The result is coherent with Figure 7.2 because these four issues are also at the highest four rankings based on the out-degree scores. Majority of the stakeholders issues with high out-status centrality values have already been pinpointed in the

nodal degree and betweenness centrality analyses; except four important issues, namely S6I2 ("Exercising stringent cost control to ensure the project is delivered within budget" sourced from quantity surveying consultant), S3I25 ("Stability against fluctuation of construction labour and material prices" sourced from project manager), S16I7 ("Provision of tight security measures and facilities" sourced from end users of office tower B) and S2I6 ("Availability and efficient allocation of workforce and resources" sourced from contractor).

Table 7.5: Important stakeholder issues in the TD project based on the out-status centrality

Rank	Issue code	Out-status centrality
1	S3I4	2.23
2	S2I5	2.13
3	S5I12	2.06
4	S3I18	1.94
5	S2I31	1.72
6	S6I2	1.44
7	S3I2	1.43
8	S15I22	1.40
9	S3I25	1.38
10	S1I24	1.37
11	S2I14	1.34
12	S16I7	1.20
13	S3I29	1.15
14	S2I6	1.13
15	S2I26	1.11

Figure 7.3 shows the status centrality map of all stakeholder issues, giving an overall picture about the relative impacts of every issue in the entire network. The stakeholder and issue categories are distinguished by different node shapes and colours respectively. In this concentric map, the impact level of an issue reduces along the radial distance between the issue location and the centre; implying that issues with larger influences are positioned more proximately to the centre. As shown in Figure 7.3, most of the centrally-positioned issues are related to the contractor, project manager and project proponent; while the issues of pressure groups, professional organisation, general public and end users are situated more peripherally.

This implies that the external stakeholders have given limited impacts in the decision making and implementation of this public development regardless of the government's emphasis on public consultation and participation. As reflected by their central positions, cost-related issues appear to be the most important issue category. This finding is consistent with previous studies where cost overrun is a major pitfall of public MCPs arousing huge concerns from various stakeholders (Doloi, 2013; Flyvbjerg et al., 2003a; Flyvbjerg et al., 2003b).

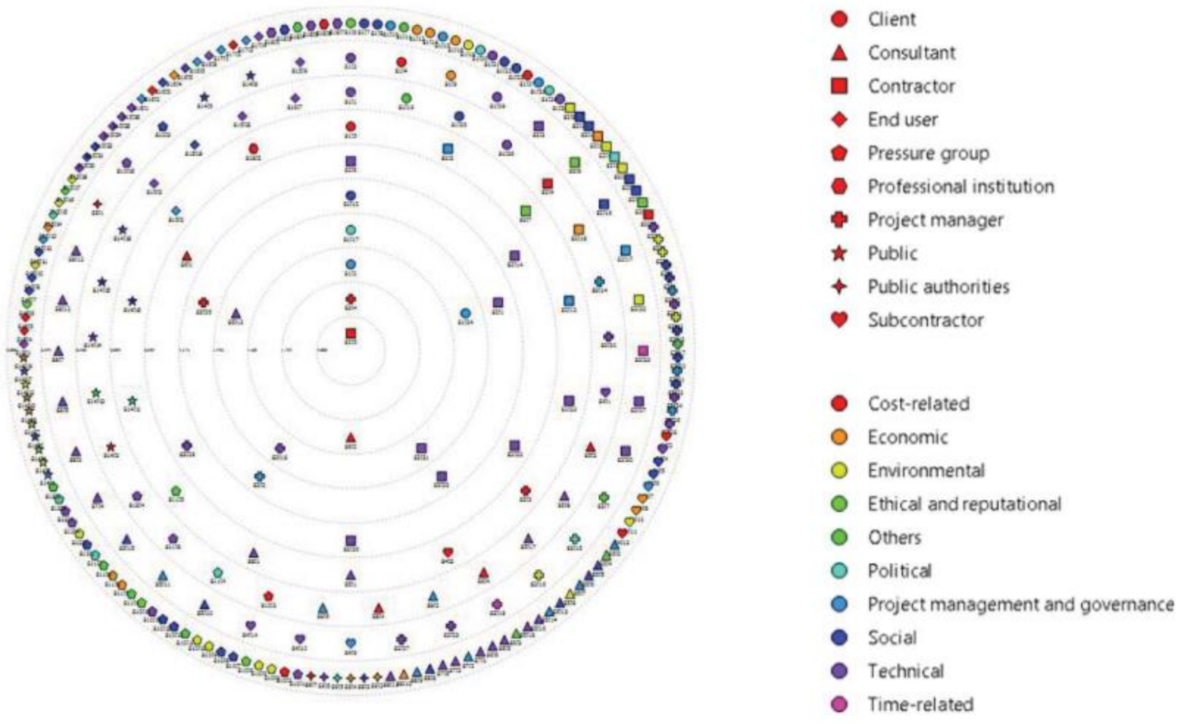


Figure 7.3: Distribution of stakeholder issues in the status centrality map for the TD project

The top fifteen stakeholder issues based on the brokerage scores are listed in Table 7.6. Stakeholder groups are chosen as the partition vector, with an intent to investigate the issues' positions and functions when bridging various stakeholder groups. Attributing to its critical liaison and itinerant roles, S2I5 is considered the most important issue with the highest brokerage value of 1679. By comparing Table 7.6 with the previous analyses of nodal degree, betweenness centrality and status centrality, three more key issues are recognised, namely

S2I7 (“Enhancing company image and fulfilling corporate social responsibility” sourced from contractor), S2I32 (“Using innovative and efficient construction methods and technology” sourced from contractor) and S2I33 (“Vulnerability of the project end product to natural disaster such as earthquake” sourced from contractor). These issues serve as fulcrums in the interactions between different stakeholder groups. If these joints are absent, the propagating effects evolved from the relevant pairs of stakeholder groups would be eliminated. It can be observed that most of the issues in Table 7.6 are related to the design-and-build contractor, suggesting its vital role in stakeholder engagement in pursuance of proper balance between diverse stakeholder interests. Table 7.7 lists the top fifteen stakeholder issues based on their ego network sizes. S2I5, S2I31 and S3I18 are the top three issues with ego network sizes of 61, 51 and 500 respectively. These issues possess a large number of direct neighbours, indicating their great extents of direct influences in the network. This finding is coherent with the previous node-level analysis results.

Table 7.6: Important stakeholder issues in the TD project based on the brokerage scores

Rank	Issue code	Coordinator	Gatekeeper	Representative	Itinerant	Liaison	Total
1	S2I5	80	379	198	248	774	1679
2	S3I18	9	48	146	159	722	1084
3	S3I29	7	57	88	285	646	1083
4	S3I4	16	85	142	189	544	976
5	S2I31	16	131	91	128	500	866
6	S1I2	37	192	98	92	426	845
7	S2I7	52	166	175	54	358	805
8	S2I26	19	62	161	109	349	700
9	S1I24	0	13	18	180	472	683
10	S3I2	20	66	131	87	357	661
11	S1I17	15	164	38	47	348	612
12	S5I12	7	46	72	75	331	531
13	S2I32	12	60	72	84	288	516
14	S2I14	19	57	73	54	182	385
15	S2I33	0	12	0	156	212	380

Table 7.7: Important stakeholder issues in the TD project based on ego network size

Rank	Issue code	Ego network size
1	S2I5	61
2	S2I31	51
3	S3I18	50
4	S1I2	47
5	S3I4	44
6	S3I29	44
7	S1I17	43
8	S2I26	42
9	S2I32	40
10	S3I2	40
11	S5I12	40
12	S2I7	38
13	S1I29	37
14	S1I24	36
15	S1I12	35

Interface-level results

The direct and global connectivity between stakeholders are presented in Table 7.8. Bold type denotes the significant interfaces which require more attentions. As shown in Table 7.8(a), many direct interdependencies are found among the pairs of internal stakeholders such as S1 (project proponent), S2 (contractor), S3 (project manager), S4 (subcontractor), S5 (lead designer) and S8 (lead building services designer). The direct connectivity of "S2→S3" and "S3→S2" are 128 and 114 respectively. These figures indicate that S2-related issues and S3-related issues receive considerable direct impacts from each other, thus the communications between these two stakeholders should be strengthened and enhanced. A comparison of Table 7.8(a) and 7.8(b) brings useful insight on potential stakeholder pairs who will interact closely from a global perspective, despite their relatively weak immediate connections. For instance, S14 (general public) is potentially influential because its impacts on S1, S2, S3 and S5 will grow substantially when examining from a global viewpoint; suggesting a need for these four stakeholders to improve their communication and engagement strategies with general public.

Table 7.8: Direct and global connectivity between stakeholders in the TD project

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
(a) Direct connectivity between stakeholders																		
S1	42	**60**	44	5	25	6	0	0	1	2	10	5	2	27	17	3	2	5
S2	**54**	**89**	**128**	26	33	8	5	35	2	2	2	2	0	10	15	1	0	6
S3	46	**114**	44	24	29	13	6	34	2	2	3	2	1	17	6	1	0	3
S4	7	25	23	26	0	0	0	20	0	0	2	0	0	0	0	0	0	0
S5	27	38	28	4	21	2	6	13	0	0	2	1	0	10	8	2	0	2
S6	2	15	7	0	1	7	0	3	1	0	0	0	0	0	0	0	0	1
S7	0	5	3	0	4	0	3	4	0	0	0	0	0	0	0	0	0	0
S8	0	40	35	19	11	7	6	17	0	0	0	0	0	0	0	0	0	0
S9	3	1	2	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0
S10	2	2	2	0	0	0	0	0	0	2	0	0	0	4	2	2	0	0
S11	12	1	6	1	4	0	0	0	0	0	7	0	2	8	4	3	0	0
S12	6	2	2	0	2	0	0	0	0	0	0	4	0	5	0	0	0	0
S13	3	0	2	0	2	0	0	0	0	0	3	0	0	2	2	1	0	0
S14	36	7	13	0	5	1	0	0	2	4	8	2	2	16	15	6	1	1
S15	19	15	8	0	6	0	0	0	0	2	6	0	2	15	8	3	0	0
S16	3	1	1	0	1	0	0	0	0	2	3	0	1	6	3	2	0	0
S17	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
S18	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
(b) Global connectivity between stakeholders																		
S1	**0.99**	**0.98**	**0.99**	0.84	**0.96**	0.88	0.58	0.76	0.84	0.88	0.95	0.84	0.88	**0.98**	0.95	0.95	0.63	0.88
S2	**0.98**	**0.98**	**0.99**	0.88	**0.97**	0.91	0.79	0.88	0.84	0.88	0.93	0.84	0.82	**0.97**	0.93	0.93	0.44	0.88
S3	**0.99**	**0.99**	**0.99**	0.88	**0.98**	0.91	0.79	0.88	0.84	0.88	0.95	0.84	0.88	**0.98**	0.95	0.95	0.44	0.88
S4	0.79	0.84	0.84	0.76	0.76	0.68	0.58	0.72	0.58	0.58	0.79	0.58	0.58	0.68	0.68	0.68	0.25	0.58
S5	**0.97**	**0.98**	**0.98**	0.88	**0.96**	0.88	0.79	0.88	0.76	0.82	0.93	0.84	0.82	0.95	0.91	0.91	0.44	0.88
S6	0.88	0.88	0.91	0.76	0.84	0.82	0.68	0.79	0.79	0.58	0.68	0.68	0.44	0.82	0.68	0.68	0.25	0.84
S7	0.58	0.79	0.79	0.68	0.79	0.68	0.68	0.79	0.44	0.44	0.58	0.58	0.25	0.58	0.58	0.58	0.00	0.58

S8	0.76	0.88	0.88	0.79	0.84	0.79	0.79	0.82	0.58	0.44	0.68	0.58	0.25	0.58	0.58	0.58	0.00	0.68
S9	0.84	0.84	0.84	0.58	0.76	0.84	0.44	0.58	0.76	0.68	0.68	0.68	0.58	0.79	0.68	0.68	0.44	0.76
S10	0.88	0.88	0.88	0.58	0.82	0.68	0.44	0.44	0.68	0.82	0.82	0.68	0.76	0.88	0.88	0.88	0.44	0.68
S11	0.95	0.93	0.95	0.84	0.93	0.76	0.58	0.68	0.68	0.82	0.93	0.76	0.88	0.93	0.93	0.93	0.44	0.76
S12	0.84	0.84	0.84	0.68	0.84	0.76	0.58	0.58	0.68	0.68	0.76	0.76	0.58	0.84	0.76	0.76	0.44	0.76
S13	0.91	0.87	0.91	0.68	0.91	0.68	0.44	0.44	0.58	0.76	0.91	0.68	0.82	0.91	0.91	0.91	0.44	0.68
S14	**0.99**	**0.97**	**0.98**	0.76	**0.96**	0.88	0.58	0.68	0.84	0.88	0.93	0.84	0.88	**0.98**	0.95	0.95	0.63	0.88
S15	0.95	0.93	0.95	0.76	0.93	0.76	0.58	0.58	0.68	0.88	0.93	0.76	0.88	0.95	0.93	0.95	0.44	0.76
S16	0.95	0.93	0.95	0.76	0.93	0.76	0.58	0.58	0.68	0.88	0.93	0.76	0.88	0.95	0.95	0.93	0.44	0.76
S17	0.63	0.44	0.44	0.25	0.44	0.44	0.00	0.00	0.44	0.44	0.44	0.44	0.44	0.63	0.44	0.44	0.44	0.44
S18	0.72	0.58	0.72	0.44	0.58	0.58	0.25	0.25	0.58	0.58	0.58	0.58	0.58	0.72	0.58	0.58	0.44	0.58

Note: Interfaces with values ≥50 in Table 7.8(a) and ≥0.96 in Table 7.8(b) are considered as significant. Important interfaces are marked in bold type.

The connectivity between issue categories are presented in Table 7.9 from the direct and global perspectives. Important interfaces are bolded. As shown in Table 7.9(a), “technical related” is the most remarkable issue category, due to three reasons: (1) technical issues exert substantial direct influences on issues of social, cost and project management and governance types; (2) technical issues also receive great impacts from issues of the three abovementioned categories; and (3) many technical issues are directly interrelated. As shown in Table 7.9(b), project management and governance issues give huge impacts on cost and technical related issues when considering both direct and global interfaces in the network.

Table 7.9: Direct and global connectivity between issue categories in the TD project

	Cost	Economic	Environmental	Ethical and reputational (ER)	Political	Project management and governance (PMG)	Social	Technical	Time	Others
(a) Direct connectivity between issue categories										
Cost	59	8	7	4	9	34	18	**117**	0	1
Economic	9	14	0	2	1	4	5	4	0	4
Environmental	7	0	8	3	3	17	4	37	0	0
ER	2	2	4	1	1	9	10	18	0	1
Political	2	0	1	4	8	5	8	27	0	10
PMG	44	4	12	10	5	75	19	**120**	10	2
Social	26	5	1	10	10	22	46	64	0	2
Technical	**125**	5	36	24	33	**122**	**81**	**319**	5	21
Time	4	0	0	0	0	7	0	3	2	0
Others	3	3	0	3	11	3	2	23	0	8
(b) Global connectivity between issue categories										
Cost	0.90	0.88	0.88	0.93	0.93	0.93	0.93	0.93	0.44	0.91
Economic	0.91	0.82	0.82	0.91	0.91	0.91	0.91	0.91	0.44	0.91
Environmental	0.88	0.76	0.82	0.88	0.88	0.88	0.88	0.88	0.44	0.82
ER	0.93	0.88	0.88	0.90	0.93	0.93	0.93	0.93	0.44	0.91
Political	0.91	0.82	0.88	0.91	0.87	0.91	0.91	0.91	0.44	0.88
PMG	**0.95**	0.88	0.88	0.93	0.93	0.93	0.93	**0.95**	0.63	0.91
Social	0.93	0.88	0.88	0.93	0.93	0.93	0.90	0.93	0.44	0.91
Technical	**0.95**	0.88	0.88	0.93	0.93	**0.95**	0.93	0.93	0.63	0.91
Time	0.72	0.58	0.58	0.58	0.58	0.72	0.58	0.72	0.44	0.58
Others	0.91	0.88	0.82	0.91	0.91	0.91	0.91	0.91	0.44	0.87

Note: Interfaces with values ≥80 in Table 7.9(a) and ≥0.95 in Table 7.9(b) are considered as significant. Important interfaces are marked in bold type.

7.2.4 Suggestions of stakeholder management measures

The calculation of SNA metrics leads to thorough investigation on the relational structures of the stakeholder issue network. A series of stakeholder management measures, which can be grouped into three main approaches, are suggested below on grounds of the network analysis results. These measures can assist the project team to improve stakeholder engagement, and address the key issues and interdependencies which would otherwise markedly escalate the network complexity.

Addressing critical stakeholder-related issues

By consolidating the calculation results of nodal degree, node betweenness centrality, status centrality, brokerage and ego network size, Table 7.10 compiles a list of 33 critical issues which ought to be paid particular attentions. The core project team should treat these issues with high urgency and attempt to alleviate them, since they play important positions in connecting other issues and exert great impacts on many predecessors and successors. Among these issues, majority are technical related (16 no.); while others are mainly cost related (5 no.), social related (5 no.), project management and governance related (4 no.), political related (1 no.), and ethical and reputational related (1 no.). This result is consistent with the findings of Flyvbjerg (2014) where he identified technical, economic, political and aesthetic sublimes as four important drivers in the recent MCP boom. Regarding stakeholder types, most critical issues are sourced from internal stakeholders, including 8 from the design-and-build contractor, 8 from the project manager, 7 from the project proponent, and 3 from designers and consultants. This observation explains why many previous MCP studies have been conducted from the perspectives of internal stakeholders (Memon and Rahman, 2014; Siva and London, 2010; Toor and Ogunlana, 2009, 2010). Seven issues are related to external stakeholders, in which general public is the largest stakeholder group. This result is coherent with the findings of Manowong and Ogunlana (2008) and Li et al. (2013), where failures in accommodating the concerns of general public can lead to severe resistance and may eventually cease the project.

Table 7.10: The identified critical stakeholder-related issues in the TD project

Issue code	Issue	Related stakeholder	Issue category
S1I2	Accommodating the requirements of various end users	Project proponent	Project management and governance
S1I5	Delivering the project within budget	Project proponent	Cost
S1I12	Enhancing international reputation or image of the city	Project proponent	Social
S1I17	Political interference to project implementation	Project proponent	Political
S1I24	Provision of good incentives and clear instructions to support project implementation	Project proponent	Project management and governance
S1I29	Sufficiency and effectiveness of public consultation	Project proponent	Technical
S1I31	Vulnerability of the project end product to natural disaster such as earthquake	Project proponent	Technical
S2I5	Delivering the project within budget	Design-and-build contractor	Cost
S2I6	Availability and efficient allocation of workforce and resources	Design-and-build contractor	Technical
S2I7	Enhancing company image and fulfilling corporate social responsibility	Design-and-build contractor	Ethical and reputational
S2I14	Adopting green and sustainable design and construction methods	Design-and-build contractor	Technical
S2I26	Achieving satisfactory construction safety performance	Design-and-build contractor	Technical
S2I31	Technical complexity in structural design and construction	Design-and-build contractor	Technical
S2I32	Using innovative and efficient construction methods and technology	Design-and-build contractor	Technical
S2I33	Vulnerability of the project end product to natural disaster such as earthquake	Design-and-build contractor	Technical
S3I2	Accommodating the requirements of various end users	Project manager	Project management and governance
S3I4	Delivering the project within budget	Project manager	Cost
S3I8	Creation of a convenient and comfortable pedestrian circulation or transport network	Project manager	Social
S3I18	Project design in terms of design concept, aesthetics and visual permeability	Project manager	Technical
S3I25	Stability against fluctuation of construction labour and material prices	Project manager	Cost
S3I27	Sufficiency and effectiveness of public consultation	Project manager	Technical
S3I29	Using innovative and efficient construction methods and technology	Project manager	Technical
S3I30	Vulnerability of the project end product to natural disaster such as earthquake	Project manager	Technical

S5I12	Project design in terms of design concept, aesthetics and visual permeability	Lead designer	Technical
S6I2	Exercising stringent cost control to ensure the project is delivered within budget	Quantity surveying consultant	Cost
S8I6	Formation of project coalition or collaborative efforts among project stakeholders	Lead building services designer	Project management and governance
S12I3	Provision of barrier-free facilities for the disabled	NGO (social welfare-related)	Social
S14I13	Possibility and freedom of access to project relevant information by civil society	General public	Others
S14I15	Provision of barrier-free facilities for the disabled	General public	Social
S14I16	Provision of public space and amenities	General public	Social
S14I18	Sufficiency and effectiveness of public consultation during project preparation	General public	Technical
S15I22	Provision of tight security measures and facilities	End users of Office Tower A	Technical
S16I7	Provision of tight security measures and facilities	End users of Office Tower B	Technical

Eliminating critical issue interdependencies

Based on the link betweenness centrality result, a list of 15 critical issue interdependencies is identified in Table 7.11. Enhancing collaborations between stakeholders of the relevant sourcing nodes and targeting nodes can help to resolve these 15 critical links. Accordingly, eliminating these links can disconnect a large number of issues, and disentangle the ‘hairball’ structure of the network into less complicated clusters. The project team should formulate stakeholder management measures to alleviate the critical issues (in Table 7.10), as well as to improve coordination between stakeholders relating to the critical links (in Table 7.11). The project team should consider both the identified key issues and the important cause-and-effect relationships between issues when developing the stakeholder management strategies. Some suggested measures are summarised in Table 7.11.

Table 7.11: Critical issue interdependencies in the TD project and their suggested stakeholder management measures

Critical links		Suggested stakeholder management measures
S1I2	→ S2I5	Contractor should actively and continuously communicate with the project proponent to fully understand the changing security and accommodation requirements of end users. In addition, contractor should consider potential cost increase caused by subsequent design changes before deciding whether to incorporate the changing requirements.
S2I31	→ S1I5	Project proponent and contractor should communicate on potential additional cost items, particularly those caused by the construction of technically complex building and structural elements.
S1I17	→ S3I27	Project manager should maintain high transparency and effectiveness of public consultation so as to mitigate potential controversies and political interference suffered by project proponent.
S3I18	→ S1I29	Project proponent should continuously monitor the effectiveness of public consultation conducted by project manager regarding the project design (in terms of design concept and aesthetics).
S1I12	→ S2I14	Contractor should communicate more with project proponent to fully understand its expectations on green design and sustainability performance which eventually help to enhance project and city images.
S1I12	→ S3I18	Project manager should communicate more with project proponent to fully understand its expectations on project design (in terms of design concept and aesthetics) which eventually helps to enhance project and city images.
S15I3	→ S2I31	If end users of Office Tower A concern about the building adaptability for future expansion, contractor should take this concern into its design and construction considerations.
S14I15	→ S3I29	Project manager should fully understand the general public's expectations on the provision of barrier-free facilities in its adoption of innovative construction methods and technologies.
S3I18 S16I1	→ S14I15 → S14I16	The general public should actively participate in public consultation to reflect their expectations on the provision of barrier-free facilities and public spaces, so that the project team can maintain an appropriate balance between the public's expectations, the project design and the end users' requirements.
S2I5	→ S1I17	Project proponent should mitigate potential controversies and political interference by imposing stringent cost control on contractor during the entire project lifecycle.
S14I15	→ S1I17	Project proponent should mitigate potential controversies and political interference by accommodating the general public's expectations on the provision of barrier-free facilities.
S14I6	→ S1I17	Project proponent should mitigate potential controversies and political interference by minimising possible disturbances to the affected vicinity and the general public owing to project development.
S3I4	→ S17I3	Project manager and end users of Office Tower C should communicate more on issues regarding operational requirements and getting statutory approvals. In addition, project manager should consider their cost implications in the subsequent design and construction processes.
S3I30	→ S1I24	Project proponent should clearly reflect its expectations and requirements on seismic-resistant works, so that project manager can define clear implementation details and appropriately engage the right professionals and experts into the project team.

Improving stakeholder communication and engagement

Based on the interface-level results, some measures to improve communication/coordination between the highly connected stakeholders and issue categories are suggested below. The important interfaces between stakeholders and issue groups have been identified in Table 7.8 and 7.9 by calculating the direct and global connectivity. Some suggested measures comprise: (a) project manager should deliver clear work instructions and end users' requirements to contractor by enhancing their communication; (b) contractor should actively and adequately communicate with project proponent to understand its project expectations and requirements; (c) contractor should proactively communicate with project manager when it faces challenges in undertaking seismic-resistant works; (d) contractor should self-inspect its design and works to ensure statutory compliance and appropriate balance between various stakeholder concerns; (e) lead designer should enhance its design coordination with the lead structural designer, the lead building services designer, and the contractor's internal design team; (f) the project proponent, contractor, project manager and lead designer should give more efforts in conducting public engagement so as to understand the project expectations of general public; (g) stakeholders should pay particular attention on the interrelationships and chain effects between technical, cost and project management and governance related issues.

7.2.5 Simulating effectiveness of the suggested stakeholder management measures

When all stakeholder management measures suggested in Section 7.2.4 are effectively and fully implemented, the 33 critical issues and 15 key issue interdependencies (as identified in Table 7.10 and 7.11 respectively) would be resolved. This section illustrates an immediate simulation of the resultant stakeholder issue network, by firstly eliminating the identified key issues and links, then re-calculating the network properties. The simulation results can help the core project team to imitate the likely effectiveness of the suggested measures, and to predict the potential of network complexity reduction. In the simulation results, the resultant stakeholder issue network is diminished to a structure of 220 nodes and 624 interactions, as shown in Figure 7.4. In comparison to the initial network of Figure 7.1, three observations are found: (1) the network is less condensed as the issue interactions are reduced considerably; (2) the number of isolated nodes increases, implying that more stakeholder issues can be handled individually without giving proliferating effects; and (3) dyadic ties increase – this implies an easier stakeholder management process when compared to the situation that many issues are interconnected, since the project team would only need to focus on the particular cause-and-effect relationships. The reduced network complexity can also be reflected by the figures of network properties. The density and cohesion of the resultant network in Figure 7.4 are 0.013 and 0.019. Comparing with the original network density and cohesion of 0.029 and 0.082, they are declined by 55.17% and 76.83% respectively. According to the simulation results, the suggested stakeholder management measures are likely to be relevant and useful in decreasing the network complexity and facilitating the stakeholder management process of the TD project. In practice, to cope with the dynamics of project environment and issue interdependencies, the stakeholder issue network should be continuously monitored and assessed. Stakeholder management measures should also be adjusted corresponding to the updated network assessment results.

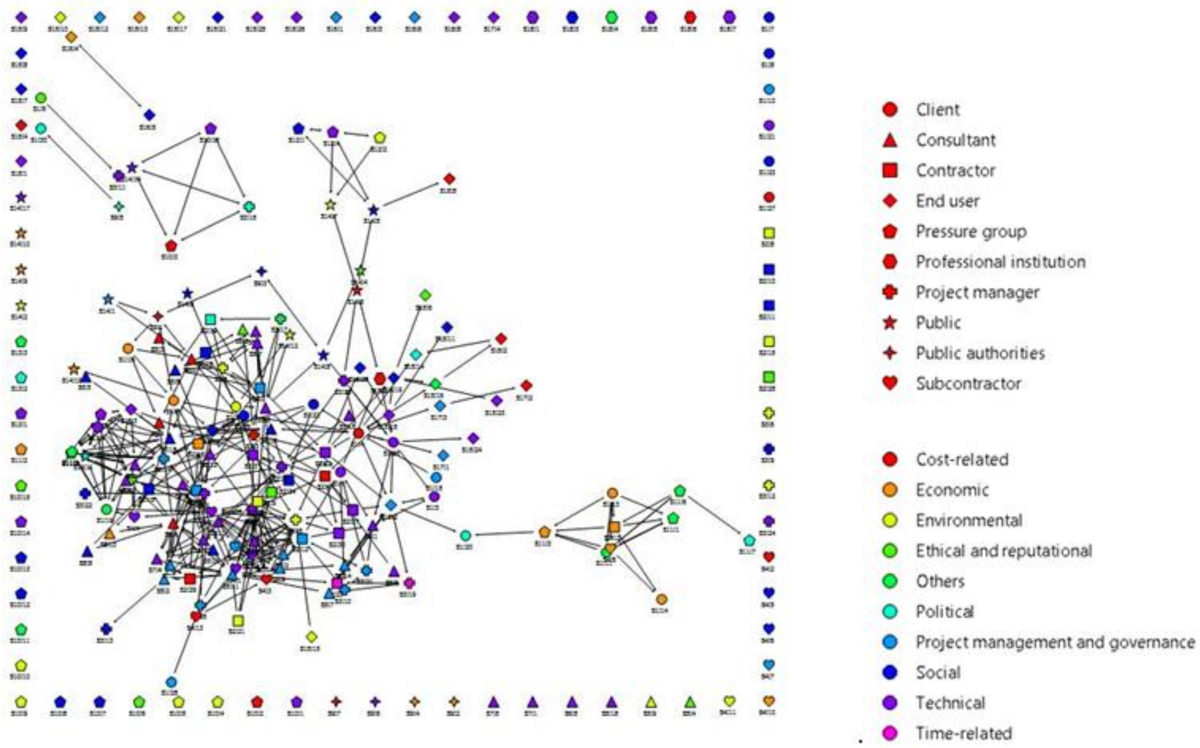


Figure 7.4: The stakeholder issue network after fully implementing the suggested stakeholder management measures for the TD project

7.2.6 Validation of the case study results

At the end of the case study, the findings were disseminated to the core project team. The researcher obtained feedbacks from the project team on the findings and the proposed social network approach via semi-structured interviews. Similar to Case Study I and II, the project team was invited to share their viewpoints on the following questions.

1. Regarding the network analysis results:

(a) Do you agree with the analysis results (e.g. the roles and functions of individual issues, the highly connected stakeholders and issue types, as well as the identified critical issues and interdependencies, etc.)?

(b) Are the results (e.g. issue network map) easy to follow and understand?

2. Regarding the proposed social network approach:

(a) Can the proposed approach identify project stakeholders and the issues sourced from each stakeholder as complete as possible?

(b) Can the proposed approach appropriately define and analyse the influence interactions between stakeholder-related issues?

(c) Can the proposed approach effectively assess the importance levels of stakeholder-related issues and issue interactions?

(d) What are your comments or suggestions to improve the proposed approach?

In general, the core project team agreed with the network analysis results. They considered that the network diagrams and SNA results are easy to follow. In addition, the project team opined that the proposed approach is useful in analysing the issue interdependencies and their chain effects on project development, as well as identifying the critical issues and interactions which ought to be addressed with higher priority. They believed that these results can provide them useful insights when developing stakeholder management and engagement strategies.

The project team considered that this approach would be particularly useful to policy makers and core project players of public MCPs, especially in the early project stage; because they can identify completely the issues related to each project stakeholder, and visualise an overall picture of the issue cause-and-effect relationships. However, they opined that this approach requires a long and time consuming process to gather issue information and relational data. Also, there might be practical difficulties to solicit support from all stakeholders in data collection, because public MCPs often contain many highly confidential and sensitive information.

7.3 Case Study IV – the AI project

7.3.1 Description of the AI project

The AI project is the construction of a 150-hectare artificial island, under a contract sum of around HK$6.98 billion, to create land for developing passenger clearance facilities and transport infrastructures in Hong Kong. This is a public development. The project scope is to construct a seawall of about 6 km long and to reclaim an area of 150 hectare for the island, using a new non-dredge method and stone columns (to expedite settlement).

The AI project is chosen for case study due to four reasons. First, this project is considered a MCP according to the definition on MCPs previously described in Chapter 2. Secondly, it involves a wide range of stakeholders and poses great challenges to the project stakeholder management. Thirdly, this project generates substantial impacts to the society, economy and environment; it makes the stakeholder issue analysis more meaningful when the issues of these kinds are in stake. Lastly, the AI project is an ongoing development. The researcher considers that it is less insightful to study past cases when their major issues and challenges are known.

The high complexities in the AI project made its stakeholder management a challenging task. For example, the non-dredge method, developed by the project proponent and resident engineer, has never been adopted for reclamation in Hong Kong until this case project. Unlike traditional reclamation, the non-dredge method intends to prevent dredging of marine mud, to minimise disturbance to seabed and to lessen the backfilling materials needed. It was considered more environmental friendly but technologically complex. The construction site was proximate to an airport, and marine traffic near the site was heavy. Marine ecology in diversified species was found at and near the site including Chinese white dolphins (CWD).

Four construction projects including superstructures were in close interface with the AI project. The project schedule was extremely tight and any time overruns (in phase or in whole) would delay the progress of interfacing projects. Desktop studies was conducted to understand the project background. Documents reviewed include two main types. The first type was publicly accessible government documents, such as project profile and progress reports prepared by the project proponent; environmental monitoring and auditing reports prepared by the environmental protection department; as well as discussion papers submitted to legislative council for funding approval. The second type was non-government documents, including project profile prepared by the contractor; articles by green groups regarding potential project environmental impacts; and discussion papers by professional institutions on technical features of the project. These documents were analysed under six themes: cost, time, scope of works, stakeholders, issues of each stakeholder, and project impacts; in order to summarise and synthesise the obtained project information. The researcher also conducted a site visit to better understand the project progress and site situation.

In view of the dynamism of stakeholder issues and their relationships, a definite time span is defined. The AI project is an ongoing development, and roughly three-fifth of the contract period of its main contract works had passed when the research was conducted. This case analysis solely focuses on stakeholder issues which are related to or arise during construction phase, and the issue network herein only reflects a screen-shot in the construction period. The findings of desktop studies and site visit helped the researcher in two tasks: (1) to fine-tune the stakeholder and issue classifications previously derived through literature review, and (2) to derive the tentative lists of stakeholder entities and issues in the case, which would be used as reference lists to assist practitioners in the network development process.

7.3.2 Development of the stakeholder-related issue influence network

Similar to the previous case study, the first step was to identify the stakeholders who were sources of the nodes (i.e. stakeholder-related issues). Chain referral sampling was used for this task. To start the referral process, three representatives from the contractor company and subcontractor were reached. These representatives were selected because they were situated at or higher than the senior management level, and have directly involved in the construction stage since contract commencement. They were invited to appoint internal stakeholder groups. Then, the nominated parties were invited to provide referrals of external stakeholders who may impact or be impacted by the project. After that, these designated parties were required to appoint any conceivably impacting or impacted groups who were still absent in the list. A provisional stakeholder list (which had been developed by literature review and desktop studies) was given for reference in the chain referral process, while feedbacks on this reference list had been sought from the three initially engaged representatives prior to the actual stakeholder identification. Accordingly, 18 stakeholders were identified and coded numerically as S_a (where a = 1 to 18). Table 7.12 summarises the stakeholder profiles.

Table 7.12: Stakeholders identified in the AI project

Stakeholder	Stakeholder description	Issue no.
S1: Project proponent	A public agency who initiates and funds the proposed reclamation works	40
S2: Resident engineer	A private engineering consultancy (appointed by S1) who undertakes site investigation and Environmental Impact Assessment; designs the reclamation method and supervises the works of S3	25
S3: Contractor	A private contractor company (employed by S1) to construct an artificial island by reclamation	48
S4: Subcontractor and supplier	Subcontractor and supplier companies including backfilling; supplying and manufacturing of steel for seawall construction	15
S5: Independent environmental checker (IEC)	An independent unit (employed by S2 under statutory requirements) to review the environmental monitoring and auditing works done by S6; and to report to S11	16
S6: Environmental team	An independent unit (hired by S3 under statutory requirements) to undertake environmental monitoring and auditing on the works of S3; and to report to S5	9
S7: Maritime engineering consultant	A private consultancy (hired by S3) to assist S3 in developing marine traffic schedules; and addressing marine safety and regulatory issues	7
S8: Environmental specialists in marine ecology	Independent and qualified specialists (hired by S6) to conduct impact monitoring on ecology in the nearby waters, in particular Chinese White Dolphins (CWD)	7
S9: Marine Bureau	A government bureau in charge of port control; shipping register and licensing; navigational issues	5
S10: Civil Aviation Bureau	A government bureau in charge of air traffic flow control; managing aviation safety; setting and implementing relevant statutory regulations	5
S11: Environmental Protection Bureau	A government bureau in charge of environmental protection and environmental legislation enforcement	13
S12: District Board	Local authority to advise the government on district administration and affairs	3
S13: Green groups	--	9
S14: Transport trades	Transport operators who provide public transport services in the water or air near the construction site	7
S15: Contractors of interfacing projects	Contractor companies of interfacing construction projects undertaken concurrently with the case project in or nearby the construction site	10
S16: Local residents	Residents who live in the vicinity of the construction site	12
S17: Fishermen groups	Fishermen whose habitual fishing grounds or fish culture zones are located near the construction site	3
S18: General public	--	13

The second step was to determine the nodes, i.e. stakeholder-related issues of the AI project. Empirical knowledge-based method was used for the said purpose. Interviews were carried out with representatives from the 18 stakeholders. The interviewees (except S16 to S18) all had direct involvement in the construction stage, also they were situated at or higher than the senior management level and with ≥10 years work experience in their profession. These sampling criteria help to make certain that the collected data were reliable and representative. Based on their experience and project knowledge, the interviewees were asked to identify their associated issues in the project. Similar to stakeholder identification step, a provisional list of stakeholder issues and issue categories (which had been compiled by literature review and desktop studies) was provided as reference to assist the issue identification task; while feedbacks on this reference list had been obtained from the three initially engaged stakeholder representatives in the stakeholder identification process. Most interviews lasted 1-2 hours and two interviews lasted 2.5-3 hours. All interviews were properly documented, the transcripts were sent back to interviewees for feedbacks. Accordingly, 247 issues sourced from the 18 stakeholders were identified. For network data processing, these nodes were coded numerically as S_eI_f, where *f* represents the issue number of a particular stakeholder *e*. It should be noted that the same issue identified by different stakeholders were distinguished as different issues, and were assigned with different numerical codes. This is because the nodes in the network analysis refer to stakeholder-related issues, i.e. issues concerned by or sourced from a particular stakeholder. When stakeholders told contradicting stories about an issue, the researcher would study and sort out the contradictions, e.g. by seeking opinions from relevant stakeholders on the contradictions and raising questions about these issues from different angles; in an attempt to reaching consensus. Based on literature review, the identified 247 issues were classified into 13 categories, as shown in Table 7.13. The top three categories were ‘environmental’(55), ‘technological’(30) and ‘social’(28); making up 45% of the nodes.

Table 7.13: Summary of stakeholder-related issue categories in the AI project

Issue category	Issue no.
Cost related	12
Economic related	5
Environmental related	55
Ethical related	14
Legal related	14
Organisational related	25
Political related	8
Procurement and contractual related	11
Quality related	17
Safety related	13
Social related	28
Technological related	30
Time related	15
Total	247

The last step was link identification and assessment. Similar to the previous case study, a link refers to the influence that a stakeholder-related issue exerts on another issue. Accordingly, a questionnaire survey was used to obtain responses from representatives of the 18 stakeholders who had previously participated in node determination (Appendix B). At the beginning, the researcher verbally explained (face-to-face or on phone) the survey purpose, instructions and questions to all respondents in an attempt to avoid their confusions. In the survey, respondents were asked to consider all possible combinations of node pairs, and to decide whether a link exist in each pair based on their empirical knowledge. Since relationships can be reciprocal, respondents had clearly defined the link directions. Next, the respondents quantified each identified link by giving two scores, namely the *intensity of impact* given by an issue on the other, and the *likeliness for this impact to happen*; with a five-point scale ('1' indicates the lowest level and '5' denotes the highest level). Multiplying the impact intensity and likeliness serves as a basis for evaluating the influence level of a pair of stakeholder issues. At last, 1,660 links connecting 247 nodes were determined. An adjacency matrix were created to represent the influence network A(247,1660) of stakeholder-related issues in the AI project.

7.3.3 Results of network analysis

Visual observation results

Figure 7.5 captures the influence network, composing of 247 stakeholder-related issues linked by 1660 ties, in the AI project. The node colours and shapes denote the issue categories and stakeholder groups respectively. An edge joining two adjacent nodes represents the presence of an influence relationship between the two issues. The centre of network is occupied by the highly connected nodes, while nodes at the periphery are those with fewer linkages. It can be observed that almost all issues were interconnected except one isolated node, showing that the project stakeholder management process was highly complex. Two 'hairball' clusters were observed in the centre of the map. The issues in each cluster were closely interrelated. Most issues in the upper cluster were technological and time related. In the lower cluster, a majority of nodes are the interconnected environmental issues, which were also closely tied to legal and organisational issues. Social and economic issues were located at the periphery, suggesting that many issues of these types were given lower attention from the stakeholder perspective.

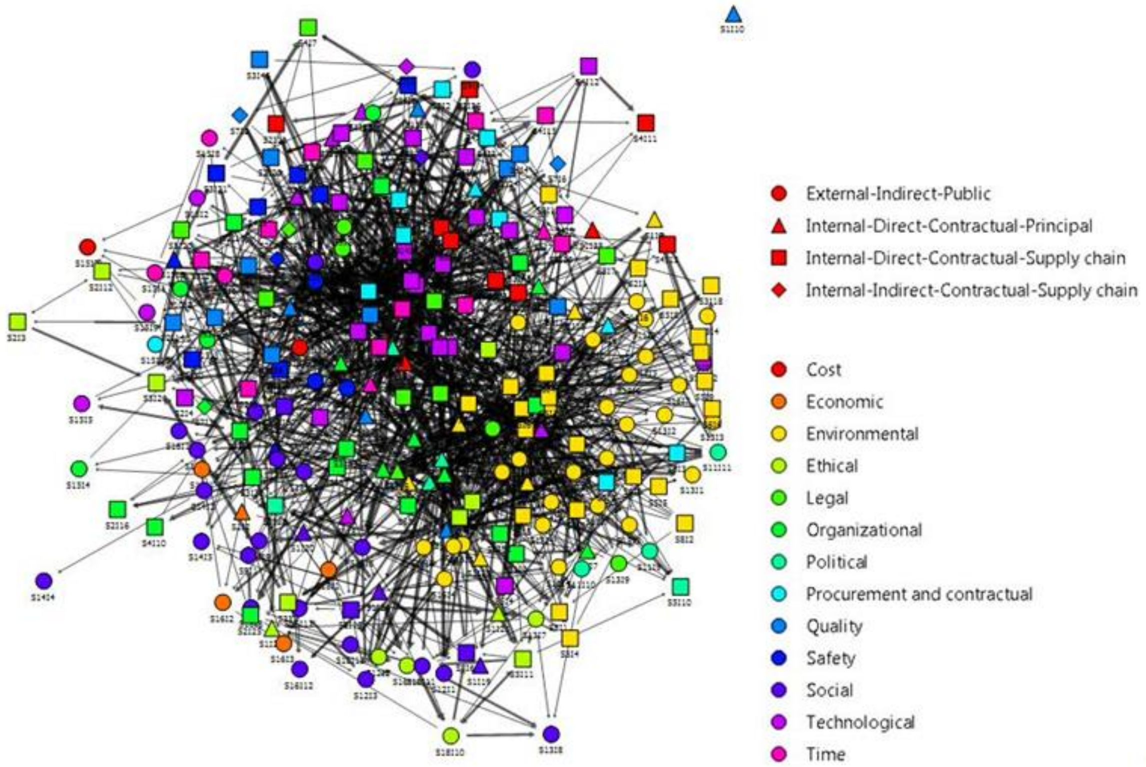


Figure 7.5: Stakeholder-related issue influence network in the AI project

Note:
(1) Node shapes and colours denote stakeholder and issue categories respectively;
(2) Stakeholders (S1-S18) are categorised from four aspects to reflect their positions in the stakeholder community: (i) internal/external interests; (ii) direct/indirect impacts on environmental management; (iii) contractual/public in considering formal contractual relationships; and (iv) principal/supply chain by further classifying the contractual parties.

Network-level results

Network-level metrics provide a quantitative means to unravel the network structure. Network density was equal to 0.321 and the average distance of nodes was 3.383 walks, showing that the issues are situated closely in a dense network. The network cohesion was 0.682. A greater cohesion than the density indicates that the network configuration is complicated in terms of node reachability.

Node-/link-level results

Figure 7.6 shows the distribution of twenty one stakeholder-related issues according to their out-degrees and degree differences. These twenty one issues were chosen and worth special attention since they either had a high weighted sum of direct outgoing impacts or showed a great net direct influence. S3I17 (“Fully implementing environmental mitigation measures throughout the construction course and making necessary revisions to suit the changing conditions” sourced from contractor) has the highest out-degree and the second largest in-degree simultaneously, in respective values of 646.50 and 584.55. S1I1 (“Unforeseen situations delay project completion and the commencement of interfacing superstructure projects” sourced from project proponent) has the second largest out-degree and degree difference of 458.35 and 304.85 respectively, due to its great number of direct successors and relatively low immediate incoming impacts from other stakeholder issues. Both issues, S1I22 (“Public pressure and controversies in case of public dissatisfaction on the project progress and performance” sourced from project proponent) and S8I4 (“Disturbance to marine ecology and biodiversity (in particular the CWD community)” sourced from environmental specialists in marine ecology), had the lowest out-degrees but the largest negative degree differences; indicating that they are most heavily impacted by their direct predecessors but can only exert little impacts on their direct successors. In this network, most issues are ordinary nodes. S1I10 (“Sustainability and reliability of the project end product after completion of works” sourced from project proponent) is the sole isolated node in the AI project, implying that it has been considered by stakeholders as an independent problem to deal with.

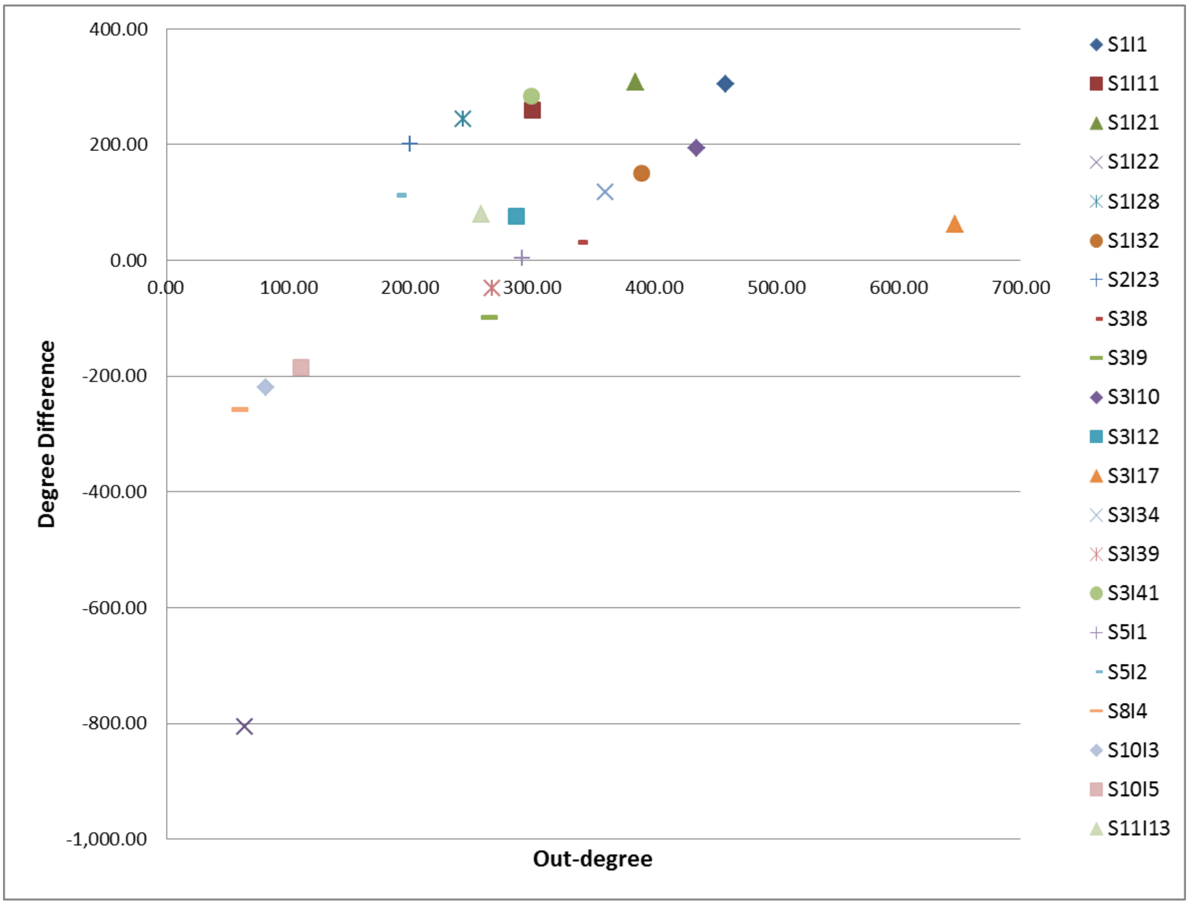


Figure 7.6: Distribution of stakeholder issues with high out-degrees and degree differences in the AI project

The top fourteen stakeholder issues and the top eighteen issue interdependencies according to their betweenness centrality are shown in Table 7.14 and 7.15 respectively. As shown, S3I17, S1I22, S3I10 ("Adopting construction methodology and systems which are experimental and leading-edge technology in the local construction industry" sourced from contractor), S3I39 ("Changes in design and construction methods due to management decisions or unforeseen engineering challenges during construction phase" sourced from contractor) and S1I1 are the top five issues with the highest betweenness centrality. These five issues are important junctions connecting many issue pairs and giving high degree of control over the interactions passing through them. Sixteen of the key interdependencies identified in Table 7.15 are flowing through these five issues. Among these sixteen relationships, "S3I10 →S1I1" and

"S3I17 →S3I39" should be handled with care because both of their sourcing and targeting nodes are the issues with the highest betweenness centrality. Comparing stakeholder issues in Figure 7.6 and Table 7.14 can recognise four more important issues which play the roles of major hubs in the network. These four issues comprise: S1I26 ("Conducting effective public and community consultation from time to time during construction" sourced from project proponent), S1I36 ("Compliance with environmental protection related legislations as required by relevant statutory bodies" sourced from project proponent), S3I32 ("Site coordination with interfacing projects to facilitate construction activities" sourced from contractor) and S3I47 ("Getting statutory approvals and passing laboratory tests as required by relevant statutory bodies to undertake construction works" sourced from contractor).

Table 7.14: Important stakeholder issues in the AI project based on node betweenness centrality

Rank	Issue code	Node betweenness centrality
1	S3I17	0.1616
2	S1I22	0.0959
3	S3I10	0.0891
4	S3I39	0.0532
5	S1I1	0.0509
6	S1I32	0.0493
7	S1I21	0.0488
8	S3I47	0.0485
9	S3I12	0.0479
10	S1I26	0.0468
11	S3I32	0.0465
12	S3I9	0.0463
13	S3I8	0.0456
14	S1I36	0.0454

Table 7.15: Important issue interdependencies in the AI project based on link betweenness centrality

Rank	Link code & link betweenness centrality			Link description
1	S1I22	→ S1I36	2,003.17	Public pressure acts as an important driver for the project proponent to ensure legal compliance with environmental protection related regulations throughout project implementation.
2	S1I22	→ S1I26	1,905.50	Public pressure is an important driving force for the project proponent to conduct sufficient and effective public and community consultation throughout the construction course.
3	S2I23	→ S3I10	1,275.04	Sufficient specialised knowledge and relevant experience from resident engineer are essential for successful application of highly complex and experimental construction methodology by the contractor in the project.
4	S16I10	→ S1I21	1,078.88	Inadequately informing the local residents of the latest project impacts and addressing their subsequent needs could bring the project proponent political pressure and public discontent.
5	S1I36	→ S3I17	910.87	The project proponent’s emphasis on legal compliance with environmental regulations is an important driver for the contractor to properly implement the agreed environmental mitigation measures.
6	S3I47	→ S3I10	731.67	Passing laboratory tests for new materials could be a technical challenge to the contractor in his application of leading-edge and complex methodology.
7	S10I4	→ S3I10	713.86	The contractor encounters technical challenges in accommodating site constraints and mitigating Civil Aviation Bureau’s concerns on potential disruption to existing aviation traffic activities.
8	S1I36	→ S1I21	696.25	Incompliance with environmental legislations during project execution could bring the project proponent political pressure and public discontent about the government.
9	S17I1	→ S3I17	684.97	The contractor’s effective implementation of environmental mitigation measures is important for minimising disruption to habitual fishing operations near the site.
10	S3I17	→ S3I39	624.02	Revisions of environmental mitigation measures during construction stage could cause the contractor to make subsequent changes to its construction methods and programme.
11	S1I22	→ S16I10	612.88	Public pressure is an important driver for the project proponent to continuously inform the local residents of the project impacts and to address their subsequent needs during the construction course.
12	S1I24	→ S3I10	547.80	Stringent cost control by the project proponent increases the contractor’s technical challenges in applying the experimental and highly complex construction methodology.
13	S3I10	→ S3I12	538.79	The use of high complex and leading-edge technology could pose challenges to the contractor in procuring appropriate materials and equipment with a sufficient quantity.
14	S3I17	→ S1I16	511.05	Effective implementation of environmental mitigation measures by the contractor could alleviate the

				project proponent's concerns on waste generation and chemical spillage by construction vessels.
15	S8I4	→ S3I17	464.48	Environmental specialists' concerns on ecological impacts (e.g. CWD) is an important driving force for the contractor to properly implement the agreed environmental mitigation measures.
16	S5I1	→ S1I1	462.12	Ineffective environmental mitigation implementation and monitoring works checked by IEC could cause unexpected delays to the works and interfacing projects as concerned by the project proponent.
17	S3I10	→ S1I1	411.97	Unexpected situations and subsequent delays may occur when the contractor adopts an experimental and leading-edge construction methodology.
18	S3I14	→ S1I1	402.68	Unclear technological specification and work instructions received by the contractor could cause unforeseen delays to the works and interfacing projects as concerned by the project proponent.

Note: The cut-off point of link betweenness centrality is 400. After plotting a graph of the link betweenness centrality results, a sharp change was observed at 400, therefore 400 was considered as the cut-off point.

The top fifteen stakeholder-related issues based on their out-status centrality are presented in Table 7.16. As shown, S3I17, S1I1, S1I21 ("Encountering political pressure and subsequently affecting public sentiment towards the government" sourced from project proponent) and S3I10 are the top four issues exerting the greatest relative impact to the entire network. The out-status centrality result is coherent with Figure 7.6 because all issues with high out-status centrality have also been highlighted in the nodal degree result.

Table 7.16: Important stakeholder issues in the AI project based on the out-status centrality

Rank	Issue code	Out-status centrality
1	S3I17	2.4010
2	S1I1	1.9755
3	S1I21	1.8837
4	S3I10	1.7589
5	S3I34	1.5313
6	S1I32	1.5192
7	S5I1	1.4592
8	S3I8	1.4388
9	S3I41	1.2354
10	S11I13	1.1997
11	S1I28	1.1425
12	S3I12	1.1355
13	S3I39	1.0870
14	S3I9	1.0806
15	S1I11	1.0321

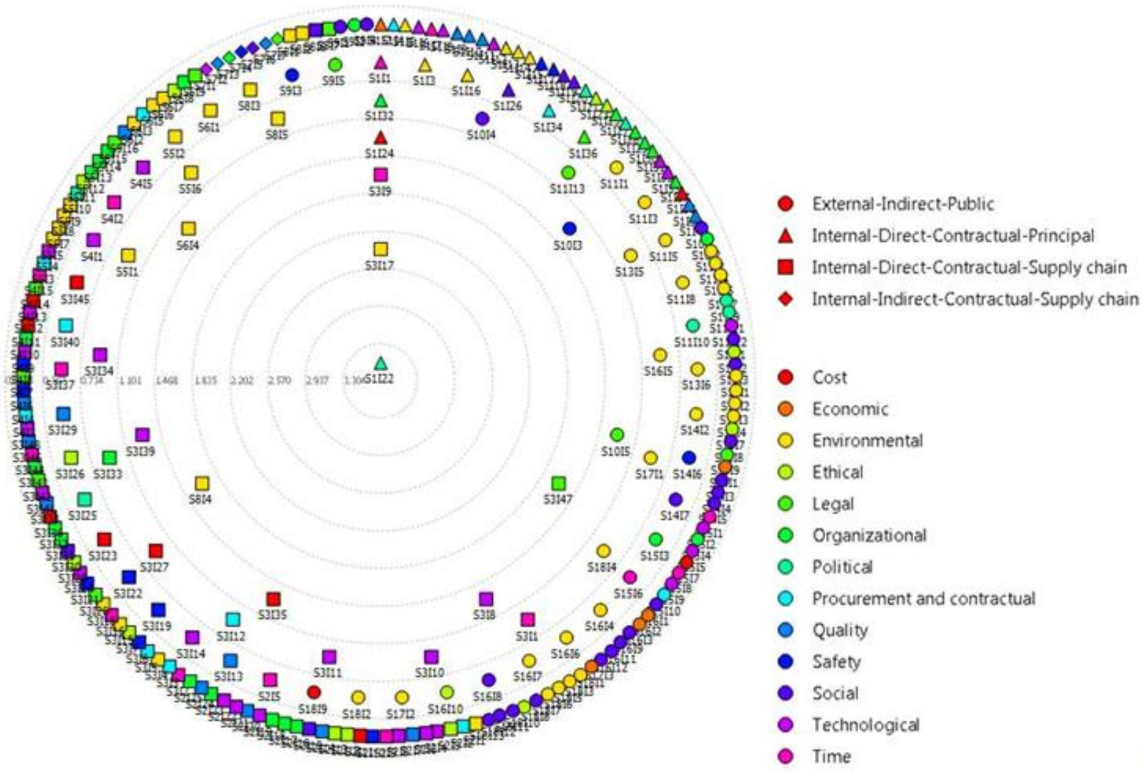


Figure 7.7: Distribution of stakeholder issues in the status centrality map for the AI project

The status centrality map of all stakeholder issues in the AI project is displayed in Figure 7.7. This figure shows an overall picture about the relative impacts of every issue in the whole network. Different node shapes and colours represent the stakeholder groups and issue categories respectively. It can be observed that, a majority of the centrally-positioned issues are sourced from internal stakeholders who can directly impact the project environmental management and are engaged under formal contractual relationships, e.g. S1, S3 and S6. The issues of green groups, local residents, fisherman groups and general public are located at the periphery; implying that the influences of these external and indirect stakeholders on project decision making are limited. S1I22 occupies the most central position in Figure 7.7, followed by environmental and legal (e.g. statutory compliance) issues; showing their strong overall impacts on the project development.

The top fifteen stakeholder issues based on their brokerage scores are presented in Table 7.17, where stakeholder groups are chosen as the partition vector. These issues are critical joints in the interactions among stakeholder groups. The proliferating impacts between stakeholder groups would be diminished when these issues are resolved. Owing to its representative and coordinator roles, S3I17 is the most critical issue in bridging stakeholder groups with the highest brokerage value of 2727. Comparing Table 7.17 and the previous node-level results can recognise two more important issues, namely S1I24 ("Completing the project within budget" sourced from project proponent) and S3I33 ("Achieving goals and objectives at project, managerial and functional levels" sourced from contractor). It can be observed that, a majority of issues in Table 7.17 are sourced from S3 (contractor) and S1 (project proponent); showing their important roles in stakeholder coordination and engagement. At last, Table 7.18 lists the ten issues with the largest ego network size, these issues can exert a great extent of direct influence since they have a large number of direct neighbours. The important issues identified in Table 7.18 are also in line with the previous node-level analysis results.

Table 7.17: Important stakeholder issues in the AI project based on the brokerage scores

Rank	Issue code	Coordinator	Gatekeeper	Representative	Itinerant	Liaison	Total
1	S3I17	630	327	1191	188	391	2727
2	S3I10	60	164	129	90	213	656
3	S1I32	29	50	193	142	159	573
4	S3I8	114	102	92	19	57	384
5	S5I1	73	75	118	38	70	374
6	S3I39	123	65	115	28	30	361
7	S3I9	86	140	48	22	52	348
8	S11I13	93	74	104	33	29	333
9	S3I12	137	131	29	11	19	327
10	S1I1	3	30	61	162	59	315
11	S3I34	42	84	55	56	57	294
12	S1I22	50	117	32	37	40	276
13	S3I47	100	112	11	2	9	234
14	S3I33	20	15	120	12	65	232
15	S1I24	0	11	11	179	28	229

Table 7.18: Important stakeholder issues in the AI project based on ego network size

Rank	Issue code	Ego network size
1	S3I17	94
2	S1I22	59
3	S3I10	48
4	S1I32	46
5	S3I8	40
6	S1I1	39
7	S3I9	38
8	S5I1	37
9	S11I13; S3I39	36

Interface-level results

The direct and global connectivity between stakeholders in the AI project are shown in Table 7.19. The critical interfaces are bolded. As shown, S2 (resident engineer) and S3(contractor) can receive great direct impacts from S1 (project proponent), therefore both resident engineer and contractor should enhance their communications with the project proponent. In addition, both "S1→S1" and "S3→S3" have high direct connectivity values of 79 and 169 respectively; showing that each of S1 and S3 has many interrelated issues of its own. As such, both the project proponent and contractor should conduct more communication activities within their own organisation. A comparison of Table 7.19(a) and 7.19(b) reveals two interesting findings. First, S5 (IEC) is a potential influential stakeholder to S1 and S11 (environmental protection bureau) – notwithstanding their relatively weak immediate connections, the impacts from S5 to S1 and S11 substantially grow from a global perspective. Secondly, although S11 has little direct connections with S1, S3 and S5, S11 can be readily impacted by these stakeholders when taking a global perspective. The findings imply a need for these relevant stakeholders to further enhance their communications and coordination.

The direct and global connectivity between issue categories in the AI project are presented in Table 7.20. The critical interfaces are bolded. Table 7.20(a) shows that many environmental issues are interconnected directly, indicating that an effective coordination among various environmental concerns is crucial to achieving satisfactory environmental performance. Also, environmental issues receive great direct impacts from technological and organisational concerns. A comparison of Table 7.20(a) and 7.20(b) identifies many important indirect interfaces from a global view. For instance, political issues can be triggered indirectly by legal, quality, social, time, organisational, and procurement and contractual related issues, notwithstanding the relatively weak direct impacts from these issues on political concerns. This worth attentions from the project team, particularly in this public development which receives high political pressure and public controversies.

Table 7.19: Direct and global connectivity between stakeholders in the AI project

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
(a) Direct connectivity between stakeholders																		
S1	**79**	**63**	**103**	3	31	11	4	13	4	2	16	3	16	13	1	25	7	21
S2	17	25	46	2	0	3	0	1	1	8	1	2	0	2	1	4	2	3
S3	**62**	11	**169**	40	13	18	7	17	15	41	23	0	16	20	26	24	14	22
S4	4	0	19	35	1	1	0	0	2	0	0	0	0	0	0	0	0	0
S5	22	1	24	0	18	14	0	10	0	0	19	0	1	0	0	0	1	9
S6	4	1	20	0	8	8	0	6	0	0	15	0	0	0	0	0	0	6
S7	1	1	16	0	0	0	1	0	4	2	0	0	0	1	0	0	0	0
S8	8	0	1	0	4	1	0	6	0	0	6	0	0	0	0	0	0	0
S9	3	0	7	0	0	0	2	0	7	0	0	0	0	0	0	0	2	0
S10	0	0	15	0	0	0	0	0	0	8	0	0	0	2	0	0	0	1
S11	8	1	13	0	10	8	0	2	0	0	13	0	8	1	0	12	3	15
S12	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
S13	4	0	0	0	3	3	0	0	0	0	4	0	6	0	0	0	0	0
S14	0	0	3	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
S15	1	0	4	0	0	0	0	0	0	2	0	0	0	0	11	0	0	0
S16	10	0	5	0	0	0	0	0	0	0	0	5	0	1	0	4	0	0
S17	3	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	1	0
S18	19	0	6	0	8	0	0	5	0	0	7	0	8	0	0	0	0	4
(b) Global connectivity between stakeholders																		
S1	**0.987**	0.881	**0.991**	0.719	**0.950**	0.933	0.719	0.911	0.842	0.842	**0.950**	0.719	0.842	0.911	0.719	0.842	0.881	0.911
S2	**0.979**	0.684	**0.984**	0.719	0.900	0.881	0.578	0.881	0.789	0.789	0.911	0.719	0.684	0.881	0.719	0.842	0.842	0.881
S3	**0.988**	0.881	**0.982**	0.719	**0.950**	0.933	0.719	0.911	0.842	0.842	**0.950**	0.578	0.842	0.911	0.719	0.789	0.881	0.911
S4	0.842	0.684	0.842	0.438	0.789	0.789	0.578	0.684	0.719	0.438	0.684	0.250	0.578	0.438	0.438	0.438	0.684	0.684
S5	**0.950**	0.842	0.911	0.578	0.900	0.911	0.438	0.911	0.578	0.578	**0.950**	0.438	0.842	0.684	0.578	0.684	0.842	0.881
S6	0.911	0.842	0.911	0.578	0.881	0.822	0.438	0.911	0.578	0.578	0.911	0.438	0.763	0.684	0.578	0.684	0.763	0.881
S7	0.789	0.719	0.881	0.578	0.438	0.578	0.578	0.578	0.789	0.789	0.578	0.438	0.438	0.842	0.578	0.578	0.684	0.684
S8	0.842	0.763	0.842	0.438	0.842	0.842	0.438	0.763	0.438	0.438	0.842	0.250	0.684	0.578	0.438	0.578	0.684	0.763
S9	0.789	0.578	0.719	0.438	0.578	0.438	0.719	0.438	0.578	0.578	0.578	0.250	0.438	0.578	0.438	0.438	0.719	0.438
S10	0.438	0.250	0.719	0.250	0.438	0.250	0.250	0.438	0.250	0.250	0.438	0.000	0.438	0.625	0.250	0.250	0.250	0.625

S11	**0.962**	0.842	**0.950**	0.578	0.933	0.911	0.438	0.911	0.578	0.578	0.925	0.578	0.842	0.842	0.578	0.789	0.842	0.881
S12	0.719	0.438	0.719	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.578	0.438	0.719	0.438	0.438
S13	0.789	0.684	0.684	0.250	0.789	0.789	0.250	0.684	0.250	0.250	0.789	0.250	0.578	0.438	0.250	0.438	0.578	0.684
S14	0.250	0.250	0.500	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.000	0.250	0.250	0.250	0.250	0.250	0.250
S15	0.625	0.438	0.719	0.438	0.438	0.438	0.438	0.438	0.438	0.719	0.438	0.250	0.438	0.578	0.438	0.438	0.438	0.578
S16	0.719	0.438	0.789	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.625	0.438	0.719	0.438	0.578	0.438	0.438
S17	0.719	0.578	0.578	0.250	0.719	0.578	0.250	0.578	0.250	0.250	0.719	0.250	0.578	0.438	0.250	0.438	0.578	0.578
S18	0.881	0.684	0.842	0.438	0.881	0.822	0.438	0.842	0.438	0.438	0.881	0.250	0.842	0.578	0.438	0.578	0.684	0.684

Note: Interfaces with values ≥60 in Table 7.19 (a) and ≥0.95 in Table 7.19(b) are considered as significant. Important interfaces are marked in bold type.

Table 7.20: Direct and global connectivity between issue categories in the AI project

	Cost	Economic	Environmental	Ethical	Legal	Organisational	Political	Procurement & contractual (PC)	Quality	Safety	Social	Technological	Time
(a) Direct connectivity between issue categories													
Cost	16	1	8	0	0	1	5	6	2	2	0	6	4
Economic	0	6	0	0	0	1	2	0	0	0	1	1	1
Environmental	6	0	**234**	0	20	3	47	2	1	3	5	21	9
Ethical	0	0	14	16	2	1	11	2	5	0	8	0	0
Legal	9	0	27	1	11	7	2	1	7	9	3	18	10
Organisational	3	9	**55**	8	11	44	3	10	25	14	36	28	8
Political	1	0	20	3	7	11	3	3	2	2	5	2	7
PC	13	0	20	2	5	2	3	3	6	10	2	13	10
Quality	5	0	23	4	10	3	4	6	13	4	12	18	1
Safety	1	0	0	4	10	3	4	0	5	14	4	7	11
Social	0	3	10	10	2	6	13	2	1	4	29	12	5
Technological	28	0	**81**	0	29	14	3	13	15	23	28	46	24
Time	9	5	22	4	2	4	4	8	8	4	2	12	22
(b) Global connectivity between issue categories													
Cost	0.900	0.719	0.911	0.822	0.900	0.950	0.950	0.911	0.933	0.933	0.925	0.950	0.950
Economic	0.684	0.578	0.763	0.684	0.763	0.842	0.842	0.763	0.763	0.763	0.842	0.842	0.842
Environmental	0.950	0.684	0.925	0.900	0.950	0.962	0.962	0.950	0.962	0.962	0.950	0.962	0.962
Ethical	0.822	0.438	0.911	0.822	0.911	0.911	0.911	0.911	0.911	0.867	0.911	0.867	0.867
Legal	0.950	0.684	0.962	0.933	0.944	**0.972**	**0.972**	0.962	**0.972**	0.962	0.962	0.962	0.962
Organisational	0.950	0.789	0.962	0.933	0.962	0.968	**0.979**	0.962	**0.972**	0.962	**0.972**	**0.972**	**0.972**
Political	0.950	0.684	0.962	0.933	0.962	**0.972**	0.958	0.962	**0.972**	0.962	0.962	0.962	0.962
PC	0.950	0.684	0.962	0.933	0.962	**0.972**	**0.972**	0.944	**0.972**	0.962	0.962	0.962	0.962
Quality	0.950	0.684	0.962	0.933	0.962	**0.972**	**0.972**	0.962	0.958	0.962	0.962	0.962	0.962
Safety	0.911	0.684	0.925	0.911	0.933	0.950	0.950	0.925	0.950	0.900	0.933	0.933	0.933
Social	0.925	0.719	0.950	0.933	0.962	**0.972**	**0.972**	0.950	0.962	0.950	0.958	0.962	0.962
Technological	0.950	0.684	0.950	0.900	0.950	0.962	0.962	0.950	0.962	0.962	0.950	0.944	0.962
Time	0.950	0.789	0.962	0.933	0.962	**0.979**	**0.979**	0.962	**0.972**	0.962	**0.972**	**0.972**	0.958

Note: Interfaces with values ≥50 in Table 7.20(a) and ≥0.97 in Table 7.20(b) are considered as significant. Important interfaces are marked in bold type.

7.3.4 Suggestions for stakeholder management measures

Similar to Case Study III, this section proposes a series of stakeholder management measures based on the SNA results, in an attempt to help the project team to reduce project stakeholder management complexity and improve stakeholder engagement. These measures include three main approaches as described below.

Addressing critical stakeholder-related issues

By consolidating the nodal results of degree, betweenness, status centrality, brokerage and ego network size, a list of 27 key stakeholder-related issues is identified in Table 7.21. These issues contribute, in a great extent, to the immediate impacts on other issues, as well as the proliferating effects on the entire issue network. As such, these issues worth special attention from the project team and should be addressed with higher priority. As shown in Table 7.21, many critical issues concern about technological (5 no.), environmental (4 no.), legal (4 no.), organisational (4 no.) and political (3 no.) aspects; and are sourced from major environmental stakeholders such as S1, S3, S5, S8, and S11. It can be observed that, many key issues relate to the potential environmental impacts caused by the AI project (e.g. disturbance to marine ecology), and the relevant measures to control and monitor environmental performance. None of the issues is ethical related, implying that the awareness of local construction practitioners on industrial ethics is still limited in this recent MCP boom. Contractor (S3, 41%) and project proponent (S1, 33%) are the most important issue owners, a majority of critical issues are associated with them. As expected, the government acts a crucial role in this public works – 44% of the key issues are sourced from government authorities (i.e. S1, S10 and S11).

Table 7.21: The identified critical stakeholder-related issues in the AI project

Issue code	Issue	Related stakeholder	Issue category
S1I1	Unforeseen situations delay project completion and the commencement of interfacing superstructure projects	Project proponent	Time
S1I11	Project design and the non-dredge methodology fulfil the client’s requirements in terms of stability, durability and constructability	Project proponent	Quality
S1I21	Encountering political pressure and subsequently affecting public sentiment towards the government	Project proponent	Political
S1I22	Public pressure and controversies in case of public dissatisfaction on the project progress and performance	Project proponent	Political
S1I24	Completing the project within budget	Project proponent	Cost
S1I26	Conducting effective public and community consultation from time to time during construction	Project proponent	Social
S1I28	Clear and comprehensive government policies and administrative procedures to support project implementation	Project proponent	Political
S1I32	Achieving goals and objectives at project, managerial and functional levels	Project proponent	Organisational
S1I36	Compliance with environmental protection related legislations as required by relevant statutory bodies	Project proponent	Legal
S2I23	Adequate engineering expertise and project experience in devising similar construction methodology	Resident engineer	Organisational
S3I8	High technological complexity in terms of system diversity and interdependence	Contractor	Technological
S3I9	Tight manufacturing schedule of seawall and construction programme	Contractor	Time
S3I10	Adopting construction methodology and systems which are experimental and leading-edge technology in the local construction industry	Contractor	Technological
S3I12	Shortage of construction labour, materials or equipment	Contractor	Procurement and contractual
S3I17	Fully implementing environmental mitigation measures throughout the construction course and making necessary revisions to suit the changing conditions	Contractor	Environmental

S3I32	Site coordination with interfacing projects to facilitate construction activities (such as sharing site possession and environmental permits)	Contractor	Organisational
S3I33	Achieving goals and objectives at project, managerial and functional levels	Contractor	Organisational
S3I34	Construction methods and processes could accommodate site constraints (such as aviation height restriction)	Contractor	Technological
S3I39	Changes in design and construction methods due to management decisions or unforeseen engineering challenges during construction phase	Contractor	Technological
S3I41	Inadequate and unreasonable planning by designer could hinder project implementation	Contractor	Technological
S3I47	Getting statutory approvals and passing laboratory tests as required by relevant statutory bodies to undertake construction works	Contractor	Legal
S5I1	Checking implementation effectiveness of the agreed mitigation measures and auditing the environmental monitoring activities and results	Independent environmental checker	Environmental
S5I2	Reviewing the contractor’s proposed mitigation measures in case of non-compliance or limit exceedance and informing feedbacks to the government	Independent environmental checker	Environmental
S8I4	Disturbance to marine ecology and biodiversity (in particular the CWD community)	Environmental specialists in marine ecology	Environmental
S10I3	Safeguarding aviation safety in the site or its vicinity throughout the construction course	Civil Aviation Bureau	Safety
S10I5	Monitoring compliance by construction team with legislations related to aviation matters (such as licensing, inspection and safety)	Civil Aviation Bureau	Legal
S11I13	Ensuring compliance by construction team with environmental protection related legislations	Environmental Protection Bureau	Legal

Eliminating critical issue interdependencies

A list of 18 key issue interdependencies is identified based on the link betweenness centrality results, as shown in Table 7.22. Similar to Case Study III, this section proposes stakeholder management measures which help to improve coordination between relevant stakeholders of the sourcing and targeting nodes, with an ultimate aim to resolve the critical links and reduce the issue interaction complexity. Table 7.22 summarises the suggested measures.

Improving stakeholder communication and engagement

According to the interface-level results in Table 7.19 and 7.20, this section proposes some measures to improve communication/coordination of the closely connected stakeholders and issue categories. The suggested measures comprise: (a) the resident engineer and contractor should talk proactively with project proponent to fully understand its project requirements and concerns; (b) contractor should adequately self-inspect its own works and carry out more communication activities among its intra-organisational members who work on the AI project; (c) IEC should talk more with project proponent and environmental protection bureau to well explain its progress of environmental monitoring and auditing works; (d) the environmental protection bureau should well communicate with project proponent, contractor and IEC; so that its concerns and requirements on environmental protection and legislation enforcement are fully understood; and (e) stakeholders should pay attention to the possible political issues indirectly caused by legal, quality, social, time, organisational and procurement related issues arising from the AI project.

Table 7.22: Critical issue interdependencies in the AI project and their suggested stakeholder management measures

Critical links		Suggested stakeholder management measures
S3I10 S3I14	→ S1I1 → S1I1	If leading-edge and experimental construction methodology is used in the project, the project proponent should communicate effectively with the contractor to make sure clear work instructions and specifications are given, so as to avoid unforeseen situations and associated delays to the works/interfacing projects.
S2I23	→ S3I10	If leading-edge and experimental construction methodology is used in the project, contractor should cooperate with resident engineer who has adequate experience and specialised technical knowledge regarding the application of that methodology.
S1I24	→ S3I10	Project proponent and contractor should increase their communication to strike appropriate balance between cost and technological requirements, because highly complex construction methodology is often exposed to higher cost risks.
S3I10	→ S3I12	Contractor should take into consideration material availability in the current market before adopting any new construction methodologies.
S8I4	→ S3I17	Contractor should communicate more with environmental specialists so as to fully understand their concerns on potential ecological impacts brought by the project. Environmental specialists' knowledge on marine ecology may help the contractor in effectively and properly implementing the agreed environmental mitigation measures.
S1I36 S1I36 S1I22 S3I17 S3I17	→ S3I17 → S1I21 → S1I36 → S3I39 → S1I16	Project proponent should communicate more with the contractor and be aware of the contractor's performance in implementing the agreed environmental mitigation measures and complying with environmental regulations during construction course; so as to avoid a series of potential implications including environmental harm brought by chemical spillage, political controversies and public discontent on the government, as well as possible delays to the programme.
S5I1	→ S1I1	Project proponent should actively communicate with IEC to make sure IEC has effectively and continuously monitored the implementation and performance of environmental mitigation.
S17I1	→ S3I17	Contractor should communicate adequately with fisherman groups to fully understand their concerns regarding potential disruptions to habitual fishing operations brought by the construction works.
S1I22 S16I10	→ S16I10 → S1I21	Project proponent should inform the local residents about the latest project impacts and address their subsequent needs from time to time during the construction course, so as to avoid political pressure and increase public satisfaction on the project outcome and performance.
S1I22	→ S1I26	Project proponent should conduct sufficient and effective public and community consultation throughout the construction course, so as to increase public satisfaction on the project outcome and performance.
S10I4	→ S3I10	The complex construction methodology in this project involves construction equipment and operations which may pose threats to aviation safety. Contractor should proactively communicate with Civil Aviation Bureau to fully understand its concerns and

		requirements on aviation matters, so as to minimise disruption to air traffic activities and safeguard aviation safety during construction works.
S3I47	→ S3I10	Leading-edge construction methodology may involve new construction materials and equipment which lack relevant quality standards, testing methods and acceptance criteria from the government. Contractor should take this into account before applying new construction methods and materials, which may otherwise pose it to threats on obtaining statutory approvals.

7.3.5 Simulating effectiveness of the suggested stakeholder management measures

Assuming all stakeholder management measures proposed in Section 7.3.4 are effectively enforced, the 27 critical issues and 18 main issue interactions (as identified in Table 7.21 and 7.22 respectively) would be addressed and eliminated. The resultant issue influence network is dwindled to a structure of 220 nodes and 801 links, as displayed in Figure 7.8. By making comparison between the initial network (Figure 7.5) and this resultant network, it is observed that: (1) in the resultant network, two more isolated nodes emerge – they can be tackled as individual problems; (2) the resultant network is sparser than the initial network, and the two 'hairballs' in the initial network become simplified structures, since a substantial number of issue interdependencies are resolved. The density and cohesion of the resultant network are 0.017 and 0.348. Comparing to the original network density and cohesion of 0.321 and 0.682, it can be found that the issue network connectivity and complexity have dropped by 94.70% and 48.97% respectively. The simulation results indicate that these proposed stakeholder management measures are likely to be relevant and useful in reducing the issue network and project stakeholder management complexities.

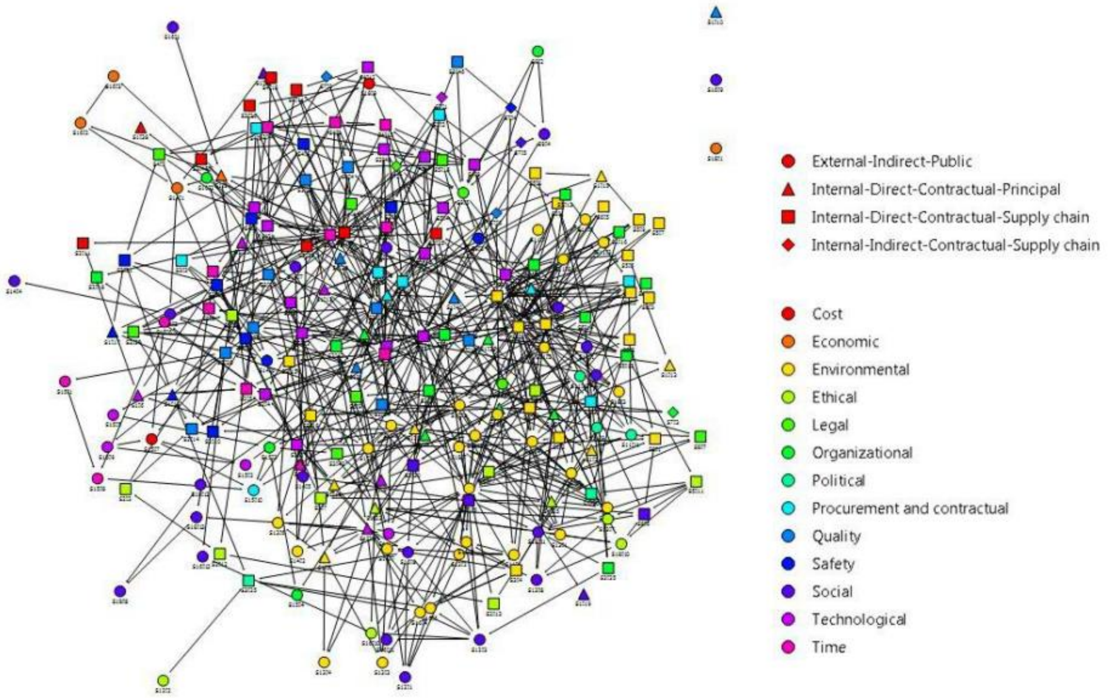


Figure 7.8: The stakeholder issue network after fully implementing the suggested stakeholder management measures for the AI project

7.3.6 Validation of the case study results

After the case study, the findings were disseminated to the core project team; through semi-structured interviews, the researcher collected feedbacks from them on the case study results and the proposed social network approach. Similar to Case Study III, the core project team of the AI project were invited to give opinions on the two questions described in Section 7.2.6 (Q1(a-b) and Q2(a-d)). Basically, the respondents consented to the SNA results and opined that they were comprehensible. They considered that the visualisation of issue relationships produced by the proposed approach was particularly interesting, the identification results of critical issues and important links are also meaningful. They added that this approach would be particularly useful for public MCPs since these developments often involve a wide range of stakeholders associated with numerous and often conflicting issues. However, similar to Case Study III, the core project team expressed concerns regarding the time consuming data collection process. In addition, they considered that the proposed approach requires specialist with sufficient knowledge and capability in network exploration and interpretation, so as to ensure the data interpretation results are reliable.

7.4 Lessons learnt from Case Study III and IV

7.4.1 Comments on the approach for analysing stakeholder-related issues

The core project teams in Case Study III and IV considered that the proposed social network approach (introduced in Chapter 6 and illustrated in Chapter 7) is a useful method to examine stakeholder-related issues and issue interdependencies in major public projects. They viewed that the approach has helped them to: (1) recognise stakeholders and their related issues in the project as complete as possible; (2) visualise and analyse the cause-and-effect relationships between issues; (3) understand the proliferating effects of issue interdependencies on project development; (4) identify critical issues and relationships which ought to be treated with high priority. They considered that the approach would be particularly useful to MCP leaders and policy makers at the early project stages – a MCP often comprises numerous stakeholders and issues, this approach offers an overall picture of issues and issue interactions to MCP leaders at the project outset, and helps them to develop more appropriate stakeholder management measures. Despite these benefits, the two project teams raised some concerns regarding the practical application of the proposed approach. First, they considered that the data collection process is time consuming but the local construction industry is fast-track. Secondly, there might be practical difficulties to engage all stakeholders in data collection, particularly when MCPs often involve political concerns and highly sensitive information. Finally, specialists with high capabilities in network analysis are crucial to reliable data interpretation.

7.4.2 Practical insights from the above two case studies

Notwithstanding that Case Study III and IV do not intend to provide findings which could be generalised to the whole local industry, they reveal important issues of major public building and engineering projects from stakeholder perspectives, and offer useful insights to future leaders of similar project developments.

Practical insights from Case Study III

Case Study III is a major public office building development in Hong Kong procured under a design-and-build contract. As shown in the network analysis results, a majority of important issues and issue interdependencies were sourced from the project proponent (S1) and project manager (S3), indicating that the government is the most influential stakeholder in public MCPs. This can be explained by the organisational structure of public MCPs – in Hong Kong, the government often takes the simultaneous roles of MCP proponent and administrator, who owe the authority and rights to establish project goals, create the framework of and make the final decisions on what to be incorporated into the design requirements. According to Lundrigan and Gil (2013), contractor is often located at the periphery of project core, since it is only part of the supply chain who gives specialised knowledge, technologies, and labour to construct, and therefore exerts limited influences on the design. However, the situation is different in Case Study III, and the main contractor was the source of many critical nodes and links. This can be attributed to the design-and-build procurement arrangement where main contractor had the power and rights to develop the design and select his own supply chain members. In this kind of MCPs, effective communication and coordination between the government and design-and-build contractor are essential because they are the key players in accommodating diverse stakeholder interests and achieving stakeholder satisfaction.

Handling public controversies and political interference is a major challenge of the core project team in recent public MCPs. In this case, albeit that the general public is not a major end user, it is the source of many critical nodes and links in the stakeholder issue network. The public has paid considerable attention over issues on value for money, cost effectiveness, public consultation sufficiency, and democratic access of project information. It implies that the government has a high accountability to the public. As taxpayer and an indirect funder of public MCPs, the public has great concerns on the proper utilisation of public treasury and the effectiveness of public engagement. As such, the government should put more efforts to ensure effective cost control, as well as to maintain continuous and democratic dissemination of project information to the public. Failures in doing so can result in unexpected resistances from the public and politicians on project development.

In Hong Kong, it is quite common that the government borrows insights from overseas experience on new construction technologies and puts them into practice in local MCPs. It is a way to push forward technological advancement in the local construction industry, as well as to strive for better project performance. The TD project is an example – it is the first building in Hong Kong adopting seismic-resistant structures. A major challenge in this case is that, relevant local building codes and similar project experience are absent in Hong Kong, therefore the government was not able to produce precise client's requirements on seismic-resistant items. Consequently, the contractor underestimated the level of technical complexity and has not engaged the right expertise into the project supply chain at the outset; leading to extra time and resources and a compromised quality in other work items. For similar future MCPs, more time and efforts on pre-project planning are required; also the design-and-build contractor should have a full understanding on the client's project expectations at the outset even if they are not clearly reflected in the client's requirements.

Practical insights from Case Study IV

Case Study IV is a large-scale public reclamation works for constructing an artificial island. The case study findings reveal some major project challenges faced by stakeholders. The first challenge relates to the application of highly advanced and complex construction technology (S3I10). As shown in the SNA results, the sufficiency of construction expertise in the design team (S2I23), the clarity of work instructions and specifications (S3I14), and cost control (S1I24) can be influential factors; while problems such as design deficiency, resources unavailability (S3I12) and unexpected delays (S1I1) may arise when the designers lack adequate expertise on the new technology. The situation may be improved by early contractor and specialist involvement in the project design and procurement. A number of researchers also stated that joint collaboration between client, designers and contractors in the design and procurement stages can largely raise design quality and constructability of major engineering projects, in particular when new technology is adopted (Jergeas and Put, 2001; Mosey, 2009; Song et al., 2009).

In this case, environmental related issues accounted for about 20% of stakeholder concerns, such a great number has shed light on the substantial environmental impacts brought by the project. Among these, the mitigation of project disruptions to the environment and marine ecology was another immense challenge faced by stakeholders. Public pressure (S1I2) along with potential environmental and ecological disruptions (S8I4, S17I1 and S1I16) are the important drivers to effective environmental mitigation, monitoring and auditing. If it is not performed well, problems such as public discontent (S1I21), construction method and programme changes (S3I39), and delays may occur. As shown in the SNA results, major environmental stakeholders (e.g. S1, S3, S5, S8 and S11) have realised the importance of the command-and-control based environmental impact assessment (EIA) follow-up approach during the construction course (Morrison-Saunders et al., 2003), e.g. enforcement of the agreed mitigation measures through environmental permits, and continuous environmental monitoring and auditing to control environmental performance. A robust mechanism and clear responsibilities of EIA follow up are crucial to enhance environmental performance in major engineering developments.

Another major concern in the AI project relates to conducting sufficient and effective public and community consultation (PCC) in construction phase (S1I26 and S16I10), while political pressure (S1I21) and public controversies (S1I22) are its driving forces and potential consequences (in case of ineffective consultation) at the same time. Although the project proponent often conducts consultations with the public and community in pre-construction phase, their dialogue should not cease even if the construction period has started. This is because some enduring concerns from the public and local community may extend their effects from early planning to construction stage, and new concerns often emerge when project influences become increasingly apparent. If the project proponent disregards the importance of PCC in construction period, dissatisfied voices from pressure groups and the community may arise; in a view that their latest issues and grievances are not adequately understood and addressed. These findings are consistent with several previous studies, pointing out that PCC during construction should be strengthened to resolve conflicts and enhance public satisfaction (Close and Loosemore, 2014; Ng et al., 2014).

Lastly, the case study findings show that, the contractor faced challenges in recognising and seeking compliance with the government standard on new materials and equipment quality (S3I47). The possible causes include the designer’s insufficient experience in using the new construction technology (S2I23), as well as a lack of clear quality standard, testing methods and acceptance criteria for the new materials and equipment established by the government (S3I47 and S3I14). The situation may be improved by more proper project planning and effective coordination between the government and project team; eventually facilitating the establishment of testing methods and acceptance criteria for new materials and plants before project commencement. Consistent with Chew's (2010) findings, the government plays a leading role in driving the adoption of pioneering technology at both project and industry levels through legislative and regulatory controls.

Despite the above practical insights, the researcher faced some limitations in the case studies. First, although chain referral sampling has been used in the network development process, it was practically infeasible to engage all stakeholders, where some of them declined to provide data due to the confidentiality issue. A higher precision of issue interdependency analysis can be yielded if all stakeholders are ideally reached. Secondly, Case Study III and IV analyse only screen-shots of the stakeholder issue influence network at a point in time during the construction phase. Longitudinal network studies are not conducted to examine the dynamics of issue interactions in the entire project lifecycle due to time limitation. Thirdly, the case study findings are each derived from limited context and could not be generalised to the whole construction industry. Lastly, owing to the limited contexts, the two case studies lack a generalisation on the thresholds of network metrics for extracting the most critical issues. It should be noted that, the importance levels of stakeholder-related issues are not solely related to the network analysis results of issue interdependencies. In practice, they can be affected by a set of external (e.g. political climate of the society) and internal factors (e.g. the stakeholder management expertise of project team).

7.5 Chapter summary

This chapter presents the validation of the social network approach for analysing stakeholder-related issues, the issue interdependencies and their proliferating impacts in MCPs (which has been proposed in Chapter 6). Two research methods are used in this chapter: case study and interviews.

This chapter presents two case studies which are of different MCP types. Case Study III is a large public office building development which is procured under design-and-build contract and adopts seismic-resistant structures. Case Study IV is a major public reclamation works which applies the highly advanced non-dredge reclamation method for the construction of an artificial island. Both developments are initiated and led by the government. They comprise diverse stakeholders and issues and show high project complexities, making a network-theory based approach for stakeholder-related issue analysis meaningful.

These two case studies have clearly illustrated the entire network-theory based stakeholder issue analysis process and its use of network metrics. The applicability of the proposed approach in investigating issues and issue interactions in MCPs has also been validated. After the case studies, the findings were disseminated to the two core project teams who have given positive feedbacks to the approach. They considered that this approach has effectively analysed stakeholder-related issues and their interdependencies, thereby identified important issues and relationships which produce significant direct and/or proliferating impacts to the project stakeholder management complexity. They opined that the approach would be particularly useful to MCP leaders and policy makers at early project stages. The case study findings also give practical insights on key issues and challenges in major public building and engineering projects from stakeholder perspective. The project teams suggested that the time consuming process and the ethical difficulties in engaging all stakeholders for data collection are some operational concerns regarding the practical application of the approach. These two opinions are taken into account in the development of the social network model for MCP stakeholder analysis which will be explained in Chapter 8.

Chapter 8 – A Social Network Model and an Application Guideline

8.1 Introduction

This chapter presents a social network model for stakeholder analysis in MCPs for Hong Kong, and an application guideline for practical use of the model. Five major components contribute to the development of this model, they are: (1) the results from an extensive literature review (Chapter 2) which comprised findings on the theory and practice of stakeholder management, as well as the theory and usage of SNA, in ordinary construction projects and MCPs; (2) research gaps identified from the literature review results (Chapter 2); (3) a social network approach for investigating stakeholders and their social interactions in MCPs (Chapter 4 and 5); (4) a social network approach for analysing stakeholder-related issues and issue interdependencies in MCPs (Chapter 6 and 7); and (5) findings from the four case studies (Chapter 5 and 7). For practical use of this model, an application guideline is developed to provide potential users with: (1) detailed descriptions to the procedures and main elements of the systematic stakeholder analysis process using a social network approach; (2) practical guidance on conducting the stakeholder analysis process using the model; and (3) some management tools which can facilitate the implementation of the process. To ensure the practicality and applicability of this model in Hong Kong MCPs, it is validated by a number of experts and industry practitioners who have experiences in managing and implementing MCPs, through face-to-face discussions and questionnaire as described in Section 8.4.

8.2 A Social Network Model for Stakeholder Analysis in MCPs

The development of this social network model intends to help the project team of a MCP to: (1) identify thoroughly the stakeholders and stakeholder-related issues; (2) analyse the social interactions between stakeholders and the influence relationships between stakeholder issues; (3) recognise the critical stakeholders, stakeholder issues and relationships; (4) develop action plans to improve stakeholder engagement and address the critical issues and interactions; and (5) make more informed decisions to improve the effectiveness of stakeholder management process, when implementing a MCP. The model can be useful to project management teams, decision makers and any practitioners in MCPs who take a major role in engaging and managing stakeholders in the project development process. This is especially useful to organisations who act as project proponent or project administrator in a MCP, e.g. the client and management consultant – these organisations often take the lead in compiling stakeholder requirements, as well as project stakeholder communication and management. This model is particularly useful in public MCPs which are extremely complex; comprise numerous stakeholders, issues and interdependencies; involve considerable public and social interests; emphasise social equity and project image; and involve long and complex public engagement process. The network approaches to identifying, assessing and prioritizing stakeholder and issue importance can help facilitate stakeholder analysis and enhance stakeholder engagement in this kind of MCPs. In this study, the model is described as a systematic description of a structured and objective process which allows users to identify, analyse, and address the stakeholders, issues and their relationships in a MCP using a social network approach (DEVB, 2005; Gemino and Wand, 2004). To facilitate understanding, a graphical method is used to present the model. In addition, the findings of earlier chapters and the comments from experts for model validation (Section 8.4) have been incorporated into the model. The model encompasses seven blocks as presented in Figure 8.1. Each block is further broken down into several components for zooming into specific details.

As shown in Figure 8.1, the model includes two main parts: *stakeholder analysis* and *continuous support* to the analysis process. The stakeholder analysis part comprises four blocks, namely ‘Setting context and stakeholder analysis planning’, ‘Social network analysis of stakeholders', 'Network analysis of stakeholder-related issues', 'Developing and implementing stakeholder management measures'. The continuous support part consists of three blocks, including 'Communication and consultation', 'Monitoring and review', and 'Documentation and reporting'.

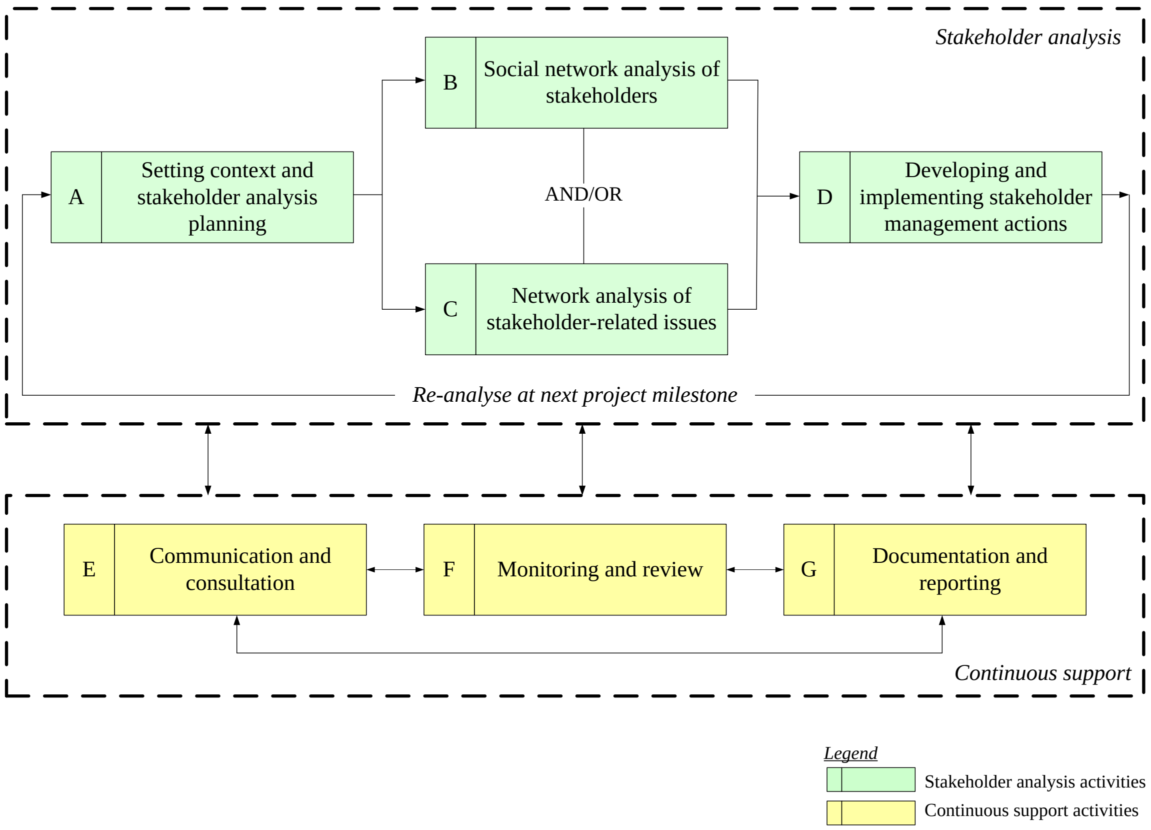


Figure 8.1: A social network model for stakeholder analysis in MCPs

Block A: Setting context and stakeholder analysis planning

Figure 8.2 ('Block A') shows the important elements of setting the project context and stakeholder analysis planning. As the initial stage of the stakeholder analysis process, this stage provides the project team an essential understanding to the internal and external context within which the project and stakeholders exist, and sets the scope of the stakeholder analysis process.

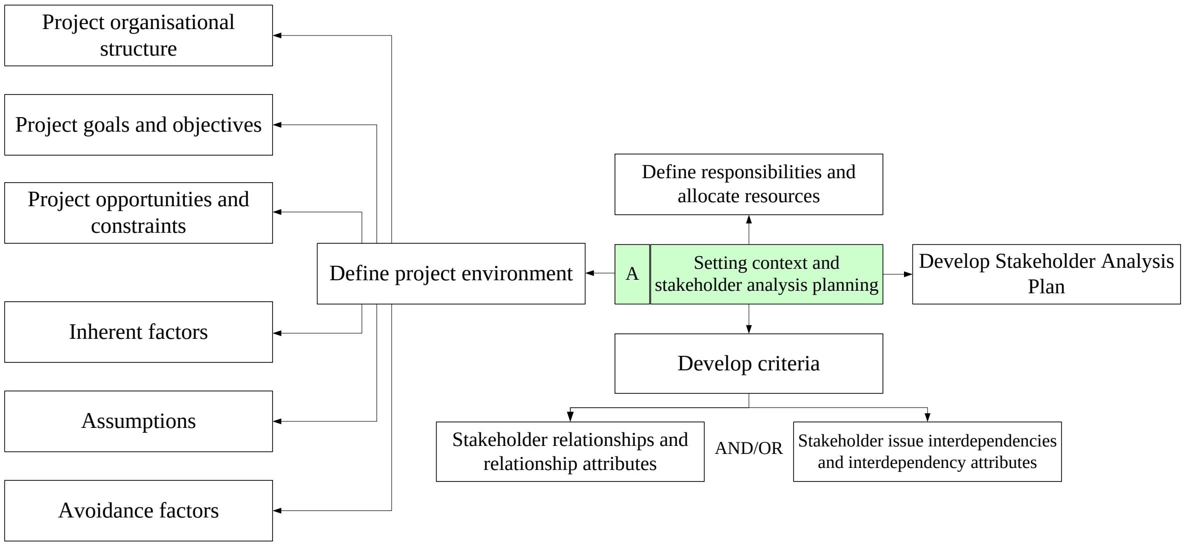


Figure 8.2: Block A – Setting context and stakeholder analysis planning

The project environment should be well defined because it sets the context within which the stakeholder analysis activities take place. To do this, the project team should have a clear and agreed understanding about: (1) the current project organisation structure, taking into account both internal and external stakeholder organisations; (2) project goals and objectives; (3) project opportunities and constraints; (4) any inherent factors that are vital to the achievement of project objectives; (5) any assumptions which have already been made at the current stage; (6) any avoidance factors that the project team should attempt to stay away from.

For effective implementation of the stakeholder analysis process, the project team should, at the outset, clearly define the responsibilities, resources, and means to procure the resources. The responsibilities and resources required depend on the complexity and scale of the MCP, as well as the availability of individuals who are skilled, knowledgeable and experienced in stakeholder management and network analysis.

Since this model assesses stakeholder impacts and issue importance by analysing stakeholder relationships and issue interactions, the project team should determine the important criteria to be used in the analysis process, including: (1) the kinds of stakeholder relationships to be examined, e.g. information exchange, knowledge sharing, communication; (2) the attributes for stakeholder relationship assessment, e.g. frequency and quality; (3) the attributes for issue interdependency assessment, e.g. impact and likelihood. The selection of analysis criteria is context-specific. It depends on the actual project situation, and the project team's perception when defining the analysis scope.

The information produced in this planning stage provides a useful framework for the project stakeholder analysis process. The information should be compiled into a project-specific document, the *Stakeholder Analysis Plan*. This plan should comprise a proposed schedule of the key stakeholder analysis activities. The implementation details and stakeholder analysis strategies may require adjustments when more project information is available or the project environment changes. As such, the Stakeholder Analysis Plan should be reviewed from time to time and updated when in need. The suggested contents of this plan are described in the sub-section on Block G. Appendix G (p.63 of Appendix G) shows an example of the plan.

Block B: Social network analysis of stakeholders

Every MCP involves a wide range of stakeholders who are interconnected instead of being stationary in a hub-and-spoke system. The roles, perceptions and behaviours of stakeholders emerge from their relational structures, the patterning and features of these structures can also influence how the stakeholders are being engaged. As such, a structured and rigorous analysis method on stakeholders and their interactions is vital to facilitate MCP decision making and coordination. A social network approach, which focuses on stakeholder relationships by engaging nearly all stakeholders and examining their actual interactions, can achieve the said purposes. Figure 8.3 shows the procedures and methods for analysing stakeholders and their social interactions in MCPs using a social network approach. As displayed in 'Block B', the whole procedures include five main steps, namely 'identify stakeholders and general issues', 'determine stakeholder relationships', 'visualise stakeholder network', 'analyse stakeholder network', and 'prioritise stakeholders and general issues'. This approach involves the use of eight SNA metrics, including *density* and *cohesion*, at the network-level; and *in-degree*, *out-degree*, *degree difference*, *power*, *betweenness* and *closeness centrality*, at the node-level. Chapter 4 provides a detailed discussion of this analysis approach. In addition, as presented in Chapter 5, two case studies (including Case Study I and Case Study II which analyse stakeholder information exchange relationships in a major cultural building project and a large-scale green building development respectively) were undertaken to illustrate the application of and validate this social network approach. By using this approach, the project team would be able to identify completely the stakeholders, map their interactions, diagnose their roles and influences through these relationships, recognise the important and peripheral stakeholders, and spot opportunities for improving project stakeholder engagement.

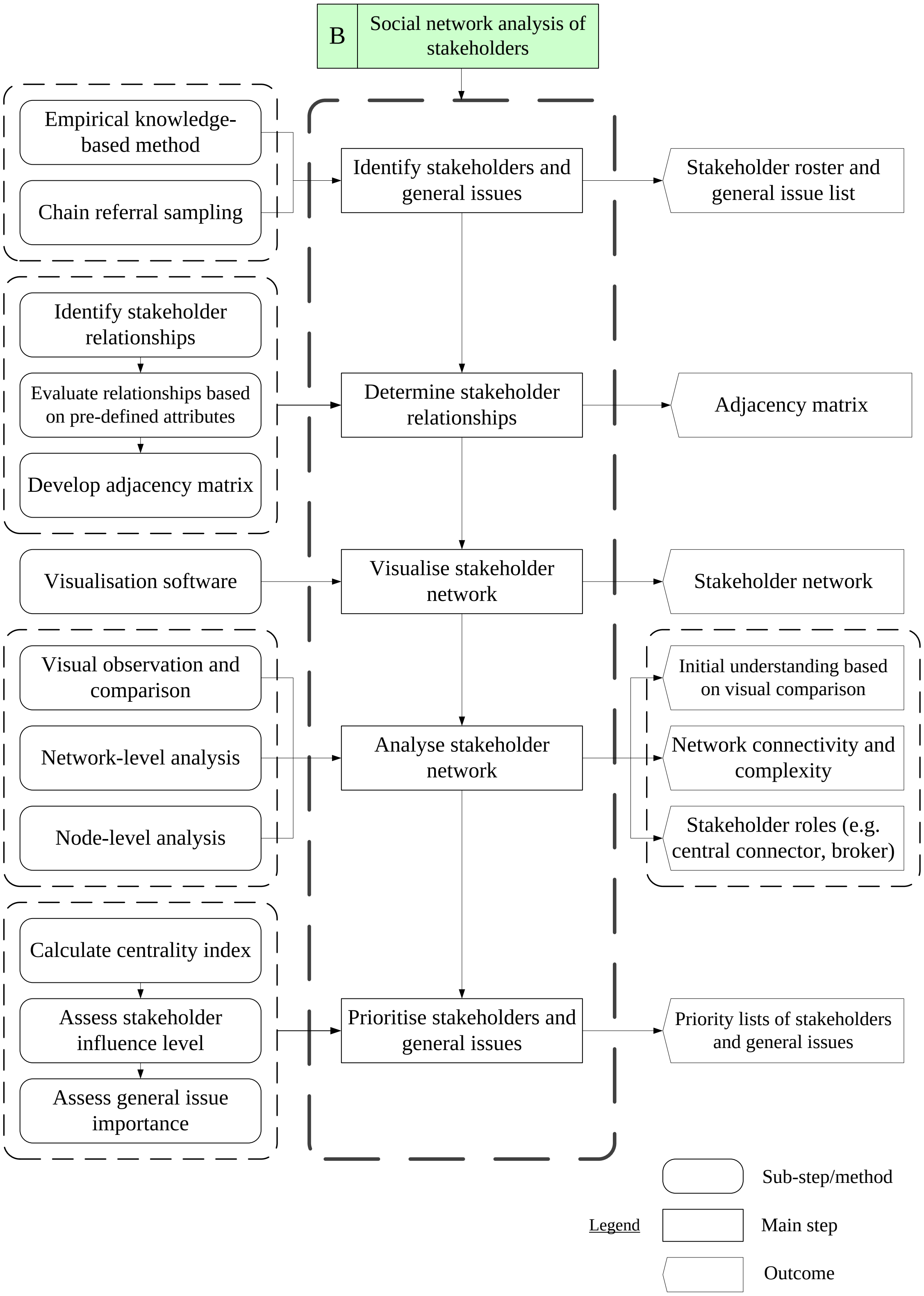


Figure 8.3: Block B – Social Network Analysis of Stakeholders

Block C: Network analysis of stakeholder-related issues

Every MCP involves numerous stakeholders who come from disparate backgrounds and raise diverse issues that are at stake in the project. These stakeholder-related issues can often be positively or negatively affected by project execution or the achievement of project objectives. In reality, stakeholder-related issues springing from a project system are interconnected – the presence of an issue can trigger or control the incidence of other directly or indirectly related issues under the same project environment. The interactions and proliferating effects between stakeholder-related issues can pose great uncertainties to stakeholder behaviours and project decision making. As such, a systematic and rigorous analysis method on stakeholder issues and their interactions is essential to improve project decision making and stakeholder management effectiveness. A social network approach which focuses on stakeholder-related issue interdependencies can achieve the said purposes. Figure 8.4 displays the procedures and methods for analysing stakeholder-related issues and their interactions in MCPs using a social network approach. As shown in 'Block C', the entire procedures comprise five main steps: (1) identifying stakeholders and stakeholder-related issues, (2) determining the issue interdependencies, (3) visualising the issue network, (4) analysing the issue network, and (5) identifying the critical issues and interdependencies. This approach adopts ten SNA metrics at three levels (i.e. network, node/link, and interface) to diagnose the structural properties of stakeholder issue network. A detailed discussion of this analysis approach is given in Chapter 6. In addition, two case studies (including Case Study III and Case Study IV which analyse the stakeholder-related issue interdependencies in a major public office building development and a large-scale public reclamation works) were carried out to illustrate the application of and validate this social network approach. The two important features of this approach lie in its capabilities to: (1) identify the right sources of stakeholder issues, and (2) investigate the issue interactions and their direct/proliferating impacts on the project development. By using this approach, the project team would be able to thoroughly identify all stakeholders and their associated issues; analyse the issue interactions and their practical implications on the project; identify the important issues and issue interdependencies which ought to be addressed with high priorities; and develop more appropriate issue treatment actions accordingly.

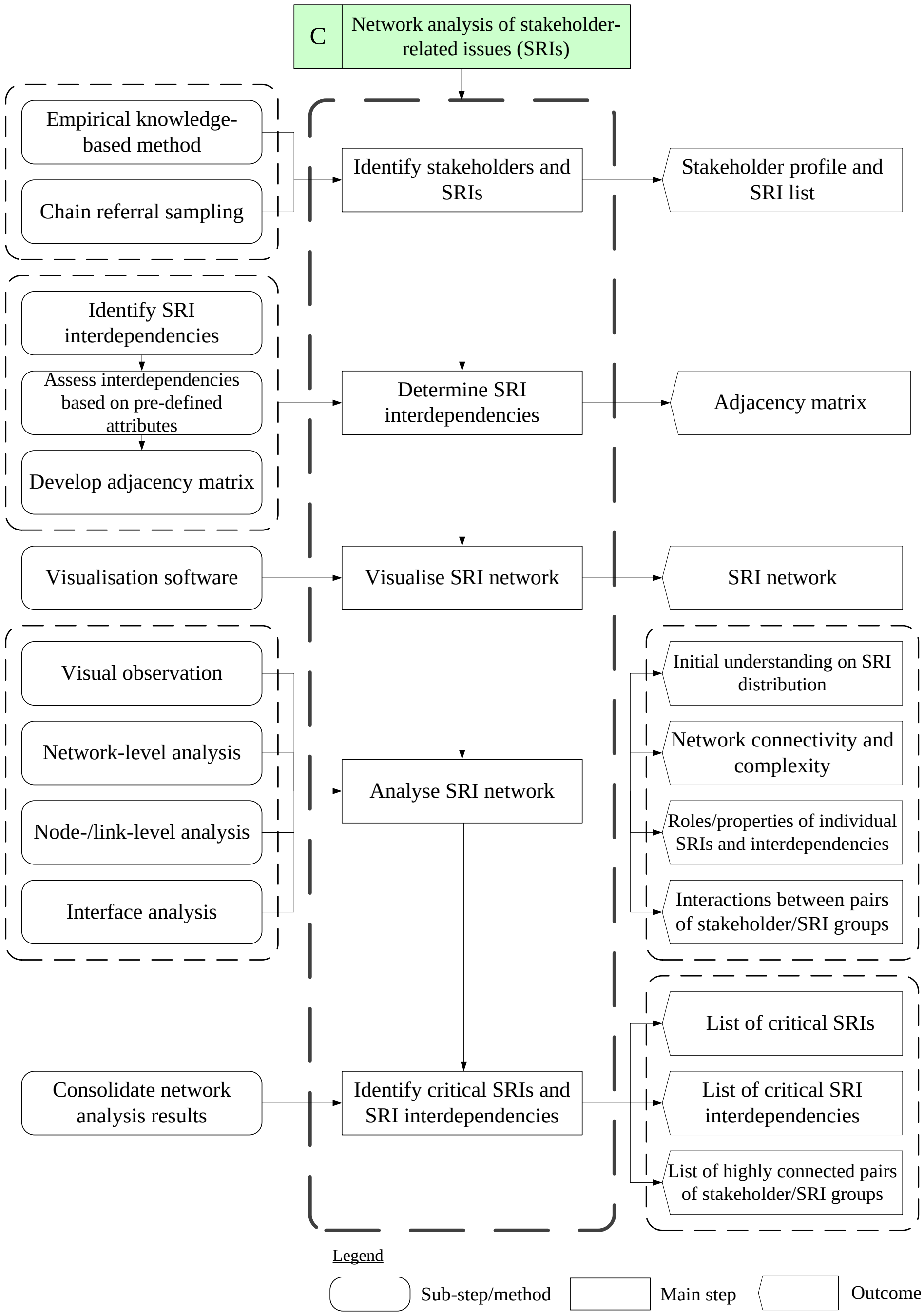


Figure 8.4: Block C – Network analysis of stakeholder-related issues

Block D: Developing and implementing stakeholder management actions

The network analysis helps to identify a list of important stakeholders, stakeholder-related issues and relationships which require further engagement or treatment. Figure 8.5 (Block D) shows the procedures and methods for developing and implementing corresponding stakeholder management actions. It involves three main parts, including: (1) identifying the stakeholder engagement and issue treatment actions; (2) simulating the likely effectiveness of actions; and (3) implementing the actions.

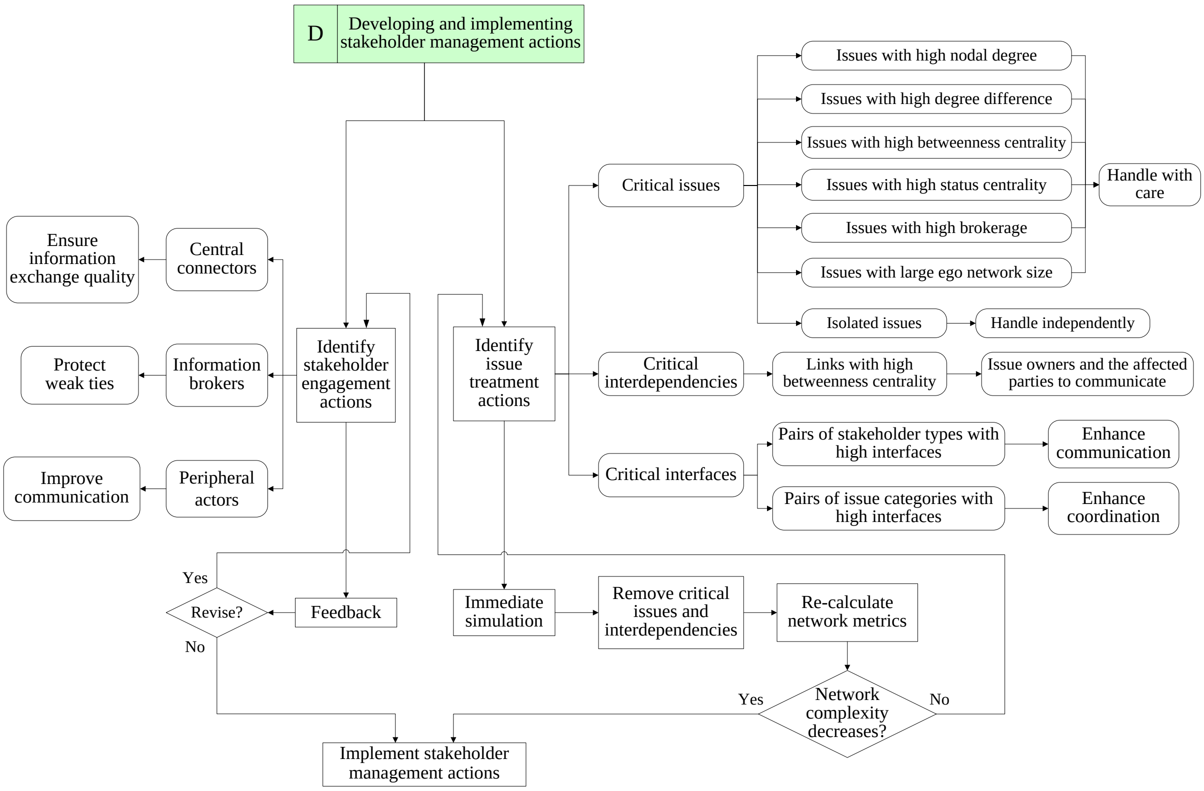


Figure 8.5: Block D – Developing and implementing stakeholder management actions

Based on the SNA results of stakeholder information exchange relationships, the project team can spot opportunities to improve stakeholder communication and develop more appropriate engagement strategies. For example, the project team should strictly monitor the information quality and information exchange behaviours of central connectors because they can quickly disseminate information to a large population; also, peripheral actors represent under-utilised knowledge sources, so the project team should increase communication with them to explore new information. A detailed discussion of the main principles to engage critical, intermediary and peripheral stakeholders are presented in Chapter 4 (Section 4.5) and Appendix G (p.31-32 of Appendix G).

The network analysis of stakeholder-related issues also helps to identify a list of key issues, issue interdependencies, and the highly connected pairs of stakeholder/issue groups, which require particular attention and treatment with care. These results provide useful clues for the project team to develop proper issue treatment actions. For instance, the project team may try to resolve critical issue interactions by improving communications between the stakeholders associated with the sourcing and targeting issues. A detailed discussion of the main principles to handle or resolve the important issues, links and stakeholder/issue interfaces are provided in Chapter 6 (Section 6.4.5) and Appendix G (p.32-33 of Appendix G). Before actual implementing the issue treatment actions, the project team can imitate the likely effectiveness of the actions by an immediate simulation. Based on the assumption that all identified key issues and links would have been addressed after effective issue treatments, this simulation eliminates the important issues and links from the issue network, re-calculates the network density and cohesion, and predicts the potential reduction of network complexity. The simulation process is discussed in detail in Chapter 6 (Section 6.5). Case Study III and IV in Chapter 7 also demonstrate the application of immediate simulation.

Usually, in practice, more than one management actions will be identified for each important stakeholder, issue and/or relationship. The actual selection and decisions of stakeholder engagement measures or issue treatment actions will be context-specific. A series of project considerations should be taken into account when developing the measures, for example: cost effectiveness; administrative and operational capacity; social, economic and environmental effects; contractual and regulatory implications; acceptability by relevant stakeholders; authorisations required from relevant government bodies; and time taken to see immediate or gradual beneficial effects. Based on the findings of the four case studies, some possible stakeholder management actions include: (1) improving communications between associated stakeholders of the critical issues and links; (2) making clear any ambiguities in the objective and requirements; (3) adopting familiar or well established construction methods, techniques and technologies; (4) gathering more useful and reliable information; (5) acquiring more relevant skills, knowledge and expertise; (6) seeking alternate approaches or processes; and (7) discontinuing or not to commence the project activities which may give rise to the critical issues and links.

After identification, feedbacks and simulation, a series of stakeholder management actions are developed to engage key stakeholders and address critical stakeholder-related issues and issue interdependencies. The project team should well define implementation details of each action, for example: (1) purpose – what actions to be undertaken relating to which specific stakeholder, issue and/or relationship; (2) responsibilities – who takes the responsibilities to undertake the actions, as well as to oversee, report, review and control the implementation; (3) resources – what project resources are required for implementation, monitoring and review; in addition, any extra resources to be mobilised or procured; (4) expected outcomes of the actions; and (5) schedule or deadlines for implementation, monitoring and review. The above implementation details should be well documented in a *Stakeholder Management Action Plan*. This plan serves as a useful monitoring tool for stakeholder management actions, and should be communicated to all appropriate parties for effective implementation and monitoring. The suggested contents of this plan are described in the sub-section on Block G. An example of this plan is shown in Appendix G (p.68 of Appendix G).

Block E: Communication and consultation

Communication and consultation is an essential component to make the social network model effective. The stakeholder management actions, their objectives, basis, deliverables, and roles and responsibilities should be effectively discussed among the relevant stakeholders. Figure 8.6 (Block E) shows the four important elements of effective communication and consultation. These elements include: (1) inclusive engagement of stakeholders – should any individuals or organisations be able to affect or be affected by a project, they ought to be identified at the outset of stakeholder analysis process and be engaged throughout the course. It is unwise to pick stakeholders or intentionally exclude any of them, since they would still appear at a later stage and the advantages of early communication and consultation would be lost; (2) interactive communications and sharing of ideas – one-way information transfer from decision makers to stakeholders is not encouraged, open discussions allow stakeholders to exchange their thoughts and understand the perspectives of each other; (3) transparent and explicit procedures – the decisions, actions and outcomes of the stakeholder management process should be made explicit to all stakeholders. This is not only because stakeholders can affect how effective the management actions would be undertaken, but also because these actions can cause implications (e.g. cost, time, resources) to stakeholders; and (4) continuous process – continuous communications between the project team, decision makers and stakeholders help to promote the stakeholder management practice and integrate it into the usual business of project organisations.

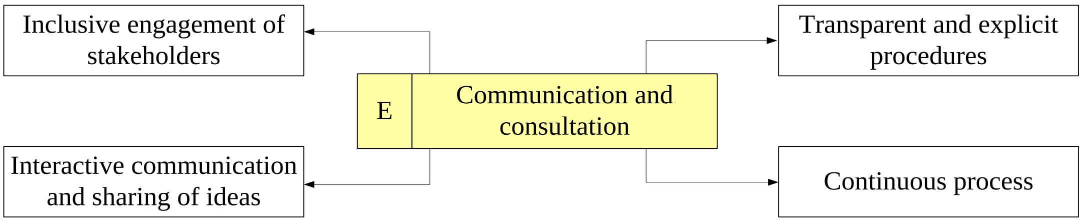


Figure 8.6: Block E – Communication and consultation

Block F: Monitoring and review

The project and stakeholder environments are dynamic. Stakeholders, their issues, as well as the relationships between stakeholders and among their related issues are changing as a MCP progresses. New (or previously neglected) stakeholders, issues and interactions may also emerge. Albeit that the social network approaches (in Blocks B and C) only capture stakeholder environments at a single point of time in the project development, the stakeholder analysis process is not a one-off. Continuous monitoring and review is necessary to maintain the relevance, usefulness and effectiveness of this stakeholder analysis approach. Figure 8.7 (Block F) outlines the two important elements of monitoring and review process.

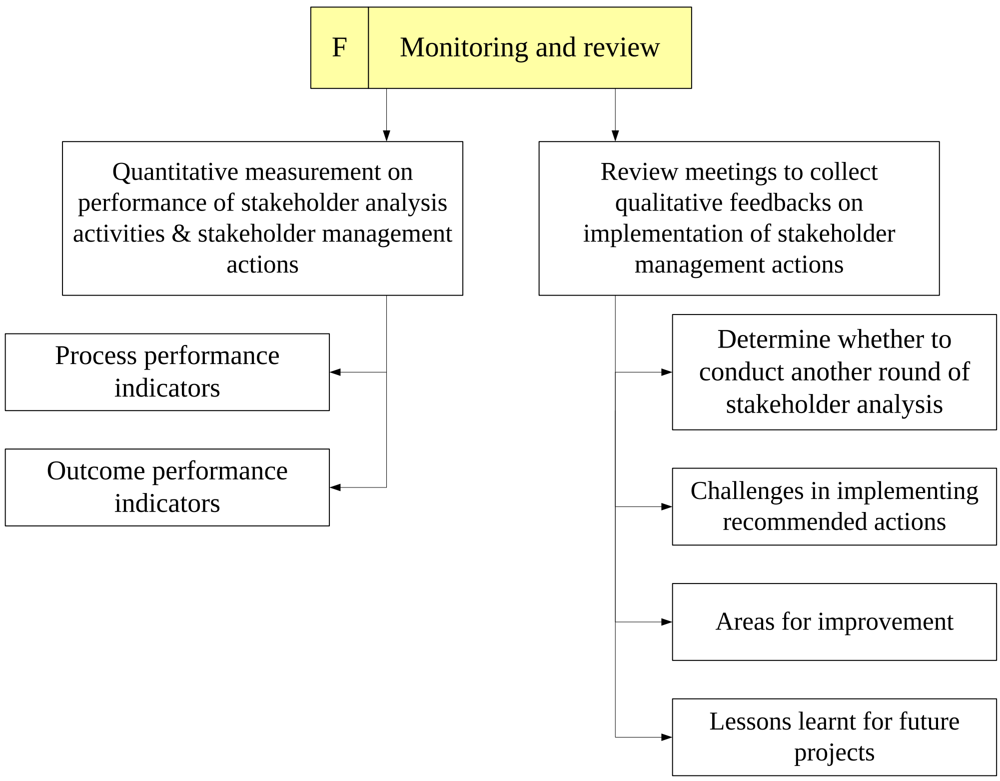


Figure 8.7: Block F – Monitoring and review

The first element considers the quantitative measurement of the performance (e.g. efficiency and effectiveness) of a past stakeholder analysis activity and/or stakeholder management action using performance indicators (e.g. process and outcome performance indicators). By assessing previous performance according to a set of predetermined criteria, performance measurement helps to ascertain how well the responsible individuals have acted in achieving the planned objectives, and to seek areas for continuous improvements. The identification and selection of performance indicators are context-specific, they depend on the actual project situations and the specific activity to be evaluated.

The second element considers conducting review meetings at set periods to collect feedbacks from the core project team and major stakeholders on the implementation and effectiveness of the stakeholder management activities. Some issues to be discussed in the meetings may include: (1) identifying any newly emerged critical stakeholders, issues and relationships which require another round of stakeholder analysis to be carried out; (2) any problems or challenges encountered in implementing the recommended stakeholder management actions; (3) any areas for improvement to increase the effectiveness of the recommended stakeholder management actions; and (4) any lessons learnt for future similar MCPs.

Block G: Documentation and reporting

Properly documenting and reporting the entire stakeholder analysis process and its outcomes are essential components to make the social network model effective. For practical use of the model, six documents are designed for recording the stakeholder analysis activities and process. These documents include 'Stakeholder Analysis Plan', 'Stakeholder Profile', 'General Issue Profile', 'Stakeholder-related Issue Profile', 'Stakeholder-related Issue Interdependency Profile', and 'Stakeholder Management Action Plan'. Figure 8.8 (Block G) outlines which specific documents to be used in various stages of the stakeholder analysis process. Table 8.1 describes the purposes and major information contained in these six documents. Appendix G (p.63-68 of Appendix G) shows the example documents.

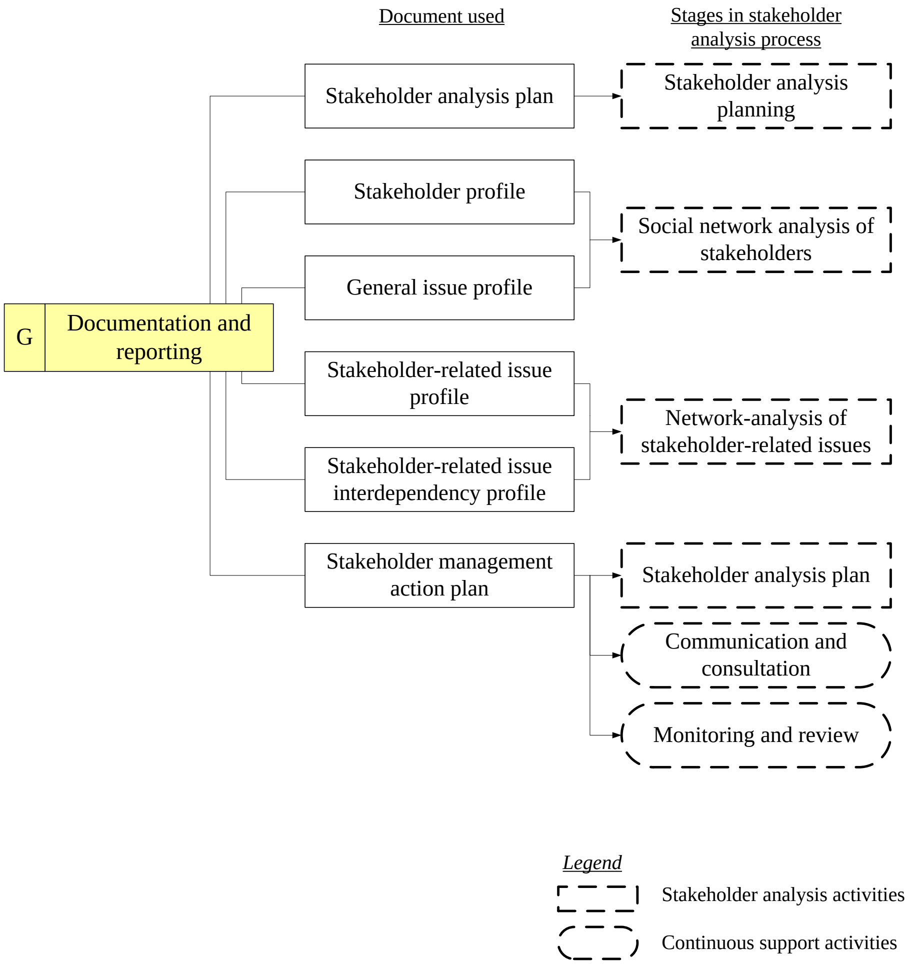


Figure 8.8: Block G – Documentation and reporting

Table 8.1: Documentations throughout the stakeholder analysis process

Documentation	In which step of stakeholder analysis process to be used	Main purpose	Key information contained in the document
Stakeholder Analysis Plan	Stakeholder analysis planning	Provide a framework of how the stakeholder analysis process and approach will be implemented in a specific project.	· A summary of the project objectives, opportunities and constraints, assumptions and avoidance factors; · What stakeholder analysis activities to be carried out in the project, the aims and scope of these activities; · Stakeholder analysis criteria (e.g. what kinds of relationships to be analysed, what relationship attributes to be assessed); · A schedule and resources allocation plan for the stakeholder analysis activities; · Who takes responsibilities to undertake various activities in the stakeholder analysis process; · What reporting formats to be used.
Stakeholder Profile	Social network analysis of stakeholders	Provide an updated status of all identified stakeholders in a specific project.	· A code number for easy identification of each stakeholder; · Description of the identified stakeholder, e.g. project role; · Details of existing measures which are already under implementation to engage the identified stakeholder; · Assessment of stakeholder impact in the project using social network analysis, e.g. role in network, ranking, influence level; · Details of proposed activities (or additional measures) which can facilitate a better engagement of the identified stakeholder, e.g. responsibility, schedule, approval for implementation; · A review of current status of the identified stakeholder.
General Issue Profile	Social network analysis of stakeholders	Provide an updated status of all identified general issues in a specific project.	· A code number for easy identification of each general issue (GI); · Description and category of the identified GI; · Details of existing measures which are already under implementation to address the identified GI; · Importance assessment of the identified GI in the project, e.g. whether the GI is considered as critical; · Details of proposed measures/actions which can help to address the identified GI more effectively and properly, e.g. responsibility, schedule;

			· A review of current status or remarks (if any) of the identified GI.
Stakeholder-related Issue Profile	Network analysis of stakeholder-related issues	Provide an updated status of all identified stakeholder-related issues in a specific project.	· A code number for easy identification of each stakeholder-related issue (SRI); · Description, category, the associated stakeholder of the identified SRI; · Details of existing measures which are already under implementation to address the identified SRI; · Impact assessment of the identified SRI using network analysis, e.g. whether it is considered as a critical issue; · Details of proposed measures/actions which can help to address the identified SRI more effectively and properly, e.g. responsibility, schedule; · A review of current status or remarks (if any) of the identified SRI.
Stakeholder-related Issue Interdependency Profile	Network analysis of stakeholder-related issues	Provide an updated status of all identified stakeholder-related issue interdependencies in a specific project.	· A code number for easy identification of each stakeholder-related issue interdependency (i.e. the link); · Descriptions and the associated stakeholders of the sourcing and targeting issues of the link; · Additional details on the specific cause-and-effect relationship; · Details of existing measures which are already under implementation to mitigate/resolve the identified link; · Impact assessment of the identified link using betweenness centrality, e.g. whether it is considered as a critical link; · Details of proposed strategy/actions which can help to mitigate the identified link more effectively, e.g. responsibility, schedule; · A review of current status or remarks (if any) of the identified link.
Stakeholder Management Action Plan	Development of stakeholder management actions; Communication and consultation; Monitoring and review	Record implementation details of the newly developed and agreed stakeholder management actions.	· Proposed action to be undertaken; · The targeted stakeholder, general issue, stakeholder-related issue, or stakeholder-related issue interdependency to be managed; · Who takes responsibilities to undertake the proposed action; · The schedule and resources required for undertaking the proposed action; · The monitoring arrangement and requirement; · The reporting formats to be used.

Systematically documenting the stakeholder analysis process and outcomes helps to achieve the following benefits: (1) showing to stakeholders that their issues have been systematically and properly identified, analysed and addressed during the project; (2) providing a basis for project decision makers to discuss, approve, undertake and review the suggested stakeholder management actions; (3) serving as a tool to administer the accountabilities and resources in implementing the suggested stakeholder management actions; (4) the comprehensive records of project stakeholders, issues and relationships help establishing a knowledge database for stakeholder management in future similar MCPs; (5) facilitating continuous improvement of project stakeholder management; and (6) enhancing communications and information sharing of stakeholders.

8.3 An Application Guideline for Practical Use of the Model

An application guideline is developed to facilitate practical use of the social network model described in Section 8.2. This guideline intends to provide potential users of the model with: (1) a clear and detailed explanation to the procedures and major elements of the stakeholder analysis process using a social network approach; (2) guidance on practical application of the model; and (3) management tools (e.g. documentation templates) which can aid the use of the model. As discussed earlier, this guideline is targeted at potential users of the social network model, i.e. the project management teams and decision makers of MCPs who involve in the engagement and management of project stakeholders. This guideline is particularly useful to stakeholder organisations in public MCPs who act as the project proponent or administrator, if they intend to use the model. This application guideline is included in Appendix G., where the comments from experts and practitioners on the guideline during model validation have also been incorporated. As presented in Appendix G, this guideline consists of ten chapters. Chapter 1 gives a brief introduction of the guideline, e.g. purposes of guideline, targeted users and potential benefits of the model. In addition, this chapter provides background information about MCP stakeholder analysis and the SNA method, so as to make sure that the model is comprehensible to potential users who have no knowledge or experience in these areas. Chapter 2 is a process overview of the social network model. This is a summary of the entire stakeholder analysis process using the social network approach, in an attempt to give potential users an initial understanding to each block before going into details. Chapter 3 to 9 give detailed explanations to the rationales, purposes, procedures and methods for the seven blocks (Blocks A to G) of the social network model. Each block is described in a separate chapter. Chapter 10 discusses four important issues regarding practical use of the model, they are: (1) the responsibilities in conducting the entire stakeholder analysis process; (2) early application; (3) continuous implementation; and (4) factors to facilitate effective use of the model. These four aspects are further discussed below.

8.3.1 Responsibilities

Stakeholder management facilitator

For proper implementation of the entire stakeholder analysis process, a single neutral party can be specifically designated to undertake this responsibility. This party may comprise one or more Stakeholder Management Facilitator(s), depending on the resources available and the project size and complexity. Responsibilities of the facilitator(s) include: (1) developing an environment in which various activities in the stakeholder analysis process can be effectively undertaken; (2) coordinating the activities in the stakeholder analysis process; (3) ensuring the representativeness of stakeholder representatives who participate in stakeholder analysis activities on behalf of their stakeholder organisations; (4) ensuring effective implementation of the stakeholder analysis process in the whole project duration through continuous monitoring and review. The individual(s) appointed as the facilitator(s) are expected to be at senior management level, and possess experience and specialised knowledge on stakeholder management, network analysis and mega project management fields. In general, individuals, with the above criteria, from stakeholder organisations who are the project proponent, administrator or management consultant in the MCP, would be considered suitable to take the facilitator role.

Senior management

Continuous support and commitment from senior management of both the client organisation and the project team are crucial to an effective implementation of the stakeholder analysis process using the social network model.

Stakeholders

For effective use of the model, all stakeholders have the following responsibilities throughout the entire stakeholder analysis process: (1) identifying potential stakeholders who have not yet been included in the stakeholder analysis process; (2) identifying their related issues in the project, providing details of the issues, and communicating these information to the facilitator; (3) identifying and assessing stakeholder relationships and issue interdependencies; and (4) undertaking the suggested stakeholder management actions in their best attempt when the actions are assigned to them. To encourage stakeholder participation, the facilitator should clearly explain to all involved parties about their responsibilities and the benefits of stakeholder analysis using the social network model.

8.3.2 Early application

This social network model for MCP stakeholder analysis should be applied in the project as early as reasonably practicable, for example, since the project definition and technical feasibility stage. The sooner the model is used, the more proactively the project stakeholders and their issues can be identified and properly managed. As a MCP proceeds, more features and components of the project (e.g. scope of works, design) would become fixed, thereby reducing the flexibility for stakeholder management strategies to make changes to a project (e.g. making design changes to major building elements after project commencement may result in substantial time and cost overruns). In addition, more time is often needed at the start-up of a stakeholder analysis process, e.g. for allocating responsibilities and resources, and getting the responsible individuals familiar with the social network model. As long as the stakeholder analysis process is set up, its implementation should be maintained throughout the whole project duration.

8.3.3 Continuous implementation

Stakeholder management is not one-off. This social network model for MCP stakeholder analysis should be used throughout the whole project duration and be integrated into different project phases. As a MCP proceeds, stakeholders may come and go, new issues may emerge, stakeholder relationships and issue interdependencies can be dynamic. It is unlikely to have all stakeholder concerns and conflicts resolved by only undertaking the stakeholder analysis once at the early project stage. To cope with stakeholder dynamics, the stakeholder analysis using this model can be conducted at least once in each of these three stages: ‘project definition and feasibility study’, ‘design’, and ‘construction’. Table 8.2 explains in detail the integration of the stakeholder analysis process using the model into these three project stages.

Table 8.2: Applying the social network model for stakeholder analysis in different project stages

Project stage	Objectives to be achieved in the stage	Purpose of undertaking stakeholder analysis in the stage	Potential stakeholder	Possible stakeholder issue category	Example issue
Project definition and feasibility study	· Justify the proposed development based on social, policy or business need · Preliminarily assess the chance of project success · Prepare a project definition statement · Illustrate that the project is technically feasible · Develop a preliminary project programme and cost estimate · Produce a technical feasibility statement	· Have an early picture of the stakeholders, issues and relationships that require special attention and management · Realise the potential stakeholders, issues and relationships before project acceptance and approval	client, contractor, designer, consultant, supplier and subcontractor, government, financer, media, green groups, pressure groups, politician, local community, public, end user, certifier, professional institutions	Social	Public controversies or opposition to the proposed development
				Political	Alignment between the proposed development and government policies
				Economic	Benefits to the macro-economy
				Commercial	Targeted profit level
				Environmental	Environmental impact assessment; Environmental impacts to marine ecology
				Cost	Tender price and construction cost trend
				Procurement	Choice of procurement arrangement in consideration of risk allocation strategy
Design	· Define end users' requirements · Develop the preliminary design from the conceptual design; at this time, the major design elements are decided · Develop and finalise the detailed design · Produce the tender, working and contract drawings · Develop specification	· Identify, assess and manage the stakeholders, issues and relationships that arise in the design stage; so that different objectives in the design stage can be achieved		Environmental	Develop appropriate environmental mitigation actions
				Economic	Increasing project cost due to inflation
				Commercial	Identify potential tenants and their users' requirements
				Procurement	Lacking local consultancies with the required expertise or specialised knowledge
				Political	Changing government policies
				Time	Design development takes more time than scheduled, leading to

					delay of project commencement
				Design	Changing end users’ requirements during the development of detailed design
Construction	· Construct the works in accordance to the construction contracts · Handover the completed project to the client	· Identify, assess and manage the stakeholders, issues and relationships that arise in the construction stage; so that the project is delivered in conformance with the required schedule, budget and quality · Troubleshooting		Time	Project delay
				Cost	Increasing labour and material cost
				Quality	Workmanship not conforming with specification
				Environment	Complaints about construction noise, dust
				Procurement	Material and labour shortage
				Contractual	Disputes and claims
				Legal/statutory	Failures in getting statutory approvals as scheduled
				Safety	Injuries or fatal accidents on site
				Technical	Workers unfamiliar with the proposed construction method

8.3.4 Factors to facilitate effective use of the model

This model intends to provide a systematic and objective process for the project team to identify, analyse, and address the stakeholders, issues and their relationships in a MCP using a social network approach; with the ultimate goals of improving stakeholder engagement and developing more appropriate stakeholder management measures. In fact, the chief determinants of the model are the human participants, i.e. the responsible individuals and the involved stakeholders. As such, an effective use of the model relies more on human factors rather than procedural factors. Listed below are some important factors (DEVB, 2015):

- A well-structured and defined stakeholder analysis process;
- Understanding, approval and support of senior management;
- Skilled and experienced individuals to undertake the entire process;
- Clear and effective communication of the stakeholder analysis activities, stakeholder management decisions and actions to all involved stakeholders;
- Effective alignment of the process to various project phases so as to get the respective project objectives achieved;
- Paying particular attention to stakeholder issues whose treatment actions require efforts from not just one single stakeholder organisation;
- Continuous monitoring and review to the stakeholders, issues, relationships, stakeholder management actions and their performances throughout the project.

8.4 Validation of the Model

To ensure the social network model is relevant and practicable for application in MCPs in Hong Kong, the model was validated by a number of experts and industry practitioners, using face-to-face discussions and questionnaire. These experts and practitioners have experiences in MCP implementation and stakeholder management, but possess limited knowledge and experience in social network theory and analysis (because SNA and its application are still in their infancy for construction project management in the Hong Kong construction industry).

8.4.1 Development of the model validation questionnaire

The social network model for stakeholder analysis in MCPs was validated using five criteria, they are: (1) degree of comprehensiveness, (2) degree of practicality, (3) degree of objectivity, (4) degree of replicability, and (5) degree of adaptability for application in different MCP types (e.g. building projects, civil engineering works, etc.). A questionnaire was designed for the said purpose, as included in Appendix F. Regarding the criteria selection, the researcher adopted these five criteria which had also been used in the similar studies of Yeung (2007) and Cheung (2009) for model validation, with relevant adjustments. Table 8.3 describes each criteria in detail. The respondents were required to rate their satisfaction levels of the model based on the five criteria using a five-point Likert scale (where '1' and '5' indicate the lowest and highest levels respectively), after understanding the model and reading the application guideline. To ensure both the application guideline (of the model) and the questionnaire are understandable, a pilot test was performed with a few research students before the actual model validation with experts and practitioners.

Table 8.3: Criteria for model validation used in the questionnaire

Validation criteria	Description
Degree of Comprehensiveness	Whether the social network model considers all essential elements for conducting stakeholder analysis in MCPs, and provides users with necessary explanations
Degree of practicality	Whether the social network model and its components (called "Blocks") are realistic in nature and can be applied in practice
Degree of objectivity	Whether the social network model avoids biased or misleading elements in favour of a particular setting or project type
Degree of replicability	Whether the social network model will provide similar outcomes when it is applied in an identical project with an identical context
Degree of adaptability for application in different MCP types	Whether the social network model provides users with guidance for application, and is applicable in different types of MCPs

Apart from the questionnaire, face-to-face discussions were also carried out with experts and practitioners, to collect their feedbacks regarding the detailed contents and presentation of the social network model and its application guideline. Both the model and application guideline were sent to the experts before face-to-face consultations and questionnaire, in order to make sure that all participants have a full understanding on the model beforehand. All responses were obtained in face-to-face discussions, whose average duration was approximately an hour. All experts' feedbacks were well recorded and they are discussed in Section 8.4.2.

8.4.2 Profile of the respondents and their comments

A total of nine experts and industry practitioners were selected for model validation using face-to-face discussion and questionnaire. The researcher considered that nine experts should suffice to provide reliable validation results, noting that previous researchers[6] also conducted model validation with comparable number of professionals in their PhD theses. Eight validation experts were selected from the industry, and one was from the academia. To have a balanced view from experts of different stakeholders' perspectives, the eight industry experts were selected from both the public and private sectors in different stakeholder roles, with a comparable portion. In addition, they have experience and knowledge in MCP management and implementation. More than half of the validation experts have ≥25 years of experience in their relevant fields. The profile of the nine experts is summarised in Table 8.4.

[6] Yeung (2007) and Cheung (2009) validated their models with 7 and 9 experts respectively.

Table 8.4: The profile of validation respondents

I.D.	Designation	Role	Years of experience
1	Director	Practitioner (Public; client)	≥ 30 years
2	Executive director	Practitioner (Public; client)	≥ 35 years
3	Senior project manager	Practitioner (Public; client)	≥ 25 years
4	Executive director	Practitioner (Private; design consultant)	≥ 30 years
5	Principal assistant secretary	Practitioner (Public; policy bureau)	≥ 30 years
6	Senior engineer	Practitioner (Private; contractor)	≥ 8 years
7	University lecturer	Academic	≥ 10 years
8	Quantity surveyor	Practitioner (Private; client)	≥ 8 years
9	Project manager	Practitioner (Public; works department)	≥ 15 years

Table 8.5 presents the comments from the above nine validation experts. These comments have been incorporated into the social network model, as explained in the response column.

Table 8.5: Comments from validation experts on the model and the corresponding responses

Extracts of comments by experts	Response in thesis
Expert No. 1 Comments: The model is comprehensive but seems to be too complicated. The model would be useful in major project developments which involve numerous stakeholders, issues and very complex interactions; but seems to be relatively less useful in conventional construction projects that require rather simple stakeholder analysis techniques. The scope of application of the model should be more clearly defined in the Guideline. The Hong Kong construction industry is fast track. There are already some well-established and clear routines of developing a project, such as market analysis and cost-benefit analysis. The purposes and merits of the model should be well explained and highlighted in the Guideline. A MCP is often highly uncertain, especially in the exploratory and feasibility study stages. Data collected from stakeholders at early stages may not be solid. This may affect the application of model in early project stages.	The suggestion was noted. A section (‘Scope of application of the Social Network Model, Section 1.6) was added into the Guideline to clearly define the scope of application of the model. It is noted that there are some well-established and systematic processes in the usual project management practice, such as market analysis, cost-benefit analysis and value management. To certain extent, stakeholder analysis is related to these processes but they have different aims and foci. The proposed model provides a systematic process of stakeholder analysis in MCPs. By using the network approach, this model enables project team to thoroughly identify stakeholders and their issues, visualise and analyse the relationship structures between stakeholders and among issues, assess stakeholder and issue importance, enhance stakeholder engagement, develop appropriate stakeholder management measures, and ultimately improve

Business and commercial considerations are often important stakeholder concerns in the early stage of MCPs, particularly in private developments. It will be useful if the model can help in analysing and addressing these issues.	stakeholder satisfaction on the project. As revised, the purposes and merits of the model were further elaborated in Section 1.7 (Benefits of the Social Network Model) in the Guideline. It is noted that empirical data collected in early project stages might not be solid. However, this situation may also occur for other stakeholder analysis approaches, e.g. Mitchell et al's (1997) Stakeholder Salience Model. In fact, the proposed model can be adapted for application in different project stages. That is, when collecting network data in different stages, users can set different parameters (e.g. stakeholder and issue groups, relationship types and attributes) and raise different questions, to achieve their specific aims and yield different outcomes. For example, in the exploratory stage, users should raise broad questions because the project scope, stakeholder composition and their requirements are not definite. As the project proceeds, more project details will be known, the questions raised for data collection should increase in clarity and specificity. It is borne in mind that stakeholders, issues and relationships are dynamic. The model needs to be adapted for application in different project phases, with different parameters and level of specificity. It is noted that commercial issues can be critical stakeholder concerns in the early stage of private MCPs. As mentioned above, the proposed model can be adapted for application in different project stages. To attain specific aims, users can define the scope of stakeholder analysis, and set relevant parameters in the model (e.g. types of issues and issue interactions to be analysed, and interdependency attributes). For example, users can undertake a specific round of stakeholder analysis that only focuses on commercial issues, their associated stakeholders and links. In this way, the model outcomes will include some management measures suggested for

	addressing the commercial issues of stakeholders.
Expert No. 2 Comments: The model is holistic but quite complicated. The model would be useful in public major developments which are extremely complex, involve considerable public and social interests, have intricate stakeholder relationships involving the government, and involve long public engagement process with numerous stakeholders. The network approach to assessing and prioritizing stakeholder/issue importance will facilitate stakeholder analysis in this kind of MCPs. Please clearly define the scope of application of the model. Besides, stakeholder management is not one-off. The model should be continuously applied throughout the MCP development process. In the Guideline, please describe how the model can be incorporated into the different stages of MCP development.	The suggestion was noted. A section (Scope of application of the Social Network Model, Section 1.6) was added into the Guideline to clearly define the scope of application of the model. It is noted that, as a MCP proceeds, stakeholders, issues and their relationships are all dynamic. It is unlikely to have all concerns addressed by just conducting the stakeholder analysis once at an early project stage. The proposed model should be incorporated into different phases of a MCP. Based on the interview findings, it is advised that the proposed process should be implemented at least once in each of these three project stages: (1) project definition and feasibility study – in this stage, project team often lacks a clear idea of what to do, what stakeholders are involved and what do they need. The model gives an early picture of the key stakeholders, issues and relationships before project approval; (2) design – using the model in design stage helps to define stakeholder requirements more accurately, and incorporate them into the project design; and (3) construction – the model can be used for troubleshooting purpose in this stage. As revised, Table 12 (Implementing stakeholder analysis in different project stages) was added in the Guideline to give more information on how the model can be incorporated into the different project stages.
Expert No. 3 Comments: The model is comprehensive. The merits of the model lie on thoroughly identifying stakeholders and issues, as well as visualising and analysing their relationship structures. Stakeholder management is still new in the local construction industry. Practitioners often identify and assess stakeholders based on their empirical knowledge, lacking a systematic and rigorous manner. The network analysis methods in the model will help to overcome	Noted. As revised, the purposes and benefits of the social network model were further elaborated and emphasised in Section 1.7 (Benefits of the Social Network Model) in the Guideline. The social network model and its guideline are useful to project management teams, decision makers and any practitioners in MCPs who take a major role in engaging and managing stakeholders in the project

these drawbacks. The Guideline may highlight this merit to encourage a wide use in practice. The Guideline should suggest the potential users of the model. Management consultants can be one of them. In practice, management consultant is an independent party, often engaged by the client to administer and oversee the entire MCP development process. Management consultants play a crucial role in stakeholder communication and management. This model provides them a comprehensive stakeholder and issue checklist, as well as a complete picture of their interactions. The model helps them to avoid having some parties or issues missed, until they are too late to be discovered.	development process. They are particularly useful to organisations who act as project proponent or project administrator in a MCP, e.g. the client and management consultant. In the Guideline, Section 1.3 (Targeted users of the Social Network Model and this guideline) was added to suggest the targeted users of the model.
Expert No. 4 Comments: The model provides a scientific method of MCP stakeholder identification and analysis, and helps to align project outcomes with diverse stakeholder needs. Earlier application of the model will bring greater benefits to the MCP development. Please further elaborate the benefits of early application in the Guideline. Besides, please describe how the model can be used in early project stages. Regarding practical use of the model, there are a few concerns: (1) data availability – the required data lie in a wide range of stakeholders, but there may be ethical and practical difficulties to engage participation from all stakeholders; (2) human resources availability – it appears that the model requires considerable human resources for data collection, processing, analysis and interpretation. It may be difficult to use the model if adequate human resources are not available; and (3) SNA is quite a new analysis tool in the local project management practice. Does the program take a long time to generate the network analysis results? Does it take a long time to interpret the results? These are practical	 In the Guideline, Section 1.7 (Benefits of the Social Network Model) was revised to further elaborate and highlight the merits of the model. The model should be applied as early as reasonably practicable in the MCP development process, e.g. since the feasibility study and exploratory stage. The sooner the model is used, the more proactively the stakeholders and their issues can be managed. In the Guideline, Section 10.2 (Early Application) was revised to further elaborate the needs and benefits of early application of the model. Besides, Table 12 (Implementing stakeholder analysis in different project stages) in the Guideline gives more information about how the model is to be applied in the ‘project definition and feasibility study’ and the ‘design’ stages. Please find the responses to the three concerns raised: (1) Albeit the use of chain referral sampling and the empirical knowledge-based method, there are still limitations in the stakeholder identification step. For example, it is ethically and

concerns since the model is to be continuously applied in the entire MCP development process.	practically challenging to engage all stakeholders, where some of them may concern the confidentiality and anonymity issues, and are disinclined to provide data. To mitigate the limitations, users may do the following in the stakeholder identification process: (a) when stakeholders are nominated, users should approach them to confirm or clarify their project role and responsibilities; and (b) after the entire referral process, the list of identified stakeholders and their description should be checked, commented (amended when in need), and confirmed by the core project team before proceeding to the next step. Despite the practical limitations, it is expected that, the stakeholder list generated from this step is reliable and representative enough for the subsequent stakeholder analysis. (2) It should be noted that, regardless of the approaches adopted, conducting stakeholder analysis and engagement in major project developments would require considerable human resources. This is attributed to the high complexity of stakeholders in a MCP. Effective use of the model requires continuous support from the core leadership team, e.g. allocating adequate, specialised and capable human resources. (3) In this research, NetMiner 4 was applied for network visualisation and analysis. NetMiner was chosen because this software package has high competence in the processing and exploratory analysis of huge networks. It does not take a long time to run the network analysis process. For example, for the influence network A (247,1660) in Case Study IV (Chapter 7), NetMiner took less than fifteen minutes to generate results for a network metric. Besides, the time taken for network result interpretation depends on the human resources allocated and their capabilities. SNA and stakeholder analysis are still new in the local project

	management practice. The provision of training and clear application guideline will facilitate the use of the model.
Expert No. 5 Comments: The network analysis methods in the model are innovative. The model will be useful to the major decision makers in public MCPs. Its merits lie on: (1) enhancing stakeholder understanding of project objectives, (2) providing platforms (e.g. workshops, discussion forums) for stakeholders to create alternative solutions, thereby (3) increasing stakeholder satisfaction and recognition on the project. The Guideline should emphasise these merits. One ultimate goal of the model is to enhancing stakeholder communication and engagement. For monitoring and review purpose, the model should include some measures to directly obtain stakeholder feedback on the implementation and effectiveness of the stakeholder management actions. It can also help to show stakeholders that their concerns have been well considered and/or addressed.	Noted. In the Guideline, Section 1.7 (Benefits of the Social Network Model) was revised to further elaborate and highlight the benefits of the model. Besides, Section 1.3 (Targeted users of the Social Network Model and this guideline) was added to suggest the potential users of the model. The suggestion was noted and incorporated into Block F (Monitoring and review) of the model. A component, 'Review Meetings', was added to Block F, as a means to collect direct feedbacks from the core project team and major stakeholders on the implementation and effectiveness of stakeholder management actions. Issues to be discussed in the review meetings may include: (1) determining whether to conduct a new round of stakeholder analysis; (2) problems and challenges in implementing the recommended stakeholder management actions; (3) effectiveness of the recommended actions and areas for improvement; (4) lessons learnt for future similar MCPs. In the Guideline, Section 8.2 (Review Meetings) was added to provide the implementation details of review meetings.
Expert No. 6 Comments: The model is comprehensive. However, as a MCP proceeds, stakeholders will come and go, new concerns will emerge, the relationships between stakeholders and among issues are also dynamic. It would be better if the model can analyse and manage the dynamics of stakeholders.	It is noted that stakeholder management is not one-off. Stakeholders, issues and relationships are all dynamic as a project proceeds. Although the network analysis methods in the model only diagnose a 'screen-shot' of the stakeholder/issue networks at a point in time, longitudinal network studies can be conducted. The proposed model can be applied regularly and at different project phases to explore the evolution of networks, as well as the dynamics of stakeholders, issues and relationships. Based on the interview findings, it is advised that the proposed

	model should be used at least once in each of these three project stages: (1) project definition and feasibility study – in this stage, the project team often lacks a clear idea of what to do, what stakeholders are involved and what do they need. The model gives an early picture of the key stakeholders, issues and relationships before project approval; (2) design – using the model in this stage helps to define stakeholder requirements more accurately, and incorporate them into the project design; and (3) construction – the model can be used for troubleshooting purpose in this stage. Continuous implementation of the model helps to analyse and manage stakeholder dynamics in a MCP. In the Guideline, Section 10.3 (Continuous Implementation) was revised to highlight these points. Table 12 (Implementing stakeholder analysis in different project stages) was also added to give more information on how the model can be incorporated into the different project stages.
Expert No. 7 Comments: More information should be provided on what the users need to plan about or prepare before actually conducting the stakeholder analysis. Stakeholder management is still in its infancy in the Hong Kong construction industry. To promote a wider use of the model, its benefits should be emphasised in the Guideline, particularly how the model can help enhancing stakeholder engagement in MCPs.	Block A (Setting context and stakeholder analysis planning) describes the initial stage of the proposed stakeholder analysis process. This Block and Section 3 of the Guideline provide information on what the users need to plan about before actually carrying out stakeholder analysis with the proposed model. In this initial stage, the users should: (1) set the context within which the project and stakeholders exist; (2) define aims and scope of the stakeholder analysis; (3) develop the criteria to be used in network analysis, e.g. the types of relationships to be examined and the relationship attributes to be used; (4) define responsibilities and allocate resources for implementing the stakeholder analysis process; and (5) prepare an implementation schedule. All information produced in this planning stage are compiled in a Stakeholder Analysis Plan. Besides, more information are given in Section 10.1 regarding the responsibilities

	and resources to undertaking the stakeholder analysis process, as well as in Section 10.4 about the key factors to successful implementation of the model. Noted. In the Guideline, Section 1.7 (Benefits of the Social Network Model) was revised to highlight the merits of the model. Some merits include: enhancing stakeholder understanding of project objectives, providing platforms for stakeholders to generate alternative solutions, more effectively realising the actual needs of stakeholders, and help showing to stakeholders that their concerns have been systematically and properly considered and/or addressed. These merits eventually help to enhance stakeholder engagement in MCPs.
Expert No. 8 Comments: For practical use of the model, it will be better to include documentation templates for collecting network data, and documenting the entire stakeholder analysis and management process.	In Block G (Documentation and reporting), six documents were designed for recording the stakeholder analysis process. As revised, documentation templates were added for each of these six documents. The templates were provided in the Guideline (refer to p.63-68 of Appendix G). Besides, two survey templates for network data collection were provided in the Guideline (refer to p.51-61 of Appendix G). These templates can help facilitate the practical use of the model.
Expert No. 9 Comments: The network analysis methods in the model seem to be complicated. Some concerns on the practical use of the model are listed below: (1) there are lots of inputted data and network analysis results (e.g. network metrics and maps). How to interpret the results and identify critical stakeholders, issues and relationships? Clear instructions are needed; and (2) for the issue network, it seems that the judgment of analysts may affect their identification of critical issues and interdependencies, thus the model outcome. An effective use of the model requires personnel with expertise on SNA and stakeholder analysis, which might not be easily available in the client or project	Please find the responses to the two concerns raised: (1) Noted and incorporated. For the model, the presentation method of Block D (Developing and implementing stakeholder management actions, Figure 6) was revised to present a clearer flow of network result interpretation; as well as the identification of key stakeholders, issues, interdependencies and interfaces. For the Guideline, Section 6.1 and 6.2 were also revised to give clearer and more detailed instructions. The Guideline should be used in conjunction with the model.

management organisations.	(2) There are several criteria in which the identification of critical issues and issue interdependencies is based on: (a) the issues' scores in the node-level results; (b) the link betweenness centrality (B.C.) values, and (c) the cut-off points of node-level and link B.C. results. It is noted that the way of cutting off the node- and link-level results could affect the identification of key issues and links. In addition, the cut-off points are case-specific, and depend on how much risks the core leadership team can take in the project. If the project team can only bear a low risk, then a lower threshold should be set for the cut-off points; so as to cover more issues and links as critical, and provide a wider lens for developing the stakeholder management actions. Besides, it would be beneficial if the network data collection and analysis are conducted by individuals with expertise in SNA and stakeholder management. Section 10.1 of the Guideline gives information on the required human resources for application of the model.

8.4.3 Validation results

The overall results of validation questionnaire are presented in Table 8.6. It is noted that, the 'degree of objectivity' and the 'degree of comprehensiveness' were given the first and second highest scores among the five validation aspects. The 'degree of objectivity' obtained a mean score of 4.11. More than 88% of the expert respondents rated this aspect with either '4' or '5', showing that this model is considered objective and without biased elements in favouring of a specific project type or setting. The 'degree of comprehensiveness' obtained a mean score of 4.00. More than 88% of the respondents gave a rating of either '4' or '5' to this aspect, indicating that the model is holistic to consider and explain all essential elements for conducting MCP stakeholder analysis. In contrast, the 'degree of practicality' and the 'degree of replicability', both obtaining the mean values of 3.67, scored relatively low among the five validation aspects. This might be attributed to several reasons: (1) some blocks (e.g. the network approaches for analysing stakeholders and stakeholder-related issues) may not be fully practical in its totality, owing to the ethical and practical challenges in identifying and engaging participation from all stakeholders; and (2) the model may not be totally replicable due to the concerns on input data quality and human factors (as discussed in Section 8.3.4). Notwithstanding its limitations, the model offers a systematic and scientific solution to assess stakeholders, issues and their relationships in MCPs. Four case studies, of different project types and contexts, were used to illustrate the practical application of and validate the model. Overall speaking, all five validation aspects obtained the mean scores over 3; showing that this social network model is considered comprehensive, practical, objective, replicable and adaptable for application in different MCP types.

Table 8.6: Results of the validation questionnaire

Validation Criteria	Poor ←				→Excellent	Mean
	1	2	3	4	5	
1. Degree of comprehensiveness	0.0% (0)	0.0% (0)	11.1% (1)	77.8% (7)	11.1% (1)	4.00
2. Degree of practicality	0.0% (0)	11.1% (1)	33.3% (3)	33.3% (3)	22.2% (2)	3.67
3. Degree of objectivity	0.0% (0)	0.0% (0)	11.1% (1)	66.7% (6)	22.2% (2)	4.11
4. Degree of replicability	0.0% (0)	11.1% (1)	22.2% (2)	55.6% (5)	11.1% (1)	3.67
5. Degree of adaptability for application in different MCP types	0.0% (0)	0.0% (0)	22.2% (2)	66.7% (6)	11.1% (1)	3.89

*Number of respondents is shown in parenthesis

8.5 Chapter summary

This chapter discusses a social network model for stakeholder analysis in MCPs. The model is developed from findings obtained throughout this research study; including an extensive literature review, the social network approaches for analysing stakeholders and stakeholder-related issues, as well as the four case studies. To aid the practical use of the model, an application guideline is also developed; which gives potential users detailed description to the procedures and methods in the model, guidance when using the model in practice, as well as the associated management tools. At the final stage of this research, the model was validated by nine experts from both industry and academia using face-to-face discussions and questionnaire. It is expected that, this model can be used by the project teams of MCPs as a systematic and effective management tool to identify, analyse and address stakeholders, their issues, and relationships (including both stakeholder interactions and issue interdependencies) throughout the project development; with the ultimate goals to improving project decision making and stakeholder management effectiveness. The next chapter, which is also the last chapter of the thesis, presents a conclusion to the entire research study, summarises its major findings, and gives recommendations to future research opportunities in this area.

Chapter 9 – Conclusions

9.1 Introduction

This chapter concludes the research study. This chapter starts with a recap of the research aim and objectives, followed by a summary of the main research findings. The contributions and significance of the research are presented. Finally, the limitations of this research study are pinpointed, together with recommendations for future research.

9.2 Review of the Research Objectives

As emphasized throughout the thesis, stakeholder analysis is an indispensable part of MCP management to assess and address the stakeholder complexities. Despite the recent growth of stakeholder analysis theories and practical approaches, the performance of stakeholder management in MCPs has still been criticized as unsatisfactory. This poor record can be attributed to three main reasons; including the inherent limitations of conventional stakeholder analysis methods, the practitioners' unfamiliarity and unawareness to conducting MCP stakeholder analysis, as well as the lack of a systematic and holistic process model. The existing MCP stakeholder management practice has been criticised as not entirely coherent and formal, and thus not adequate to manage the complex stakeholder interfaces in mega developments. It is believed that, a systematic and holistic model is in need of development for analysing and managing stakeholder complexities in MCPs. Consequently, this research study has aimed:

> *To develop a systematic and holistic model for stakeholder analysis and management in MCPs, specifically investigating stakeholder interactions and stakeholder-related issue interdependencies from a network perspective.*

In order to achieve the research aim, three objectives are needed to be fulfilled:

Objective 1. *To develop and refine a social network approach for analysing stakeholders and their interactions in MCPs, and validate the proposed approach by using real-life MCPs.*

Objective 2. *To develop and refine a social network approach for analysing stakeholder-related issues and their interdependencies in MCPs, and validate the proposed approach by using real-life MCPs.*

Objective 3. *To develop and validate a systematic and holistic model, and its application guideline, building upon the network perspective, for stakeholder analysis and management in MCPs.*

9.3 Summary of the Main Findings

The research objectives have been fulfilled mainly through literature review, case studies, interviews and questionnaire survey, conducted in Hong Kong. The main findings of the research can be summarized into four areas, as discussed below.

9.3.1 A social network approach for analysing stakeholders in MCPs

A social network approach for analysing stakeholders and their relationships in MCPs was proposed (refer to Chapter 4), the detailed analytical variables and procedures of the approach were demonstrated (refer to Chapter 5). The approach and its demonstration were based on the findings of literature review, network analysis, and two case studies in Hong Kong.

Findings from Chapter 2 and 3 indicated that, to cope with the high stakeholder complexities in MCPs, it is essential to assess stakeholder interactions and their impacts on project development through these connectivity structures. A social network approach for analysing stakeholders and their relationships in MCPs was thus developed, with an emphasis on their information exchange interactions. This approach involves the use of *four data collection and analysis methods* (including the chain referral sampling, SNA, interview and survey), *a software package* for network visualisation and exploration, *three relationship attributes* for relationship assessment (namely frequency, timeliness, and information quality), and the calculation of *two network-level and six node-level metrics*. The procedure comprises five major steps: (1) identifying stakeholders (i.e. nodes) and general issues, (2) determining stakeholder relationships (i.e. links), (3) visualising stakeholder network, (4) analysing stakeholder network, and (5) prioritising stakeholders and general issues. Findings show that the proposed approach can identify *three critical stakeholder roles* in a MCP: central connector, information broker and peripheral actor. The general issues in a MCP can also be prioritised based on stakeholders' perception on an issue's importance in the project, and the actual influences of corresponding stakeholders in the real relationship situation.

The applicability of the proposed approach was validated by two MCPs in Hong Kong (refer to Chapter 5). The effectiveness of the approach was confirmed by the core project teams in the two case studies, whom reflected that it was a useful evaluation tool of stakeholder relationships, roles and influences; and the results provided valuable basis for improving their project stakeholder engagement strategies. Experiences from the empirical studies revealed two limitations of the approach when assessing issue importance: (1) overlooking the origins of issues in the issue identification step, and (2) disregarding the issue interdependencies and their propagating effects when assessing the issue importance. These limitations confirmed a proposition from Chapter 2 about the need of analysing stakeholder-related issues and their interdependencies in MCPs, and provided directions for the development of the stakeholder issue analysis approach in Chapter 6.

9.3.2 A social network approach for analysing stakeholder-related issues in MCPs

A network approach for analysing stakeholder-related issues and their interdependencies in MCPs was proposed (refer to Chapter 6); the application, analytical variables and procedures of the approach were illustrated (refer to Chapter 7). The findings from literature review, SNA, and two case studies in Hong Kong contributed to the development and demonstration of the proposed approach.

Findings from Chapter 2-5 indicate that, an effective stakeholder issue analysis in MCPs requires the recognizing of the origins of stakeholder issues, as well as the modelling of issue interdependencies and their proliferating impacts on project development. A network-theory based approach for analysing stakeholder-related issues and issue interdependencies in MCPs was therefore developed. This approach involves the application of *four data collection and analysis methods* (including the chain referral sampling, SNA, interview and survey), *a software package* for network visualisation and investigation, *two interdependency attributes* for interdependency assessment (namely the intensity of impact and the likeliness for impact to occur); together with the calculation of *two network-level*, *five node-level*, *one link-level, and two interface-level metrics*. The entire process comprises five major steps: (1) identifying stakeholders and stakeholder-related issues (i.e. nodes), (2) determining issue interdependencies (i.e. links), (3) visualising issue network, (4) analysing issue network, and (5) identifying critical issue and issue interdependencies. Findings indicate that this approach can identify the important stakeholders, stakeholder-related issues, issue relationships, and stakeholder-/issue-interfaces, which should be handled with higher priority and care by core project team; corresponding management measures can be formulated based on these results. The approach also included an immediate simulation to theoretically imitate and predict the likely effectiveness of the management measures, mainly based on re-calculation of the two network-level metrics.

The applicability of the issue analysis approach was tested by two MCPs in Hong Kong (refer to Chapter 8). The core project teams in the two case studies agreed the effectiveness of the approach. They opined that the approach unlocked the cause-and-effect relationships between issues, as well as their direct and indirect effects on the project development; which laid the groundwork for formulating suitable issue treatment and stakeholder engagement strategies. Experiences from the empirical studies reflected that the proposed approach was considered particularly useful in public MCPs at the early project stages because: (1) public MCPs often have considerable social interests and involve long engagement process with numerous stakeholders; and (2) an earlier project stage allows a greater flexibility to more proactively manage the stakeholders and their issues.

9.3.3 A social network model and its application guideline

A finalized social network model for stakeholder analysis in MCPs in Hong Kong, together with an application guideline for practical use of the model were proposed (refer to Chapter 8). Findings from the literature review, two network-theory based approaches for analysing stakeholders and stakeholder-related issues, and four case studies in Hong Kong, contributed to the development of the proposed model and guideline. Figure 9.1 shows the linkage between the nine chapters of the thesis with the blocks of the social network model.

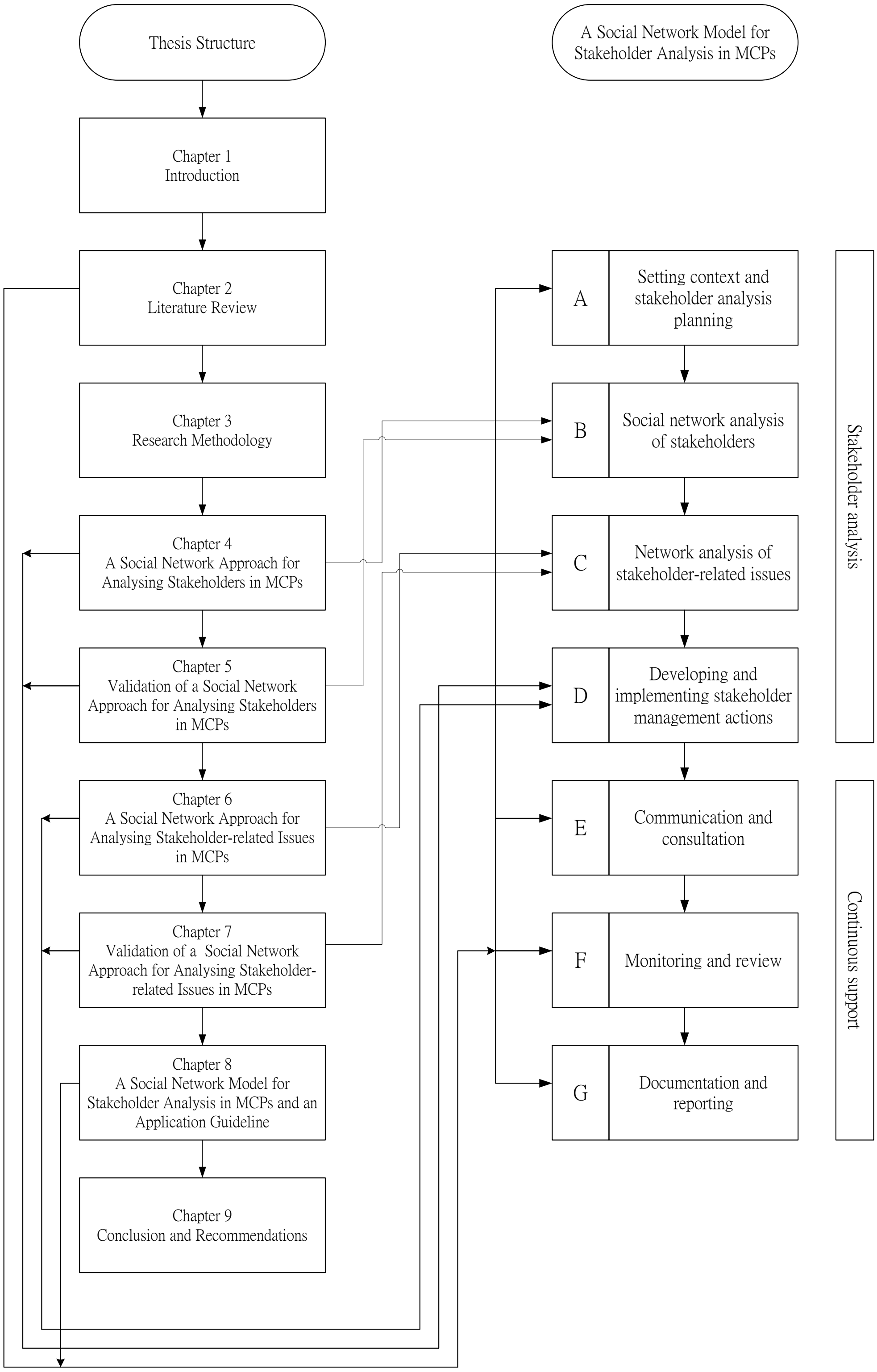


Figure 9.1: Linkage between the thesis chapters and the model

The main body of the model is formed by seven blocks that are arranged in two parts. The *stakeholder analysis* part comprises four blocks: (1) setting context and stakeholder analysis planning, (2) social network analysis of stakeholders, (3) network analysis of stakeholder-related issues, and (4) developing and implementing stakeholder management measures; while the *continuous support* part includes three blocks: (1) communication and consultation, (2) monitoring and review, and (3) documentation and reporting. The model is considered particularly useful in public MCPs, and for organisations who act as project proponent or project administrator in a MCP such as the client and management consultant. The application guideline, for facilitating practical use of the model, comprises three major parts: (1) detailed explanation of the procedures and elements of the proposed stakeholder analysis and management process, (2) practical guidance on implementing the model, and (3) management tools (e.g. documentation templates). Contents of the guideline were arranged in ten chapters, while each block of the model was described in a separate chapter.

The applicability of the proposed model and guideline were validated by experts from the industry and academia using face-to-face discussions and questionnaire survey. The experts confirmed that the model and guideline were comprehensive, practical, objective, replicable and adaptable for application in different MCP types. An important conclusion indicated in Chapter 8 is that, the finalized model and guideline can serve as a systematic and effective management tool to identify, analyse and address the stakeholders, issues, relationships (including both stakeholder interactions and issue interdependencies), and their impacts in MCPs; ultimately improving their project decision making and stakeholder management effectiveness.

9.3.4 Practical insights from the case studies

Four case studies of MCPs in Hong Kong have been conducted in the development and refinement process of the two network-theory based approaches for analysing stakeholders (refer to Chapter 5) and stakeholder-related issues (refer to Chapter 7) in MCPs.

The four case projects represent different MCP types, including cultural building, green building, design-and-build public office building, and infrastructure projects. From the results, the major stakeholder issues and challenges in MCPs were identified, management measures were also suggested, as summarized in Table 9.1. Although the researcher did not intend to generalize the case study findings across the construction industry, the findings reveal some important issues and possible causes behind the major project challenges from stakeholder perspectives, and offer useful insights to practitioners when they deal with similar problems in future MCPs.

Table 9.1: Practical insights summarised from the four case studies

<table>
<tr><th>Major stakeholder issues and project challenges</th><th>Recommendations</th></tr>
<tr><td colspan="2">Case Study I – A cultural building project</td></tr>
<tr><td>1. Variations of different art forms and without deciding the resident operator prior to design can bring extra difficulties to developing an accurate end users' requirements</td><td rowspan="2">The core leadership team should avoid planning fallacy. Large cultural building projects, which are often in aesthetic and remarkable design, may be exposed to higher cost and schedule risks than typical construction projects, when the design uniqueness and technology complexity are not adequately acknowledged in cost plan and programme</td></tr>
<tr><td>2. Alignment between design uniqueness, aesthetics, budget, end users' requirements and the actual project programme</td></tr>
<tr><td>3. The core leadership team effectively exercising its project decision making power</td><td>Having a charisma, clear vision, and well combination of the right people in the core leadership team are crucial to effective project governance and administration</td></tr>
<tr><td colspan="2">Case Study II – A green Research and Development office and laboratory building</td></tr>
<tr><td>1. Fulfilling statutory requirements and obtaining relevant approvals for green building features</td><td>The government providing more comprehensive green building standards and enhancing communications between the involved government departments</td></tr>
<tr><td>2. Stakeholders' concerning the practicality and</td><td>Building common understanding and mutual</td></tr>
</table>

value for money of green building features	goals between stakeholders regarding what sustainability targets (e.g. green certifications, energy saving targets) are to be achieved
3. Adopting and showcasing leading-edge green design and technologies in the project	The project team having a 'can-do' attitude
Case Study III – A design-and-build public office building development	
1. The core project team handling political interference and public controversies over issues on the project's value for money, cost effectiveness, public consultation sufficiency and effectiveness, and democratic access of project information	The government putting more efforts to ensure effective cost control, as well as maintaining continuous and democratic dissemination of project information to the public
2. Adopting new construction technology, but the industry lacking relevant local building codes and adequate construction expertise	Improving pre-project planning; engaging the right expertise into the project supply chain at the outset; effective communication between the client and design-and-build contractor regarding the client's requirements at the outset
Case Study IV – A reclamation works	
1. Applying complex and leading-edge construction technology, but the designers lacking adequate expertise	Encouraging early contractor involvement to integrate their construction expertise in design and procurement
2. Mitigating project disruptions to the environment and marine ecology	Improving the implementation and monitoring of environmental mitigation; maintaining a robust mechanism and setting clear responsibilities of EIA follow up
3. Conducting consultation with the public and local community during construction	Encouraging more sufficient and effective PCC in construction phase by changing the practitioners' mindsets that PCC is not important after project commencement
4. Recognising and seeking compliance with the government standard on new materials and equipment quality	Improving project planning and coordination between various government departments and project team; establishing appropriate testing methods and acceptance criteria for new materials and plants brefore project commencement.

An important conclusion confirmed from the four case studies is that, to cope with the high complexities of stakeholders in MCPs, a network perspective should be taken to analyse and manage the project stakeholders, their associated issues, and the challenges they encountered throughout the MCP development.

9.4 Contributions of the Research

This research study has contributed to the body of knowledge and improved understanding of MCP stakeholder analysis and management in four areas, as explained below.

First, this research reiterated the significance of taking a network perspective to analyse and engage stakeholders, and developed a social network approach for investigating stakeholders and their interrelationships in MCPs. These findings provide core project team an analytical tool to identify completely the project stakeholders and their general concerns, visualise the social interactions of stakeholders (e.g. project information exchange interactions), examine the characteristics of these connectivity structures, identify the influential stakeholders and important issues which worth high attention, as well as spot out opportunities for improving stakeholder communication. These findings improve the traditional MCP stakeholder analysis practice which has often regarded stakeholders as staying in a hub-and-spoke environment, and relied too heavily upon the individual stakeholder attributes when assessing stakeholder impacts.

Secondly, this research explored the methodological potential of using a network perspective to analyse and address stakeholder-related issues, and developed a network-theory based approach for examining stakeholder-related issues and issue interdependencies in MCPs. The findings provide the core project team an analytical tool to identify a complete boundary of project stakeholders and their associated issues, visualise the cause-and-effect relationships between issues, investigate the direct and indirect effects of these interdependencies on MCP development; as well as identify the key stakeholders, issues and links that should be handled with special care and urgency. The findings improve the conventional MCP stakeholder issue analysis practice which has often ignored the sources or origins of stakeholder issues, and considered issues as being independent and stationery in project environment.

Thirdly, this research developed a social network model and an application guideline. The model described a structured, holistic and objective process for stakeholder analysis and management in MCPs in Hong Kong; specifically investigating stakeholder interactions, stakeholder-related issue interdependencies and their proliferating impacts from a network perspective. The guideline contained practical guidance and management tools to facilitate implementation of the model. The model and guideline together serve as a systematic and generic reference for MCP leaders, to design and conduct a network-theory based stakeholder management process which suits the characteristics and needs of their MPCs.

Lastly, four case studies, each of different MCP types, were conducted in the process of developing and refining the two network-theory based stakeholder analysis methods. These empirical studies identified the critical stakeholders, issues and relationships in the projects, also revealed the project challenges and suggested recommendations from the stakeholders' perspective. The major project pitfalls reported in the case studies provide practical value to practitioners who are involved or take the lead in managing and implementing these kind of MCPs; besides, the possible causes and recommendations discussed can bring them useful insights when dealing with similar problems in future MCPs.

9.5 Limitations of the Research and Suggestions for Future Research

9.5.1 Limitations of the research

The following limitations in this research study should be noted with attention:

1. The development, refinement and validation of the network-theory based methods (refer to Chapter 4-7), and the social network model and application guideline (refer to Chapter 8) are mainly based on case studies, interviews and questionnaire survey in Hong Kong. All case projects and respondents were also from Hong Kong. Therefore, one limitation is that, the findings in this research are limited to the Hong Kong MCP context; whilst this research does not consider the impact of national culture on stakeholder management in MCPs. Time and resources shortages are the main reasons of this limitation.

2. The network investigation in each of the four case studies is only a one-off analysis, and the network-theory based approaches were applied only in one phase of each case project. Hence, the network in each case only captures a snapshot of the stakeholders/issues and their interactions at a single point of time in one phase of the project. There are two main reasons for this. The first one is time limitation. MCPs often involve a long lead time. For instance, the construction phase of the AI project (Case Study IV) has already taken five years and will last for another year or two; which is even longer than the duration of this research study. The second reason is high project sensitivity. The four case projects are all high-profile and controversial. Despite the attempts of researcher, the core project teams of the four cases were disinclined to take part in another round of network data collection.

3. Despite the use of chain referral sampling for stakeholder identification, it is practically and ethically challenging to engage all stakeholders of a MCP for data collection in the network building process. For example, some stakeholders concerned the confidentiality and anonymity issues and were disinclined to take part in the case studies. A higher precision in the relationship and stakeholder/issue impact assessment can be yielded if all stakeholder entities are ideally reached. Despite that, the researcher tried to mitigate this

limitation by the following measures: (1) when stakeholders are nominated, the researcher have approached them to confirm or elucidate their project role, responsibilities and involvement; (2) after the entire referral process, the list of identified stakeholders and a brief description of them had been returned to core project team for feedbacks; and (3) after minor amendments, the stakeholder list and brief description were confirmed with the core project team before proceeding to the next step.

4. Each of the four case studies in this research represents a type of MCP (namely a cultural building, a green commercial development, an office building, and a reclamation works), giving practical insights on the critical stakeholders and issues in different kinds of mega projects. However, it should be noted that the case study findings for each MCP type are derived from a single case, hence the practical insights may not be generalised across the construction industry; yet they reveal some possible reasons behind the project challenges and suggest potential management measures. In addition, due to the limited context of single case for each project type, this research lacks a generalization on the thresholds of network metrics, for extracting the most critical stakeholders and issues in each MCP type.

5. In the four case studies of this research, interviews and survey are the main means of data collection and corroboration, instead of via workshops or focus group. It is acknowledged that, workshop (with the presence of all stakeholder representatives) can be an ideal way of data collection and corroboration; because different stakeholders may tell different stories about their relationships and issues, and discussions can be an effective means to reach consensus and resolve contradiction. In the research design of the four case studies, the researcher had considered to conduct workshops for data collection, and tried to invite stakeholders. However, most respondents in the projects refused to join workshops and

they preferred interviews, due to two reasons: (1) the projects are highly sensitive, so the stakeholders were not willing to meet the others in occasions other than their work routines. Even if they attend workshop, they would not feel comfortable to freely express their views with the presence of other stakeholders; and (2) it was practically difficult to arrange workshop which fits everyone's schedule in the cases.

6. In this research, some case studies (e.g. the XC project in Case Study I) were conducted at a time early in the project implementation. The researcher acknowledged that this study will provide greater practical contributions, if the case study findings can be actually used by project leaders/stakeholders as an avenue for improving performance and the ultimate outcomes of the project. However, one limitation is that, the researcher faced practical difficulties in knowing whether the case study findings have been actually used by project leaders, as well as the extent of actual impacts (if being used). There are two main reasons: (1) the case projects are still ongoing and thus the ultimate project outcomes are not yet known, and (2) in reality, a series of project governance and administrative procedures will have to be gone through across various hierarchies, before the findings can be used to develop stakeholder management measures for real enforcement in Hong Kong.

7. The social network model and application guideline (refer to Chapter 8) are generic and qualitative in nature. They systematically and graphically present the network-theory based MCP stakeholder analysis process. One limitation is that there are no real MCPs to illustrate the practical use of the whole model and guideline; instead, they were validated by experts and practitioners who possess intimate knowledge of MCP development and stakeholder management, and are potential users. Despite that, the model and guideline

are considered a systematic and generic reference for MCP stakeholder analysis using a network perspective.

9.5.2 Suggestions for future research

In view of the above limitations, four recommendations are suggested for future research, as stated below:

1. Future research can be conducted to explore the impact of national cultural diversity on MCP stakeholder management. National culture refers to the common understandings accumulated from the norms of an entire society or national environment. These deeply rooted values can shape the way that stakeholders (of a nation) perceive about the project, pursue their interests, and interact with other stakeholders. In future, comparative studies can be conducted by applying the social network model in MCPs of eastern and western cultures. The effects of trans-national and trans-regional stakeholder involvement in MCPs may also be worth exploring, because a country can have different subcultures. It will help enhancing stakeholder collaboration across national and regional borders.

2. Longitudinal network studies are needed in future to empirically explore the dynamics of stakeholder relationships and issue interdependencies throughout the entire lifecycle of a MCP.

3. Future empirical studies, using the social network model, can be conducted in other MCP types and contexts to compare the findings and develop more comprehensive stakeholder management strategies.

4. The importance level of a stakeholder, issue or interdependency should not be solely determined based on the network analysis results. In practice, it can also be affected by a set of external (e.g. political climate of the society) and internal factors (e.g. expertise of the core project team in stakeholder management). To increase practicality of the network approach, future research should develop a method to define and generalize the thresholds of network metrics; which can simultaneously take into account the internal and external influential factors, and integrate the network analysis results from previous case studies.

9.6 Chapter Summary

This chapter sums up the entire research study. It outlines the research aim and objectives, encapsulates the main findings, highlights the value and significance, explains the limitations, and suggests future research directions. It is expected that this research can contribute to new knowledge and improve understanding of MCP stakeholder management; particularly on the network perspective to analysing stakeholder interrelationships and issue interdependencies, as well as practical insights for engaging stakeholders and addressing critical issues in MCPs in Hong Kong.

APPENDICES

Appendix A – List of Publications

Refereed Journal Articles

1. **Mok, K.Y.**, Shen, G.Q., Bao, H.X.H., Skitmore, M., Koncarevic, B. Managing stakeholder interests and relationships in mega construction projects: a network-based and behavioral economics approach. (Under Review)

2. **Mok, K.Y.**, Shen, G.Q., Yang, R.J. (2018). Stakeholder complexity in large scale green building projects: a holistic analysis towards a better understanding. Engineering, Construction and Architectural Management. (Accepted)

3. **Mok, K.Y.**, Shen, G.Q., Yang, R.J. (2017). Addressing stakeholder complexity and major pitfalls in large cultural building projects. International Journal of Project Management, 35(3), 463-478.
(DOI: 10.1016/j.ijproman.2016.12.009)

4. **Mok, K.Y.**, Shen, G.Q., Yang, R.J., Li, C.Z. (2017). Investigating key challenges in major public engineering projects by a network-theory based analysis of stakeholder concerns: A case study. International Journal of Project Management, 35(1), 78-94.
(DOI: 10.1016/j.ijproman.2016.10.017)

5. **Mok, M.K.Y.** and Shen, G.Q. (2016). A network-theory based model for stakeholder analysis in major construction projects. Procedia Engineering, 164, 292-298. Selected papers from Creative Construction Conference 2016.
(http://dx.doi.org/10.1016/j.proeng.2016.11.622)

6. **Mok, K.Y.**, Shen, G.Q., Yang, R.J. (2016). A network-theory based analysis of stakeholder issues and their interrelationships in large construction projects: a case study. International Journal of Construction Management, 1-18.
(DOI: 10.1080/15623599.2016.1187246)

7. Li, C.Z., Hong, J.K., Xue, F., Shen, G.Q., Xu, X., **Mok M.K.**, (2016). Schedule risks in prefabrication housing production in Hong Kong: a social network analysis. Journal of Cleaner Production, Volume 134, Part B, 482-494.
(DOI: 10.1016/j.jclepro.2016.02.123)

8. **Mok, K.Y.**, Shen G.Q., and Yang, J. (2015). Stakeholder management studies in mega construction projects: A review and future directions. *International Journal of Project Management*, 33(2), p.446-457.
(DOI: 10.1016/j.ijproman.2014.08.007)

Conference Presentations and Publications

1. **Mok, K.Y.** and Shen, G.Q. (2015). Assessing stakeholder concerns in major infrastructure projects: A shift from the traditional approach to a social network approach. Proceedings of 2015 Seoul International Conference on Engineering and Applied Science, Seoul, South Korea, 8-10 January 2015.

2. **Mok, K.Y.** and Shen, G.Q. (2014). Measuring the performance of stakeholder analysis in mega construction projects: A conceptual framework. Proceedings of 2014 Tokyo International Conference on Engineering and Applied Science, Tokyo, Japan, 17-19 December 2014.

<u>Others</u>

1. **Mok, M.K.Y.** and Shen, G.Q. (2017). Value-oriented stakeholder engagement in sustainable development, in Future Challenges in Evaluating and Managing Sustainable Development in the Built Environment (eds. P.S. Brandon, P. Lombardi and G.Q. Shen), John Wiley & Sons, Ltd, Chichester, UK.
(DOI: 10.1002/9781119190691.ch12)

Appendix B – A Sample Questionnaire for Analysing Stakeholders in MCPs

SURVEY QUESTIONS

Section I. General Information *(Only overall statistical data will be compiled, i.e. individual information not disclosed)*

Q1a. Name of your organisation:

Q1b. Stakeholder role of your organisation in the Project:

Q1c. Your position in the organisation:

Q1d. Scope of work of your department and organisation in the Project:

Q1e. Your work experience:

☐ 5 years or below ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ Over 20 years

Section II. Stakeholder Concerns in the Project

Q2. The following table shows the stakeholder concerns in the Project. Please rate the relative importance of the following concerns to you based on your experience from 1-5, where **"1" represents "least important"**, **"5" represents "most important"** and **"N/A" represents "the concern is not related to me at all"**.

Concern categories	**Stakeholder concerns**	Least important ← **1**	**2**	**3**	**4**	Most important → **5**	**N/A**
	I1	☐	☐	☐	☐	☐	☐
	I2	☐	☐	☐	☐	☐	☐
	I3	☐	☐	☐	☐	☐	☐
	I4	☐	☐	☐	☐	☐	☐
	I5	☐	☐	☐	☐	☐	☐
	I6	☐	☐	☐	☐	☐	☐
	I7	☐	☐	☐	☐	☐	☐
	I8	☐	☐	☐	☐	☐	☐
	I9	☐	☐	☐	☐	☐	☐
	I10	☐	☐	☐	☐	☐	☐
	I11	☐	☐	☐	☐	☐	☐
	I12	☐	☐	☐	☐	☐	☐
	I13	☐	☐	☐	☐	☐	☐
	I14	☐	☐	☐	☐	☐	☐
	I15	☐	☐	☐	☐	☐	☐
	I16	☐	☐	☐	☐	☐	☐
	I17	☐	☐	☐	☐	☐	☐
	I18	☐	☐	☐	☐	☐	☐

Section III. Information Exchange Relationships

This section collects your opinions regarding your information exchange relationships with each of the stakeholders in the Project.

<u>Definition of information</u>

In this survey, information refers to: (1) any information which is related to the stakeholder concerns shown in Section II, and (2) any information whose transmission can help or is essential for the stakeholders to understand or address these concernS.

<u>Definition of information exchange</u>

Information is exchanged in two directions. In one direction, you **OBTAIN** information from a set of stakeholders to help in understanding/addressing stakeholder concerns (please refer to Q3). In the opposite direction, you **PROVIDE** information to a set of stakeholders to facilitate them in understanding/addressing stakeholder concerns (please refer to Q4).

<u>Instructions</u>

In Q3 and Q4, please firstly identify the stakeholders who have information flow relationships with you (a *Stakeholder List* is provided in the Appendix for your reference). Information flow includes two directions: **Q3 considers you as the information recipient; Q4 considers you as the information provider**.

Then, in Q3 and Q4, please evaluate your information flow relationships with each of the identified stakeholders according to three relationship attributes *(frequency, access, and information quality)* using a numerical scale of 1-5. The numerical scale is defined below.

<u>Numerical scale</u>

(i) Frequency:	"1"= "less than once a month", "2"= "biweekly to monthly", "3"= "weekly", "4"= "several times a week", and "5"= "at least once per day"
(ii) Access	"1"= "very untimely access", "2"= "untimely access", "3"= "fairly timely access", "4"= "timely access", and "5"= "very timely access"
(iii) Information quality:	"1"= "very low quality", "2"= "low quality", "3"= "fair quality", "4"= "good quality", and "5"= "very good quality"

Note: Definitions of the above relationship attributes will be given in Q3 and Q4.

Q3. From which stakeholders do you **OBTAIN** information to assist in understanding/addressing the stakeholder concerns shown in Section II? Please list these stakeholders and their project role in Q3a.
For each identified stakeholder, please rate the following items from 1-5 according to the numerical scale shown in Page 4:
(i) *Frequency*: **How often** do you obtain information from the identified stakeholder? Please rate in Q3b;
(ii) *Access*: Do you obtain information from the identified stakeholder **in a timely manner**? Please rate in Q3c;
(iii) *Information quality*: What is the **quality of the information obtained** (e.g. correctness, completeness and comprehensibility)? Please rate in Q3d.

3a. From which stakeholder(s) do you OBTAIN information?		3b. Frequency					3c. Access					3d. Information quality				
Stakeholder	Role in the Project	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Note: (i) Please identify as many stakeholders as possible. Stakeholders not identified are considered as **having no relationships** with you.
(ii) Please feel free to add more rows if necessary.

Q4. To which stakeholders do you **PROVIDE** information to assist them in understanding/addressing the stakeholder concerns shown in Section II? Please list these stakeholders and their project role in Q4a.

For each identified stakeholder, please rate the following items from 1-5 according to the numerical scale shown in Page 4:

(i) *Frequency*: **How often** do you provide information to the identified stakeholder? Please rate in Q4b;

(ii) *Access*: Do you provide information to the identified stakeholder **in a timely manner**? Please rate in Q4c;

(iii) *Information quality*: What is the **quality of information transferred** by you (e.g. correctness, completeness and comprehensibility)? Please rate in Q4e.

4a. To which stakeholder(s) do you PROVIDE information?		4b. Frequency					4c. Access					4d. Information quality				
Stakeholder	Role in the Project	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Note: (i) Please identify as many stakeholders as possible. Stakeholders not identified are considered as **having no relationships** with you.

(ii) Please feel free to add more rows if necessary.

Appendix. Stakeholder List for Reference

The table below shows the stakeholders of this Project. You may refer to this list when you identify stakeholders in Q3 and Q4.

Code	Role in the Project	Stakeholder
S1		
S2		
S3		
…		
S18		

(End)

Thank you for your kind cooperation and valuable assistance in participating in this survey

Appendix C – A Sample Questionnaire for Analysing Stakeholder-related Issues in MCPs

SURVEY QUESTIONS

Section I. General Information *(Only overall statistical data will be compiled, i.e. individual information not disclosed)*

Q1a. Name of your organisation:

Q1b. Stakeholder role of your organisation in the Project:

Q1c. Your position in the organisation:

Q1d. Scope of work of your department and organisation in the Project:

Q1e. Your work experience:

☐ ≤ 5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ ≥ 20 years

Section II. Identifying Stakeholders in the Project

Q2. Please list stakeholders and their role in the project. Please assign each stakeholder with a numerical code in ascending order, e.g. S1, S2, S3,…,S_n.

Category	Stakeholder	Role in the Project	Code no.
Client			S
			S
			S
Contractor			S
			S
			S
Design consultant			S
			S
			S
Subcontractor and supplier			S
			S
			S
Funding organisation			S
			S
			S
Government			S
			S
Insurer			S
			S
Certifier/assessor			S
			S

Q2. (Cont'd)

Category	Stakeholder	Role in the Project	Code no.
End user			S
			S
			S
Pressure group			S
			S
			S
Environmentalist			S
			S
			S
Public			S
			S
			S
Local community			S
			S
			S
Others			S
			S
			S

Note: (i) Please identify as many stakeholders as possible, no matter their associated issues are related to you or not.
(ii) Please feel free to add more rows when necessary.

Section III. Identifying Stakeholder-related Issues in the Project

Q3. Please list issues relating to each identified project stakeholder (as identified in Q2). Please assign each identified stakeholder-related issue with a numerical code as S_aI_b, e.g. S1I1, S1I2, S1I3, …, S1In, S2I1, S2I2, S2I3, …, S2Ik (where S2Ik indicates the k^{th} issue of the second stakeholder in the project).

Stakeholder: S1

Category	Issue related to S1	Code no.
Cost		S1I_
		S1I_
Economic		S1I_
		S1I_
Environmental		S1I_
		S1I_
Ethical		S1I_
		S1I_
Legal		S1I_
		S1I_
Organisational		S1I_
		S1I_
Political		S1I_
		S1I_
Procurement and contractual		S1I_
		S1I_
Quality		S1I_
		S1I_
Safety		S1I_
		S1I_
Social		S1I_
		S1I_
Technological		S1I_
		S1I_
Time		S1I_
		S1I_
Others		S1I_
		S1I_

Note: (i) Please identify as many stakeholder-related issues as possible, no matter the particular issue is related to your issue or not.

(ii) Please add separate pages for each identified stakeholder to list their related issues in the project.

(iii) Please also identify your issues/concerns in the project using a separate page.

Stakeholder: S2

Category	Issue related to S2	Code no.
Cost		S2I_
		S2I_
Economic		S2I_
		S2I_
Environmental		S2I_
		S2I_
Ethical		S2I_
		S2I_
Legal		S2I_
		S2I_
Organisational		S2I_
		S2I_
Political		S2I_
		S2I_
Procurement and contractual		S2I_
		S2I_
Quality		S2I_
		S2I_
Safety		S2I_
		S2I_
Social		S2I_
		S2I_
Technological		S2I_
		S2I_
Time		S2I_
		S2I_
Others		S2I_
		S2I_

Stakeholder: S_

Category	Issue related to S_	Code no.
Cost		S2I_
		S2I_
Economic		S2I_
		S2I_
Environmental		S2I_
		S2I_
Ethical		S2I_
		S2I_
Legal		S2I_
		S2I_
Organisational		S2I_
		S2I_
Political		S2I_
		S2I_
Procurement and contractual		S2I_
		S2I_
Quality		S2I_
		S2I_
Safety		S2I_
		S2I_
Social		S2I_
		S2I_
Technological		S2I_
		S2I_
Time		S2I_
		S2I_
Others		S2I_
		S2I_

Section IV. Assessing Interdependencies between Stakeholder-related Issues in the Project

Q4. Based on the stakeholder issue identification results in Q3, this question assesses the influence relationship between each pair of stakeholder-related issues in the project. When an issue exerts influence over another issue, an interdependency is said to exist between the two issues.

In the table below, please quantify each interdependency from two aspects: (a) the *strength of impact* of this interdependency, and (b) the *likelihood* for this interdependency to happen. Please rate the *impact* (P) and *likelihood* (L) of each interdependency from 1-5, where “1” represents “the lowest impact/the least likely” and “5” represents “the highest impact/the most likely”. If an issue does not influence another, put zero in the cell.

	S_I_	S_I_	S_I_	S_I_	S_I_	S_I_	S_I_	S_I_	S_I_
S_I_	**P** / **L**								
S_I_									
S_I_									
S_I_									
S_I_									
S_I_									

Note: (i) “Impact” is denoted by “P” and “Likelihood” is denoted by “L”.

(ii) Please read the matrix from the column to the row. Each cell represents the influence exerted by the ‘column issue’ to the ‘row issue’.

(iii) Please feel free to add more pages for the matrix when needed.

(End)

Thank you for your kind cooperation and valuable assistance in participating in the survey

Appendix D – A Sample Invitation Letter for Participation in Case Study

Dear,

Invitation for interview on the project (Project name)

With the support of the HKSAR Research Grants Council, a research team at the Hong Kong Polytechnic University, comprising my chief supervisor, Prof. Geoffrey Q.P. Shen, is now conducting a research project entitled "Analysing stakeholder-organisation relationships in mega construction projects: a social network approach". This research aims to develop a practical social network model for stakeholder analysis in mega construction projects, and to improve the accuracy and effectiveness of the overall stakeholder management practice in the local construction industry.

As (Project name) is a large scale and iconic project with unique nature in Hong Kong, it would be grateful if we could use this project as our subject of case study for analysis. Therefore, we would like to seek kind assistance from relevant parties for interviews and questionnaire survey. We are kindly inviting you or your colleagues who have participated in this project for an interview and survey, which would take around 30 minutes. We understand that you have a very tight schedule, but we wish that you can share your insights and expertise with us at a time convenient to you.

All the information provided by you will be used **solely for academic purpose** and we shall observe your advice on **confidentiality**. If anything needs further clarification, please contact me at (mobile number) or (office number). Thank you for your kind attention.

Yours faithfully,

Margaret K.Y. MOK
PhD Candidate
Department of Building and Real Estate
The Hong Kong Polytechnic University

Appendix E – A Sample Letter of Confidentiality Undertaking

Letter of Confidentiality Undertaking

To : (Stakeholder organisation)

From: The Research Team at the Hong Kong Polytechnic University

Date: (Date)

Dear Sirs,

(Project name)

We are writing to request the (Stakeholder organisation) to participate in interviews and questionnaire survey regarding the captioned project for academic study by a research team at the Department of Building and Real Estate, the Hong Kong Polytechnic University, for the research project funded by the Research Grants Council entitled "Analysing stakeholder-organisation relationships in mega construction projects: a social network approach" and a Doctor of Philosophy research project entitled "A social network model for stakeholder analysis in mega construction projects". This research aims to develop a practical social network model for stakeholder analysis in major construction projects, and to improve the accuracy and effectiveness of the overall stakeholder management practice in the local construction industry.

In consideration of you agreeing to participate in the interviews and questionnaire survey regarding the captioned project, we hereby undertake, acknowledge and agree as follows:

1. All the information and data provided by you will be used solely for **academic research purpose**;
2. The names and specific identities of the involved organisations and personnel are kept **anonymous**;
3. **No written disclosure** of the names of the building and the project.

Yours faithfully,

Ms. Margaret K.Y. MOK
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Endorsed by:

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Appendix F – Sample List of Interview Questions

The Hong Kong Polytechnic University
RGC Research Project

Background:
With the support of the HKSAR Research Grants Council, a research team at the Hong Kong Polytechnic University, comprising the chief supervisor, Prof. Geoffrey Shen, is now conducting the research project entitled "Analysing stakeholder-organisation relationships in mega construction projects: a social network approach". In order to develop an innovative and practical social network model for stakeholder analysis in mega construction projects (MCPs), we would like to seek your kind assistance for an interview.

Face-to-face interview aim:
1. To understand the stakeholders involved and their major issues in the (Project name);
2. To understand the current practice, real life experience and major challenges encountered regarding stakeholder analysis and engagement in the (Project name).

Interview questions:
<u>The case projects</u>
1. What is the role of your organisation in this project?

2. What is the scope of the (Project name)? What are the main features of this project? What are the major project constraints in terms of design, social, technical, financial, legal and environmental aspects?

3. From the project management perspective, how are MCPs different from the ordinary sized construction projects?

4. What challenges do you encounter in the (aspects) of this project?

5. In future similar MCPs, what areas of improvement could be made regarding (aspects)?

<u>Stakeholder identification and analysis</u>
6. Who are the major stakeholders[7] in this project? Which stakeholder(s) do you have frequently interacted or collaborated with? For the stakeholders you have just mentioned, what are the key issues/interests of each of them at the planning, design and construction stages?

[7] Stakeholders are defined as "individuals and organisations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion" (Project Management Institute, 1996)

7. What methods are used for stakeholder identification and analysis [8] (including identifying stakeholders and their concerns, analysing stakeholder relationships and stakeholder impacts) in this project?

8. In which project stage(s) do you think that the stakeholder analysis process is most critical and gives the greatest impact/benefits to the project?

9. In evaluating the effectiveness of a stakeholder analysis method, what performance criteria do you think is important?

10. What are the key factors which affect the effectiveness of a stakeholder analysis method and its application?

11. Do you see any limitations or weaknesses in the current stakeholder analysis practice in MCPs? If yes, what are they and the potential solutions?

12. Does your organisation provide any institutional guidelines and procedures for undertaking stakeholder analysis in practice? If yes, what are they?

Stakeholder engagement[9]

13. What methods are used at different project stages to engage stakeholders and enhance communication with them? Please answer with respect to both internal and external[10] stakeholders.

14. What strategies are used to balance the diversified interests of multiple stakeholders in the project? Do you think the diversified interests of multiple stakeholders in this project have been sufficiently and effectively accommodated?

[8] Stakeholder analysis comprises five steps: (1) identifying stakeholders, (2) categorizing and prioritizing stakeholders, (3) identifying and analysing stakeholder concerns, (4) analysing stakeholders' relationship and (5) assessing stakeholders' influence on the project (Young, 2006; Yang et al., 2011).

[9] Stakeholder engagement is defined as the process "to communicate with, involve and develop relationships with stakeholders (Yang et al., 2011).

[10] External stakeholders are defined as stakeholders who are not the primary participants directly involved in the project (Newcombe, 2003).

Appendix G – Validation Form for the Social Network Model and its Application Guideline

A Social Network Model for Stakeholder Analysis in Mega construction projects and its Application Guideline – Validation Form

I. Introduction

A social network model for stakeholder analysis in mega construction projects (MCPs) and its application guideline have been developed based on extensive literature review, case studies, questionnaire surveys, as well as semi-structured interviews with various construction practitioners and key stakeholders of MCPs. To ensure that the proposed model and guideline are relevant and suitable for application in the local construction industry, they will be validated in terms of five aspects, namely: (i) 'Comprehensiveness', (ii) 'Practicality', (iii) 'Adaptability for different types of MCPs', (iv) 'Replicability', and (v) 'Objectivity', by experienced practitioners and professionals.

II. General Information

Your organisation and post: ______________________
Your role: ______________________
Years of work experience (approx.): ______________________

III. Validation Criteria

Please rate the level of satisfaction with the model and its guideline in the following items from 1 – 5, where "1" represents "The lowest" and "5" represents "The highest".

Validation Criteria	Lowest ←				→ Highest
	1	2	3	4	5
1. Degree of Comprehensiveness	☐	☐	☐	☐	☐
2. Degree of Practicality	☐	☐	☐	☐	☐
3. Degree of Adaptability for different types of MCPs	☐	☐	☐	☐	☐
4. Degree of Replicability	☐	☐	☐	☐	☐
5. Degree of Objectivity	☐	☐	☐	☐	☐

IV. Comments (Optional)

____

____

Explanatory Notes of Validation Criteria:

1. Degree of Comprehensiveness: Whether the model and its guideline consider all essential elements for conducting stakeholder analysis in MCPs, and provide the users with necessary explanations.
2. Degree of Practicality: Whether the model and its components (called "Blocks") are realistic in nature and can be applied in practice.
3. Degree of Adaptability for different types of MCPs: Whether the model and its guideline can provide users with guidance for application and are applicable in different types of MCPs.
4. Degree of Replicability: Whether the model will provide similar outcomes when it is applied in an identical project with an identical context.
5. Degree of Objectivity: Whether the model and its guideline avoid biased or misleading elements in favour of a particular setting or type of project development.

Appendix H – Proposed Application Guideline to the Social Network Model

An Application Guideline to Social Network Model for Stakeholder Analysis in Major Construction Projects

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1. INTRODUCTION

1.1 Background

With the support of the HKSAR Research Grants Council, a research team from the Hong Kong Polytechnic University is conducting a research project entitled "Analysing stakeholder-organisation relationships in mega construction projects: a social network approach". In order to improve the accuracy and effectiveness of the overall stakeholder management practice in the local construction industry, a social network model for stakeholder analysis in major construction projects is developed; and an application guideline to the practical use of this social network model is developed for reference.

1.2 Purpose of this guideline

Major construction projects (MCPs) involve a wide range of stakeholders who have diverse values and expectations, and are interrelated by various relationships. Successful project development requires the establishment of a common ground and strong collaboration among stakeholders, yet the complexity of stakeholders has been a hurdle in achieving these goals. Failure to manage stakeholders can have serious implications to project development, such as

- Failure to identify the actual needs of stakeholders and incorporate them in the project;
- Poor stakeholder communication, engagement and coordination;
- Failure to achieve stakeholder satisfaction with project outcomes;
- Potential harm to the reputation of project organisations;
- Potential harm to future business opportunities.

In the above context, there is clearly a need to analyse and address the complexity of stakeholders when undertaking MCPs. This can be done through a systematic stakeholder analysis using Social Network Analysis (SNA) method.

This guideline aims to provide guidance on conducting a systematic process for interpreting stakeholder environment in MCPs using SNA. More specifically, this guideline provides:

- A background to MCP stakeholder analysis;
- Details of the main elements of the social network model which is developed for stakeholder analysis in MCPs;
- Practical guidance on implementing the stakeholder analysis process with the social network model;
- Some management tools that can be utilised to implement the process.

The information resulting from the stakeholder analysis can be used to:

- Identify critical stakeholders, stakeholder-related issues and issue interdependencies;
- Develop action plans to improve the engagement of important stakeholders;
- Develop action plans to handle key stakeholder issues and issue interdependencies;

- Provide inputs for other analyses (e.g. risk assessment);
- Provide guidance for other consensus building processes by sharing the stakeholder information and encouraging discussion (e.g. value management workshop).

1.3 Targeted users of the Social Network Model and this guideline

The social network model and its guideline are useful to project management teams, decision makers and any practitioners in MCPs who take a major role in engaging and managing stakeholders in the project development process. They are particularly useful to organisations who act as project proponent or project administrator in a MCP, e.g. the client, management consultant. These organisations often take the lead in compiling stakeholder requirements, as well as project stakeholder communication and management.

1.4 What is Stakeholder Analysis

Stakeholder analysis is a process of systematically interpreting the complex stakeholder environment when developing and/or implementing a project. More specifically, it is a process of identifying stakeholders and stakeholder issues, analysing stakeholder relationships and issue interdependencies, and assessing stakeholder influence and issue importance in a project. For the purpose of this guideline, the definitions below have been adopted.

Stakeholder – "*Any individuals or organisations who are actively involved in a project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion"* (Project Management Institute: 1996 – Project Management Body of Knowledge). Generally, in a MCP, stakeholders include: client, contractor, designer, consultant, supplier and subcontractor, government, financer, media, environmental organisation, politician, local community, public, end user, certifier, and professional institution.

Stakeholder issue – *Any concerns or vested interests of stakeholders in a project, which may be favourably or unfavourably affected due to project execution or completion*. They are the interests that a stakeholder tries to safeguard by influencing project implementation or decision marking. They are also important considerations of a stakeholder when it makes decisions or takes actions in a project.

Stakeholder relationship – *Any relationships that connect stakeholders directly or indirectly across functional and organisational borders in a project*. Stakeholder relationships can be formal or informal. Examples of formal stakeholder relationships include inter-organisational contractual relationships on resources sharing or construction services supply. Examples of informal stakeholder relationships include communication, collaboration, information/knowledge exchange, interpersonal relationships (e.g. trust). Stakeholder relationships can affect stakeholders' values, perceptions, and behaviours in safeguarding their interests.

Stakeholder issue interdependencies *– The cause-and-effect relationships between any stakeholder issues in a project*. Stakeholder issues in a project are interdependent because the presence of an issue can trigger or govern the occurrence of other directly/indirectly related issues. The interdependencies and chain effects between stakeholder issues can increase uncertainties in stakeholder behaviours and project decision making.

Stakeholder analysis is an integral part of project stakeholder management. It allows project management team to determine 'who can make an influence' and 'which issues to be addressed with high priority'. It provides essential understanding for developing management actions and strategies.

1.5 What is Social Network Analysis

The Social Network Theory perceives a MCP as a network system consisting a definite set of actors connected by various relationships. The patterning and characteristics of this connectivity structure determine the behaviours of its actors, as well as the robustness and performance of the entire network system. SNA, which evolves from the Social Network Theory, is a quantitative method to analyse relationship structures by integrating mathematical, computational and statistical techniques. Using SNA for stakeholder analysis helps to visualise and examine the social interactions of stakeholders, the cause-and-effect relationships between stakeholder issues, and the implications of the above on project development. The SNA process comprises five major steps:

1. defining the network boundary (i.e. which stakeholders or issues to be included);
2. identifying and assessing meaningful relationships (i.e. stakeholder relationships or issue interdependencies);
3. visualising the network with sociographs (i.e. stakeholder network or issue network);
4. analysing the network structure;
5. presenting the results of analysis.

1.6 Scope of application of the Social Network Model

The social network model in this guideline is developed for stakeholder analysis in MCPs. The model is particularly useful in public major project developments which are extremely complex; comprise numerous stakeholders, issues and interdependencies; involve considerable public and social interests; emphasise social equity and project image; and involve long and complex public engagement process. The network approach to identifying, assessing and prioritizing stakeholder and issue importance will help facilitate stakeholder analysis and enhance stakeholder engagement in this kind of MCPs.

1.7 Benefits of the Social Network Model

Stakeholder environments in MCPs are complex and uncertain. Despite the need of a rigorous MCP stakeholder analysis approach, stakeholder management is still new in the local MCP management practice. Practitioners often identify and assess stakeholders based on empirical knowledge; but owing to their cognitive limitations, the accuracy and objectivity of their judgment might decrease when the project increases in size and complexity. The social network model in this guideline helps to overcome these drawbacks. The model provides a scientific, objective and systematic means to MCP stakeholder analysis. By using the network approach, this model enables the project team to thoroughly identify stakeholders and issues, visualise and analyse the relationships between stakeholders and among issues, assess and prioritize the importance of stakeholders and issues, align project outcomes with stakeholder needs, and create more informed project decisions. Eventually, it helps to achieve the benefits below:

- Avoiding hidden stakeholders, issues and relationships which may be less apparent but exert great impacts on project development;
- Identification of critical stakeholders, issues and relationships which should be handled at higher priorities and with greater care;
- More effective realisation of stakeholders' actual needs, requirements and expectations;
- Providing platforms (e.g. workshops, discussion forums) for stakeholders to create alternative project solutions;
- Objective comparison and selection of response options;
- Enhancing stakeholder understanding of project objectives;
- Help showing to stakeholders that their concerns have been systematically and properly considered and/or addressed;
- Enhancing stakeholder communication, engagement and coordination;
- Enhancing stakeholder satisfaction and recognition on the project;
- Improved information for project planning and decision making;
- Enhanced reputation and future business opportunities of project organisations.

2. PROCESS OVERVIEW OF THE SOCIAL NETWORK MODEL

A social network model for stakeholder analysis in MCPs is shown in Figure 1. The model comprises 7 Blocks. Chapter 2 provides an overview of the model. Each block is further broken down into several components. Specific details of each block will be explained in the following chapters.

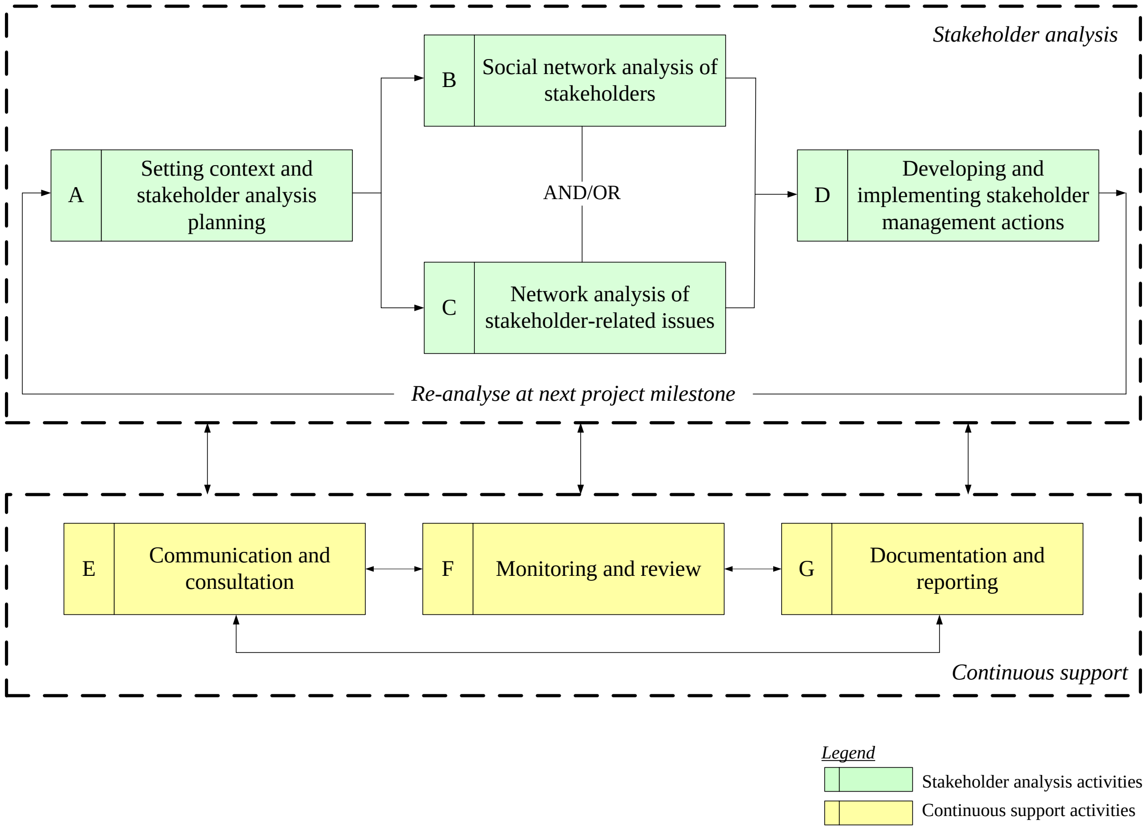


Fig. 1. A social network model for stakeholder analysis in MCPs

Block A – ***Setting context and stakeholder analysis planning*** – This sub-process is to define the internal and external context within which the MCP exists and the project stakeholder analysis process will take place. Project objectives and constraints will be outlined. The aims and scope of stakeholder analysis will be specified. Based on these initial contextual understanding, the following analysis criteria should be defined:

- The kinds of stakeholder relationships to be examined;
- Attributes against which stakeholder relationships will be evaluated;
- The kind of stakeholder-related issue interdependencies to be analysed;
- Criteria against which issue interdependencies will be assessed.

For systematic implementation of the analysis process, the following arrangements of stakeholder analysis activities should also be clearly defined:

- Responsibilities to carry out stakeholder analysis process;

- Resources allocation for the process;
- Proposed timeframe of key stakeholder analysis activities.

The information produced in this stakeholder analysis planning stage should be compiled into a Stakeholder Analysis Plan.

Block B – ***Social network analysis of stakeholders*** – This is a process of analysing the structure and patterning of stakeholder relationships in the project. It aims to understand stakeholders' roles and influences through these relationships, and identify the important and under-engaged stakeholders.

Block C – ***Network analysis of stakeholder-related issues*** – When a stakeholder issue exerts influence over another issue, a link is said to exist between the two issues. This process examines the structure and patterning of stakeholder issue interdependencies in the project. It aims to identify the critical stakeholders, issues, and issue interdependencies in the project.

Block D – ***Developing and implementing stakeholder management actions*** – This process firstly develops stakeholder management actions in two parts:

- Based on the analysis results of stakeholder relationships, the influential, intermediary and peripheral stakeholders are identified. Strategies for enhancing stakeholder engagement and communication are developed;
- Based on the analysis results of issue interdependencies, a list of key issues and links which should be addressed at high priority are identified. Corresponding treatment actions are developed.

Next, this process imitates effectiveness of the issue treatment actions by undertaking an immediate simulation. Assuming that the identified key issues are addressed after treatment actions implemented, the simulation removes the key issues and links in the issue influence network, re-calculates the network density and cohesion, and predicts the potential of network complexity reduction.

Block E – ***Communication and consultation*** – The stakeholder analysis process should not be segregated from other organisational and project activities. Communication of stakeholder information, as well as consultation of the analysis results with project team and stakeholders, should be carried out proactively from time to time in the entire MCP development.

Block F – ***Monitoring and review*** – The project and stakeholder environments in a MCP are dynamic. Continuous monitoring and review are therefore essential to cope with such dynamics. As a MCP proceeds, stakeholders and their issues will change, so as the interactions among stakeholders and between stakeholder-related issues. New (or previously neglected) stakeholders, issues and interdependencies may also emerge. Notwithstanding that the social network model captures and examines the stakeholder environment at a single point of time in the project development, the stakeholder analysis process is not an one-off. The status of stakeholders, issues, stakeholder relationships, and issue interdependencies should be periodically updated. The performance/outcome of stakeholder engagement and issue treatment actions should also be continuously monitored to maintain their relevancy and effectiveness.

Block G** – **Documentation and reporting – Five documents are designed for documenting the stakeholder analysis process and presenting the results. They are the Stakeholder Profile, General Issue Profile, Stakeholder-related Issue Profile, Stakeholder-related Issue Interdependency Profile, and Stakeholder Management Action Plan. Chapter 9 outlines the suggested contents of these documents, and Appendix B shows the examples of them.

3. SETTING CONTEXT AND STAKEHOLDER ANALYSIS PLANNING

Chapter 3 discusses Block A – Setting context and stakeholder analysis planning, and Figure 2 outlines the major elements of this block. Block A represents the first stage of the stakeholder analysis process. This stage provides essential understanding to the context within which the project and stakeholders exist, and set the scope for the stakeholder analysis process.

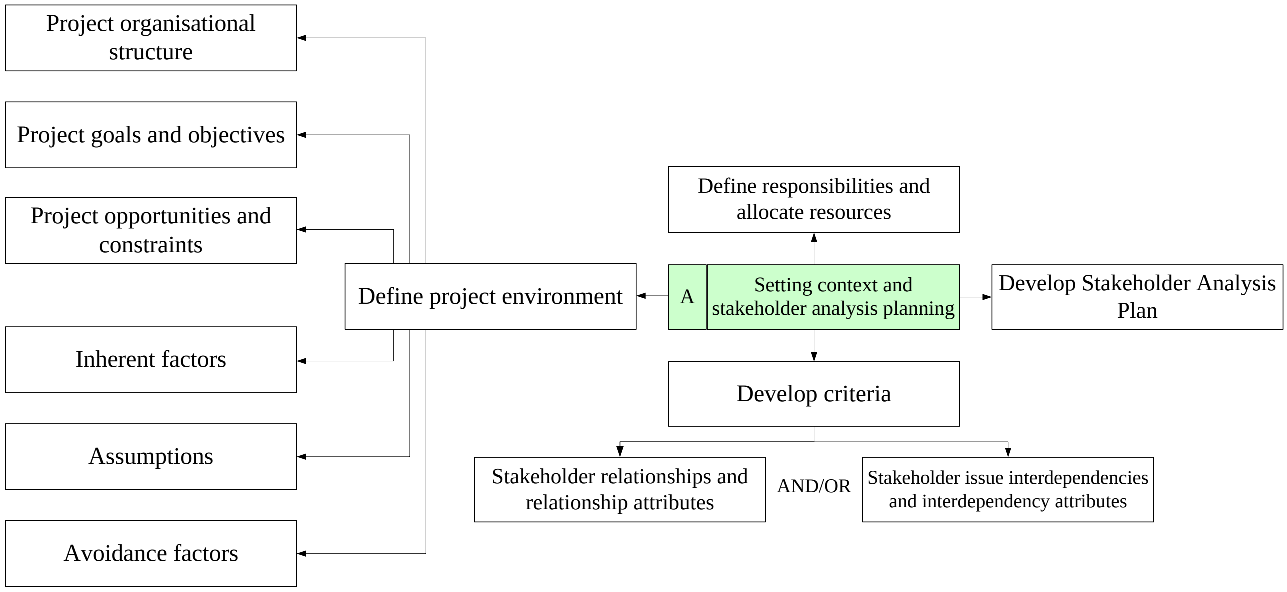


Fig. 2. Block A – Setting context and stakeholder analysis planning

3.1 Define project environment

Defining project environment helps to set the context in which the stakeholder analysis activities will take place. In this step, the following elements should be determined:

- *Project organisational structure* – Take into account both internal and external stakeholder organisations;
- *Project goals and objectives*;
- *Project opportunities and constraints*;
- *Inherent factors* – What factors are inherent in the project or vital to the achievement of project goals and objectives?
- *Assumptions* – What assumptions have been made at the current project stage? Are these assumptions appropriate or mistaken?
- *Avoidance factors* – What items should the project team attempt to stay away from?

Information on the above can be collected by semi-structured interviews or focus groups with key project participants and stakeholders, as well as review of project documents.

3.2 Define Responsibilities and Allocate Resources

For effective implementation of the stakeholder analysis activities, the following elements should be well defined at the outset:

- *Responsibilities* – Who takes the responsibilities to implement and manage the entire stakeholder analysis process? For the purpose of this application guideline, this responsible individual(s) is referred to as the Stakeholder Management Facilitator, i.e. '*the Facilitator*';
- *Resources* – What resources are needed/essential to implement the process? How to procure the required resources?

The above elements are context-specific. They depend on the complexity and scale of the project; as well as the availability of individuals who are skilled, knowledgeable and experienced about stakeholder management.

3.3 Develop Criteria

The social network model assesses stakeholder impacts and issue importance by analysing stakeholder relationships and issue interdependencies. This step considers and defines important criteria which will be adopted in the analysis process. These criteria include:

- *The kinds of stakeholder relationships to be analysed* – e.g. information/knowledge exchange, communication, and contractual links;
- *Attributes to assess the strengths of stakeholder relationships* – e.g. frequency and quality of stakeholder interactions;
- *The kinds of stakeholder-related issue interdependencies to be analysed* – e.g. influence between issues;
- *Criteria to evaluate the strengths of issue interdependencies* – e.g. likelihood, impact.

The selection of criteria is context-specific. It depends on the actual situation of the particular project, as well as the perceptions of project team when defining the scope of analysis.

3.4 Develop Stakeholder Analysis Plan

The information produced in this planning stage provides an useful framework for the stakeholder analysis process to be adopted in the project. These information should be compiled into a project-specific document, the *Stakeholder Analysis Plan*. This plan should also comprise a proposed schedule of the key stakeholder analysis activities.

The implementation details and strategies of stakeholder analysis may require adjustments when more project information is available or the project/organisational environment changes. As such, the Stakeholder Analysis Plan should be reviewed from time to time and updated when in need. Chapter 9 lists the suggested contents of the Plan. Appendix B shows an example of the Plan.

4. SOCIAL NETWORK ANALYSIS OF STAKEHOLDERS

Chapter 4 discusses Block B – Social network analysis of stakeholders, and Figure 3 outlines its major steps and elements. Block B represents a process of analysing the structure and patterning of stakeholder relationships in the project. It aims to assess stakeholders' roles and influences through these relationships; and identify the important, intermediary and under-engaged stakeholders. This process comprises five major steps: (1) identify stakeholders and general issues; (2) determine stakeholder relationships; (3) visualise stakeholder network; (4) analyse stakeholder network; and (5) prioritise stakeholders and general issues.

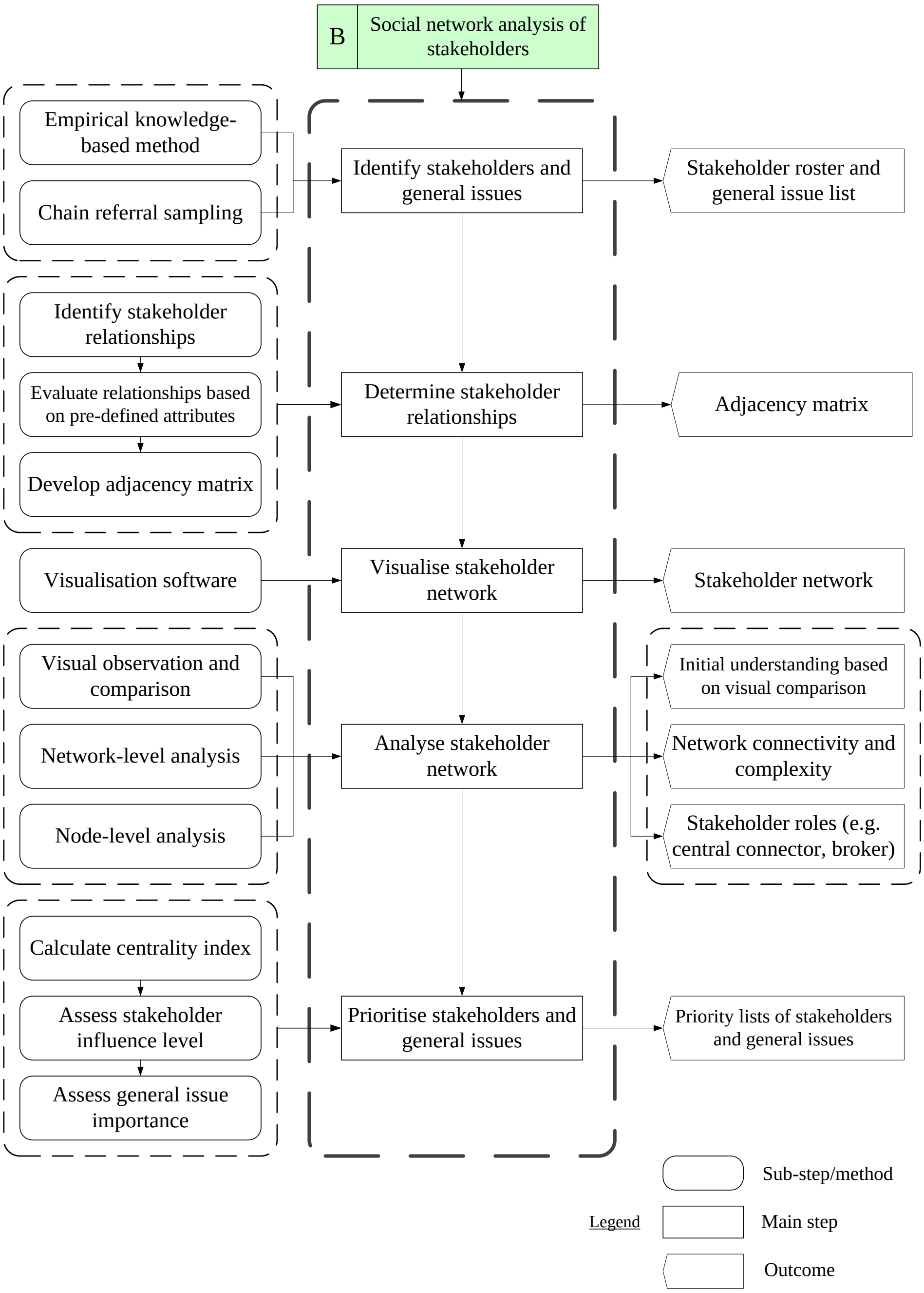


Fig. 3. Block B – Social network analysis of stakeholders

4.1 Identify Stakeholders and General Issues

This stage aims to produce comprehensive lists of stakeholders and issues which may be affected due to project implementation or the achievement of project objectives. The definitions of 'stakeholder' and 'stakeholder issue' stated in Section 1.4 should apply in the identification. Two approaches for stakeholder and issue identification are described below. They might be employed separately or in combination, depending on the stakeholder analysis context.

4.1.1 Empirical knowledge-based method

A commonly used means of identifying stakeholders and issues and gathering relevant information is the empirical knowledge-based method. This method is to engage a representative group of project participants from the project team and other stakeholders as appropriate via workshops, semi-structured interviews or questionnaire surveys; and collect their opinions on the questions below:

- Who are the stakeholders in the project? Who might impact or be impacted by the project implementation or the achievement of project objectives?
- What are the issues, concerns, or vested interests of these stakeholders in the project?
- Why the abovementioned issues are at stake?

This method is said to be 'empirical knowledge-based' because stakeholders and issues are identified based on the experience, professional and/or project-specific knowledge of stakeholders. To facilitate the identification process, the Facilitator may prepare a reference list of possible stakeholders and issues based on the summarised information in the 'Context and planning' stage or by reviewing project documents. If the identification was conducted via workshops or interviews, the process should be free flowing; in addition, all identified stakeholders and issues should be well recorded to avoid missing information. In comparison with interviews and surveys, workshops is a preferred means because workshop participants can effectively reach consensus on a set of stakeholders and issues to be analysed. The pros and cons of the empirical knowledge-based method are listed below.

Pros
· Relatively time efficient · Easily implemented · Utilises experience of core stakeholders
Cons
· Complete stakeholder and issue identification is difficult due to cognitive limitations · Accuracy of identification results decreases when the project grows in complexity · Easily loses focus without skilled and experienced facilitator

4.1.2 Chain referral sampling

A particularly useful means of engaging nearly all stakeholders is the chain referral sampling. While the empirical knowledge-based method identifies stakeholders based on a small group of stakeholders' experiences, the chain referral sampling can generate an almost complete stakeholder list through referrals directed by people who know the potentially relevant others. The chain referral sampling method identifies stakeholders in three steps: (1) the core project team members are invited to appoint internal stakeholder groups; (2) these nominated parties are then invited to provide referrals of external stakeholders who may impact or be impacted by the project; and (3) these referrals are required to appoint any conceivably impacting of impacted groups who are still absent in the list. This method produces a complete stakeholder roster. Interviews, workshops or surveys can then be carried out with the identified stakeholders to identify issues in the project. The pros and cons of the chain referral sampling method are listed below.

Pros
· Complete stakeholder identification · Accurate stakeholder identification results in complex project · Not restrained by cognitive limitations
Cons
· Time consuming · Practical difficulties, e.g. people might concern about anonymity and are declined to provide referrals

This identification stage yields a stakeholder roster and an issue list of the project. All identified stakeholders and issues will be coded numerically as S_a (where a = 1…n; n is the number of identified stakeholders) and I_b (where b = 1…k; k is the number of identified issues) respectively, for subsequent data processing and analysis.

4.2 Determine Stakeholder Relationships

This stage involves determining the kind of stakeholder relationships to be analysed, identifying and assessing the relationships based on pre-defined attributes and numerical scales, and developing an adjacency matrix. The matrix provides an input for subsequent network visualisation and analysis.

4.2.1 Information exchange relationships

Information exchange is an important kind of relationships to be managed in the construction project context. Every project activity requires information transmissions. This social network model focuses on information exchange between stakeholders, because in the social context, project stakeholders are engaged and managed through efficient information flows. Understanding their information flows can therefore help to explain how the stakeholders are engaged and who sit in the hub of communication, and identify areas for improving stakeholder communication.

For the purpose of this model, *information exchange* between stakeholders refers to their provision or receipt of information which facilitates them in understanding or addressing stakeholder issues in the project. Accordingly, *information* refers to: (1) any information relating to the issues identified in the 'Stakeholder and issue identification' stage; and (2) any information whose transmission can help or is essential for stakeholders to understand or accommodate these issues. The *means of information exchange* can cover face-to-face meetings, tele-/video-conferences, phone calls, emails, letters, memos, and discussions on e-platforms, etc., depending on the actual project situations.

4.2.2 Evaluating the relationships

Information is exchanged in two directions – in one direction, one obtains information from a set of stakeholders to help in understanding or addressing stakeholder issues; in the opposite direction, one provides information to a set of stakeholders to facilitate them in understanding or addressing stakeholder issues. This stage firstly requires each identified stakeholder to identify its information providers and recipients among the *n* identified stakeholders in the project. After that, the respondents are asked to evaluate each identified link based on three relationship attributes (frequency, timeliness, and quality) with a five-point scale. Table 1 presents the definitions of relationship attributes and the sample descriptions of rating scale.

Questionnaire survey is a useful means to solicit responses in this relationship identification and assessment stage. A sample survey instrument is presented in Appendix A. To avoid ambiguities, the Facilitator should conduct a sanity check to identify any mismatch in the collected relational data; e.g. S1 declares to give information to S2, but S2 does not identify S1 as an information provider.

Relationship attribute	Definition	Rating scale	
Frequency	The frequency of information transmission	1	Fewer than once a month
		2	Biweekly to monthly
		3	Weekly
		4	Several times a week
		5	At least once per day
Timeliness	The level of timeliness in which information is obtained from or provided to stakeholders	1	Very untimely access
		2	Untimely access
		3	Fairly timely access
		4	Timely access
		5	Very timely access
Quality	The quality of information in terms of correctness, completeness and comprehensibility	1	Very low quality
		2	Low quality
		3	Fair quality
		4	Good quality
		5	Very good quality

Table 1. Relationship attributes and their example evaluation criteria

4.2.3 Developing adjacency matrix

This step develops an *adjacency matrix* which is part of the input data required for network visualisation and analysis. Table 2 shows a sample adjacency matrix. The first row and column are the identified stakeholders represented in their numerical codes S_a. The numbers in the cells are the information transfer frequency from the 'column' stakeholder to the 'row' stakeholder'. This matrix indicates the stakeholder information exchange network.

	S1	S2	S3	S4	S5
S1		3		5	2
S2	1		3	3	
S3		2		5	1
S4	4	4			1
S5	5	2		3	

Table 2. An example of adjacency matrix

4.3 Visualise Stakeholder Network

NetMiner, NetDraw, UCINET and Pajek are some popular network visualisation and analysis software packages. Among the various packages, this social network model applies NetMiner due to its high competence in handling huge data sets and interactive network exploration. The node list, link list and adjacency matrix compose the major input data for network visualisation and analysis. A sociogram G(N, M) can be developed to represent the stakeholder information exchange network, where the *n* identified stakeholders are drawn as N nodes joined by M valued edges. Node shape indicate the stakeholder types, and edges represent the information flow from one stakeholder to another.

4.4 Analyse Stakeholder Network

This stage can be broken down into three sub-stages: (1) *visual observation* – the stakeholder network was differentiated into three sociographs based on relationship attributes, then the sociographs were visually inspected and compared to gain initial insights regarding the effectiveness of stakeholder information exchange in the project; (2) *descriptive analysis* – three network level metrics (density, cohesion, and centralisation) are computed to quantitatively examine the overall network structure; and (3) *assessing stakeholder roles* – four node-level centrality measures (degree, power, betweenness, and closeness) are computed to assess the roles of individual stakeholders (e.g. central connector, information broker, and peripheral actor) and their influences in the network.

4.4.1 Visual observation

A sociogram G of the stakeholder network, in terms of information exchange frequency, has been developed in the previous stage 'Visualisation'. This network graph can be differentiated into two more sociograms based on the relationship attributes of timeliness and quality. Removing links of fair and poor information quality (i.e. those scoring '≤3' in the attribute 'quality') yields the network G'. Further eliminating links of fair and poor information access timeliness (i.e. scoring '≤3' in the attribute 'timeliness') from G' produces G''. In these sociograms, nodes denote the stakeholders, and links represent the existence of information flow between stakeholders. The more links a stakeholder has, the more central place it occupies. Observing variations of the three sociograms (G, G' and G'') in term of network structure and central nodes can render initial understanding to their interaction patterns. The Facilitator may pay attention to the following points in the visual comparison:

- Connectedness and cut-points – Is that many stakeholders can mutually reach each other in G? Is that G'' contains more one-way interactions and cut-points? Cut points refer to nodes who connect the otherwise isolated stakeholder through weak ties. This scenario indicates that the relational structure of stakeholders is vulnerable to disruption when timeliness and quality are taken into consideration. The weak ties should be protected from attacks to maintain stakeholder communication.
- Central stakeholders – Do the central stakeholders in G occupy a peripheral location in G' and G''? The scenario reflects that there is a need for these stakeholders to improve their quality and timeliness because they frequently interact with others.

4.4.2 Descriptive analysis

Density, cohesion and degree centralisation are three useful network-level metrics to analyse the network structure quantitatively. Density measures the network connectivity, where the higher density represents the higher incidence of information flows. Cohesion indicates the time taken for information to be diffused in the network. A lower cohesion favours information flow because it implies a quicker dissemination. A cohesion value of 2 can be regarded reasonable for information network. In-degree centralisation measures the extent that particular stakeholders control the incoming links of information flow. The descriptive analysis results of the three networks (G, G' and G") can also be compared to yield useful findings. For example, if there is a sharp decrease between the density values of G and G', it implies that many links in G are rated fair and poor regarding information quality; indicating a need for stakeholders to improve the correctness, completeness and comprehensibility of information. Table 3 presents the theoretical definitions and practical meanings of the network-level metrics in stakeholder information exchange network.

Metrics	Theoretical definition	Practical explanation	Implication for the stakeholder information exchange network
Density	The ratio of actual ties in a network to the greatest number of possible ties when all nodes are interconnected.	The overall network connectivity.	A higher density value represents a higher occurrence of information exchange in the whole project.
Cohesion	The number of ties, or the length of path, to reach nodes in a network.	The time taken for information to be diffused in the network.	A lower cohesion value benefits information flow, as it represents a shorter time or path for information to be disseminated among stakeholders.
Degree centralisation	A measure of variability of the nodes' centrality scores and it ranges from 0 to 1. Centralisation equals to 0 if all nodes have the same centrality scores. It gains the greatest value of 1 if a node interacts with all other nodes, and they are tied to this node only.	The extent to which specific stakeholders control the flow of information in the network.	In a highly centralised network, information flow is controlled by one or a few stakeholders. A decentralised network is more favourable for long term information or knowledge sharing, as the majority of ties are no longer hold by a few stakeholders.

Table 3. Network-level metrics in the stakeholder information exchange network

4.4.3 Assess stakeholder roles

Degree, power, betweenness and closeness centrality are four useful node-level metrics to analyse stakeholder roles in information exchange and assess their influences. Table 4 shows the theoretical definitions and practical meanings of the node-level metrics in stakeholder information exchange network. Based on these calculations, three stakeholder roles, namely *central connector, information broker,* and *peripheral actor,* can be identified. Table 5 explains the meanings of these roles.

Stakeholder role	Description	The metrics applied
Central connector	• Directly responsible for many information provisions in the network • At the same time, it is the information source heavily relied by its neighbours because they are not well connected to others else	Out-power centrality and out-degree centrality
Information broker	• The gatekeeper • It controls or filters information to stakeholders which may otherwise be disconnected from the network	Betweenness centrality
Peripheral actor	• Relatively less influential because it is an information receiver more than provider	Degree difference

Table 5. Stakeholder roles identified in the social network model

Power and degree are two distinct centralities to measure an actor's power and influence respectively. *Out-power* indicates the extent that a stakeholder is being relied on by its connected others for information access. The higher the out-power, the more powerful a stakeholder is since its neighbours are not well connected and thus become dependent on the actor to obtain information. *Out-degree* measures the extent that a stakeholder provides information to its direct neighbours. The higher the out-degree, the more influential a stakeholder is because its information can quickly reach a large population. Plotting out-power against out-degree will help to identify *central connectors* who are respectable and influential in the information network. Figure 4 shows an example of the plot. As shown in Figure 4, stakeholders outside the pink cluster are considered central connectors; they are the direct information sources that many others have heavily relied upon.

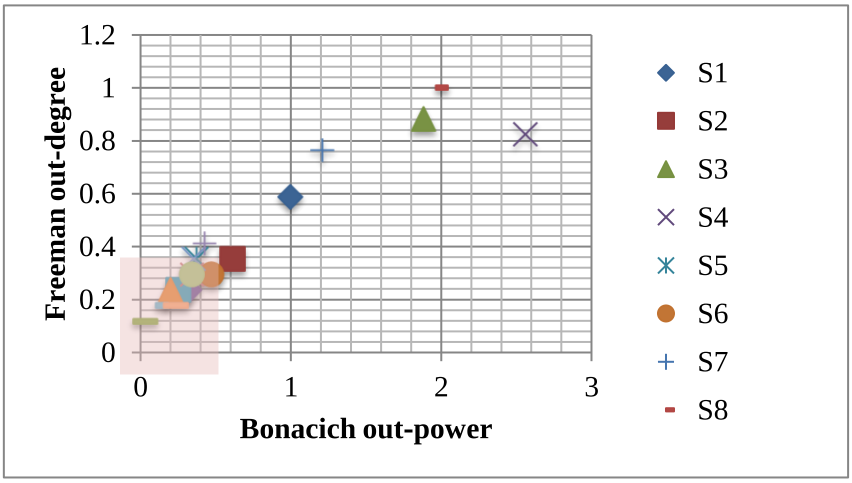


Fig. 4. An example plot of out-power against out-degree

Betweenness centrality measures the extent that a stakeholder lies between two non-adjacent others in the network. Stakeholders with high betweenness score are considered *information brokers*, as they control the information flow to others who may otherwise be disintegrated from the network. Information brokers take a leader role in the network as well by urging their neighbours to devote more to solutions for tackling project problems.

Degree difference helps to identify *peripheral actors* who have more incoming than outgoing links. There are two potential reasons of these stakeholders being peripheral: (1) they possess specialised skills and knowledge which are peripheral in nature, so they are relatively less perceived by others as useful information sources; and (2) they may not be eager to share what they know. Regardless of reasons, these peripheral actors represent the under-utilised resources, implying high potential to explore new information from them.

4.5 Prioritise Stakeholders and General Issues

4.5.1 Assess stakeholder influence

This stage aims to assess stakeholders' influence in the project. It involves three sub-steps: (1) calculating *centrality index* of each identified stakeholder by averaging its normalized degree, betweenness and closeness centrality scores; (2) *ranking stakeholders* according to centrality index results; and (3) *assessing the influence level* of each stakeholder in the project using Eq. (1)[11]:

$$S_q = \frac{R+1-r(q)}{\sum_{p=1}^{n}[R+1-r(p)]} \tag{1}$$

where S_q= influence level of a stakeholder q in the project; R = the maximum rank among all project stakeholders; $r(q)$ = fractional rank of a stakeholder q; and n = total number of project stakeholders.

4.5.2 Assess stakeholder issue importance

This stage prioritizes stakeholder issues according to their importance level. For this purpose, this study calculates the importance level of each identified stakeholder issue in the project by Eq. (2):

$$I = \sum_{m=1}^{n}(S_m \times C_m) \tag{2}$$

where I = importance level of a stakeholder issue in the project, S_m = influence level of a stakeholder m; C_m = rating given by a stakeholder m on the corresponding issue; and n = total number of project stakeholders.

Stakeholders' ratings on an issue, C_m, can be elicited from representatives of all identified stakeholders by a survey. In the survey, respondents are invited to rate their perceived importance of each issue based on their empirical knowledge with a five-point scale (where

[11] Eq. (1) assesses the actual influence of each stakeholder among all project stakeholders. For this purpose, the calculation firstly inverts a stakeholder's rank value (by subtracting it from 'R+1'), then performs normalization (i.e. dividing the obtained value by the sum of all stakeholders' influence levels).

‘1’ denotes the lowest importance, ‘5’ represents the highest, and ‘N/A’ indicates an unrelated issue). Eq. (2) assesses how critical an issue is by taking into account both *stakeholders’ perception on an issue’s importance*, and the *influences of corresponding stakeholders in the actual connectivity structure*. In theory, the highly ranked issues are considered critical, because they are perceived important and are frequently communicated by stakeholders in the project.

Metrics	Theoretical definition	Practical explanation	Implication for central stakeholders
Degree centrality	The number of ties that occur directly at a node. According to the direction of ties, in-degree refers to the number of direct incoming ties transmitted to a node, and out-degree refers to the number of direct outgoing ties emitted by a node. Degree difference is calculated by deducting the out-degree from in-degree.	In-degree reflects the extent to which a stakeholder receives information from its direct neighbours. Out-degree indicates the extent to which a stakeholder provides information to its direct neighbours in the network.	A stakeholder with high out-degree is influential as it can quickly disseminate one's information to a large population. A stakeholder with larger in-degree than out-degree is considered peripheral, i.e. less influential, in the project; as it is an information receiver more than provider.
Power centrality	The degree of which a node's immediate neighbours are dependent on this node. In degree measure, a node's centrality is determined by the number of its direct ties/neighbours. In power measure, a node's centrality is a function of the centrality scores of its immediate neighbours.	The extent to which a stakeholder is being relied on by its connected others for information access.	A stakeholder with high power centrality score is powerful, as its interacting others are not themselves well connected. In contrast, if the interacting others are already well connected to other stakeholders, they would be less dependent on this stakeholder for information access, thus this stakeholder is less powerful.
Betweenness centrality	The incidence in which a specific node falls on the geodesic distance between other node pairs.	The extent to which a stakeholder acts the role of broker/gatekeeper in the communication between other stakeholders by controlling or filtering the information flow between them.	A stakeholder with high betweenness score is information broker. This role facilitates communication by diffusing information to stakeholders which may otherwise be disintegrated from the network. This role may also interfere communication if it transmits information in a poor quality or untimely manner.
Closeness centrality	The distance, or the number of intermediaries, of a specified node to every other nodes in the network on the basis of shortest path.	An indication of how the entire network is proximate to or rivet on a stakeholder. It also reflects a stakeholder's independence in the relational activities in the network.	A stakeholder with high closeness score enjoys a higher quality of communication (e.g. lower chance of information distortion, and shorter information transmission time) due to their shorter distance with other stakeholders. However, it is difficult for this stakeholder to act alone without drawing others' attention.

Table 4. Node-level metrics in the stakeholder information exchange network

5. NETWORK ANALYSIS OF STAKEHOLDER-RELATED ISSUES

Chapter 5 discusses Block C – Network analysis of stakeholder-related issues, and Figure 5 shows its major steps and elements. Block C represents a process of analysing stakeholder-related issues, their interdependencies and propagating effects in the project. It helps to identify the critical issues and issue interactions which require particular attention and/or further treatments by the project team. This process includes five major steps: (1) identify stakeholders and stakeholder-related issues; (2) determine stakeholder issue interdependencies; (3) visualise stakeholder issue network; (4) analyse stakeholder issue network; and (5) identify critical issue and issue interdependencies.

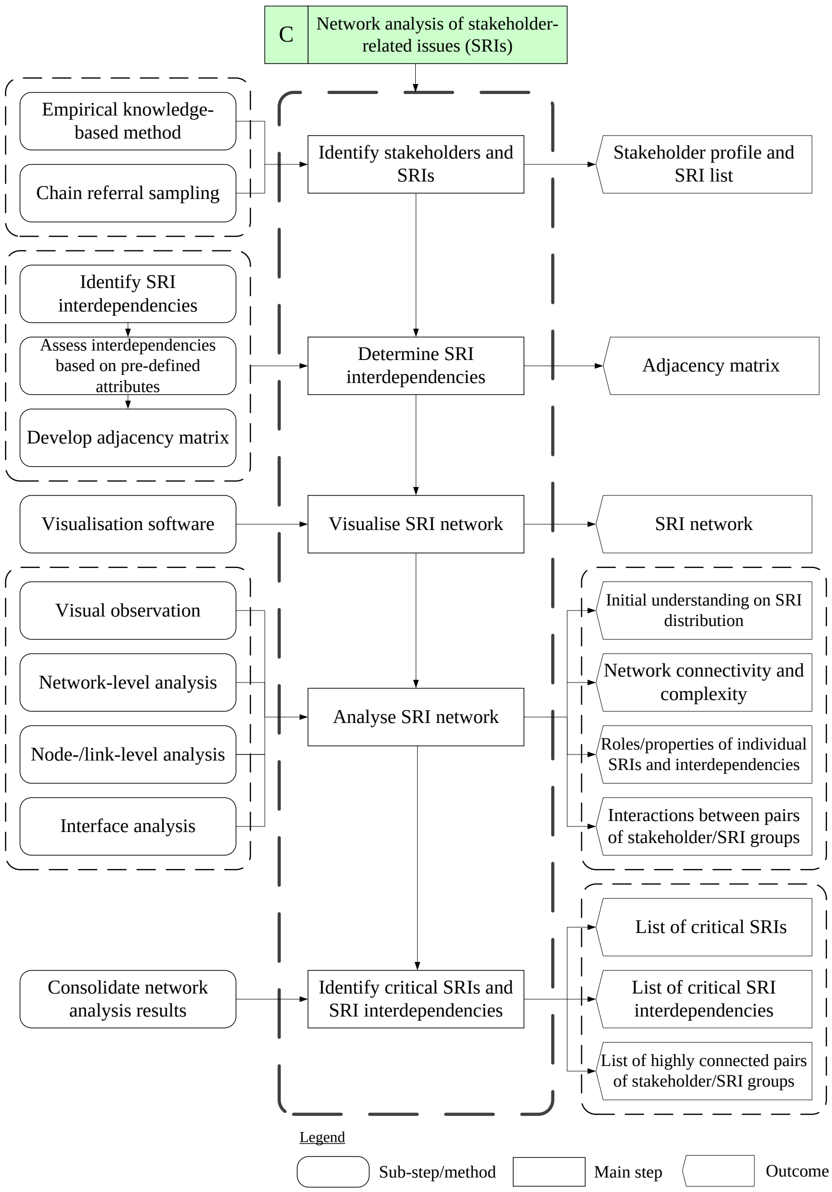


Fig. 5. Block C – Network analysis of stakeholder-related issues

5.1 Identify Stakeholders and Stakeholder-related Issues

This stage aims to completely identify all stakeholders and stakeholder-related issues in the project. Similar to the 'Social network analysis of stakeholders', two identification methods, *empirical knowledge-based method* and *chain referral sampling*, can be used in this stage. Section 4.1 explains these methods in detail. Basically, their principles and main procedures, as explained in Section 4.1, still apply in this identification process. The main differences are:

- In 'Social network analysis of stakeholders', these two identification approaches are used to identify *stakeholders* and *issues* in the project; while in 'Network analysis of stakeholder issues', they are applied to identify *stakeholders* and *stakeholder-related issues*;
- *Issues* refer to the general concerns of stakeholders in a project; while *stakeholder-related issues* refer to the concerns relating to or associated with a specific stakeholder in the project;
- In addition, in 'Network analysis of stakeholder issues', both the identified stakeholders and stakeholder-related issues can be categorised into different types for easy data processing. Stakeholder types may include *client*, *contractor*, *subcontractor/supplier*, *designer*, *public authority*, *pressure group*, *end user*, etc.. Issue categories may include *cost*, *economic*, *environmental*, *ethical*, *legal*, *organisational*, *political*, *procurement*, *quality*, *safety*, *social*, *technological*, and *time*, etc.

The outcomes of this stage are the lists of *stakeholders* and *issues specific to each identified stakeholder*. Each stakeholder will be coded as S_u (where u = 1…n; n is the number of identified stakeholders). In addition, each issue will be assigned a numerical code S_uI_v, in which v represents the issue number of a particular stakeholder u. For example, S5I6 denotes the sixth issue relating to the fifth stakeholder. It should be noted that the same concern identified by different stakeholders will be distinguished as different issues, and assigned with different codes. If stakeholders tell opposite stories about an issue, the contractions should be investigated and sorted out. Workshop with key project participants and stakeholder representatives is a useful means to resolve contradictions. These lists of coded stakeholders and issues should be well recorded for subsequent network data processing.

5.2 Determine Issue Interdependencies

This stage defines the interdependencies between stakeholder-related issues. It involves three sub-steps: identifying the links; assessing the links; and developing adjacency matrix.

5.2.1 Identifying the links

When a stakeholder-related issue influences another issue, a link is said to exist between these two issues. This task requires each identified stakeholder to consider all possible combinations of issue pairs, and to decide whether a link presents in each pair based on their project knowledge. Since relationships can be reciprocal, respondents are required to make explicit the direction of links. In other words, the influence of S_aI_b on S_cI_d is treated as a distinct relationship from the influence given by S_cI_d on S_aI_b.

5.2.2 Assessing the links

The stakeholders are required to assess each identified link by assigning two scores: (1) the *strength of impact* in which one issue exerts on the other, and (2) the *possibility* for this impact to occur, on a five-point scale ('5' = 'the highest degree' and '1' = 'the lowest degree'). The influence level of each issue interdependency is calculated by multiplying the impact and possibility scores. The influence level will be zero when there is no influence between two issues.

These relational data can be obtained from each identified stakeholder using semi-structured interviews, in conjunction with a survey instrument in a matrix format to facilitate the link assessment process. Workshops with the identified stakeholders is also a potential means, during which the participants can identify and assess the links through the survey. Appendix A presents a sample survey instrument.

5.2.3 Developing adjacency matrix

An adjacency matrix is created to indicate influence relationships among stakeholder-related issues. In this matrix, stakeholder-related issues are listed at the top row and along the left-hand side. Influence values of the links are inputted into the cells accordingly, with zero on the diagonal as an issue is not considered to give impact on itself. The matrix represent the stakeholder-related issue influence network.

5.3 Visualise Stakeholder Issue Network

Similar to 'Social network analysis of stakeholders', NetMiner is used for network visualisation and analysis. The node list, link list and adjacency matrix are the required input data. A sociogram H(N,Z) can be developed to represent the stakeholder issue network; where the n identified stakeholder-related issues (S_uI_v) are the N nodes joined by Z valued edges. The stakeholder types and issue categories can be denoted by different node shapes and node colours respectively. The edges indicate the influence from one stakeholder-related issue to another.

5.4 Analyse Stakeholder Issue Network

This stage aims to examine the structural characteristics of stakeholder issue network, as well as the roles and propagating effects of individual issues and links. It comprises four sub-stages: *visual observation*, *descriptive analysis* and *node/link analysis*, and *interface analysis*.

5.4.1 Visual observation

Visual observation enables the Facilitator to acquire preliminary understanding on the main stakeholder-related issues and their distribution in the network. The Facilitator may pay attention to the following in the observation:

- Are many issues interconnected? The higher connectedness may imply the higher project complexity;
- Are there any isolated issues? What are they? Isolated issues might be addressed more easily as they are independent from the others;
- What categories of issues are located more centrally? They might be critical in the project. What categories of issues are located near the network border? They might be overlooked by the project team;
- What categories of issues are located close together? Their cause-and-effect relationships may worth more attention.

5.4.2 Descriptive analysis

Two network-level metrics, *density* and *cohesion*, were computed to uncover the structural characteristics of the entire stakeholder issue network in terms of connectivity and complexity. Table 6 explains their theoretical and practical meanings in the stakeholder issue influence network.

Metrics	Theoretical definition	Practical explanation	Implication for the stakeholder issue influence network
Density	The proportion of existing relationships in the entire network to the largest number of possible ties when all nodes are joined together. Density ranges from zero (all nodes are isolated) to one (all nodes are interconnected to each other else).	The overall network connectivity.	A dense network implies that many stakeholder issues are interrelated to each other.
Cohesion	The length of path, or the number of ties, to reach nodes in a network based on the shortest path.	The overall network complexity.	A greater cohesion implies a more complicated network, since more number of walks are needed for a node to reach the others.

Table 6. Network-level metrics in the stakeholder issue influence network

5.4.3 Node/link analysis

In this part, five node-level metrics (including *nodal degree*, ego network size, *node betweenness centrality*, *status centrality*, and *brokerage*) and one link-level metric (*link betweenness centrality*) are calculated to analyse the roles and characteristics of individual issues and interdependencies, and to measure their importance in the network. Table 7 explains their theoretical and practical meanings in the stakeholder issue influence network.

5.4.4 Interface analysis

In stakeholder management process, ‘what’ and ‘who’ are two fundamental considerations, thus stakeholder-related issues can be classified into different divisions based on the issue nature and associated stakeholders. Interface analysis is to measure the interactions and accessibility between different pairs of divisions (i.e. stakeholder types or issue categories). Two interface-level metrics, *direct connectivity* and *global connectivity*, can be calculated for the said purpose. Table 8 shows their theoretical and practical explanations.

Metrics	Theoretical definition	Practical explanation
Direct connectivity of stakeholder types	The number of direct links between every pair of stakeholder types.	The interactions between various stakeholder types from a local perspective.
Direct connectivity of issue categories	The number of direct links between every pair of issue categories.	The interactions between various issue categories from a local perspective.
Global connectivity of stakeholder types	The number of both direct and indirect connections between every pair of stakeholder types.	The interactions between various stakeholder types from a global point of view.
Global connectivity of issue categories	The number of both direct and indirect connections between every pair of issue categories.	The interactions between various issue categories from a global point of view.

Table 8. Interface-level metrics in the stakeholder issue influence network

5.5 Identify Critical Stakeholder-related Issues and Issue Interdependencies

There are three parts in this stage: (1) identifying the key stakeholder-related issues by consolidating the node-level analysis results; (2) identifying the key issue interdependencies based on the link betweenness centrality results; and (3) identifying the pairs of stakeholder/issue divisions which have high direct/global connectivity. It should be noted that, in identifying the critical network actors, the cut-off points of the results of SNA metrics would be case-specific.

Node-level analysis			
Metrics	Theoretical definition	Practical explanation	Implication for central stakeholder-related issue
Nodal degree	The weight sum of relationships directly occurred at a specified node. According to the direction of links, in-degree considers incoming relationships transmitted to a node; and out-degree considers outgoing relationships radiated from a node. Nodal degree difference is obtained by subtracting the in-degree from the out-degree of a particular node. To spot out influential nodes, out-degree can be plotted against degree difference.	The direct impact of a stakeholder issue by considering its immediate connectivity to other issues. In-degree indicates the direct impact received by an issue. Out-degree reflects the direct impact given out by an issue. Degree difference measures the net direct influence level of an issue to the others.	Issues with high out-degree and high degree difference magnitude both worth particular attention from the project team. An issue with high degree difference magnitude implies that it can readily impact or be impacted by others.
Ego network size	The number of nodes located in the direct neighbourhood of a focal node.	The number of immediate successors or predecessors of a stakeholder issue.	Large egonet size implies a great extent of influence of a stakeholder issue.
Betweenness centrality	The extent to which a particular node is located upon the geodesic distance between all combinations of other pairs of nodes.	The power of a stakeholder issue in controlling the influences passing through it.	An issue with high betweenness centrality is critical. First, it takes a broker role to join different parts of a network which may otherwise be segregated. Second, it acts as a gatekeeper to influence the impact flowing through it to others.
Status centrality	The number of nodes adjacent to or from a focal node, plus the number of secondary nodes which indirectly connect to the focal node through its direct neighbours.	The relative impact of a stakeholder issue in the whole network. According to the direction of impacts, in-status considers relative impact received by an issue; and out-status refers to relative impact emitted from an issue. To identify key issue, out-status is adopted in the analysis.	An issue with high out-status value worth special attention because it can readily impact the entire network.
Brokerage	The incidence of which a specified node acts as a coordinator, liaison, itinerant, representative, and gatekeeper in linking different subgroups of nodes under a chosen node partition.	The roles and ability of a stakeholder issue in connecting different subgroups of issues. When (partition = ‘stakeholder type’), brokerage	An issue which scores high brokerage is critical, because it plays special roles in generating the chain effects between issues, and increase the network

	In this analysis, node partition can either be the stakeholder types or issue categories as previously identified.	indicates an issue's role in connecting issues associated with various stakeholder types. When (partition = 'issue categories'), brokerage reflects an issue's role in connecting issues of different categories.	complexity.
Link-level analysis			
Metrics	Theoretical definition	Practical explanation	Implication for central issue interdependencies
Betweenness centrality	The extent to which a particular link is situated upon the geodesic distance between all combinations of other pairs of links.	The power of an issue interdependency in controlling the influences passing along it.	A link with high betweenness centrality is critical since it acts as a gatekeeper to control the influences passing along it.

Table 7. Node-/link-level metrics in the stakeholder issue influence network

6. DEVELOPING AND IMPLEMENTING STAKEHOLDER MANAGEMENT ACTIONS

Chapter 6 discusses Block D – Developing and implementing stakeholder management actions, and Figure 6 outlines the major steps. Arising from network analysis, there will be a list of critical stakeholders, stakeholder-related issues, and issue interdependencies requiring further engagement or treatment. Block D represents the process of developing stakeholder management actions. It involves three main parts: (1) identify the management actions, (2) simulate the likely effectiveness of actions, and (3) implement the actions.

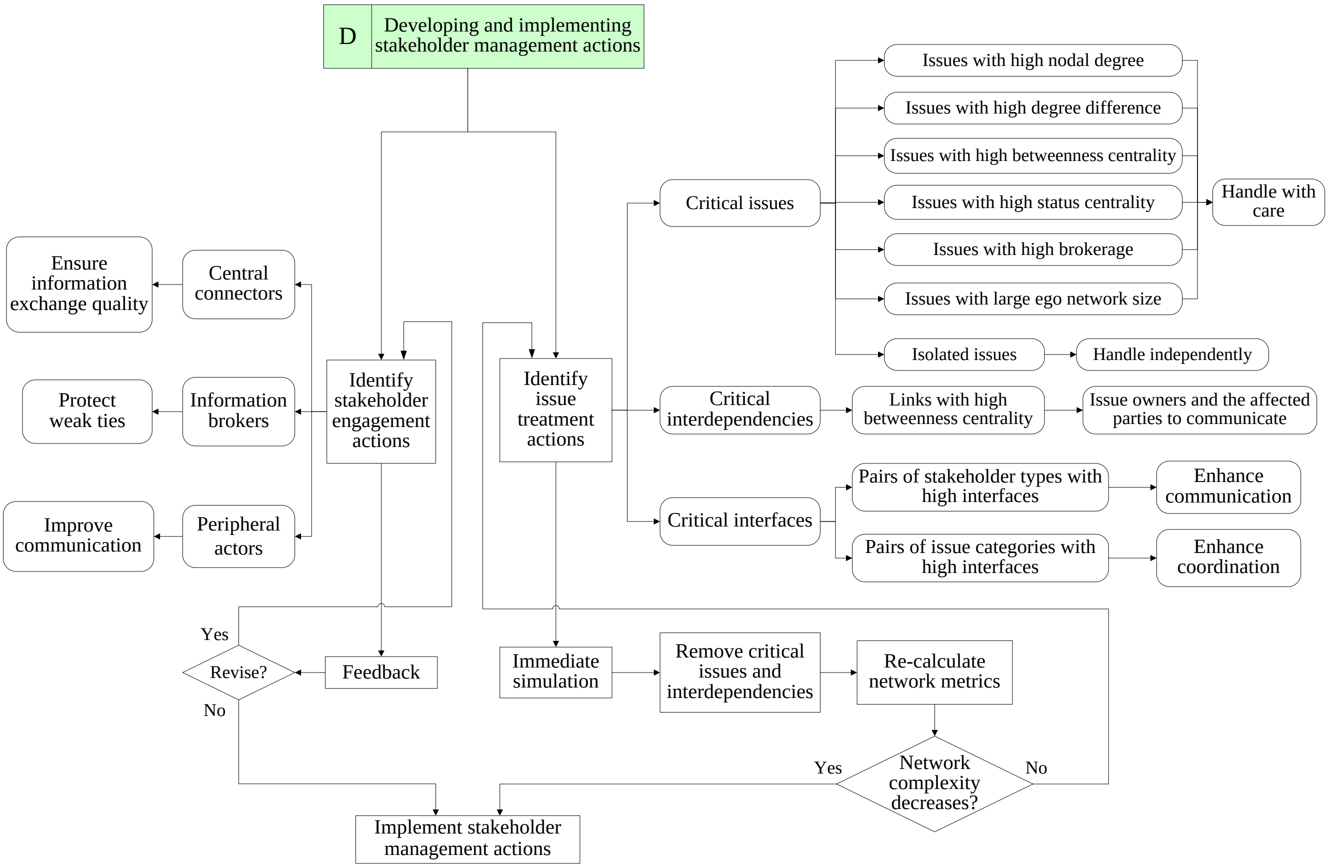


Fig. 6. Block D – Developing and implementing stakeholder management actions

6.1 Identify Stakeholder Engagement Actions

The social network analysis of stakeholders helps to prioritise stakeholders and their general concerns in the project based on their level of importance, and identify a list of stakeholders which require particular attention or improving engagement. Outlined below are the main principles to manage critical stakeholders:

- Stakeholders with high out-power and out-degree are central connectors. They are influential and powerful because they can quickly disseminate information to a large population; and at the same time, being relied upon by their information receivers as important information sources. The project team should be aware of their influences in project information flow, and monitor their information quality as well as information exchange behaviours.

- Stakeholders with high betweenness centrality are information brokers. They can control or filter information to others who may otherwise not be able to access to that information. Although these weak ties may not be favourable for transferring complex information, the project team should protect the weak ties from attack so as to maintain stakeholder communication.
- Stakeholders with large degree difference are peripheral actors. They might represent under-utilised sources of knowledge, or they may not be willing to share what they know. The project team should improve communication and engagement with them so as to explore new information/knowledge.

6.2 Identify Stakeholder-related Issue and Interdependency Treatment Actions

The network analysis of stakeholder-related issues helps to identify a list of key issues and issue interdependencies which require special attention and treatment with care. Outlined below are the main principles to handle or resolve these critical issues and links.

6.2.1 Critical issues and interdependencies to be treated

Based on the *node-level* analysis results,

- Issues with high out-degree values can exert high direct impact on the others generally;
- Issues with large magnitude of nodal degree difference can either give high direct impact on or receive high direct impact from the others generally;
- Issues with large ego network size can impact or be impacted by a large number of adjacent issues;
- Issues of the ‘transmitter’ type can only impact the others but will not be impacted by the others;
- Issues of the ‘carrier’ type have both their out-degree and in-degree equal to one, indicating that they have the maximum direct outgoing impact on and incoming impact from the others;
- Issues with high betweenness centrality can have great control on the impacts passing through them;
- Issues with high out-status centrality have high overall impact on the whole network;
- Issues with high brokerage play special and important roles in generating the chain effects between issues, thus increasing the network complexity.

All the above stakeholder-related issues are critical. The project team should address or resolve them with high priority and particular care.

In contrast, issues of 'isolate' and 'receiver' types can be handled relatively easily. Isolated issues have no connections to the others, i.e. they can be treated independently without a need of considering the other issues. Issues of the 'receiver' type can only be impacted by the others but have no outgoing impact, i.e. they contribute the least to the propagating effects between stakeholder issues.

Based on the *link-level* analysis results, issue interdependencies with high betweenness centrality are critical because they are connecting a large number of issues which may otherwise be segregated from the issue network. Theoretically, eliminating these links can disconnect many issues, and disentangle the network into a less dense and complex structure. Therefore, the project team should enhance communications between the stakeholders associated with the sourcing issues and targeting issues of the identified critical links. In addition, these communications should be specific on developing treatment actions to alleviate or resolve the critical links. More details on the possible treatment actions will be presented in the next section.

Based on the *interface-level* analysis results,

- For the pairs of stakeholder types with high connectivity values, the project team should enhance communications between the specific stakeholder types of each pair;
- For the pairs of issue categories with high connectivity values, the project team should increase coordination between the specific issue categories of each pair.

6.2.2 Treatment strategies and actions

Table 9 lists the possible critical issue and interdependency treatment strategies, as well as some specific means by which these can be accomplished. Usually, more than one treatment strategy and action will be identified for each critical issue and/or link. The actual decision on which treatment action to be undertaken will be context specific. It depends on the issue/link nature. A series of project considerations should also be taken into account, for example:

- *Cost effectiveness* – Is the proposed action cost-effective? Any alternate means with the same result but at a lower cost?
- *Administrative and operational capacity* – Is the proposed measure easy to be adopted and administered? Are the required expertise and resources available?
- *Social, economic and environment effects* – What are the implications of the proposed action on the society, economy and environment?
- *Contractual and regulatory implications* – What are the contractual implications of the proposed action? Will any regulatory requirements be violated?
- *Authorisation* – Does the implementation of the proposed measure require approval or authorisation from the relevant government departments?

- *Acceptability* – Would the proposed measure be accepted by the relevant stakeholders, the public and communities?
- *Time* – Are the beneficial effects of the proposed measure immediate or gradual?

Possible treatment strategies	
Treating the critical issues	Accept or retain the issue
	Prevent the issue from happening
	Resolve the issue completely
	Alleviate the issue by reducing its strength of impact and/or its possibility to occur
Treating the critical interdependencies	Lower the probability of link occurrence by aiming to resolve the sourcing issue
	Lower the strength of impact of the link by launching contingency plans and measures
	Mitigate the sourcing issue by dealing with its common causes with generic measures
Possible specific means	
Discontinue or not to commence the project activities which may give rise to the issue and/or link	
Improve communications between the associated stakeholders of the issue and/or link	
Make clear any ambiguities in the objectives and requirements	
Adopt familiar or established methods, techniques, tools and technology	
Gather more useful and reliable information	
Acquire more skills, knowledge and expertise	
Use simulation, prototyping or modelling tools	
Seek alternate processes and/or approaches	

Table 9. Possible treatment strategies and actions

Workshops, focus groups and project meetings are some useful channels for the project team and relevant stakeholders to identify possible treatment actions, consider and discuss their potential implications. It is important that the relevant parties share their thoughts and reach consensus through discussions.

6.3 Immediate Simulation

An immediate simulation can be conducted to assess the likely effectiveness of the identified stakeholder-related issue and interdependency treatment actions. The simulation involves two main steps:

1. Remove all the identified critical stakeholder-related issues and issue interdependencies from the issue influence network (it is assumed that all critical issues resolved and critical links eliminated after undertaking the identified issue/link treatment actions);
2. Re-calculate the two network-level metrics, density and cohesion;

This quick simulation method is based on the following assumption: If the proposed issue/link treatment actions are effective, all the identified key stakeholder-related issues and interdependencies will be addressed after implementation.

As such, this simulation method removes the key issues and links, re-generates the issue influence network, and re-calculates the network level metrics. If both density and cohesion decrease significantly, it indicates that the proposed actions are likely to be effective and useful.

6.4 Implement Stakeholder Management Actions

After identification, feedback and simulation, a series of appropriate stakeholder management actions are developed to engage key stakeholders and address critical stakeholder-related issues and issue interdependencies. The following implementation details should be well defined for each action:

- *Purpose* – What actions to be undertaken relating to which specific stakeholder, stakeholder-related issue and/or issue interdependency?
- *Responsibility* – Who takes the responsibility to undertake the action? Who is in charge of overseeing, reporting, reviewing and controlling the implementation?
- *Resources* – What project resources are required for implementation, monitoring and review ? Any extra resources to be mobilised or procured?
- *Deliverables* – What are the deliverables or expected outcomes by undertaking the action?
- *Time* – What are the schedule or deadlines for implementation, monitoring and review?

The above implementation details should be well documented in a Stakeholder Management Action Plan. This Plan serves as a useful monitoring tool for stakeholder management activities. For effective implementation and monitoring, this Plan should be communicated to all appropriate parties responsible for undertaking, overseeing and reviewing stakeholder management activities. Chapter 9 discusses the details and suggested contents of the Stakeholder Management Action Plan. Appendix B shows an example of the Plan.

7. COMMUNICATION AND CONSULTATION

Chapter 7 discusses Block E – Communication and consultation, and Figure 7 outlines the important elements of effective communication and consultation.

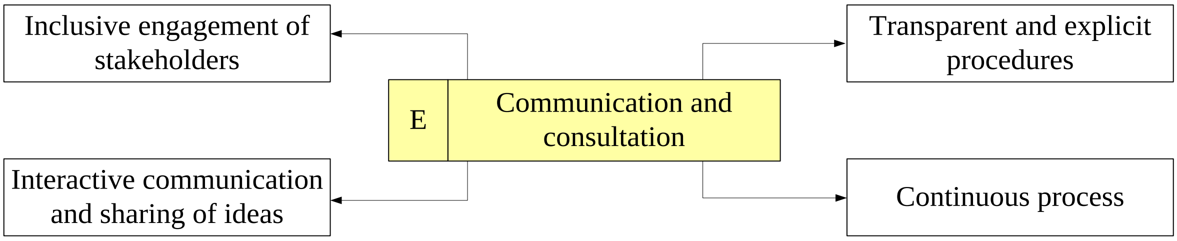


Fig. 7. Block E – Communication and consultation

7.1 Purpose and Advantages

The decisions and actions of stakeholder management are often undertaken in a social context. As such, the communication and consultation (C&C) of stakeholders is an essential component to make the stakeholder analysis model introduced in this guideline effective. C&C provides a platform in which the objectives, activities and deliverables of stakeholder management can be effectively discussed among all stakeholders. To be more specific, the following topics can be brought to discussion in the C&C process:

- what decisions are made after stakeholder analysis;
- what basis on which these decisions are reached;
- what actions to be undertaken to be undertaken to engage stakeholders and address their specific issues;
- what roles and responsibilities to be taken by which stakeholders for the required actions.

An effective C&C of stakeholders will help to achieve the following:

- a mutual understanding of stakeholders on each other’s issues;
- a better understanding of stakeholders on the management actions to be undertaken and their potential implications;
- realisation or higher awareness on the likely ‘hidden’ stakeholders and issues;
- sharing the lessons learnt of various stakeholders;
- an added value to the whole stakeholder management process.

7.2 Four Essential Elements of Effective C&C

7.2.1 Inclusive engagement

In general, stakeholders should be engaged as inclusively as possible in the C&C activities. Should any individuals/organisations be able to affect or be affected by a project, they ought to be identified at the outset of the stakeholder analysis process and be engaged throughout the course. It is unwise to pick stakeholders or intentionally exclude any of them, because they would still appear at a later stage and the advantages of early C&C would be lost.

Stakeholder management is a dynamic and iterative process – different stakeholders may come and go throughout the course according to the changing project and stakeholder environment. As such, the Facilitator should undertake stakeholder identification regularly during the whole project course for updated decisions on who to be analysed, consulted, and managed.

7.2.2 Interactive discussion

The communications with stakeholders should encourage interactive conversations and sharing of ideas among all participants, instead of being an one-way information transfer from decision makers to stakeholders. Open discussion allows stakeholders to exchange their thoughts and understand the perspectives of each other.

7.2.3 Transparent and explicit procedures

An effective stakeholder management necessitates a transparent and explicit consultation with stakeholders. The decisions, actions and outcomes of the stakeholder management process should be made explicit to all stakeholders. This is not only because stakeholders can affect how effective the management actions would be undertaken, but also because these actions can cause implications (e.g. cost, time, resources) to stakeholders.

A communication and consultation checklist may facilitate a better planning of the C&C process, as well as enhancing its clarity and transparency. The checklist may include the following elements:

- the aims of C&C;
- the people to be involved (e.g. project team, public authorities, local community, professionals, etc.);
- the means or channels of communications to be applied;
- the issues of stakeholders which need to be considered.

7.2.4 Continuous C&C

C&C is not an one-off activity. Continuous communications between the project team, decision makers and stakeholders help to promote the stakeholder management practice and integrate it into the usual business of project organisations.

8. MONITORING AND REVIEW

Chapter 8 discusses Block F – Monitoring and review, and Figure 8 outlines the important elements of monitoring and review process.

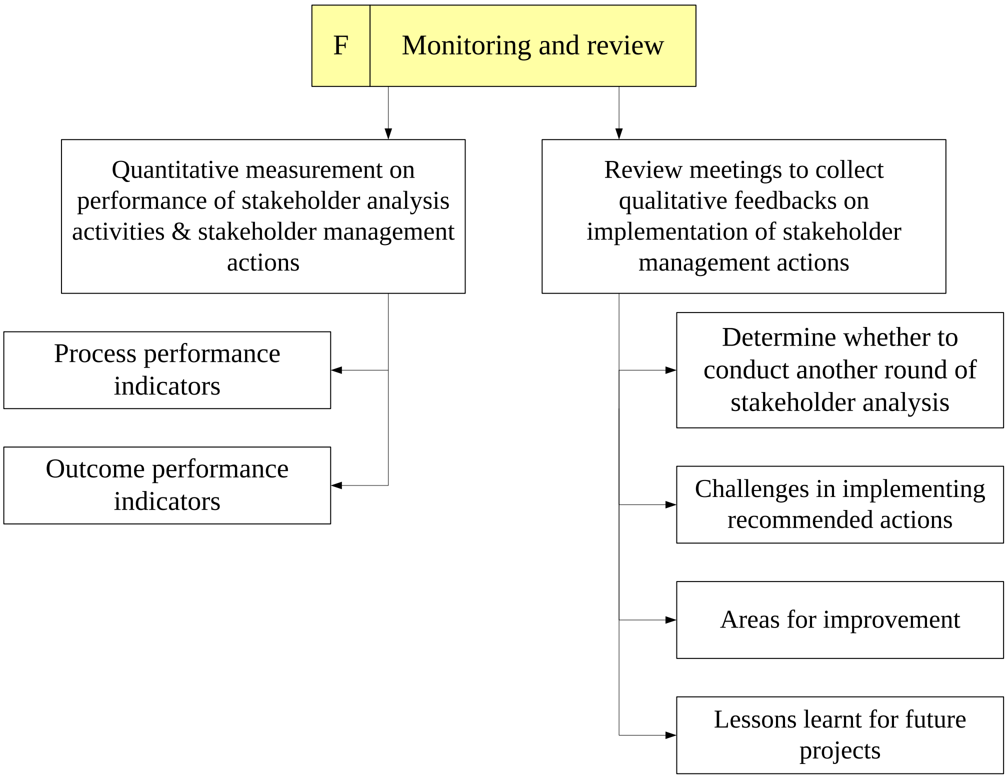


Fig. 8. Block F – Monitoring and review

An important concept emphasised in the guideline is that the project and stakeholder environments are dynamic over time. Stakeholders, their issues, as well as the relationships between stakeholders and among their issues are changing as a MCP progresses. Continuous monitoring and review is therefore necessary to maintain the relevance, usefulness and effectiveness of the proposed stakeholder analysis process. Basically, monitoring and review involves two components:

1. Quantitative measurement of the performance of stakeholder analysis activities and stakeholder management actions using performance indicators, and
2. Review meetings to collect opinions from project participants and stakeholders on the implementation and effectiveness of stakeholder management activities.

The outcomes will provide useful lessons learnt to the Facilitator and project team for continuous improvement of the project stakeholder management process.

8.1 Quantitative Performance Measurement

This process is to quantitatively evaluate the effectiveness and efficiency of a past stakeholder analysis activity and/or stakeholder management action using performance indicators. By assessing previous performance according to a set of predetermined criteria, performance measurement helps to ascertain how well the responsible individuals have acted in achieving the planned objectives, and to seek areas for continuous improvements.

Performance indicators refer to the core parameters for measuring the effectiveness or quality of a past activity or item. In general, there are two kinds of performance indicators to be used in this process, namely *process performance indicators* and *outcome performance indicators*. The Facilitator should monitor the trends of the measurement results, pay special attentions to and investigate any sudden changes in the trend. Table 10 explains them in detail.

The identification and selection of performance indicators are context-specific. They depend on the actual project situation and the specific activity to be evaluated. The Facilitator and project team may pay attention to the followings in their selection of performance indicators:

- Indicators from multiple perspectives should be included to avoid biased and incomprehensive performance measurement;
- The selected indicators should be practically feasible to be measured;
- The measuring process of selected indicators should require reasonable time and resources;
- The measuring outcomes of selected indicators should be able to facilitate continuous improvement of the project stakeholder management process.

Performance indicator	Purpose	Nature of indicators	Sub-groups	Examples
Process performance indicator	Measure the efficiency of a past stakeholder analysis activity and/or stakeholder management action	Leading (Normally, they include the influencing factors of a past activity)	Organisation; technology; action; people	· Complexity of the techniques and procedures in a past activity · Cost spent on an activity · Time taken for an activity · The extent that a proposed action is undertaken · The pact that a planned objective is achieved
Outcome performance indicator	Measure the effectiveness of a past stakeholder analysis activity and/or stakeholder management action	Lagging	Tangible; intangible	· Satisfaction towards the outcome of an activity · Reduction in total project cost · Total project time saved

Table 10. Process and outcome performance indicators

8.2 Review Meetings

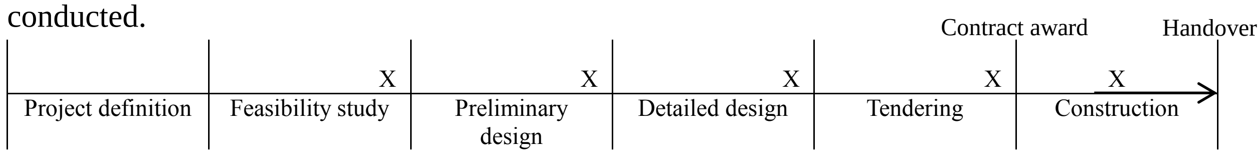
In the monitoring and review process, review meetings can be conducted at set periods to collect feedbacks from the core project team and major stakeholders on the implementation and effectiveness of the stakeholder management activities. To be more specific, the following issues can be discussed in the meetings:

- Identifying any newly emerged critical stakeholders, issues and relationships which require another round of stakeholder analysis to be carried out?
- Any problems or challenges in implementing the recommended stakeholder management actions?
- The effectiveness of the recommended stakeholder management actions? Any areas for improvement?
- Any lessons learnt for future similar MCPs?

The review meetings can be led by the Facilitator. It should be noted that the Facilitator is not the one responsible for assessing stakeholders, suggesting and reviewing the management actions. Instead, he creates an open atmosphere for discussion and sharing thoughts among the participants. The Facilitator should pay attention to the followings in organising and leading the review meetings:

- *Involving the right participants* – The review meetings should involve the key project team members and major stakeholders who are relevant to the objectives of the specific review. In addition, the participants should be representative enough to express the views, make decisions or undertake responsibilities on behalf of their organisations.
- *Well planned meetings* – The review meetings should be well planned. The objectives, rundown and subjects of discussion should be well communicated to all participants in advance (as long as they agree to attend). For constructive and effective discussion, the participants should be allowed adequate time to get prepared for the meeting and brainstorm ideas beforehand.
- *Open discussion* – The Facilitator should build up an open atmosphere for discussions, encourage ideas from quiet people and avoid domination by a few people.

Figure 8 is a timeline, suggesting the appropriate timing in which the review meetings can be conducted.



"X" denotes a suggested appropriate timing for review meeting

Fig. 9. The suggested timings for review meetings

9. DOCUMENTING THE STAKEHOLDER ANALYSIS PROCESS

Chapter 9 discusses Block G – Documentation and reporting, and Figure 10 outlines the specific documents to be used in various stages of the stakeholder analysis process.

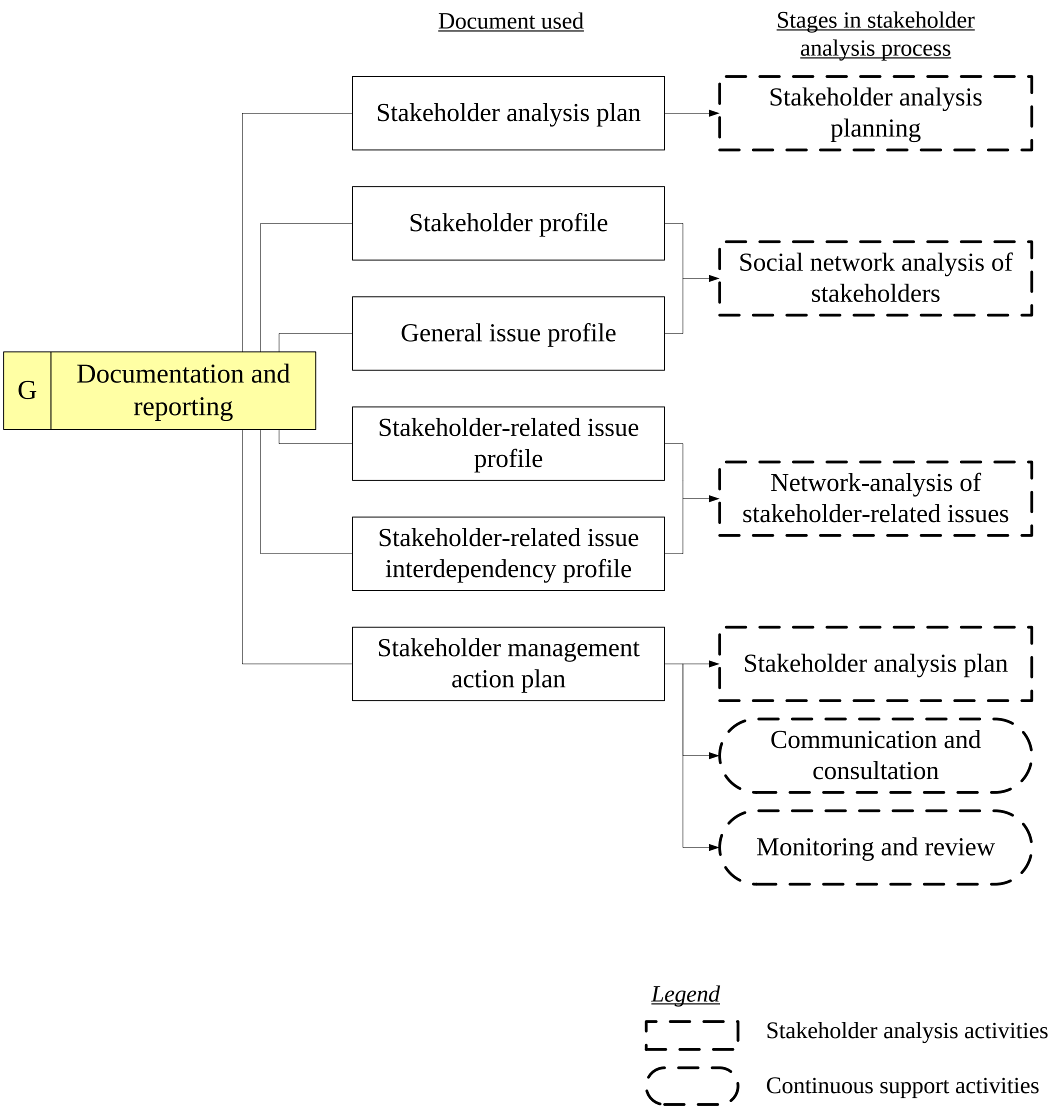


Fig. 10. Block G – Documentation and reporting

9.1 Purpose and Advantages

Properly documenting the stakeholder analysis process and outcomes helps to achieve the following advantages:

- Showing to stakeholders that their issues have been systematically and properly identified, analysed and addressed during the project;
- Decisions agreed in the stakeholder analysis process can be systematically recorded and reviewed;

- Providing a basis for project decision makers to discuss, approve, subsequently undertake and review the suggested stakeholder management actions (as recorded in a Stakeholder Management Action Plan);
- Serving as a tool to administer the accountabilities and resources in implementing the suggested stakeholder management actions;
- The comprehensive records of project stakeholders, issues and relationships help establishing a knowledge database for stakeholder management in future projects;
- Facilitating continuous improvement, monitoring and review of the stakeholder analysis process;
- Enhancing communications and information sharing of stakeholders.

9.2 Documentations

In this guideline, six documents are designed for recording the stakeholder analysis activities and process. These documents include: (1) Stakeholder Analysis Plan, (2) Stakeholder Profile, (3) General Issue Profile; (4) Stakeholder-related Issue Profile, (5) Stakeholder-related Issue Interdependency Profile, and (6) Stakeholder Management Action Plan. Table 11 explains the purposes and major information contained in these documents. Appendix B shows the example documents.

Documentation	In which step of stakeholder analysis process to be used	Main purpose	Key information contained in the document
Stakeholder Analysis Plan	Stakeholder analysis planning	Provide a framework of how the stakeholder analysis process and approach will be implemented in a specific project.	· A summary of the project objectives, opportunities and constraints, assumptions and avoidance factors; · What stakeholder analysis activities to be carried out in the project, the aims and scope of these activities; · Stakeholder analysis criteria (e.g. what kinds of relationships to be analysed, what relationship attributes to be assessed); · A schedule and resources allocation plan for the stakeholder analysis activities; · Who takes responsibilities to undertake various activities in the stakeholder analysis process; · What reporting formats to be used.
Stakeholder Profile	Social network analysis of stakeholders	Provide an updated status of all identified stakeholders in a specific project.	· A code number for easy identification of each stakeholder; · Description of the identified stakeholder, e.g. project role; · Details of existing measures which are already under implementation to engage the identified stakeholder; · Assessment of stakeholder impact in the project using social network analysis, e.g. role in network, ranking, influence level; · Details of proposed activities (or additional measures) which can facilitate a better engagement of the identified stakeholder, e.g. responsibility, schedule, approval for implementation; · A review of current status of the identified stakeholder.
General Issue Profile	Social network analysis of stakeholders	Provide an updated status of all identified general issues in a specific project.	· A code number for easy identification of each general issue (GI); · Description and category of the identified GI; · Details of existing measures which are already under implementation to address the identified GI; · Importance assessment of the identified GI in the project, e.g. whether the GI is considered as critical; · Details of proposed measures/actions which can help to address the identified GI more effectively and properly, e.g. responsibility, schedule; · A review of current status or remarks (if any) of the identified GI.
Stakeholder-related Issue Profile	Network analysis of stakeholder-related issues	Provide an updated status of all identified stakeholder-related issues in a specific project.	· A code number for easy identification of each stakeholder-related issue (SRI); · Description, category, the associated stakeholder of the identified SRI; · Details of existing measures which are already under implementation to address the identified SRI; · Impact assessment of the identified SRI using network analysis, e.g. whether it

			is considered as a critical issue; · Details of proposed measures/actions which can help to address the identified SRI more effectively and properly, e.g. responsibility, schedule; · A review of current status or remarks (if any) of the identified SRI.
Stakeholder-related Issue Interdependency Profile	Network analysis of stakeholder-related issues	Provide an updated status of all identified stakeholder-related issue interdependencies in a specific project.	· A code number for easy identification of each stakeholder-related issue interdependency (i.e. the link); · Descriptions and the associated stakeholders of the sourcing and targeting issues of the link; · Additional details on the specific cause-and-effect relationship; · Details of existing measures which are already under implementation to mitigate/resolve the identified link; · Impact assessment of the identified link using betweenness centrality, e.g. whether it is considered as a critical link; · Details of proposed strategy/actions which can help to mitigate the identified link more effectively, e.g. responsibility, schedule; · A review of current status or remarks (if any) of the identified link.
Stakeholder Management Action Plan	Development of stakeholder management actions; Communication and consultation; Monitoring and review	Record implementation details of the newly developed and agreed stakeholder management actions.	· Proposed action to be undertaken; · The targeted stakeholder, general issue, stakeholder-related issue, or stakeholder-related issue interdependency to be managed; · Who takes responsibilities to undertake the proposed action; · The schedule and resources required for undertaking the proposed action; · The monitoring arrangement and requirement; · The reporting formats to be used.

Table 11. Documentations throughout the stakeholder analysis process

10. APPLICATION OF THE SOCIAL NETWORK MODEL

This chapter discusses four issues regarding practical use of the social network model. These four issues include: (1) responsibilities in undertaking the entire stakeholder analysis process; (2) early application; (3) continuous implementation; and (4) factors to successful implementation of the model.

10.1 Responsibilities

10.1.1 Stakeholder management facilitator

For a proper implementation of the stakeholder analysis process, a single neutral party can be specifically designated to undertake this responsibility. This party may comprise one or more Stakeholder Management Facilitator(s) (i.e. the '*Facilitator*' as mentioned in this guideline), depending on the resources available and the project size and complexity. The Facilitator is not the one to identify and assess stakeholders, issues and relationships; instead, his responsibilities are:

- Developing an environment in which various activities in the stakeholder analysis process can be effectively undertaken;
- Coordinating the activities in the stakeholder analysis process;
- Ensuring representativeness of the stakeholder representatives who participate in stakeholder analysis activities on behalf of their stakeholder organisations;
- Ensuring an effective implementation of the stakeholder analysis process in the whole project duration through continuous monitoring and review.

The individual(s) appointed as the Facilitator(s) is expected to be at senior management level, and possess experience and specialised knowledge on the stakeholder management, network analysis and project management fields. Generally, the project managers in the project team may be considered suitable for this role.

10.1.2 Senior management

A continuous support and commitment from senior management of both the client organisation and project team are crucial to an effective implementation of the proposed stakeholder analysis process.

10.1.3 Stakeholders

Throughout the entire stakeholder analysis process, all stakeholders have the following responsibilities:

- To identify potential stakeholders who have not yet been included in the stakeholder analysis process;

- To identify their issues in the project, provide details of the issues, and communicate these details to the Facilitator;
- To identify and assess stakeholder relationships and stakeholder issue interdependencies;
- To undertake the suggested stakeholder management actions in their best attempt when the actions are assigned to them.

It is important that all involved parties have a clear understanding on their responsibilities and expected contributions in the stakeholder analysis process. In fact, many duties and responsibilities in construction projects are governed by contracts, and this is particular true for the internal stakeholders. Since stakeholder management is not a contractual requirement, both internal and external stakeholders are not obliged to undertake the stakeholder analysis activities. As such, it is crucial for the Facilitator to clearly explain to all involved parties about their responsibilities and the benefits of stakeholder management, as well as to encourage their participation.

10.2 Early Application

The social network model for stakeholder analysis should be applied on a MCP as early as reasonably practicable, e.g. since the project definition and technical feasibility stages. The sooner the model is applied, the more proactively the project stakeholders and their issues can be managed. As a MCP proceeds, more features and components of the project (e.g. scope of works, design) would become fixed. The flexibility for stakeholder management strategies to make changes to a project is reduced, for example, design changes to the major building elements after project commencement may result in substantial time and cost overruns. In addition, more time is often needed at the start-up of a stakeholder analysis process, e.g. allocating responsibilities and resources, getting the responsible individuals familiar with stakeholder management and network analysis. As long as the stakeholder analysis process is set up, its implementation should be maintained throughout the whole project duration.

10.3 Continuous Implementation

Stakeholder management is not one-off. The proposed stakeholder analysis process and approach should be implemented throughout the whole project duration and be integrated into different project phases. As a MCP proceeds, stakeholders may come and go, new issues may emerge, stakeholder relationships and issue interdependencies can be dynamic. It is unlikely to have all stakeholder concerns and conflicts resolved by just undertaking the stakeholder analysis once at an early project stage. It is recommended that the stakeholder analysis process to be implemented at least once in each of these three stages: (1) project definition and feasibility study, (2) design, and (3) construction. Table 12 explains in detail the integration of stakeholder analysis process into these project stages.

Project stage	Objectives in the stage	Purpose of undertaking stakeholder analysis in the stage	Potential stakeholder	Possible stakeholder issue category	Example issue
Project definition and feasibility study	· Justify the proposed development based on social, policy or business need · Preliminarily assess the chance of project success · Prepare a Project Definition Statement · Illustrate that the project is technically feasible · Develop a preliminary project programme and cost estimate · Produce a Technical Feasibility Statement	· Have an early picture of the stakeholders, issues and relationships that require special attention and management · Realise the potential stakeholders, issues and relationships before the project acceptance and approval	client, contractor, designer, consultant, supplier and subcontractor, government, financer, media, green groups, pressure groups, politician, local community, public, end user, certifier, professional institutions	Social	Public controversies or opposition to the proposed development
				Political	Alignment between the proposed development and government policies
				Economic	Benefits to the macro-economy
				Commercial	Targeted profit level
				Environmental	Environmental impact assessment; Environmental impacts to marine ecology
				Cost	Tender price and construction cost trend
				Procurement	Choice of procurement arrangement in consideration of risk allocation strategy
Design	· Define end users' requirements · Develop the Preliminary Design from the conceptual design; at this time, the major design elements are decided · Develop and finalise the Detailed Design · Produce the tender, working and contract drawings · Develop specification	· Identify, assess and manage the stakeholders, issues and relationships that arise in the design stage; so that different objectives in the design stage can be achieved		Environmental	Develop appropriate environmental mitigation actions
				Economic	Increasing project cost due to inflation
				Commercial	Identify potential tenants and their users' requirements
				Procurement	Lacking local consultancies with the required expertise or specialised knowledge
				Political	Changing government policies
				Time	Design development takes more time than scheduled, leading to delay of project commencement
				Design	Changing end users' requirements during the development of detailed design
Construction	· Construct the works in accordance to the construction contracts · Handover the completed	· Identify, assess and manage the stakeholders, issues and relationships that arise in the construction stage; so that the		Time	Project delay
				Cost	Increasing labour and material cost
				Quality	Workmanship not conforming with specification

	project to the client	project is delivered in conformance with the required schedule, budget and quality · Troubleshooting		Environment	Complaints about construction noise, dust
				Procurement	Material and labour shortage
				Contractual	Disputes and claims
				Legal/statutory	Failures in getting statutory approvals as scheduled
				Safety	Injuries or fatal accidents on site
				Technical	Workers unfamiliar with the proposed construction method; on-site problems related to construction processes

Table 12. Implementing stakeholder analysis in different project stages

10.4 Factors to Successful Implementation

Stakeholder management is a process in which the responsible individuals engage project stakeholders and develop appropriate strategies to address their issues. In fact, the chief determinants of this process are the human participants, i.e. the responsible individuals and involved stakeholders. As such, an effective and successful implementation of the proposed stakeholder analysis process relies more on human factors rather than procedural factors. Listed below are some important factors:

- A well-structured and defined stakeholder analysis process;
- Understanding, approval and support of senior management;
- Skilled, experienced and effective leadership;
- Clear and effective communications of stakeholder issues, stakeholder analysis activities, stakeholder management decisions and actions to all stakeholders;
- Continuous implementation (including identification, assessment, monitoring and review) throughout the entire project;
- Effective alignment of the stakeholder analysis process to various project phases so as to get the respective project objectives achieved;
- Paying particular attention to stakeholder issues whose treatment actions require efforts from not just one single stakeholder organisation;
- Continuous monitoring and review to the stakeholders, issues, stakeholder management actions and their performances.

In fact, there is no single universal way of implementing the proposed stakeholder analysis process. Its implementation can be affected by various internal and external factors such as the resources available, the actual stakeholder situations, and the project size and complexity. It is a challenge for the Facilitator, project participants and stakeholders.

References:

PMI (1996) *Project Management Body of Knowledge*, Project Management Institute (PMI), Inc., Newtown Square, PA.

DEVB (2002) *Special Conditions of Contract for Use in Mega Project Contracts*, Works Bureau Technical Circular No. 26/2002, Development Bureau (DEVB), The Government of the Hong Kong Special Administrative Region.

DEVB (2005) *Implementation of Systematic Risk Management in Public Works Projects*, Works Bureau Technical Circular No. 06/2005, Development Bureau (DEVB), The Government of the Hong Kong Special Administrative Region.

APPENDIX A. SAMPLE SURVEY INSTRUMENTS FOR DATA COLLECTION

Appendix A1. Sample survey instrument for social network analysis of stakeholders

SURVEY QUESTIONS

Section I. General Information *(Only overall statistical data will be compiled, i.e. individual information not disclosed)*

Q1a. Name of your organization:

Q1b. Stakeholder role of your organization in the Project:

Q1c. Your position in the organization:

Q1d. Scope of work of your department and organization in the Project:

Q1e. Your work experience:

☐ 5 years or below ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ Over 20 years

Section II. Stakeholder Concerns in the Project

Q2. The following table shows the stakeholder concerns in the Project. Please rate the relative importance of the following concerns to you based on your experience from 1-5, where **"1" represents "least important"**, **"5" represents "most important"** and **"N/A" represents "the concern is not related to me at all"**.

Concern categories	Stakeholder concerns	Least important ← 1	2	3	4	Most important → 5	N/A
	I1	☐	☐	☐	☐	☐	☐
	I2	☐	☐	☐	☐	☐	☐
	I3	☐	☐	☐	☐	☐	☐
	I4	☐	☐	☐	☐	☐	☐
	I5	☐	☐	☐	☐	☐	☐
	I6	☐	☐	☐	☐	☐	☐
	I7	☐	☐	☐	☐	☐	☐
	I8	☐	☐	☐	☐	☐	☐
	I9	☐	☐	☐	☐	☐	☐
	I10	☐	☐	☐	☐	☐	☐

Page 1

Section III. Information Exchange Relationships
This section collects your opinions regarding your information exchange relationships with each of the stakeholders in the Project.

Definition of information
In this survey, information refers to: (1) any information which is related to the stakeholder concerns shown in Section II, and (2) any information whose transmission can help or is essential for the stakeholders to understand or address these concern.

Definition of information exchange
Information is exchanged in two directions. In one direction, you **OBTAIN** information from a set of stakeholders to help in understanding/addressing stakeholder concerns (please refer to Q3). In the opposite direction, you **PROVIDE** information to a set of stakeholders to facilitate them in understanding/addressing stakeholder concerns (please refer to Q4).

Instructions
In Q3 and Q4, please firstly identify the stakeholders who have information flow relationships with you (a *Stakeholder List* is provided in the Appendix for your reference). Information flow includes two directions: **Q3 considers you as the information recipient; Q4 considers you as the information provider**.

Then, in Q3 and Q4, please evaluate your information flow relationships with each of the identified stakeholders according to three relationship attributes *(frequency, access, and information quality)* using a numerical scale of 1-5. The numerical scale is defined below.

Numerical scale

(i) Frequency:	"1"= "less than once a month", "2"= "biweekly to monthly", "3"= "weekly", "4"= "several times a week", and "5"= "at least once per day"
(ii) Access	"1"= "very untimely access", "2"= "untimely access", "3"= "fairly timely access", "4"= "timely access", and "5"= "very timely access"
(iii) Information quality:	"1"= "very low quality", "2"= "low quality", "3"= "fair quality", "4"= "good quality", and "5"= "very good quality"

Note: Definitions of the above relationship attributes will be given in Q3 and Q4.

Q3.From which stakeholders do you **OBTAIN** information to assist in understanding/addressing the stakeholder concerns shown in Section II? Please list these stakeholders and their project role in Q3a.
For each identified stakeholders, please rate the following items from 1-5 according to the numerical scale shown in Page 4:
(i) *Frequency*: **How often** do you obtain information from the identified stakeholder? Please rate in Q3b;
(ii) *Access*: Do you obtain information from the identified stakeholder **in a timely manner**? Please rate in Q3c;
(iii) *Information quality*: What is the **quality of the information obtained** (e.g. correctness, completeness and comprehensibility)? Please rate in Q3d.

3a. From which stakeholder(s) do you OBTAIN information?		3b. Frequency					3c. Access					3d. Information quality				
Stakeholder	Role in the Project	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Note: (i) Please identify as many stakeholders as possible. Stakeholders not identified are considered as **having no relationships** with you.
(ii) Please feel free to add more rows if necessary.

Q4. To which stakeholders do you **PROVIDE** information to assist them in understanding/addressing the stakeholder concerns shown in Section II? Please list these stakeholders and their project role in Q4a.

For each identified stakeholders, please rate the following items from 1-5 according to the numerical scale shown in Page 4:

(i) *Frequency*: **How often** do you provide information to the identified stakeholder? Please rate in Q4b;

(ii) *Access*: Do you provide information to the identified stakeholder **in a timely manner**? Please rate in Q4c;

(iii) *Information quality*: What is the **quality of information transferred** by you (e.g. correctness, completeness and comprehensibility)? Please rate in Q4e.

4a. To which stakeholder(s) do you PROVIDE information?		4b. Frequency					4c. Access					4d. Information quality				
Stakeholder	Role in the Project	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Note: (i) Please identify as many stakeholders as possible. Stakeholders not identified are considered as **having no relationships** with you.
(ii) Please feel free to add more rows if necessary.

Page 4

Appendix. Stakeholder List for Reference

The table below shows the stakeholders of this Project. You may refer to this list when you identify stakeholders in Q3 and Q4.

Code	Role in the Project	Stakeholder
S1		
S2		
S3		
…		
S18		

(End)

Thank you for your kind cooperation and valuable assistance in participating in this survey

Appendix A2. Sample survey instrument for network analysis of stakeholder-related issues

SURVEY QUESTIONS

Section I. General Information *(Only overall statistical data will be compiled, i.e. individual information not disclosed)*

Q1a. Name of your organization:

Q1b. Stakeholder role of your organization in the Project:

Q1c. Your position in the organization:

Q1d. Scope of work of your department and organization in the Project:

Q1e. Your work experience:

☐ ≤ 5 years ☐ 6-10 years ☐ 11-15 years ☐ 16-20 years ☐ ≥ 20 years

Section II. Identifying Stakeholders in the Project

Q2. Please list stakeholders and their role in the project. Please assign each stakeholder with a numerical code in ascending order, e.g. S1, S2, S3,…,Sn.

Category	Stakeholder	Role in the Project	Code no.
Client			S
			S
			S
Contractor			S
			S
			S
Design consultant			S
			S
			S
Subcontractor and supplier			S
			S
			S
Funding organisation			S
			S
			S
Government			S
			S
			S
Insurer			S
			S
			S
Certifier/assessor			S
			S
			S

Page 1

Q2. (Cont'd)

Category	Stakeholder	Role in the Project	Code no.
End user			S
			S
			S
Pressure group			S
			S
			S
Environmentalist			S
			S
			S
Public			S
			S
			S
Local community			S
			S
			S
Others			S
			S
			S

Note: (i) Please identify as many stakeholders as possible, no matter their associated issues are related to you or not.
(ii) Please feel free to add more rows when necessary.

Page 2

Section III. Identifying Stakeholder-related Issues in the Project

Q3. Please list issues relating to each identified project stakeholder (as identified in Q2). Please assign each identified stakeholder-related issue with a numerical code as S_aI_b, e.g. S1I1, S1I2, S1I3, …, S1In, S2I1, S2I2, S2I3, …, S2Ik (where S2Ik indicates the kth issue of the second stakeholder in the project).

Stakeholder: S1

Category	Issue related to S1	Code no.
Cost		S1I_
		S1I_
Economic		S1I_
		S1I_
Environmental		S1I_
		S1I_
Ethical		S1I_
		S1I_
Legal		S1I_
		S1I_
Organizational		S1I_
		S1I_
Political		S1I_
		S1I_
Procurement and contractual		S1I_
		S1I_
Quality		S1I_
		S1I_
Safety		S1I_
		S1I_
Social		S1I_
		S1I_
Technological		S1I_
		S1I_
Time		S1I_
		S1I_
Others		S1I_
		S1I_

Note: (i) Please identify as many stakeholder-related issues as possible, no matter the particular issue is related to your issue or not.
(ii) Please add separate pages for each identified stakeholder to list their related issues in the project.
(iii) Please also identify your issues/concerns in the project using a separate page.

Stakeholder: S2

Category	Issue related to S2	Code no.
Cost		S2I_
		S2I_
Economic		S2I_
		S2I_
Environmental		S2I_
		S2I_
Ethical		S2I_
		S2I_
Legal		S2I_
		S2I_
Organizational		S2I_
		S2I_
Political		S2I_
		S2I_
Procurement and contractual		S2I_
		S2I_
Quality		S2I_
		S2I_
Safety		S2I_
		S2I_
Social		S2I_
		S2I_
Technological		S2I_
		S2I_
Time		S2I_
		S2I_
Others		S2I_
		S2I_

Page 4

Stakeholder: S_

Category	Issue related to S_	Code no.
Cost		S2I_
		S2I_
Economic		S2I_
		S2I_
Environmental		S2I_
		S2I_
Ethical		S2I_
		S2I_
Legal		S2I_
		S2I_
Organizational		S2I_
		S2I_
Political		S2I_
		S2I_
Procurement		S2I_
and contractual		S2I_
Quality		S2I_
		S2I_
Safety		S2I_
		S2I_
Social		S2I_
		S2I_
Technological		S2I_
		S2I_
Time		S2I_
		S2I_
Others		S2I_
		S2I_

Page 5

Section IV. Assessing Interdependencies between Stakeholder-related Issues in the Project

Q4. Based on the stakeholder issue identification results in Q3, this question assesses the influence relationship between each pair of stakeholder-related issues in the project. When an issue exerts influence over another issue, an interdependency is said to exist between the two issues.

In the table below, please quantify each interdependency from two aspects: (a) the *strength of impact* of this interdependency, and (b) the *likelihood* for this interdependency to happen. Please rate the *impact* (P) and *likelihood* (L) of each interdependency from 1-5, where “1” represents “the lowest impact/the least likely” and “5” represents “the highest impact/the most likely”. If an issue does not influence another, put zero in the cell.

	S_I_	S_I_	S_I_	S_I_	S_I_	S_I_	S_I_	S_I_	S_I_
S_I_	**P** / **L**								
S_I_									
S_I_									
S_I_									
S_I_									
S_I_									

Note: (i) “Impact” is denoted by “P” and “Likelihood” is denoted by “L”.

(ii) Please read the matrix from the column to the row. Each cell represents the influence exerted by the ‘column issue’ to the ‘row issue’.

(iii) Please feel free to add more pages for the matrix when needed.

(End)

Thank you for your kind cooperation and valuable assistance in participating in the survey

APPENDIX B. SAMPLE STAKEHOLDER ANALYSIS DOCUMENTATIONS

Appendix B1. Example Stakeholder Analysis Plan

<table>
<tr><td colspan="5">Stakeholder Analysis Plan</td><td rowspan="2">Revision No:</td></tr>
<tr><td colspan="5">Project Name:</td></tr>
<tr><td colspan="6">Project Context</td></tr>
<tr><td colspan="6">Project objectives:</td></tr>
<tr><td colspan="6">Summary of project opportunities, constraints, assumptions, factors to avoid (if any):</td></tr>
<tr><td colspan="6">Details of Planned Stakeholder Analysis Activities (Implementation plan)</td></tr>
<tr><td>Activity</td><td>Methods to be used</td><td>Resources required</td><td>Schedule for implementation</td><td>Responsibility</td><td>Acknowledged by: (Responsible person(s))</td></tr>
<tr><td>(e.g. stakeholder identification)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(e.g. stakeholder relationship assessment)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(e.g. stakeholder-related issue identification)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(e.g. stakeholder-related issue interdependency assessment)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(e.g. stakeholder management action development)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(e.g. stakeholder management review)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Stakeholder Analysis Criteria</td></tr>
<tr><td colspan="6">Which network analysis to conduct? ☐ Social network analysis of stakeholders ☐ Network analysis of stakeholder-related issues ☐ Both</td></tr>
<tr><td colspan="6">Type(s) of stakeholder relationships to be analysed:</td></tr>
<tr><td colspan="6">Relationship attribute(s) to be used for stakeholder relationship assessment:</td></tr>
<tr><td colspan="6">Type(s) of stakeholder-related issue interdependencies to be analysed:</td></tr>
<tr><td colspan="6">Evaluation criteria to be used for issue interdependency assessment:</td></tr>
<tr><td colspan="2">Approved by:
(Stakeholder Management Facilitator)

Signature:…………………………..</td><td colspan="2">Supervised by:
(Stakeholder Management Facilitator)

Signature:…………………………..</td><td colspan="2">Approval Date:

…………………………..</td></tr>
</table>

Appendix B2. Example Stakeholder Profile

Stakeholder Profile		**Revision No.:**
Project Name:	**Stakeholder network analysed:**	**Date of network analysis:**

Stakeholder ID	Identified Stakeholder			Existing Engagement Strategies (EES)		Social Network Analysis of Stakeholders			Proposed Engagement Activities (PEA)					Current Status
	Stakeholder	Stakeholder role in project	Additional details	Details of EES already under implementation	Responsible person(s)	Stakeholder role in network	Ranking	Influence level in project	Details of PEA	Approved for implementation	Responsible person(s)	Schedule for implementation	Stakeholder management action plan ref. no.	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				
										☐ Approved				

Approved by: **(Stakeholder Management Facilitator)** Signature:…………………………..	**Approval Date:** …………………………..

Notes:

(a)	Identification code for each identified stakeholder, in the form of S_e (where e = 1…n, n is the total number of stakeholders)	(f)	Responsible person(s) for implementation of the specified EES	(k)	Tick the box if it is confirmed that senior management has approved the specified PEA for implementation
(b)	The identified stakeholder	(g)	Role of the identified stakeholder in the stakeholder network, e.g. information broker, central connector, peripheral actor, etc.	(l)	Responsible person(s) for undertaking the specified PEA
(c)	Role of the identified stakeholder in the project, e.g. main contractor, structural engineer, electrical subcontractor, etc.	(h)	Ranking of the identified stakeholder obtained by prioritising all stakeholders according to their centrality indexes in the social network analysis result	(m)	Schedule for undertaking the specified PEA
(d)	Additional details (as appropriate) of the stakeholder at the time he was identified, e.g. attitude towards the project, behaviours which worth special attention	(i)	Relative impact of the identified stakeholder in the project calculated based on stakeholders' rankings and the social network analysis result	(n)	Reference no. of the corresponding Stakeholder Management Action Plan (if any)
(e)	Details of existing measures which are already under implementation to engage the identified stakeholder	(j)	Details of the proposed activities (or additional measures) which can facilitate a better engagement of the identified stakeholder	(o)	A review of current status of the identified stakeholder

Appendix B3. Example General Issue Profile

General Issue Profile		**Revision No.:**
Project Name:	**Stakeholder network analysed:**	**Date of network analysis:**

General issue ID	Identified General Issue		Existing Treatment Strategies (ETS)		General Issue Importance			Proposed Treatment Activities (PTA)					Current Status
	Description	Category	Details of ETS already under implementation	Responsible person(s)	Importance level in project	Ranking	Critical issue	Details of PTA	Approved for implementation	Responsible person(s)	Schedule for implementation	Stakeholder management action plan ref. no.	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				
							☐ Critical		☐ Approved				

Approved by: **(Stakeholder Management Facilitator)** Signature:…………………………..	**Approval Date:** …………………………..

Notes:

(a)	Identification code for each identified general issue (GI), in the form of I_r (where r = 1…k, k is the total number of general issues)	(f)	Importance level of the identified GI in the project; taking into account both stakeholders' perception on the GI's importance, and the influences of corresponding stakeholders in the network	(k)	Responsible person(s) for undertaking the specified PTA
(b)	Description of the identified GI	(g)	Ranking of the identified GI based on its importance level	(l)	Schedule for undertaking the specified PTA
(c)	Category of the identified GI, e.g. social, environmental, economic, procurement, legal, cost, time, design, quality, political, etc.	(h)	Tick the box if the identified GI is considered as critical based on its importance level	(m)	Reference no. of the corresponding Stakeholder Management Action Plan (if any)
(d)	Details of existing measures which are already under implementation to address or deal with the identified GI	(i)	Details of the proposed (or additional) measures/actions which can help to address the identified GI more effectively	(n)	A review of current status or remarks of the identified GI
(e)	Responsible person(s) for implementation of the specified ETS	(j)	Tick the box if it is confirmed that senior management has approved the specified PTA for implementation		

Appendix B4. Example Stakeholder-related Issue Profile

Stakeholder-related Issue Profile		**Revision No.:**
Project Name:	**Stakeholder-related issue network analysed:**	**Date of network analysis:**

Stakeholder-related issue ID	Identified Stakeholder-related Issue				Existing Treatment Strategies (ETS)		Network Analysis of Stakeholder-related Issues							Proposed Treatment Actions (PTA)					Current Status
	Issue description	Issue category	Related stakeholder	Stakeholder category	Details of ETS already under implementation	Responsible person(s)	Critical Issue	High value(s) in						Details of PTA	Approved for implementation	Responsible person(s)	Schedule for implementation	Stakeholder management action plan ref. no.	
								Out-degree	Degree difference	Ego network size	Betweenness centrality	Out-status centrality	Brokerage						
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)						(j)	(k)	(l)	(m)	(n)	(o)
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				
							☐ Critical								☐ Approved				

Approved by: **(Stakeholder Management Facilitator)** Signature:…………………………..	**Approval Date:** …………………………..

Notes:

(a)	Identification code for each identified stakeholder-related issue (SRI), in the form of S_eI_f (which stands for the f^{th} issue related to the e^{th} stakeholder)	(f)	Details of existing strategies/measures which are already under implementation to address or deal with the identified SRI	(k)	Tick the box if it is confirmed that senior management has approved the specified PTA for implementation
(b)	Description for the identified SRI	(g)	Responsible person(s) for implementation of the specified ETS	(l)	Responsible person(s) for undertaking the specified PTA
(c)	Category of the identified SRI, e.g. social, environmental, economic, procurement, legal, cost, time, design, quality, political, etc.	(h)	Tick the box if the SRI is identified as a critical issue based on the network analysis results	(m)	Schedule for undertaking the specified PTA
(d)	The stakeholder to whom the identified SRI is related/associated	(i)	Tick the box(es) if the SRI scores high in the specific node-level analysis results: i. Out-degree measures direct out-going impact; ii. Degree difference measures the net direct impact; iii. Ego network size measures the extent of influence; iv. Betweenness centrality measures the power in controlling an influence; v. Out-status measures the level of relative impact; vi. Brokerage measures the ability in bridging subgroups of issues.	(n)	Reference no. of the corresponding Stakeholder Management Action Plan (if any)
(e)	Category of the associated stakeholder, e.g. designer, contractor, etc.	(j)	Details of the proposed (or additional) measures/actions which can help to address the identified SRI more effectively	(o)	A review of current status or remarks of the identified SRI

Appendix B5. Example Stakeholder-related Issue Interdependency Profile

Stakeholder-related Issue Interdependency Profile		**Revision No.:**
Project Name:	**Stakeholder-related issue network analysed:**	**Date of network analysis:**

Link ID	Identified Link					Existing Treatment Strategies (ETS)		Network Analysis of links		Proposed Treatment Actions (PTA)						Current Status
	Sourcing issue		Targeting issue		Link description	Details of ETS already under implementation	Responsible person(s)	Critical link	Betweenness centrality	Strategy	Specific actions	Approved for implementation	Responsible person(s)	Schedule for implementation	Stakeholder management action plan ref. no.	
	Issue Description	Related stakeholder	Issue Description	Related stakeholder												
(a)	(b)		(c)		(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				
								☐ Critical				☐ Approved				

Approved by: **(Stakeholder Management Facilitator)** Signature:…………………………..	**Approval Date:** …………………………..

Notes:

(a)	Identification code for each identified stakeholder-related issue interdependency (i.e. the link), in the form of $S_eI_f \rightarrow S_cI_d$	(f)	Responsible person(s) for implementation of the specified ETS	(k)	Tick the box if it is confirmed that senior management has approved the specified PTA for implementation
(b)	Sourcing issue of the identified link, including the issue description and associated stakeholder	(g)	Tick the box if the identified link is considered as critical based on the link betweenness centrality result	(l)	Responsible person(s) for undertaking the specified PTA
(c)	Targeting issue of the identified link, including the issue description and associated stakeholder	(h)	Betweenness centrality value of the identified link	(m)	Schedule for undertaking the specified PTA
(d)	Description (or additional details) of the identified link, specifying the cause-and-effect relationship	(i)	Proposed strategy to mitigate/resolve the identified link, e.g. lowering its probability to occur, lowering its strength of impact	(n)	Reference no. of the corresponding Stakeholder Management Action Plan (if any)
(e)	Details of existing strategies/measures which are already under implementation to mitigate/resolve the identified link	(j)	Details of the proposed specific action which can help to mitigate/resolve the identified link more effectively	(o)	A review of current status or remarks (if any) of the identified link

Appendix B6. Example Stakeholder Management Action Plan

<table>
<tr><td colspan="4">Stakeholder Management Action Plan</td><td colspan="2" rowspan="2">Action Plan No:</td></tr>
<tr><td colspan="4">Project Name:</td></tr>
<tr><td colspan="6">Action Purpose</td></tr>
<tr><td>Purpose</td><td>Detail</td><td>ID No.</td><td>Full description</td><td colspan="2">Summary of likely impact if not managed properly</td></tr>
<tr><td>☐ To engage important stakeholder</td><td>Targeted stakeholder</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>☐ To address important general issue (GI)</td><td>Targeted GI</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>☐ To address critical stakeholder-related issue (SRI)</td><td>Targeted SRI</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>☐ To mitigate critical stakeholder-related issue interdependency</td><td>Targeted link</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="6">Planned Stakeholder Management Action (implementation Plan)</td></tr>
<tr><td colspan="6">Strategy:</td></tr>
<tr><td colspan="6">Action or specific means:</td></tr>
<tr><td colspan="6">Resources required:</td></tr>
<tr><td colspan="6">Responsibility:</td></tr>
<tr><td colspan="6">Schedule for implementation:</td></tr>
<tr><td colspan="6">Monitoring requirement:</td></tr>
<tr><td colspan="6">Agreed reporting format:</td></tr>
<tr><td>Action plan approved by: (Stakeholder Management Facilitator)

Signature:…………………
Date: …………………</td><td>Acknowledging action plan for implementation by:

Signature:…………………
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