RMIT UNIVERSITY

A DECISION-MAKING FRAMEWORK TO SELECT A PUBLIC-PRIVATE PARTNERSHIP SCHEME FOR INFRASTRUCTURE DEVELOPMENT IN VIETNAM

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Minh Hang VU

BConstEc, University of Transport and Communications, Vietnam

MBA, La Trobe University, Australia

School of Engineering

College of Science, Engineering and Health

RMIT University

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DECLARATION

I certify that, except where due acknowledgment has been made; the work is that of the author alone. The work has not been submitted previously, in whole or in part, to qualify for any other academic award. The content of the thesis is the result of work, which has been carried out since the official commencement date of the approved research program. Any editorial work, paid or unpaid, carried out by a third party is acknowledged; and ethics procedures and guidelines have been followed.

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Name: Minh Hang Vu

ABSTRACT

Public-Private Partnership (PPP) is recognised as a procurement strategy for governments to mobilise capital, skills and expertise of the private sector to deliver key infrastructures. A growing number of PPP schemes, as of a contract arrangement between public and private sectors such as Build-Operate-Transfer (BOT) and Design-Build-Operate-Maintain (DBOM), have been formed and used worldwide to deliver public services. Within the broad spectrum of PPP arrangements, several variations of PPP schemes have been developed and are on the increase. Every PPP scheme has its own pros and cons and application, however understanding of different PPP schemes varies. The lack of common understanding and a systematic categorisation of PPP schemes pose challenges for practitioners in choosing the most appropriate one to best deliver the project. Despite that, few systematic studies have focused on the selection of an appropriate PPP scheme. A simple method is lacking to enable decision-makers to compare among PPP scheme alternatives. In light of this, through an in-depth literature review about various types of PPP schemes are currently being used worldwide, this study was initiated to create common interpretation by classifying thoroughly different types of PPP schemes, and to develop a decision-making framework that assists the decision-makers to choose the right PPP scheme for procuring a specific infrastructure project.

Similar to many other developing countries where securing investment for infrastructure is a major challenge, Vietnam is no exception. The Vietnamese Government has been attempting to utilise PPPs to respond to the rapid development of the economy and urgent needs of infrastructure. Until 2018, despite the considerable attempt of the government to promote PPP programmes, only 194 PPP projects have been implemented with 120 BOT, 71 BT and 3 BOO projects. Over the past 20-year practice in Vietnam, eight PPP schemes, including Build-Transfer (BT), have been regulated into the legal system. Yet, in reality, only three out of the eight PPP schemes have been practised because of an absence of a formal guidance in selecting the most suitable scheme for an infrastructure development project.

This research developed a decision-making framework that aims to select an optimal PPP scheme for a given project. The five main objectives of the research are: (i) to categorise different types of PPP schemes, then to conduct a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis of different types of PPP families; (ii) to identify the set of criteria associated with the selection of PPP schemes; (iii) to ascertain the current PPP implementation practice in Vietnam; (iv) to develop a decision-making framework for selecting PPP schemes; and (v) to validate the proposed framework in procuring infrastructure projects in Vietnam.

These objectives were obtained through an in-depth literature review of previous studies, governments and organisations' reports and guidelines that helped to review and identify principles and procedures of PPPs, different types of PPP schemes, adoption drivers and PPP process. With further help of international experts from both academic and industry practitioners, a comprehensive set of 25 criteria was identified and used to develop a framework to select an appropriate PPP scheme. Based on the literature review outcomes, more than 20 PPP schemes were categorised into four different families: O&M, Public-financed, Private-financed and Hybrid family. SWOT analyses were conducted to further understand the advantages and disadvantages of different PPP families. Then, an international questionnaire survey was conducted to collect data on the selection criteria of four different PPP families by a series of statistical analysis. The results from the comparative analysis between developed and developing countries provided an in-depth understanding of the differences and similarities of how a scheme is chosen. Then, the study scope was narrowed down to focus on the circumstances that happens in Vietnam. Several interviews were carried out in Vietnam to further explore the circumstances that happens in Vietnam. Finally, an ANP-based decision-making framework for the selection of PPP scheme was developed and Group 4: Hybrid family was used as an example. The validation of the framework was done using interview.

This research has made significant theoretical and practical contribution to the PPPs research and practice. The theoretical contributions include (i) a systematic categorisation of PPP schemes into four families, (ii) a complete set of key criteria for selection of PPP scheme, (iii) an ANP-based model to conquer the interdependence of key selection criteria when developing the decision-making framework.

The practical contributions include (i) a detailed SWOT analysis, which provides an efficient way to understand different PPP schemes, and (ii) an ANP-based model decision-making framework, which helps the government and the private sector to choose a suitable PPP scheme for procuring an infrastructure project. The framework can be used as a practical tool that helps decision-makers to assess and compare different PPP schemes, then decide on the most suitable one. The decision-making framework can further improve into a user-friendly tool. Since Group 4: Hybrid family has the most application in Vietnam (7 out of 8 PPP schemes), the research chooses to develop a decision-making framework based on this group to demonstrate its application. This framework is also applicable to other developing countries that share similar characteristics with Vietnam.

Keywords: Public-Private Partnership, scheme selection, developed countries, developing countries, procurement, Vietnam

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AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
ASA	Authorized State Agency
CI	Consistency Index
CND	Canadian Dollar
CR	Consistency Ratio
e.g.	*'exempli gratia'* or 'for the sake of example'
EC	European Commission
FDI	Foreign Direct Investment
FX	Foreign exchange
GAO	General Accounting Office of the United States
GM	Geometric Mean
GoV	Government of Vietnam
i.e.	*'id est'* or 'in other words'
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
KMO	Kaiser-Meyer-Olkin
KPI	Key Performance Indicator
MAUT	Multi-Attribute Utility Technology
MCDA	Multi-Criteria Decision Analysis or Aid
MOF	Ministry of Finance
MOT	Ministry of Transport
NAV	National Assembly of Vietnam
ODA	Official Development Assistance, Official Development Aid
OECD	Organization for Economic Co-operation and Development
P3	Public-Private Partnership
PM	Project Management
PPI	Private Participation in Infrastructure
PPP	Public-Private Partnership
PSC	Public Sector Comparator
PSP	Private-Sector Participation
RI	Random Index
SD	Standard Deviation
SOE	State-Owned Enterprise
SPV	Special Purpose Vehicle
SWOT	Strengths, Weaknesses, Opportunities and Threats
USD	United States Dollar
VDR	Vietnam Development Report
V*f*M	Value-for-Money
VGF	Viability Gap Funding
VND	Vietnam Dong
WEF	World Economic Forum
WTO	World Trade Organization

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Chapter 1

INTRODUCTION

Public-Private Partnerships (PPPs) have assisted many developed and developing nations in resolving budget constraints, alleviating risks and stimulating innovation to enhance economic developments. To deliver a successful project, selection of the most appropriate procurement method is critical. This chapter presents an overview of the current research study by investigating the background relating to it and highlighting gaps in the current literature. The chapter then discusses the significance and expected contribution of the study, research objectives and research questions, and gives a brief introduction to the research methodology. The chapter concludes with an outline of the structure of the thesis.

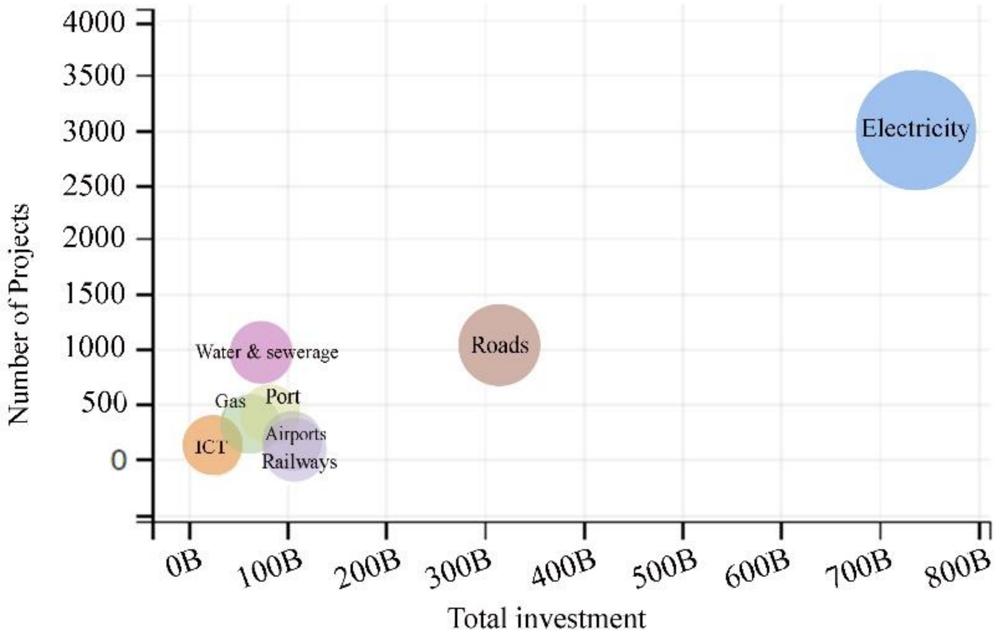
1.1 BACKGROUND OF THE RESEARCH

A PPP can be understood simply as a combination effort between the public and the private sector for the purpose of delivering public services (Jayasuriya, Zhang & Jing Yang 2019). PPPs are being adopted by many governments around the world because they can mobilise essential resources from the private sector, maximise Value-for-Money (VfM), improve project creativity and efficiency, and be a source of fiscal stimulus (Kim, J 2018). PPPs involve the participation of the public sector, the private sector and members of the community (Grimsey & Lewis 2009). PPPs are expected to bring 'win-win-win' solutions for governments, the private sector and the community by reducing cost and time overruns with quicker and better quality of service. VfM, as the results of improved public services at a lower lifecycle cost (Wall & Connolly 2009), is a key requirement of government and the driver for adopting the PPP approach, rather than capital scarcity or a balance sheet treatment (Australian Government 2015).

The first recorded use of PPPs was by the Roman Empire two thousand years ago, however, starting from the 1990s, the use of PPPs worldwide has grown significantly and globally with more than 6,000 projects and a total investment commitment of around USD1.5 trillion (World Bank [WB] Database 2019). In 2017-18, many countries initiated Private Participation in Infrastructure (PPI), which demonstrated smaller project sizes and a higher number of projects. In the first half of 2018, 68% of investments were financed by private sources, while public sources financed 13%, and development finance institutions financed 19% (WB 2018a). In developed countries such as the UK, Ireland, Australia, USA and Canada, PPPs have been well established and successfully implemented (Cheung, E, Chan & Kajewski 2012; Jefferies 2006; Li et al. 2005a; Osei-Kyei & Chan 2017c). Although not all countries in the developed world have successfully implemented PPPs (Chou & Pramudawardhani 2015), experiences and lessons learnt have long been of reference for other jurisdictions. Especially in developing countries, where there were two apparent waves occurred, one was appeared in the early

1990s, and a second wave started in 2004 (Romero 2015), PPPs are in still the early stages of development with many of the initiated projects still at the preparatory stages (Osei-Kyei & Chan 2016).

In the aftermath of the 2007-2008 Global Financial Crisis, governments of both developed and developing countries are increasingly turning to PPPs to solve the problem of public sector budget restraints, while keeping pace with the economic growth (WB 2016). As seen in Figure 1-1, PPPs are observed in many infrastructure sectors such as transportation, energy, water supply and telecommunications, as well as in more service sectors such as education, health care and defence. In the past decade, projects in the electricity sector experienced the highest investment at USD735.849 billion for 2,994 projects. In the first half of 2018, East Asia and the Pacific region have received the largest amount of investment, with 40 percent of global PPI investments and a total of USD17.3 billion (WB Database 2019). This further illustrates that many governments in developing countries are interested in adopting PPP projects.



Source: World Bank [WB] Database (2019) (https://ppi.worldbank.org/)

Figure 1-1: Number of projects and investment by sectors

Important obstacles in implementing an infrastructure development project under PPP are the lack of appropriate standard project procurement frameworks and poor project definition. Zhang, Xueqing (2005b) suggested that formulation of appropriate PPP schemes is one of the solutions to overcoming this issue. Several other studies further highlighted that selecting an appropriate delivery method with better risk management is one of the most critical factors for the overall success of a PPP project (Luu, Ng & Chen 2005; Moon et al. 2011). Rahmani et al. illustrated that a sound selection process in a disciplined and objective way is critical to achieve the project objectives (Rahmani, Maqsood & Khalfan 2017). A recent study exemplifies that factors to select an appropriate PPP scheme are central to PPP procurement (Regan, Smith & Love 2015). This further justifies the necessity to identify a set of selection factors and their relative importance for evaluating the suitability of a PPP project delivery scheme. Effective decision-making regarding the reliability of PPP development could be supported with a clear framework.

In reality, PPP projects come in different shapes and sizes, from flexible collaborations to strict contract-based partnerships (Warsen et al. 2018). A PPP scheme (or a procurement option) is a form of contract arrangement between the public and the private sector to carry out a PPP project. A typical PPP project can be categorised into various schemes and terms used such as: Private Finance Initiative (PFI), Operate and Maintain (O&M), Design-Build-Operate (DBO), Design-Build-Finance-Operate (DBFO), or Build-Own-Operate-Transfer (BOOT) and many others, which are based on the project characteristics, private party responsibilities, risk sharing between parties and source of investment. According to Renda and Schrefler (2006), BOOT/BOT is the most dominant scheme of PPP, DBFO represents the most successful form of PPP, and DBO is the most sophisticated and complex scheme of PPPs. In order to deliver a project successfully, the ‘best fit’ procurement is critical. An appropriate procurement system may also improve the probability of project success (Luu, Ng & Chen 2005). Therefore, selecting an appropriate and effective PPP scheme is a fundamental driver of achieving the best outcomes, both financially and from a holistic perspective (Australian Government 2012). However, in developing countries, ineffective selection procedures and project monitoring are major consequences that influence the successful delivery of PPP projects (Soomro & Zhang 2011). Therefore, a well-defined selection framework is necessary in order to achieve the successful delivery of a PPP project.

Many forms of PPP schemes exist, and they are continuously being developed to suit project characteristics. Efforts have been made by different researchers to align different PPP schemes into different contexts of service provision responsibilities and control of assets, which are often confused (Delmon 2010). By the using of terms interchangeably, in practice, similar projects may use different terminologies, while projects with different characteristics may use similar terminology. A new alternative PPP scheme is frequently introduced to address issues such as increasing project complexity, size of project, and demand for a shorter delivery period with higher quality.

Selecting an appropriate delivery method that will achieve project objectives with better risk management is one of the most critical factors in the overall success of a project (Moon et al. 2011). Such schemes should provide insights in the rationale and intervention logic of PPPs in any specific situation. Furthermore, a universal PPP representation is seldom understood and absence of internationally accepted guidelines including transparent accounting, reporting practices and contractual arrangements, complicates the uniform understanding of PPP schemes. Clear and commonly accepted definitions of various types of PPP schemes are essential in ensuring the effective delivery of PPP projects (Jomo et al. 2016).

Although various aspects and several phases of PPPs have been observed in the literature, a framework for selecting PPP schemes has yet to be developed in the construction industry. A number of studies have considered how decisions are made on project delivery methods, but these are mainly traditional procurements, design-bid-build (DBB), design-build (DB) and construction management with no-to-little reference to PPPs, such as reported in Love, PE, Skitmore and Earl (1998, 2012), El-Sayegh (2007), Mahdi and Alreshaid (2005) and Naoum and Egbu (2016). No specific selection techniques have gained widespread acceptance (Love, P et al. 2007). Except for the procurement decision-making framework developed by Love, PE et al. (2012), the other frameworks were developed a decade ago and are too simple to address the current complex construction project environment (Naoum & Egbu 2016). On the other hand, the selection of the most appropriate PPP scheme is a complex decision-making process associated with sophisticated political, economic, financial and risk considerations. Inappropriateness of the choice of procurement method may lead to failure of meeting performance requirements (Bowen, Pearl & Edwards 1999; Ibbs, W & Chih 2011). Few research studies have focused on how to select an appropriate or optimal PPP delivery model that can minimise the likelihood of future issues (Zhao & Ying 2019).

Despite many successful PPP projects, notable failures have been recorded, in which incorrect PPP scheme selection may be the major cause of failure (Soomro & Zhang 2015a). Some projects were initially initiated using the BOT scheme but later reverted back to the traditional financing model (Cheung, E & Chan 2009). An example is the Hong Kong – Zhuhai - Macau Bridge project that was promoted by the governments of the People's Republic of China, Macau Special Administrative Region and the Hong Kong Special Administrative Region, China. The major reason of change was the difference in legislation systems between the three governments, which failed to achieve a unique agreement (Cheung, E & Chan 2009). In the *Kai Tak* Cruise Terminal project, the Hong Kong government proposed the project to be carried out under the BOT scheme; however, the private sector was not interested in the project. The government then had to change the financing model to a mix of DB and O&M and re-invite the private sector for bids (Cheung, E & Chan 2009). In this project, the government spent HK$7.2 billion to design and build the terminal, then the facilities were leased to a private operator, the Worldwide Cruise Terminals Consortium, to operate and manage (O&M contract) the cruise terminal whilst the local government retained ownership of the site and terminal (Luk 2012). In Poland in 1997, Gdansk Transport Company was granted to finance, build and operate an A1 Toll Motorway Project, but, the contract could not be signed as the government recognised that a legal framework for PPP was needed (Cuttaree, Vickram, Humphreys & Muzira 2009). The contract was later signed in 2004 under the BOT scheme (Moszoro 2007). In Vietnam, the contractual structure of the *Phu My* Bridge Project, the first cable-stayed bridge project in Ho Chi Minh City, was based on a BOT contract. Inefficient feasibility study and poor decision-making process contributed to the failure of this project (Likhitruangsilp et al. 2018). Contract was terminated, and the project reverted back to the government (Likhitruangsilp, Do & Onishi 2017). These case studies justify that the identification of the appropriate PPP scheme at the initial decision-making stage is necessary to achieve a successful project delivery.

Since the 1990s, resembling other developing countries, the Government of Vietnam (GoV) also adopted PPP projects by incorporating only BOT into the legal system as a solution to improve national infrastructure. This is because securing investment for infrastructure projects poses a greater challenge to the government (Nguyen, XT & Dapice 2009). Since then, only 14 projects reached contract-end, which implies that PPP are still new to Vietnam's government and industry stakeholders and the process remains largely decentralised with some ministries and provinces having more experience than others (IE Singapore 2016). Vietnam has demonstrated very limited success in planning and implementing outstanding PPPs, there having been a number of PPP-enabling framework challenges (Asian Development Bank [ADB] 2012).

Until 2018, most of the PPP projects were carried out under BOT (120 out of 194 projects), Build-Own-Operate (BOO-3 projects) and Build-Transfer (BT-71 projects) (Ministry of Planning and Investment of Vietnam [MPI] 2018). Currently in Vietnam, there is an absence of formal guidance in selecting the most suitable PPP scheme for an infrastructure development project. Despite the existing availability of eight PPP schemes, none of the five other PPP schemes (apart from the three mentioned above) have been implemented yet in Vietnam (ADB 2017; MPI 2018). Hence, it is significant to consider which PPP scheme will best balance the control of project costs and risks against achieving project objectives. This will eventually provide the best V*f*M of a project while meeting the governments' service objectives. Therefore, it is important to develop a decision-making framework to assist practitioners in Vietnam to select the most suitable PPP scheme for a given infrastructure construction project.

To date, to the best of the author's knowledge, no systematic effort has been made internationally or in Vietnam to explore the selection of suitable PPP schemes for an infrastructure development project. Therefore, this study was initiated to classify thoroughly different types of PPP schemes into categories that create common interpretation. This study was also to develop a decision-making framework that assists the decision-maker to choose the most suitable PPP scheme for a given infrastructure project.

1.2 RESEARCH OBJECTIVES AND QUESTIONS

1.2.1 Research Questions (RQ)

Based on the scope of the research, the following research questions were formulated prior to undertaking the study.

RQ 1. **How** can different PPP schemes be categorised?

RQ 2. **What** are the key features and Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of different PPP families?

RQ 3. **What** are the criteria for selection of a suitable PPP scheme?

RQ 4. **How** can a suitable PPP scheme be chosen in practice to procure an infrastructure project in Vietnam?

The first question investigates various types of PPP schemes and classifies them into different groups of PPP families based on key features and certain characteristics. This question was achieved through extensive literature review and verified with international experts. The second question examines the key features of different groups of PPP schemes and thereafter provides a SWOT matrix of PPP families. The third question explores criteria for the selection of PPP schemes. These three questions were addressed by a comprehensive literature review and semi-structured interviews with experienced industry practitioners. The criteria will help to inform decisions on appropriate PPP schemes. With the identification of the selection criteria and methods for decision-making, a framework for PPP scheme selection was developed. The fourth question examines how a proposed decision-making model can help identify which scheme is suitable for a particular infrastructure project in the context of Vietnam. The results and conclusion section will focus on the fourth question.

1.2.2 Research Objectives (RO)

Based on the above research questions, the following research objectives of the study are proposed:

RO 1. To categorise different types of PPP schemes; then to identify their characteristics and conduct a SWOT analysis between different types of PPP families.

RO 2. To identify the set of criteria associated with the selection of PPP schemes.

RO 3. To ascertain the current PPP implementation practice in Vietnam.

RO 4. To develop a decision-making framework for selecting PPP schemes in Vietnam.

RO 5. To validate the proposed framework in procuring infrastructure project in Vietnam.

The study is aimed at contributing to current knowledge on ways to select an optimised PPP scheme for a given project in both developing and developed countries. The outcome of the study can assist both public and private sectors in effectively choosing a PPP scheme for a particular infrastructure investment project. The study aims to fulfil four significant goals:

- Categorising different PPP schemes into different groups according to their characteristics.
- Conducting a SWOT analysis of different types of PPP groups, which can aid practitioners in their decision-making.

- Providing practitioners with a framework to aid the selection of an appropriate project delivery scheme in accordance with the project features, financial, managerial and expert capabilities.
- Constructing an appropriate framework for the selection of the PPP scheme in infrastructure development in Vietnam.

1.3 SIGNIFICANCE AND CONTRIBUTIONS OF THE RESEARCH

PPP is not new in Vietnam; however, since its introduction, most PPP projects were carried out under the BOT scheme without having a proper selection process or procedures. This was evident as some projects reverted back to the government after receiving strong public opposition (Le 2018). Therefore, the current research is significant in the following aspects:

- Former literature studies have highlighted the importance of the optimised PPP scheme to the successful implementation of the project. However, definitions and scope of PPP schemes are often confused;
- Previous studies have proposed decision-making frameworks, but have neglected the selection of a suitable PPP scheme;
- There is a necessity for a user-friendly decision-making toolkit for the optimum PPP scheme selection for construction projects.

This study recommends a systematic classification of PPP schemes according to their nature, responsibilities of the private party and source of investment. The outcome of the study can benefit decision makers of both public and private sectors in effectively choosing the appropriate PPP scheme that can minimise the likelihood of failure in the operational stage.

1.4 OVERVIEW OF THE RESEARCH

This research follows a systematic exploratory process as illustrated in Figure 1-2. The present study adopted a mixed-method approach with sequential procedures to collect data to address research problems. The methodology was carefully developed to achieve the research objectives and be consistent with the internal logic of the study and the research approach was divided into three stages:

The first stage involved research content including theoretical foundation, research aim and identification of research gap, research objectives and the design of research methodology. Initially, a literature review was commenced to broadly investigate the research gap in the field of PPPs and PPP scheme selection. After the research gaps were identified, an in-depth literature review was initiated to sort out assorted PPP schemes into groups. Then, the further literature review was conducted to analyse the SWOT of different PPP categories and identify the set of selection criteria of the PPP scheme. The results involved the achievement of objective one, two and three. This stage was attained through literature review, informal discussion with experts and brainstorming with supervisors and colleagues.

In the second stage, based on the results of the literature review in Stage 1, data were collected through semi-structured interviews with targeted experienced international PPP practitioners and an international questionnaire survey. This stage also focused on data analysis by a series of statistical analysis. Then, the multi-criteria decision-making framework for the selection of a PPP scheme was developed using an ANP approach. The decision-making framework model based on Group 4 of PPP family then was illustrated by using two case studies.

The proposed model in stage 2 was further validated in stage 3.

1.5 DELIMITATION OF SCOPES

This research studied PPP schemes that fall within the broad spectrum of contractual relationships between public and private sectors in terms of infrastructure development. Proper definition of research scope can determine the system boundary for the intended study and highlight the assumptions and limitations. Failure to identify the scope properly would result in distorted results and conclusions.

This research considered PPP schemes that fall within the economic and social infrastructure, from no-to-limited amount of construction (e.g. O&M) to a substantial amount of construction (such as BOT or DBM), regardless of greenfield (new build) or brownfield (existing asset) projects.

1.6 THESIS STRUCTURE

Chapter 1 provides an introduction to the study. It describes the background of the research, research gaps and research questions, followed by the significance of the research. The structure of the study is also highlighted, in addition to research contribution and limitations.

Chapter 2 provides a comprehensive literature review for all the relevant research areas. Areas that have been investigated and discussed are PPP principles (including PPP definitions, typical PPP structure and PPP process and V*f*M), guidelines and handbooks on PPP implementation and different PPP schemes.

Chapter 3 justifies the research design used in achieving the research objectives identified in Chapter 1. This chapter demonstrates important steps in the research methodology including research design, research methods and research process.

Chapter 4: Different types of PPP schemes were classified into different PPP categories and then, SWOT analysis was conducted for each group of PPP family.

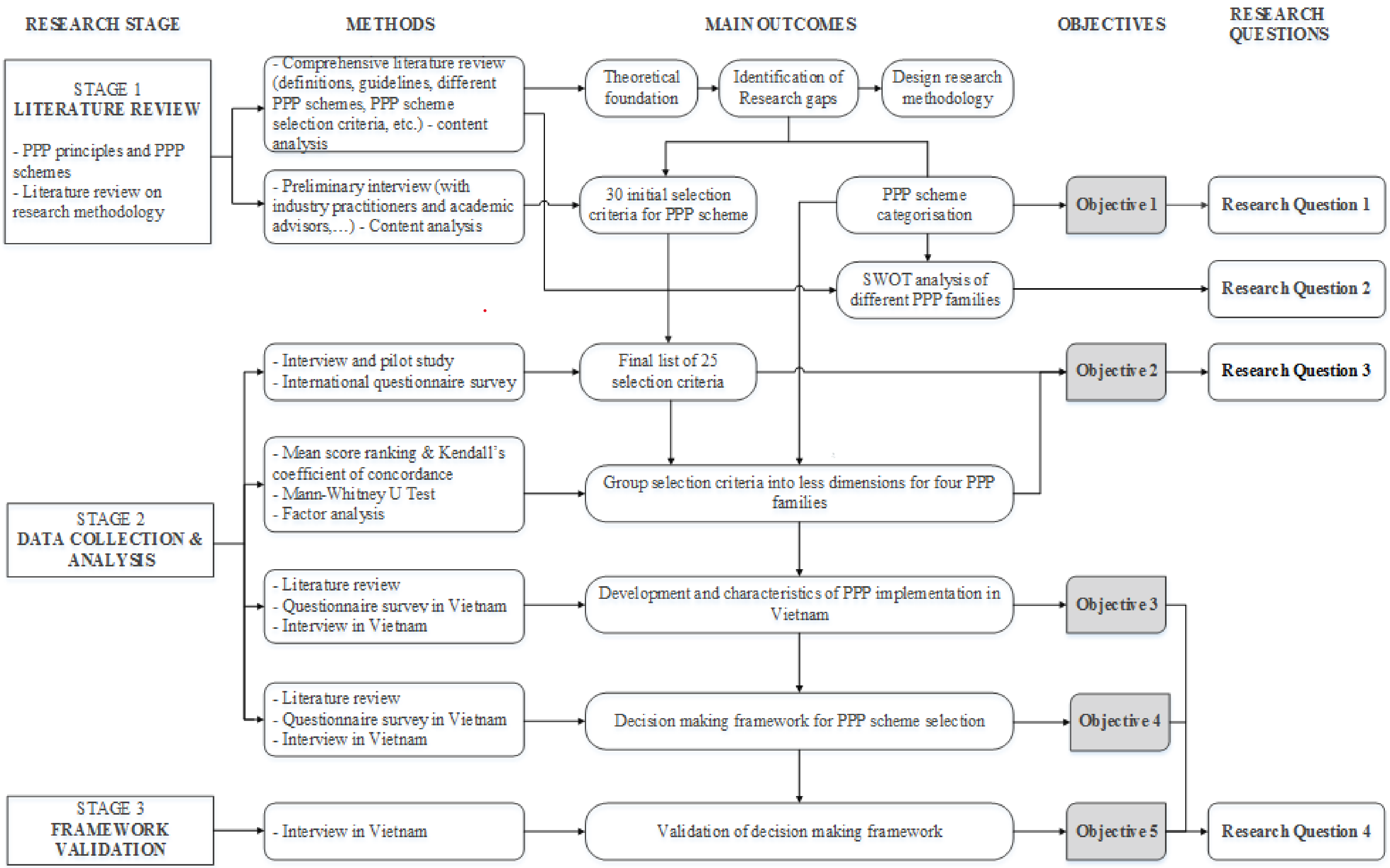


Figure 1-2: Flow diagram of research approach

Chapter 5 identifies criteria affecting the selection of a PPP scheme. A questionnaire was designed based on the selected selection criteria. The questionnaires were delivered to several targeted experts in many countries including public clients, consultants, concessionaires, contractors, financiers, lawyers and academic experts related to PPP in infrastructure construction projects. The results and findings of the questionnaire survey were presented by using several statistical tests.

Chapter 6 describes the current PPP implementation and regulation system in Vietnam. It also investigates the results of the questionnaire survey that was carried out in Vietnam. In order to further understand the existing situation of PPP implementation practice, the results and findings of semi-structured interview by using content analysis are presented.

Chapter 7 implements the ANP approach by using Super Decision software to develop and calculate the ANP model. The results enable the criteria to be prioritised and help to select the appropriate scheme.

Chapter 8 describes the achievement of the research objectives and sets out the conclusions, contributions and implications of the research. This chapter also addresses the limitations of the research and proposes future research directions. A number of appendices are provided as supporting evidence for this research.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

In order to explore the research topic and identify research gaps, the relevant literature was reviewed and presented in this chapter. A thorough picture of PPPs including definitions of PPPs, reasons for adoptions, PPP structure, parties, processes and payment mechanisms were provided. Then, the literature review concentrated on PPP schemes and explored various existing PPP schemes in different organisation guidelines and in different countries. After that, a systematic review of criteria for PPP scheme selection was carried out. The uniqueness of PPP schemes and the procurement process in the context of Vietnam was then presented. Subsequently, Multi-Criteria Decision-Making (MCDM) methods in relation to the selection of a PPP scheme were discussed. The major objective of this literature review was to identify the gaps in existing research on PPP infrastructure projects and identify areas for further investigation.

The literature review was divided into two major parts, as illustrated in Figure 2-1. Initially, a background study was conducted to understand the general PPP mechanisms, procedures and features of a PPP infrastructure project. The second is a research-specific study to investigate different types of PPP schemes, selection criteria for PPP scheme, decision-making in PPPs and most importantly PPP projects in Vietnam to understand the nature of PPP projects and gaps in current practice.

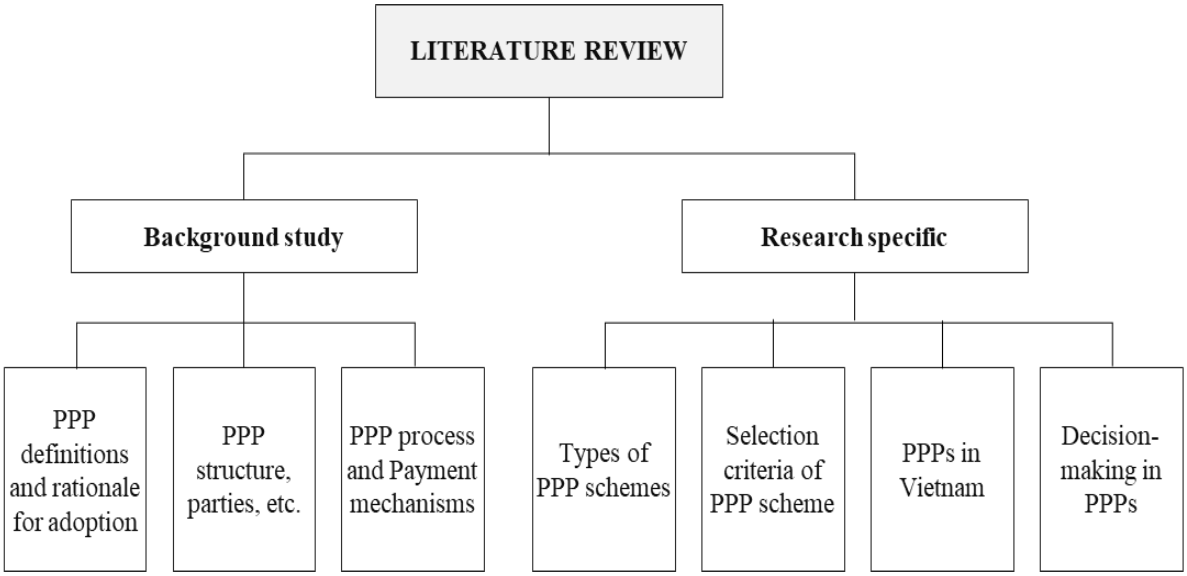


Figure 2-1: Literature review breakdown

2.2 PPP PRINCIPLES AND PROCEDURES

2.2.1 Definitions of PPPs

PPPs have been and continue to be an integral part of many governments' strategies for infrastructure procurement (Liu, HJ et al. 2017). A PPP is a procurement method among a broader range of contractual relationships between the public and private sectors to produce an asset and/or provide a service in delivering infrastructure or associated services (Australian Government 2008a). These services are usually delivered by the public sector (Delmon 2010). Other contracts are traditional procurement methods (e.g. DBB, DB), alliancing, managing contractors, or outsourcing (Australian Government 2015). PPP falls between traditional procurements (DBB) and privatisation. So many other terms of PPP are used to refer to the relationship between public and private sectors, such as Private Participation in Infrastructure (PPI), Private-Sector Participation (PSP) or P3. A well-structured PPP can provide accountability, transparency of outcomes and performance, clarity of the roles and responsibilities of the contracting parties, effective assessment of project risks, competition for the delivery of services, and the motivation to succeed (Grimsey & Lewis 2007).

There is no precisely recognised standard for the definition of PPP. The European Commission (EC), Organization for Economic Co-operation and Development (OECD), International Monetary Fund (IMF), the WB and other organisations have used various definitions to define a PPP. Each country, depending on its institutional and legal requirements, has also adopted and tailored the definition of PPP in its laws. In many countries, definitions of PPP have been formed for convenience and consistency with existing laws and other private sector participation programs, but not with theoretical precision (WB 2007). Definitions of PPP can also differ, according to different contextual factors of a project.

Following are some of the PPP definitions from organisations, institutions and countries:

- The EC (2003) defines a PPP as a partnership between the public sector and the private sector for the purpose of delivering a project or a service traditionally provided by the public sector.
- IMF (2006) defines PPPs as arrangements under which the private sector supplies infrastructure assets and infrastructure-based services that traditionally have been provided by the government.
- For the OECD (2012), PPPs are long-term agreements between the government and a private partner whereby the private partner delivers and funds public services using a capital asset, sharing the associated risks.
- The Australian Government (2008a:7) identified PPP as a 'service contract between the public and private sectors where the government pays the private sector (typically a

consortium) to deliver infrastructure and related services over the long term. The private provider will build the facility and operate or maintain it to specified standards over a long period. The private provider usually finances the project.’

- In Hong Kong, PPPs are collaborations in which the public and private sectors both bring their complementary skills to a project, with different levels of involvement and responsibility, in order to provide public services more efficiently (Hong Kong Efficiency Unit 2003).

Scholars also provide different definitions with different angles and directions of PPP. Some definitions and features of the definition are shown in the Table 2-1:

Table 2-1: PPP definitions by different authors

Definition	Features
PPP is a co-operation of some durability between public and private actors in which they jointly develop products and services and share risks, costs and resources, which are connected with these products (Van Ham & Koppenjan 2001).	co-operation inter-organizational relationship risk-sharing resource-sharing
PPP is a co-operation between public and private actors with a durable character in which actors develop mutual products and/or services and in which risk, costs, and benefits are shared (Klijn & Teisman 2003)	risk-sharing resource-sharing benefit-sharing inter-organizational co-operation
PPPs are defined as ‘a contracting arrangement in which a private party, normally a consortium structured around a Special Purpose Vehicle (SPV), takes responsibility for financing and long term maintenance or operation of a facility to provide long-term service outcomes’ (Duffield, Raisbeck & Xu 2008:7).	long-term contract private finance

While some definitions focus on risk sharing among parties, some emphasise that the private party should finance the project. The other definitions are broadly based on describing a variety of arrangements of PPP schemes, such as definition defined by IMF (2006). In this definition, PPPs include arrangements under which the private sector supplies infrastructure assets and infrastructure-based services that traditionally have been provided by the government. In some countries, PPP definitions might exclude privatisation, while in others, PPPs are designed to promote the private sector participating in infrastructure development by allowing partly or full private divestiture (WB 2007).

Although PPP definitions vary widely between different approaches, they share some common features such as:

- '*cooperation*' between the public and private sectors on various features of the project;
- a relatively '*long-term contract*' between the public and private partners. The concession period should be long enough that the private sector can recoup the investment costs and normally ranges from 20 to 30 years (Xu et al. 2012). The length depends on the type of project, type of contract and policy considerations;
- project funding can come from either '*public financing or partially/entirely private financing arrangements*' (Gaffey 2010; State Government of Victoria 2001);
- a public focus on defining the '*objectives and goals*' of the project and monitoring compliance with these objectives, and a private focus on the '*design, completion, implementation, and funding*' of the project (Gaffey 2010); and
- '*the transfer of some risks*' traditionally from the public sector to the private partner (Yuan et al. 2010) or '*sharing of risks*' with the party who is best able to manage it at the lowest price (Li et al. 2005a).

Although many exist, in this research, the definition of PPP is adopted from the WB Reference guide Version 3 (WB 2017:1), PPP is:

> *'a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility and remuneration is linked to performance.'*

This definition can cover all characteristics of a wide range of possible PPP schemes. It incorporates a number of important characteristics that will be used for this study. First, there is cooperation between the public and the private sector that may involve some new or existing products or services. Second, the cooperation is under a long-term commitment. Third, the goal is to provide public assets or service. Fourth, risks are shared between the public and private sector. Finally, the compensation of the private party depends on its performance.

2.2.2 History and rationale for adopting a PPP

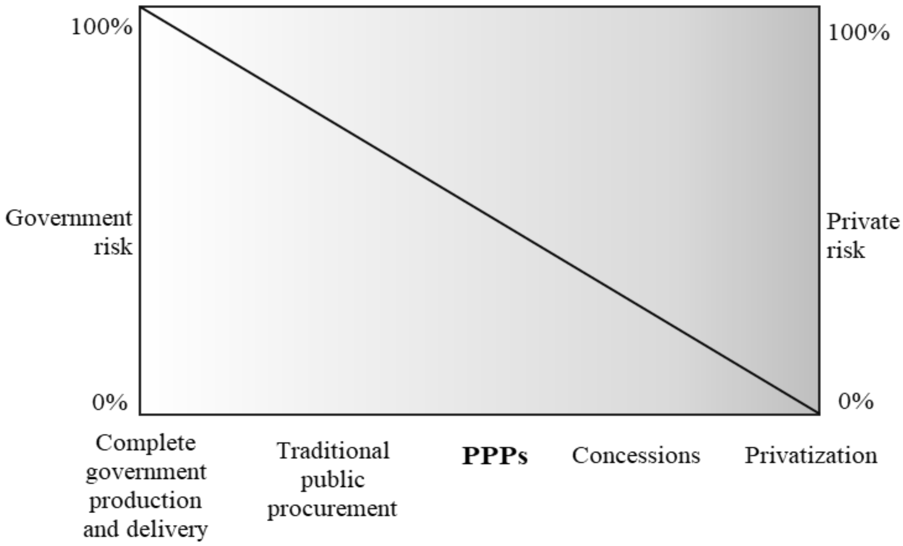
PPPs have a long history of development. PPPs, in respect of concession contracts, were first used nearly two thousand years ago by the Roman Empire (Public-Private Infrastructure Advisory Facility PPIAF 2009) and the toll concession was used on Little Saint Bernard's Pass (Strabo (63BC–AD 21), as cited in Grimsey, Darrin and Lewis, Mervyn K (2005)). However, such schemes disappeared with the collapse of the Roman Empire and then reappeared in the Middle Ages in the construction of new towns and in France for the occupation of new lands in the 12th and 13th century (PPIAF 2009).

During the 16th and 17th centuries, European countries, particularly France, started using more expansive public works 'concession' programs in canal construction, road concessions, waste collection, and public transportation. In this type of PPP, particularly the concession, the private party (the concessionaire) was allowed to charge 'user fees' to the public in order to use the facility to recoup the investment and operational cost (Yescombe 2011). PPPs then developed in the USA for regional and urban regeneration in the 1930s. From the 1950s onwards in Germany, PPPs were implemented mainly for infrastructure services (Bovaird 2010).

Private Finance Initiative (PFI), one of the PPP schemes, first launched by the UK's conservative government in 1992, was subsequently used in many other countries such as the US, New Zealand, and Australia (Akintoye et al. 2003). Fundamentally, the aim of a PFI is to use the private sector's finance, management skills and expertise to deliver the public facilities and services (Katz & Smith 2003). Up to now, PPPs have been used globally and are considered vital for infrastructure development in many developed and developing countries.

The aim of a PPP is to make the best use of the resources in both the public and private sectors; to deliver improved services and better V*f*M, primarily through appropriate risk allocation, encouraging innovation, greater asset utilisation and integrated whole-of-life management (Australian Government 2015). Typically large and complex projects are suitable for PPPs that enable opportunities for innovation in delivery (U.S. Department of Transportation 2016). If designed appropriately, PPPs can generate substantial benefits for consumers and taxpayers (EC 2003). Two common approaches have been used by governments for the implementation of PPPs: (i) a finance-based approach and (ii) a service-based approach (Abdel Aziz 2007). The finance-based approach aims to use private finance to satisfy infrastructure needs. This method normally relies on user fees and project demand to fund the projects and is occasionally called a concession (EC 2003). On the other hand, the service-based approach aims to use the private sector's skills, innovation and management to optimise the time and cost efficiencies with the goal of better services (Abdel Aziz 2007).

PPPs involve joint development and risk sharing between the partners, which are areas that the traditional procurement processes fail to address (Wang, H et al. 2018). As shown in Figure 2-2 the delivery options range from complete government production and delivery, to full private delivery (OECD 2008). PPPs are placed in the middle of this continuum, in which both public and private sectors share risks of the project delivery. Through PPPs, public and private actors expect to create added value with the effort to improve the quality and innovation of the solution (Steijn, Klijn & Edelenbos 2011). This is effected by the co-ordination of different projects and initiatives (Gaffey 2010).



Source: OECD (2008)

Figure 2-2: Spectrum of combination of public and private participation, classified according to risk and mode of delivery

Adopting a PPP can have typical pros and cons based on the objectives of the project. These advantage and disadvantage factors of adopting PPPs, are presented in Table 2-2:

Table 2-2: Advantages and disadvantages factors of adopting PPPs

Advantages	Disadvantages
- Solve the problem of public sector budget restraint (Chan, AP et al. 2009); - Allocate risk to the party who better manage them (Hood & McGarvey 2002); - Provide stronger incentives to make cost-reducing investments (Hoppe, Kusterer & Schmitz 2013); - Mitigate the risks associated with cost over-runs and project delays (Li & Akintoye 2008); - Reduce public money tied up in capital investment (Chan, AP et al. 2009); - Speedy efficiency and cost efficiency delivery of projects (Kwak, Chih & Ibbs 2009);	- Few schemes reach the contract stage (Li et al. 2005b); - They are threatened by a lack of experience and appropriate skills (Morledge and Owen, 1998; Ezulike et al., 1997); - They can lead to higher direct charges to users (Li et al. 2005b); - They impose excessive restriction on participation (Li et al. 2005b); - High participation costs are incurred (Ezulike et al., 1997; Saunders, 1998; Birnie, 1999); - High risk in relying on private sector (Li et al. 2005b);

Advantages	Disadvantages
- Promote sustainable development without much burden on the government budget (Bastin 2003); - Cap the final service costs (Li et al. 2005b); - Improve maintainability and buildability (Li et al. 2005b); - Enhance government integrated solution capacity (Li et al. 2005b); - Encourages competition from within and outside the country through joint venture and partnering (Bastin 2003); - Facilitate creativity and encourage innovation in infrastructure development (Cruz & Marques 2013b; Kwak, Chih & Ibbs 2009); - Transfer new technologies (Brzozowska 2006); - Allow the government to concentrate on the core competencies (Cumming 2007); - Promote local economic growth and employment opportunities (Kwak, Chih & Ibbs 2009).	- Confusion can arise over government objectives and evaluation criteria (Li et al. 2005b); - May lead to high project costs (Ezulike et al., 1997; Birnie, 1999; Public Services Privatization Research Unit, 2000); - Lengthy delays caused by political debate (Infrastructure Journal, 2001a, b); - Extra management time is spent in contract transaction (Ezulike et al., 1997); - Lengthy delays can arise in negotiation (Li et al. 2005b); - Lower project accountability (Li et al. 2005b); - Offers fewer employment opportunities (Li et al. 2005b); - Success relies on well-articulated, functional and service specifications (Australian Government 2010); - Minimum budget requirement in a country specific context (Susilawati & Armitage 2004).

PPPs have been considered as a useful approach that can provide good V*f*M and superior whole-of-life outcomes compared to traditional procurement models. V*f*M as defined in HM Treasury (2006) is the optimum combination of whole-of-life costs and quality (or fitness for purpose) of the goods or service to meet the users' requirement. In other words, simply, V*f*M is the maximum quality and features that meet specifications at the best possible prices (OECD 2008). V*f*M can be achieved through the utilisation of private sector competencies, and an appropriate allocation of responsibilities between the public customer and the private contractor (Bertrán & Vidal 2005). The projects are considered to achieve V*f*M when (i) projects are awarded in a competitive environment; (ii) economic appraisal techniques are rigorously applied, and that risk is reasonably allocated between the public and private sectors; and (iii) comparisons between publicly and privately financed options are fair, realistic and comprehensive (Grimsey, Darrin & Lewis, Mervyn K. 2005).

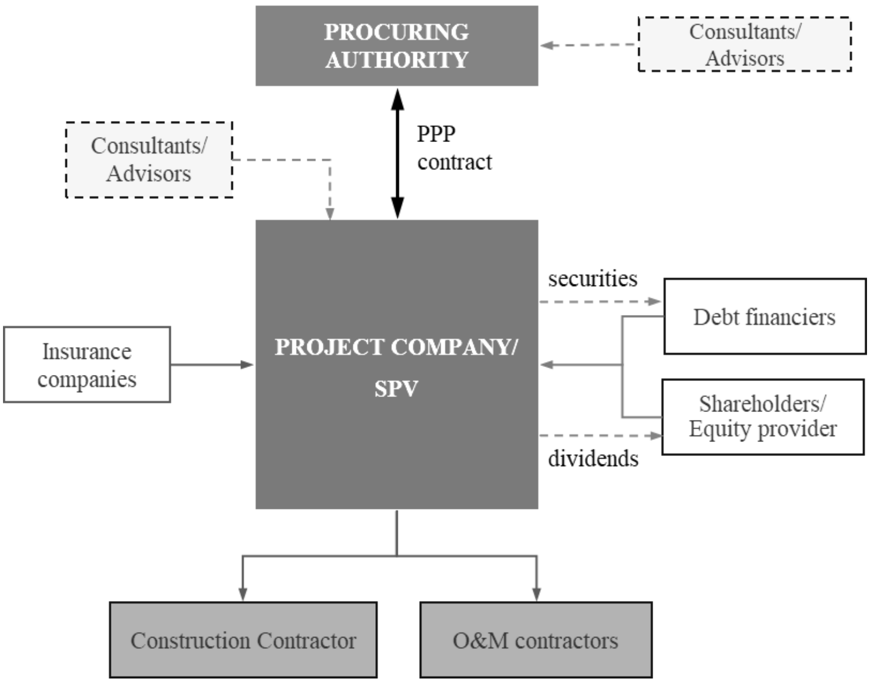
2.2.3 PPP structure, parties and types involved in PPP projects

2.2.3.1 PPP structure

A typical PPP structure is quite complex involving contractual arrangements between a number of parties including client, project sponsor, construction contractor, project operator, facilities management contractors, financiers, suppliers, contractors, engineers, and users or community members (Roumboutsos 2016). The public sector includes any public administrators that act as promoters, or regulators at any level, and the private sector includes different private participants in a PPP project, mainly landowners, constructors, operators, financiers and advisory firms. The users are involved either directly or indirectly within the payment process of the PPP project.

By investing in a PPP project, private sector companies aim to achieve a return on their investment in generating sufficient future cash flows to cover initial capital costs and finance charges, thereby providing enough profit to invest in future projects and pay shareholder dividends. On the other hand, the public sector aims to ensure a high level of services to the community, in a more timely, cost-efficient and of higher quality level than do the more traditional projects (Ng, A & Loosemore 2007). Communities also benefit from the private provision of public infrastructure when project risks are distributed appropriately between private and public sectors with better infrastructure.

The actual structure of a PPP depends on the type of PPP scheme. The simplified PPP structure can be seen in Figure 2-3 as follows:

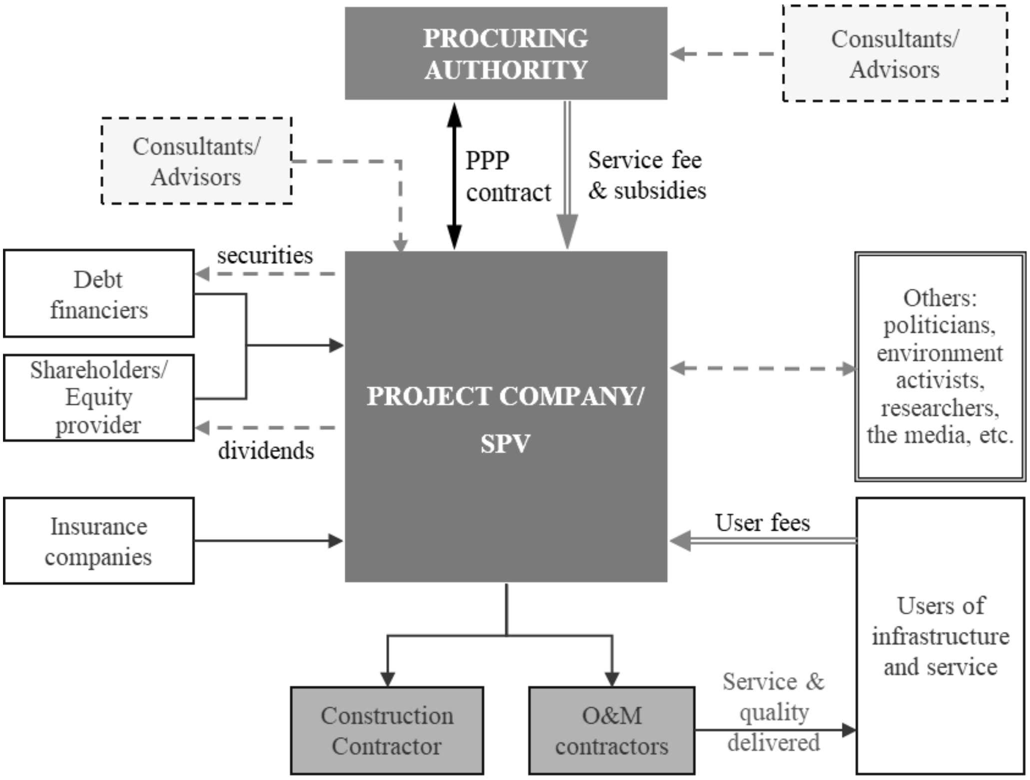


Source: adapted from Farquharson et al. (2011)

Figure 2-3: Typical PPP structure

2.2.3.2 *PPP stakeholders*

The typical stakeholders for a PPP are represented in Figure 2-4 below:



Source: adapted from Farquharson et al. (2011)

Figure 2-4: Typical stakeholders for a PPP project

A procuring authority (or 'Public authority', 'Public Entity', 'Public Party', 'Government Procuring Entity', 'Institution', 'Contracting Authority' or just the 'Authority') may be a central government department, a state or regional government, a local municipal authority, a public agency or any other entity that is public-sector controlled (Yescombe 2011). The government changes the role from owner and manager of infrastructure assets to a buyer of infrastructure services (Regan, Smith & Love 2014).

The Project Company, also known as a Special Purpose Vehicle (SPV), or a Special Purpose Entity (SPE) or a Concessionaire lies at the centre of all the contractual and financial relationships in a PPP project. The project company is a legal entity set up solely to contract with the government with the intention of implementing a specific project or activity. It also assists with off-balance sheet treatment (Scottish Futures Trust 2012).

Financiers include various parties investing in a project, comprising equity providers and debt financiers. Financiers may include domestic and foreign banks and financial institutions, bi-lateral and multi-lateral donor agencies, development banks, and other similar agencies. The initial equity investors, who develop the PPP proposal, are typically called project shareholders. Typical equity investors may be project developers, engineering or construction companies, infrastructure management companies and private equity funds. Lenders to PPP projects in developing countries may include commercial banks, multilateral and bilateral development banks and finance institutions, and institutional investors such as pension funds and insurance companies.

Users of infrastructure and service are people who use the infrastructure or services provided through PPPs. They benefit from assets that are well maintained, savings from travel time and so on.

2.2.3.3 Economic and social infrastructure PPP projects

A project is considered as an economic infrastructure project when it provides key intermediate services to business and industry, while a social infrastructure project provides basic services to households (Grimsey, Darrin & Lewis, Mervyn K 2005). In other words, economic infrastructure will help to improve productivity and innovation and social infrastructure improves quality of life and welfare for the society. At the same time, infrastructure can also be classified into 'hard' and 'soft' infrastructure, as exhibited in Table 2-3. Regardless of economic or social, hard infrastructure refers to physical facilities and soft infrastructure is related to provision of services (Yescombe 2011).

Table 2-3: Classification of infrastructure by type

	Hard	**Soft**
Economic	roads, motorways, bridges, ports, railways, airports, telecommunications, power	vocational training, financial institutions, R&D facilitation, technology transfer, export assistance
Social	hospitals, schools, water, supply, housing, sewerage, childcare, prisons, aged care homes	social security, community services, environmental agencies (EPAs)

Source: Grimsey, Darrin and Lewis, Mervyn K (2005)

Economic infrastructure PPP projects are projects where the private party bears market (demand) risks and the primary source of revenue takes the form of charges paid by the users of the infrastructure. In social infrastructure PPPs, the private sector's primary revenue stream takes the form of a service (or availability) payment from the government (PwC 2017). Economic infrastructure is typically used for schools, hospitals, prisons and so on. These differ from social infrastructure projects where the government retains demand risk, traditionally through an availability-based payment mechanism. Examples of economic infrastructure projects include toll-roads. Compared with economic infrastructure projects, social ones are often smaller in scale and complex due to the community's involvement (Jefferies & McGeorge 2009).

2.2.4 PPP process

Since the government has the responsibility to choose the right project, select a qualified bidder, and set the specifications within which the private partner operates, many governments have promulgated the PPP process. Such processes include several steps that must be followed in order to develop and implement a PPP project (WB 2017). It is not easy to allocate proper responsibilities to parties, and most of the time, misallocation results in time overruns and costly disputes. Many of the problems are due to the incoherence between phases; for example, errors may be detected in the designs during construction (Nguyen, DA, Garvin & Gonzalez 2018). The standardising process helps ensure that all PPPs are developed in a way that is coherent with the government's objectives.

Once a project has passed 'go' or 'no-go' screening to be implemented under PPP, the public agencies begin detailed evaluations to determine if the project is economically beneficial and financially viable. Then, public agencies conduct V*f*M analysis to answer the critical question of which delivery model is best for the project. These evaluations help decision-makers choose the best project scope definition and the optimal structure of a potential PPP project. The project selection process is to ensure that the investments that will be carried out offer V*f*M.

The general process of implementing a PPP project includes four phases (European PPP Expertise Centre 2012):

(i) project identification:

- Project identification (project selection and output specifications)
- Assessment of PPP option (affordability, risk allocation, bankability, VfM)

(ii) detailed preparation:

- Getting organized (project team, advisory team, plan and timetable)
- Before launching tenter (further studies, detailed PPP design, procurement method, bid evaluation criteria, draft PPP contract)

(iii) Procurement:

- Bidding process (notice and prequalification, invitation to tender, interaction with bidders, contract award)
- PPP contract and financial (final PPP contract, financing agreements, financial closes)

(iv) project implementation:

- Contract management (management responsibilities, monitoring service outputs, changes to the PPP contract, dispute resolution, PPP contract termination)
- Ex-post evaluation (institutional framework, analytical framework).

However, similar to PPP definitions, processes adopted using PPP varied from country to country, between solicited and unsolicited PPP proposals along with the types of PPP schemes. However, less effort has been made in the process of assessing the PPP options. A framework for selecting PPP schemes has yet to be developed in the construction industry.

2.2.5 Payment mechanism

A payment mechanism is the heart of a PPP contract. A payment mechanism can be an incentive for the service provider to improve performance, and can also be a tool for financial deductions when services are not delivered (Scott & Robinson 2009). Payments are always predefined in the PPP contract (Shen, L-Y, Platten & Deng 2006) and do not usually start until the service is delivered and meet the performance standards or output qualifications. The revenue or funding payments for the private sector can come from two main sources: customer payments (or user charge), or public sector payments or combinations thereof.

Payment models for PPP projects are presented in Figure 2-5.

<Image removed due to copyright restrictions>

Source: Iossa, Spagnolo and Vellez (2007)

Figure 2-5: Payment mechanism of PPP projects

The most appropriate type of payment mechanism should be decided based on the allocation of demand risk between the public and private partners, to be specific:

- User charge or user-pay is adopted if the demand risk is fully transferred to the private sector. The payment is collected by the private party directly from users of the service; if the private party cannot recoup its investment by user charges only, public subvention can be applied. Subvention comprises one or more of usage payment, availability payment, performance payment, capital grant, support or guarantees.
- Usage payment (e.g. shadow tolls) is applied when demand risk is shared between the private-sector party and the public-sector;
- Performance-based payments: payments from the public sector that vary according to the quality of service provided.
- Availability payment if demand risk is retained by the public sector party, that is, conditional on the availability of an asset or service to the specified quality.

The different types of payment mechanisms are explained below:

2.2.5.1 User charge

For user–charge or user-pays PPPs, the PPP contract gives the counterparty the right to tariff specified tolls or other charges on users of the infrastructure once construction is complete. Examples of such charges are tolls for road usage, fees for metro trains. The project is considered suitable with user charges if the principal objective is to attribute an appropriate proportion of the costs of constructing and operating the project to its users (IDELG - Ireland Department of the Environment and Local Government 2000).

2.2.5.2 Usage payment

Under a usage payment mechanism, no actual tolls are collected from the users. The public-sector party pays the private sector party what is called a shadow toll, based on how much the infrastructure or service is used. A shadow toll is the amount that the public sector, not the facility user, pays the operator for every vehicle that uses the service (Hodge 2004). The using of shadow tolls can help to leverage the limitation of budget constraints and provide multiple funding sources to the project (Tillman 1997). Under this mechanism, the public sector retains the demand risk and the private party receives steady revenue and reduces its risk. If there are excess revenues, the amount will go to the public sector rather than the concessionaire.

2.2.5.3 Performance-based payments

Payments from the Contracting Authority that vary according to the quality of service provided are termed performance-based payments. A financial penalty is set for each criterion, and if the private party fails to satisfy the minimum requirement of performance or if the failure has not been treated within the specified period, a deduction will be made (Ireland Department of the Environment and Local Government 2000). Robust key performance indicators and a sound performance monitoring system are the most difficult components for a payment mechanism to develop.

2.2.5.4 Availability payment

The government entity pays to its private sector partner a unitary service payment when construction is completed, regardless of whether there is a demand for that service. The payment is based on performance to specified levels and the availability of the contracted infrastructure. A deduction will be made if the work is below the specified quality. The definition and time of unavailability, for example facilities closure due to planned maintenance, are of great importance and should be developed as early as possible.

2.2.6 Summary/research gap

The review of PPP principles under this section provides general background of PPPs. PPP falls between traditional procurements (DBB, DB) and privatisation. PPP have several definitions that suit specific purposes and are varied from country to country, organisation to organíation and author to author. This research adopts the definition of PPP from the World Bank (2017). Basic characteristics of PPP definitions are defined as the cooperation and long-term contract between public and private sector to achieve the project objectives; investment responsibility and risk sharing. There are advantages and disadvantages of adopting PPPs; however, compared to traditional procurement models, PPP is expected to generate considerable benefits by providing good V*f*M and outstanding whole-of-life outcomes. Additionally, PPPs involve joint development and risk sharing between the partners, which traditional procurement cannot achieve. Typically, any PPP project involves a complex contractual relationship and is comprised of three main stakeholders including public sector, private sector and the users. Each stakeholder engaged in the partnership has a different purpose. The public sector wishes for high quality of service to the community, while the private party expects to generate sufficient return on the investment. The users, on the other hand, seek a well-maintained asset. The general PPP process comprises of four major phases (i) project identification, (ii) detailed preparation, (iii) procurement and (iv) project implementation. Select an appropriate PPP scheme are central to PPP procurement, however, a framework for selecting PPP schemes has yet to be developed in the construction industry. To conclude, the chapter presented four different types of payment mechanism, which are user charge, usage payment, performance-based and availability payment.

2.3 DIFFERENT TYPES OF PPP SCHEMES

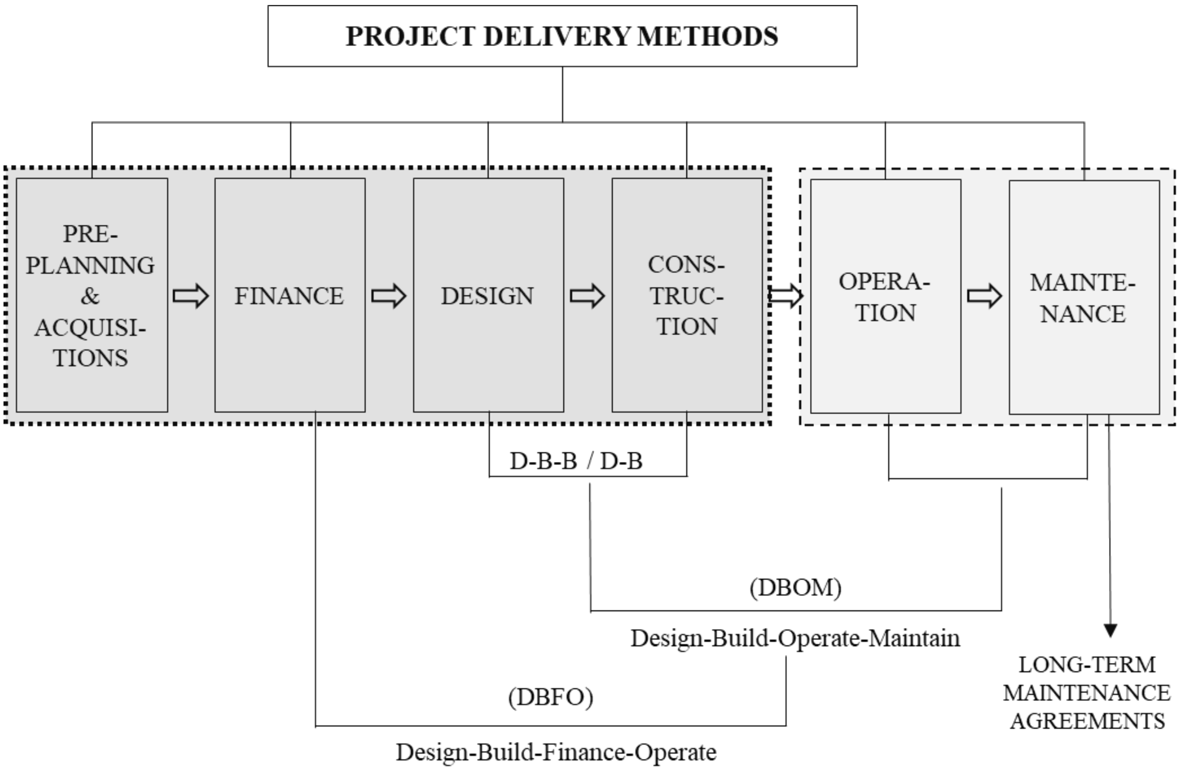
2.3.1 Types of PPP schemes

To attract private sector participation, various types of PPP schemes (sometimes called PPP models or PPP procurement options or PPP modalities) have been offered such as O&M, DBO, BOT, etc. (please refer to Appendix A for a list of scheme abbreviations). Each scheme presents different characteristics to be assessed and is more promptly adapted to particular sectors or project types (ADB 2008). A PPP scheme is a form of contract arrangement between the public and the private sector to perform a PPP project. According to EC (2003), selection of the most suitable PPP type is one of the key issues in PPPs among others such as open market access and competition, protecting the public's interest, defining the right level of grant contribution, success and constraint factors, timing, and future requirements. When considering to use a PPP, the foremost decision to be made is to choose the PPP scheme that is best suited to the proposed project (Zhang, S et al. 2016). There is a consensus that for an individual project, there is one scheme which is 'better' than all others, but no one scheme is better than others across all types of projects (Love, PE, Skitmore & Earl 1998). The careful consideration of the type of PPP scheme to be adopted and the degree of private sector involvement would minimise the chance of project failure during the operational stage, maximise the likelihood of achieving project objectives and improve management of risk (Australian Government 2008b).

Many forms of PPP scheme exist, and they are continuously being developed to suit project characteristics. However, similar to the definition of PPPs, PPP schemes also receive different understanding by different continents, different countries and different guidelines. The understanding of different PPP schemes is varied and often confused. In reality, projects with similar natures may use different terminology, while dissimilar projects may use the same terminology (Delmon 2010).

Pakkala (2002) introduced the system to identify project delivery schemes from traditional DB, DBB to more innovative schemes such as PPPs or full delivery (program management). Schemes and key phases of the processes are shown in Figure 2-6.

PPP arrangements should not be entered into merely for the sake of undertaking a PPP project. A detailed review of the costs and benefits of private sector involvement versus public alternatives must be undertaken to ensure that a PPP enhances the public benefit. The decision-makers consider several aspects when designing PPP delivery models such as cost-benefit analysis, private sector participation, value for money, risks and a variety of other circumstances that need to be addressed in the design of appropriate PPP structures (Delmon 2010).



Source: adapted from Pakkala (2002)

Figure 2-6: Project delivery methods

There is no preferred or standard model for PPP projects. For any given project, the scheme is determined by a number of factors, such as solutions for core services, V*f*M and the public interest (Australian Government 2008b). Each type of PPP scheme involves a different combination of private and public involvement, degree of responsibility and risk taken by the public and private sector for design, construction, operation, management and capital investment.

The PPP options available for delivery of public infrastructure are based on the increasing degree of private sector involvement and risk allocation (Kwak, Chih & Ibbs 2009; Teker & Teker 2012). The degree of private involvement needs to be carefully matched to the objectives, needs of the project and a review of the costs and benefits of private sector involvement versus public alternatives (EC 2003). Assessment must be undertaken to ensure that a PPP boosts the benefits of using PPPs.

Names of PPP contracts vary by the type of assets and services involved and depend on functions of the responsible private party (Grimsey, Darrin & Lewis, Mervyn K 2005; WB 2017), in which each letter of PPP scheme represents the life cycle stage of the project partnership and features in the contractual relationships. To be specific:

- Design (D) - also called 'Engineering' work, means developing the project from initial concept and output requirements to construction-ready design specifications;
- Build (B) or Rehabilitate (R) - when PPPs are used for new infrastructure assets, they typically require the private party to construct the asset and install all equipment. Where PPPs involve existing assets, the private party may be responsible for rehabilitating or extending the asset;
- Finance (F) - when a PPP includes building or rehabilitating the asset, the private party is typically also required to finance all or part of the necessary capital expenditure;
- Maintain (M) - PPPs assign responsibility to the private party for maintaining an infrastructure asset to a specified standard over the life of the contract. This is typically considered a defining feature of PPP contracts;
- Operate (O) - the operating responsibilities of the private party to a PPP can vary widely, depending on the nature of the underlying asset and associated service;
- Own (O) - a private sponsor owns and operates the facility at its own risk over the life of the contract;
- Lease (L) - a private party leases the facility from/to the government, and then operates and maintains the facility at its own risk for the contract period;
- Transfer (T) - the facility is transferred back to the government at the end of the contract period.

A combination of each component is bundled together to form a PPP scheme such as DBOM, BOLT, etc. Besides popular schemes such as BOT, DBFO, O&M, various schemes were tailored in practice to carry out infrastructure projects. Some transport projects, including the Sydney Harbour

Tunnel and the Citylink toll road complex in Melbourne, were undertaken under Build-Own-Finance-Transfer (BOFT) (Regan, Smith & Love 2011). In China, more than 20 Transfer-Operate-Transfer (TOT) water supply projects have been applied in different cities such as Shanghai, Shenyang, Shenzhen, Lanzhou, Tianjin, Chongqing, and Kunming (Meng, Zhao & Shen 2011) and a Rehabilitate-Own-Operate-Transfer (ROOT) was custom-made for a toll road project in Hangzhou, China. In Canada, the Barrie Corridor Grading and Bridge Expansion project, the Cambridge Memorial Hospital Capital Redevelopment project and many others were undertaken under Build-Finance (BF) and DBF scheme (The Canadian Council for PPPs). Each procurement contract type is seen as unique with specific characteristics (Borg & Lind 2014).

Considering the adopted definitions of PPP in this research from the WB Reference Guide Version 3, it is important to identify the procurement options that can be considered as PPPs or that just simply present the participation of the private sector in public infrastructure projects (PSP, PPI). Some schemes share the same features as PPPs (long-term contract, risk sharing, or output-based), however, they differ in some fundamental manner from a PPP - usually in duration, objectives, or legal status and structure.

Given the WB definition, the following schemes are not considered as a PPP scheme in this research:

- Service, Short-term O&M, short-term Management, short-term service or short-term Maintenance contract: these fall out of the definition of PPP just because they are short-term. Additionally, the risks lie greatly in the public sector. Long-term contracts are considered as PPPs.
- Build only (B) or DBB contracts, DB, Turnkey or Engineering-Procurement-Construction (EPC) contracts. However, these schemes do not comply with the long-term/full life cycle cooperation and risk-sharing nature of PPP projects, while in some context, DB is considered as a PPP scheme (Abdel Aziz 2007).
- DBF or BT: this procurement option is usually for the public sector, to avoid a short-term restriction of funds. The government retains the responsibilities and risks related to the state of the asset in the long term.
- Full or partial divestiture or privatisation: The government transfers 100 percent (permanent transfer) or part of the equity in the state-owned company to private entities (operator, institutional investors) and in turn transfers all the risk to the private party.
- BOO: The private party is responsible for design, construction, finance and operation and retains ownership of the facility during the concession period. By the end of the contract, there is no provision to return the underlying asset to the public sector. There may be two types of BOO:
    - A form of privatisation where the private sector retains the permanent ownership of the asset (Sozzani 2001). It also means that there is no time limit on ownership. This type of BOO should not be considered as a PPP.

- At the end of the concession period, the original agreement may be renegotiated, a new agreement may be negotiated, or the facility may be purchased by the government (Grimsey, Darrin & Lewis, Mervyn K 2005). Alternatively, the asset constitutes facilities that are fully depreciated and at the end of their useful life, their accounting salvage value is zero. Following the proposed definition, this type of BOO should be considered as a PPP.

2.3.2 PPP schemes under different organisations' guidelines

2.3.2.1 Public-Private Partnerships by International Monetary Fund (IMF)

The IMF categorised different types of PPP schemes into three different groups as shown in Table 2-4. For group 1, the main character is that the private party finances and possesses the new project. Other tasks include designing, building, developing, operating and managing the facility. Group 2 includes Buy-Build-Operate (BBO), Lease-Develop-Operate (LDO) and Wrap-Around Addition (WAA) in which the private party buys or leases the existing asset and owns the facility perpetually. In the first two groups, the private party owns the asset with no obligation to transfer the project back to the government. Group 3 comprises BOT scheme variants in which the private party designs and builds an asset and operates it. Then the private party has responsibility to transfer the asset back at the end of the concession period or at some pre-determined time.

Table 2-4: PPP schemes and modalities

Schemes	Modalities
BOO, BDO, DCMF	The private sector designs, builds, owns, develops, operates and manages an asset with no obligation to transfer ownership to the government. These are variants of DBFO schemes.
BBO, LDO, WAA	The private sector buys or leases an existing asset from the government, renovates, modernises, and/or expands it, and then operates the asset, again with no obligation to transfer ownership back to the government.
BOT, BOOT, BROT, BLOT, BTO	The private sector designs and builds an asset, operates it, and then transfers it to the government when the operating contract ends, or at some other pre-specified time. The private partner may subsequently rent or lease the asset from the government.

Source: IMF (2004)

2.3.2.2 *European Commission (EC) Guidelines for Successful PPPs*

Forms of PPP relationships, according to the guidelines from EC (2003), range from minimal to maximal private sector involvement.

Cluster 1 is 'Private involvement options with traditional public sector procurement'. This cluster presents opportunities for the private sector to participate in varying degrees in maintenance, O&M and leasing. This cluster comprises:

- Service Contracts: operational requirements of the new facility for short periods of time (a few months to a few years).
- O&M Contracts: encourage and enhance efficiencies and technological sophistication in the short term.
- Leasing: Leases provide a means for private firms to purchase the income streams generated by publicly owned assets in exchange for a fixed lease payment and the obligation to operate and maintain the assets. Lease agreements can be expected to extend for a period of five to fifteen years.

Cluster 2 is 'integrated project development and operation opportunities'. The structures include BOT, Turnkey delivery, DBOT in which the limited responsibilities are transferred to the private sector.

Cluster 3 describes 'partnership project development and investment opportunities' that assign new opportunities to the private party. This cluster is divided into two sub-categories including:

- Concessions: The private sector is responsible for financing and constructing an asset. Revenue can be recouped via operation of infrastructure improvement. The duration of a concession period often ranges from 25 to 30 years.
- Private Divestiture: This is the maximum involvement of private party when the asset is sold to the private sector. This sub-group includes 'Complete Private Divestiture' and 'Partial Private Divestiture'.

2.3.2.3 *The Asian Development Bank (ADB) PPP handbook*

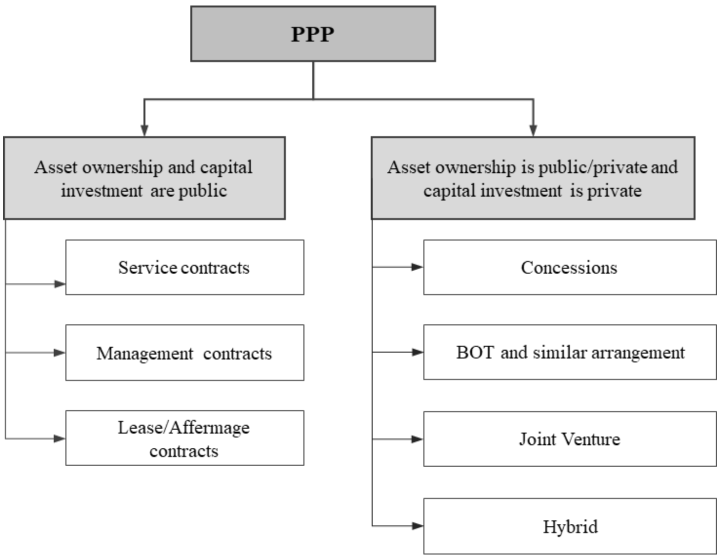
According to the PPP handbook from the ADB (2008), as shown in Figure 2-7, PPPs are grouped based on the asset ownership during concession period and investment responsibility.

Two groups include where: (i) asset ownership and capital investment are public; and (ii) asset ownership is public or private and investment belongs to a private party.

Cluster 1 comprises service contracts, management contracts and lease/affermage contracts. The funding requirements of any capital investments are the responsibility of the government. The duration of the contract is up to 10 years. In the service contract, the private party is hired in the short period contract, from one to three years, to provide specified tasks or services, and then paid based on pre-determined specifications. A management contract includes some or all of the O&M of the public service for the duration of two to five years.

Both service and management contracts are typically short term. In the lease and affermage contract, the private entity provides services to the specific quality and service standards for the duration of about 10 years with chances of renewal. The private sector keeps revenue and pays a specified lease amount or affermage fee to the contracting authority and retains the remaining revenue.

Cluster 2 consists of concession, BOT and similar arrangement, JV and Hybrid. A concession, under the handbook, is introduced as the method where the private sector operator (concessionaire) is responsible for the full delivery of services, comprising operation, maintenance, collection and management with their own capital. BOT and similar variants are a kind of specialised concession in which a private firm or consortium finances and develops a new infrastructure project or a major component. Joint ventures are alternatives to full privatisation in which the infrastructure is co-owned and operated by the public sector and private operators. Hybrid arrangements are tailored to specific projects to bring together the characteristics most suitable to a particular project's requirements and operating conditions.



Source: adapted from ADB (2008)

Figure 2-7: Types of PPP under ADB handbook

2.3.2.4 The WB Reference Guide version 3

In the Reference guide, all PPPs have three features. Firstly, the type of asset can be a new asset (greenfield project), or an existing asset (brownfield project). Secondly, the functions are assigned to the private party. Tasks can be any of the following: design, build/rehabilitate, finance, maintain and operate. Third is the source of payment that the private party receives. The concessionaire can be paid entirely by service users, or the government agency makes some or all payments. Different types of PPP schemes are provided in Table 2-5.

Table 2-5: PPP nomenclatures

PPP nomenclature	Type of asset	Functions transferred	Payment source
DBFOM, DBFO, DCMF	New	As apprehended by contract name	Either government or user pays
BOT, BOOT, BTO	New	Design, build, finance, maintain, and some or all operations Under some definitions, BOT or BTO may not include private finance, whereas BOOT always includes private finance	Either government or user pays
ROT	Existing	As above, but rehabilitate instead of build	Either government or user pays
Concession	New or existing	Design, rehabilitate, extend or build, finance, maintain, and operate — typically providing services to users	Usually user pays— in some countries, the private party might pay a fee to government or might receive a subsidy
PFI	New	Design, build, finance, maintain — may include some operations, but often not providing services directly to users	Government pays
O&M	Existing	Operations and maintenance	Government pays
Affermage	Existing	Maintain and operate, providing services to users	User pays—private party typically remits part of user fees to government to cover capital expenditures
Management Contract	Existing	Operations and maintenance	Management fees extended to the contractor
Franchise	Existing or new	May include design, build, and finance, or may be limited to maintaining and operating an asset	User or government pays

Source: World Bank Group (2017)

2.3.2.5 Summary/Research gaps

This section reviewed various types of available PPP schemes that are currently in use and available. It can be observed that terms of PPP schemes are often used interchangeably and inconsistently. The designations of PPP schemes vary by the type of assets and services involved and depend on functions of the responsible private party. Four different systems of PPP scheme categorisation in the guidelines of different organisations were reviewed in this part. Four organisations' guidelines and handbooks were reviewed including two international financial institutions, one regional bank and association. These four organisations were chosen to observe the diversity across different regions across the world. It can be observed that there is a lack of common structure in the categorisations, even though there are some similarities and overlaps among the above systems. For instance, the services that the private party provides in an affermage and management contract, according to the categorisation of the WB (2017), are similar to the O&M contract. The difference only lies in the payment source of the service. The concession, in the ADB handbook, is used when the private sector is responsible for the full delivery of services using their own capital. Nevertheless, in other guidelines, a concession implies any contracts that involve end-user payments (WB 2017). For this reason, there is a need to have a common understanding of PPP schemes, as well as internationally accepted guidelines for the selection of PPP schemes that is practical and easy to adopt.

2.3.3 PPPs in infrastructure development around the world

PPPs have been long implemented in developed countries and therefore have been better established in comparison to developing economies. The maturity of PPPs is different from country to country and mainly depends on various factors such as geography, the local political climate, and the sophistication of the capital market (Eggers & Startup 2006). The maturity of PPPs in different countries is presented in Figure 2-8.

<Image removed due to copyright restrictions>

Source: Northoff (2008)

Figure 2-8: PPP maturity curve

2.3.3.1 PPPs in developed countries

A number of Organization for Economic Co-operation and Development (OECD) countries such as the UK, Australia, the Netherlands, Ireland, the US, France, Italy and Germany have rich PPP programs. The majority of PPPs in the UK are schools, hospitals and defence facilities projects; roads in Australia and Ireland, social housing and urban regeneration in the Netherlands (PPIAF 2009). In Canada and Japan, PPPs are quite new and dominated by road projects. PPPs in UK and Australia are at the highest point of the maturity curve and have moved to a more advanced phase, with new innovative models and more comprehensive risk models that give greater focus to a project's whole life cycle (Eggers & Startup 2006).

The UK is the pioneer of adopting PPP projects in Europe. Having launched these initiatives during the John Major administration in 1992 as the Private Finance Initiative (PFI) program, the UK views PPPs as a procurement approach that brings the public and private sectors together in long-term partnerships for mutual benefit (Akintoye, Beck & Hardcastle 2003). Before PFIs, other forms of procurement such as outsourcing, BOT and privatisation were also used (Mustafa 1999), and thereafter, PFIs became the dominant method for building large-scale projects in the UK. In 2012, the government introduced the second generation of PFI, the PFI2, with some structural changes that provide greater transparency and risk reallocation. The PFI model was similar to a DBFO or DBFM scheme (Grimsey & Graham 1997), and the majority of PPP projects in the UK are funded by the availability of payments, while a small proportion is funded by user fees (Richards, Calder & Hadrill 2019). Recently, more PPP projects are introduced in the sector for schools, hospitals and defence facilities.

Australia was one of the earliest countries to adopt PPPs in infrastructure via a strategy that created long-term contractual obligations, sharing of risks and rewards between the private and public sector. Most of the new infrastructures such as highways are built newly by PPPs. In a typical PPP in Australia, the private party will take the responsibility of designing, financing, constructing, maintaining and operating the facility in a period ranging from 20 to 35 years (Australian Government 2008b). According to Zou and Yang (2016), there are three motivations for adoption of PPP in Australia. The first driver is the need for more infrastructure including highway networks, and social and public buildings due to the increase in the population. The second motivation is the lack of government funding to fulfil the increasing demand for more and better infrastructure. The third one is the need for better integration of project finance, design, construction and management and the opportunity for innovation that PPP brings. Australian governments at state and federal level continue to affirm their commitment to the PPP model, with updates to PPP policies and guidelines (Griffis, Carney & Wei 2018).

Ireland began applying PPPs relatively late – as formal initiatives since 1998 – following the UK model. However, the country has matched pace (Sheppard & Beck 2018). As a fast-growing and wealthy OECD country, there was no urge to use private-financed PPP for infrastructure development.

PPPs have gained popularity by providing efficiency to the public sector, together with policy transfers and institutional legitimacy. The types of PPP schemes that are currently and primarily in use in Ireland are DBO, DBFM, DBFOM and concessions (Parliamentary Budget Office of Ireland 2018).

In the Netherlands, the public entity and the private sector enter into a long-term collaboration on government building and infrastructure projects. The goal of the partnerships is to produce better-quality end products at a lower cost. Tasks and risks are shared, and each party is responsible for the tasks it is best equipped to perform, as well as for the associated risks. The vast majority of PPP projects for social housing and urban regeneration in the Netherlands include private financing; schemes in use are DBFM or DBFOM (Hebly & Klijn 2016).

France: PPPs have been in official use in France since 2004. Since then, France has become a leading country in using PPP to strengthen infrastructures, especially in terms of sports or cultural facilities (41%), buildings such as colleges, schools, train stations (29%), and information and communications technology and energy, water and waste systems (15%), urban infrastructure (11%) and transportation (4%) (Saussier & Tran 2012). Two types of PPPs that are mainly used in France are (i) concession agreements and (ii) partnership contracts (which can be compared to PFI contracts) (Edwards, Hafer & Riedy 2015). Concession agreements, in which the compensation of the concessionaire will mainly arise through payments made by end users, serve to implement major infrastructure projects such as canals, motorways, water distribution systems and toll bridges. On the other hand, partnership contracts, for which the public sector will pay the rent for the performance of the facilities, are for financing, design, construction and maintenance (DBFM) or financing, design, construction, operation and maintenance (DBFOM) (Vaissier, Martin-Sisteron & Seniuta 2016).

Contrary to France, Germany is a late adopter of PPPs, starting in 2000s. Since then PPPs have exclusively been financed with bank loans. German procurement law permits project bond financing for a PPP. PPP schemes are identified by an ownership structure, a compensation scheme and risk allocation (Jacob et al. 2014). The most common models of PPPs in Germany are BOT, BTO, BOO, contracting models, concession models and shareholder models (Bundesministerium für Verkehr, Bau und Stadtentwicklung 2003 as cited in Jacob et al. 2014).

Switzerland: In Switzerland, PPPs are not entered because of a shortage of public funding. One reason for Switzerland’s economic success is its political stability. Switzerland exhibits one of the lowest numbers of PPPs within European countries (Athias, Macina & Wicht 2019). Concessions and BOT are used in a period ranging from five to 15 years and can be tailored to specific situations to maximise contributions to the local economy.

<Image removed due to copyright restrictions>

Source: Athias, Macina and Wicht (2019)

Figure 2-9: Number of PPP projects in European countries in 1994-2016

In North America, the US embarked on regional and urban development through PPPs starting from the 1930s. Yet, until the late 1980s, PPPs gradually started to play a significant role in the development of the US highway infrastructure. PPPs have been used across a wide range of infrastructure and services and are typically long-term arrangements, where the private sector partner funds much of the project but the public sector partner retains ownership of the project in the long term (Edwards, Hafer & Riedy 2015). However, only a small number of highway projects have involved private financing (Kile 2014). The National Council for PPPs currently recognises 18 types of PPPs that can be divided into two categories:

Table 2-6: Types of PPP in the US

PPPs for new construction	PPPs for existing facilities and services
Design–Build (DB)	Operate and Maintain (O&M)
Design–Build–Maintain (DBM)	Operate-Maintain and Management (OMM)
DBO, DBFOM	Buy–build–operate
Design–Build–Operate–Maintain (DBOM)	Enhanced-use leasing
Design–Build–Finance–Operate–Maintain–Transfer (DBFOMT)	Lease–develop–operate
BOT, BOO	
Developer finance, Lease/purchase	
Sale/leaseback, Tax-exempt lease, Turnkey	

Source: adapted from Edwards, Hafer and Riedy (2015)

Canada is generally regarded as an emerging giant in terms of PPP development with over 300 infrastructure projects delivered through PPPs as of 2018. The UK indicated Canada as one of the models that the UK should follow when developing a new approach to PPPs (HM Treasury 2012, p.9). Many large PPPs receive substantial upfront public investment that can account for up to two thirds of the project capital costs. Today, PPPs in Canada primarily follow variants of the DBFOM model for greenfield projects even though the schemes include O&M, BF, DBFM, DBFOM and concession (The Canadian Council for PPPs). Concession periods are typically between 25 to 50 years. On many projects, much if not all of the upfront private capital invested is recouped through government payments to the concessionaire, rather than through toll revenues or user fees. Canadian PPPs are most commonly based on availability payment structures (Siemiatycki 2015). The concessionaire is paid a specified amount at scheduled intervals on the condition that the asset is meeting predetermined standards. In Canada, most infrastructure assets remain publicly owned, rather than ownership being transferred to the private sector partner over the duration of the concession.

In Japan, prior to 1990, during the rapid economic development, infrastructure development was carried out through public funding owing to sufficient funds. However, since 1990, considering that the tax revenue declined, private infrastructure funding gained attractiveness (Nemoto 2015). In 1999, the Japanese Government adopted PFIs from the UK by the ‘PFI Act’ and in 2013, the Shinzo Abe cabinet introduced a ‘PPP/PFI Action Plan’ to support PPPs. Contracts with schemes used such as BOT, BTO, BOO, BT and O&M are usually 20 years of concession. As of 31 March 2017, PFI projects in Japan totalled 609 projects, amounting to approximately Japan Yen ¥5.5 trillion, equivalent to USD50.71 trillion (Yao et al. 2018).

The Republic of Korea, another developed country in Asia, started using the PPP modality as a response to a sharp decline in public and private investment in infrastructure in the late 1990s, amid the Asian financial crisis. This has been a success and has contributed to delivering economic and social welfare benefits. There are two types of PPP projects: government-initiated projects (or publicly financed projects) and privately initiated projects (Yi, Shim & Chung 2019). A key reason for this is the country’s strong legal, regulatory and institutional frameworks to facilitate infrastructure PPP projects. Schemes used are BOO, BOT, BTL, BTO, ROT.

In Hong Kong, China, PPPs have been adopted to cope with population and urban growth since the 1970s, with various forms of PPP models such as DBO, BOT, DBOM and Management-Operate and Maintain (MOM). Private party involvement in infrastructure development was considered in order to provide sustainable and efficient service delivery with a whole-life costing approach, rather than for funding purposes (Lam & Javed 2015).

Briefly, developed countries have a long history of practicing PPPs for infrastructure development. Even though some failed or distressed PPP projects have been recorded, many have been proved to provide V*f*M and add value to society. Those developed countries have put much effort into initiating the unified and rigorous framework for PPP development. Anywhere in this world, different PPP schemes and procedures should be meticulously analysed and evaluated in order to obtain successful projects and continue to learn from practices (Monteiro 2005). Experiences in developed countries demonstrate the effective use of PPPs in infrastructure development and what can be learned from successful PPP projects.

2.3.3.2 PPP in developing countries

Many developing countries – later adopters – such as Chile, Brazil, China, India, the Philippines and Vietnam, also use PPPs for the development of infrastructure. Since many developing countries cannot rely solely on financial sources, such as Official Development Assistance (ODA), Foreign Direct Investment (FDI) and international financial institutions like WB, IMF and ADB, pressure on public funding is on the increase. Hence, PPP is adopted as an innovative approach to accelerate economic development. However, developing countries find it more difficult to attract private sector investment in infrastructure projects because of risks and uncertainty (Wang, H et al. 2019).

In China, a PPP contract can be signed between the government and the social capital county or upper-level governments in charge of implementing the PPP projects within their territories (Wang, J, Han & Miao 2019). The types of PPP schemes explicitly mentioned in the Ministry of Finance (MOF) PPP Guidelines mainly include O&M, management contract (MC), BOT, BOO, BOOT, TOT and ROT. The type of PPP project is chosen in light of the specific conditions of each project and business or political requirement of the parties (Sun 2018). BT was very popular in China from the late 1990s to the end of 2012. However, the BT model could not deliver value for money (Wang 2013) and was no longer considered as a PPP option in China.

In 2010, the Government of the Philippines relaunched the PPP program to address major infrastructure gaps, seeking to mobilise private sector resources to achieve economic growth and development. In July 2010, the government introduced a renewed focus on the PPP approach as a strategy for infrastructure development. There is a shift in emphasis to solicited projects consistent with the Philippine Development Plan (ADB 2016). This helped to strengthen the government's fiscally constrained infrastructure investments and to derive V*f*M through efficient delivery of infrastructure by the private sector.

Vietnam is a fast-growing country with ambitious infrastructure plans. However, when the ODA cannot solve the problem of an insufficient budget, Vietnam has increasing openness to private sector participation. PPPs are supported to boost economic growth and develop public infrastructure. BOT, BTO, BT, BLT, BTL, O&M and hybrid models have been adopted, especially BOT and BT models that were frequently adopted in procuring power projects and toll roads in Vietnam (Frasers Law 2015).

PPP projects in the South Asia region, namely Sri Lanka, Pakistan, Nepal, Bhutan and Bangladesh, except for India, are facing multi-faceted challenges such as weak legal/ regulatory frameworks, poorly prepared/structured projects, a lack of capacity and a weak financial environment (Agarwal 2015). In contrast, in India, although PPPs are still new, there are currently approximately 1,500 PPP projects in various stages of implementation, with a dominance of roads and port sectors (PPP Cell 2018). Many innovative financial tools such as viability gap funding (VGF), annuity models and stimulation for availability of debt with support of the government have been used, and have encouraged the private sector to go in for infrastructure investments via PPP projects (Telang & Kutumbale 2014). Common types of PPP schemes in India are DB, O&M, DBFO, BOO, BOOT, BBO, BOLT, operation license and finance-only (Gupta, V & Singh 2018).

PPPs in Sub-Saharan Africa remain a very small market, although a lack of modern infrastructure is a major challenge to Africa's economic development. These countries had adopted and followed the arrangements being used by advanced economies (Sanni & Hashim 2014).

Developing countries, whose PPPs are at elementary stages, can avoid mistakes by learning from more mature PPP markets in developed economies, as well as adopting more flexible, creative PPP models (Eggers & Startup 2006).

2.3.4 Summary/research gap

Literature has confirmed that various forms of PPP scheme exist, and they are continuously being developed to suit project characteristics. The selection of the most suitable PPP scheme is the key to project success and the top decision to be made when deciding to implement a project under PPP. However, definitions and scope of PPP schemes are often used interchangeably or confused. By the using of terms interchangeably, in practice, projects that share similar features may use different expressions, while projects with different characteristics may use similar terminology. The dissimilarity in understanding and lack of clear PPP scheme categorisation have made PPP study and learning lessons more complex. Hence, there is a need for common understanding and categorisation of PPP schemes and a systematic categorisation of PPP schemes needs to be developed.

2.4 SELECTION CRITERIA OF PPP SCHEME

2.4.1 Identification of the selection criteria for PPP scheme

One of the obstacles in implementing an infrastructure development project under PPP is the poor project definition and lack of appropriate standard project procurement framework. Zhang, Xueqing (2005b) suggested that one of the solutions is formulation of appropriate PPP schemes. The selection of the most appropriate procurement method is consequently critical for both clients and project participants and is becoming an important and present day issue (Love, PE, Skitmore & Earl 1998). In selecting a delivery scheme for a particular project, owners should consider the various criteria affecting the projects. The preliminary selection criteria of a PPP scheme were identified through a systematic literature review of previous studies on different types of PPP schemes.

2.4.1.1 *Stable politics and government system and stable macro-economics*

Considering the long-term nature and comprehensiveness of PPP projects, the instability of political and government systems as well as the volatility of macroeconomics seem to be a major obstacle to the use of many types of PPP projects (Tam 1999), especially in developing countries because they can cause and increase the risks to a private party. The unstable political environments are associated with frequent changes in government's premiers and policies (Cheung, E et al. 2012), hence a private party may react with scepticism regarding the commitment of the new administration (Muhammad & Johar 2018).

2.4.1.2 *Supportive political climate for PPP projects*

Supportive political climate to PPP projects supports the development of PPP projects and further, is a pre-condition for a successful PPP project (Qiao et al. 2001). The confidence of private sector participation in PPP infrastructure services will much depend on the level of political support, especially with foreign investors when considering investment in other countries (Li et al. 2005a). In developing a new transportation PPP project, it is essential to understand existing local economic conditions at the project's site and evaluate the government' s future plans affecting existing economic trends (Soomro & Zhang 2015b). Along with toll-road traffic demand, political and economic changes, especially in user-pays projects, are extremely sensitive to project economic cycles (Vassallo, Ortega & Baeza 2012).

2.4.1.3 *Community/Public support to PPP projects*

The public/community opposition, at any stage and by any stakeholder of a PPP project, can lead to delay, inconveniences caused during the construction phase (Salman, Skibniewski & Basha 2007) or even project cancellation or nationalisation (Siemiatycki 2015). Opposition may arise from politicians, environmentalists, users or citizens at the project area, then can consequently lead to social and political problems (Zhang, Xueqing 2009). A robust community support can contribute and is essential to guarantee the success of the projects (Jefferies, Gameson & Rowlinson 2002). In some projects, the concession can be prematurely ended due to strong public opposition even though projects were completed on schedule and within budget (Soomro & Zhang 2011), such as Hungary's M1/M15, the Scottish Skye Bridge and the Sydney Cross City Tunnel (Aziz & Migliaccio 2015; Levy 1996). Some states in the United States (US) experienced strong political and citizen opposition against privatisation using the BOO model in delivering transportation infrastructure projects (Siemiatycki 2009). In the failure case of the Camino Colombia BOT toll road in the US, public protests led to political pressure to lease back the infrastructures (Soomro & Zhang 2015b).

2.4.1.4 *Mature legal system required to support PPP procurements*

An immature legal framework caused the projects to be less viable financially and in an unattractive investment environment (Trangkanont & Charoenngam 2014). If the new government is unwilling or unable to meet the contractual obligations, the franchisees will fall into difficulties (Tam 1999). A different legal framework can affect the type of PPP regulatory framework they adopt (WB 2018b). On the contrary, in developed countries the legal framework and contractual conditions have matured so that they protect both parties' interests. To be successful, PPPs require robust and comprehensive legal and institutional frameworks and processes (Jefferies, Gameson & Rowlinson 2002; Li et al. 2005a). Legal changes make PPP vulnerable and can cause significant delays (Cuttaree, Vickram, Humphreys & Muzira 2009; Parliamentary Budget Office of Ireland 2018).

2.4.1.5 *Government experience*

The government's expertise for managing the PPP partnerships, in both O&M stage and project management field, is of great concern among academics (Robinson et al. 2009). Commitment, skill, capacity, and coordination of the public sector are crucial for a government to implement successful PPPs (Ng, ST, Wong & Wong 2012). Lack of government experience in project management can be reason for insufficient risk transfer to the private sector and delays in giving government approvals on essential land and environmental aspects, and are subject to constant delays and cost overruns (Cuttaree, Vickram 2008). Throughout the procurement process, the lack of government experience and expertise to prepare, procure and manage PPP projects creates an important barrier to attracting private sector investments (World Bank 2018b; Zou, Zhang & Wang 2007). It can also lengthen the bidding duration that leads to delays (Ozdoganm & Birgonul 2000; Zhang, Xueqing 2005a, 2005b). An inexperienced government cannot provide support and commitment for projects (Liu, T & Wilkinson 2011).

2.4.1.6 *Financial attraction and financial viability*

Financial attraction to investors and financial viability are major concerns for both the public sector and private consortium whilst evaluating a PPP project (Ng, ST, Wong & Wong 2012). In some type of PPP schemes such as BOT, in particular, commercial and financial conditions, rather than the technical components, are likely to be the final determinants in awarding the BOT contract (Qiao et al. 2001). In deliberation of a PPP project's viability, the NPV and risk-adjusted present value usually has a greater impact than the physical design or construction costs (Zhang, Xueqing 2005a).

2.4.1.7 *The project scale and the amount of total investment*

Size and complexity of the project increase the risks and can deter private investment. As PPP projects usually have a high proportion of debt relative to equity, the larger the project, the higher the borrowing needed (Cuttaree, Vickram, Humphreys & Muzira 2009). Shen, L-Y, Platten and Deng

(2006) argued that BOT is especially suitable with large-scale infrastructure projects. Considering the high level of debt ratio, large scale and complexity of PPP projects, the impact of the capital expenses can be tremendous, PPPs usually are not suitable for small investments (Cruz & Marques 2013a).

2.4.1.8 Risks during project life-cycle

Given the complexity, size of project and concession period, there are an enormous range of potential risks which can affect expected outcomes (Ng, A & Loosemore 2007). PPP scheme selection should comprise what associated risks the private sector might be prepared to accept (Farquharson et al. 2011). Many projects have been abandoned or cancelled due to an insufficient understanding of risks and the financial consequences (Nguyen, A, Mollik & Chih 2018). Project risks include (i) technical risk due to engineering and design failures; (ii) construction risk, due to faulty construction techniques and cost escalation and delays in construction; (iii) operating risk due to higher operating costs and maintenance costs; (iv) financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold; (v) financial risks arising from exchange rate volatility, transaction costs and financing costs (as cited in Grimsey & Lewis 2017); and (vi) regulatory/political risks due to legal changes and unsupportive government policies

The actual technical/engineering method of service delivery can be matters entirely of the private sector (Lewis 2001). Technical risk, due to the technology adopted not being mature, disastrous engineering and design failures as well as construction risk, can be sources of delays, cost overrun (Ng, A & Loosemore 2007) and make the projects unable to meet the required specifications (Ke et al. 2010). Successful completion of construction is paramount to the overall success of the PPP project. Operating risks are comprised of increases in operating and maintenance costs (Cabrera, Suárez-Alemán & Trujillo 2015). Operating risks relate to production and operation procedures, availability and quality of inputs, quality and efficiency of project management, and maintenance and upgrade requirements. If the facility cannot meet the Key Performance Indicators (KPIs), the consequence can be that the costs of operating the facility will exceed projections and therefore reduce projected returns (Grimsey, Darrin & Lewis, Mervyn K 2005).

The financial meltdown and shortage on credit availability have turned the financial risk into one of the most relevant challenges that current PPP projects face (Cruz & Marques 2013a). Financial risks can arise from many sources such as inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold. These risks can influence an increase in estimated cost and reduction in expected revenue of projects. One source of financial risks comes from unreasonable and optimistic forecasts. The excess optimism about the outcomes of planned actions leads to the fact that the revenue collection was much lower than originally expected (Soomro & Zhang 2015b). The tendency of optimism in forecasting is not only be found in road sector but also water supply and health sectors (Baeza & Vassallo 2010). Marques and Berg (2010) argued that forecasts on drinking water consumption are consistently towards greater volumes in order to increase the financial viability of the projects. In the health sector, demand forecasting is even more difficult, especially forecasting the number of patients searching for health services, and types of patients including their disease profile (Cruz & Marques 2013a). This is an almost impossible task due to the number and complexity of the explanatory variables.

Political risk has a significant impact on PPP projects. For BOT projects, political is really the most difficult risk element (Tam 1999). Time and cost overruns in the construction stage can be resulted from political risks such as changes in law or delays in approval. Many projects were ended by changes in government and political systems. The 2.015 MW *Dabhol* Power Plant PPP project in India, which was forced to stop by the newly elected government, is one of many examples (Ng, A & Loosemore 2007).

2.4.1.9 Innovation in PPP

Innovation is without doubt a success factor in winning the project (Jefferies 2006; Jefferies, Gameson & Rowlinson 2002). Innovation can be in technology (Tiong 1996), management and operation (Johnston, F 2004). In developed countries, innovation is a factor that makes the technical proposal more attractive, hence increasing the probability to win the bidding (Salman, Skibniewski & Basha 2007). Through innovation, the quality and efficiency of infrastructure services and facilitates can improve (Carbonara & Pellegrino 2018).

2.4.1.10 Government provides guarantees

The government providing guarantees is considered as an important critical success factor as a guarantee from the government can lower this risk and raise the level of confidence of investors and lenders (Li et al. 2005a). This also means the guarantee of multi-benefits objectives and political support (Babatunde, Opawole & Emmanuel Akinsiku 2012) and help countries to reduce risks associated with negative factors (Dikmen, Birgonul & Atasoy 2009). In addition, for projects with significant economic value and political and environmental goals but that are not financially feasible, the guarantees will not only help projects become financially viable (Zhang, Xueqing 2005a) but also encourage private parties to commit and be more involved in the project (Almarri & Abu-Hijleh 2017).

2.4.1.11 Project design and construction complexity

The project complexity including the complexity in project design and construction stage along with the complexity in the operation and/or management stage involves more functions and more activities. The complexity is essential in choosing the procurement method (Skitmore & Marsden 1988). The Australian Government (2008b) also advises decision makers that they should consider the complexity as factors that may affect the choice of suitable PPP schemes. Project complexity can be the source of delays in construction and consequently results in servicing the debt (Ng, A & Loosemore 2007).

The list of selection criteria that governs the suitable PPP scheme selection, which has been obtained from the literature, is listed in Table 2-7 as follows:

Table 2-7: Literature related to the selection criteria of PPP scheme

Selection criteria of PPP scheme	Authors
Stable politics and government system	Chan et al. (2010); Li et al. (2005); Ng et al. (2012); Jefferies (2006); Ozdoganm and Talat Birgonul (2000); Babatunde et al. (2012); Qiao et al. (2001)
Stable macro-economic during the project life cycle	Chan et al. (2010); Li et al. (2005)
Supportive political climate for PPP projects	Li et al. (2005); Qiao et al. (2001); Ng et al. (2012)
Community/Public support to PPP projects	Jefferies et al. (2002); Li et al. (2005); Salman et al. (2007)
Mature legal system required to support PPP procurements	Jefferies et al. (2002); Li et al. (2005)
Government experience in O&M	Ozdoganm and Talat Birgonul (2000); Ng, ST, Wong and Wong (2012); Li et al. (2005)
Government experience in Project Management (PM)	
The project scale and the amount of total investment	Cuttaree et al. (2009)
Financial attraction	Ng et al. (2012); Qiao et al. (2001); Zhang (2005); Jefferies et al. (2002)
Financial viability	
Technical risk due to engineering and design failures	Grimsey and Lewis (2002, 2017) Farquharson et al. (2011)
Construction risk, due to faulty construction techniques and cost escalation and delays in construction stage	
Operating risk due to higher operating costs and maintenance costs	
Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold leading to revenue deficiency	
Financial risks arising from exchange rate volatility, transaction costs and financing costs	

Selection criteria of PPP scheme	Authors
Regulatory/Political risks due to legal changes and unsupportive government policies	
Innovation in technology	Jefferies et al. (2002); Ng et al. (2012); Qiao et al. (2001) Tiong (1996); Jefferies (2006); Salman et al. (2007)
Innovation in management	
Innovation in operation	
Government provides guarantees against financial risks, political/legal risk	Li et al. (2005); Dikmen et al. (2009); Babatunde et al. (2012)
Project design and construction complexity	Australian Government (2008); Jefferies et al. (2002); Skitmore and Marsden (1988)
The complexity in the operation and/or maintenance stage	
Type of asset: Economic infrastructure	Grimsey and Lewis (2009); Grimsey and Lewis (2017)
Type of asset: Social infrastructure	

2.4.2 Summary/research gap

PPP scheme selection, as a key task in the preparation procedure, is vital to yield positive results during project operation. In order to decide which procurement method is best suited, a comparison of the procurement options with careful consideration of selection criteria is undertaken in the early stages of the procurement process (Regan, Smith & Love 2015). A comprehensive list of the criteria affecting the selection of PPP scheme has yet to be fully identified in this study through a systematic research approach.

2.5 DECISION-MAKING IN PPPS

2.5.1 Decision support tools in PPPs

The decision-making in PPPs is '*extremely complex*' and decisions have to be linked to various stakeholders, aspects and networks (Klijn & Teisman 2003:138). In PPPs, different types of decisions have been made, for instance, selecting the project to be implemented, screening the project as a PPP, selecting an appropriate scheme or selecting the right concessionaire and so on. Decisions can range from very simple to very complicated and challenging ones with a variety of considerations for numerous conditions. Decisions were often made on a case-by-case basis with no systematic approach (Australian Government 2008a). Various decision-making aspects have been observed in literature, namely tender evaluation, concessionaire selection and project delivery model. Regarding tender evaluation, methods that are currently in use include: the simple scoring method, Net Present Value (NPV) method, multi-attribute analysis, the Kepner-Tregoe decision analysis technique, the two-envelope method, NPV method plus scoring method, and binary method plus NPV method (Kwak, Chih & Ibbs 2009; Zhang, Xueqing 2004). The binary method, simple scoring method and two-envelope method may be suitable techniques for tender evaluation of small and simple PPP projects (Zhang, Xueqing 2004); whilst, the NPV and multi-attribute analysis methods are the two most commonly used and most recommended by experts and experienced practitioners for complex project (Zhang, Xueqing 2006). The Hong Kong government uses the Kepner-Tregoe decision analysis technique to select the concessionaire for its BOT projects (Zhang, XQ et al. 2002). Xie and Thomas Ng (2013) proposed the use of Bayesian network technique Decision Support to consider the feasibility of the scheme both from the economical and non-economical perspectives. The TOPSIS model is widely used in performance and risk evaluation in solving a MCDM problems (Liu, J & Wei 2018). As mentioned previously, a number of studies have considered project delivery selection, but these are mainly traditional procurements with no-to-little reference to PPPs. Hence, a research on decision-making framework on PPP scheme selection is crucial.

2.5.2 Decision-making in PPPs

Regan, Smith and Love (2014) affirmed that ‘the systematic evaluation of the procurement options available’ is the first important factor to the operation of a PPP. In the PPP preparation process , it is important to be very clear about why the government is looking to partner with the private sector, what forms of PPP it has in mind, and how it should articulate this complex concept (World Bank 2008). The scheme selection analysis takes into account many key elements such as project objectives, policy context, financial viability, risk analysis etc.; this is to answer the question of which model will best achieve requirements and objectives and reduces risks (Australian Government 2008b).

At the beginning, all available data related to the potential project is collected for further analysis. The number of potential PPP projects is chosen from the broader public investment plan. Project selection must reflect pre-identified objectives that ensure projects only proceed if they provide the greatest net benefit to stakeholders (Queensland Government 2015). The decision on investment must meet its requirements of equity, efficiency and accountability (HM Treasury 2003). Qualitative, high-level screening is useful as an initial test for PPP suitability (WB 2017). A simple decision can be made by assessing the ‘must’ criteria that helps to eliminate alternatives by a ‘Yes/No’ or ‘Go/No-Go’ judgement (Zhang, Xueqing 2004). Some governments assess the initial PPP screening by defining the minimum amount of investment for a project. In Australia, a project with total investment of more than AU$50 million can be triggered for PPP (Australian Government 2015), while in Canada, the minimum value of a project that is viable for PPP was CND$50 million (Whiteside 2013) and now is CND100 million (The Canadian Council for PPPs 2015). In Vietnam, there is no minimum requirement of the investment for a PPP project. Candidate PPP projects that pass the initial qualitative screening can go through a more quantitative, detailed evaluation (U.S. Department of Transportation 2016). Comparison and selection of PPP options can be made by comparing the suitability of implementing the project under PPP with various procurement options (for instance alliancing, design-construct and maintain). A review of the international evidence by Regan, Smith and Love (2011) suggests that in evaluating PPP options, the use of the Public Sector Comparator (PSC) with integrated V*f*M evaluation criteria is achieving improved procurement outcomes for government service (Quiggin 2004). The PSC is the assumed cost of developing the project through traditional procurement (Cruz & Marques 2012). The costs of delivering a project under PPP are then compared with the PSC. If the costs of the desired project are lower than the PSC, then the project will be implemented under PPP and is expected to provide V*f*M. Once a decision is made to go with the PPP option, another question is how the project can be delivered most efficiently (Poole, Toohey & Harris 2014).

The availability of diversified schemes of PPPs has made it possible to develop partnerships for almost any type of project (Zhang, Xueqing & Ali Soomro 2016). An appropriate scheme is a key project success because it defines the overall project delivery strategy (Al Khalil 2002). The choice of PPP scheme is a critical step in the project and in the development of the procurement strategy (Australian Government 2008b). Comparisons of different PPP scheme options are carried out at the early stage of the procurement process as part of the Business Case Analysis (Regan, Smith & Love 2014). However, a scheme selection becomes more challenging when considering a diverse continuum of procurement options, client characteristics and requirements, project characteristics and external conditions (Kumaraswamy & Dissanayaka 2001). To maximise the benefits of each party in the partnership, each player involved in the contract needs to select the most appropriate type of scheme that fits the goals and resources. For doing this, adequate knowledge of the characteristics, strengths and weaknesses of the schemes is essential (Sebastian & van Gelderen 2007).

In order to select the right PPP scheme, appropriateness, cost, and the ability to effectively implement and manage PPP projects should be of paramount consideration. This is to ensure that a PPP project enhances the public benefit, and the degree of private involvement needs to be carefully matched to the objectives and needs of the project and the community (EC 2003). PPP scheme selection should comprise an early assessment of many features, including but not limited to payment structure; what the government or the users can afford to pay (and when); service level, and structure; and what associated risks the private sector might be prepared to accept (Farquharson et al. 2011).

2.5.3 Summary/research gap

The review under this section commenced with decision-making in PPPs in general, and selection of PPP procurement option in particular. Various types of PPPs decisions have been made and decision-making in PPPs is an intricate process. In terms of selection of procurement method, research has mostly focused on traditional procurement methods but neglected PPPs. While the selection of PPP scheme has been vitally significant, few research studies focus on how to select an appropriate or optimal option.

Efforts have been made to sort out how different PPP schemes might fit in the context of responsibility for service provision and control of assets but there is no clear consensus and even more confusion across national and regional boundaries, and between different sectors (Delmon 2010). To select the most appropriate type of scheme that fits the goals and resources, ample knowledge of the features, strengths and weaknesses of the schemes is critical (Sebastian & van Gelderen 2007). Accordingly, a decision-making framework is proposed to be developed.

2.6 PPP IN VIETNAM

2.6.1 Definition and characteristics of PPP in Vietnam

Although BOT has been adopted since 1992 to attract foreign investors, the term 'Public-Private Partnership' was officially introduced in 2010. The current definition of PPP regulated by the Government of Vietnam (GoV) in Decree 63/2018 (*'Decree 63'*) on 'investment in the form of PPP' is as follows:

> *'PPP is any form of investment on the basis of a contract between an Authorized State Agency (ASA) and an investor or an SPV to build, renovate, operate and manage infrastructure and public service projects' (GoV 2018).*

In this definition, key features of PPP in Vietnam are:

Firstly, it is a legal contract agreement signed by the public and the private sectors. The public party comprises the ASAs, which are Ministries and People's Committees of provinces. The ASAs, within their functions, tasks and powers, have the authority to sign the project contracts and to follow the rights and obligations agreed upon in the project contract with investors or projects designated by the competent authority (Decree 63, Art. 08). The private party is an investor or an SPV. Investor means any organisation or individual that invests in a project according to the regulations, or a joint venture of investors to carry out a PPP project. SPV means an enterprise incorporated by an investor or a joint venture of investors to undertake a PPP project (Decree 63, Art. 01).

Secondly, the definition mentioned that the responsibility of the private party would be to build or renovate, operate and manage the infrastructure. However, the schemes are regulated in the Decree 63 including O&M and BT scheme. The O&M contract is for operation and maintenance stage only. The BT contract indicates that after constructing the facility, the asset will be transferred back to the government. The duration of a BT contract often ranges from three to five years and does not include the operating stage. In the Vietnamese context, BT is still considered as a PPP scheme; however, the world practices do not consider BT as PPP, due to the short nature of the contract.

Thirdly, the definition mentions about infrastructure and public service. As regulated in Law No. 15/2017/QH14 on 'Management and use of public property', public property is constituted as infrastructural property that serves national and public interests. Hence, the infrastructure and public service project that is defined in the definition is understood as public infrastructure and its related service.

2.6.2 Legal framework for PPP Projects in Vietnam

Vietnam is a socialist republic country that is based on the civil law system with some major modifications from Marxist-Leninist ideology. The legal framework in Vietnam comprises of multiple layers including constitution, laws, ordinances, decisions and decrees and so on. The National Assembly of Vietnam (NAV) is the highest-level representative body of the people, which has the power to make, amend and promulgate laws and resolutions. In 2015, the NAV passed Law No. 80/2015/QH13 on the promulgation of legal documents, which came into effect in July 2016. Types of documents and corresponding agencies are presented in Table 2-8.

Table 2-8: Vietnam's system of legal documents

Kinds of documents	Promulgating agencies
Constitution	National Assembly
Code/Law, Resolution	
Ordinance, Resolution	Standing Committee of the National Assembly
Order, Decision	President
Decree	Government, or between the Government and Management Board of Central Committee of Vietnamese Fatherland Front
Decision	Prime Minister
Resolution	Judge Council of the People's Supreme Court
Circular	Executive judge of the People's Supreme Court, the Chief Procurator of the Supreme People's Procuracy, Ministers, Heads of ministerial agencies
Resolution	The People's Councils of central-affiliated cities and provinces
Decision	The People's Committees of provinces
Legal normative documents	Local governments in administrative - economic units.
Resolution	The People's Councils of all level
Decision	The People's Committees of all level

Source: Law 80/2015- The National Assembly of Vietnam (2015)

PPPs in Vietnam are directly managed under series of Decrees such as Decree 63: Decree on investment in the form of PPPs (GoV 2018) and Decree 30: Guidelines for some articles on investor selection of the Law on Bidding (GoV 2015) and indirectly under the governance of broader laws, including the Law on Public Debt Management, Law on Public Investment, Law on Bidding, Law on Investment, Law on Construction, Law on Enterprise, and other related laws and decrees.

Decrees, promulgated by the GoV, prescribe specific guidelines for articles, clauses, and paragraphs assigned in the laws and resolutions of the NAV (NAV 2015). However, laws take precedence over decrees, which conflict with restrictions under the laws. The same content, but subject to the adjustment of many laws, will increase the complexity and risks in the implementation of specific projects and the results reduce the attractiveness of investment under the PPP model.

An investigation of the current legal framework for PPP projects in Vietnam by Nguyen, HV (2017) shows that although the fundamentals of the framework are in place, Vietnam lacks a mature legislation. There are also inadequate regulations together with comprehensive guidelines that help to assess the V*f*M and avoid failures. The PPP regulation appears to be supportive to the mobilisation of private investment for PPP projects, however, there has been very limited success in planning and implementing PPP transactions with PPP framework challenges (ABD 2012). The government seeks to introduce new project evaluation concepts, new project contract and financing structures, and a greater focus on competitive bidding and more certainty in the overall project development process (Boots 2015). Despite the availability of eight PPP schemes, only BOT, BT and BOO have been implemented in Vietnam (ADB 2017; MPI 2018). Private sectors have criticised that there is an absence of formal guidance on the selection of PPP schemes. Therefore, it is important to consider which PPP scheme will best balance the control of project cost and risk in achieving project objectives and outcomes. The decision-making framework that assists the decision-maker to choose the right PPP scheme is essential and vital in Vietnam.

2.6.2.1 Previous PPP regulations

Since 1992, GoV introduced BOT in the amended Foreign Investment Law for the first time in the history of PPP legislation to help build essential public projects (Ohya, Le Bang & Van Trang 2019). Later, on November 23, 1993, GoV issued Decree No. 87-CP permitting privately owned and operated infrastructure projects through a BOT investment form. GoV provided preferential treatment and an investment guarantee to encourage all foreign organisations and individuals to invest capital and technology. By the time when the Asian currency crisis started in 1997, GoV promulgated Decree 77-CP dated 18 June 1997 '*the Regulation on Investment in the form of BOT Contract applicable to the domestic investment*' for full participation of domestic investors. At this time, PPP projects of domestic investors were mainly established by the SOEs with the aim to implement such projects without state budget allocation (Ohya, Le Bang & Van Trang 2019).

In 2009, GoV issued Decree No. 108/2009 (*'Decree 108'*) that introduced BTO and BT to the existing BOT. This decree was hoped for encouraging competitive bidding and attracting private investors. Decision 71/2010/QD-Ttg, issued by the Prime Minister, regulated on Pilot Investment using PPP model and co-existed with Decree 108. In April 2011, Decree 24/2011/ND-CP ('*Decree 24*') modified some articles of Decree 108, and expanded the applicability to additional sectors: health, education and training, culture, sports, and facilities for state entities. Despite these ambitious goals, the BOT regulations have failed to attract foreign investment (ADB 2012).

The co-existence of Decision 71 and Decree 108 confused investors and could only be solved by the issuance of Decree 15/2015/ND-CP (*'Decree 15')* on Feb 14, 2015 and Decree 30/2015/ND-CP (*'Decree 30')* on March 17, 2015. Decree 15 regulates on the investment in the form of PPPs and Decree 30 on investor selection. These PPP regulations appear to be closer to international practice and supportive to the mobilisation of private investment for PPP projects. Many practitioners and law reviewers have found that some areas of the legal framework on PPPs are incomplete and overlap (Benson et al. 2018). Conflict and restriction, owing to the lack of guidelines, appears during PPP impletion. Many implementing circulars and guidelines for these decrees are needed to be developed for proper PPP implementation.

2.6.2.2 Current PPP regulations

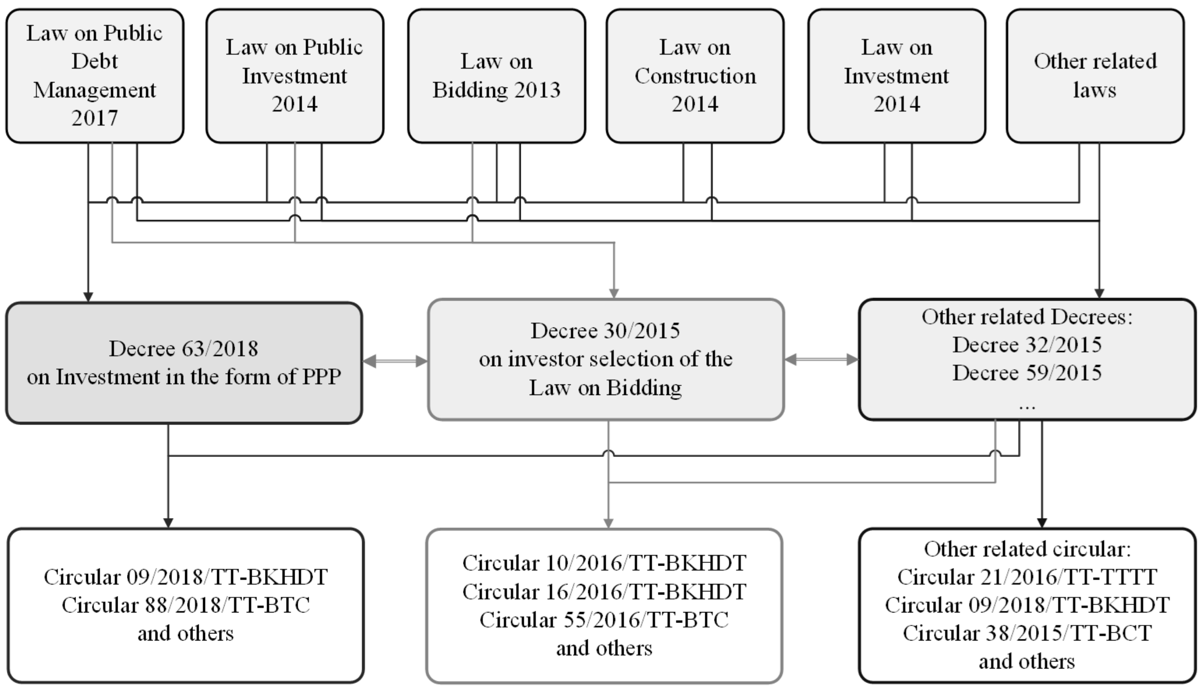


Figure 2-10: Legal and regulatory framework for PPPs in Vietnam

Given the shortcomings of Decree 15 on investment under PPP, on May 2018, GoV issued the new Decree 63/2018/ND-CP ('Decree 63') replacing the old Decree 15 to eliminate bottlenecks in the PPP execution process. Decree 30 and Decree 63 are currently in effect for PPP regulations in Vietnam. In order to simplify the procedure of PPP implementation, Decree 63 promulgates that investors are no longer required to obtain an investment registration certificate. Besides, Decree 63 increases the minimum equity requirement of private investors from 15% in Decree 15 to 20% for PPP projects with total investment capital of up to VND 1,500 billion (about USD66 million). This article is expected to assure the financial capabilities of the private party and the viability of the PPP projects. Moreover, the private investors are only allowed to transfer a part or all of the rights and obligations under the PPP contract upon completion of construction works or commencement of the operation of such projects (Art. 43); and the transferee(s) must satisfy the financial and managerial capability and other requirements.

Two types of PPP proposal are solicited and unsolicited. The solicited proposals are proposed by Ministries, Provincial People's committees and Regulatory bodies. Unsolicited proposals are applied for projects proposed by the investors. Both of them must include the required information such as the necessity of investment, the advantages of implementing the project under public-private partnership investment form compared to other investment forms, and the [proposed] type of project contracts (for instance BOT, BOO or BLT).

To clarify Decree 63, MPI promulgates a Circular 09/2018/BKHDT providing guidance on pre-feasibility study reports and feasibility study reports on investment project under form of PPP. The most suitable PPP scheme in the project proposal must be determined based on interpretations of technical plans, demand projections, financial plans and many other criteria (MPI 2018). It is important to note that there is currently no framework or guidance, to guide both public and private investors to choose the appropriate types of PPP schemes.

Another issue of doing PPPs in Vietnam is the complicated management system. PPP projects related to transportation are under management of the Ministry of Transport (MOT). A water and waste system involves the Ministry of Construction (MOC), the Ministry of Agriculture and Rural Development, the Ministry of Natural Resources and Environment and the Ministry of Health. Power plant projects (including thermal power, solar and wind turbine power plant) come under the purview of the Ministry of Industry and Trade, and Ministry of Information and Communications. Furthermore, all projects that use public debt will be under the control of MOF. An example of a building a new road project is provided to illustrate how a project is affected by different laws. First, to implement a project under PPP, the investor must establish a new project company following the procedures established in the Law on Enterprises and the Law on Investment (WB 2013). The approval to invest and build a new toll road project is managed by MPI, and then the implementation is supervised by MOT. Then the maintenance of the road is the responsibility of Vietnam Roads Administration and finally, the reimbursement is under MOF responsibility.

2.6.2.3 Related laws on PPP

The Law on Public Debt Management No. 20/2017/QH14 relates to PPP projects in cases where loans for the project are guaranteed by the government. The guarantees are used to encourage private investors to finance new infrastructure that can allow the government to get the infrastructure built without paying anything up front, and to benefit from the skill and expertise of the private sector (Irwin 2007). 'Public debts' comprise government debts, sovereign-guaranteed debts, and provincial debts. Any debts that arise from a loan borrowed by an enterprise or a bank for social policies and guaranteed by the Government are called 'sovereign-guaranteed debt' (Law 20/2017). Most of the PPP projects in Vietnam used loans that are guaranteed by the government (Nguyen, HV 2017). If the lenders fail to pay the debt on schedule, the government shall take the responsibility to pay for the debts.

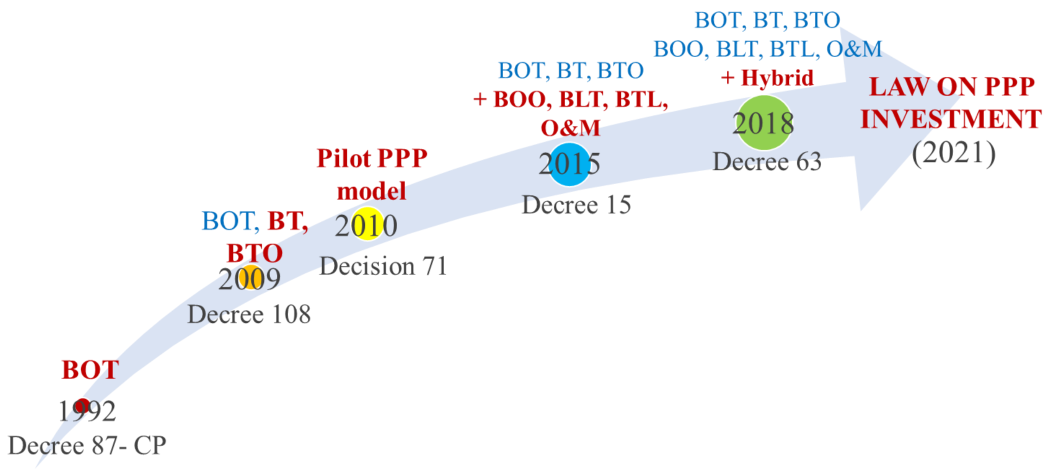
Law of Bidding No. 43/2013/QH13: In order to contribute to improving the PPP legal framework, Bidding Law has supplemented the regulations on selecting investors to implement PPP projects into the scope of the Law. It is hoped that the selection procedure is fair, transparent, competitive and economically effective.

Law on Public Investment No. 49/2014/QH13: The participation of the state in PPP projects is one of the contents that helps to increase the feasibility plus shows the commitment of the government when implementing the PPP. Therefore, in order to have an effective implementation mechanism, the Public Investment Law No. 49/2014/QH13 stipulates a number of issues related to PPP projects. Accordingly, state investment in PPP projects is considered one of the public investment areas and investment in PPP form is one of the recommended principles in public investment management. The conditions for deciding the policy of investment in the project program are priorities for implementing PPP projects.

Law on Investment No. 67/2014/QH13: Investment Law regulates investment in PPP form, in which investors and project enterprises sign PPP contracts with competent state agencies to implement new or renovated investment projects, upgrading, expanding, managing and operating infrastructure works or providing public services.

2.6.3 PPP types in Vietnam

BOT is first officially introduced in Vietnam in 1992. Then in 2009, Decree 108 introduced BTO, BT to the existing BOT. In 2015, four new types of PPP scheme that were introduced and regulated in Decree 15 are BOO, BTL, BLT and O&M. At present, Decree 63 recognises hybrid contracts as another type of PPP scheme, which can be a combination of seven existing types of PPP scheme under Decree 15. In Vietnam, several major infrastructure projects have been delivered by the BOT and BT models and no new PPP projects have yet been recorded under new schemes of Decree 15 framework (ADB 2017).



	1992	2009	2015	2018
Number of PPP types defined in the PPP regulations	1	3	7	8

Figure 2-11: Development of PPP schemes in the legislation system in Vietnam

Considering all definitions of different PPP schemes provided in Decree 63, the definitions focus on the fact that it is a type of contract between an ASA and investor/SPV for a specified period of time. Other wordings provide very brief information on the responsibility of the private party including build, operate and transfer at some specified time. Other features such as duration of the contract, financing responsibility, ownerships of the facility, etc. are not mentioned elsewhere. To illustrate, the study provides three of the definitions as follows:

> *'BOT contract means a type of contract to build an infrastructure project between an ASA and an investor or SPV. After completion of the works, the investor or SPV shall be entitled to operate it for a specified period of time. At the end of the contract, the investor or SPV shall transfer the asset to the ASA.'*

> *'BLT contract means a type of contract to build an infrastructure project between an ASA and an investor or SPV. After completion of the works, the investor shall have the right to provide services based on operation of such project for a specified period of time. The ASA shall lease and make payment for the investor or SPV's services. When the lease term expires, such project shall be transferred to the ASA.'*

> *'O&M contract means a type of contract to operate in whole or in part of a project between an ASA and an investor or SPV for a specified period of time.'*

2.6.4 PPP procurement process

The process of investment under the form of PPPs comprises of (i) project preparation; (ii) list of projects implemented under PPP; (iii) approval of project proposal and project feasibility study; (iv) tender evaluation; (v) contract and project permit; and (vi) project implementation. The authorized state agency (i.e. the Ministry of Transport for expressway development project) is primarily responsible for the entire procedure from project preparation to project contract. The Prime Minister's approval is needed for projects costing more than VND 1.5 trillion at the stage of preparation of a feasibility study report. Ministry of Planning and Investment (MPI) is liable for the issuance of Investment Certificate (IC) to investors/project companies after a project contract is made. However, the procedures for granting ICs and establishment of project companies also encountered some difficulties due to the regulations in this matter, not taking into account the differences between PPP schemes (Dinh, TT & Pham 2015). The procedure and requirements (who and what) for the PPP project implementation is illustrated Figure 2-12.

2.6.5 Risks in doing PPP in Vietnam

Many PPP projects in Vietnam have been abandoned or cancelled owing to a lack of appropriate risk allocation mechanisms (Tang 2010). Among risks associated with PPP projects in Vietnam, the study of To and Ozawa (2008) shows that doing PPP is quite risky. Risks involved in large infrastructure PPP projects are categorised into five general groups, as follows (JICA study 2000):

- Project preparation, design and construction risks
- Project finance risks
- Market Risks
- O&M stage risks
- Project external Risks

2.6.5.1 Project preparation, design and construction risks

Land acquisition risks including delay in completing the land requisition, frequent changes in compensation policy, large cost of acquisition compensation, poor management, lack of unified standards in compensation and resettlement price regulations, the opposition to land resettlement and irrational compensation by community, etc. are the key risks (Vu et al. 2016). These risks can lead to cost overrun, especially when the cost is borne by the private sector. The implementation of land acquisition (typically by the local government) usually takes time due to compensation and resettlement plan negotiation congestions (Vu, TH 2017). Land acquisition could also lead to delays in construction and significant increase in cost for the private investor and was the most critical risk in doing PPP in Vietnam (Nguyen, A, Mollik & Chih 2018). This risk occurred in many projects in Vietnam such as *Binh Trieu* II bridge, *Yen Lenh* Bridge, BOT *My Phuoc – Tan Van*, and *Co May* Bridge (Nguyen, A, Mollik & Chih 2018)..

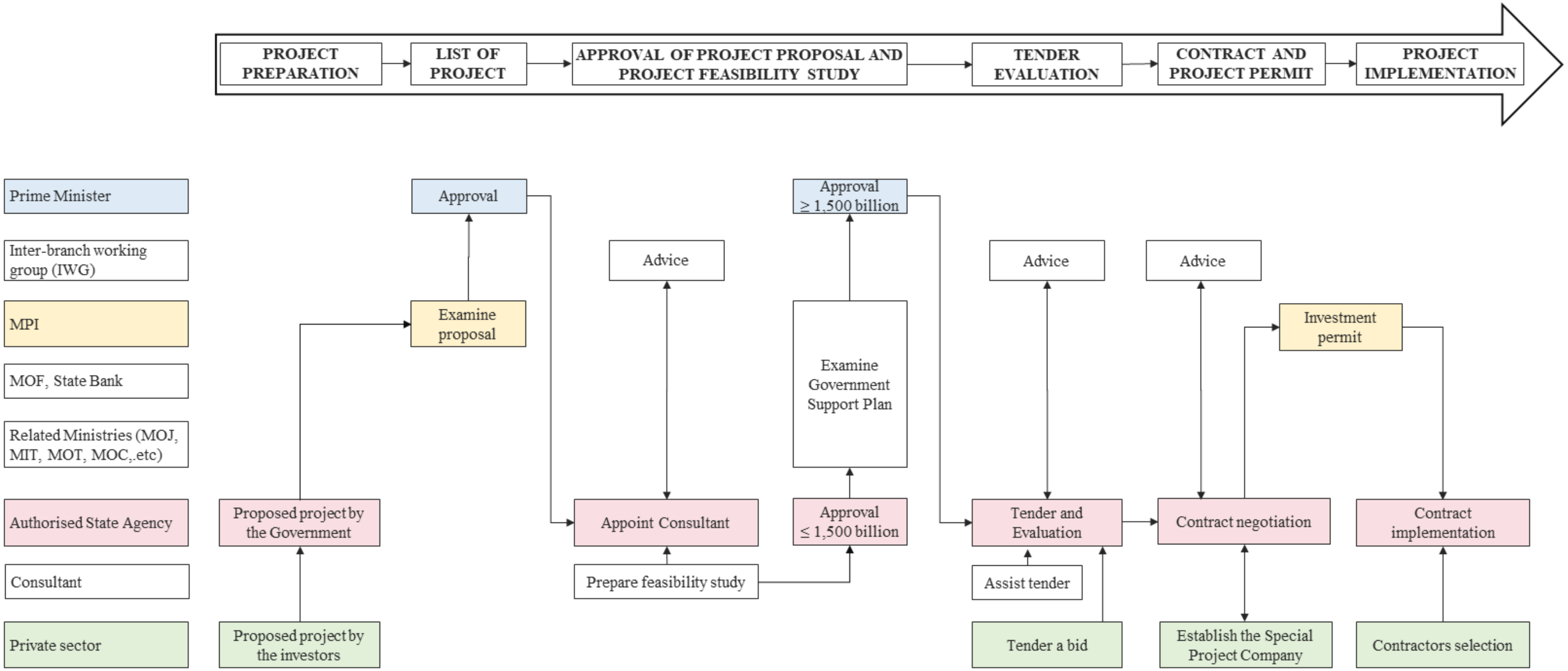


Figure 2-12: PPP procurement procedure in Vietnam (adapted from JICA Study)

Environment and social risk: The current conditions of the environment at the project site can affect the project. This is also about fulfilling Environment Impact Assess (EIA) requirements and other related guidelines involved to comply with regulations set by the government as well as guidelines of contributors and other related stakeholders. The procedures on obtaining appropriate approvals could trigger delays or sometimes require changes to the plan of the project. The potential risk is the damage of the project to the environment or local communities.

Technical risk: The risk associated with the inadequate design required for the project in compliance with output specifications, legal requirements and standards, as well as some of the engineering areas of the project (JICA study 2000). Public authority requests to change the original approved design as per contract and improper technical requirements and specifications as provided in bidding documents, are the second and third critical risk that affect the financial viability of a PPP project (Nguyen, A, Mollik & Chih 2018). In general, structures such as tunnels and bridges require extra attention, because there are many more potential technical factors that can cause delays in these areas.

Construction risk results from faulty construction techniques, cost escalation and delays in construction. Land acquisition and technical risk can be reasons to cost escalation and delay, then consequently will lead to revenue reduction (Nguyen, A, Mollik & Chih 2018).

2.6.5.2 Project finance risks

Finance risks: PPP projects in Vietnam may stall due to investor's difficulty in reaching financial closure with the lender. Concession agreement maybe signed but the investor may fail to convince the lender on project profile and security aspects. For example, the USD750 million expressway project, *Dau Giay-Phan Thiet*, was halted over financing uncertainties.

2.6.5.3 Market Risks

Traffic demand risk: Traffic demand risk occurs when the actual demand is lower than the forecast levels of traffic under an existing network and tariff scenario. This is also a function of how to make assumptions on the future traffic needs of industrial users, as well as general road users along the alignment. The *Phu My* Bridge Project had failed to recoup investment capital due to lower than the forecasted number of users.

Tariff risk: Tariff levels and adjustments have extremely high sensitivity to the Internal Rate of Return (IRR) of the project. Therefore, if tariff adjustments are not made according to an agreed scenario, this will have enormous consequences on the revenue and profitability of the project. Investors and lenders are extremely cautious about public infrastructure, especially when it involves tariff risks, which are beyond their control.

Network Risk: Infrastructure is a network business. This project can be a supplement or compete one with each other. Therefore, scenario changes to the network plan can significantly affect the traffic for a given expressway. In general, the network plans are written in the BOT contract, with the line ministry that will be responsible for the plans of other network nodes.

2.6.5.4 O&M stage risks

Project completion risk: Completion risks have happened in many projects in Vietnam, namely *Yen Lenh* Bridge, *Phu My* Bridge, and National Highway 1A: *An Suong – An Lac*. Quality, cost, delivery and safety features of the facility require tight control under the construction and supervision process. If any of these criteria is off track, risks will be posed to the completion of the project.

O&M risks: after the facility construction is completed and the operation commences, several O&M risks may occur, including operator inability (*Co May* Bridge), early termination of concession by the concessionaire (*Binh Trieu* II Bridge, National Highway 13), maintenance risk and availability risk. Maintenance risk refers to the risk of improper maintenance, resulting in under performance and higher costs for maintenance. Availability risk is the risk that the infrastructure is not available to use and/or not meeting the quality or expected level of performance.

2.6.5.5 Project External Risks

Foreign exchange (FX) risk: The revenue of a PPP project in Vietnam is based on the local currency tariff. Overseas investors and lenders would want to convert local currency to hard currency and send across borders. Therefore, for overseas investors and lenders, the FX risk will be an important element to consider. In general, long-term movement of FX rates should be driven by the long-term outlook of economic fundamentals of the country. FX risk cannot be managed and therefore it is a matter of risk allocation and hedging between investors, lenders and the government.

Interest rate risk: The project's cost of debt will be subject to changes in interest rate, for the portion that is linked to market interest rate movements. Investors will need to take this into account when they plan for equity return. One example of a project that was affected by interest rate risk is *Yen Lenh* Bridge.

Regulatory Risk: Every PPP project is implemented under various legal structures. Changes in these regulations can sometimes negatively affect the profitability of the project. Hence, investors will typically discuss this matter in detail with the local government.

Renegotiation and early termination risk: This risk is associated with the chance that the project is being terminated before the end of the concession period. Others subsequent risks my follow, such as huge compensation to the private party, additional financial cost arbitration fees, and intervention or suspension of public services (HM Treasury 2007).

Unsupportive government policy: This risk has a negative impact on the project. An example is the lack of commitment on the part of the government that builds connecting roads and the unwillingness of *Saigon Port*, situated in the centre of *Ho Chi Minh* City, to relocate to *Thi Vai* and *Cai Mep* port. The main reason behind this is perhaps the lack of interest from foreign investors and the aforementioned projects are deferred indefinitely.

Political risk/Force majeure: These risks are related to labour disputes, delay in project approvals and permits, natural disasters and other unforeseen events that may negatively affect the project. This risk can occur in any type of infrastructure project.

2.6.6 Summary/research gap

PPPs are vital for infrastructure development in Vietnam, especially when the Official Development Aid (ODA) decreases in the future. BOT and BT were frequently adopted in Vietnam since their introduction in 1992. Regardless of the government's effort to attract private and foreign investment, many local investors still hesitate to take risks and limited records of PPP infrastructure projects involving international investors. The main reason is that Vietnam lacks a mature legislation system. The legal system for PPPs is not only too complicated but also overlaps. There are also inadequate regulations together with comprehensive guidelines that help to assess the V*f*M and choose an optimised PPP scheme. At the same time, many risks have been embedded during the implementation of PPPs in Vietnam; hence, investors are reluctant to invest. The definition of PPP as well as definitions of PPP schemes are too broad and cannot highlight the significant features of each type of PPP scheme. In return, investors found the selection of the suitable PP scheme is it too complicated and confusing. For this reason, formal guidance specific to the selection of a PPP scheme in Vietnam is essential, so needs to be developed.

2.7 RESEARCH GAPS AND SUMMARY

This chapter presented and comprehensively discussed the literature review related to the current research scope and objectives. The chapter focussed on key areas of study that are relevant to the current research. The entire review was divided into five main sections, including PPP principles and procedures, different types of PPP schemes, selection criteria for PPP schemes, PPP in Vietnam and decision-making in PPPs. All the reviewed topics actively contributed towards identifying the research gap and development of the research framework.

The chapter started with the review of PPP definitions from different organisations, countries and authors. It is widely acknowledged that no unique definition is provided. However, those definitions share similar features, in that a PPP is a cooperation between the public and the private sector, and there is a long-term relationship with funding that can come either partially or entirely from the private sector.

The public sector focuses on the objectives and goals of the project and monitoring the implementation, whilst the private sector focuses on the design, completion, implementation, and funding of the project. The risks are shared between public and private sector, and allocated to whichever party is better in managing the risk.

A PPP would not be the right solution for all the projects; however, PPPs are proven to be the best use of the expertise and innovation of the private sector when applied in appropriate circumstances. It can be argued that the determination of the most suitable PPP scheme and the degree of the private party involvement would minimise the risk and enhance the project success during the operational stage. Despite this, the confirmation from the literature review affirmed that the selection of an appropriate delivery model can minimise the risk of problems occurring later.

Based on the literature review, the following research gaps in the scope of existing research are identified and summarised as follows:

1. PPP schemes received different understanding by continents, countries and guidelines, and a systematic categorisation of PPP schemes has yet to be fully developed.
2. A comprehensive list of criteria for selection of the most suitable PPP scheme has yet to be consolidated.
3. Very few PPP schemes are currently being adopted in Vietnam and there is a lack of effective guidelines for practitioners to select a suitable PPP scheme.
4. Most studies have focused on how to select the best traditional procurement method while only seldom have studies focused on a PPP procurement method. Hence, there is a necessity to develop a robust decision-making tool for choosing the suitable PPP scheme.

The current research gaps, shown in Figure 2-13, were identified based on the observations of the current research gaps. An in-depth analysis of the literature review showed that studies have neglected the selection of the appropriate PPP scheme.

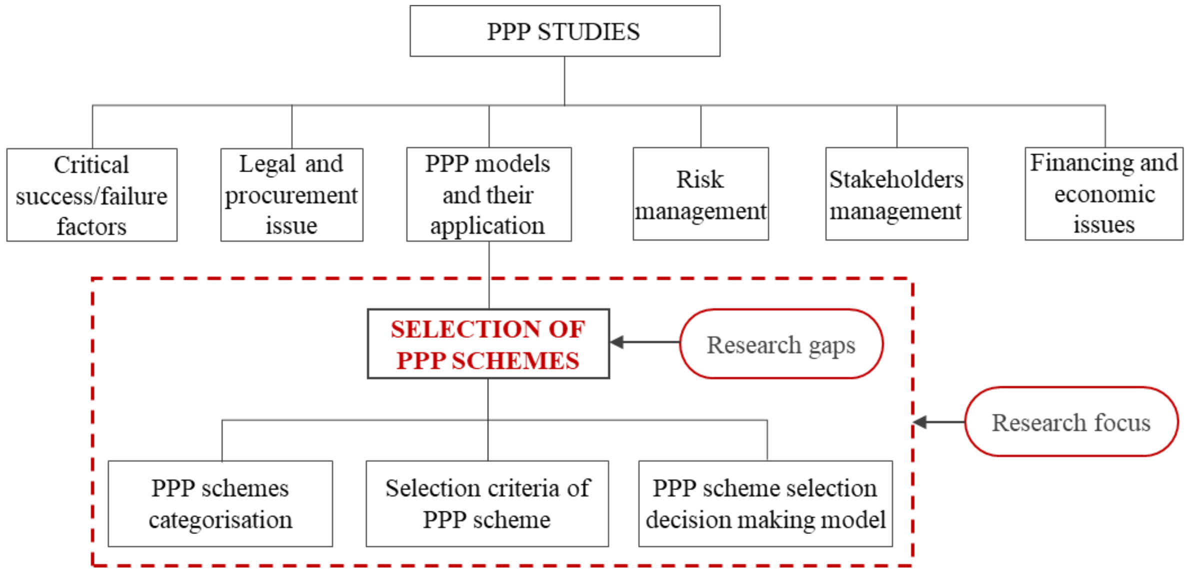


Figure 2-13: Research gap and focus

The results of the study are expected to contribute to the future development of a decision-making framework to assist public and private stakeholders in selecting a suitable PPP scheme for an infrastructure project. The next chapter will describe the research methods used in the development process of the decision-making framework for the selection of an appropriate PPP scheme in infrastructure development.

Chapter 3

RESEARCH METHODOLOGY DEVELOPMENT

3.1 INTRODUCTION

This chapter aims to explain the research design and methodology adopted in the research. In order to answer the research questions and research objectives described in Section 1.3, the appropriate research methods are carefully chosen and justified in this chapter. The research design comprises purpose of study, types of investigation, extent of researcher interference with the study, unit of and time horizon as in Section 3.2. The data collection methods and tools for data analysis are studied in Section 3.3, 3.4. Ethical issues are discussed in Section 3.5. Following, methodology of the decision analysis is examined in Section 3.6. The detailed research process in this research is described in Section 3.7.

3.2 RESEARCH DESIGN

The quality of the research can be reflected in an accurate research design and a systematic process (Sandanayake 2016). A research design is a process that provides an interconnection between data collection and data analysis (Bryman & Bell 2015). Based on the research objectives and questions, a particular research strategy was carefully chosen to answer the research questions.

The nature of this research is investigated in this section, as shown in Figure 3-1. The basic aspects of a research design include:

(i) research strategies

(ii) the extent of how the researchers interfere and control the research

(iii) study setting

(iv) unit of analysis, and

(v) duration of the study.

<Image removed due to copyright restrictions>

Source: Sekaran and Bougie (2016)

Figure 3-1: The research design

3.2.1 Research strategies

A research strategy is a plan to meet the research objectives (Sekaran & Bougie 2016). Bryman (2016) argued that a research design could be used to form three distinctive clusters: quantitative, qualitative and mixed method.

Qualitative research is ‘an empirical research where data are not in the form of numbers’ (Punch 2013:3) or is ‘an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem’ (Creswell & Creswell 2017). The advantages of qualitative methods are criticised because the researcher’s categories and theories may not reflect the understanding of the local constituencies. Moreover, the qualitative method generally takes more time to collect and analyse data, compared to quantitative study (Johnson & Onwuegbuzie 2004). Creswell and Creswell (2017) and Sekaran and Bougie (2016) categorised qualitative methods into different research strategies: narrative research, phenomenology, grounded theory, ethnography, and case studies.

Table 3-1: Justification of selection of qualitative data collection method

Research method	Justification for the usage	Applicability
Narrative research	a design of investigation from the humanities in which the researcher studies the lives of individuals and asks one or more individuals to provide stories about their	Applicable

Research method	Justification for the usage	Applicability
	lives, which are then restated by the researcher into a narrative chronology (Riessman 2008).	
Phenomenological research	a design of inquiry coming from philosophy and psychology in which the researcher describes the lived experiences of individuals about a phenomenon as described by participants.	Not applicable
Ethnography	a research strategy that has its roots in anthropology, where the researcher studies the shared patterns of behaviour, language and actions of an intact cultural group in a natural setting over a lengthy time (Sekaran & Bougie 2016)	Not applicable due the time constraints of the project and the nature of PPP projects
Grounded theory	a systematic set of procedures to develop an inductively derived theory from the data (Stauss & Corbin 1990)	Not applicable
Case studies	Case studies focus on collecting information about a specific object, event or activity, such as a particular business unit or organisation (Sekaran & Bougie 2016).	Not applicable

Among the available strategies, narrative research is chosen for this study as narrative research is a design of investigation from the humanities in which the researcher studies the lives of individuals and asks one or more individuals to provide stories about their lives, which are then restated by the researcher into a narrative chronology (Riessman 2008). Data for narrative analysis is often collected via interviews (Sekaran & Bougie 2016). In this study, narrative research is best suited for the scenarios as it involves asking many questions from practitioners to provide stories about their experience and knowledge related to PPP projects. The comprehensions of experts will help to obtain real-world realities which will be very beneficial in the model development.

On the other hand, quantitative research is ‘concerned with numerical measurement, statistics, and mathematical models to test hypotheses, and supports the view of the positivist paradigm that there is an objective reality that can be accessed and measured’ (Saunders, Lewis & Thornhill 2009), and ‘an approach for testing objective theories by examining the relationship among variables’ (Creswell & Creswell 2017). Quantitative research generates statistics through the use of large-scale survey research, using methods such as questionnaires or structured interviews (Dawson 2009). Quantitative analysis techniques such as graphs, charts and statistics help to explore, present, describe and examine relationships and trends within the data in which, before having been processed and analysed, the data have a little meaning (Saunders, Lewis & Thornhill 2009, p. 414). Quantitative research has some disadvantages such as it may not be able to consider the different levels and aspects of interactions sufficiently with a chance of missing important phenomena due to the focus on theory or hypothesis-testing (Gnisci, Bakeman & Quera 2008).

Table 3-2: Justification of selection of quantitative data collection method

Research method	Justification for the usage	Applicability
Experiment	adopted to study causal relationships between variables by studying the effect of changes in the independent variables on the dependent variables; however, its limitation is hard to apply to solve a management problem.	Not applicable
Survey	is a system for collecting information from or about people to describe, compare, or explain their knowledge, attitudes, and behaviour (Fink 2003) by asking exactly the same questions to the groups of people. Exploratory and descriptive research often uses survey to collect data.	Applicable

Surveys is adopted in this research because it allows researchers to collect qualitative and quantitative data on many types of research questions and to collect feedbacks of about the research findings. The results obtained internationally were compared between developed and developing countries to provide an in-depth understanding of the differences and similarities of how a scheme is chosen. Furthermore, the result from the questionnaire that carried out in Vietnam was used to understand how Vietnamese practitioners chose an appropriate PPP scheme.

Mixed methods research, is an approach involving collecting, analysing and mixing both qualitative and quantitative data in a single study or series of studies (Creswell & Creswell 2017). Mixed-method research aims to answer research questions that cannot be answered by the qualitative or quantitative approaches alone. This method allows researchers to combine inductive (discovery of patterns), and deductive thinking (testing of theories and hypotheses), and abduction (uncovering and relying on the best of a set of explanations for understanding one's results) to address the research problem and to solve the problems using different types of data (Johnson & Onwuegbuzie 2004; Sekaran & Bougie 2016). Mixed-method research can compensate for the weaknesses of each of the methods by neutralising the problems in any single method or cancelling the biases of the other method (Cooper, D & Schindler 2008; Creswell & Clark 2007; Neuman 2014).

Action research is sometimes undertaken by consultants who want to initiate change processes in organisations. The researcher begins with a problem that is already identified; and then gathers relevant data to provide tentative problem solutions. The effects are then evaluated, defined and diagnosed, and the research continues on an ongoing basis until the problem is fully resolved.

3.2.2 Extent of researcher interference with the study

There could be varying levels of how the researchers manipulate and control the variables with the normal flow of work in the workplace in the correlational study or cause-and-effect research (Sekaran & Bougie 2016). The degree of interference can be minimal, moderate or excessive. The study conducted in a natural environment with minimal interference to the normal flow of events by the researcher is called a correlational study. A causal study involves the researcher trying to manipulate certain variables to study the effects of such manipulation on the dependent variable of interest. Compared to the casual study, a correlation study is considered to be minimal interference by researcher (Bryman & Bell 2015).

This research focuses on identifying the criteria for selection of PPP schemes and then associated with the framework; hence, this will be the correlational study. Data collected for the purpose of this study was from public clients, consultants, concessionaires, contractors, financiers, lawyers and academic experts related to PPP in infrastructure construction projects through online questionnaire surveys and semi-structured interviews. The opinions collected are considered representative of their individual situation, and then synthesised to imply the various components of the framework as comprehensively as possible. This process allowed respondents to express their real opinions in a natural and open-minded environment. The researcher did not interfere with normal activities in PPP projects or organisation activities. Thus, researcher interference was minimal.

3.2.3 Study setting

Business research can done in the natural environment where events proceed normally (non-contrived setting), or in an artificial, contrived setting (Sekaran & Bougie 2016). Studies done in non-contrived settings are called field studies, while studies conducted to establish cause-and-effect relationships using the same natural environment in which the subjects under study (employees, consumers, managers and the like) normally function, are called field experiments. This research was conducted in a natural environment with very limited interventions of the researcher, and the type of investigation is a correlational study as explained in Section 3.2.2, so the study setting was non-contrived. As the aim of this research is to carry out an exploratory and descriptive study, hence, the field studies were conducted, and various factors are inspected whereas daily activities go on as normal with minimal researcher interference.

3.2.4 Unit of analysis

The unit of analysis refers to ‘the level of aggregation of the data collected during the subsequent data analysis stage’ (Sekaran & Bougie 2016, p. 102). It is essential to determine the unit of analysis as the data collection methods, variables integrated in the framework can be decided or guided by the level at which data are aggregated for analysis (Sekaran & Bougie 2016). The units of analysis comprise individuals, dyads, groups, machines, organisations and cultures. In this research, data is collected from different projects/ organisations, and analysed by comparison and synthesis. Therefore, the unit of analysis is organisation.

3.2.5 Time horizon

The research time dimension is either cross-sectional or longitudinal (Sekaran & Bougie 2016). In a cross-sectional study (snapshot), data are gathered just once, possibly days, weeks or months, in order to answer a research question. Contrarily, in some cases, the researcher might want to study people or phenomenon at more than one point. This study is known as a longitudinal study. This research employed a survey strategy conducted over a short period of months. Data with respect to this research had not been collected before, and will not be collected again; therefore, it is a cross-sectional study.

3.3 DATA COLLECTION METHODS

The selection of investigation type depends solely on the research questions and the problem definition (Sandanayake 2016). This study uses both qualitative and quantitative data obtained through the research methods.

Data collection methods are an integral part of research design (Sekaran & Bougie 2016). The selection of data collection method is presented in Table 3-3.

Table 3-3: Selection of data collection method

Research method	Brief description	Applicability to research proposition
Survey research	Survey research is developed within the positivists approach to social science and produces numerical results about the beliefs, opinions, characteristics and past or present behaviour, expectation and knowledge of respondent (Neuman 2014).	The study has a clear set of variables to be measured. Therefore, a survey, i.e. questionnaire, can be conducted to collect broad opinions about the details in the selection of PPP scheme, and the feedback of project management teams about the research findings.

Research method	Brief description	Applicability to research proposition
Case study	Case study intensively investigates one or a small set of cases and focuses on details within each case and the context (Neuman 2014). Data may be derived from document analysis, measurement, observation and/or interview (Fellows & Liu 2015).	Case studies are used to illustrate the framework for selection of a suitable PPP scheme.
Interview	A method of eliciting a large quantity of fact, knowledge and/or opinion from a selected sample of respondents (Kelly 2005).	It is a suitable method to collect the practitioners' experience in stakeholder management.

3.3.1 Literature review

A literature review is an efficient and effective means to understand development trends in the research field (Zhang, S et al. 2016) and to show critiques of existing works to identify knowledge gaps and provide insights into future research directions (Bao et al. 2018). A literature review evaluates related works in the field of study that can fall under qualitative design or quantitative design and consolidates related previous studies by other researchers/authors. According to Hart (2018, p. 3:3), a literature review is the process of '*selecting from different texts, concepts, theories, arguments and interpretations that seem relevant to the development of your particular theoretical frame of reference and/or use of particular methodology*'. The objective of the literature review is to demonstrate an author's knowledge about a particular field of study, including vocabulary, theories, key variables and phenomena, and its methods and history (Randolph 2009).

In this study, a comprehensive review was conducted from various sources such as academic journals, textbooks, published and unpublished reports, conference papers, guidelines and doctoral theses. This was, first, to understand the research problem, define the research scope and objectives, then to establish the theoretical background for this research study. It was found from the literature that there is no clear consensus about PPP schemes across boundaries, and between different sectors. In addition, hardly any of studies have been performed on how to develop a sound decision-making tool for choosing the most appropriate PPP scheme.

The objectives of the literature review in this study were to:

- examine various aspects of PPPs such as definitions, historical development, reasons for adopting PPPs, structure, stakeholders and most importantly the types of PPP schemes;

- identify the preliminary selection criteria of a PPP scheme;
- review decision-making in PPPs in general, and selection of PPP procurement option in particular;
- identify the status quo of PPP practice in general and PPP scheme selection in Vietnam;
- develop an instrument for questionnaire survey, interview and the basis of framework was established to develop a decision-making framework for PPP scheme selection.

3.3.2 Questionnaire survey

A questionnaire is one of the most frequently used methods as this approach has several advantages over other methods. Survey data can be either quantitative in nature with numeric outcomes, or qualitative with detailed narrative outcomes. A survey is used to describe a population, identify characteristics of a group, describe attributes and characteristics of research interest, explain a phenomenon, or explain how variables are related (Buchanan & Hvizdak 2009). Questionnaire survey was adopted in this research because it is an efficient data-collection tool when the researcher knows exactly what is required and how to measure the variables of interest (Sekaran & Bougie 2016). They are typically less costly and time consuming than interviews and observations as they can be administered personally, distributed electronically, or mailed to the respondents (Sekaran & Bougie 2016). For example, it is capable of producing large quantities of highly structured, standardised data; can be made anonymously and hence, provides response that is more honest. At the same time, this technique allows respondents to take time to answer the questions and check records; it can also avoid self-presentation and interviewer bias while encouraging efficiency in terms of low labour, less cost and geographical dispersion (Kumar 2019; Murdoch et al. 2014; Wright 2005).

This study used internet-based surveys to collect data on the selection criteria of four different PPP families. One advantage of internet-based survey research is that it may save time for researchers and online surveys allow a researcher to reach thousands of people with common characteristics in a short amount of time, despite possibly being separated by great geographic distances (Bachmann, Elfrink & Vazzana 1996; Yun & Trumbo 2000). This also allows researchers to conduct preliminary analyses on collected data while waiting for the desired number of responses to accumulate (Ilieva, Baron & Healey 2002). The aim of this questionnaire survey was to achieve the list of selection criteria for each of the PPP family, thus contributed to the achievement of objective two.

3.3.2.1 <u>Questionnaire design</u>

The questionnaire survey aims to obtain feedback based on participants' extensive knowledge and valuable working experience in the selection of PPP schemes related to infrastructure construction projects. The questions are designed quite generally and do not include any sensitive questions. This study used an external site, Qualtrics, to create, collect and analyse data collected in a survey format. One advantage of online survey research is that it provides access to groups and individuals who would be difficult, if not impossible, to reach through other channels (Garton, Haythornthwaite & Wellman 1999).

The questionnaire template (please refer to Appendix B) is divided into two sections:

- Section 1 covered the general background of the respondents including their PPP experience, the type of PPP project they have been involved in, roles of organisation of respondents and types of PPP projects in which those respondents participated.
- Section 2 includes four main parts that requested respondents to rate the importance of the refined 25 selection criteria in selecting a scheme for each group of PPP families in which 25 selection criteria were obtained through in-depth literature review and interviews with international experts.

In order to ensure a common understanding, the introductory section of the questionnaire provided the working definition adopted for PPP and the aim of the research. Nominal (for categorical data) was used to deal with non-numeric variables and ordinal scale was for rankings and ordered values (Pallant 2016). In Section 2, practitioners were requested to rate the relative significance of the selection criteria; hence a Likert-style rating scale (Likert 1932) was adopted. This rating scale was considered sufficient because it offers adequate reliability and meaningful results of survey responses (Garland 1991). A Likert scale used in this study has the following meanings: 1 = 'not important at all', 2= 'not very important', 3= 'neutral', 4= 'important' 5 = 'extremely important'. The scale is commonly used in construction management in general and in PPP research in particular, such as in Cheung, E, Chan and Kajewski (2012), Jayasuriya (2017), Liang and Wang (2019), Liu, T, Wang and Wilkinson (2016), Mesfin and Abera (2016).

Prior to official delivery of the questionnaire, the initial designed questionnaire was sent to PPP experts with adequate industrial and/or academic experiences for review to test the suitability and comprehensibility to confirm the quality of the questionnaire survey. Suggestions by experts were rephrased, amended and added to the final version of the questionnaire survey. The questionnaire survey was sent with a cover letter introducing the aim of the research. Potential respondents were assured that all information provided would remain confidential and used solely for research purposes.

3.3.2.2 Respondent selection and recruitment strategy

The appropriate selection of respondents is a key component to the research. A number of public clients, concessionaires, lawyers and academic experts related to PPP in infrastructure construction projects in many countries have been approached and invited to participate in the questionnaire survey. Academic experts in the respective field of research were selected based on their recent publications, publicised information and research experience related to PPP projects. Industry stakeholders and organisation personnel including consultants, concessionaires, contractors, and financiers were selected, based on the following criteria:

- Intensive knowledge and experience in PPP projects relating to infrastructure development;
- Extensive working expertise and/or research experience for at least one PPP project in a role to select PPP.

Following the above criteria, a careful procedure was carried out to recruit the participants as follows:

- Interviewees in preliminary interview stage were happy to disseminate the questionnaire link among their colleagues;
- PPP-related academics and researchers were contacted through publicly available emails provided in journal/conference papers and university/institution websites. PPP-related journals include International Journal of Project Management (IJPM), Construction Management and Economics (CME), Journal of Facilities Management (JFM), Journal of Construction Engineering and Management (ICJM), Australian Journal of Public Administration (AJPA) and many others;
- A list of several associations, organisations, government agencies and corporations (such as the WB, ADB, Infrastructure Australia, Department of PPP Management Unit in Vietnam), which have been exposed to PPPs, were investigated and approached to circulate the questionnaire. In Australia, several websites (such as https://www.infrastructureaustralia.gov.au/ and https://www.dtf.vic.gov.au/public-private-partnerships/partnerships-victoria-ppp-projects) were used to detect the list of PPP projects, thus, stakeholders in the projects were identified. Then, further research using the company's website was carried out. In Vietnam, the list of investors with email address is available at http://ppp.mt.gov.vn/pppunit/investors.
- Professional network for business and career such as LinkedIn and Xing were used to approach people with experience in PPPs.

An email with an invitation to take part in the questionnaire survey was sent directly via email to the administration/communication officers and publicly available personal/business emails. The administration officers were asked to send the flyer and the questionnaire survey link to the relevant personnel in their organisation. Regarding professional networks such as LinkedIn, profile screening was carried out by using key words 'PPPs', 'Public-Private Partnerships'. Invitations with a very brief note to request acceptance to participate in PPP research were sent to thousands of people and 1,212 were accepted. Then, the full invitation with the questionnaire link was distributed to all those people who accepted. As well, the administrators of several LinkedIn group pages of PPP were contacted to request delivery of the questionnaire link to their pages, namely Africa PPP, PPP Australia, and PPP/P3 for Economic Growth. The flyer that was attached in the invitation contained a brief explanation of the research as well as the criteria to identify the prospective respondents.

The snowball sampling recruitment strategy that was originally introduced by Coleman (1958) was adopted in this study. Practitioners who had participated in the questionnaire survey were asked to nominate other people they believed would be suitable to contribute. This creates a chain of participants based on people who know people who know people who would be good sources (Patton 2015).

3.3.3 Semi-structured Interview

An interview is a guided, purposeful conversation between two or more people (Sekaran & Bougie 2016). Interviews allow respondents to share more experiences, and at the same time, the researchers are able to focus and explore new issues on the investigated issues (Merriam & Tisdell 2015). There are many types of interview and the most common ones used in construction management are unstructured, semi-structured and structured interview. In unstructured interviews, interviewees do not enter the interview setting with a planned sequence of questions to be asked of the respondent. Unstructured interviews allow a focus on the particular phenomenon being studied (Maxwell 2012) and may include open-ended questions for the interviewees to talk about. Structured interview is used when the information that is needed to be collected is known from the outset. The content of a structured interview can be prepared in advance (Sekaran & Bougie 2016). Semi-structured interviews are non-standardised interviews and used to gather data, which are normally analysed qualitatively (Saunders, Lewis & Thornhill 2009). Semi-structured interviewing is perhaps the most common type of interviewing used in qualitative social research, while unstructured or in-depth interviews are often approached for life history research and structured interviews are used frequently in market research (Dawson 2009). Semi-structured interviews allow sufficient flexibility for the researcher to fully understand the study context by asking further questions as necessary to clarify any doubts (Sekaran & Bougie 2016). In addition, by using semi-structured interviews, chances are given to both the researcher and interviewees to easily present their own opinions and provide comments on the questions and the possible solutions according to their understanding, knowledge and experience. At the same time, the researcher can clarify ambiguities in questions or answers immediately during the interviews. In addition, in this research, some experts can participate in more than one interview.

This research adopted the semi-structured interview, in which questions are designed as open-ended questions and used in preliminary interviews to identify the research gaps. The purpose of carrying out semi-structured interviews in this study was to have a holistic view and in-depth understanding of the public and private sectors perspectives on the general implementation practices of PPP, development of PPP in the context of Vietnam. Interviews were also used to develop the final list of the PPP scheme selection criteria and to validate the framework.

Interviewees were chosen based on the criteria adopted for the questionnaire survey (see Section 3.3.2.2), however, they were selected from the top management level, leading researchers in PPPs, and well-experienced and knowledgeable experts. Participants voluntarily accepted to participate in the study and provided consent by signing the "Participant Information Sheet/Consent Form for Interview". The participants were explained clearly in the cover letter that all information provided would be used for research purposes only and would be kept confidentially.

Table 3-4: Methods to achieve research objectives

Research objectives	Research Methods						
	Data collection methods			Data analysis methods			
	Litera-ture review	Question-naire survey	Semi-structured interview	Content analysis	MS ranking techniques *	Factor analysis	ANP decision making
To categorise different types of PPP schemes; then to identify their characteristics and conduct a SWOT analysis between different types of PPP families.	✓			✓			
To identify the set of criteria associated with the selection of PPP schemes.	✓	✓	✓	✓	✓	✓	
To ascertain the current PPP implementation practice in Vietnam.			✓	✓			
To develop a decision-making framework for selecting PPP schemes in Vietnam.	✓		✓				✓
To validate the proposed framework in procuring infrastructure project in Vietnam.			✓		✓		

** MS ranking techniques include Cronbach's alpha, Mean Score ranking and standard Deviation, Kendall's coefficient of Concordance, and Mann-Whitney U-Test and Kruskal-Wallis Test.*

3.4 DATA ANALYSIS METHODS

Various analytical techniques adopted to achieve the research objectives. The analytical techniques adopted include Content analysis, Kendall‘s Coefficient of Concordance (W), Mean Score (MS) ranking, Mann Whitney U test and Factor analysis. All data should be assessed by validity, reliability, and practicality to ensure its efficacy (Cooper, DR & Emory 1995). Validity is the extent to which differences found with a measuring tool reflect true differences among respondents tested. It has three major forms: (i) the achievement of the insurance of content validity by a) a broad literature review and b) feedback from the research participants; (ii) the achievement of criterion related validity by an appropriate survey design; and (iii) the achievement of construct validity by statistics methods, e.g. factor analysis. Reliability has to do with the accuracy and precision of a measurement procedure (Cooper, DR & Emory 1995). In this research, content analysis is adopted to assess the qualitative data; the quantitative data is plugged into SPSS (Statistical Package for Social Sciences) and an Excel spread sheet. Choosing the appropriate software for data analysis can shorten analysis timeframes, can provide more thorough and rigorous coding and interpretation, then provide researchers with enhanced data management (Jones 2007). The scientific requirements of a research project call for the measurement process to be reliable and valid, while the operational requirements call for it to be practical (Cooper, DR & Emory 1995). The practicality of this research study is tested by validating the proposed framework in three real projects, and the applicability of the proposed framework is evaluated by project managers of these three projects. Qualitative analysis is based on interpretation and requires reflection and iteration (Babbie 2015; Miles, Huberman & Saldana 2013).

Different statistical analysis methods, are as shown in Table 3-5:

Table 3-5: Methods of data analysis

Methods	Purpose of method	Outcome
Content analysis	To analyse the literature review and semi-structured interviews.	The comprehensive list of criteria. First version of the questionnaire, validation of decision tree classifier, the current constraints in doing PPPs in Vietnam and validation of the decision making framework.
Reliability test (Cronbach's alpha)	To measure the degree of stability or consistency of the measurement scales and the variables that makes them up.	The internal consistency of the survey data variable.

Methods	Purpose of method	Outcome
Descriptive statistic (Frequencies: Means and Standard Deviation)	To rank the relative importance of the selection criteria of PPP scheme based on means.	The ranking of the selection criteria of PPP scheme according to different respondents and types of PPP project.
Kendall's Coefficient of Concordance	To measure the agreement of respondents on the ranking of the selection criteria of PPP scheme.	Level of agreement of respondents.
Mann-Whitney U-Test (Nonparametric test 2-independent samples)	Examining the level of agreement between two independent groups on the scores of the selection of PPP scheme.	The differences in the importance of the selection criteria of PPP scheme across groups.
Factor analysis (Principal component analysis)	Determining the underlying relationships among 25 selection criteria.	Groupings of the selection criteria of PPP scheme.

3.4.1 Content analysis

Content analysis is 'a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use' (Krippendorff 2018 p.24). Content analysis enables the researcher to refine words into fewer content-related categories (Elo & Kyngäs 2008). This technique was adopted in this study to analyse the literature review and semi-structured interviews. Themes derived were then grouped into categories that helped to interpret the circumstance, ease the understanding and generation of knowledge (Cavanagh 1997).

3.4.2 The reliability coefficient

Cronbach's alpha is a reliability coefficient that reflects how well the items in a set are positively correlated to one another (Sekaran & Bougie 2016). Cronbach's alpha requires only a single test administration to provide a unique estimate of the reliability for a given test (Gliem & Gliem 2003). Cronbach's alpha can be computed using the following Equation 3.1:

$$\alpha = \frac{k\overline{vov}/\overline{var}}{1+(k-1)\overline{vov}/\overline{var}}$$

where k *: the number of items in the scale*

$\overline{cov}$ *: the average covariance between items*

$\overline{var}$ *: the average variance of the items* α coefficient normally ranges between 0 and 1. George and Mallery (2003:231) provide the following rules of thumb as shown in Table 3-6.

Table 3-6: Rule for describing internal consistency using Cronbach's alpha

Cronbach's alpha	Internal consistency
$\alpha > 0.9$	Excellent (High-stakes testing)
$0.7 \leq \alpha < 0.8$	Good (Low-stakes testing)
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Questionable/Poor
$\alpha < 0.5$	Unacceptable

The closer α coefficient is to 1.0, the greater the internal consistency of the items in the scale. However, α is expected to be less than 0.95 as, if value is higher than 0.95, there might be a signal of redundancy (Bland & Altman 1997; DeVellis 2012; Nunnally & Bernstein 1994). Pallant (2016) advised that it is essential to check that each of the scales is reliable with the particular sample.

3.4.3 Mean Score Ranking and Standard Deviation Technique

3.4.3.1 Ranking of the selection criteria of PPP scheme

The first analysis ranked the selection criteria of the PPP scheme according to the mean values of the responses. The mean score rating is calculated using Equation 3.2:

$$Mean = \frac{1(n_1) + 2(n_2) + 3(n_3) + 4(n_4) + 5(n_5)}{n_1 + n_2 + n_3 + n_4 + n_5}$$

where n_1, to, n_5 represent the total number of responses for selection criteria 1 to 5, respectively.

The ranking of the selection criteria of the PPP scheme was carried out in this study based on their mean values and standard deviations to access the relative importance of the list of the selection criteria. The higher the mean value is, the higher the rank is and vice versa. If two or more criteria had the same mean value, the one with lowest standard deviation was ranked as being of the highest importance. This research adopted the cut-point of mean of 3.40, in which if the criteria have a mean that is greater than 3.40, it may preliminarily indicate that the criteria are essential for the selection of the PPP scheme. This cut-point is similar to the studies of Chileshe and Kikwasi (2014) and Yalegama, Chileshe and Ma (2016).

3.4.3.2 Standard Deviation

The Standard Deviation (SD) is the most frequently used measure of the spread and it summarises the distance the data values are from the average (Cooper, DR & Schindler 2014, p. 401). The SD is calculated using Equation 3.3:

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

where n *: number of cases*

$\sum_{i=1}^{n}(x_i - \overline{x})^2$ *: the sum of the squared distances from mean for all cases*

3.4.4 Kendall's Coefficient of Concordance

In this thesis, Kendall's Coefficient of Concordance is used to test a reasonable degree of consensus among the respondents within the group on the rankings of selection criteria. It is considered to be essential to determine the degree of agreement on the survey responses in each respondent group (i.e. participants in developed countries and developing countries) because various participants were contributed to the study. The Kendall's Coefficient of Concordance value ranges from zero to 1. If the Kendall's coefficient of concordance (W) was statistically significant at a predefined significance level of 0.05, it indicated a reasonable degree of consensus among the respondents within the group on the rankings of drivers.

The calculation of Kendall's coefficient of Concordance uses Equation 3.4:

$$W = \frac{\sum_{i=1}^{n}(\bar{R}_i - \bar{R})^2}{\frac{n(n^2-1)}{12}}$$

where n *: number of criteria being ranked*

$\overline{R}_i$ *: average of the ranks assigned to the* i^{th} *selection criteria*

$\overline{R}$ *: average of the ranks assigned across all selection criteria*

According to Siegel and Castellan (1988), depending on the number of attributes, in this case, the number of attributes is greater than 7, the χ^2 is used as a near approximation instead. The critical value of χ^2 is further achieved by referring to the table of critical values of χ^2 distribution, which can be found in Fisher and Yates (1943, p. 31- Table 4) with a 0.05 significance level.

3.4.5 Mann-Whitney U-Test and Kruskal-Wallis Test

In PPP research, respondents are often from different jurisdictions with different economic and socio-political settings and ideologies (Osei-Kyei 2017), so it is appropriate to investigate the significant difference(s) in the perceptions of respondents. In this study, the assumptions for using parametric (including normal distribution and homogeneity of variance) were violated by using the Shapiro-Wilk Test; as a result, non-parametric statistical techniques were used. This study used two non-parametric statistic tests: Mann-Whitney U-Test and Kruskal-Wallis Test.

In addition, the ultimate goal of PPP practitioners in developing countries is to achieve successful projects as realised in the developed economies (Osei-Kyei & Chan 2017a). Hence, a comparative analysis between developed and developing economies to solicit the difference in point of view of the former and the latter is essential, which can help to discover how practitioners in the developed economies choose the schemes of PPPs. Mann-Whitney U-Test was used in Chapter 4 and Kruskal-Wallis Test together with Mann-Whitney U-Test was adopted in Chapter 6.

3.4.5.1 Mann-Whitney U-Test

The Mann-Whitney U-Test, an alternative to the t-test for independent samples, was adopted to examine the level of agreement between two independent groups by converting the scores ranks and comparing the mean rank for each group (Pallant 2016). Mann-Whitney U-Tests (non-parametric test 2-independent samples) were conducted to investigate differences in the perceptions of respondents from two groups of respondents (developed and developing countries) on the scores of the selection criteria of the PPP scheme. Given the unequal sample sizes of the two independent groups and since the data set is not assumed to follow normal distribution pattern, Mann-Whitney U-Test tool was considered appropriate (Osei-Kyei & Chan 2017c). The results were interpreted by the probability value (p-value) with 0.05 significance.

The calculation of Mann-Whitney U-Tests uses Equation 3.5:

$$U = n_1 n_2 + \frac{n_2(n_2+1)}{2} - \sum_{i=n_1+1}^{n_2} R_i$$

where n_1 *: sample size 1*

n_2 *: sample size 2*

R_i *: rank of the sample size*

If the p-value is less than 0.05, there is a suggestion to reject the null hypothesis and accept the alternative hypothesis that there is a significant difference between two medians of the groups.

3.4.5.2 Kruskal-Wallis Test

The survey respondents in this study can be categorised into two groups: developed and developing countries. The Kruskal-Wallis Test is the non-parametric alternative to a one-way between-groups analysis of variance (ANOVA) that is used to compare the scores on some continuous variable for three or more groups (Pallant 2016) and can be used with different sample sizes (Dudkin & Välilä 2006). If this significance level is less than 0.05, there is a statistically significant difference in the continuous variable across the groups. However, the output from the test shows only a statistically significant result but does not show which of the groups are of significant statistical from one another. Therefore, the follow-up Mann-Whitney U tests was conducted. The hypotheses for the Kruskal-Wallis test are similar to the Mann-Whitney U Tests.

The test uses the following Equation 3.6:

$$H = \frac{12}{n(n+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(n+1)$$

where: n *: size of a sample*

n_i *: size of the* i^{th} *sample*

k *: number of samples*

R *: sum of ranks in a sample.*

R_i *: sum of the ranks of the* i^{th} *sample*

3.4.6 Factor analysis

Factor analysis is a technique that is commonly used in construction management. Factor analysis allows a large set of variables or scale items to be condensed down to a smaller, more manageable and critical number of dimensions (Pallant 2016). In this study, this method was used to determine the groupings of the 25 selection factors and to represent relationships among sets of many inter-related variables. Then based on the results of factor analysis, the output was used as input for development of the selection of PPP scheme framework using ANP. Prior to conducting the factor analysis, the respondents' data must be checked for suitability. Pallant (2016) and Nunnally (1978) suggested that the overall sample size should be 150+ and Tabachnick and Fidell (2013) recommended a ratio of at least five cases for each of the variables.

To be considered suitable for factor analysis, the correlation matrix should show at least some correlations of $r = 0.3$ or greater (Tabachnick & Fidell 2013), Bartlett's test of sphericity (Bartlett 1954) should be statistically significant at $p < 0.05$ and the Kaiser-Meyer-Olkin ('KMO') value should be 0.6 or above (Kaiser 1970). These values are presented as part of the output from factor analysis. KMO measures the amount of variance that can be explained by the factors within data. If KMO is less than 0.5, the value of partial correlation among the attributes is large and therefore the technique would not be valid (Norusis 2008). Bartlett's test is used to indicate if the data is factorable. It checks for the significance of diversion of the observed correlation matrix from the identity matrix (Almarri & Abu-Hijleh 2017). If Bartlett's test of sphericity is large and the significance is small (< 0.05), it will be unlikely that the correlation is an identity matrix (Norusis 2008).

The Varimax rotation was chosen because it attempts to minimise the number of variables that have high loadings on a factor and produces a rotated component matrix that is easy to interpret as compared to the other rotations methods (Osei-Kyei, Ayirebi & Joseph 2014) and is the most commonly adopted (Ahadzie, Proverbs & Olomolaiye 2008). The Varimax method attempts to minimise the number of variables that have high loadings on each factor (Pallant 2016). The anti-image correlation matrix showed that the partial correlation coefficients were close to zero, which suggests that factor analysis assumptions are satisfied (Norusis 2008). The eigenvalue is also adopted because it is a widely used cut-off criterion in construction management research and is the sum of the squared factor loadings of the variables, representing the amount of variance explained by a factor (Cheung et al., 2000). Factors with eigenvalues above 1.0 are regarded as significant. Each of the variables belongs to only one of the principal factors while the absolute value of the loadings exceeds 0.50 and are sorted in the factor pattern matrix so that same factors appear together (Norusis 2008).

3.5 ETHICAL ISSUES

Research conducted with the involvement of human beings (people, their data and/or bio-specimens) is categorised as human research and must be carried out in a safe and ethically responsible manner (Australian Government 2007 - Updated 2018). Human research includes a range of activities but is not limited to participation in surveys, interviews or focus groups, observations by researchers, or access to their information (in individually identifiable, re-identifiable or non-identifiable form) as part of an existing published or unpublished source or database, and many others. Cooper, DR and Schindler (2014) define ethics as '*norms or standards of behaviour that guide moral choices about research behaviour'*. Ethics are critical aspects of the success of any research project (Saunders, Lewis & Thornhill 2009).

Any individual researchers, institutions and organisations who conduct human research are required to follow the National Statement on Ethical Conduct in Human Research, the Australian Code for the Responsible Conduct of Research as well as the RMIT policy. Obtaining formal Research Ethics Committee approval for the proposed research, including the data collection methods, prior to commencement of the research (RMIT University) is mandatory.

In this research, all participants were sent letters with an official university letterhead and a Participant Information Sheet/Consent Form with a plain language statement about the research itself, the actual data collection process and the participants' rights. Participants were given a clear explanation of the nature of the research and participated in this research freely. Participants were reminded that their involvement in the research was strictly voluntary. If they did not consent to participate or should any discomfort and inconvenience of participants appear, they had the right to withdraw at any time. Through all stages of data collection, the identities of the participants and organisation's information was treated as strictly confidential. For the questionnaire survey, the author received the implied consent and for the interview, a copy of consent form was given to interview participants. For interviewing purposes, permission was asked regarding the use of a recording device; however, information about the interviewee was not be recorded or noted in the interview transcribing process. The organisations, projects and respondents in this research were all considered to be anonymous, with assurance of confidentiality.

3.6 MULTI-CRITERIA DECISION-MAKING METHODS

3.6.1 Reasons for using ANP

Decision-making happens in everyday situations, not only in personal circumstances but also in organisation, business and academic environments. The decision-maker has to choose one solution based on a number of criteria, and very often, there are conflicts among them. Multi-Criteria Decision-Making (MCDM) or Multi-Criteria Decision Analysis or Aid, MCDA, involves making a decision based on more than one criterion to choose the best alternative among others (Belton & Stewart 2002). MCDM involves optimising multiple attributes, objectives, and goals to arrive at an optimal solution (Ababutain 2002). The decision-making process can vary widely from a simple to very complex procedure (Mardani et al. 2015). Decision-making in PPPs is an extremely complex process as different stakeholders have their own game strategy (Klijn & Teisman 2003) and PPPs have tended to replicate the hierarchical decision-making practices found within government through the PPP arrangement (Roberts & Siemiatycki 2015). The selection is even more complicated because it is not just to establish a contractual relationship but involves creating a unique set of social relationships (Love, P et al. 2007).

There are a variety of MCDM methods available:

Multi-attribute Utility Technology (MAUT) is a technique that allows decision-makers choose the best solution that gets the greatest multi-attribute utility from a limited possible number of available alternatives (Jansen 2011). This method was adopted by several researchers, such as Skitmore and Marsden (1988) and (Love, PE, Skitmore & Earl 1998) in choosing an appropriate project delivery system. However, MAUT also contains limitations when the process involves a group of decision makers to derive these utility functions; it can become very burdensome, time consuming and incorrect (Ibbs, CW & Crandall 1982).

Analytical Hierarchy Process (AHP) is '*a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales*' (Saaty, Thomas L 2008b). Its use of pairwise comparisons can allow decision makers to weight coefficients and compare alternatives with relative ease. The strength of this approach is that it organises tangible and intangible factors in a systematic way, and provides a structured yet relatively simple solution to decision-making problems (Skibniewski & Chao 1992). AHP can be used when MAUT is not available (Ibbs, W & Chih 2011). Analytical Network Process (ANP) (Saaty, T. L. 1996) is an extension of the AHP (Saaty, Thomas L 1977, 1980), Compared to AHP, ANP model is more generalised and allows interdependencies, outer dependencies and feedback among decision elements in the hierarchical or non-hierarchical structures (Görener 2012).

The purpose of this study is to develop an effective and practical decision-making tool that will help decision-makers to acquire the appropriate schemes for a particular PPP project. Subject to the goal of the study, decision-makers could choose from various evaluation methods that differ in advantages and limitations, in data standardisation techniques, and in the methods for assessments of alternatives (Agarski et al. 2012).

In this research, the ANP-based decision-making model was considered because of the following reasons:

- The selection of a PPP scheme can be considered as an MCDM because it brings various criteria into consideration (Farquharson et al. 2011). Comparing to other MCDM models, AHP/ANP are not complicated, and this makes the model transparent to the management of businesses and organisations and helps them understand it better.
- The ANP is a comprehensive decision-making technique that has capability to include all relevant criteria in arriving at a decision. ANP has suitability in handling tangible and intangible factors which involve interaction, dependencies and feedback (Taslicali & Ercan 2006).
- The use of the AHP/ANP technique enables the decision-maker to structure a complex problem in the form of a simple hierarchy and to evaluate and mix a large number of qualitative and quantitative factors into a decision in a systematic manner under multiple criteria (Cheung, S-O et al. 2001). Application of multi-hierarchical criteria is especially applicable in cases with multiple criteria, which can be grouped into several functional classes (Hermann, Kroeze & Jawjit 2007). In AHP/ANP, judgements are completed using a decomposition approach, which

has been shown in empirical studies to reduce decision-making errors (Taslicali & Ercan 2006); therefore, ANP is considered more accurate and useful.

- AHP/ANP techniques employ pairwise comparisons of selection criteria (Saaty, Thomas L 1988). Decision makers have to compare each criterion with all the remaining ones, hence enhance objectivity and downplay too much subjectivity (Cheung, S-O et al. 2001). In this research, pairwise comparisons were used to assess tangible and intangible factors affecting the choice of the selection of PPP scheme based on knowledge, experience and available data to yield consistent and systematic judgements.

- AHP/ANP allows a more precise parameter of weighting to interpret the obtained results and is often used for solving various multi-parameter problems (Agarski et al. 2012). This helps to gain a better understanding of the problem and make a more reliable final decision. It is necessary to derive a set of numerical weights representing the relative importance of the criteria with respect to the goal and each decision-maker is to derive his own set of importance weightings for the selection criteria.(Cheung, S-O et al. 2001).

- The major difference between AHP and ANP is that ANP is capable of handling inter-relationships between the decision levels and criteria by obtaining the composite weights through the development of a ‘supermatrix’ (Saaty, Thomas L. 2010). The supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two components or clusters in a system (Saaty, Thomas L 2004b). As the criteria for scheme selection contain dependencies among criteria (please see 7.3.2.2), consequently, ANP will be used.

- AHP/ANP can help multiple stakeholders reach an agreeable solution due to its structure, and if implemented appropriately, can be used as a consensus-building tool. The ANP can resolve complex multi-criteria decision problems when problems involve multi-criteria or hierarchy dependence relationships. At the same time, it allows a more precise and inclusive analysis than the AHP (Taslicali & Ercan 2006).

- ANP measures the consistency of the judgements. If the judgements are not consistent, they should be judged again to comply with the desired level of consistency.

- As it is based on deriving ratio scale measurements, ANP provides a way to input judgements and measurements to the distribution of influence among the factors in the decisions (Jharkharia & Shankar 2007). Thus, it can act as a quantitative tool for strategy decision-making problems.

However, ANP has some disadvantages such as: The ANP model requires significant time and resources because the formation of pairwise comparison matrices is a prolonged and complex task (Jharkharia & Shankar 2007). The level of complexity in an ANP model increases significantly with the number of criteria and their interdependencies and outer-dependencies. As a result, ANP requires more calculations and formations of additional pairwise comparisons. Furthermore, the outcome of the model depends mostly on experts' knowledge and expertise; hence group decision-making is preferred in order to reduce bias and improve the accuracy of the judgement (Saaty, Thomas L. 2010).

3.6.2 Network model construction

In the ANP, a complicated decision problem is decomposed into a rational decision hierarchy based on related attributes or criteria. By using of super matrices, the ANP can effectively address problems whose elements interact and form a network structure. Figure 3-2 presents the structural difference between a linear (AHP) and a nonlinear network (ANP).

<Image removed due to copyright restrictions>

Sources: Görener (2012); Saaty, Thomas L (2004b)

Figure 3-2: A general structure different between AHP and ANP processes

A hierarchy is a linear top down structure. In ANP, the components in a cluster can interact with some or all of the components of another cluster. A network spreads out in all directions and involves cycles between clusters and loops within the same cluster (Saaty, Thomas L. 2005; Saaty, Thomas L. & Vargas 2013).

3.6.3 Application of ANP method

The ANP approach comprises the following steps (Al-Harbi 2001; Chung, Lee & Pearn 2005; Görener 2012; Saaty, T. L. 1996; Yüksel & Dagdeviren 2007):

3.6.3.1 *<u>Step 1: Define the problem and determine its goal</u>*

The goal of this research is to select the appropriate scheme for a given infrastructure project.

3.6.3.2 *<u>Step 2: Model construction and problem structuring</u>*

The problem should be stated clearly and decomposed into a rational system like a network.

3.6.3.3 *<u>Step 3: Pairwise comparisons and priority vectors</u>*

In ANP, similar to AHP, pairs of decision elements at each cluster are compared with respect to their importance to their control criteria. In addition, interdependencies among criteria of a cluster must also be examined pairwise; the influence of each element on other elements can be represented by an eigenvector. The relative importance values are determined with Saaty's scale.

Similar to AHP, ANP uses a comparison scale developed by (Saaty, T. L. 1980, 1996) to represent the relative importance of criteria as shown in Table 3-7.

Table 3-7: The fundamental scale of absolute numbers

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is strongly favored and its dominance
8	Very, very strong	
9	Extremely importance	The evidence favor one activity over another is of the highest possible order of affirmation
Reciprocals of above non-zero numbers		If the activity *i* has one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared to *i*.
Rational Ratios arising from the scale		If consistency were to be forced by obtaining n numerical values to span the matrix

Source: Saaty, Thomas L. and Vargas (2013)

The pairwise comparison obtained from experts' judgements is a one-on-one comparison between every criteria (Sandanayake 2016). The judgements then are used to obtain the relative importance of each indicator for the considered criteria. Then the matrix of pairwise ratios is formed. The relative weight matrix is exhibited in Figure 3-3.

	A1	A2	A3	…	An
A1	$\frac{w_1}{w_1}$	$\frac{w_1}{w_2}$	$\frac{w_1}{w_3}$	…	$\frac{w_1}{w_n}$
A2	$\frac{w_2}{w_1}$	$\frac{w_2}{w_2}$	$\frac{w_2}{w_3}$	…	$\frac{w_2}{w_n}$
A3	$\frac{w_3}{w_1}$	$\frac{w_3}{w_2}$	$\frac{w_3}{w_3}$	…	$\frac{w_2}{w_n}$
⋮	⋮	⋮	⋮	⋮	⋮
An	$\frac{w_n}{w_1}$	$\frac{w_n}{w_2}$	$\frac{w_3}{w_3}$	…	$\frac{w_2}{w_n}$

Figure 3-3: Relative weight matrix

Example of the typical pairwise comparison matrix of n criteria is shown in Figure 3-4 with those highlighted being responses from an expert.

	A_1	A_2	A_3	…	A_n
A_1	1	5	1/4	…	7
A_2	1/5	1	3	…	2
A_3	4	1/3	1	…	1/2
⋮	⋮	⋮	⋮	⋮	⋮
A_n	1/7	1/2	2	…	1

Figure 3-4: Example of typical Pairwise Comparison Matrix

The matrix equation is as follows:

$$\begin{array}{c c} A & \begin{array}{cccc} A_1 & A_2 & \cdots & A_n \end{array} \\ \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_n \end{array} & \begin{pmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \cdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{pmatrix} \end{array} \begin{pmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{pmatrix} \overset{A}{=} n \begin{pmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{pmatrix}$$

The solution $Aw=nw$ (Equation 3-7) is called the principal right eigenvector of A (Saaty, Thomas L 1990, 2008a). The matrix $A=(a_{ij})$, $a_{ij}=w_i/w_j$, where $i,j=1,\ldots,n$, has positive entries everywhere and has satisfied the reciprocal property that $a_{ji}=1/a_{ij}$.

In this research, in order to avoid the subjective opinion as each expert has different priorities of importance, comparisons by group decision-making were conducted. It has been proved that the geometric mean (GM), not the arithmetic mean, is the only way to obtain a single representative judgement for a group choice that the reciprocal of the synthesised judgements is equal to the syntheses of the reciprocals of these judgements (Saaty, Thomas L 2008b). Thus, the GM is formed and used to aggregate individual judgements to represent a group judgement (Saaty, Thomas L. & Vargas 2013).

Considering that *m* experts give evaluation of the pairwise comparison for a matrix $A=[a_{ij}]$, e_{ijk} is the judgement of k^{th} expert, then the GM is computed following the Equation 3-8:

$$GM = a_{ij} = \sqrt[m]{\prod_{k=1}^{m} e_{ijk}} \ and\ k = 1, \ldots, m$$

3.6.3.4 Step 4: Calculate the weights of the criteria

Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria. By using Saaty's eigenvector procedure, each decomposed level with respect to a higher level forms a matrix and the pairwise comparison data are summarised in the absolute priority weights. The relative importance of elements was calculated using Equation 3-9:

$$Aw = \lambda_{max} w$$

where A *the matrix of pair-wise comparison*

w *the eigenvector*

λ_{max} *is the principal or largest eigenvalue of A*

Associated with the weights is an inconsistency index of a matrix. The inconsistency index is used to assess the reliability of experts' judgements by studying the consistency in rating the relative importance of the elements (Saaty, Thomas L 2008a). The Consistency Index (CI) is measured by Equation 3-10:

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

where n *is the dimension of the square pairwise comparison matrix.*

Under each matrix, there is a consistency ratio (CR) used to compare the inconsistency of the set of judgements. If CR = 0, the pairwise comparison matrix is complete and consistent, otherwise, it is not.

The CR is obtained by Equation 3-11:

$$CR = \frac{CI}{RI}$$

where RI is Random Index (RI), which is listed in Table 3-8.

Table 3-8: Random Index

Order	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

The commonly accepted maximum value of CR is 0.10. For a 3-by-3 matrix, the CR should be about 5%, a 4-by-4 ratio is about 8% and for a larger matrices, the CR is 10% (Saaty, Thomas L 1994). If the CR value is greater than 0.1, the priority weight is rejected and the judgements will be adjusted in order to be more consistent and obtain a lower CR (Mu & Pereyra-Rojas 2017).

3.6.3.5 Step 5: Supermatrix formation

To obtain global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix. As a result, a supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two clusters in a system. The supermatrix resembles the Markov chain process and summarises all influences where each sub-matrix is composed of a set of relationships between clusters. Three super matrices are unweighted, weighted, and limit super matrices.

3.6.3.6 Step 6: Synthesis of the criteria and alternatives' priorities and selection of the best alternatives

The final priority weights of the criteria can be found in the limit supermatrix. All the columns of the limit supermatrix have the same value as the priorities normalised by the cluster. In this research, the ANP was developed with the aid of Super Decisions software. The Super Decisions is the free decision support software that implements the AHP and ANP.

3.7 RESEARCH PROCESS

The research was conducted in three main phases, including three flow-stages. Stage 1: Literature review, Stage 2: Framework development, Stage 3: Framework validation.

3.7.1 Stage 1: Literature review

According to Hart (1998), literature review is the process of selection, effective evaluation and critical analysis of the relevant available documents (both published and unpublished) on the topic being studied to fulfil the aims of the research. This process will help to provide the researcher a comprehensive understanding of the topic that has already been covered and then help to identify research gaps or inconsistencies in existing studies. It ensures the ability to carry out the research topic before 'proper' research commences. Quality means having appropriate breadth and depth, rigor and consistency, clarity and brevity, and effective analysis and synthesis of the use of the ideas in the literature to justify the particular approach to the topic, the selection of methods, and demonstration that this research contributes something new. A substantive, thorough, sophisticated literature review is a precondition for doing substantive thorough, sophisticated research (Boote & Beile 2005).

Gall, Borg, and Gall (1996) argue that the literature review plays a role in:

- delimiting the research problem;
- seeking new lines of inquiry;
- avoiding fruitless approaches;
- gaining methodological insights;
- identifying recommendations for further research; and
- seeking support for grounded theory.

The key components of conducting and reporting a literature review are (i) a rationale for conducting the review; (ii) research questions or hypotheses that guide the research; (iii) an explicit plan for collecting data, including how units will be chosen; (iv) an explicit plan for analysing data; and (v) a plan for presenting data (Randolph 2009).

The two areas of literature review to be searched are: (i) literature on the relevant topic, and (ii) literature on research methodology and data collection techniques. The purpose of this stage is to identify different PPP definitions and schemes as well as different PPP family categorisations, features, pros and cons of each PPP family. The main sources of the literature review include journals, conference proceedings, books, post-graduate dissertations, governmental publications and guidelines, international guidance on research area, and finally yet importantly, other reports related to the topic to be studied. The outcomes of this step will be the answer for Objective 1 and answers for Questions 1 and 2.

3.7.2 Stage 2: Framework development

The framework is developed and refined by the application of several research methods: (i) a literature review, (ii) interviews and (iii) a questionnaire survey. Together with the preliminary interview with experts and research advisors, the research gap and the design research methodology are well defined. The outcomes of this step will be the answers for Objectives 2, 3, 4 and Research question 3.

The proposed framework will initially be setup. A semi-structured interview was used to collect information from practitioners and identify a comprehensive set of criteria regarding to the selection of the PPP scheme. Based on the questionnaire survey, different statistical analysis methods using the SPSS® and Microsoft Excel for quantitative data were analysed by using the comparative method including logical thinking, common sense and rigor to achieve given goals (Catherine & Gretchen 2015). The questions listed below are answered as in sections 5.5, 5.6, 5.7 and 5.8:

1. What is the ranking of the selection criteria of the PPP scheme in each PPP family-based respondent group?

2. Is there a general agreement on the rankings of the selection criteria of the PPP scheme of different PPP families across respondent groups?

3. Is there any correlation between the score values of the selection criteria of PPP scheme and respondent group types?

4. What are the true differences in perceptions on the relative importance of selection criteria of PPP across respondent groups?

5. How can the selected PPP scheme selection criteria for different PPP families be clustered?

After identifying the criteria and groups for the selection of PPP schemes, these results were used to develop an initial framework (Chapter 6). An ANP model was developed to prioritise each of the criteria and was used to help in selecting the suitable PPP scheme. In this step, an ANP questionnaire was conducted to collect data. The results of this step achieved Objective 4. Two case projects were used as illustrations of how to use the proposed model.

3.7.3 Stage 3: Framework validation

In order to ensure the quality of the research outcome, a validation process was carried out. Validation is used to test whether the system meets the needs of users (O'Keefe, Balci & Smith 1986). Validation could be conducted by either qualitative or quantitative method. Quantitative validation uses statistical techniques to evaluate the expert system against some pre-identified criteria while qualitative validation acquires subjective opinions on the performance of an expert system (O'Keefe, Balci & Smith 1986). In this research, the qualitative validation was adopted to assess reliability of the model because it is very difficult to find PPP projects to apply the selection model considering the time and resource limit. Hence, validation included feedback from experts to collect their responses about the level of agreement with the research findings. The results of this step achieved Objective 5 and finally, answered Question 4.

The research process, which shows the relationship between the research objectives, research questions and the methodology, is shown in Figure 3-5 below.

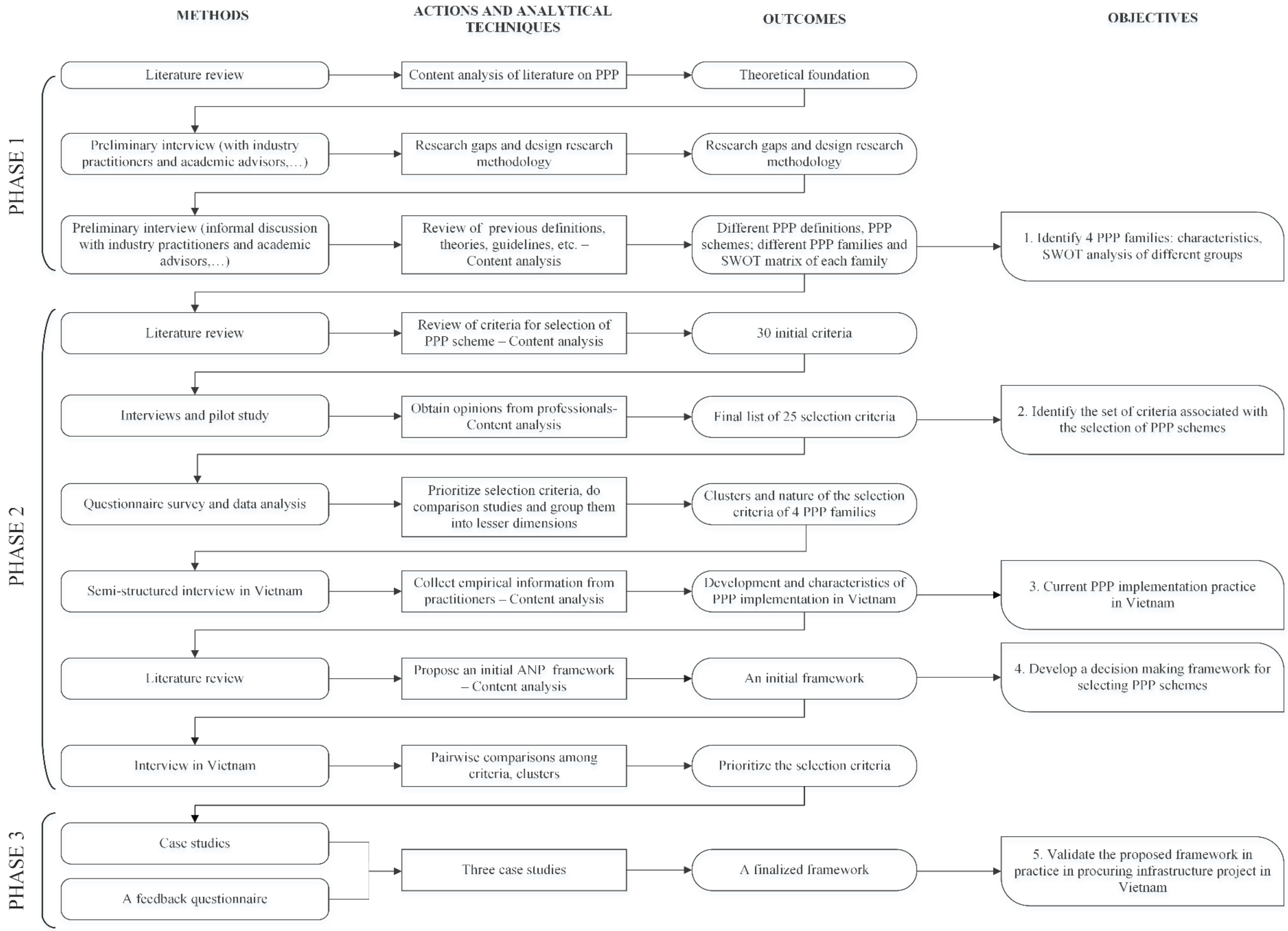


Figure 3-5: Research process

3.8 SUMMARY

This chapter justifies the research design used in achieving the research objectives described in Chapter 1. The primary research methods in this study are literature review, a survey and interviews. This research was carried out in three phases. Phase 1 is the review of the literature about PPP and identifies the comprehensive set of criteria for selection of a PPP scheme. The first phase has been completed in Chapter 2 and Chapter 3. Four categories of PPP: O&M, public-financed family, private-financed family and hybrid family were presented in Chapter 4. Phase 2 is the framework development. The results from the questionnaire survey conducted internationally on the list of PPP scheme selection criteria are shown in Chapter 5. Understanding about the development and characteristics of PPP in Vietnam was highlighted in Chapter 6. Finally, the development and the validation of the framework were provided in Chapter 7. The next chapter presents the categorisation of various types of PPP schemes as well as SWOT analysis of PPP families.

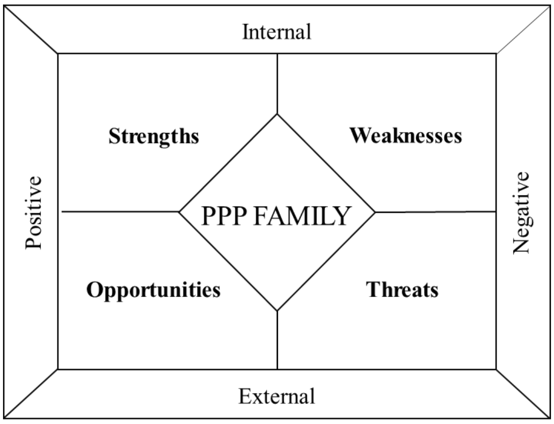
Chapter 4

PPP SCHEME CATEGORISATION

4.1 INTRODUCTION

The selection of the most appropriate procurement method is critical for both clients and project participants, and is becoming an important and contemporary issue within the building industry (Love, PE, Skitmore & Earl 1998). As mentioned in section 2.3.1, there are various types of PPP schemes, and terms such as concession, lease, affermage, outsourcing, and acronyms such as PFI, O&M, DBO, RBO, DCMF, are often seen and used interchangeably and inconsistently. Across the globe, lessons are learned from experiences and good practices of the forerunners, and this process will become complicated because of the current complexity and confusion of terminology (Delmon 2010). Misinterpretation about various types of PPP schemes can create difficulties in learning and applying PPP in practice; therefore, a systematic and generalised categorisation is of importance.

Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis is an important support tool for decision-making and has been widely used to evaluate alternative strategies in order to determine the best one for a given business setting (Yüksel & Dagdeviren 2007). A SWOT matrix (Figure 4-1), in theory, presents a mechanism for facilitating the linkage among strengths and weaknesses (internal factors), and threats and opportunities (external factors) (Sevkli et al. 2012).



Source: adapted from Sevkli et al. (2012)

Figure 4-1: SWOT analysis of different PPP families

SWOT analysis also provides a framework for identifying and formulating strategies. To select the most appropriate type of scheme that fits the goals and resources of each party, adequate knowledge of the characteristics, strengths and weaknesses of the schemes is essential (Sebastian & van Gelderen 2007). For this reason, SWOT analysis was conducted for different types of PPP families (e.g. O&M family, public-financed family).

4.2 PPP FAMILY CATEGORISATION

The various types of PPP schemes are presented in Figure 4-2. The categorisation is based on the (i) the existence of an asset; (ii) the involvement of private finance; and (iii) the tasks and features assigned to the private party. The scheme is named following the tasks and features that are bundled and assigned to a private sector. D for design, B for build, R for rehabilitate, F for finance, O for operate, M for maintain and T for transfer, as well as specific features in the contractual relationships such as L for lease, and O for own (in BOO or BOLT). This helped in categorising all the different types of PPP schemes into four broad areas as: Group 1: The O&M family; Group 2: Public-financed family; Group 3: Private-financed family, and Group 4: Hybrid family.

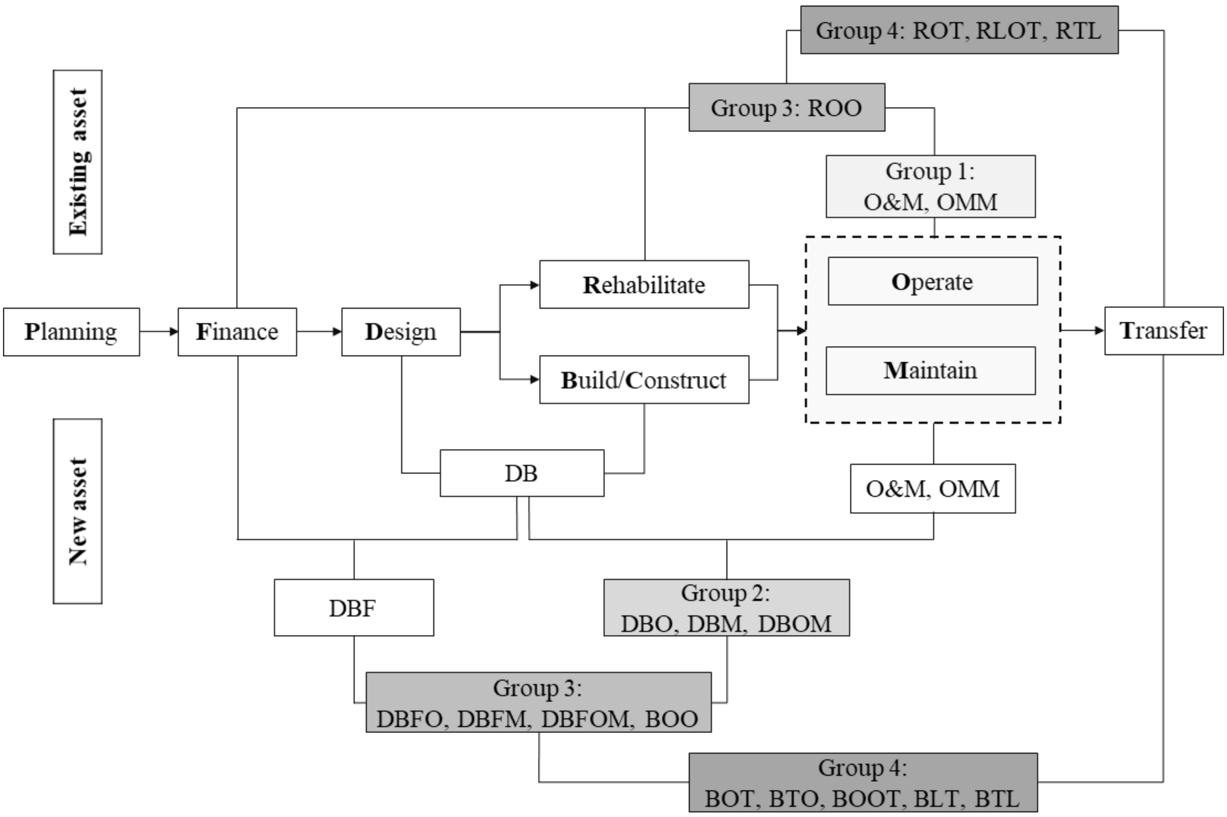


Figure 4-2: Types of PPP over the lifecycle of the project

The decision tree for the selection of PPP family is proposed as a tool to provide indicative guidance to select the PPP family that is likely to be most suitable. The process is typically preceded by identifying a priority investment project. Once a priority project has been identified, the next step is to assess whether the potential project may provide V*f*M if implemented under PPP. Then, the decision involves several stages as illustrated in Figure 4-3.

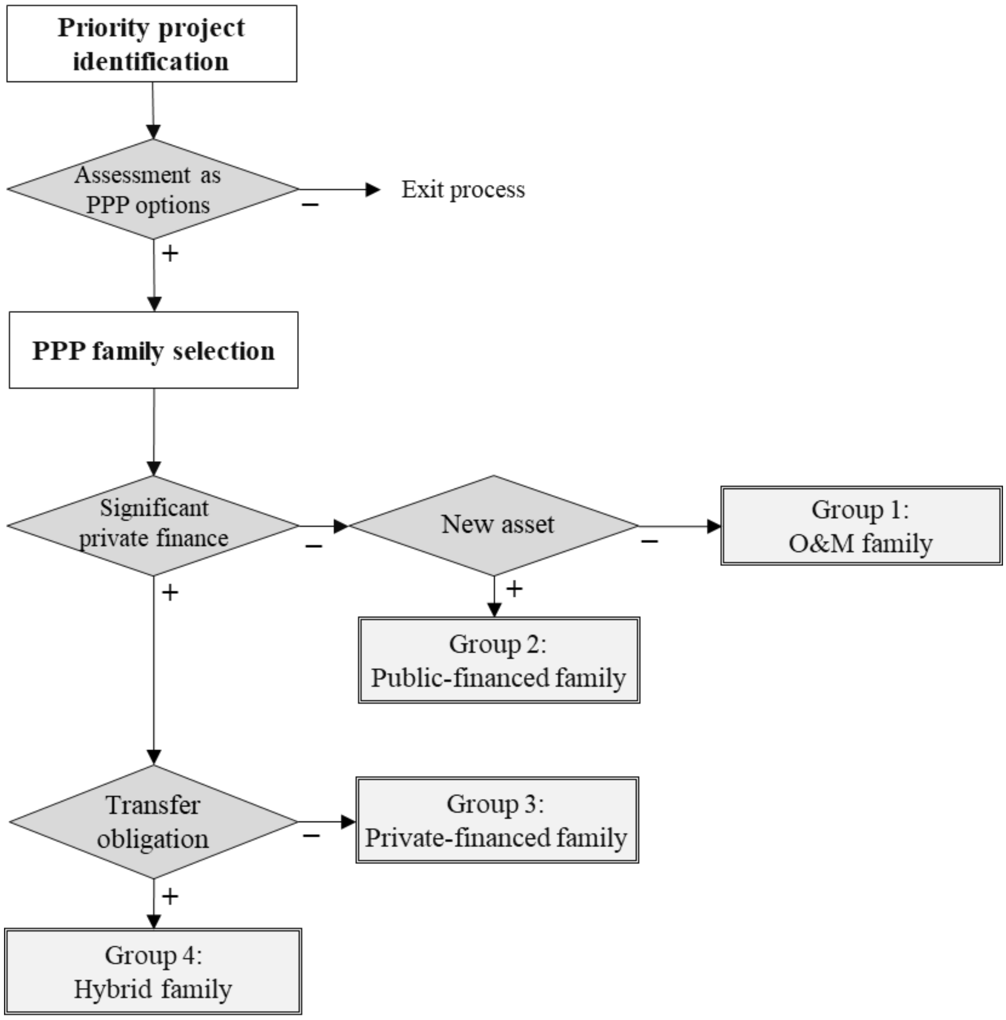


Figure 4-3: Decision tree classifier for selection of PPP family

The figure illustrates the steps involved in the selection of PPP family. After passing the initial step of PPP scanning as a ‘go/no go’ PPP option, the project will be under the process of PPP family selection. The choice of PPP family should be decided by some key determinants. If the asset is existed and has involved insignificant private finance, it falls into Group 1: O&M family. On the other hand, if the asset is new with insignificant private finance, it belongs to Group 2: Public-financed family. Either new or existing assets, which involve significant private finance, falls into Group 3: Private- financed family if there is no transfer obligation. Otherwise, a project belongs to Group 4: Hybrid family.

4.3 GROUP 1: THE O&M FAMILY

4.3.1 The O&M family characteristics

The O&M family includes two (02) types of contracts: Operation & Maintenance (O&M) and Operation, Maintenance and Management (OMM) or Management contract, in which the private party is responsible for the process of operation and maintenance to sustain the performance and profitability of the facility. Characteristics of O&M family are shown in Table 4-1.

Table 4-1: Characteristics of O&M family

Types of contracts	Responsibility of Private sector						Ownership of the facility	Investment responsibility
	Design	Build	Operation	Maintenance	Management	Transfer		
O&M			✓	✓			Public	Private for maintenance expenses
OMM/ Management contract			✓	✓	✓		Public	Public, Public/private

a. Operation and Maintenance (O&M):

Under an O&M contract, a selected private sector is responsible for operating and maintaining a facility for a specified time (WB 2007). The private party (also called the Operator) is also responsible for maintenance expenditure and is paid a fixed fee or a performance-based fee for their services. The ownership and overall management of the facility are responsibilities of the Public sector.

b. Operation, Maintenance, and Management (OMM)

OMM (also called a Management Contract) is an agreement whereby a public agency contracts with a private party to operate, maintain, and manage the operation of a facility. Under this contract option, the public agency retains ownership of the facility, but the private party is responsible for the management and operation of the facility, under a long-term contract. The private operator may invest some of its own capital, and will perform under the contract in order to recover the investment and earn a reasonable return (The United States General Accounting Office- GAO 1999).

4.3.2 SWOT analysis of O&M family

The SWOT of the O&M family is shown in Table 4-2.

Table 4-2: SWOT Matrix of O&M family

	SWOT matrix of O&M family	
	Strengths	**Weaknesses**
Internal factors	- The contracts are less difficult to develop than others and can be less controversial. The contracts are relatively low cost (ADB 2008).	- If the operator is paid a portion of profits or given an incentive payment, safeguards are required to prevent inflation of reported achievements or deficient maintenance of the system to increase profits (ADB 2008).

	SWOT matrix of O&M family	
	- The project is sustainable in the long-term and allows for the correct provision of services and benefit of end-users (Dillon 2019). - O&M prevents the systems collapsing, avoiding environmental and health hazards with the involvement of community (Dillon 2019). - Useful where condition of assets is uncertain and the private sector would be unwilling to accept more extensive risk (PPP Legal Resource Center 2018).	- O&M activities cost time and money, and therefore a provision for financing O&M has to be planned before the project start (Dillon 2019). - Limited potential for improvements in efficiency and performance (PPP Legal Resource Center 2018). - Ambiguous assignment of rights and duties (Michler-Cieluch, Krause & Buck 2009).
	Opportunities	**Threats**
External factors	- Sustain overall profitability of a facility by addressing tenant comfort, equipment reliability and efficient operation (PECI 1997). - Equipment is maintained properly mitigating any potential hazard arising from deferred maintenance (Sullivan et al. 2010). - Availability of a wide range of hard and soft skill expertise (Michler-Cieluch, Krause & Buck 2009). Private sector approaches projects with fresh perspectives and offer private innovations (Chan, H 2015).	- Face with design and construction defects as well as unsolvable problems of liability (Michler-Cieluch, Krause & Buck 2009). - Lack of regulatory framework supporting co-management arrangements (Michler-Cieluch, Krause & Buck 2009). - Operator may be required to collect bills on behalf of the utility and may accept some collection risk in terms of performance standards but is unlikely to collect bills on its own behalf (PPP Legal Resource Center 2018). - Owners have to manage interface between design/construction and O&M personnel, creating opportunity for contractor claims and allowing arguments that O&M contractor (Smith & Castellana 2004). - Can raise disputes between agency O&M contractor due to bad design or construction fault (Smith & Castellana 2004).

4.4 GROUP 2: THE PUBLIC-FINANCED FAMILY

4.4.1 Public-financed family characteristics

The feature of this group is that the asset investment is largely or fully financed by public sector and the asset ownership stays with the government from the beginning. Popular schemes for this group are DBO, DBM, and DBOM.

Table 4-3 presents the characteristics of a Public-financed family. Characteristics of an O&M family are shown in Table 4-3.

Table 4-3: Characteristics of Public-financed family

Types of contracts	Responsibility of Private sector						Ownership of the facility	Investment responsibility
	Design	Build	Operation	Maintenance	Management	Transfer		
DBO	✓	✓	✓				Public	Public
DBM	✓	✓		✓			Public	Public
DBOM	✓	✓	✓	✓			Public	Public

a. Design, Build and Operate (DBO)

DBO is a form of PPP, in which the public sector provides finance for a capital investment project but the providers of the projects retain the design and construction and deliver some or all of the operational elements (Grimsey, Darrin & Lewis, Mervyn K 2005).

b. Design, Build and Maintenance (DBM)

The private party assumes the obligation to design, construct and maintain a facility under a long-term maintenance arrangement. The public sector retains ownership and operation of the infrastructure (Amade 2012).

c. Design, Build, Operation and Maintenance (DBOM)

Under a DBOM contract, the private party is responsible for the design and construction of a facility, as well as its operations and maintenance, for a specified period of time after construction. The project is financed by the public sector (GAO 1999).

4.4.2 SWOT analysis of Public-financed family

The SWOT matrix of the Public-financed family is shown in Table 4-4.

Table 4-4: SWOT matrix of Public-financed family

	SWOT matrix of Public-financed family	
	Strengths	**Weaknesses**
Internal factors	- The contractual arrangements of this family are longer and more sophisticated than O&M contracts, however, they are often shorter and simpler than other contracts under Private-financed and Hybrid PPP families (ADB 2018; Cracchiolo & Simuoli 2001);	- Longer tendering process, high tendering costs, limiting competition (Pakkala 2002); - Client needs to make quicker decisions; Clients bringing design requirements >30% hence reduces the innovation (Pakkala 2002);
	- Faster delivery with significant time savings, a higher long-term operational viability, and better V*f*M and lower life cycle (Beringer 1999; Cracchiolo & Simuoli 2001);	- Requires a proactive approach of the owners (Cracchiolo & Simuoli 2001);
	- Efficient and sustainable in economic terms, and with higher economic value potential; Encourages use of innovative, cost-saving approaches that can be highly beneficial to the project, not only to achieve high standards in the O&M phase, but also to consider the quality of materials and construction practices during the DB phase (Smith & Castellana 2004);	- Lack of innovation and lifecycle cost control; Possibility of order changes and cost overruns (Anastasopoulos et al. 2011).
	- Operations and/or maintenance risk can be transferred to a concessionaire that has the capacity and background for successful O&M (Hill, Reed & Crutchfield 2007);	
	- Fluctuating OM expenses are replaced with relatively predictable payments that consequently assist owners in their planning efforts and stabilise user and tax rates (Fitch, Odeh & Ibbs 2015);	

	SWOT matrix of Public-financed family	
	- For projects with high technical requirements, the system provider would not guarantee what another entity operates, and a third-party operator would not provide availability guarantees for a system built by another entity (Smith & Castellana 2004); - Generates competition on how to achieve the performance requirements in the most cost-effective manner and can result in innovative proposals (Culp 2011). - The product is a much better product compared to O&M, particularly since the equipment supplier was part of the consortium (Smith & Castellana 2004).	
	Opportunities	**Threats**
External factors	- Avoidance of adversarial interface between designers and constructors on different contracts, including conflicts and claims (Cracchiolo & Simuoli 2001); - Provides a powerful incentive for the team to build a high-quality system that will stand the test of time (Smith & Castellana 2004).	- It is important to properly structure and manage the contract to ensure that the benefits of the project delivery method are fully realised (Cracchiolo & Simuoli 2001); - Can result in multiple design changes to facilitate construction activities and meet schedules while maintaining the construction budget for the project (Hill, Reed & Crutchfield 2007); - Owners need assistance from experienced technical people who know how to design and build assets (Beringer 1999).

4.5 GROUP 3: THE PRIVATE-FINANCED FAMILY

4.5.1 Private-financed family characteristics

The main feature of this group is that the project is largely or fully financed by private party with no obligation to transfer ownership to the government (IMF 2004, EC 2003). This group of PPP includes types of schemes like BOO, ROO, DBFOM, DBFO, DBFM. Private-financed family characteristics are shown in Table 4-5.

Table 4-5: Characteristics of Private-financed family

Types of contracts	Responsibility of Private sector						Ownership of the facility	Investment responsibility
	Design	Rehabilitate	Build	Operation	Maintenance	Transfer		
BOO	✓		✓	✓	✓		Private during concession	Private
ROO		✓		✓	✓		Private during concession	Private
DBFOM	✓		✓	✓	✓		Private during concession	Private
DBFO/PFI	✓		✓	✓			-	Private
DBFM/PFI	✓		✓		✓		-	Private

a. Build, Own, Operate (BOO)

Under the BOO, the private party is responsible for the design, funding, construction, operation and maintenance of the facility during the concession period, with no provision for transfer of ownership to the government. At the end of the concession period, the original agreement may be renegotiated, a new agreement may be negotiated or the facility may be purchased by the government (Grimsey and Lewis (2004, 2007).

b. Rehabilitate, Own, Operate (ROO)

ROO is a variant of BOO and refers to a rehabilitation of an existing facility (PPIAF 2009).

c. Design, Build, Finance, Operate and Maintenance (DBFOM)

Under the DBFOM approach, the responsibilities of designing, building, financing, operating and maintaining the asset are bundled together and transferred to the private party (WB 2017). The full up-front capital financing is added to the list of the private sector's responsibilities" (Lammam, MacIntyre & Berechman 2013).

d. Design, Build, Finance, Operation (DBFO)

DBFO is the contract where the private party is responsible for the design, construction, financing and operation of an asset. Operation refers to the provision of some or all of the services related to the asset's use (Grimsey & Lewis 2007). Under a DBFO, the public party uses revenues generated from the operation of the facility (such as tolls) to repay the private entity and other financing used to construct it (Rall et al. 2010). The private sector has to manage the overall financing of the entire project (Broadbent & Laughlin 2003).

e. Design, Build, Finance, Maintenance (DBFM)

Under a DBFM approach, the private party is not responsible for ‘operations’ of the asset (except for maintenance and some technical services) in the terms of the agreement (WB 2017). A private party is responsible for design, construction, financing and maintenance (Lenferink, Tillema & Arts 2013; Verweij 2015).

DBFO and DBFM are two popular schemes of Private Finance Initiative (PFI). The PFI was introduced by the UK government to provide public services by the private sector (Akintoye & Chinyio 2005). In PFI, the public sector does not own an asset but pays the SPV a stream of committed revenue payments for the use of the facilities over the contract period. Once the contract has expired, ownership of the asset either remains with the private sector contractor, or is returned to the public sector, depending on the terms of the original contract (Allen 2003).

4.5.2 SWOT analysis of Private-financed family

The SWOT analysis of private-financed family is presented in Table 4-6.

Table 4-6: SWOT matrix of Private-financed family

	SWOT matrix of Private-financed family	
	Strengths	**Weaknesses**
Internal factors	- Attracts private sector finance and debt finance discipline to complete projects that could not normally be accomplished with internal funding (EC 2003; Pakkala 2002). - Integrates the process of design, construction and maintenance with maintenance and any operations aspects can be considered during the design process (Pakkala 2002). - Delivers more predictable and consistent cost profile; Greater potential for accelerated construction program; and increased risk transfer provides greater incentive for private sector contractors to adopt a whole life costing approach to design (EC 2003);	- Funding guarantees may be required and change management system required (EC 2003). - More costly than other procurements due to three main factors: the cost of procurement, the level of risk transfer, and the cost of private finance (Deloitte 2008). - Contracts can be more complex and tendering process can be long; contract management and performance monitoring systems required (EC 2003). - Possible conflict between planning and environmental considerations (EC 2003).

	SWOT matrix of Private-financed family	
	Strengths	**Weaknesses**
	- Ability to spread cost over lifetime of asset with greater predictability over cost and time; Focus on V*f*M over lifetime of asset; Strong performance incentives; Potential to be off-balance sheet (Deloitte 2008); - Projects completed faster – better life cycle costs, better NPV (Pakkala 2002) as design and construction services can be carried out with construction proceeding on early phases of the project while latter parts are still under design (Culp 2011).	- Inflexibility and unsuitable for small projects or project with a lead time that is short. There is a high level of uncertainty over the condition of existing assets, or future asset and service requirements (Deloitte 2008). - Funding guarantees may be required and change management system required (EC 2003).
	Opportunities	**Threats**
External factors	- Provides a powerful incentive for the team to build a high-quality system that will stand the test of time (Smith & Castellana 2004).	- Future political changes may not accept/agree with prior agreements/ commitments (Pakkala 2002); - Political (as well as some cultural) threats make investors wary about entering into any long-term investments (Durdyev & Ismail 2017).

4.6 GROUP 4: THE HYBRID FAMILY

4.6.1 Hybrid family characteristics

As shown in Table 4-7, the Hybrid family includes schemes that the private sector designs, builds, operates the facility for some period of time and transfers the facility back to the government at the end of the concession period or at another pre-specified time. The private partner may subsequently lease the asset to the government. The key feature of this group is that the project can be partly or fully financed by the private party and the asset is transferred back to the government when the operating contract ends or at some other pre-specified time. Examples of this group are BOT, BOOT, BLT/BOLT, ROT, RLOT, etc. Characteristics of Hybrid family are shown in Table 4-7.

Table 4-7: Characteristics of Hybrid family

Types of contracts	Responsibility of Private sector						Ownership of the facility	Investment responsibility
	Design	Rehabilitate	Build	Operation	Maintenance	Transfer		
BOOT	✓		✓	✓	✓	✓	Private during concession	Private
BLT/BLOT	✓		✓			✓	Private during lease	Private
BOT	✓		✓	✓	✓	✓	Private during concession	Partly or 100% private
BTO	✓		✓	✓	✓	✓	Public	Partly or 100% private
BTL	✓		✓	✓		✓	Public	Partly or 100% private
ROT		✓		✓	✓	✓	Private during concession	Partly or 100% private
RLT		✓		✓	✓	✓	Private during concession	Partly or 100% private

a. Build, Operate, Transfer (BOT)

BOT is an agreement where a facility is designed, partly or fully financed, operated and maintained by the concessionaire for the period of time (WB 2017). The concessionaire assumes ownership of the infrastructure facilities during the concession period after completion of construction. The facility is transferred to the government upon termination of the concession period (Kim, J-H et al. 2011).

b. Build, Transfer, Operate (BTO)

BTO is a contract in which the private party transfers ownership to the public sector after construction is completed, and then is authorised to operate the facility for a period of time. This model also includes some or full private financing of the design, construction, operation and maintenance of a facility (Rall et al. 2010).

c. Build, Own, Operate, Transfer (BOOT)

BOOT is an arrangement whereby a facility is designed, constructed, fully financed, operated and maintained by a private company. Ownership rests with the private party until the end of the concession period, at which point ownership and operating rights are transferred to the government (Grimsey, Darrin & Lewis, Mervyn K 2005).

d. Build, Lease, Transfer (BLT) or Build, Own, Lease, Transfer (BOLT)

BLT or BOLT is a contract in which the private party constructs and owns the facility, leases the facility to the public authority and/or others for a period of time over a long-term period, then at the end of the lease period, transfers ownership to the public party (WB 2017). The responsibility of operation belongs to the public sector during the lease period but maintenance responsibility may rely either on public or private sector.

e. Build, Transfer, Lease (BTL)

Under a BTL, the private party makes an investment to build an asset then transfer the ownership to the public sector upon completion of construction. The private party receives government payments (lease payment plus operational cost) based on operational performance (e.g., availability, service quality) for a specified period of time (Kim, J-H et al. 2011).

f. Rehabilitate, Operate, and Transfer (ROT).

A private party rehabilitates an existing facility and then operates and maintains the facility at its own risk for the contract period (WB 2008).

g. Rehabilitate, Lease or Rent, and Transfer (RLT).

A private party rehabilitates an existing facility at its own risk, leases or rents the facility from the government owner, and then operates and maintains the facility at its own risk for the contract period (WB 2008).

4.6.2 SWOT analysis of Hybrid family

Table 4-8: SWOT matrix of Hybrid family

	SWOT matrix of Hybrid family	
	Strengths	**Weaknesses**
Internal factors	- Increases the commitment from contractors and financiers alike towards the successful operation of projects and reduces the chances of and the application of inappropriate technology (Grausam 1997). - Integrates the process of design, construction and operation with maintenance and any operations' aspects can be considered during design process (Pakkala 2002). Transfer of design, construction and operating risk; Potential to accelerate construction then provides incentive for adoption of whole life costing approach (EC 2003).	- Are not applicable to all kinds of infrastructure projects (Durdyev & Ismail 2017). - Usually require high pricing and tariff structures for returns to be attractive or obtained; thus possibly distorting the existing local pricing structures (Grausam 1997). - Due to devaluation and currency convertibility, revenues normally have to be generated in hard convertible currencies (Durdyev & Ismail 2017).

	SWOT matrix of Hybrid family	
	- Promotes private sector innovation and improved V*f*M (EC 2003). Allocation to the private sector of project risk and burden that would otherwise have to be borne by the public sector (Sorgenfrei 2018). - The involvement of private sponsors and experienced commercial lenders, which ensures an in-depth review and is an additional sign of project feasibility (Sorgenfrei 2018). - Reduces financial pressures and operating responsibilities on the host government (Durdyev & Ismail 2017). - Increases the participation and contribution from the range of parties, as this is necessary for successful project implementation and operation (Durdyev & Ismail 2017). - Reduces the cost and time overruns of projects, as well as inappropriate technology applications (Durdyev & Ismail 2017).	- Usually involve the provision of guarantees and extensive legal agreements as a prerequisite for investment, which may increase the project costs (Grausam 1997). - Possible conflict between planning and environmental considerations; Contracts are more complex and tendering process can take longer; Contract management and performance monitoring systems required (EC 2003).
	Opportunities	**Threats**
External factors	- Promote direct foreign investment into developing countries and reduce the pressures on government in terms of both financing infrastructure projects and recurrent expenditure generated by projects (Grausam 1997); - Suited to projects that involve a significant operating content (EC 2003); - Create opportunities for private sector participation and also the development and use of emerging markets to fund projects (EC 2003);	- The threat of the facility being run down at the transfer stage of the scheme exists (Durdyev & Ismail 2017); - Political instability and the threat of nationalisation sometimes exist and make investors cautious about entering into any long-term arrangements on build operate schemes (Grausam 1997); - If the schemes are not structured properly, natural resources in developing countries could be wastefully utilised and depleted by the project promoters (Grausam 1997);

	SWOT matrix of Hybrid family	
	- Act as a vehicle for introducing new technologies rapidly and successfully into developing countries and provide a good basis for technology transfer and training of local staff (Grausam 1997);- Creates additional capital inflows into a country, reduces capital flight and reduces unemployment in the country by creating new job opportunities (Durdyev & Ismail 2017).	- Future political changes may not accept/agree with prior agreement/ commitments (Pakkala 2002).

4.7 SUMMARY

The objective of the research in this chapter is to develop a systematic tool to categorise different types of PPP schemes in PPP families, in which some share similar features and characteristics. Based on project characteristics, tasks assigned to private party and source of funding, different type of PPP schemes were classified into four categories including O&M family, public-financed family, private-financed family and hybrid family. Later, SWOT analyses of these PPP families were carried out in order to understand the strengths and weaknesses. The next chapter presents the results from the questionnaire survey on different types of PPP scheme families.

Chapter 5

THE CRITERIA FOR SELECTING A PPP SCHEME

5.1 INTRODUCTION

This chapter presents the results from the questionnaire survey conducted internationally on the list of PPP scheme selection criteria. A questionnaire survey was adopted as the primary data collection method to explore the relative importance and to investigate the groupings of these criteria. The chapter compares the responses of practitioners of developed countries to that of those in developing countries in order to draw lessons and useful experiences. This helped to answer the second research questions of this study. The data were inputted and then analysed using SPSS® Version 24 and Microsoft Excel. The results are also presented in this chapter.

5.2 THE DEVELOPMENT OF THE LIST OF THE PPP SCHEME SELECTION CRITERIA

The preliminary list of PPP scheme selection criteria was identified through literature review (please refer to Section 2.4) and the Decision tree classifier for selection of PPP family (please refer to Section 4.2) needs to be further confirmed by professionals from the construction industry. Six experts were invited, the first to validate the Decision tree classifier for selection of PPP family, and later to confirm the comprehensiveness of the list of PPP scheme selection criteria. Interviews were conducted with academic and industrial experts to improve the accuracy and comprehensiveness of the preliminary selection criteria list. For the reason that the questionnaire survey was designed based on the results from the PPP scheme categorisation, the validation of the Decision tree classifier for selection of PPP family was compulsory. In general, all the experts agreed that the Decision tree classifier for selection of PPP family is practical in classifying all existing PPP schemes. The detailed results of the validation are shown in Section 7.5.1. All of these interviewees were experienced in both the construction industry and PPP projects with different roles (Table 5-1); in which two of the interviewees have experience as both industrial practitioners and academics. All had more than seven years of experience in PPPs.

Table 5-1: Profiles of interviewees

Code	Organization characteristics/ Roles in projects	Nationality	Years of experi-ence in construction	Years of experience in PPPs	Major	Industry and Countries of experience
IN01	Consultant and Researcher	Australia	30	30	Lead partner social infrastructure and PPP policy	Infrastructure/ Australia, UK and Asia.
IN02	International Consultant/ Project director	Japanese	31	17	Project director of many large-scale PPP and non-PPP infrastructure projects	Infrastructure/ Asia (Vietnam, China, Japan, Thailand, etc.), Central American (El Salvador, Honduras), South America (Peru, Columbia)
IN03	Researcher and Concessionaire/ Vice General Director	Vietnam	21	10	Vice General Director of the SPV company of one toll road and four tunnel projects	Infrastructure/ Vietnam
IN04	Consultant	Vietnam	25	10	Project director of many large-scale PPP and non-PPP infrastructure projects	Infrastructure/ Vietnam, Laos, Indonesia
IN05	Concessionaire/ CTO	Vietnam	17	11	Investment and Technical Manager	Experience in PPP projects for road and school projects in Vietnam.
IN06	Financial Institutions/ Financial analyst	German	7	7	Financial analyst	Large scale Insurance Corp in Europe

A list of 24 criteria was identified through the initial literature review, which can be used to select different types of PPP schemes, and was presented to the interviewees. All interviewees agreed that the proposed 24 criteria were critical to choose a scheme and the interviewees provided valuable comments on the descriptions of the criteria statements. As a result, some of the criteria were amended to be more detailed and specific. For example, the criterion '*Stable macro-economic during the project life cycle*' was changed to '*Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)*'. The criterion '*Financial viability*' was changed to '*Financial viability based on NPV and risk-adjusted present value*', and criterion '*Financial attraction*' was changed to '*Financial attraction of project to investors*'.

Four out of six interviewees argued that alternative infrastructure solutions around the project's site may affect the demand of the PPP project and thus, is crucial for the selection of PPP schemes. This is especially true of a private-financed PPP family because the economic benefit cannot be guaranteed if the demand of the project reduces. An example is the Thailand *Don Muang* Tollway, for which the government failed to remove a local road (as pre-described in the PPP contract). As a result, the project failed to pay its debt (Cuttaree, Vickram 2008). Hence, 'alternative solutions which may affect the demand of the PPP project' was added to the list.

The list of 25 selection criteria was amended based on the feedback from the interviews. The criteria were coded from C01 to C25 and are shown in Table 5-2.

Table 5-2: The list of the PPP scheme selection

No.	Criteria
C.01	Stable politics and government system
C.02	Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)
C.03	Supportive political climate for PPP projects
C.04	Community/Public support to PPP projects
C.05	Mature legal system required to support PPP procurements
C.06	Government experience in Operation and Maintenance
C.07	Government experience in Project Management
C.08	The project scale and the amount of total investment
C.09	Financial attraction of project to investors
C.10	Financial viability based on NPV and risk-adjusted present value
C.11	Technical Risk due to engineering and design failures

No.	Criteria
C.12	Construction risk, due to faulty construction techniques and cost escalation and delays in construction
C.13	Operating risk due to higher operating costs and maintenance costs
C.14	Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold.
C.15	Financial risks arising from exchange rate volatility, transaction costs and financing costs
C.16	Regulatory/Political risks due to legal changes and unsupportive government policies
C.17	Innovation in technology
C.18	Innovation in management
C.19	Innovation in operation
C.20	Government provides guarantees against financial risks, political/legal risk
C.21	Project design and construction complexity
C.22	The complexity in the operation and or maintenance stage
C.23	Alternative solutions which may affect the demand of the PPP project
C.24	Type of asset: Economic infrastructure
C.25	Type of asset: Social infrastructure

5.3 THE QUESTIONNAIRE SURVEY

5.3.1 Survey administration

In order to confirm the quality of the questionnaire survey, a pilot study was conducted by sending the questionnaire to a group of university lecturers with research expertise on PPP and stakeholders with PPP industry experience, as tabulated in Table 5-3.

Table 5-3: Profiles of pilot study participants

Code	Organization characteristics	Roles in projects	Years of experi-ence in PPPs	Major experience
PL01 (IN04)	Consultant	Project Director	10	Over 25 years of experience in infrastructure construction projects and 10 years of experience in PPP projects as technical advisory and design role and project manager serving for both the government and the client.

Code	Organization characteristics	Roles in projects	Years of experi-ence in PPPs	Major experience
PL02 (IN06)	Financial Institution	Senior business analyst	7	The investment vehicles are buying shares in PPP projects all over the world and selling the shares of their investment vehicles to institutional investors (e.g. mainly large German insurance groups).
PL03	Local government	Project manager	10	Executing the social BOT and BT infrastructure projects
PL04	Consultant	Acting Chief Representative	8	Project formation studies for PPP projects (to be financed by Japanese ODA and Japanese investors)
PL05	Public sector	Head of Programme	15	Experience in transportation projects in the UK
PLRG	Group of researchers	Researcher	Varied	Researchers in PPP

The aim of the pilot study was to test the suitability and comprehensibility of the questionnaire. In general, the expert panel found the content was easy to understand; thus increasing likelihood that the target population would also be able to comprehend and complete the questionnaire survey. The participants corrected some minor errors including the length of the questionnaire and typos and confirmed the validity, reliability and significance of the questionnaire survey.

Following the comments, the general section of the questionnaire was truncated into a concise version to request only the critically required information. However, the second part of the questionnaire was not changed as it included important questions, which reflected the scope and the objectives of the study.

A full-scale survey was conducted for a duration of three months, and 269 responses were received. Participants were requested to answer and submit the questionnaire survey within three-week's time. Reminders were sent weekly to increase the response rate. Twenty-eight responses were partly completed, as they had not responded to all parts of the questionnaire survey. This is because these respondents did not have any experience in other PPP families. Hence, they only answered questions corresponding to specific PPP families. Therefore, these responses were used for the analysis of the respective sections that they had answered. The respondents were from many geographical locations across the globe in which 47 respondents were from Australia, 48 were from other developed countries such as the UK, US, Japan, Germany, Canada, France, Switzerland. A further 174 were from developing countries including the Philippines, India, Brazil, Ukraine, and Vietnam. The sample size is suitable for further analysis. The demographic information about the background of the respondents is shown in Figure 5-1.

Figure 5-1: Geographical locations of respondents

5.3.2 Characteristics of respondents

Out of 269 returned responses shown in Table 5-4, the number of respondents from developed countries and developing countries was 95 and 174, representing 35.3% and 64.7% respectively. Out of the number of respondents from developing countries, 116 came from Vietnam. The primary reason for a large number of respondents is that the recruitment strategy was more concentrated on getting more responses from Vietnam, as this was the focus of the research. Some respondents, throughout their working duration, have had experience in various positions across public agencies, private sector companies and research organisations.

Table 5-4: Descriptive statistics by respondent background

Characteristic	Developed countries		Developing countries		Total	
	Freq.	%	Freq.	%	Freq.	%
By sector						
Public sector	37	34.9%	49	27.4%	86	30.2%
Private sector	57	53.8%	105	58.7%	162	56.8%
Researched and others	12	11.3%	25	14.0%	37	13.0%
Total	**106**	**100%**	**179**	**100%**	**285**	**100%**

Characteristic	Developed countries		Developing countries		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
By number of years of experience in PPP						
< 5 years	27	28.4%	110	63.2%	137	50.9%
5-10 years	42	44.2%	41	23.6%	83	30.9%
10-20 years	22	23.2%	20	11.5%	42	15.6%
> 20 years	4	4.2%	2	1.1%	6	2.2%
Missing	0	0%	1	0.6%	1	0.4%
Total	**95**	**35.3%**	**174**	**64.7%**	**269**	**100%**

Regarding the roles of organisation of respondents, all the participants are classified into three groups, based on the organisations they presented as: Public Sector including local government, central government and public enterprises; Private Sector including concessionaire, main and sub-contractors, consultant, designer, O&M contractor, supplier and financier; and Researcher and Others including academic, financial and transaction advisers, and so on. Over 85% of the respondents from developed and developing countries respectively are industrial practitioners. Respondents from public and private sectors are exposed directly to the PPP practice, compared to 15% of respondents who are researchers, financial institutions and transfer consultant.

In developing countries, 63.2% of respondents have less than five years of experience. On the contrary, 71.6% of respondents in developed countries possessed rich experience in PPP practice. This can be explained as in developing economies/countries, very few projects have been implemented and introduced, with many of the initiated ones still at the preparatory stage (Osei-Kyei & Chan 2016). Furthermore, the majority of respondents in developed countries have sound experience, rendering more valuable and fruitful results of the survey response.

Table 5-5 shows that the number of respondents from the public sector is 26.63%, the private sector is 63.32%, while the other 10.05% is researchers and others. This result is unsurprising as in PPP projects, more private parties are involved than public sector parties. Researcher and others included academic, financial adviser, transaction advisors and so on.

Table 5-5: Descriptive statistics on roles of organisation of respondents

Sector	**Freq.**	**%**	**Respondent background**	**Freq.**	**%**
PI1: Public sector	98	26.63%	Local Government	26	26.53%
			Central Government	48	48.98%
			Public enterprises	18	18.37%

Sector	Freq.	%	Respondent background	Freq.	%
			Others	6	6.12%
			Total	**98**	**100.00%**
PI2: Private sector	233	63.32%	Concessionaire	62	26.61%
			Main contractor	37	15.88%
			Consultant	59	25.32%
			Designer only	17	7.30%
			O&M Contractor	26	11.16%
			Supplier	2	0.86%
			Subcontractors	7	3.00%
			Financier	20	8.58%
			Other	3	1.29%
			Total	**233**	**100.00%**
PI3: Researcher and others	37	10.05%	Researcher	30	81.08%
			Others	7	18.92%
			Total	**37**	**100.00%**

Figure 5-2 gives the descriptive statistics for the experience of respondents in relation to their experience working in social infrastructure, economic infrastructure and both types. The majority of respondents (53.39%) had experience in both social and economic infrastructure projects, while the remainder had experience in social infrastructure projects (15.94%) and economic projects (30.68%) only.

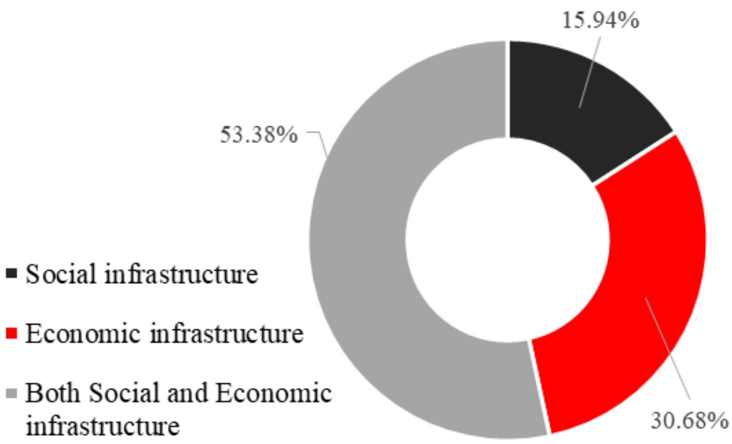


Figure 5-2: Descriptive statistic for types of infrastructure

Figure 5-3 shows the sample distribution of the types of PPP project that respondents have been involved in. The types of PPP projects were categorised according to the four different families, which was explained in Chapter 4. Some people have involved in more than one type of PPP project. The figure shows that approximately 20% and 17% of respondents had experience in O&M family projects and Public-financed family (such as DBO and DBOM) respectively. Further, about 29% and 32% of respondents had worked on Private-financed and Hybrid PPP families.

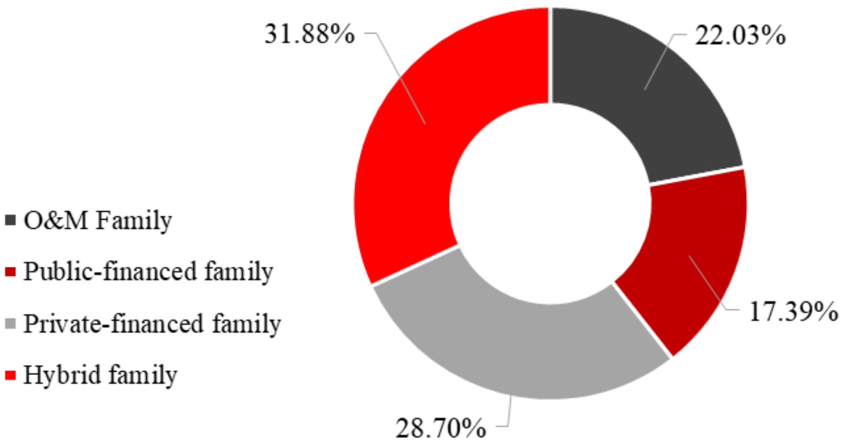


Figure 5-3: Types of PPP projects that participants involved in

5.4 TOOLS FOR DATA ANALYSIS

The obtained raw data were inputted and analysed with the aid of the Statistical Package for Social Sciences (SPSS) computer software Version 24 and Microsoft Excel®.

5.4.1 Reliability test

Cronbach's alpha (α) tests the internal consistency of the items in the scale. In this research, as shown in Table 5-6, all the α values are greater than 0.8 and less than 0.95 with significance at 0.000 level; this means that there is very good internal consistency reliability for the scale.

Table 5-6: Reliability of Data – Cronbach's alpha

Group of PPP	International	
	α	Sig.
Group 1: O&M family	.893	0.000
Group 2: Public-financed family	.917	0.000
Group 3: Private-financed Family	.933	0.000
Group 4: Hybrid family	.933	0.000

5.4.2 The Kendall's Coefficient of Concordance (W^a)

The Kendall's Coefficient of Concordance (W^a) is used to test the general agreement among the respondents. The W^a for ranking the 25 selection criteria of PPP schemes of different groups of PPP family was conducted and shown in Table 5-7, which were statistically significant at 1% level. This suggested that there was a general agreement among the respondents on the ranking of the selection criteria of PPP scheme. Thus, the respondents shared similar values about the relative importance of these selection criteria.

Table 5-7: Results of Kendall's coefficient of Concordance analysis for selection criteria

Characteristics	O&M family	Public-financed family	Private-financed family	Hybrid family
Number of survey response	265	253	250	241
Kendall's Coefficient of Concordance (W^a)	.094	.073	.141	.134
Chi-square value ($\chi 2$)	600.194	444.655	843.908	777.515
Critical value of Chi-Square	36.415	36.415	36.415	36.415
Degree of freedom (df)	24	24	24	24
Asymptotic Significance	0.000	0.000	0.000	0.000

As shown in Table 5-7, W^a for the rankings of the selection criteria of four families were 0.094, 0.073, 0.141, 0.134 respectively, with significance values of $p = 0.000$. This suggested that there was a general agreement among the respondents on the ranking of the selection criteria of the PPP scheme. Thus, the respondents shared similar values about the relative importance of these selection criteria.

As the number of attributes was 25, which are greater than 7, the computed $\chi 2$ value would be referred to rather than the W^a value. According to the degree of freedom, the critical value of $\chi 2$ values was 36.415, which is lower than the computed value of $\chi 2$ of the four groups. Hence, the assessment by respondents is proved consistent. This also reaffirms the validity of the survey responses for analysis.

5.4.3 Ranking of criteria

This section focuses on the ranking of the selection criteria of PPP schemes. The ranking of the selection criteria of PPP schemes was carried out based on their mean values and standard deviations. The higher the mean value of the criteria, the higher the rank of the criteria and vice versa. If two or more criteria had the same mean value, the one with the lowest standard deviation was ranked the highest importance. A factor is preliminarily considered as 'important' if it scored a mean index greater than 3.40. The adoption of this cut-point of 3.40 was similar to studies of Chileshe and Kikwasi (2014) and Yalegama, Chileshe and Ma (2016). Ranking of the 25 criteria selection of PPP scheme factors was obtained by computing the means for the overall sample as well as for separate groups of developed countries and developing countries.

It is recognised that for most groups of PPP families, respondents ranked 'C01 - Stable politics and government system', 'C09 - Financial attraction of project to investors' and 'C05 - Mature legal system required to support PPP procurements' as the most important criteria for all PPP families. For the O&M

family, ‘C15 - Financial risks arising from exchange rate volatility, transaction costs and financing costs’, ‘C18 - Innovation in management’ and ‘C21 - Project design and construction complexity’ ranked least important with mean score of 3.377, 3.356, 3.133 respectively; then were deleted for further analysis. In regards to Public-financed family, all criteria related to innovation, which are ‘C17 - Innovation in technology’, ‘C18 - Innovation in management’, ‘C19 - Innovation in operation’ and ‘C23 - Alternative solutions which may affect the demand of the PPP project’ have the mean score of less than 3.40, therefore these criteria were excluded. Similarly, for a private-financed family, only ‘C06 - Government experience in O&M’ and ‘C07 - Government experience in PM’ were considered least important in order to choose a PPP scheme. In contrast, all criteria in the Hybrid family are considered important, as all values are greater than 3.40.

5.4.4 Factor analysis of the selection criteria

Factor analysis has the ability to condense a broad set of variables or scale items down to a smaller, more manageable number of dimensions or factors (Pallant 2016). In this survey, this method was used to determine the groupings of the 25 selection criteria.

1. Sample size: Pallant (2016) and Nunnally (1978) suggested that the overall sample size should be 150+. Lingard and Rowlinson (2006), Hair et al. (2010) and Tabachnick and Fidell (2013) recommended there should be a ratio of at least five cases for each of the variables. As there are 25 criteria, 125 respondents must be obtained. As shown in Table 5-8, a number of responses for all PPP families are satisfied for factor analysis.

Table 5-8: Number of responses for each group of PPP family

Group of PPP	Number of responses
Group 1: O&M family	265
Group 2: Public-financed family	253
Group 3: Private-financed Family	250
Group 4: Hybrid family	241

2. To be considered suitable for factor analysis, the correlation matrix should show at least some correlations of $r=0.3$ or higher (Tabachnick & Fidell 2013), Bartlett’s test of sphericity (Bartlett 1954) should be statistically significant at $p < 0.05$ and the Kaiser-Meyer-Olkin (Kaiser 1970) value should be 0.6 or above. These values are presented as part of the output from factor analysis. The cumulative variance is attributable to factors, which, with eigenvalues greater than 1.000, should satisfy the basic requirement of 60% advocated by Malhotra (2010). These conditions were tested in this research for each of the PPP family.

Table 5-9: Ranking of PPP Selection Criteria

Criteria	Group 1			Group 2			Group 3			Group 4		
	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank
01- Stable politics and government system	4.06	1.01	3	4.13	0.93	1	4.22	1.03	3	4.25	0.96	3
02- Stable macro-economic outlook during the project life cycle	3.75	0.91	9	3.83	0.89	5	4.15	0.88	6	4.17	0.86	6
03- Supportive political climate for PPP projects	3.95	0.92	6	3.98	0.93	4	4.21	0.97	4	4.21	0.91	4
04- Community/Public support to PPP projects	3.75	1.00	10	3.63	1.05	15	3.99	1.01	9	4.07	0.95	8
05- Mature legal system required to support PPP procurements	4.08	0.95	2	4.05	0.98	2	4.19	0.98	5	4.27	0.89	2
06- Government experience in O&M	3.41	0.97	21	3.46	0.97	20	3.20*	1.06	25	3.40	1.04	25
07- Government experience in Project Management	3.57	1.03	13	3.74	0.97	12	3.30*	1.11	24	3.48	1.09	22
08- The project scale and the amount of total investment	3.71	0.98	11	3.82	1.00	6	3.92	0.98	10	3.96	0.92	9
09- Financial attraction of project to investors	4.09	1.04	1	3.77	1.13	8	4.37	0.88	1	4.32	0.86	1
10- Financial viability based on NPV and risk-adjusted PV	3.98	1.00	4	3.75	1.04	10	4.30	0.85	2	4.20	0.90	5
11- Technical Risk due to engineering and design failures	3.57	1.01	12	3.76	0.90	9	3.72	0.95	17	3.61	1.01	18
12- Construction risk, due to faulty construction techniques and cost escalation and delays in construction	3.43	1.20	20	3.80	0.95	7	3.80	0.91	12	3.80	0.98	12
13- Operating risk due to higher operating costs and maintenance costs	3.80	0.96	8	3.69	0.91	13	3.74	0.95	15	3.70	0.95	16
14- Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand	3.81	0.95	7	3.74	0.93	11	4.03	0.92	8	3.92	0.95	10

Criteria	Group 1			Group 2			Group 3			Group 4		
	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank
15- Financial risks arising from exchange rate volatility, transaction costs and financing costs	3.38*	0.94	23	3.45	1.01	21	3.79	0.92	13	3.75	1.01	15
16- Regulatory/Political risks due to legal changes and unsupportive government policies	3.98	1.00	5	3.99	0.99	3	4.09	1.02	7	4.11	0.93	7
17- Innovation in technology	3.43	0.97	19	3.38*	0.97	23	3.59	0.95	18	3.56	0.97	21
18- Innovation in management	3.36*	1.03	24	3.34*	1.04	25	3.52	1.00	21	3.45	1.02	24
19- Innovation in operation	3.46	0.95	17	3.37*	0.99	24	3.51	0.95	22	3.45	0.96	23
20- Government provides guarantees against financial, political/legal risk	3.52	1.04	14	3.58	1.08	16	3.81	1.12	11	3.88	0.96	11
21- Project design and construction complexity	3.13*	1.02	25	3.51	0.98	18	3.54	0.96	20	3.62	0.94	17
22- The complexity in the operation and/or maintenance stage	3.41	1.00	22	3.47	0.93	19	3.55	0.92	19	3.61	0.94	19
23- Alternative solutions which may affect the demand of the PPP project	3.45	0.91	18	3.40	0.98	22	3.76	1.00	14	3.78	1.00	13
24- Type of asset: Economic infrastructure	3.49	0.96	16	3.53	0.96	17	3.73	1.11	16	3.77	0.97	14
25- Type of asset: Social infrastructure	3.49	1.03	15	3.64	1.02	14	3.47	1.04	23	3.60	0.99	20

5.5 GROUP 1: O&M FAMILY KEY FINDINGS

5.5.1 Mean analysis and significant difference(s) on rankings of selection criteria in developed and developing countries for O&M family

The mean importance of the 25 selection criteria of PPP scheme factors was obtained by computing the means for the overall sample as well as for separate groups of developed countries and developing countries and ranges from 3.13 to 4.09. When choosing to carry out a project under the O&M family, respondents from both developed and developing rank '*C09 - Financial attraction of project to investors*' and '*C05 - Mature legal system required to support PPP procurements*' as the two most important criteria with a mean score of 4.09 and 4.08 respectively. '*C15 - Financial risks arising from exchange rate volatility, transaction costs and financing costs*', '*C18 - Innovation in management*' and '*C21 - Project design and construction complexity*' are not critical as all mean values are less than 3.40.

Experts from developed and developing countries have varying views on the importance of '*C13 - Operating risk due to higher operating costs and maintenance costs*'. This criterion is ranked 4th in developed countries and 11th in developing countries. This is unsurprising considering the fact that in developed countries with long experience in PPP implementation, there is sufficient experience to assess operational risks.

'*C17 - Innovation in technology*' and '*C18 - Innovation in management*' are ranked 23rd and 24th respectively in developed countries. On the contrary, respondents from developing countries ranked these two criteria 15th and 18th of important.

The respondents from developed and developing countries ranked '*C20 - Government provides guarantees against financial risks, political/legal risk*' 21st and 12th of important respectively. For O&M schemes, the private party is only responsible for the maintenance expenses and immediately receives the revenue when the facility comes to the operational stage. With a stable economic and politic system, together with experience in PPP projects, it is easy to understand that the developed countries assess this criterion as less critical, compared to developing countries.

Table 5-10: Results of Mann-Whitney U-Tests for O&M family

O&M FAMILY	Developed countries N=94			Developing countries N=171			Total N=265			Mann-Whitney U Test				
	Mean	Std.	Rank	Mean	Std.	Rank	Mean	Std.	Rank	(1) mean rank	(2) mean rank	Mann-Whitney U	Z	p value
01- Stable politics and government system	4.12	0.926	2	4.02	1.057	3	4.06	1.012	3	135.46	131.65	7806.000	-0.411	0.681
02- Stable macro-economic outlook during the project life cycle	3.69	0.868	9	3.78	0.936	8	3.75	0.912	9	126.27	136.70	7404.000	-1.128	0.259
03- Supportive political climate for PPP projects	3.87	0.883	8	3.99	0.942	5	3.95	0.922	6	124.62	137.61	7249.500	-1.403	0.161
04- Community/Public support to PPP projects	3.66	0.990	11	3.80	1.005	7	3.75	1.000	10	126.44	136.61	7420.000	-1.085	0.278
05- Mature legal system required to support PPP procurements	4.12	0.840	1	4.06	1.013	2	4.08	0.954	2	132.61	133.22	8000.000	-0.066	0.947
06- Government experience in O&M	3.31	0.962	22	3.47	0.966	19	3.41	0.966	21	125.62	137.06	7343.500	-1.223	0.221
07- Government experience in PM	3.50	1.013	15	3.60	1.037	13	3.57	1.028	13	126.38	136.64	7414.500	-1.088	0.277
08- The project scale and the amount of total investment	3.69	0.995	10	3.71	0.979	10	3.71	0.983	11	132.03	133.54	7945.500	-0.161	0.872
09- Financial attraction of project to investors	4.09	1.074	3	4.09	1.022	1	4.09	1.039	1	134.29	132.29	7915.500	-0.218	0.828
10- Financial viability based on NPV and risk-adjusted PV	3.96	1.074	7	4.02	0.961	4	3.98	1.002	4	129.90	134.70	7746.000	-0.516	0.606
11- Technical Risk due to engineering and design failures	3.62	1.048	12	3.54	0.995	14	3.57	1.013	12	136.29	131.19	7728.000	-0.541	0.588
12- Construction risk, due to faulty construction techniques and cost escalation and delays in construction	3.42	1.315	18	3.44	1.138	22	3.43	1.201	20	133.71	132.61	7970.000	-0.116	0.908
13- Operating risk due to higher operating costs and maintenance costs	4.07	0.806	4	3.66	1.002	11	3.80	0.957	8	152.61	122.22	6194.000	-3.264	0.001*
14- Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand	3.92	0.890	6	3.75	0.981	9	3.81	0.955	7	140.45	128.91	7337.000	-1.247	0.212
15- Financial risks arising from exchange rate volatility, transaction costs and financing costs	3.34	1.022	20	3.40	0.898	23	3.38	0.942	23	129.65	134.84	7722.000	-0.557	0.577
16- Regulatory/Political risks due to legal changes and unsupportive government policies	3.99	0.100	5	3.97	0.997	6	3.98	0.996	5	134.03	132.44	7940.500	-0.170	0.865
17- Innovation in technology	3.25	1.023	23	3.53	0.934	15	3.43	0.975	19	120.47	139.89	6859.500	-2.069	0.039*

O&M FAMILY	Developed countries N=94			Developing countries N=171			Total N=265			Mann-Whitney U Test				
	Mean	Std.	Rank	Mean	Std.	Rank	Mean	Std.	Rank	(1) mean rank	(2) mean rank	Mann-Whitney U	Z	p value
18- Innovation in management	3.11	1.082	24	3.49	0.978	18	3.36	1.031	24	114.57	143.13	6305.000	-3.019	0.003*
19- Innovation in operation	3.36	1.076	19	3.52	0.877	16	3.46	0.953	17	125.57	137.08	7338.500	-1.234	0.217
20- Government provides guarantees against financial, political/legal risk	3.32	1.029	21	3.62	1.029	12	3.52	1.037	14	117.15	141.71	6547.000	-2.603	0.009*
21- Project design and construction complexity	3.00	1.037	25	3.21	0.100	25	3.13	1.016	25	123.76	138.08	7168.500	-1.522	0.128
22- The complexity in the operation and or maintenance stage	3.56	0.990	13	3.32	0.992	24	3.41	0.996	22	144.37	126.75	6968.000	-1.875	0.061
23- Alternative solutions which may affect the demand of the PPP project	3.43	1.010	17	3.46	0.849	20	3.45	0.907	18	132.69	133.17	8008.000	-0.052	0.959
24- Type of asset: Economic infrastructure	3.54	1.021	14	3.46	0.922	21	3.49	0.957	16	137.59	130.48	7605.500	-0.761	0.447
25- Type of asset: Social infrastructure	3.45	1.073	16	3.52	1.008	17	3.49	1.030	15	129.31	135.03	7690.000	-0.607	0.544

Note: (1) Developed countries *(2) Developing countries*

5.5.2 Factor analysis results

The Bartlett's test of Sphericity is significant (sig. <0.05) and the KMO is 0.836 (Table 5-11), which is above 0.6, suggesting the data set is suitable for factor analysis. The results of these tests confirmed that the data were appropriate for factor analysis.

Table 5-11: KMO and Barlett's Test Group 1: O&M family

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.836
Bartlett's Test of Sphericity	Approx. Chi-Square	2171.748
	df	231
	Sig.	.000

The factor grouping based on Varimax rotation was adopted and is shown in Table 5-12. Principal component analysis produced a six-factor solution with eigenvalues greater than 1.000, with the cumulative variance of 62.273% of the variance (greater than 60%) and the factor grouping based on Varimax rotation, as shown in Table 5-12. Each variable belongs to only one of the clusters, with the loading on each factor exceeding 0.50.

Table 5-12: Total variance explained for Group 1: O&M family

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.374	28.973	28.973	2.901	13.188	13.188
2	2.548	11.583	40.557	2.627	11.942	25.129
3	1.362	6.192	46.748	2.322	10.555	35.684
4	1.272	5.784	52.532	2.077	9.440	45.124
5	1.116	5.072	57.604	1.950	8.865	53.988
6	1.027	4.668	62.273	1.823	8.284	62.273
7	0.937	4.260	66.532			
…	…	…	…			
22	0.225	1.023	100.000			

This is further shown in Figure 5-4: the Scree Plot of the total variance of the underlying grouped factors can be used to represent the data adequately.

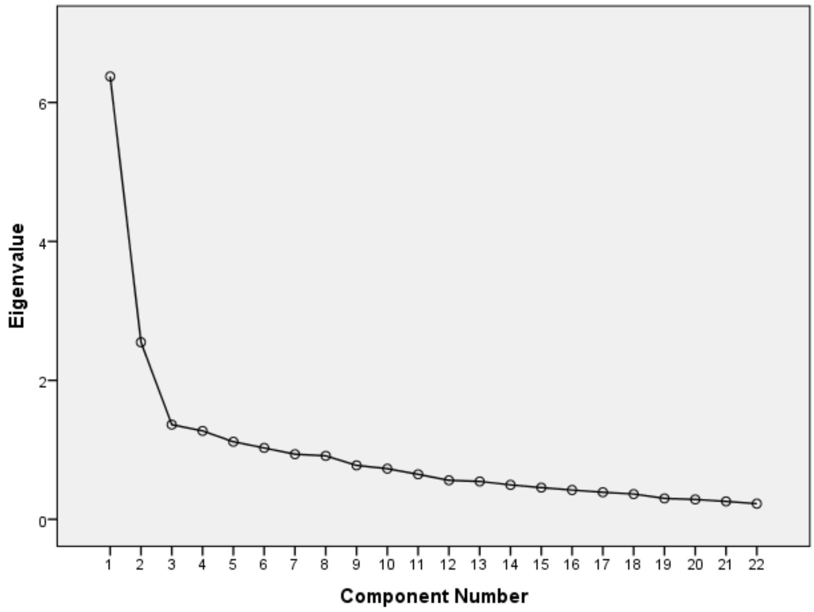


Figure 5-4: The scree plot showing extracted factors on O&M family

The factor grouping based on Varimax rotation was adopted and is shown in Table 5-13.

Table 5-13: Rotated Component Matrix[a] O&M family

	Factor loading	Rotation Sums of Squared Loadings		
		Total	**% of Variance**	**Cumulative %**
Cluster 1.1: Favorable investment environment		**2.901**	**13.188**	**13.188**
C01 - Stable politics and government system	0.770			
C02 - Stable macro-economic outlook	0.725			
C03 - Supportive political climate	0.632			
C05 - Mature legal system	0.601			
C16 - Regulatory/Political risks	0.515			
Cluster 1.2: Risks and financial viability at preparation and construction stage		**2.627**	**11.942**	**25.129**
C12 - Construction risk	0.715			
C10 - Financial viability	0.699			
C09 - Financial attraction to investors	0.682			
C11 - Technical Risk	0.672			
Cluster 1.3: PPP project complexity at O&M stage		**2.322**	**10.555**	**35.684**
C13 - Operating risk	0.730			
C14 - Financial risks from inaccurate forecast	0.691			

	Factor loading	Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %
C22 - The complexity in the O&M stage	0.611			
Cluster 1.4: Types of PPP project		**2.077**	**9.440**	**45.124**
C25 - Social infrastructure	0.828			
C24 - Economic infrastructure	0.794			
Cluster 1.5: Government proficiency in PPP projects		**1.950**	**8.865**	**53.988**
C06 - Government experience in O&M	0.830			
C07 - Government experience in PM	0.800			
Cluster 1.6: Innovation in PPP project		**1.823**	**8.284**	**62.273**
C17 - Innovation in technology	0.831			
C19 - Innovation in operation	0.819			

5.5.3 Findings and discussions

The selection criteria can be grouped into six principal clusters as follow:

- Cluster 1.1 represents Favorable investment environment
- Cluster 1.2 represents Risks and financial viability
- Cluster 1.3 represents PPP project complexity at O&M stage
- Cluster 1.4 represents Types of PPP project
- Cluster 1.5 represents Government proficiency in PPP projects
- Cluster 1.6 represents Innovation in PPP projects

Favourable investment environment accounts for 13.188% of the total variance and includes five criteria: ‘C01 - Stable politics and government system’, ‘C02 - Stable macro-economic outlook’, ‘C03 - Supportive political climate’, ‘C05 - Mature legal system’ and ‘C16 - Regulatory/Political risks’. Stable politics and government system, as well as stable macro-economic environment, are important for the O&M family because of its long term operating and maintenance agreement. The two variables have loading factors of 0.770 and 0.725 respectively. Stable status can make infrastructure investments more secure, hence in turn, attract private party to engage in a PPP project. The lower loadings were given to ‘C03 - Supportive political climate’, ‘C05 - Mature legal system’, ‘C16 - Regulatory/Political risks’ with factors loading of 0.632, 0.601, and 0.515 respectively.

Risks and financial viability at preparation and construction stage have a significance of 11.942% of the total variance and include risks and financial viability in the design and construction stage. The cluster comprises four criteria, which are '*C12 - Construction risk, due to faulty construction techniques and cost escalation and delays in construction stage'*; '*C10 - Financial viability based on NPV and risk-adjusted present value*'; '*C09 - Financial attraction of project to investors*' and '*C13 - Operating risk due to higher operating costs and maintenance costs*'. The loading factors are 0.715, 0.699, 0.682 and 0.672 respectively.

PPP project complexity at O&M stage has a significance of 10.555% and consists of three criteria: 'C13 - Operating risk due to higher operating costs and maintenance costs', 'C14 - Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold' and 'C22 - The complexity in O&M stage'. The 'C13 - Operating risk due to higher operating costs and maintenance costs' loading is very high on the PPP project complexity cluster and indicates that this risk is critical for the O&M family. The lower loading is given to 'C14 - Financial risks arising from the inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold' with loading factor of 0.691. This criterion will affect the revenue of the PPP project. The last item loaded onto PPP project complexity during O&M stage is 'C22 - The complexity in the O&M stage' with loading factor of 0.611.

'*C25 - Type of asset: Social infrastructure*' and '*C24 - Type of asset: Economic infrastructure*' have considerably high loading factors of 0.830 and 0.800 respectively, associated with the 'Cluster 1.4: Types of PPP project'. The cluster accounts for a significance of 9.440%.

Government proficiency in PPP projects has a significance of 8.865 and includes two government experience criteria. '*C06 - Government experience in O&M*' and '*C07 - Government experience in PM*' have very high loading factors of 0.830 and 0.800 respectively.

Both '*C17 - Innovation in technology*' and '*C19 - Innovation in operation*' receive high loadings of 0.831 and 0.819 respectively. Innovative means motivation for a private party to increase business efficiency with the limited use of resources.

5.6 GROUP 2: PUBLIC-FINANCED FAMILY KEY FINDINGS

5.6.1 Mean analysis and significant difference(s) on rankings of selection criteria in developed and developing countries for Public-financed family

This section focuses on the ranking of the selection criteria of the PPP scheme. The ranking of the selection criteria of PPP scheme criteria was carried out based on their mean values and standard deviations. The mean of 25 criteria ranges from 3.34 to 4.12, in which three criteria, namely '*C17- Innovation in technology*', '*C18- Innovation in management*' and '*C19- Innovation in operation*' have mean value less than 3.40. This means that respondents consider three innovation criteria are not critical when choosing a public-financed scheme.

Respondents from both public sector and private sector all agreed that the top three important criteria are '*C01- Stable politics and government system*' (mean = 4.13), '*C05- Mature legal system required to support PPP procurements*' (mean = 4.05) and '*C16- Regulatory/Political risks due to legal changes and unsupportive government policies*' (mean = 3.99). This is not hard to understand as for the public-financed family, the stability of the political system, as well as the maturity of the legal system, would ensure the success of this family.

The significance test results on the ranking of selection criteria among developed and developing countries are presented in Table 5-14. If the p-value of any criteria is less than 0.05, it suggests that respondents from the two groups rank the criteria differently and vice versa. As shown in Table 5-14, 6 out of 25 criteria are significantly different. Four criteria that are ranked higher in developing countries, are ranked lower in developed countries. '*C04- Community/Public support to PPP projects*' is ranked 19 in developed countries whereas respondents from developing countries rank this criterion 12th. The level of public opposition can lead to delay, cancellation or nationalisation (Siemiatycki 2015). This is especially crucial with user-pay PPP, as if there are too many costs and too few users, the project itself cannot meet its debt and the private party cannot recoup their investment. However, in developed countries where political and economic status is stable, the risk of public opposition is less.

'*C06 - Government experience in O&M*' is ranked 23rd in developed countries while respondents from developing countries ranked it 18th. The governments in developed countries have very comprehensive experience compared to their counterparts. Many projects in developing countries have failed to operationalise because of the lack of experience (Osei-Kyei & Chan 2016). This explains why professionals in developing countries ranked this criterion of higher importance.

'C15 - Financial risks arising from exchange rate volatility, transaction costs and financing costs' and 'C20 - Government provides guarantees against financial, political/legal risk' were ranked higher or critical for respondents in developing countries compared to developed countries. This is unsurprising as developing countries, in recent years, have had unstable macroeconomic indicators particularly with an exchange and interest rate fluctuation, which can cause an increase in the overall project cost and user charges (Osei-Kyei & Chan 2017c). Respondents from developed countries considered these criteria are not crucial for choosing this public- financed scheme.

The two criteria ranked higher in developed countries than in developing countries are related to technical and project complexity. '*C11- Technical Risk due to engineering and design failures*' ranked the fifth in developed countries whereas it ranked 14th in developing countries and '*C22 - The complexity in the operation and or maintenance stage*' ranked 15th and 24th respectively. Any construction work will be subject to some technical risks (Shen, L, Wu & Ng 2001). The higher and more complex the technical level is, the more risks there are (van den Hurk & Verhoest 2015). Technical risk can play destructive roles in building up the project (Goh et al. 2014) as the risk due to engineering and design failures can lead to other risks in the construction stage and during the operating phase.

Table 5-14: Results of Mann-Whitney U-Tests for Public-financed family

PUBLIC-FINANCED FAMILY	Developed countries N=87			Developing countries N=166			Total N=253			Mann-Whitney U Test				
	Mean	Std.	Rank	Mean	Std.	Rank	Mean	Std.	Rank	(1) mean rank	(2) mean rank	Mann-Whitney U	Z	p value
01- Stable politics and government system	4.17	0.838	1	4.11	0.972	1	4.13	0.927	1	127.91	126.52	7141.50	-0.154	0.878
02- Stable macro-economic outlook during the project life cycle	3.77	0.817	9	3.86	0.929	5	3.83	0.892	5	120.32	130.50	6639.50	-1.128	0.259
03- Supportive political climate for PPP projects	4.03	0.841	4	3.95	0.974	4	3.98	0.930	4	130.33	125.25	6931.00	-0.556	0.578
04- Community/Public support to PPP projects	3.43	1.019	19	3.74	1.050	12	3.63	1.048	15	112.89	134.40	5993.00	-2.315	0.021*
05- Mature legal system required to support PPP procurements	4.08	1.014	2	4.03	0.969	2	4.05	0.983	2	130.58	125.12	6909.50	-0.597	0.551
06- Government experience in O&M	3.26	0.994	23	3.57	0.949	18	3.46	0.973	20	111.98	134.87	5914.50	-2.478	0.013*
07- Government experience in PM	3.63	0.929	16	3.79	0.990	6	3.74	0.970	12	118.58	131.41	6488.50	-1.387	0.165
08- The project scale and the amount of total investment	3.91	0.972	6	3.77	1.007	8	3.82	0.995	6	134.06	123.30	6607.00	-1.162	0.245
09- Financial attraction of project to investors	3.74	1.224	11	3.78	1.085	7	3.77	1.133	8	127.17	126.91	7206.00	-0.028	0.977
10- Financial viability based on NPV and risk-adjusted PV	3.75	1.025	10	3.76	1.045	9	3.75	1.037	10	125.74	127.66	7111.00	-0.208	0.835
11- Technical Risk due to engineering and design failures	3.97	0.784	5	3.65	0.946	14	3.76	0.905	9	141.66	119.32	5945.50	-2.445	0.014*
12- Construction risk, due to faulty construction techniques and cost escalation and delays in construction	3.89	0.868	7	3.75	0.994	11	3.80	0.953	7	131.55	124.61	6825.00	-0.753	0.452
13- Operating risk due to higher operating costs and maintenance costs	3.82	0.815	8	3.63	0.956	16	3.69	0.913	13	135.07	122.77	6519.00	-1.344	0.179
14- Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand	3.71	0.875	12	3.75	0.956	10	3.74	0.927	11	124.56	128.28	7008.50	-0.405	0.686
15- Financial risks arising from exchange rate volatility, transaction costs and financing costs	3.21	1.080	25	3.57	0.955	17	3.45	1.013	21	110.94	135.42	5824.00	-2.643	0.008*
16- Regulatory/Political risks due to legal changes and unsupportive government policies	4.06	0.957	3	3.95	1.008	3	3.99	0.990	3	131.47	124.66	6832.50	-0.743	0.458
17- Innovation in technology	3.31	1.004	21	3.42	0.955	21	3.38	0.971	23	122.11	129.56	6796.00	-0.808	0.419

PUBLIC-FINANCED FAMILY	Developed countries N=87			Developing countries N=166			Total N=253			Mann-Whitney U Test				
	Mean	Std.	Rank	Mean	Std.	Rank	Mean	Std.	Rank	(1) mean rank	(2) mean rank	Mann-Whitney U	Z	p value
18- Innovation in management	3.23	1.064	24	3.39	1.026	23	3.34	1.040	25	118.94	131.22	6520.00	-1.325	0.185
19- Innovation in operation	3.44	1.031	18	3.34	0.975	25	3.37	0.994	24	131.92	124.42	6793.00	-0.815	0.415
20- Government provides guarantees against financial, political/legal risk	3.37	1.132	20	3.70	1.036	13	3.58	1.079	16	113.21	134.23	6021.00	-2.258	0.024*
21- Project design and construction complexity	3.67	0.923	14	3.42	0.998	22	3.51	0.978	18	137.81	121.33	6280.50	-1.790	0.073
22- The complexity in the O&M stage	3.64	0.876	15	3.39	0.951	24	3.47	0.932	19	140.01	120.18	6089.00	-2.177	0.029*
23- Alternative solutions which may affect the demand of the PPP project	3.26	1.083	22	3.47	0.919	20	3.40	0.981	22	118.48	131.46	6480.00	-1.409	0.159
24- Type of asset: Economic infrastructure	3.47	1.020	17	3.57	0.930	19	3.53	0.961	17	123.56	128.80	6922.00	-0.569	0.570
25- Type of asset: Social infrastructure	3.67	1.146	13	3.63	0.950	15	3.64	1.019	14	130.61	125.11	6907.00	-0.594	0.553

Note: (1) Developed countries *(2) Developing countries*

5.6.2 Factor analysis results

The Bartlett's test of Sphericity is significant (sig. <0.05) and the KMO is 0.846 (Table 5-15), which is above 0.6, suggesting the data set is suitable for factor analysis. The results of these tests confirmed that the data were appropriate for factor analysis.

Table 5-15: KMO and Barlett's Test for International Survey for Public-financed family

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.846
Bartlett's Test of Sphericity	Approx. Chi-Square	2710.843
	df	231
	Sig.	.000

The factor grouping based on Varimax rotation was adopted and is shown in Table 5-16. The principal component analysis produced five-factor solutions, explaining 65.035% of the total variance with eigenvalues greater than 1.000 being regarded as significant.

Table 5-16: Total variance explained for Public-financed family

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.454	33.883	33.883	3.173	14.424	14.424
2	2.327	10.578	44.460	3.131	14.232	28.656
3	1.423	6.468	50.929	2.916	13.254	41.909
4	1.363	6.197	57.125	2.789	12.676	54.585
5	1.300	5.910	63.035	1.859	8.450	63.035
6	0.962	4.373	67.408			
…	…	…	…			
22	0.157	0.713	100.000			

This is further shown in Figure 5-5: the Scree Plot of the total variance of the underlying grouped factors, and can be used to represent the data sufficiently.

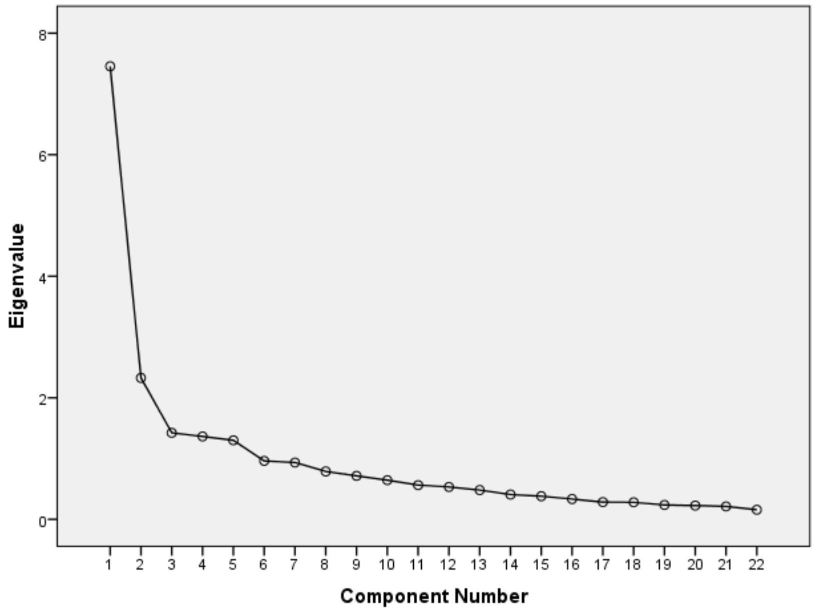


Figure 5-5: The scree plot showing extracted factors on Public-financed family

The factor grouping based on Varimax rotation is shown in Table 5-17. Each dimension consists of a set of criteria and each variable belongs to only one of the clusters, with the loading on each factor exceeding 0.50 (Hair et al. 2010). Three criteria have the absolute values less than 0.5 including '*C14 - Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold*', '*C16 - Regulatory/Political risks due to legal changes and unsupportive government policies*', '*C20 - Government provides guarantees against financial risks, political/legal risk*'.

Table 5-17: Rotated Component Matrix[a] for Public-financed family

	Factor loading	Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %
Cluster 2.1: Risks in PPP project		**3.131**	**14.232**	**28.656**
C12 - Construction risk	.835			
C11 - Technical Risk	.821			
C13 - Operating risk	.749			
Cluster 2.2: Favourable investment environment with stability of government and policy system		**3.131**	**14.232**	**28.656**
C01 - Stable politics and government system	.821			
C03 - Supportive political climate	.783			

	Factor loading	Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %
C02 - Stable macro-economic outlook	.775			
C05 - Mature legal system	.579			
C04 - Community/Public support	.515			
Cluster 2.3: Types of PPP project and its complexity		**2.916**	**13.254**	**41.909**
C25 - Social infrastructure	.756			
C24 - Economic infrastructure	.756			
C23 - Alternative solutions	.607			
C21 - Project design and construction complexity	.597			
C22 - The complexity in the O&M stage	.581			
Cluster 2.4: Viable financial package		**2.789**	**12.676**	**54.585**
C09 - Financial attraction of project to investors	.833			
C10 - Financial viability	.763			
C08 - The project scale and the amount of total investment	.621			
C15 - Financial risks arising from exchange rate volatility	.521			
Cluster 2.5: Government experience		**1.859**	**8.450**	**63.035**
C07 - Government experience in PM	.878			
C06 - Government experience in O&M	.834			

5.6.3 Findings and discussions

The selection criteria can be grouped into five principal clusters as follows:

- Cluster 2.1 represents *Risks in PPP project*
- Cluster 2.2 represents Favourable investment environment with the stability of government and policy system
- Cluster 2.3 represents Types of PPP project and its complexity
- Cluster 2.4 represents Viable financial package
- Cluster 2.5 represents *Government experience*

5.6.3.1 Cluster 2.1: Risks in PPP project

This cluster accounts for 14.424% of the total variance and includes risks throughout the project life cycle. To ensure V*f*M for both public and private sectors, a well-structured PPP project with effective risk management including appropriate risk identification and allocation/sharing is of absolute importance for the successful implementation of a PPP project (Darvish et al. 2006). The cluster comprises three criteria, which are: '*C12 - Construction risk, due to faulty construction techniques and cost escalation and delays in the construction stage*', '*C11 - Technical Risk due to engineering and design failures*' and '*C13 - Operating risk due to higher operating costs and maintenance costs*'. The first three components with very high loading factors are construction risk, operating risk and technical risk (0.835, 0.821 and 0.749 respectively). Construction projects with complexity contain inherent enormous risks (Zou, Zhang & Wang 2007), especially for PPP projects with long concession periods.

5.6.3.2 Cluster 2.2: Favourable investment environment with the stability of government and policy system

This cluster accounts for 14.232% of the total variance. The investment environment, to be favourable for PPP, must include '*C01 - Stable politics and government system*', '*C03 - Supportive political climate for PPP projects*', '*C02 - Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)*' with very high cluster loading (0.821, 0.783 and 0.775 respectively). The successful public-financed family PPP types will depend on these criteria as the confidence of private sector participation in PPP infrastructure services will much depend on the level of political support. The other two criteria are '*C05 - Mature legal system required to support PPP procurements*' and '*C04 - Community/public support to PPP projects*' (loading cluster 0.579 and 0.515 respectively). The favourable legal framework is crucial for the selection of PPP scheme as public opposition can lead to political debates and even ruin the project (Zhang, Xueqing 2005a). The public/community opposition, at any stage and by any stakeholder of a PPP project, can lead to delay, inconveniences caused during the construction phase (Salman, Skibniewski & Basha 2007) or even project cancellation or nationalisation (Siemiatycki 2015).

5.6.3.3 Cluster 2.3: Types of PPP project and its complexity

This cluster accounts for 13.254% of the total variance between the scheme selection criteria. Types and project complexity are crucial for decision-makers when choosing an appropriate PPP scheme. '*Economic infrastructure*' and '*social infrastructure*' both have the loading factor of 0.756. '*C23 - Alternative solutions which may affect the demand of the PPP project alternative solutions which may affect the demand of the PPP project'*, '*C21 - Project design and construction complexity*' and '*C22 - The complexity in the operation and/or maintenance stage*' (loading factor: 0.607, 0.579, and 0.581

respectively). The more complex and the more the amount of investment, the more critical is the government experience for smooth implementation of a PPP project.

5.6.3.4 Cluster 2.4: Viable financial package

This cluster accounts for 12.676% of the total variance. 'C09 - Financial attraction of project to investors' 'C10 - Financial viability based on NPV and risk-adjusted present value', and 'C08 - The project scale and the amount of total investment' (loading cluster 0.833, 0.763 and 0.621 respectively). In PPP projects, a financial package usually has a more significant impact on a project's viability than the physical design or construction costs (Zhang, Xueqing 2005a). The last component of this cluster related to 'C15- Financial risks arising from exchange rate volatility, transaction costs and financing costs' with loading factor of 0.521.

5.6.3.5 Cluster 2.5: Government experience

'*C06- Government experience in O&M*' has a loading factor of 0.878 and '*C07- Government experience in PM*' has a loading factor of 0.834. This cluster accounts for 8.450% of the total variance. Government experience plays a critical role in project scale (loading factor: 0.636) and plays an important part in both public sector and private investors deciding whether to implement a project under PPP and which scheme will bring most benefits for all stakeholders.

5.7 GROUP 3: PRIVATE-FINANCE FAMILY KEY FINDINGS

5.7.1 Mean analysis and significant difference(s) on rankings of selection criteria in developed and developing countries for Private-financed family

Ranking of the selection of 25 PPP scheme factors was obtained by computing the means for the overall sample as well as for separate groups of developed countries and developing countries. Of the mean importance values of 25 criteria, of ranges from 3.19 to 4.37 for the selection of the PPP families, '*government experience in O&M*' as well as in '*government experience PM*', have the mean score of 3.189 and 3.296 respectively. These are less than 3.4; hence these two factors are considered as not important for the selection of PPP schemes. The rest of the 23 criteria are considered as important.

The Mann-Whitney U-Test for each of the 25 selection factors examined the significant difference in mean value responses between the two respondent groups from developed countries and developing countries. These tests were carried out and the results are shown in Table 5-18.

Five crucial criteria for selection of private-financed family schemes are 'C09 - Financial attraction of project to investors' (mean value 4.372), 'C10 - Financial viability based on NPV and risk-adjusted present value' (mean score 4.296), 'C01 - Stable politics and government system' (mean score 4.224), 'C03 - Supportive political climate for PPP projects' (mean score 4.208) and 'C05 - Mature legal system required to support PPP procurements' (mean score 4.192). Both respondents from developed and developing countries shared agreement on that 'C09 - Financial attraction of project to investors' (mean value 4.372) and 'C10 - Financial viability based on NPV and risk-adjusted present value' (mean value 4.296) are the most important criteria for the selection of a PPP scheme for private-financed projects. Both respondents from developed and developing countries ranked these two criteria as the most important criteria. This is easy to understand, as the fundamental motivation of these schemes is to bring private funding for public infrastructure services. The willingness of private sector investors and lenders to develop public infrastructure projects depends significantly on the environment where these projects operate. 'C05 - Mature legal system required to support PPP procurements' ranks 3rd in developing countries whilst ranking 9th for developed countries. In contrast, 'C16 - Regulatory/Political risks due to legal changes and unsupportive government policies' ranks 3rd in developed countries but ranks 8th in developing countries. Political or policy changes during concession can lead to project breach or termination of contracts, and the inability to recoup the investment. Experiences in some developed countries show that political risks are far more difficult to control (Johnston, J & Gudergan 2007), while in developing countries such as China and Thailand these risks are not imaginary (Koppenjan & Enserink 2009). It is clear that for PPP projects, those that require private finance with a large amount of investment, the profit gain should be greater to overcome investment. Hence, to ensure the profit of the project, criteria related to a stable political and government system are critical to the success of the PPP project, as the government can help to create and maintain a stable investment environment.

As presented in Table 5-18, in the significance test results using Mann-Whitney U-Test on rankings of the selection criteria of PPP scheme between two independent groups at a significance level 0.05, respondents from developed and developing countries shared similar agreement on the ranking in 16 out of 25 criteria. The rest of the 9 criteria indicated that there is a difference in the perception of the two groups of respondents. These criteria, with the exception of '*C09 - Financial attraction of project to investors*', are more critical in developed countries than in developing countries. Respondents ranked the attraction in the profitability of the project as the first essential criteria when choosing a project to be carried out in both developed and developing countries. However, the mean value of the former is 4.63 compared to the later mean value, which is 4.28.

Respondents from developed countries ranked '*C08 - The project scale and the amount of total investment*' more important than participants in developing countries (8th and 10th respectively). This is because the investment in PPP in developed countries is are often made by private investors (Osei-Kyei & Chan 2017b); hence the scope of service must be considered carefully to ensure the project success. On the contrary, for most developing countries, the major source of investment for PPP infrastructure projects comes from banks, rather than utilising private investment (Hyun, Park & Tian 2018) and foreign aid is a significant source of funding (Trebilcock & Rosenstock 2015).

Table 5-18: Results of Mann-Whitney U-Tests for Private-financed family

PRIVATE-FINANCED FAMILY	Developed countries N=86			Developing countries N=164			Total N=250			Mann-Whitney U Test				
	Mean	Std.	Rank	Mean	Std.	Rank	Mean	Std.	Rank	(1) mean rank	(2) mean rank	U statistic	Z	p value
01- Stable politics and government system	4.35	0.930	4	4.16	1.074	4	4.22	1.029	3	133.06	121.53	6401.5	-1.313	0.189
02- Stable macro-economic outlook during the project life cycle	4.23	0.836	6	4.11	0.907	6	4.15	0.883	6	131.28	122.47	6554.5	-0.983	0.326
03- Supportive political climate for PPP projects	4.34	0.889	5	4.14	1.002	5	4.21	0.968	4	134.08	121.00	6314.0	-1.475	0.140
04- Community/Public support to PPP projects	4.04	0.999	10	3.97	1.024	7	3.99	1.014	9	128.40	123.98	6802.5	-0.484	0.628
05- Mature legal system required to support PPP procurements	4.19	1.000	9	4.20	0.978	3	4.19	0.983	5	125.63	125.43	7040.5	-0.023	0.982
06- Government experience in O&M	3.15	1.057	25	3.21	1.059	25	3.20	1.057	25	121.96	127.36	6747.5	-0.585	0.558
07- Government experience in Project Management	3.27	1.078	24	3.31	1.127	24	3.30	1.109	24	120.81	127.96	6649.0	-0.771	0.441
08- The project scale and the amount of total investment	4.20	0.931	8	3.77	0.976	10	3.92	0.980	10	147.15	114.15	5190.0	-3.604	0.000*
09- Financial attraction of project to investors	4.63	0.687	1	4.24	0.946	1	4.37	0.884	1	144.58	115.49	5411.0	-3.415	0.001*
10- Financial viability based on NPV and risk-adjusted PV	4.42	0.711	2	4.23	0.904	2	4.30	0.846	2	133.08	121.52	6400.0	-1.314	0.189
11- Technical Risk due to engineering and design failures	3.88	0.832	17	3.63	0.991	15	3.72	0.945	17	135.16	120.44	6221.5	-1.627	0.104
12- Construction risk, due to faulty construction techniques and cost escalation and delays in construction	4.01	0.759	11	3.69	0.963	13	3.80	0.910	12	139.99	117.90	5806.0	-2.445	0.014*
13- Operating risk due to higher operating costs and maintenance costs	3.99	0.833	12	3.61	0.982	16	3.74	0.949	15	143.55	116.03	5499.5	-3.035	0.002*
14- Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand	4.22	0.860	7	3.93	0.934	9	4.03	0.918	8	140.08	117.85	5798.0	-2.463	0.014*
15- Financial risks arising from exchange rate volatility, transaction costs and financing costs	3.94	0.860	16	3.71	0.940	12	3.79	0.918	13	136.72	119.62	6087.5	-1.889	0.059
16- Regulatory/Political risks due to legal changes and unsupportive government policies	4.35	0.891	3	3.95	1.056	8	4.09	1.018	7	143.84	115.88	5474.5	-3.097	0.002*
17- Innovation in technology	3.57	0.875	21	3.60	0.989	18	3.59	0.950	18	123.81	126.38	6907.0	-0.282	0.778

PRIVATE-FINANCED FAMILY	Developed countries N=86			Developing countries N=164			Total N=250			Mann-Whitney U Test				
	Mean	Std.	Rank	Mean	Std.	Rank	Mean	Std.	Rank	(1) mean rank	(2) mean rank	U statistic	Z	p value
18- Innovation in management	3.44	0.989	23	3.56	1.005	19	3.52	0.999	21	119.88	128.45	6568.5	-0.936	0.349
19- Innovation in operation	3.58	0.874	20	3.47	0.993	21	3.51	0.953	22	130.27	123.00	6642.0	-0.797	0.425
20- Government provides guarantees against financial, political/legal risk	3.95	1.084	15	3.73	1.130	11	3.81	1.117	11	134.70	120.67	6260.5	-1.518	0.129
21- Project design and construction complexity	3.77	0.877	18	3.42	0.984	23	3.54	0.961	20	141.30	117.21	5693.0	-2.638	0.008*
22- The complexity in the operation and or maintenance stage	3.69	0.871	19	3.48	0.937	20	3.55	0.918	19	135.45	120.28	6196.5	-1.671	0.095
23- Alternative solutions which may affect the demand of the PPP project	3.99	1.023	13	3.64	0.971	14	3.76	1.001	14	142.35	116.66	5603.0	-2.791	0.005*
24- Type of asset: Economic infrastructure	3.96	1.153	14	3.61	1.077	17	3.73	1.114	16	141.64	117.04	5664.0	-2.658	0.008*
25- Type of asset: Social infrastructure	3.50	1.013	22	3.45	1.058	22	3.47	1.041	23	127.15	124.63	6910.0	-0.272	0.785

Note: (1) Developed countries (2) Developing countries

Among six risk criteria, four of them have significant differences for developing countries and developed countries. They are '*C12 - Construction risk, due to faulty construction techniques and cost escalation and delays in construction*', '*C13 - Operating risk due to higher operating costs and maintenance costs*', '*C14 - Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold*' and '*C16 - Regulatory/Political risks due to legal changes and unsupportive government policies'*. Respondents from developed countries ranked these criteria of higher importance than those from the developing countries. In contrast, '*C15 - Financial risks arising from exchange rate volatility, transaction costs and financing costs*' was ranked higher in criticality compared to developed countries. This is understandable as developing countries, in recent years, have had unstable macroeconomic indicators particularly with an exchange and interest rate fluctuation, which can cause an increase in the overall project cost and user charges (Osei-Kyei & Chan 2017c). '*C14 - Financial risks arising from the inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold*' ranked 7th for developed countries and 9th for developing countries. Incorrect demand forecast due to improper or limited data and overly optimistic perspective were the main reasons that led to the failure of many projects in developing countries such as Hungary, Laos Republic, Mexico as shown in Soomro and Zhang (2015b). The estimation of the financial viability of projects heavily depends on the accuracy of traffic demand forecasts. The decrease in customer trust in the performance of the service will lead to the decrease in traffic demand. This is also the reason for less revenue generation.

Through the project life cycle, risks in the construction stage are the most perilous (Zou, Zhang & Wang 2006). '*C16 - Regulatory/Political risks due to legal changes and unsupportive government policies*' ranked the third in developed countries whereas it ranked 8th in developing countries. Actions such as termination of the concession, imposing of taxes or regulations that emerge, change in government, and so on, can severely reduce the value to investors and in turn, affect the private sector's ability to generate profit (Medda 2007).

'*C21 - Project design and construction complexity*' and '*C23 - Alternative solutions which may affect the demand of the PPP project*' are ranked more critical for developed countries as compared to developing countries. Because the PPP concept was implemented recently in developing countries, only a few projects have so far been fully implemented, compared to the relatively long life of the concession period, from 20 to 30 years.

5.7.2 Factor analysis results

The Bartlett's test of Sphericity is significant (sig. <0.05) and the KMO is 0.909 (Table 5-19) which is above 0.6, suggests the data set is suitable for factor analysis. The results of these tests confirmed that the data were appropriate for factor analysis.

Table 5-19: KMO and Barlett's Test for Private-financed family

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.909
Bartlett's Test of Sphericity	Approx. Chi-Square	3704.920
	df	253
	Sig.	.000

The factor grouping based on Varimax rotation was adopted and is shown in Table 5-20. The principal component analysis produced four-factor solutions with eigenvalues greater than 1.000, is regarded as significant, explaining 65.235% of the variance.

Table 5-20: Total variance explained for Private-financed family

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.435	41.022	41.022	5.273	22.928	22.928
2	2.800	12.175	53.197	3.634	15.800	38.728
3	1.666	7.242	60.439	3.297	14.334	53.062
4	1.103	4.796	65.235	2.800	12.173	65.235
5	0.986	4.285	69.520			
…	…	…	…			
23	0.141	0.614	100.000			

This is further shown in Figure 5-6: the Scree Plot of the total variance of the underlying grouped factors can be used to present the data adequately.

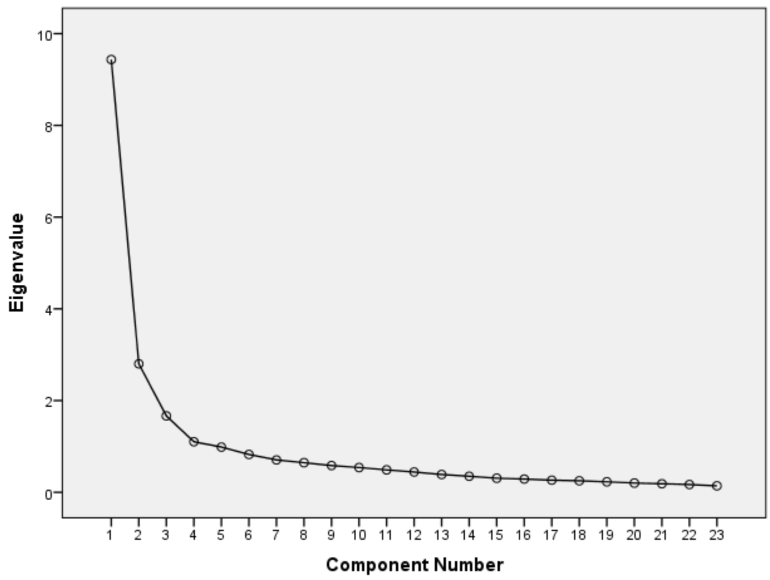


Figure 5-6: The scree plot showing extracted factors on Private-financed family

The factor grouping based on Varimax rotation is shown in Table 5-21. Each dimension consists of a set of factors and each variable belongs to only one of the clusters, with the loading on each factor exceeding 0.50 (Hair et al. 2010). The loading of each criterion represents its contribution to the underlying components (Ameyaw et al. 2016).

Table 5-22: Rotated Component Matrix[a] for Private-financed family

	Factor loading	Initial Eigenvalues		
		Total	% of variance	Cumulative %
Cluster 3.1: Favourable investment environment with viable financial package		**9.435**	**41.022**	**41.022**
C01 - Stable politics and government system	.860			
C03 - Supportive political climate	.822			
C02 - Stable macro-economic outlook	.766			
C16 - Regulatory/Political risks	.715			
C05 - Mature legal system	.697			
C04 - Community/Public support	.592			
C20 - Government provides guarantees	.582			
C10 - Financial viability	.555			
C09 - Financial attraction	.533			
Cluster 3.2: Risks in PPP project		**2.800**	**12.175**	**53.197**
C12 - Construction risk,	.841			
C11- Technical Risk	.830			
C13 - Operating risk	.772			
C14 - Financial risks arising from inaccurate forecast	.512			
Cluster 3.3: Types of PPP project and its complexity		**1.666**	**7.242**	**60.439**
C24 - Economic infrastructure	.737			
C25 - Social infrastructure	.681			
C22 - The complexity in the O&M stage	.598			
C08 - The project scale and the amount of total investment	.575			
C21 - Project design and construction complexity	.570			
C23 - Alternative solutions	.554			
Cluster 3.4: Innovation		**1.103**	**4.796**	**65.235**
C18 - Innovation in management	.859			
C19 - Innovation in operation	.857			
C17 - Innovation in technology	.822			

As the criteria '*C15: Financial risks arising from exchange rate volatility, transaction costs and financing costs*' has the loading factor of less than 0.5, that does not belong to any of the factor groups. The rest of the 22 selection criteria can be grouped into four principal clusters as follows:

- Cluster 3.1 represents Favourable investment environment with viable financial package
- Cluster 3.2 represents *Risks in PPP project*
- Cluster 3.3 represents Types of PPP project and its complexity
- Cluster 3.4 represents *Innovation*

5.7.3 Findings and discussions

5.7.3.1 Cluster 3.1: Favourable investment environment with viable financial package

This cluster group accounts for 41.022% of the total variance in the factor analysis and consists of nine criteria. The investment environment that is favourable for PPP must include '*C01 - Stable politics and government system*', '*C03 - Supportive political climate for PPP projects*', '*C02 - Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)*' with very high factor loading (0.860, 0.822, and 0.766 respectively). These criteria are crucial for the successful private-financed family PPP types. The other three factors are '*C16 - Regulatory/Political risks due to legal changes and unsupportive government policies*', '*C05 - Mature legal system required to support PPP procurements*', and '*C04 - Community/public support to PPP projects*' (loading factor 0.715, 0.697 and 0.592 respectively). The favourable legal framework is crucial for the selection of a PPP scheme, as public opposition can lead to political debates and even ruin the project (Zhang, Xueqing 2005a). The last three components are '*C20 - Government provides guarantees against financial risks, political/legal risk*', '*C10 - Financial viability based on NPV and risk-adjusted present value*', and '*C09 - Financial attraction of project to investors*' (loading factor 0.582, 0.555, and 0.533 respectively). In a PPP project, a financial package usually has a greater impact on a PPP project's viability than the physical design or construction costs (Zhang, Xueqing 2005a). Government support in the form of guarantees is needed to improve the confidence of the private sector, especially in economies in which the market is not yet mature and access to the financial market is often held up by vague regulations (Yang, Y, Hou & Wang 2013).

5.7.3.2 Cluster 3.2: Risks over the project life cycle

This cluster accounts for 12.175% of the total variance and includes risks throughout the project life cycle. This cluster grouping is very critical in the selection of a PPP scheme, especially for PPP projects with the use of private sector capital to fund an asset. When risks are not managed properly, the chance of contract dispute, construction claims and litigation is high and continue to increase (Jin, Zhang & Yang 2012). The first three components with very high loading factors are '*C12 - Construction risk, due to faulty* *construction techniques and cost escalation and delays in construction*', '*C11 - Technical Risk due to engineering and design failures*', and '*C13 - Operating risk due to higher operating costs and maintenance costs*' (loading factor 0.841, 0.830, and 0.772 respectively). The last component of this cluster, related to financial risks arising from the inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold leading to revenue deficiency, with loading factors is 0.512.

5.7.3.3 Cluster 3.3: Types of PPP project and its complexity

This cluster accounts for 7.242% of the total variance between the scheme selection criteria. Types and project complexity are crucial for decision-makers when choosing an appropriate PPP scheme. '*C24 - Type of asset: Economic infrastructure*' and '*C25 - Type of asset: Social infrastructure*' have the loading factor (0.737, 0.681 respectively). '*C22 - The complexity in the O&M stage'*, '*C08 - The project scale and the amount of total investment*', '*C21 - Project design and construction complexity*', '*C23 - Alternative solutions which may affect the demand of the PPP project*' (loading factor: 0.598, 0.575, 0.570, and 0.554). The more complex and the more the amount of investment, the more critical the government experience for smooth implementation of a PPP project.

5.7.3.4 Cluster 3.4: Project innovation

PPP allows the private party to apply innovative ways to deliver a PPP project in the generation and performance of public services with utilisation of innovation from the private sector hence innovation is one of the important advantages for the adoption of a PPP scheme. This cluster is responsible for 4.796% of the total variances of criteria for scheme selection. There are three elements of this cluster, which are '*C18 - Innovation in management*', '*C19 - Innovation in operation*', and '*C17 - Innovation in technology*' (loading factor 0.859, 0.857, and 0.857 respectively). Innovation is an important factor that can enable the private sector to bring new ideas and provide more cost-efficient services of public services (Spackman 2002). '*Innovation in management*' can create value, build trust between partners, effectively share project risks, and foster public support (Roberts & Siemiatycki 2015). '*C19 - Innovation in operation*' and '*C17 - Innovation in technology*' in PPPs are essential for the competitiveness of regions and individual countries (Witters, Marom & Steinert 2012). Technical innovation is of great importance especially for projects that request considerable high technological and a sophisticated approach.

5.8 GROUP 4: HYBRID FAMILY KEY FINDINGS

5.8.1 Mean analysis and significant difference(s) on rankings of selection criteria in developed and developing countries for Hybrid family

The mean value of the importance of the 25 criteria ranges from 3.40 to 4.32, which are greater than 3.40, and shows that all of these 25 criteria are important for selecting a PPP scheme under the Hybrid family. Respondents from developed countries consider '*C09 - Financial attraction of project to* *investors', 'C03 - Supportive political climate for PPP projects*' and '*C10 - Financial viability based on NPV and risk-adjusted present value*' are the three most important criteria for a scheme selection. While respondents from developing countries chose '*C05 - Mature legal system required to support PPP procurements*', '*C01 - Stable politics and government system*' and '*C09 - Financial attraction of project to investors*' as the three most important factors. Some practitioners admitted that the greatest risk for hybrid family PPP projects in developing countries was political stability and government support (Alhashemi 2008).

The result from the Mann-Whitney U test show that there was a significant difference between respondents from developed and developing countries about '*C09 - Financial attraction of project to investors*', which ranked No.1 in developed countries while ranked No.3 in developing countries. Even though ranking very high in both two groups, respondents from developing countries are concerned more with the adequacy of the legal system combined with a stable political environment. Those are premises that guarantee the success of Hybrid family PPP projects (Yang, J, Nisar & Prabhakar 2017).

Table 5-23: Results of Mann-Whitney U-Tests for Hybrid family

HYBRID FAMILY	Developed countries N=77			Developing countries N=164			Total N=241			Mean Rank		Mann-Whitney U Test		
	Mean	Std.	Rank	Mean	Std.	Rank	Mean	Std.	Rank	(1)	(2)	Mann-Whitney U	Z	p value
01- Stable politics and government system	4.27	0.772	4	4.24	1.032	2	4.25	0.955	3	116.76	122.99	5987.50	-0.707	0.479
02- Stable macro-economic outlook during the project life cycle	4.17	0.733	8	4.17	0.915	4	4.17	0.860	6	117.79	122.51	6067.00	-0.525	0.599
03- Supportive political climate for PPP projects	4.32	0.715	2	4.15	0.988	5	4.21	0.912	4	125.37	118.95	5977.50	-0.721	0.471
04- Community/Public support to PPP projects	3.99	0.939	10	4.11	0.953	7	4.07	0.948	8	114.21	124.19	5791.50	-1.099	0.272
05- Mature legal system required to support PPP procurements	4.27	0.898	5	4.27	0.887	1	4.27	0.889	2	121.44	120.79	6280.00	-0.074	0.941
06- Government experience in O&M	3.30	1.077	25	3.40	1.020	25	3.40	1.037	25	115.15	123.75	5863.50	-0.937	0.349
07- Government experience in Project Management	3.38	1.136	24	3.54	1.065	22	3.48	1.088	22	114.30	124.15	5798.00	-1.065	0.287
08- The project scale and the amount of total investment	4.18	0.790	7	3.86	0.959	9	3.96	0.919	9	136.21	113.86	5143.00	-2.454	0.014
09- Financial attraction of project to investors	4.52	0.661	1	4.22	0.927	3	4.32	0.861	1	134.87	114.49	5246.00	-2.330	0.020*
10- Financial viability based on NPV and risk-adjusted PV	4.33	0.834	3	4.14	0.919	6	4.20	0.895	5	129.90	116.82	5629.00	-1.462	0.144
11- Technical Risk due to engineering and design failures	3.69	1.029	18	3.57	1.003	20	3.61	1.011	18	126.68	118.34	5877.00	-0.907	0.365
12- Construction risk, due to faulty construction techniques and cost escalation and delays in construction	3.96	0.910	11	3.73	1.011	14	3.80	0.984	12	131.19	116.21	5529.00	-1.636	0.102
13- Operating risk due to higher operating costs and maintenance costs	3.87	0.833	14	3.62	0.986	17	3.70	0.945	16	131.53	116.05	5503.00	-1.696	0.090
14- Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand	4.10	0.836	9	3.83	0.994	11	3.92	0.954	10	133.06	115.34	5385.00	-1.941	0.052
15- Financial risks arising from exchange rate volatility, transaction costs and financing costs	3.92	0.943	12	3.67	1.040	15	3.75	1.015	15	132.12	115.78	5457.50	-1.787	0.074
16- Regulatory/Political risks due to legal changes and unsupportive government policies	4.21	0.922	6	4.07	0.934	8	4.11	0.931	7	128.38	117.53	5745.50	-1.200	0.230
17- Innovation in technology	3.57	0.979	20	3.56	0.967	21	3.56	0.969	21	122.27	120.4	6216.00	-0.205	0.838
18- Innovation in management	3.42	1.068	23	3.47	0.993	23	3.45	1.016	24	120.55	121.21	6279.50	-0.072	0.943

HYBRID FAMILY	Developed countries N=77			Developing countries N=164			Total N=241			Mean Rank		Mann-Whitney U Test		
	Mean	**Std.**	**Rank**	**Mean**	**Std.**	**Rank**	**Mean**	**Std.**	**Rank**	**(1)**	**(2)**	**Mann-Whitney U**	**Z**	**p value**
19- Innovation in operation	3.57	0.922	21	3.40	0.977	24	3.45	0.961	23	129.73	116.9	5642.00	-1.403	0.161
20- Government provides guarantees against financial, political/legal risk	3.91	0.976	13	3.86	0.959	9	3.88	0.962	11	123.69	119.74	6107.00	-0.435	0.664
21- Project design and construction complexity	3.73	0.912	16	3.57	0.953	19	3.62	0.941	17	127.55	117.92	5809.50	-1.056	0.291
22- The complexity in the operation and or maintenance stage	3.61	0.920	19	3.60	0.950	18	3.61	0.939	19	120.23	121.36	6255.00	-0.124	0.902
23- Alternative solutions that may affect the demand of the PPP project	3.71	1.157	17	3.80	0.919	12	3.78	1.000	13	120.14	121.41	6247.50	-0.138	0.890
24- Type of asset: Economic infrastructure	3.83	1.069	15	3.74	0.918	13	3.77	0.967	14	128.27	117.59	5754.50	-1.169	0.243
25- Type of asset: Social infrastructure	3.45	1.056	22	3.67	0.948	16	3.60	0.987	20	111.16	125.62	5556.50	-1.575	0.115

Note: (1) Developed countries (2) Developing countries

5.8.2 Factor analysis results

The Bartlett's test of Sphericity is significant (sig. <0.05) and the KMO is 0.890 (significance of 0.000), which is above 0.6, suggesting the data set is suitable for factor analysis. The results of these tests confirmed that the data were appropriate for factor analysis.

Table 5-24: KMO and Barlett's Test for Hybrid family

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.890
Bartlett's Test of Sphericity	Approx. Chi-Square	3718.144
	df	300
	Sig.	.000

From Table 5-25 it is noticeable that 70.036% of the cumulative variance is attributable to the first six factors, which satisfy the basic requirement of 60% advocated by Malhotra (2010).

Table 5-25: Total Variance Explained for Hybrid family

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.672	38.687	38.687	4.188	16.751	16.751
2	2.504	10.015	48.702	3.842	15.369	32.120
3	1.820	7.279	55.980	2.744	10.976	43.096
4	1.269	5.075	61.056	2.570	10.281	53.377
5	1.169	4.678	65.734	2.214	8.856	62.233
6	1.076	4.303	70.036	1.951	7.803	70.036
7	0.915	3.659	73.696			
…	…	…	…			
25	0.121	0.483	100.000			

The principal component analysis produced a six-factor solution with eigenvalues greater than 1.000, explaining 70.036% of the variance and the factor grouping based on Varimax rotation is shown in Table 5-26. Each variable belongs to only one of the clusters, with the loading on each criteria exceeding 0.50.

This is further shown in Figure 5-7: the Scree Plot figure of the total variance of the underlying grouped factors and can be used to adequately represent the data.

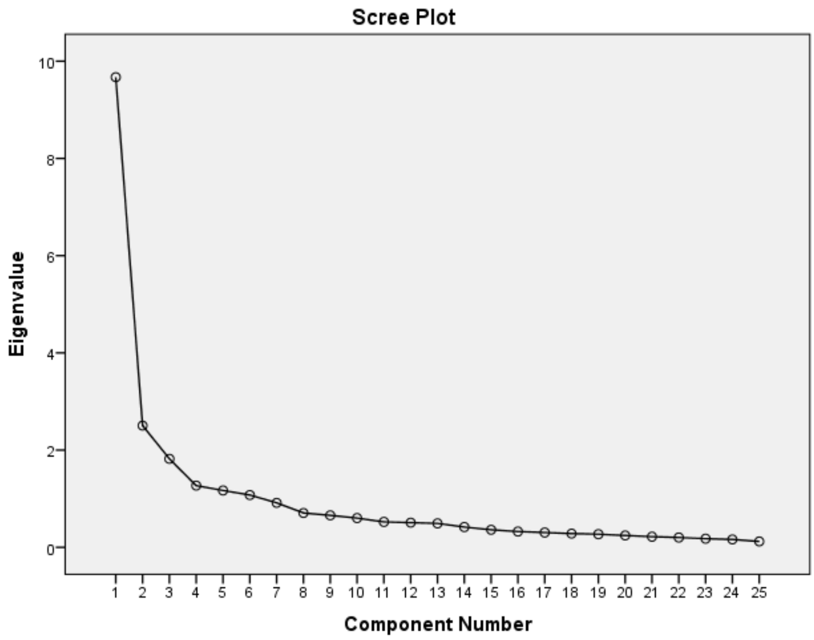


Figure 5-7: The scree plot showing extracted factors on Hybrid family

The factor grouping based on Varimax rotation was adopted and is shown in Table 5-26.

Table 5-26: Rotated Component Matrix[a] for Hybrid family

	Loading factor	Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %
Cluster 4.1: Risks over project life cycle (R)		**4.188**	**16.751**	**16.751**
C12 - Construction risk	.809			
C13 - Operating risk	.784			
C11 - Technical Risk	.763			
C14 - Financial risks arising from inaccurate forecast	.734			
C15 - Financial risks arising from exchange rate	.641			
Cluster 4.2: Political and Macro-economic conditions (P)		**3.842**	**15.369**	**32.120**
C01 - Stable politics and government system	.815			
C03 - Supportive political climate	.762			
C02 - Stable macro-economic outlook	.729			
C16 - Regulatory/Political risks	.658			
C05 - Mature legal system	.656			
C04 - Community/Public support	.540			
Cluster 4.3: Project Innovation (I)		**2.744**	**10.976**	**43.096**

	Loading factor	Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %
C19 - Innovation in operation	.843			
C17 - Innovation in technology	.840			
C18 - Innovation in management	.828			
Cluster 4.4: Types and project complexity (T)		**2.570**	**10.281**	**53.377**
C25 - Social infrastructure	.773			
C24 - Economic infrastructure	.749			
C23 - Alternative solutions	.598			
Cluster 4.5: Government experience and project scale (G)		**2.214**	**8.856**	**62.233**
C06 - Government experience in O&M stage	.837			
C07 - Government experience in PM	.834			
C08 - The project scale and the amount of total investment	.511			
Cluster 4.6: Financial viability (F)		**1.951**	**7.803**	**70.036**
C10 - Financial viability	.774			
C09 - Financial attraction	.767			

5.8.3 Findings and discussions

As ‘C20 - Government provides guarantees against financial, political/legal risk’, ‘C21 - Project design and construction complexity’ and ‘C22- The complexity in the operation and or maintenance stage’ with the loading factor is less than 0.5, they do not belong to any of the factor groups.

The rest of the 22 selection criteria can be grouped into six principal clusters as follows:

- Cluster 4.1 represents Risks over project life cycle
- Cluster 4.2 represents Political and Macro-economic conditions
- Cluster 4.3 represents *Project innovation*
- Cluster 4.4 represents Types and project complexity
- Cluster 4.5 represents Government experience and project scale
- Cluster 4.6 represents *Financial viability*

5.8.3.1 Cluster 4.1: Risks over project life cycle

This cluster accounts for 16.751% of the total variance and includes risks throughout the project life cycle. This cluster grouping is very critical in the selection of a Hybrid family PPP scheme.

Appropriate risk identification and allocation/sharing is of absolute importance for the successful implementation of a PPP project. The cluster comprises five criteria, which are:

C12 - Construction risk, due to faulty construction techniques and cost escalation and delays in construction

C13 - Operating risk due to higher operating costs and maintenance costs

C11 - Technical Risk due to engineering and design failures

C14 - Financial risks arising from the inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold

C15 - Financial risks arising from exchange rate volatility, transaction costs and financing costs

The first three components with very high loading factors are construction risk, operating risk and technical risk (0.809, 0.784 and 0.763 respectively). The other two following components related to financial risks with loading factors are 0.734 and 0.641, respectively.

5.8.3.2 Cluster 4.2: Political and Macro-economic conditions,

This cluster is very important for any PPP projects and accounts for 15.369% of the total variance. The factor structure of this group consists of:

C01 - Stable politics and government system

C03 - Supportive political climate for PPP projects

C02 - Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)

C16 - Regulatory/Political risks due to legal changes and unsupportive government policies

C05 - Mature legal system required to support PPP procurements

C04 - Community/Public support to PPP projects

C01, C03 and C02 with very high factor loading (0.815, 0.762 and 0.729 respectively) are crucial for the success of any Hybrid family schemes. C04 -Community/Public support- with loading factor of 0.540 is critical for the selection of a PPP scheme as public opposition can lead to political debates and even ruin the project (Zhang, Xueqing 2005a).

5.8.3.3 Cluster 4.3: Project innovation

Innovation is one of the important advantages for the adoption of a PPP scheme. This cluster is responsible for 12.283% of the total variances of criteria for scheme selection. There are three elements of this cluster: '*C18 - Innovation in management*', '*C19 - Innovation in operation*' and '*C17 - Innovation in technology*'. Innovations in management and operation have significance value of 0.856 and 0.802. Innovation in technology criteria has a loading factor of 7.32. When choosing hybrid family schemes, management and operation can affect the overall performance of the project. Innovation is of great importance and requires a considerably high technological and sophisticated approach as PPP allows a private party to adopt innovative ways to deliver a PPP project.

5.8.3.4 Cluster 4.4: Types and project complexity

This cluster accounts for 10.281% of the total variances and comprises of three criteria. '*C25 - Social infrastructure*' and '*C24 - Economic infrastructure*' have significance value of 0.773 and 0.749 respectively. '*C23 - Alternative solutions which may affect the demand of the PPP project*' has a loading factor of 0.511.

5.8.3.5 Cluster 4.5: Government experiences and project scale:

The cluster accounts for a significance of 11.682% of the total variances, which comprises of three criteria. '*C06 - Government experience in O&M*', '*C07 - Government experience in PM*' and '*C08 - The project scale and the amount of total investment*' have loading factors of 0.837, 0.834 and 0.511 respectively. Government experiences received high loading factors; hence are important in choosing a project scheme.

5.8.3.6 Cluster 4.6: Financial viability

This cluster grouping accounts for 7.344% of the total variability in the factor analysis with two criteria related to financial attraction and financial viability (loading factors are 0.741 and 0.723 respectively). These criteria are of very significant importance for the selection of PPP schemes.

5.9 SUMMARY OF THE CHAPTER

PPPs, with the use of private funding, can help governments worldwide to boost economic development with better infrastructure. Choosing the most appropriate PPP scheme that will help stakeholders to achieve V*f*M with shorter delivery time and higher quality is pivotal for project success. The objective of this chapter is to identify the criteria to choose an appropriate private-financed PPP scheme by using the questionnaire survey with international experts from both developed and developing countries, who have expertise in the position of choosing a PPP scheme. The Cronbach's alphas show strong consistency and reliability of the survey for further data analysis. The Kendall's coefficients of concordance of all PPP families show a strong agreement among respondents.

Table 5-27: Summary of results from questionnaire survey

	Group 1: O&M	**Group 2: Public-financed**	**Group 3: Private-financed**	**Group 4: Hybrid**
No. of important criteria ranked by mean scores and standard deviations	22	22	23	25
No. of clusters extracted from factor analysis	6	5	4	6
No. of criteria resulted from factor analysis	18	19	22	22

The next chapter presents the development practice of PPP in Vietnam and results from the questionnaire survey and semi-structured interviews conducted in Vietnam to understand the constraints involved in doing PPP in Vietnam.

Chapter 6

PPP IMPLEMENTATION PRACTICE IN VIETNAM

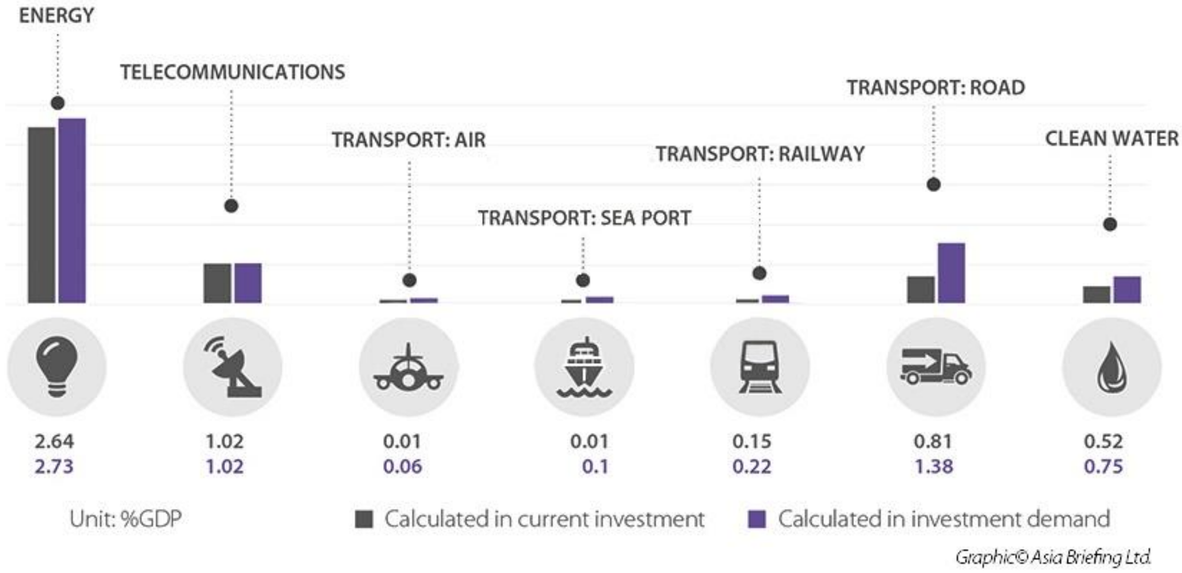
6.1 INTRODUCTION

PPP in Vietnam is not completely new, as it has been adopted since the 1990s, with a vision to achieve rapid developments in the economy and in infrastructure. This chapter provides a comprehensive review and assessment of the development and current implementation practices of PPP in Vietnam. First, the chapter focuses on providing information on the development of PPP infrastructure in Vietnam, then it discusses the findings from the questionnaire survey. The chapter also presents the findings of semi-structured interviews conducted with PPP practitioners of senior management level from the public, private sectors and consultant firms to find out the current constraints in doing PPPs in Vietnam. These results provide a better understanding of current PPP practice projects in Vietnam.

6.2 DEVELOPMENT OF PPP INFRASTRUCTURE IN VIETNAM

In 1986, at the sixth National Congress, the Communist Party of Vietnam introduced the *Đổi Mới* (Reform) policy, which adopted a market-based economy in Vietnam and opened the market to foreign investors. As a member of World Trade Organization (WTO) since 2007 and with a population exceeding 96 million, Vietnam is attempting to establish a market economy, survive global competition through international economic integration, and maintain economic stability. Thus far, Vietnam has signed 12 regional and bilateral trade agreements as evidence of their attempts to encourage economic growth (Nguyen, HV 2017).

In order to improve the essential infrastructure systems and to push for rapid economic development, the Government of Vietnam (GoV) has invested millions of dollars annually. Data from the WB and Ministry of Planning and Investment (MPI) of Vietnam show that private sectors have been actively involved in energy (electricity in particular) and road and highway sectors. As shown in Figure 6-1, Global Infrastructure Outlook has forecast that from 2016-2040, 5.16% of the Gross Domestic Product (GDP) will be invested in the infrastructure sector despite the demand being 6.26% of the GDP. Out of the major sectors, demand for investments in energy and road sectors will be the highest, with 2.73% and 1.38% of GDP respectively. Telecommunications and clean water are forecast to receive investments equivalent to 1.02% and 0.75% of GDP respectively. Other infrastructure sectors have focused less on investments due to the observed less demand.

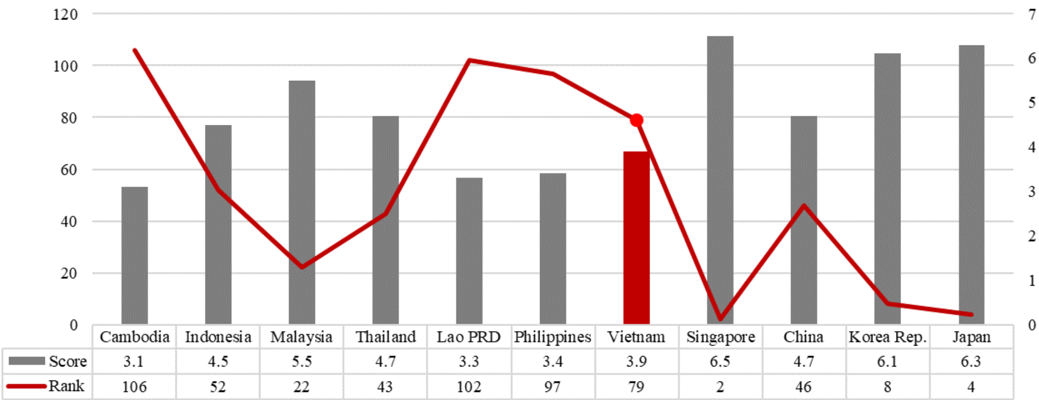


Source: Global Infrastructure Outlook (2017)

Figure 6-1: Infrastructure investment forecast 2016-2040 in terms of GDP

The Vietnam Development Report (VDR) showed that the financing needed to meet Vietnam's future infrastructure needs has reached an unaffordable level (Mishra 2011). With this huge investment demand, GoV finds it difficult to be the sole provider of all the funding sources. Despite the efforts of GoV to substantially invest in various financial sources such as governmental funds, Official Development Assistance (ODA) funds, Foreign Direct Investment (FDI) and PPP in all sectors of infrastructure, a considerable gap still exists between demand and supply (WB 2012). Hence, attracting private investments in infrastructure development is a key mechanism that can address the challenges of infrastructure development in Vietnam. the World Economic Forum (WEF) (2017) highlighted that out of 16 issues in undertaking business in Vietnam, 'access to financing' is the most problematic issue, which further highlights the importance of procurement of sufficient funding. The observations are similar to the findings issued by WB (2015) that further exemplify that 'access to financing' and 'transportation' are the biggest obstacles when managing a business in Vietnam. Besides, 'poor educated workforce' and 'corruption' are also considered as great concerns of functioning as a proper business.

Moreover, as illustrated in Figure 6-2, WEF's competitiveness index (2017-2018) for infrastructure in Vietnam records a score of 3.9, which is below many Asian countries and better than only the Philippines, Lao PRD and Cambodia. The score ranks 79 out of the 137 countries considered, which further signifies the importance of improving the existing systems, and investing in new quality infrastructure systems.



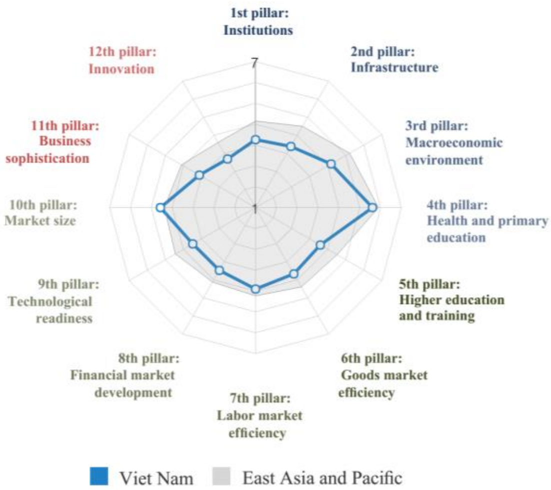
Source: WEF (2018)

Figure 6-2: Ranking of infrastructure condition in 2017-2018

The report also assessed the score on infrastructure among eleven policy domains such as institutions, macroeconomic environment, health and primary education, market size or innovation. The score on the infrastructure based on several components such as the quality of overall infrastructure, quality of roads, railroad, and port infrastructure. The score on infrastructure (score 3.9) is lower than the overall Global Competitiveness Index (score 4.4). The scores and rankings of the infrastructure indicators are shown in Table 6-1**.**

Table 6-1: Score of infrastructure in Vietnam

Indicator	Score	Rank
Overall Competitive Index	**4.4**	**55/137**
2nd pillar: Infrastructure	**3.9**	**79/137**
Quality of overall infrastructure	3.6	89
Quality of roads	3.4	92
Quality of railroad infrastructure	3.0	59
Quality of port infrastructure	3.7	82



Source: The Global Competitiveness Report 2017-2018 (WEF 2017) (Note: *Lower value indicates improved adequacy over higher number)*

The transport network in Vietnam is shown in Figure 6-3. Vietnam's road network has a length of about 260,000 km, of which 17,500 km are national highways, 23,500 km are provincial roads and the rest are other local roads (i.e., district roads, communal roads, urban roads and exclusive roads). The quality of the road network is narrow and has limited capacity, with scores of 3.4 out of 7. The main mode of freight transport is by road. The country has to deal with poor road conditions, inexperienced project managers, time and cost overruns, as long eastern seaboard, difficult subsoil conditions, and the need for higher vehicle clearances (Duong 2014).

The quality of railroad infrastructure is really poor, backward and not maintained due to limited investments from the government (Vu, AM 2017). The quality index of railroad only observes a score of 3.0 out of 7. The cost of rail service is high, and the quality is low. GoV has set a plan to make full use of the existing railway infrastructure and build up a new line. A 1,559-km high-speed rail line is planned with a total investment of USD59 billion. The first stage is set to initiate from 2020-2032 and the second stage is expected to be completed in 2050. However, this project is very ambitious and there is no strict deadline for it, as the total amount of investment is enormous.

'The port infrastructure quality index' for Vietnam is 3.7, which ranks the country 82 out of 140 countries. The current problem is that the country's port infrastructure has 80 small ports in coastal provinces that service inter-provincial trade and the fishing industry (Duong 2014) and only two deep-water ports. The first port *Cai Mep* International Terminal, operating since 2009, is running at only 30% of its capacity. Another deep-water port *Lach Huyen*, has recently commenced its duties since 2016. Many other deep-water seaport projects are at a standstill while looking for investments (Vietnam Briefing 2015). These observations further demonstrate that the majority of the infrastructure systems require either upgrades or new developments and are restrained by lack of sufficient investments.

The socio-economic development plan (Vietnam 2011, p.1) sets the national development orientation as '*creating a foundation for the country to basically become a modernity-oriented industrial nation by 2020*'. The objective of the plan is to build an infrastructure system that synchronises with modern projects, focus on traffic system and larger urban systems with comprehensive, modern and environment-friendly infrastructure. The government has realised the importance of infrastructure development and has given the highest priority to establishing a comprehensive system of infrastructure. However, Vietnam faces a significant infrastructure financing gap (ADB 2012) and lacks a mature legal framework, inadequate regulations and a missing buy-out clause (Nguyen, HV 2017).

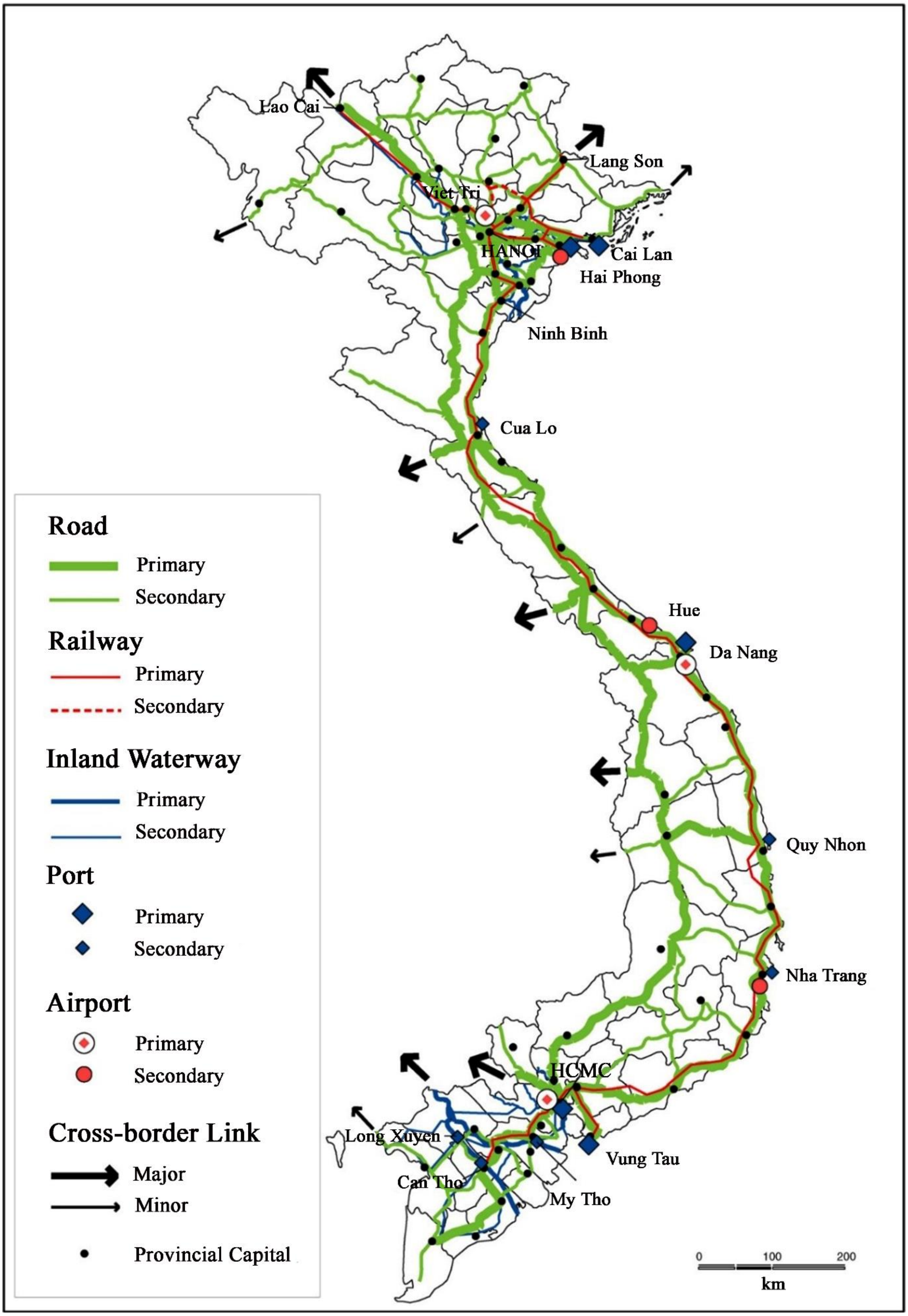


Figure 6-3: Long-term transport network in Vietnam (JICA study 2000)

For Vietnam, the key to financing and effective PPP implementation is the use of improved project selection methodologies (WB 2006). The procedures of preparation, bidding and operation of PPP projects should align with international best practices (Do 2016). To attract private investment, since 2009, GoV has granted a number of exceptional incentives to investors, such as exemption from corporate income tax, tax reduction, etc.

Every year, GoV invests millions of dollars on developing critical large-scale infrastructure. However, the increasing project costs and significant demand for infrastructure systems have made it increasingly difficult for GoV to fund a project solely. As a lower-middle-income country, the level of Official Development Assistance will be lower in the future (Dinh, TT & Pham 2015); hence, private investment is crucial to fill the public budget shortage. The Government hopes to source a significant portion of the capital through Public Private Partnership (PPP), including foreign investors (Ngo & Huynh 2017). Since 2009, with the intention of attracting private investment, GoV has granted a number of exceptional incentives to investors in the form of corporate income tax exemptions and tax reductions. For Vietnam, the key to effective financing and PPP implementation is the use of improved project selection methodologies (WB 2006). The procedures of preparation, bidding and operation for PPP projects should align with international best practices (Do 2016). Despite efforts by GoV with its increasing openness to private sector participation, private investment in infrastructure, PPPs have attracted less interest (ADB 2012). Lack of return on investments and high-risks associated with foreign investors are the two major reasons for lack of investments in PPP infrastructure projects in Vietnam (Cooper, GT 2018). Land acquisition risks, traffic demand risks, interest rates, uncertainties in traffic volume, operation costs increase, and unexpected tariff changes are the major risks preventing a successful implementation of a PPP project in Vietnam (tariff escalation) and exchange rare risks (JICA 2011). Majority of PPP projects in Vietnam that applied, selected tendering for choosing investors, leading to low competitiveness and lack of transparency. The supervision of projects' implementation has been ineffective, leading to low quality construction works and many other problems (Cooper, GT 2018). Many road and bridge projects are much less successful and were to be turned over to the government (Nguyen, XT & Dapice 2009).

Many PPP projects in Vietnam are often undertaken by State-Owned Enterprises (SOE) in which conflict of interest can be seen here (Nguyen, HV 2017). Concerns increase when SOEs, which are fully or partly managed and owned by government authorities, bid for PPP projects, which are developed and governed by their parent entities. Little equity is funded by the SOEs and their financing comes from the government budget, bank loans, bond issues with government guarantees (Nguyen, HV 2017; Nguyen, XT & Dapice 2009). Until all SOEs are equitized and no longer under the management of the ASAs, this issue will continue to impact negatively on PPP investments and is a source why the PPP market remains immature (Nguyen, HV 2017). To ensure competitive bidding, in Decree 30 on

‘Guidelines for investor selection of the Law on Bidding’, SOEs, which are under the management of the ASAs, must enter into a joint venture with other enterprises to propose a project.

Vietnam is one of the region’s most attractive destinations for foreign investors (Breu et al. 2012). There have been very limited records of PPP infrastructure projects involving international investors, even though GoV has made progress to create a transparent legal framework for investment projects. However, foreign investors still hesitate in investment in Vietnam because of the perceived level of corruption in public or public-managed procurement and project implementation (Benson et al. 2018). In the period from 2007 to 2015, PPPs with participation of foreign investors were only seen in energy sector. Foreign and domestic independent power producer projects account for 62 percent of the total new thermal capacity planned (Nguyen, XT & Dapice 2009) and the government provided guarantee for most foreign PPP projects for their power purchase agreement.

Table 6-2: Main foreign investors and highlighted PPP projects in Vietnam

<table>
<tr><th>Name</th><th>Country of origin</th><th>Name of project</th><th>Types of PPP</th><th>Investment amount (USD mil)</th></tr>
<tr><td>Malakoff BHD</td><td>Malaysia</td><td>Duyen Hai 2 Thermal Power Plant</td><td>BOT</td><td>2,400</td></tr>
<tr><td>Marubeni</td><td>Japan</td><td>Nghi Son 2 Thermal Power Plant</td><td>BOT</td><td>1,869</td></tr>
<tr><td>AES</td><td>USA</td><td rowspan="3">Mong Duong II Thermal Power Generation Project</td><td rowspan="3">BOT</td><td rowspan="3">1,950</td></tr>
<tr><td>China Investment</td><td>China</td></tr>
<tr><td>POSCO</td><td>Korea, Rep.</td></tr>
<tr><td>China Southern Power Grid</td><td>China</td><td rowspan="2">Vinh Tan 1 Coal Plant</td><td rowspan="2">BOT</td><td rowspan="2">1,740</td></tr>
<tr><td>China Power Investment</td><td>Hong Kong, China</td></tr>
<tr><td>British Petroleum</td><td>UK</td><td rowspan="2">Nam Con Son Gas Pipeline</td><td rowspan="2">BOO</td><td rowspan="2">1,300</td></tr>
<tr><td>Conoco Phillips</td><td>US</td></tr>
<tr><td>Tokyo Electric Power Co</td><td>Japan</td><td rowspan="3">Phu My 2.2 Power Plant</td><td rowspan="3">BOT</td><td rowspan="3">480</td></tr>
<tr><td>Sumitomo</td><td>Japan</td></tr>
<tr><td>Electricite de France</td><td>France</td></tr>
<tr><td>Nissho Iwai</td><td>Japan</td><td rowspan="2">Phu My 3 Power Plant</td><td rowspan="2">BOT</td><td rowspan="2">412</td></tr>
<tr><td>SembCorp Industries
THK-BP</td><td>Singapore
Russia</td></tr>
<tr><td>B. Grimm Group</td><td>Thailand</td><td>Dau Tieng 1 & 2 Solar PV Power Plants</td><td>BOO</td><td>397.4</td></tr>
<tr><td rowspan="2">Super Wind Energy</td><td rowspan="2">Thailand</td><td>Bac Lieu Wind Power Project (Phase 3)</td><td>ROT</td><td>390</td></tr>
<tr><td>Soc Trang Wind Plant</td><td>BOT</td><td>237</td></tr>
</table>

Source: Private Participation in Infrastructure Database (WB 2019)

Among the broad spectrum of available PPP delivery models, GoV adopts and supports BOT, BTO, BLT, BTL (Hybrid family) and O&M, BT, BOO (non-Hybrid family) by regulating these types of PPP schemes in Decree 63 to encourage investments. This is expected to boost the economic growth and develop public infrastructure. BOT and BT models, that were introduced under Decree 108/2009, are frequently adopted in procuring power projects and toll roads in Vietnam (Frasers Law 2015). Despite the increase in the number of PPP projects, several PPP road projects in Vietnam are still facing consequences of failures (Dinh, TTH 2016).

Table 6-3: PPP project by sector and total investment in Vietnam

Authority signed the contract	Number of contracts signed	Investment sector				Types of contract				Progress	
		Transpor-tation	Energy	Waste supply,	Others	BOT	BT	BOO	Others	On going	Contract ended
I. Projects of Ministry's levels	87	75	9	0	3	79	7	1	0	86	1
1. Ministry of Defense	2				2		2			1	1
2. Ministry of Industry and Trade	9		9			9				9	
3. Ministry of Transport	75	75				69	5	1		75	
II. Projects of People's committees of Provinces	108	84	0	7	17	42	64	2	0	89	13
Total	**194**	**159**	**9**	**7**	**20**	**121**	**71**	**3**	**0**	**175**	**14**

Source: Ministry of Planning and Investment (MPI) – 2018

As shown in Table 6-3, out of the total 194 signed PPP contracts, 159 are transportation projects, which implies the importance of road infrastructure projects in Vietnam. To date, majority of privately invested infrastructure projects in Vietnam have been developed under the BOT model (Harris, Boots & Lovells 2018). Furthermore, 120 projects out of 195 have been implemented under the BOT scheme, 71 project were under BT and only three projects were recorded to be carried out under BOO (PMI 2018). This signifies that practitioners in Vietnam have more experience in implementing BOT projects.

While international practices recognise V*f*M as the major tool to compare benefits of PPP versus traditional procurement (Morallos & Amekudzi 2008), GoV has never used V*f*M assessment in similar projects. Thus there are criticisms over the selection of the best procurement option (Dinh, TTH 2016). Many organisations such as PPIAF, PPP in Infrastructure Resource Centre (PPPIRC), Japan International Cooperation Agency (JICA) and U.S. Agency for International Development (USAID) have helped Vietnam to develop a charter, legal framework, business plan template and implementation framework to improve the quality of PPP implementation in Vietnam.

6.3 FINDINGS FROM QUESTIONNAIRE SURVEY

A full-scale survey was conducted for a three-month duration and 112 survey responses were received. The following survey analysis is based on these 112 responses.

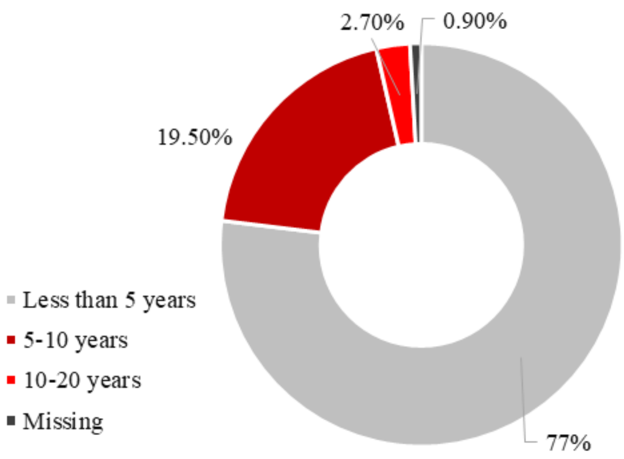


Figure 6-4: Descriptive statistic on years of experience

Since PPP is quite new in Vietnam, the majority of respondents (77.0%) have less than five years of experiences, whereas only 19.5% and 2.7% of respondents have 5-10 years and 10-20 years of experiences respectively. One respondent did not give any information about his or her experience (0.9%). This is because the number of PPP projects in Vietnam has increased significantly since the introduction of Decree 108 in 2009.

Table 6-4: Descriptive statistics on roles of organisation of respondents

Sector	Freq.	%	Respondent background	Freq.	%
PI1: Public sector	18	15.7%	Local Government	6	33.3%
			Central Government	4	22.2%
			Public enterprises	8	44.4%
			Others	0	0.0%
			Total	18	100%
PI2: Private sector	86	74.8%	Concessionaire	38	34.2%
			Main contractor	19	17.1%
			Consultant	33	29.7%
			Designer only	19	17.1%
			O&M Contractor	0	0%
			Financier	2	1.8%
			Total	111	100%
	11	9.6%	Researcher	8	72.7%

Sector	Freq.	%	Respondent background	Freq.	%
PI3: Researcher and others			Policy maker	0	0%
			Others	3	27.3%
			Total	11	100%

6.3.1 Ranking of the selection factors

The mean of 25 criteria ranges from 3.27 to 4.20, in which the mean scores of '*Government experience in O&M*', '*Innovation in management*' and '*Innovation in operation*' are less than 3.40; hence they are considered as not important. The rest of 22 criteria are essential for selecting a PPP scheme. Respondents from Vietnam consider '*Financial attraction to investors*', '*Mature legal system required to support PPP procurements*' and '*Financial viability based on NPV*' as the three most important factors for a scheme selection. This is easy to understand as a legal and dispute resolution framework is yet to be tested and effectiveness in implementation has not been proven (IE Singapore 2016). The concerns about the economic performance of the country, existing financial conditions, the governance practices and uncertainty and less than ideal legal framework are factors that made foreign investors reluctant to engage in PPP projects in Vietnam (Nguyen, HV 2017). This is consistent with the Global Competitiveness Report 2017-2018 (WEF 2017), in that access to financing is the most problematic factor for doing business in Vietnam.

The statistically significant results for the Kruskal-Wallis Test, unfortunately, do not show which of the groups are statistically and significantly different from one another. Hence, the follow-up Mann-Whitney U tests between pairs of groups were carried out. The test has a recalculated alpha value of 0.05, with a hypothesis that there is no significant difference in the importance of selection criteria between the two groups. The test result shows that 13 out of 25 criteria received a different viewpoint in ranking with the significance of less than 0.05, as shown in Table 6-5. The result is not surprising since the respondents were from different countries with different legal systems and were involved in different PPP projects.

Among 13 criteria with significant difference resulted from the Kruskal-Wallis Test, six criteria have statistically significant difference in the perception of respondents from both developed countries versus Vietnam and developing countries versus Vietnam. The criteria are: 'C*03- Supportive political climate for PPP projects*', '*C08- The project scale and the amount of total investment*', '*C13- Operating risk due to higher operating costs and maintenance costs*', '*C16- Regulatory/Political risks due to legal changes and unsupportive government policies*', '*C21- Project design and construction complexity*' and '*C24- Type of asset: Economic infrastructure*'. Respondents from Vietnam positioned these criteria as lower in importance compared to their partners in both developed and developing countries. Two criteria have significant differences in perceptions between developed countries and Vietnam and five criteria received different points of view between developing countries and Vietnam.

Five criteria that have significant difference between respondents from the developing countries and Vietnam are C01, C02, C06, C19 and C25. '*C01 - Stable politics and government system*' and '*C02 - Stable macro-economic outlook during the project life cycle*' are ranked higher in developing countries whereas counterparts in Vietnam ranked them of lower importance. Respondents in Vietnam considered that the economics and development of Vietnam is stable; hence, they ranked these two criteria of lower importance. According to the assessment of the Australian Trade and Investment Commission Australian Government), Vietnam has a very stable socio-political environment ('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')('Private Participation in Infrastructure Database - Vietnam snapshots')compared to many other developing countries; unfavourable economic environment is a great barrier to the development of PPP, which is the inverse in advanced economies (Yang, Y, Hou & Wang 2013).

Respondents in developed countries and Vietnam ranked '*C06- Government experience in O&M*' and '*C19- Innovation in operation*' as not important (mean = 3.27, 3.30 respectively) while their counterparts in developing countries ranked 23rd (mean = 3.70, 3.61 respectively). The differences in mean scores are quite high.

Two criteria that have significant differences between developed countries and Vietnam are 'C09- Financial attraction of project to investors' and 'C15- Financial risks arising from exchange rate volatility, transaction costs and financing costs'. Both ranked C09 1st of importance, however, the difference in mean rank is wide, which are 4.52 and 4.20 respectively. C15 is ranked 12th in developed countries while it is ranked 15th in Vietnam. As there are not many PPP projects in Vietnam that involve foreign investors they are not affected by foreign currencies; hence respondents in Vietnam ranked this criterion less important.

Table 6-5: Ranking of selection criteria of PPP scheme according to countries of respondents

	Developed countries			Developing countries			Vietnam			Total			Kruskal-Wallis Test	Mann-Whitney U Test	
	N=77			N=52			N=112			N=241				(1) Vs (3)	(2) Vs (3)
	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank			
01- Stable politics and government system	4.27	0.772	4	4.61	0.891	1	4.07	1.054	4	4.25	0.955	3	0.000*	0.405	0.000*
02- Stable macro-economic outlook during the project life cycle	4.17	0.733	8	4.47	0.828	3	4.03	0.925	6	4.17	0.860	6	0.004*	0.451	0.002*
03- Supportive political climate for PPP projects	4.33	0.715	2	4.49	0.918	2	4.00	0.986	7	4.21	0.912	4	0.001*	0.042*	0.000*
04- Community/Public support to PPP projects	3.99	0.939	10	4.26	0.905	7	4.05	0.972	5	4.07	0.948	8	0.228	-	-
05- Mature legal system required to support PPP procurements	4.27	0.898	5	4.45	0.777	4	4.19	0.925	2	4.27	0.889	2	0.258	-	-
06- Government experience in O&M	3.30	1.077	25	3.70	0.981	23	3.27*	1.013	25	3.37	1.037	25	0.037*	0.950	0.014*
07- Government experience in PM	3.38	1.136	24	3.78	1.002	21	3.43	1.080	22	3.49	1.088	22	0.100	-	-
08- The project scale and the amount of total investment	4.18	0.790	7	4.10	1.015	9	3.75	0.915	11	3.96	0.919	9	0.002*	0.001*	0.016*
09- Financial attraction of project to investors	4.52	0.661	1	4.28	1.087	6	4.20	0.847	1	4.32	0.861	1	0.022*	0.006*	0.163
10- Financial viability based on NPV and risk-adjusted PV	4.33	0.834	3	4.16	0.998	8	4.13	0.885	3	4.20	0.895	5	0.314	-	-
11- Technical Risk due to engineering and design failures	3.69	1.029	18	3.78	0.997	20	3.47	0.994	19	3.61	1.011	18	0.069	-	-
12- Construction risk, due to faulty construction techniques and cost escalation and delays in construction	3.96	0.910	11	3.86	0.971	17	3.66	1.027	13	3.80	0.984	12	0.122	-	-
13- Operating risk due to higher operating costs and maintenance costs	3.87	0.833	14	3.86	0.864	15	3.51	1.022	17	3.70	0.945	16	0.025*	0.019*	0.036*
14- Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand	4.10	0.836	9	3.98	0.960	12	3.76	1.007	10	3.92	0.954	10	0.051	-	-
15- Financial risks arising from exchange rate volatility, transaction costs and financing costs	3.92	0.943	12	3.86	1.048	18	3.58	1.028	15	3.75	1.015	15	0.037*	0.018*	0.072

	Developed countries			Developing countries			Vietnam			Total			Kruskal-Wallis Test	Mann-Whitney U Test	
	N=77			N=52			N=112			N=241				(1) Vs (3)	(2) Vs (3)
	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank			
16- Regulatory/Political risks due to legal changes and unsupportive government policies	4.21	0.922	6	4.41	0.748	5	3.91	0.973	8	4.11	0.931	7	0.004*	0.030*	0.002*
17- Innovation in technology	3.57	0.979	20	3.77	1.041	22	3.46	0.919	20	3.56	0.969	21	0.106	-	-
18- Innovation in management	3.42	1.068	23	3.63	1.067	24	3.39*	0.953	23	3.45	1.016	24	0.273	-	-
19- Innovation in operation	3.57	0.922	21	3.61	1.123	25	3.30*	0.889	24	3.45	0.961	23	0.034*	0.290	0.036*
20- Government provides guarantees against financial, political/legal risk	3.91	0.976	13	4.02	1.093	10	3.79	0.885	9	3.88	0.962	11	0.104	-	-
21- Project design and construction complexity	3.73	0.912	16	3.85	0.937	19	3.45	0.938	21	3.62	0.941	17	0.014*	0.049*	0.007*
22- The complexity in the operation and or maintenance stage	3.61	0.920	19	3.86	0.864	15	3.48	0.968	18	3.61	0.939	19	0.080	-	-
23- Alternative solutions which may affect the demand of the PPP project	3.71	1.157	17	4.00	0.990	11	3.71	0.874	12	3.78	1.000	13	0.082	-	-
24- Type of asset: Economic infrastructure	3.83	1.069	15	3.98	0.960	12	3.63	0.880	14	3.77	0.967	14	0.032*	0.048*	0.021*
25- Type of asset: Social infrastructure	3.45	1.056	22	3.90	0.891	14	3.55	0.957	16	3.60	0.987	20	0.036*	0.435	0.034*

Note: (1): Developed countries (2): Developing countries (3): Vietnam

6.3.2 Factor analysis

The Bartlett's test of Sphericity is significant (sig. <0.05) and the KMO is 0.846 (Table 6-6), which is above 0.6, suggesting the data set is suitable for factor analysis. The results of these tests confirmed that the data were appropriate for factor analysis.

Table 6-6: KMO and Barlett's Test for international Survey

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.846
Bartlett's Test of Sphericity	Approx. Chi-Square	1558.593
	df	231
	Sig.	.000

Principal component analysis based on Varimax rotation produced a six-factor solution explaining 74.363% of the variance is shown in Table 6-7. Each variable belongs to only one of the clusters, with the loading on each factor exceeding 0.50. From Table 6-7, it is noticeable that 74.363% of the cumulative variance is attributable to the first five factors, which satisfy the basic requirement of 60% advocated by (Malhotra 2010).

Table 6-7: Rotated component matrix[a] for Vietnamese survey

	Factor loading	Rotation Sums of Squared Loadings		
		Total	**% of Variance**	**Cumulative %**
Cluster 1:		**4.199**	**19.088**	**19.088**
C12 - Construction risk	.854			
C13 - Operating risk	.831			
C11 - Technical Risk	.814			
C14 - Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold	.727			
C15 - Financial risks arising from exchange rate volatility, transaction costs and financing costs	.697			
C23 - Alternative solutions	.562			
Cluster 2		**3.803**	**17.288**	**36.376**
C01- Stable politics and government systems	.821			
C03 - Supportive political climate for PPP projects	.791			
C02 - Stable macro-economic outlook	.788			
C05 - Mature legal system	.740			

	Factor loading	Rotation Sums of Squared Loadings		
		Total	**% of Variance**	**Cumulative %**
C16 - Regulatory/Political risks	.631			
C04 - Community/Public support to PPP projects	.588			
Cluster 3		**2.511**	**11.413**	**47.789**
C18 - Innovation in management	.840			
C17 - Innovation in technology	.837			
C19 - Innovation in operation	.773			
Cluster 4		**2.216**	**10.072**	**57.861**
C06 - Government experience in O&M	.833			
C07 - Government experience in PM	.806			
C08 - The project scale and the amount of total investment	.598			
Cluster 5		**1.832**	**8.327**	**66.188**
C25 - Type of asset: Social infrastructure	.769			
C24 - Type of asset: Economic infrastructure	.709			
Cluster 6		**1.799**	**8.175**	**74.363**
C09 – Financial attraction	.864			
C10 - Financial viability	.766			

As the factor analysis of the questionnaire survey for respondents from Vietnam produces six groups of the cluster, that is much similar to the cluster in Section 5.8.2 with slight difference in Criteria 23. In this section, Criteria 23 belongs to Cluster 1 instead of Cluster 5 including criteria 24 and 25. At the same time, the sample size of the factor analysis was only 112, which is less than the minimum requirement of 150 (as discussed in Section 5.4.4); hence, the result from factor analysis in Section 5.8.2 will be used for illustration of framework development later in Chapter 7.

6.4 CURRENT CONSTRAINTS IN IMPLEMENTING PPPS IN VIETNAM

6.4.1 Interview process

Since the focus of this research is on exploring how a PPP scheme is selected in Vietnam, following the questionnaire survey with the results discussed in Section 6.3, semi-structured interviews were further conducted to obtain an in-depth understanding of the implementation practices of PPPs. Interviews were adopted because this facilitates a deeper investigation of problems (Bennett 1991). This qualitative technique was considered suitable to gain more valuable and insightful information under the study (Osei-Kyei 2017). Interviews were conducted in two months in 2018 with experienced PPP experts from both public and private sectors as well as consultants in Vietnam. The interviews were carried out in the interviewees' offices, with a duration of 45 minutes to 1 hour, depending on the interviewees' time availability.

In total, ten interviewees from public institutions and agencies and private sector were carried out. The qualitative data was transcribed and analysed manually by using the content analysis technique. Experts are knowledgeable with the status quo in PPP implementation in Vietnam. All these experts had more than ten years' overall experience of PPP in Vietnam and played various roles within their work. Table 4.5 shows the detailed background of the public and private sector interviewees. For the purpose of anonymity, the names of interviewees are represented with codes.

Table 6-8: Profiles of interviewees in Vietnam

Inter-viewee	Sector	Organisation characteristics	Years of experience	Activities and experiences of interviewee
MOF	Public	Department of Investment, MOF	13	Provide procurement advisory services to public sectors
MOT	Public	Department of PPPs, MOT	15	Contributed to many PPP guidelines and policy frameworks transport sector
MPI	Public	Public Procurement Agency, MPI	19	Contributed to many PPP guidelines and policy frameworks in general
CON1	Consultant	International law firm	20	Provided legal advice and consultancy in previous and on-going PPP projects as legal advisor
CON2 (IN02)	Consultant	International consultant firm	31	Provided consultancy services to private investors as well as the government with many on-going market PPP projects
PRI1	Private	Investor	17	Engaged in on-going PPP projects in many sectors (expressway, school, hospital projects)
PRI2	Private	Investor	13	Participated in the implementation of investment of expressway and tunnel projects
PRI3	Private	Investor	21	Negotiate, monitor the signing and implementation of investment contracts in water and sanitation system, power plants projects.

The public sector interviewees are from key institutions such as Ministry of Finance (MOF), Ministry of Transport (MOT), and Ministry of Planning and Investment (MPI) that are actively involved in PPP implementation. All interviewees from public sectors have held high positions in their organisation. They also have expertise in providing PPP trainings. On the other side, the private sector interviewees have different expertise, from both economic and social infrastructure, large-scale (e.g. tunnel and expressway) and smaller scales projects (e.g. school, hospital and water systems). One interviewee (CON1) is from an international law firm that provided legal advice for international corporations in investing in PPP projects in Vietnam. Another interviewee is from an international consulting agency that has provided services to many PPP highway and expressway projects in Vietnam and internationally. Generally, all interviewees demonstrate their in-depth knowledge and their responses were considered reliable and satisfactory for analysis.

6.4.2 Findings from interviews

Table 6-9 represents the summary extracted from interviews regarding the existing issues in doing PPP in Vietnam.

Table 6-9: Summary of interview responses on existing issues in doing PPP in Vietnam

What is/are the existing issue(s) in implementing PPP in Vietnam?	Public sector			Private sector			Consultant		Total
	MOT	MPI	MOF	PRI1	PRI2	PRI3	CON1	CON2	
Legal and regulatory issues									
PPP regulations were so complicated and overlap	✓			✓	✓	✓	✓	✓	6
Lack of guidelines or unclear guidelines	✓	✓	✓	✓	✓	✓	✓	✓	8
Institutional and Capacity Issues									
Lack of transparency							✓	✓	2
Lack of competitive bidding							✓	✓	2
Human resources lack experience and appropriate skill	✓	✓						✓	3
Financing issues									
Lack of government guarantee	✓		✓	✓	✓	✓	✓	✓	7
Funding difficulties	✓						✓	✓	3
The size of domestic banks is small	✓							✓	2

All interviewees agree that PPP is an inevitable trend to develop infrastructure systems and public services when the state budget is limited. However, the failure of a number of PPP projects in the transport sector, such as the *Binh Trieu* II bridge, the expansion of interprovincial highway 15 BOT project in *Ho Chi Minh* City, and *Dau Giay – Phan Thiet* expressway, showed that achieving the designed outcomes of PPPs is not as easy as expected. To support their opinions, the interviewees provided numerous examples of problematic PPP projects: inadequate legal system, lack of guidelines, financial issues and superficial investment preparation work and weak in forecasting. Other issues related to inexperienced staff with adequate skills in Human Resources.

6.4.2.1 Legal and regulatory issues

Six out of eight interviewees from both public and private sectors and consultant firms agreed that regulations on PPP in Vietnam are complicated. A well-structured and defined legal system is crucial to successful PPP implementation (Babatunde, Opawole & Emmanuel Akinsiku 2012; Hwang, Zhao & Gay 2013) because it ensures the private party's confidence in investing in PPP. In Vietnam, projects are administered by laws, circulars and legal instruments of local governments as well (Nguyen, HV 2017). PPP projects are being directly controlled by Decree 63, Decree 30 and related circulars; however, at the same time, indirectly adjusted by other laws such as the provisions of the Law on Public Investment, the State Budget Law and the Law on Public Debt Management. The PPP implementation process has to comply with various impractical requirements at law level, aimed at the non-PPP situation, as a law is superior to a decree. Despite there being stable politics, policy is not stable and this is of great concern, not only for foreign investors but also for local private sectors. As explained by Interviewee PRI1:

> *'We (private corporations) are suffering from many risks in the process of implementing PPP projects. Those risks don't come from politics as the politics are stable. One of the reasons is that the legal framework on PPPs is incomplete and too sophisticated'. [PRI1]*

Interviewees from both private sectors and consulting firms shared a common view that, adding to being governed by complicated legislation documents, the current PPP regulation system guidelines are insufficient or unclear. They emphasised that these are the main source of delays and pose numerous risks for investors. Another issue is that the procedures for granting investment registration certificates are lengthy, hence slowing down the project schedule. The process of implementing a PPP project contains the potential of conflicts of interest; however, there is no proper instruction for monitoring and analysing the outcomes. Too many institutional players can lead to delay and are a barrier to PPPs implementation (Zhang, Xueqing 2005b). They proposed that the development of a fit-for-purpose legal framework is crucial and can provide consistency and clarity to all parties related to PPP projects.

> *'During the process of preparing to propose a new project, we had faced some issues that were not regulated or too broad. In that case, we have to seek recommendations from the multiple departments of different Ministries. Each of them requires lots of time. And this is truly a lengthy and exhausting process.' [PRI3]*

'PPP projects are now being managed by way of a traditional procurement process. Regulations on government guarantee mechanisms on minimum revenue, foreign currency exchange, policy risks are not clear in the Decree.' [PRI02]

Regarding the PPP scheme selection, all private sector interviewees affirmed that there is no guideline from the government or tool within their organisation for selecting a suitable PPP scheme. When preparing an unsolicited proposal, BOT and BT are two types of PPP schemes that they keep in mind. If the project involves the right to operate the works or services of another project or an exchange for a land parcel, headquarters or infrastructure, it will be proposed to use the BT scheme. When source of revenue is from user-pays, the proposed scheme will be BOT. The final option is a hybrid scheme, which is the combination of BOT and BT. To further explain these choices, interviewees have highlighted that BOT and BT have long been adopted in Vietnam and the public sector have more experience in managing BOT and BT projects. Other schemes, such as BLT, BTL and BOO, were introduced in 2015 but there is no circular guiding how to select these schemes. All interviewees from private sectors emphasised that the application as well as international experiences of BLT, BTL and BOO schemes should be reviewed and clarified to provide the private sector more options to implement a PPP project.

Another issue that was highlighted by the private sector interviewees was about fees and service charges of toll road projects. Fees and service charges are currently controlled by the government and are not entirely consistent with the market-based mechanism, as highlighted by Interview PRI2:

'Government has the inclination to freeze toll rates, or to keep them as low as possible. The rate cannot be adjusted freely by the private tollway operator and requires prior approval from the government each time the adjustment is contemplated. Thus, the project becomes non-bankable.' [PRI2]

Investors are passive in determining the price of public services because they are unsure of the road map to adjust fees and prices accordingly, and this makes project revenue less reliable. Public opposition due to high toll rates and unreasonable locations of toll booths has been increased and has happened in many BOT highway projects, namely BOT *North Thang Long,* BOT *My Loc,* BOT *Ninh An,* BOT *An Suong-An Lac,* BOT *Deo Ca – Khanh Hoa* and *BOT Cai Lay.* One solution for these oppositions is to reduce the collected fees, which leads to traffic revenue risk in BOT road project (Babatunde & Perera 2017). At the same time, a project's concession period can be extended to help investors collect enough revenue to meet their return target (Tran, HD 2019). Many PPP projects around the world have experienced public opposition on this issue, e.g. the Cross City Tunnel, Sydney, Australia (Siemiatycki 2009), Hungary M1/M15 Toll Motorway Project (Cuttaree, Vickram 2008) and the *Tha Ngone* bridge project in the Laos PDR (Kumaraswamy & Zhang 2001).

From the public perspective, there is concern that the current regulation is not comprehensive enough. Interviewee MPI thought that the minimum scale of the project to be implemented under the form of PPP should be defined. Moreover, since the transaction costs of PPP projects are quite high, implementing small-scale projects will lead to inefficiency. Guarantee of minimum revenue should also be added into the legal system. Many recent countries to adopt PPP, such as Korea, Malaysia, and Canada, have also applied these implementations in the first stage of developing the PPP market, to make it more attractive for the investors.

Despite risk sharing being one of the drivers of adopting a successful PPP, the current Vietnamese regulation system does not provide guidance on the allocation of risks among parties. The ASAs will usually negotiate and reach an agreement on the basis of case-by-case with investors. A number of respondents also provided numerous solutions such as clearly identifying the source of commitment - a specific mechanism for state participation to participate in the project, a mechanism to protect both sides of the PPP agreement if any party failed to meet the terms of the contract. For instance:

> *'A mechanism is needed to protect investors when the parties do not comply with the contract. Intervention by administrative rules and orders has broken the principles of PPP. The government responsibilities must be clear, too.' [PRI02]*

> *'…the regulations on preparation of the pre-feasibility study and feasibility study reports, forms of contracts, financial mechanisms for the project, methods of mobilising investment etc. are still unclear and are not yet in line with international practice'. [PRI1]*

Some respondents also pointed out that a government guarantee mechanism was seen as critical to bringing in foreign investors and should be added to the regulation. Both interviewee MOT from public sector and CON1 from law firm affirmed that in order to attract foreign investors, government guarantee mechanism in PPP projects should be clearly stated in the legal system, such as minimum revenue guarantee, exchange rate guarantee for foreign currency and loan guarantee. Many studies have highlighted that guarantees from government are a critical success factor for PPP projects in infrastructure development, especial for developing countries (Cheung, E, Chan & Kajewski 2012; Gupta, A, Chandra Gupta & Agrawal 2013; Osei-Kyei & Chan 2017b).

Interviewees all recommended the necessity to issue law on investment under PPPs as well as the adequate guideline system, as proposed by interviewee PRI2:

> *'There is an urgent need of a separate law on PPP investment to be stipulated throughout the life cycle of a PPP project, from the preparation of investment to implementation of investment and operation and exploitation of projects.' [PR02]*

6.4.2.2 Institutional and capacity issues

Interviewees from a consultancy firm pointed out that there is a lack of competitive bidding and very low numbers of investors are interested in PPPs. If there is no competitive bidding, there is no competitive price. Direct appointment of investor is a common phenomenon in Vietnam. The application of investor direct appointment has affected the transparency and competitiveness of the investment environment, limiting the ability to select investors with financial capacity and project management experience. Although direct appointment is legal, it was adopted to meet the critical demand of social-economic development. However, the government will lose the chance to assess, compare and choose the most appropriate investor to implement the project, as well as reducing the competitiveness.

Furthering discussion on this, interviewees CON1 and CON2 contended that there was a lack of transparency over PPPs, which is a well-recognised constraint in the PPP literature. The information of the project has not been publicised, transparent and limits access to information of investors. The PPP agreements were normally considered as confidential. Many investors have not felt confident to invest in the Vietnamese market, even though the political and economic system is quite stable.

> *'Considering the long-term nature of PPP, stakeholders and citizens deserve accurate information.' [CON2]*

Interviewee MOT frankly admitted that the capability in PPP still needed to improve, though a lot of training and education has been carried out. The management and supervision of the quality of the project were still weak, almost entrusted to investors from the stage of project formulation, project approval and project implementation.

The capacity of many domestic infrastructure development enterprises is still limited, and the development of supporting industries is still underdeveloped (Tran, DT & Phi 2015). There were also concerns from the public sector about the financial capacity of the private party; interviewee MOT argued that:

> *'Weak financial capacity of investors is one of the reasons leading to delay, even cancellation of the projects. Some that cannot be implemented must sell projects to other investors or switch from PPP to investment with the state budget.' [MOT]*

6.4.2.3 Financing issues

Some respondents agreed that the finance sector in Viet Nam is still relatively underdeveloped and unable to provide sufficient long-term capital needed by investors. Despite the ambitious aim to attract foreign investors, the number of projects with foreign investment was limited. Besides, the risk of the immature legal system and the lack of government guarantees are of significant concern for both domestic and international investors. Despite this, GoV has applied much financial support such as providing tax-deductible or exemption of land tax and land use levy, enterprise income tax, import tax or VAT incentives (Tran, HD 2019). These incentives from the government can greatly reduce the construction and operational risks of the project company. However, the request for a guarantee mechanism for foreign exchange, interest rate and minimum revenue is mandatory. These comments support the finding of the previous study of Nguyen, A, Mollik and Chih (2018), that government support and guarantees in the mitigation of the risks in developing countries are crucial, and governments need to actively get involved in managing these risks and planning for the associated government support.

> *'We (MOF) affirmed that the application of forms of guarantee is a necessary condition to continue encouraging private investment. To some important projects, the government did provide a loan guarantee for investors to carry out PPP projects. However, the governments were adopting a specific guarantee for each group of projects, based on concession models and the complexity of the projects.' [MOF]*

As the cash flow generated from the infrastructure is in the local currency, projects involving foreign investors will assume the currency exchange risk. Through the legal restriction conditions related to foreign currency, international investors cannot obtain guarantees. If investing in infrastructure projects, foreign investors are 'playing' with a double-edged sword, because the risks of interest rate loans, guarantee revenue, exchange rates, etc. have not been handled as international practices. Foreign investors have not been interested in PPP expressway and highway projects in Vietnam because it is still believed that there are many risks related to exchange rates. With current regulations, Vietnam does not apply the exchange rate guarantee. The restriction on foreign exchange provision explained the reason why, despite great efforts to promote, in Vietnam, there is not yet any PPP infrastructure project with the participation of foreign investors successfully deployed.

> *'… in our project, the problem of foreign currency conversion has not been solved for five years. Our company imported coal in USD, collected electricity usage charge in VND, but when we needed to convert foreign currency, it faced many difficulties.' [PRI3]*

Interviewee PRI2 argued that if the mechanism for guarantee is soon to be issued, it will not only increase economic significance but also social implication. This is because if the project is delayed during implementation, say for a few years, the cost may double, particularly the cost of land acquisition and resettlement; such responsibility belongs to the state.

Another issue related to PPP in Vietnam is about funding. Some participants believed that the size of domestic banks is small while most PPP investments in infrastructure are being financed by the banks; therefore this can generate huge risk. Interview MOT, on governance perspective, highlighted that:

> *'The amount of investor equity to the project is low. The rest of funding is mainly borrowed and guaranteed by the Government. Hence, this makes the funding responsibility eventually shift toward the government. Consequently, some PPP projects switched back to the government shortly after operation.' [MOT]*

To solve this problem, recent Decree 63 increases the minimum requirement of investor equity with the aim to assure the financial capabilities of the private investors and the viability of these PPP projects (GoV 2018). Viability gap funding is the central element of PPP, however, no projects are benefiting from VGF. Increasing equity will increase asset prices and create speculative bubbles as well as risks of instability in macro-economic. When the Government was forced to tighten credit, raising interest rates to control inflation, the asset bubbles burst, interest burden increased while expected income declined. This makes businesses unable to repay their debts and consequently, the banking system might collapse.

All interviewees showed great expectations on the upcoming PPP law and hope that the new law will break the bottleneck, be closer to international practices, attract more investors domestically and internationally. The new law is also expected to provide clear guidance on risk allocation, a framework to implement different types of PPP schemes, and standard project deeds for different types of projects.

6.5 CHAPTER SUMMARY

This chapter first introduced the development of PPP in infrastructure development in Vietnam. It then presented in-depth views of the public, private sectors and consultants on the implementation practices of PPP. The key purpose was to explore current issues of implementing PPP projects, including the selection of a suitable PPP scheme. The results from the questionnaire survey and interviews are consistent with the findings from the literature review, that Vietnam lacks a mature legislation system, with many risks having been encountered during the implementation of PPPs. The results provide a better understanding of PPP implementation in Vietnam. Schemes are chosen based on their historical background because BOT has long been applied. The next chapter presents the development of a decision-making framework using Analytical Network Process (ANP) to select the optimum PPP scheme. The framework was built based on the results from factor analysis in Chapter 5 and 6. Then, the framework was illustrated by using Group 4: Hybrid family as an example.

Chapter 7

DEVELOPMENT OF A DECISION-MAKING FRAMEWORK TO SELECT THE SUITABLE PPP SCHEME

7.1 INTRODUCTION

This chapter aimed to develop a decision-making framework to assist the government and private sector to select the suitable PPP scheme for procuring an infrastructure development project. Analytical Network Process (ANP) was deployed to aid the problem-solving process. It focused on how to structure a hierarchical decision model and how to measure the relative importance of the decision criteria. After obtaining judgements from experts, the relationships among criteria for the selection of PPP scheme were identified. Then, the ANP structure and final priorities of this system were built, using the Super Decision software.

7.2 DEVELOPMENT OF THE FRAMEWORK

The process to develop an ANP involves the following steps (Al-Harbi 2001; Saaty, Thomas L 1990), as illustrated in Figure 7-1:

7.2.1 Step 1: Define the problem and determine goal

The decision-making problem is deconstructed according to its main components. The overall goal of PPP scheme selection is to find the best PPP scheme for a particular project. The clusters and sub-clusters were determined based on the results of the factor analysis as in Sections 5.5.2, 5.6.2, 5.7.2, 5.8.2. The systematic procedure of defining the problem and goal corresponds with the methodology explained in the research methodology chapter.

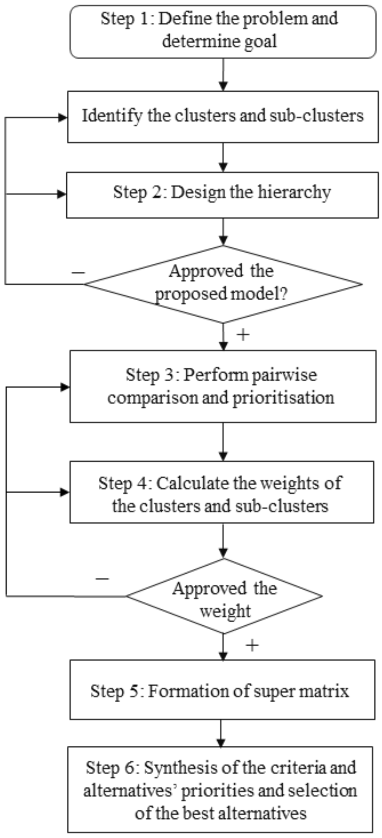


Figure 7-1: Diagram of the proposed model for PPP scheme selection

7.2.2 Step 2: Design the hierarchy

Structure the hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which subsequent levels depend) to the lowest level, which usually contains the list of alternatives.

An ANP model is composed of four levels and the hierarchy is exhibited in Figure 7-2 as follows:

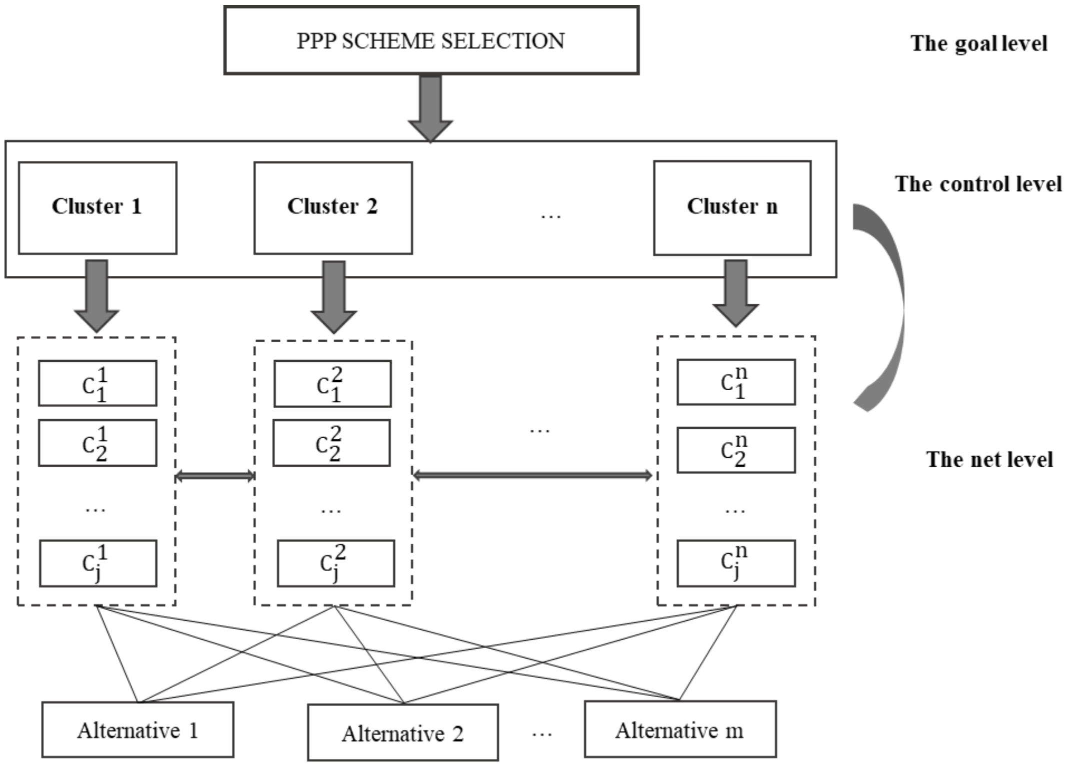


Figure 7-2: The proposed ANP model for the selection of PPP scheme

The first level defines the ultimate goal of 'The selection of PPP scheme'. The second level, which is allocated at the control level, includes clusters to be used in the process of selection of suitable PPP scheme. Each PPP family has different clusters obtained from the results of Chapter 5 (Sections 5.5.2, 5.6.2, 5.7.2, 5.8.2). The clusters of the second level are connected to the goal with a single directional arrow. The arrows in the second level represent the interdependencies among the cluster. The interdependencies among the clusters at this level are taken into account and in this way, the effects of the clusters on each other are analysed. Sub-clusters related to the clusters are in the third level of the model, which is named the net-level. The alternatives are the schemes of each family. For example, alternatives of public-financed family are DBO, DBM, and DBOM).

7.2.3 Step 3: Perform pairwise comparison and prioritisation

Once the problem has been decomposed and the hierarchy constructed, prioritization procedure starts from control level to net level in order to determine the relative importance of the elements within each level. Pairwise comparisons were conducted with a list of experts to provide a one-on-one comparison between every criteria. The pairwise comparisons are done to measure which element is dominating the other. A set of pairwise comparison matrices for each of the lower levels with one matrix for each element in the level immediately above is constructed by using the relative scale measurement shown as discussed in Section 3.6.3 (Table 3-7).

7.2.4 Step 4: Calculate the weights of the clusters and sub-clusters

Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria. The priority weights for each attribute calculated as discussed in Section 3.6.3.4. The sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.

7.2.5 Step 5: Supermatrix formation

With interdependent influences, the system that consists of cluster and sub-cluster matrices must translate to a supermatrix. To obtain global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix. As a result, a supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two clusters in a system. Three supermatrices are unweighted, weighted, and limit super matrices as discussed in Section 3.6.3.5.

7.2.6 Step 6: Synthesis of the criteria and alternatives' priorities and select of the best alternatives

The priority weights of the criteria are found in the normalised supermatrix and the final score of the selection criteria. The final score of each prospective alternative was calculated by multiplying the final weights of the proposed model and project managers' assessments. Which alternative has the highest score among prospective alternatives will be chosen as the final option.

7.3 FRAMEWORK BASED ON GROUP 4: HYBRID FAMILY

The overall process of developing an ANP-based decision-making framework for selection of PPP scheme was presented in Section 7.2. As the focus of this research is to develop a framework for the selection of PPP scheme in Vietnam and as explained in detail under Section 6.3.2, the Hybrid family is used to illustrate the development of the ANP model.

7.3.1 Step 1: Define the problem and determine its goal.

The overall goal is to find the best PPP scheme under Hybrid family. Clusters and sub-clusters of the Hybrid family were determined in Chapter 5 – Section 5.8.2: 'Factor analysis of Hybrid family' and are represented in Table 7-1 with codes.

Table 7-1: Clusters and sub-clusters used in the model

Cluster		Sub-clusters
Cluster 1: Risks over project life cycle (R)	R1	C12 - Construction risk, due to faulty construction techniques and cost escalation and delays in construction stage
	R2	C13 - Operating risk due to higher operating costs and maintenance costs
	R3	C11 - Technical risk due to engineering and design failures
	R4	C14 - Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold leading to revenue deficiency
	R5	C15 - Financial risks arising from exchange rate volatility, transaction costs and financing costs
Cluster 2: Political and Macro-economic conditions (P)	P1	C01 - Stable politics and government system
	P2	C03 - Supportive political climate for PPP projects
	P3	C02 - Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)
	P4	C16 - Regulatory/Political risks due to legal changes and unsupportive government policies
	P5	C05 - Mature legal system required to support PPP procurements
	P6	C04 - Community/Public support to PPP projects
Cluster 3: Project innovation (I)	I1	C19 - Innovation in operation
	I2	C17 - Innovation in technology
	I3	C18 - Innovation in management
Cluster 4: Types and project complexity (T)	T1	C25 - Type of asset: Social infrastructure
	T2	C24 - Type of asset: Economic infrastructure
	T3	C23 - Alternative solutions which may affect the demand of the PPP project
Cluster 5: Government experience and project scale (G)	G1	C06 - Government experience in O&M
	G2	C07 - Government experience in Project Management
	G3	C08 - The project scale and the amount of total investment

Cluster		Sub-clusters
Cluster 6: Financial viability (F)	F1	C10 - Financial viability based on NPV and risk-adjusted PV
	F2	C09 - Financial attraction of project to investors

7.3.2 Step 2: Design the hierarchy

7.3.2.1 Establish a hierarchical structure and the ANP network

This model has four levels as described in Section 7.2.2.

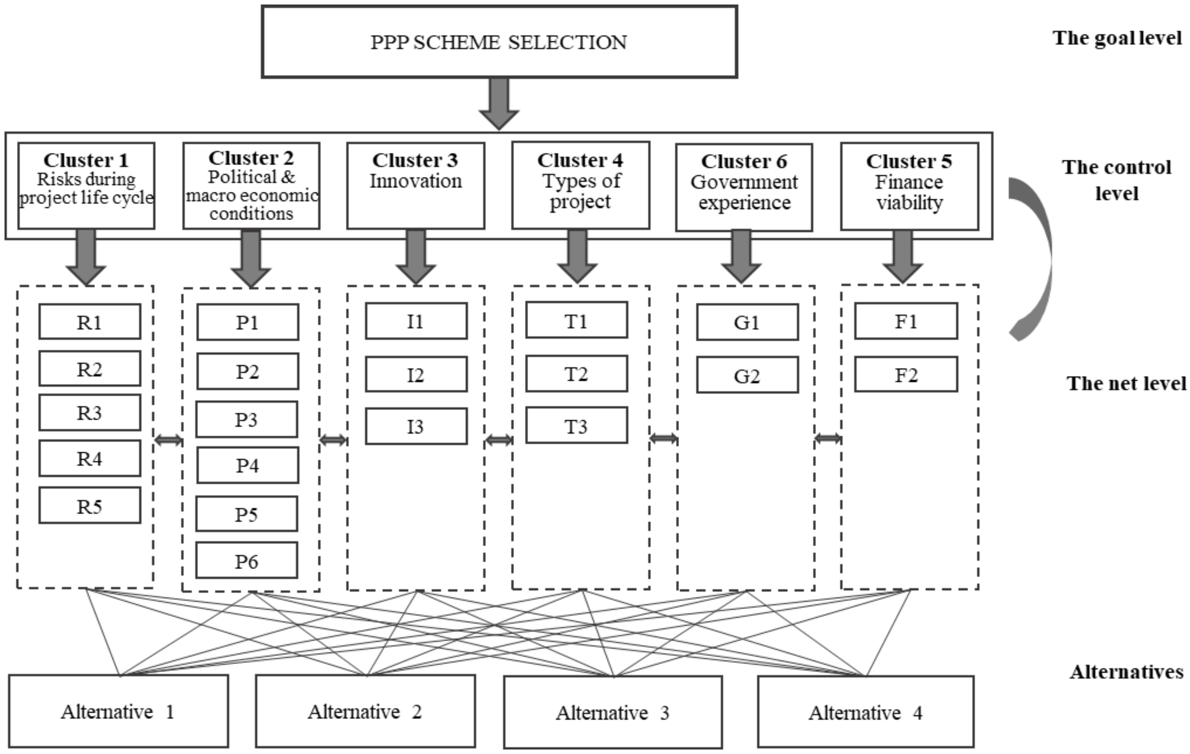


Figure 7-3: The proposed ANP model for the selection of PPP scheme of Hybrid family

The goal level is 'PPP scheme selection'. The second level is the control level, which includes six clusters. The third level is the net-level, which are sub-clusters that are detailed in Table 7-1. The fourth level presents the alternatives of the Hybrid family (e.g. BOT, RTO, BLT or BOOT). Following the above process, the concept model was developed. The proposed ANP for selection of PPP scheme for hybrid family is shown in Figure 7-3.

7.3.2.2 Identifying dependencies among criteria

Seven experts were asked to decide the interdependencies among the criteria. The results are shown in Table 7-3. If 4 out of 7 (4/7) experts shared the same consensus on the direct relationship between any pair of criteria, it is considered that two criteria have inter-relationships with each other. The results were then coded into a single zero-one matrix of criteria against criteria using a binary value of 0 and 1 to signify the independence of one sub-factor on another (Table 7-4). Experts were chosen based on the criteria that shown in Section 3.3.3. The profiles of seven experts are displayed in Table 7-2.

Table 7-2: Experts' profiles for development of the decision-making framework

No.	Position	Organization	Years of experience	Years of experience in PPPs
A	Project manager (IN04)	Consultant	25	10
B	Deputy Head of Project Management Department	Concessionaire	14	11
C	Researcher	PPPs researcher	40	15
D	Officer of Procurement Department	Both public and private	16	9
E	Project Manager	Private	11	7
F	Head of Project Management Department	Concessionaire	13	9
G	Assistant Project Manager	Private	5	5

Table 7-4 shows all the possible connections among sub-factors, where a_{ij} can take any of the following values:

0 → There is no relationships exists based on 7 experts' consensus;

0 → There is less than (<) 4 experts' consensus;

1 → There is more than (≥) 4 and less than (<) 7 experts' consensus;

1 → The items received 7 experts' consensus

The entries represented by 1s indicate the existence of a direct relationship from sub-factor i to sub-factor j, for example if i depends on j, a_{ij}=1. Super Decisions® was used to construct the network model, which is illustrated in Figure 7-4. It uses arrows to signify dependence among sub-factors and its directions start from one sub-factor to another. Arrows are generated between clusters to represent outer dependence, while inner dependence is represented by the loop arrows. As shown in Figure 7-5, criteria P2 has inner dependence with criteria within clusters (namely P1, P3, P4, P5) and outer dependence with criteria R2, R4 under Cluster C1, criteria I2, I3 under Cluster C3 and so on.

Table 7-3: Aggregated dependency matrix

			Cluster 1					Cluster 2						Cluster 3			Cluster 4			Cluster 5			Cluster 6	
			R1	R2	R3	R4	R5	P1	P2	P3	P4	P5	P6	I1	I2	I3	T1	T2	T3	G1	G2	G3	F1	F2
			CR_12	CR_13	CR_11	CR_14	CR_15	CR_01	CR_03	CR_02	CR_16	CR_05	CR_04	CR_19	CR_17	CR_18	CR_25	CR_24	CR_23	CR_06	CR_07	CR_08	CR_10	CR_09
Cluster 1	R1	CR_12	0	7	7	6	6	2	2	2	2	2	7	5	5	5	3	3	3	1	3	6	7	7
	R2	CR_13	2	0	4	5	5	2	4	2	4	2	7	7	4	6	2	3	2	4	3	5	7	7
	R3	CR_11	7	7	0	6	5	1	1	2	2	3	7	4	5	3	3	3	4	2	3	5	6	5
	R4	CR_14	3	5	0	0	3	4	4	3	4	3	7	6	4	6	4	5	4	4	4	6	7	7
	R5	CR_15	6	7	0	4	0	2	3	1	7	3	6	6	4	6	6	6	5	4	4	6	7	7
Cluster 2	P1	CR_01	1	2	1	6	7	0	7	7	7	7	6	3	2	2	7	6	2	3	3	7	4	4
	P2	CR_03	0	2	0	6	7	5	0	3	7	7	7	4	5	4	6	6	7	4	4	7	7	5
	P3	CR_02	1	6	0	7	7	5	5	0	4	3	6	4	3	4	3	6	4	4	5	7	6	6
	P4	CR_16	1	5	1	5	7	6	6	7	0	7	7	4	3	3	7	5	4	5	5	7	5	6
	P5	CR_05	2	4	2	5	7	4	5	5	6	0	6	4	2	5	4	5	2	4	5	6	6	6
	P6	CR_04	1	3	1	6	6	5	6	4	5	5	0	5	3	5	7	7	6	2	3	7	5	5
Cluster 3	I1	CR_19	0	7	1	5	5	0	2	1	1	4	5	0	2	4	4	4	5	3	4	4	7	5
	I2	CR_17	7	7	5	5	5	0	2	1	1	3	5	6	0	6	3	5	4	6	6	6	6	7
	I3	CR_18	6	6	6	6	6	0	2	1	1	4	5	7	4	0	4	4	7	6	6	7	7	6
Cluster 4	T1	CR_25	3	5	2	5	6	5	5	5	6	4	7	3	3	4	0	3	3	4	4	7	6	7
	T2	CR_24	3	6	3	5	6	3	5	4	6	4	7	5	4	4	4	0	4	4	4	7	6	7
	T3	CR_23	2	3	2	7	7	3	5	4	5	4	7	7	5	7	6	6	0	6	5	6	7	6
Cluster 5	G1	CR_06	3	7	2	7	6	2	6	3	4	5	6	7	6	6	5	5	6	0	6	4	6	6
	G2	CR_07	4	6	4	7	6	4	6	5	4	7	6	4	4	6	6	6	7	6	0	6	4	6
	G3	CR_08	6	7	5	6	6	4	3	4	6	3	7	6	7	7	7	7	7	6	6	0	7	7
Cluster 6	F1	CR_10	3	3	0	6	7	3	4	5	5	4	6	7	6	6	6	6	6	4	4	7	0	7
	F2	CR_09	1	3	1	3	4	3	4	1	5	4	5	6	5	7	6	7	6	5	5	7	7	0

Table 7-4: Binary aggregated dependency matrix

			Cluster 1					Cluster 2						Cluster 3			Cluster 4			Cluster 5			Cluster 6	
			R1	R2	R3	R4	R5	P1	P2	P3	P4	P5	P6	I1	I2	I3	T1	T2	T3	G1	G2	G3	F1	F2
			CR_12	CR_13	CR_11	CR_14	CR_15	CR_01	CR_03	CR_02	CR_16	CR_05	CR_04	CR_19	CR_17	CR_18	CR_25	CR_24	CR_23	CR_06	CR_07	CR_08	CR_10	CR_09
Cluster 1	R1	CR_12	0	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	1
	R2	CR_13	0	0	1	1	1	0	1	0	1	0	1	1	1	1	0	0	0	1	0	1	1	1
	R3	CR_11	1	1	0	1	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	1	1	1
	R4	CR_14	0	1	0	0	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1
	R5	CR_15	1	1	0	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1
Cluster 2	P1	CR_01	0	0	0	1	1	0	1	1	1	1	1	0	0	0	1	1	0	0	0	1	1	1
	P2	CR_03	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	P3	CR_02	0	1	0	1	1	1	1	0	1	0	1	1	0	1	0	1	1	1	1	1	1	1
	P4	CR_16	0	1	0	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1
	P5	CR_05	0	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1
	P6	CR_04	0	0	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	0	1	1	1
Cluster 3	I1	CR_19	0	1	0	1	1	0	0	0	0	1	1	0	0	1	1	1	1	0	1	1	1	1
	I2	CR_17	1	1	1	1	1	0	0	0	0	0	1	1	0	1	0	1	1	1	1	1	1	1
	I3	CR_18	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1
Cluster 4	T1	CR_25	0	1	0	1	1	1	1	1	1	1	1	0	0	1	0	0	0	1	1	1	1	1
	T2	CR_24	0	1	0	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
	T3	CR_23	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Cluster 5	G1	CR_06	0	1	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1
	G2	CR_07	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
	G3	CR_08	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1
Cluster 6	F1	CR_10	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
	F2	CR_09	0	0	0	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0

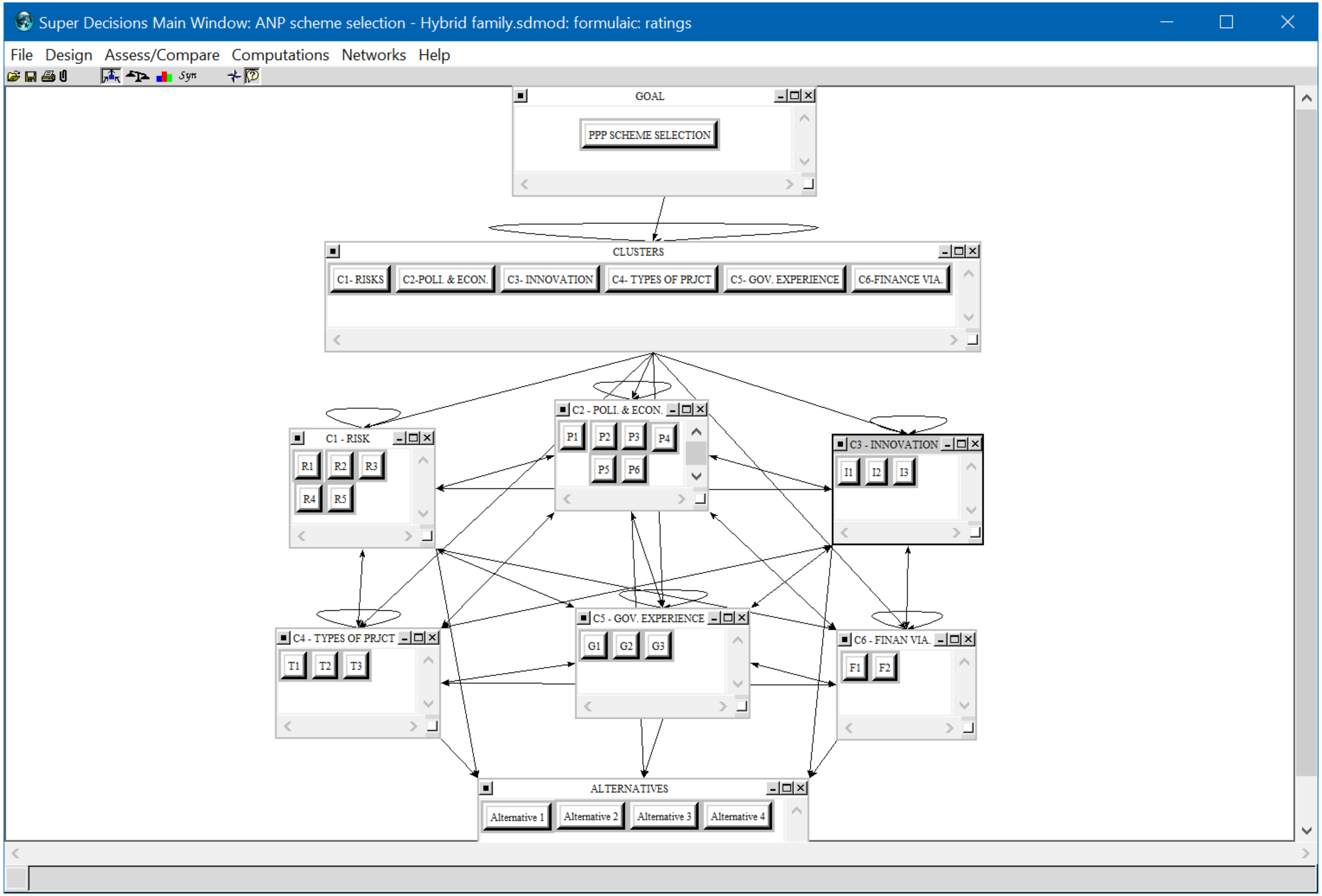


Figure 7-4: The relation between Goal, Cluster, Sub-clusters and the Alternatives.

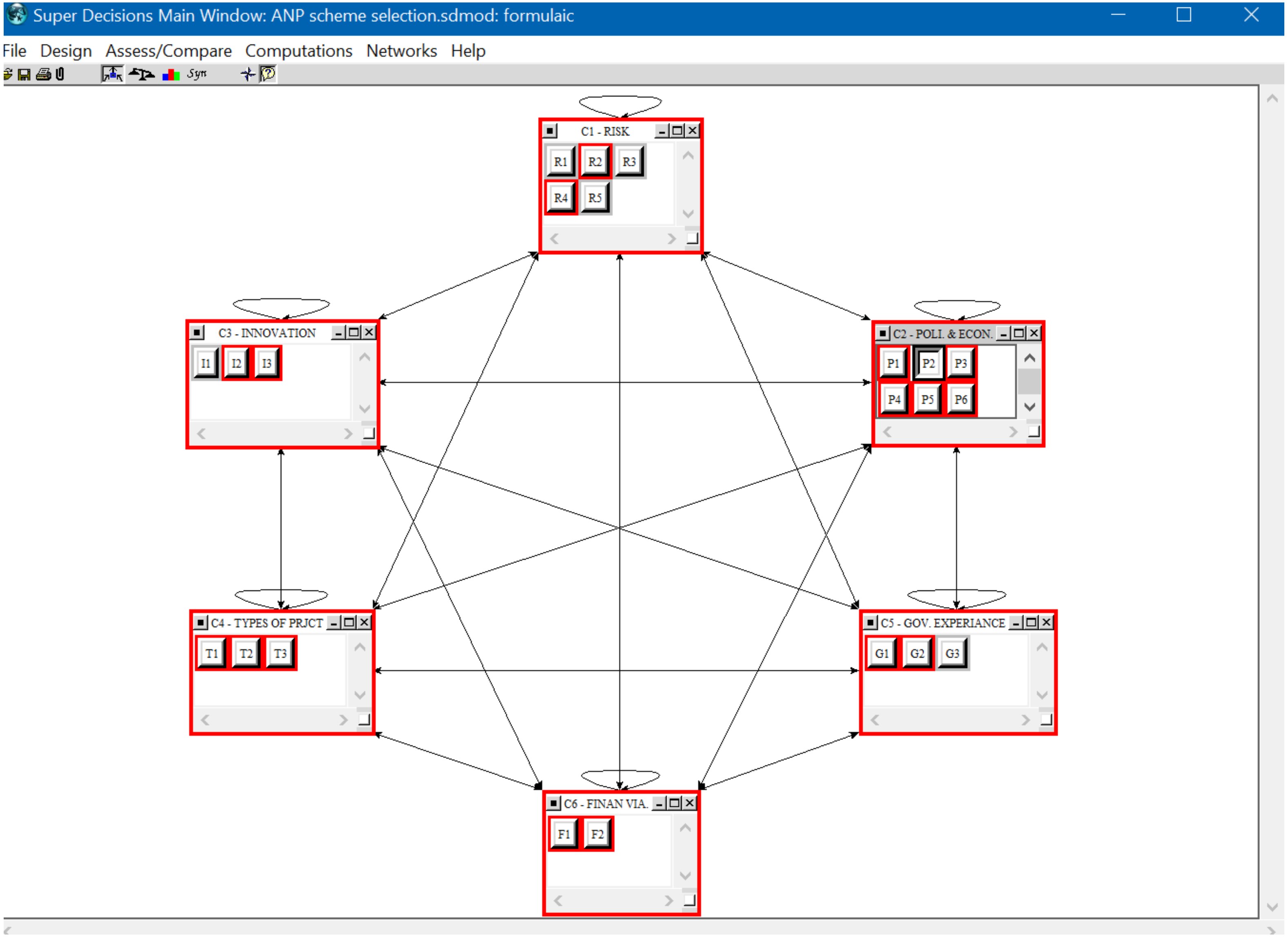


Figure 7-5: ANP network model with pairwise comparison clusters and sub-clusters using Super Decisions®

7.3.3 Step 3: Pairwise comparisons

After constructing the ANP network, pairwise comparisons were conducted using experts' opinions to provide judgements. Based on the network and the relations in the network designed in the previous stage, questionnaires were designed to ask the judges' idea about the relevant importance of two elements (namely cluster and criteria) at a time, with regards to a control element. A question asked throughout the interview was, '*Given a parent element and comparing elements A and B under it, which element has greater influence* ***on*** *the parent element?*'

The subjective judgements were entered and assigned numerical values based on the nine-point scale suggested by (Saaty, Thomas L 1988) to obtain the corresponding pairwise judgement matrices. A score of 1 indicates equality between the two sub-clusters, whereas a score of 9 represents the dominance of the row sub-cluster in the matrix over the column sub-cluster. A reciprocal value is automatically assigned in the opposite position of the matrix, i.e. $a_{ij} = 1/a_{ji}$.

7.3.3.1 Number of pairwise comparisons

The number of comparisons for comparing cluster and node in each cluster is calculated as below:

$$n_c = \frac{n \times (n-1)}{2}$$

where n : *Number of elements*

n_c : *Number of comparisons*

a. Number of Cluster comparisons

The numbers of comparisons to be made for each cluster are 6×(6-1)/2=15

There are six clusters; the numbers of comparisons to be made for cluster comparisons are 15x6=90

b. Number of Node comparisons

Number of comparisons in each node based on the number of criteria to be compared is calculated, as shown in Table 7-5 below:

Table 7-5: Number of pairwise comparisons

		CT1					CT2						CT3			CT4			CT5			CT6	
		R1	**R2**	**R3**	**R4**	**R5**	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**I1**	**I2**	**I3**	**T1**	**T2**	**T3**	**G1**	**G2**	**G3**	**F1**	**F2**
CT1	No. of criteria	2	4	2	4	3	1	2	0	3	0	5	5	5	4	2	2	3	3	2	5	5	5
	No. of pairwise	1	6	1	6	3	0	1	0	3	0	10	10	10	6	1	1	3	3	1	10	10	10
CT2	No. of criteria	0	3	0	6	6	5	5	4	5	4	5	5	1	4	5	6	4	4	4	6	6	6
	No. of pairwise	0	3	0	15	15	10	10	6	10	6	10	10	0	6	10	15	6	6	6	15	15	15
CT3	No. of criteria	2	3	2	3	3	0	0	0	0	2	3	2	1	2	2	3	3	2	3	3	3	3
	No. of pairwise	1	3	1	3	3	0	0	0	0	1	3	1	0	1	1	3	3	1	3	3	3	3
CT4	No. of criteria	0	2	0	3	3	1	3	3	3	3	3	2	2	3	2	1	1	3	3	3	3	3
	No. of pairwise	0	1	0	3	3	0	3	3	3	3	3	1	1	3	1	0	0	3	3	3	3	3
CT5	No. of criteria	2	3	2	3	3	2	2	2	3	2	3	3	3	3	3	3	3	2	2	2	3	3
	No. of pairwise	1	3	1	3	3	1	1	1	3	1	3	3	3	3	3	3	3	1	1	1	3	3
CT6	No. of criteria	0	0	0	1	2	0	2	1	2	2	2	2	2	2	2	2	2	2	2	2	1	1
	No. of pairwise	0	0	0	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Total comparisons		3	16	3	30	28	11	16	10	20	12	30	26	15	20	17	23	16	15	15	33	34	34

The number of comparisons for all sub-networks is 427. Hence, the total number of comparisons for the study is N = 427 + 90 = 517 comparisons.

The questionnaire of pairwise comparisons was designed in MS-Excel Spreadsheets, as shown in Appendix 6.1: Experts' answers to ANP model's pairwise questions.

7.3.3.2 Group decision-making

In order to minimise experts' biases when answering pairwise comparison questions, four judgements with the help of Experts A, B, C and D (as shown in Table 7-2) were obtained for each particular question, as shown in Appendix 6.1-1 and Appendix 6.1-2. All judgements obtained from individual experts were gathered into a representative group judgement by calculating the geometric mean as the outcomes for each pairwise. The geometric mean, representing the consensus of experts, can provide more accurate results (Saaty, Thomas L 2008b) and is calculated using Equation 3-8 (Section 3.6.3).

7.3.3.3 Pairwise Questionnaire

A sample pairwise questionnaire with respect to ('wrt') parent criteria P1 that was filled by the evaluators is shown in Table 7-6. The question asked was '*Given a parent criteria 'P1- Stable politics and government system', and comparing elements 'P2- Supportive political climate for PPP projects' and 'P3- Stable macro-economic outlook during the project life cycle' under P1, which element has greater influence* ***on*** *the parent element P1*?' Expert 1's judgement was that P3 is 'strongly more important than P2' (5P3) while Expert 2 considered that P3 is 'very strongly more important' than P2 (7P3) and so on. The group judgement using Geometric Mean was that P3 is 'strongly' to 'very strongly' more important than P2 (6P3).

Table 7-6: Pairwise comparison questionnaire sample - Node comparisons with respect to node P1 under C2

wrt	P1									
Expert	P2 or P3	P2 or P4	P2 or P5	P2 or P6	P3 or P4	P3 or P5	P3 or P6	P4 or P5	P4 or P6	P5 or P6
A	5P3	2P4	4P5	5P6	5P3	3P3	3P3	2P5	3P4	2P5
B	7P3	3P4	5P5	4P6	7P3	6P3	6P3	1	2P4	3P5
C	5P3	4P4	4P5	2P6	5P3	4P3	5P3	2P5	2P4	2P5
D	6P3	3P4	4P5	6P6	5P3	6P3	5P3	3P5	3P4	4P5
GM	**6P3**	**3P4**	**4P5**	**4P6**	**5P3**	**5P3**	**5P3**	**2P5**	**2P4**	**3P5**

In matrix form, all the criteria to be compared are written on the left column of the matrix and the row on the top of the matrix. The elements of the matrix are the priority of the left criteria to the top criteria. The questionnaire shown in Table 7-6 is converted to the matrix form in Table 7-7.

Table 7-7: The pairwise comparison matrix example- Node comparisons with respect to node P1 under C2

	P2	P3	P4	P5	P6
P2	1	1/6	1/3	1/4	1/4
P3	6	1	5	5	5
P4	3	1/5	1	1/2	2
P5	4	1/5	2	1	1/3
P6	4	1/5	1/2	3	1

Example to show how the judgements are entered into Super Decisions is presented in Figure 7-6. A score of 1 indicates equality between the two sub-factors, the blue scores represent the dominance of the row sub-factor in the matrix (e.g., P2) over the column sub-factor (e.g., P3) and the red scores vice versa. The group judgement was that P3 is 'strongly' to 'very strongly' more important than P2 (6P3). Therefore, a red score of 6 corresponding to the group judgement regarding this question was clicked to highlight the sub-factor of higher importance.

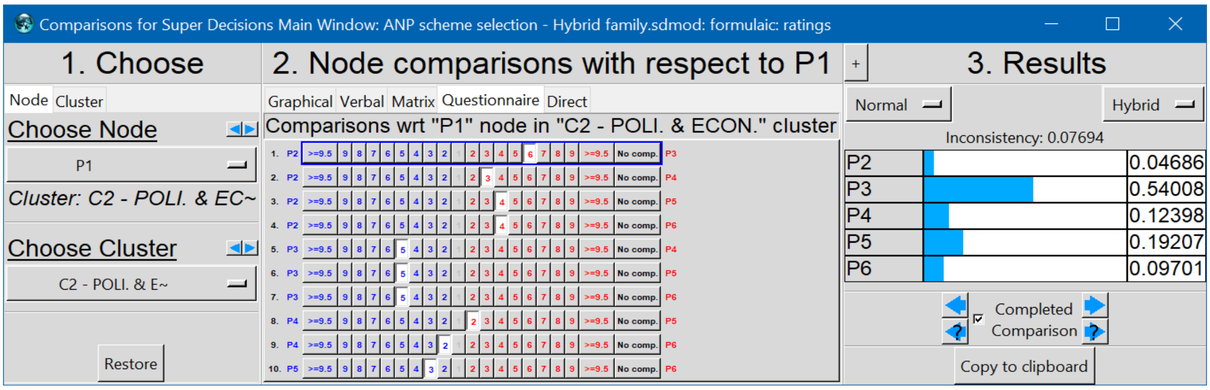


Figure 7-6: Example of *Super Decisions* – Node comparisons with respect to node P1 under C2

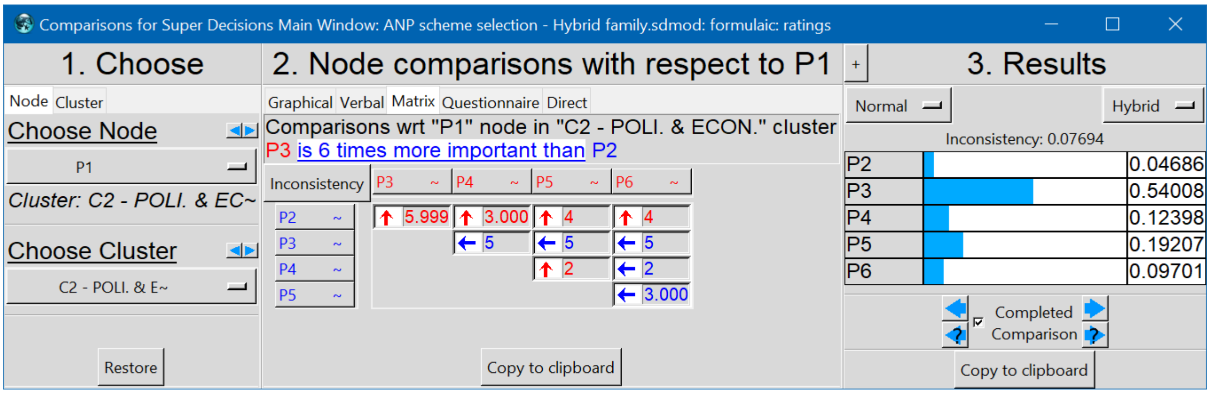


Figure 7-7: Example of comparisons matrix of sub-clusters in cluster C2 with respect to P1

7.3.3.4 Consistency Check

In the decision-making process, there is an inconsistency issue involved when different criteria are used. Inconsistency in judgements happens when, for example, an evaluator believes criteria A is more important than criteria B; and in another comparison, criteria B is believed to be more important than criteria C; and a third comparison states that criteria C is more important than criteria A. Hence, the last comparison is inconsistent with first two comparisons because A would logically be more important than B and C. Consequently, these judgements are inconsistent and should be revised to improve the consistency.

Super Decisions calculates the consistency ratio (CR) automatically and displays as 'inconsistency' check result in the right pane of Figure 7-7 (Mu & Pereyra-Rojas 2017). The inconsistency ratio limit of 0.1 is an acceptable level, as suggested by Saaty, Thomas L (2004a) . If any inconsistency is higher than 0.1, then the evaluators were asked to revise their judgement and compare the criteria again. Then, the comparisons matrix is formed and the priority of each sub-factor is computed automatically by Super Decisions, as shown in Figure 7-7. Since the value of inconsistency is 0.07694, which is less than 0.1, this matrix is considered acceptable.

7.3.4 Step 4: Calculate the weight of criteria

The priority weights are presented in Table 7-8 which is based on (Saaty, Thomas L 2006; Wu, Shih & Chan 2009) and the network form of the proposed model is shown in Figure 7-8:

Table 7-8: Generalised supermatrix

	Goal	Cluster	Criteria	Alternatives
Goal	-			
Cluster	W_{21}	W_{22}		
Criteria		W_{32}	W_{33}	
Alternatives			W_{43}	-

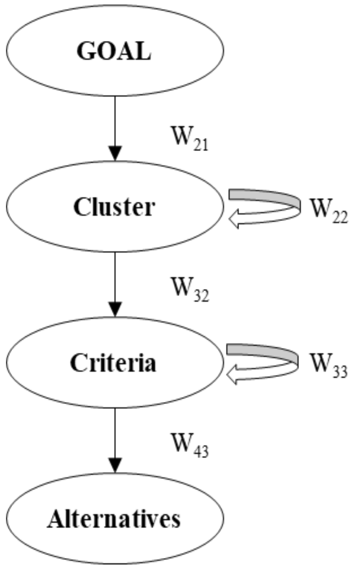


Figure 7-8: The network form of the proposed model

The clusters consist of Cluster 1: Risks over project life cycle (R), Cluster 2: Political and Macro-economic conditions (P), Cluster 3: Project innovation (I), Cluster 4: Types and project complexity (T), Cluster 5: Government experience and project scale (G), Cluster 6: Financial viability (F) and their contribution to evaluate the scheme selection were performed in Table 7-9.

Table 7-9: Pairwise comparisons matrix with respect to goal (W_{21})

Top goal	①	②	③	④	⑤	⑥	Weights
①	1	1/5	4	3	3	1/6	0.10407
②	5	1	7	6	5	1/4	0.26059
③	1/4	1/7	1	2	2	1/9	0.05019
④	1/3	1/6	1/2	1	2	1/9	0.04212
⑤	1/3	1/5	1/2	1/2	1	1/8	0.03578
⑥	6	4	9	9	8	1	0.50726

Consistency ratio: 0.07805

The priorities for the cluster, W_{21}, can be shown as follows:

$$W_{21} = \begin{bmatrix} CT_1 & 0.10407 \\ CT_2 & 0.26059 \\ CT_3 & 0.05019 \\ CT_4 & 0.04212 \\ CT_5 & 0.03578 \\ CT_6 & 0.50726 \end{bmatrix}$$

The eigenvector indicated the importance of each cluster, and it can be seen that with respect to overall goal, financial viability has the highest weight with 0.50726 to determine PPP scheme. The second highest is the political and macro-economic conditions with 0.26059. The least one is the government experience (0.03578).

Table 7-10: Example of pairwise comparisons matrix with respect to C1 under C1-Risk (W_{22})

①-Risk	①	②	③	④	⑤	⑥	Weights
①	1	2	5	4	3	3	0.33024
②	1/2	1	5	4	4	5	0.31937
③	1/5	1/5	1	1/2	1/3	1/5	0.03991
④	1/4	1/4	2	1	1	1/3	0.06699
⑤	1/3	1/4	3	1	1	1/5	0.00738
⑥	1/3	1/5	5	3	5	1	0.16966

Consistency ratio: 0.08987

Table 7-11: Example of pairwise comparisons matrix with respect to R2 under C1-Risk (W_{32})

C1-Risk	R1	R3	R4	R5	Weights
R1	1	1/2	3	3	0.29211
R3	2	1	3	5	0.48070
R4	1/3	1/3	1	2	0.10153
R5	1/3	1/5	1/2	1	0.12566

Consistency ratio: 0.05843

7.3.5 Step 5: Formation of super-matrix

There are three super-matrices in the network: the unweighted super-matrix, the weighted super-matrix and the limit super-matrix. The unweighted super-matrix contains the local priorities derived from the pairwise comparisons throughout the network. The weighted super-matrix is obtained by multiplying all the sub-factors in a component of the unweighted super-matrix by the corresponding cluster weight matrix, which makes each column therein add up to 1. The column vectors of the cluster weight matrix can be determined from the eigenvectors of the pairwise comparison of clusters. The limit super-matrix is obtained by raising the weighted super-matrix to powers by multiplying it with itself. When the column of numbers is the same for every column, the limit matrix has been reached and the matrix multiplication process is halted.

Table 7-12: Generalised supermatrix

	R1	R2	R3	R4	R5	P1	P2	P3	P4	P5	P6	I1	I2	I3	T1	T2	T3	G1	G2	G3	F1	F2
R1	0	0.29211	0.85714	0.50330	0.69083	0	0	0	0	0	0.41513	0.13795	0.46381	0.27351	0	0	0	0	0	0.45231	0.19490	0.26275
R2	0	0	0.14286	0.05958	0.16033	0	0.20000	0	0.14676	0	0.15246	0.24157	0.15513	0.57052	0	0	0	0.66667	0	0.12788	0.04917	0.09607
R3	0.88889	0.48070	0	0.32220	0.14884	0	0	0	0	0	0.30940	0.50300	0.27741	0	0	0	0.21764	0	0	0.29210	0.12871	0.05719
R4	0	0.10153	0	0	0	0	0.80000	0	0.76924	0	0.08321	0.07611	0.05871	0.10229	0.80000	0.83333	0.69096	0.16667	0.75000	0.07115	0.57909	0.54395
R5	0.11111	0.12566	0	0.11492	0	0	0	0	0.08400	0	0.03980	0.04138	0.04494	0.05368	0.20000	0.16667	0.09140	0.16667	0.25000	0.05655	0.04813	0.04004
P1	0	0	0	0.02988	0.22159	0	0.27952	0.60896	0.12534	0.15210	0.14272	0	0	0	0.13591	0.07709	0	0	0	0.03065	0.04212	0.11119
P2	0	0	0	0.04336	0.08094	0.04686	0	0	0.32988	0.68226	0.35513	0.05669	0	0.59054	0.33582	0.17324	0.58649	0.08551	0.17973	0.05022	0.10766	0.25978
P3	0	0.11397	0	0.13059	0.12084	0.54008	0.06656	0	0.03750	0	0.08581	0.09430	0	0.10285	0	0.02681	0.05171	0.15070	0.06439	0.11802	0.17689	0.03810
P4	0	0.48064	0	0.24247	0.49457	0.12398	0.07503	0.07808	0	0.11117	0.03406	0.17539	0	0	0.42432	0.33667	0.13306	0.35353	0.37026	0.18177	0.37854	0.14423
P5	0	0.40539	0	0.06498	0.04785	0.19207	0.44009	0.08276	0.04886	0	0.38228	0.19645	0	0.06284	0.05996	0.04794	0	0.41025	0.38562	0.24174	0.02784	0.02976
P6	1.00000	0	1.00000	0.48872	0.03423	0.09701	0.13880	0.23019	0.45842	0.05447	0	0.47716	1.00000	0.24376	0.04399	0.33825	0.22874	0	0	0.37760	0.26695	0.41693
I1	0	0.54693	0.16667	0.13111	0.40000	0	0	0	1.00000	0.33333	0.09534	0	0	0.20000	0.50000	0.11111	0.24931	0	0.25828	0.10853	0.08898	0.08522
I2	0.87500	0.10853	0.83333	0.20813	0.20000	0	0	0	0	0	0.65481	0.33333	0	0.80000	0	0.44444	0.59363	0.16667	0.63699	0.54693	0.32339	0.64422
I3	0.12500	0.34454	0	0.66076	0.40000	0	0	0	0	0.66667	0.24986	0.66667	0	0	0.50000	0.44444	0.15706	0.83333	0.10473	0.34454	0.58763	0.27056
T1	0	0.33333	0	0.09051	0.28571	0	0.68334	0.32748	0.32339	0.32748	0.64422	0	0	0.16033	0	0	0	0.08522	0.16033	0.33333	0.08875	0.18839
T2	0	0.66667	0	0.15125	0.57143	0	0.19981	0.41260	0.58763	0.41260	0.08522	0.20000	0.75000	0.14884	0.20000	0	0	0.64422	0.14884	0.33333	0.35219	0.73064
T3	0	0	1.00000	0.75825	0.14286	0	0.11685	0.25992	0.08898	0.25992	0.27056	0.80000	0.25000	0.69083	0.80000	0	0	0.27056	0.69083	0.33333	0.55907	0.08096
G1	0	0.10853	0	0.10853	0.31962	0	0.80000	0	0.08110	0.16667	0.72585	0.70494	0.21764	0.21764	0.09242	0.24985	0.10853	0	0.80000	0.14286	0.08875	0.08110
G2	0.88889	0.54693	0.85714	0.34454	0.12196	0.66667	0.20000	0.50000	0.57691	0.83333	0.17212	0.21092	0.69096	0.09140	0.42317	0.65481	0.54693	0.83333	0	0.85714	0.35219	0.57691
G3	0.11111	0.34454	0.14286	0.54693	0.55842	0.33333	0	0.50000	0.34200	0	0.10203	0.08414	0.09140	0.69096	0.48441	0.09534	0.34454	0.16667	0.20000	0	0.55907	0.34200
F1	0	0	0	0	0.88889	0	0.80000	0	0.50000	0.20000	0.88889	0.80000	0.80000	0.80000	0.25000	0.88889	0.85714	0.50000	0.50000	0.87500	0	1.00000
F2	0	0	0	0	0.11111	0	0.20000	0	0.50000	0.80000	0.11111	0.20000	0.20000	0.20000	0.75000	0.11111	0.14286	0.50000	0.50000	0.12500	1.00000	0

Table 7-13: Weighted super-matrix (W_{33})

	R1	R2	R3	R4	R5	P1	P2	P3	P4	P5	P6	I1	I2	I3	T1	T2	T3	G1	G2	G3	F1	F2
R1	0	0.1162	0.3409	0.2002	0.2281	0	0	0	0	0	0.1174	0.0256	0.0899	0.0508	0	0	0	0	0	0.0665	0.0743	0.1001
R2	0	0	0.0568	0.0237	0.0530	0	0.0584	0	0.0415	0	0.0431	0.0449	0.0301	0.1059	0	0	0	0.0980	0	0.0188	0.0187	0.0366
R3	0.3846	0.1912	0	0.1282	0.0492	0	0	0	0	0	0.0875	0.0934	0.0538	0	0	0	0.0346	0	0	0.0429	0.0490	0.0218
R4	0	0.0404	0	0	0	0	0.2336	0	0.2175	0	0.0235	0.0141	0.0114	0.0190	0.1216	0.1323	0.1097	0.0245	0.1102	0.0105	0.2206	0.2072
R5	0.0481	0.0500	0	0.0457	0	0	0	0	0.0238	0	0.0113	0.0077	0.0087	0.0100	0.0304	0.0265	0.0145	0.0245	0.0367	0.0083	0.0183	0.0153
P1	0	0	0	0.0115	0.0708	0	0.1307	0.4573	0.0567	0.0959	0.0646	0	0	0	0.0651	0.0386	0	0	0	0.0147	0.0101	0.0268
P2	0	0	0	0.0167	0.0259	0.0388	0	0	0.1493	0.4304	0.1607	0.0059	0	0.0618	0.1609	0.0867	0.2934	0.0409	0.0859	0.0240	0.0259	0.0625
P3	0	0.0438	0	0.0502	0.0386	0.4469	0.0311	0	0.0170	0	0.0388	0.0099	0	0.0108	0	0.0134	0.0259	0.0721	0.0308	0.0564	0.0426	0.0092
P4	0	0.1849	0	0.0933	0.1580	0.1026	0.0351	0.0586	0	0.0701	0.0154	0.0184	0	0	0.2033	0.1684	0.0666	0.1690	0.1770	0.0869	0.0911	0.0347
P5	0	0.1559	0	0.0250	0.0153	0.1589	0.2057	0.0622	0.0221	0	0.1730	0.0206	0	0.0066	0.0287	0.0240	0	0.1961	0.1844	0.1156	0.0067	0.0072
P6	0.4184	0	0.3846	0.1880	0.0109	0.0803	0.0649	0.1729	0.2074	0.0344	0	0.0500	0.1093	0.0255	0.0211	0.1692	0.1144	0	0	0.1805	0.0642	0.1003
I1	0	0.0263	0.0080	0.0063	0.0160	0	0	0	0.0319	0.0148	0.0030	0	0	0.0084	0.0188	0.0044	0.0098	0	0.0102	0.0043	0.0111	0.0106
I2	0.0458	0.0052	0.0401	0.0100	0.0080	0	0	0	0	0	0.0209	0.0140	0	0.0337	0	0.0174	0.0233	0.0066	0.0252	0.0216	0.0402	0.0801
I3	0.0065	0.0166	0	0.0318	0.0160	0	0	0	0	0.0297	0.0080	0.0281	0	0	0.0188	0.0174	0.0062	0.0329	0.0041	0.0136	0.0731	0.0336
T1	0	0.0269	0	0.0073	0.0191	0	0.0393	0.0303	0.0180	0.0254	0.0359	0	0	0.0331	0	0	0	0.0177	0.0333	0.0692	0.0069	0.0146
T2	0	0.0538	0	0.0122	0.0383	0	0.0115	0.0382	0.0328	0.0321	0.0048	0.0413	0.1618	0.0308	0.0084	0	0	0.1337	0.0309	0.0692	0.0272	0.0565
T3	0	0	0.0807	0.0612	0.0096	0	0.0067	0.0240	0.0050	0.0202	0.0151	0.1653	0.0539	0.1427	0.0338	0	0	0.0562	0.1434	0.0692	0.0432	0.0063
G1	0	0.0097	0	0.0097	0.0236	0	0.0780	0	0.0077	0.0219	0.0685	0.0477	0.0154	0.0147	0.0204	0.0575	0.0250	0	0.0431	0.0077	0.0106	0.0096
G2	0.0860	0.0486	0.0762	0.0306	0.0090	0.1151	0.0195	0.0783	0.0545	0.1097	0.0163	0.0143	0.0488	0.0062	0.0933	0.1507	0.1259	0.0449	0	0.0462	0.0419	0.0686
G3	0.0107	0.0306	0.0127	0.0486	0.0412	0.0575	0	0.0783	0.0323	0	0.0096	0.0057	0.0065	0.0467	0.1068	0.0219	0.0793	0.0090	0.0108	0	0.0664	0.0406
F1	0	0	0	0	0.1508	0	0.0684	0	0.0414	0.0231	0.0736	0.3147	0.3285	0.3147	0.0172	0.0638	0.0615	0.0370	0.0370	0.0647	0	0.0581
F2	0	0	0	0	0.0189	0	0.0171	0	0.0414	0.0923	0.0092	0.0787	0.0821	0.0787	0.0516	0.0080	0.0103	0.0370	0.0370	0.0093	0.0581	0

Table 7-14: Limiting super-matrix

	R1	R2	R3	R4	R5	P1	P2	P3	P4	P5	P6	I1	I2	I3	T1	T2	T3	G1	G2	G3	F1	F2
R1	0.0647	0.0647	0.0647	0.0647	0.0647																	
R2	0.0262	0.0262	0.0262	0.0262	0.0262																	
R3	0.0571	0.0571	0.0571	0.0571	0.0571																	
R4	0.0718	0.0718	0.0718	0.0718	0.0718																	
R5	0.0168	0.0168	0.0168	0.0168	0.0168																	
P1						0.0598	0.0598	0.0598	0.0598	0.0598	0.0598											
P2						0.0930	0.0930	0.0930	0.0930	0.0930	0.0930											
P3						0.0495	0.0495	0.0495	0.0495	0.0495	0.0495											
P4						0.0663	0.0663	0.0663	0.0663	0.0663	0.0663											
P5						0.0807	0.0807	0.0807	0.0807	0.0807	0.0807											
P6						0.1198	0.1198	0.1198	0.1198	0.1198	0.1198											
I1												0.0079	0.0079	0.0079								
I2												0.0164	0.0164	0.0164								
I3												0.0135	0.0135	0.0135								
T1															0.0196	0.0196	0.0196					
T2															0.0245	0.0245	0.0245					
T3															0.0332	0.0332	0.0332					
G1																		0.0259	0.0259	0.0259		
G2																		0.0572	0.0572	0.0572		
G3																		0.0278	0.0278	0.0278		
F1																					0.0446	0.0446
F2																					0.0237	0.0237

7.3.6 Step 6: Compute the overall score of each potential alternative

Table 7-15 exemplifies the final priorities of this ANP model which are derived from the Limiting super-matrix through 'Super Decisions' software (shown in Table 7-14). The criteria with higher priorities can be identified as more important.

Table 7-15: Final priorities of the ANP model

Name		Priorities Normalized By Cluster	Priorities from Limiting matrix
R1		0.2733	0.0647
R2		0.1108	0.0262
R3		0.2411	0.0571
R4		0.3036	0.0718
R5		0.0712	0.0168
P1		0.1274	0.0598
P2		0.1983	0.0930
P3		0.1055	0.0495
P4		0.1413	0.0663
P5		0.1721	0.0807
P6		0.2553	0.1198
I1		0.2091	0.0079
I2		0.4338	0.0164
I3		0.3571	0.0135
T1		0.2541	0.0196
T2		0.3168	0.0245
T3		0.4291	0.0332
G1		0.2337	0.0259
G2		0.5153	0.0572
G3		0.2510	0.0278
F1		0.6531	0.0446
F2		0.3469	0.0237

The final weights of criteria can be generated after multiplying the final priorities with their respective clusters' weights. The results are presented in Table 7-16.

Table 7-16: Final weights of the ANP model (W_{43})

Clusters	Normalized value of a category from the average limiting supermatrix	Criteria	Relative weight of criteria	Final weights (FW)	
C1	0.10407	R1	0.0647	0.0067	
		R2	0.0262	0.0027	
		R3	0.0571	0.0059	
		R4	0.0718	0.0075	
		R5	0.0168	0.0018	
C2	0.26059	P1	0.0598	0.0156	
		P2	0.0930	0.0242	
		P3	0.0495	0.0129	
		P4	0.0663	0.0173	
		P5	0.0807	0.0210	
		P6	0.1198	0.0312	
C3	0.05019	I1	0.0079	0.0004	
		I2	0.0164	0.0008	
		I3	0.0135	0.0007	
C4	0.04212	T1	0.0196	0.0008	
		T2	0.0245	0.0010	
		T3	0.0332	0.0014	
C5	0.03578	G1	0.0259	0.0009	
		G2	0.0572	0.0020	
		G3	0.0278	0.0010	
C6	0.50726	F1	0.0446	0.0226	
		F2	0.0237	0.0120	

The top six most important criteria for selection of a PPP scheme in Table 7-16 were highlighted in bold. Criteria '*P6- Community/Public support to PPP projects*' has a final weight of 0.0312 and Criteria '*P2- Supportive political climate for PPP projects*' has a final weight of 0.0242. The third important criteria is '*F1 - Financial viability based on NPV and risk-adjusted present value*' with final weight of 0.0226. Criteria '*P4- Regulatory/Political risks due to legal changes and unsupportive government policies*' and '*P*5-*Mature legal system required to support PPP procurements*' have final weights of 0.0173 and 0.0210 respectively.

The project managers of a particular project were then invited to rate each of the selection criteria against all potential alternatives (e.g. BOT, BTO, BLT and BTL). By multiplying the final weights of the proposed model and case study specific ratings from experts who are responsible for selection of a

PPP scheme, the final score of each potential alternative can be calculated. The alternative with the highest score among prospective alternatives, will be chosen as the final option.

7.4 FRAMEWORK APPLICATION ILLUSTRATION

7.4.1 General process of PPP scheme selection

The selection of the PPP scheme consists of a three-step procedure as shown in Figure 7-9:

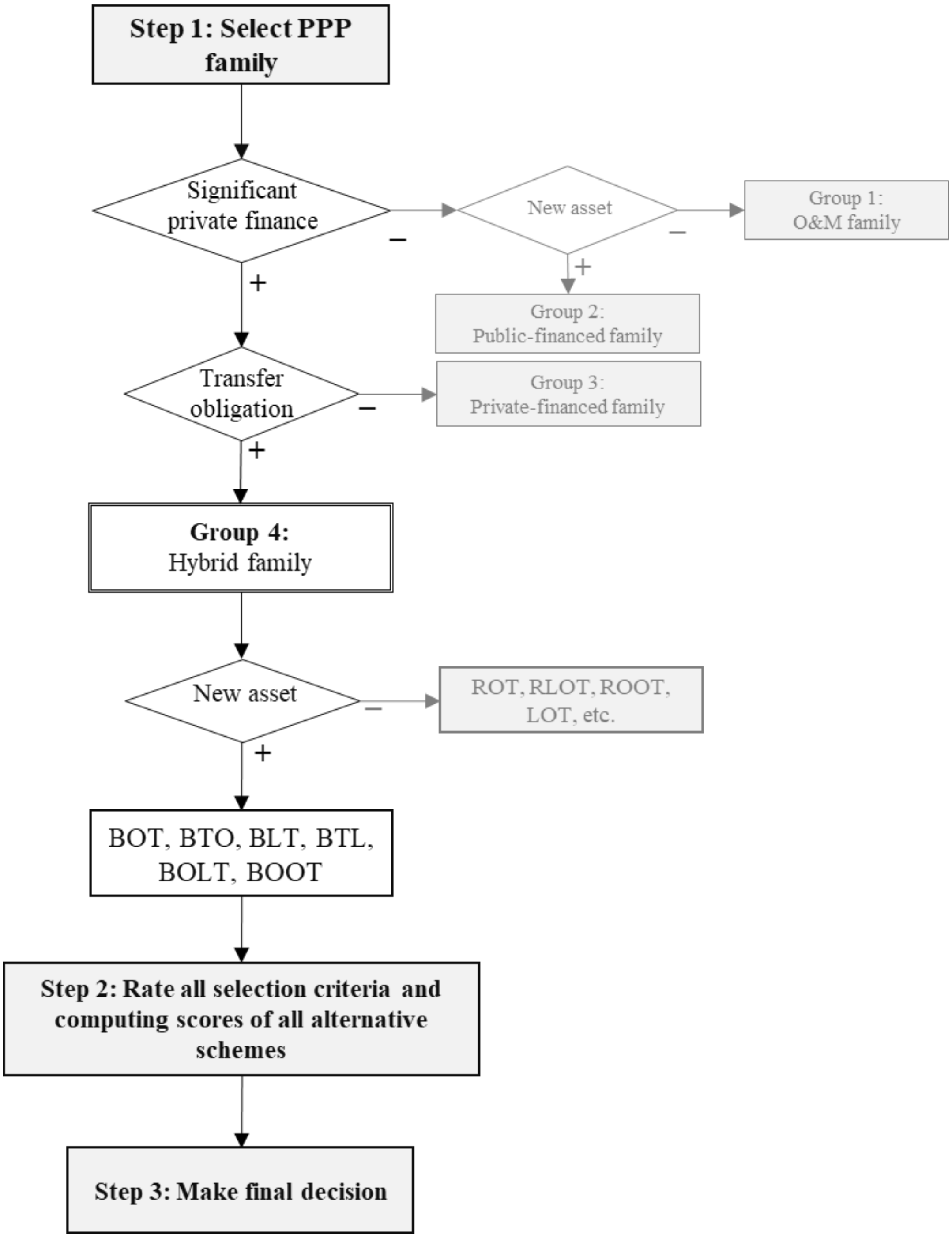


Figure 7-9: General process of PPP scheme selection

Step 1: Select PPP family and propose potential alternatives

As explained in Section 4.2, steps involved in the process of selection of PPP family and scheme options are shown in Figure 4-3.

PPP family: Any PPP scheme falls in one of four PPP families as categorised in Section 4.2, namely O&M, Public-financed, Private-financed and Hybrid family. Based on the information of private finance and transfer obligation, the decision-makers will decide the PPP family of the project.

Potential alternatives: Then, based on the information on whether the facility is a new or existing asset and characteristics of different PPP schemes, decision-makers will select potential PPP schemes within a PPP family. The selection is based on their understanding and experience of the current and past projects, and pros and cons of different PPP schemes available.

Step 2: Rate all selection criteria and computing scores of all alternative schemes

Prospective PPP schemes are then judged by decision-makers. Experts will rate each of the selection criteria against all potential alternatives. The ratings are based on experts' expertise and understanding about the case project. The measures were determined by applying a ten-point scale where 0 indicates 'not suitable' and 9 indicates 'most suitable'.

The final scores of each alternative can be obtained by multiplying the final weight of each criterion (

Table 7-16) with the detailed criterion score rated by experts using Equation 7.1:

$$FS = \sum_{i=1}^{n} FW_i DCS_i$$

where FW_i: final weight value of criterion i

DCS_i: a detailed criterion score from interviewees

n: number of criteria

Step 3: Make the decision

Based on the final score of each prospective option, the alternative with the highest score among others should be preferred over others.

This process was carried out for each of the two considered case projects.

7.4.2 Respondents' background

Six experts were invited to participate (three experts for each project), to illustrate the use of the framework. The profiles of respondents are displayed in Table 7-17. The selected participants are directly in positions of selection of PPP projects. Furthermore, four out of six experts hold senior positions in their organisations with robust knowledge and extensive experience in the field of construction industry and PPPs as well. The interviewees were asked, based on their experience and knowledge, to assess the criteria against each PPP scheme alternative.

Table 7-17: Profiles for illustration of the decision-making framework

No.	Position	Organization	Years of experience in construction	Years of experience in PPPs
H1	Head of Project Management Department	Concessionaire/ H Tunnel	13	9
H2	Deputy general director / Researcher	Concessionaire, University/ H Tunnel	21	15
H3	Officer of Procurement Department	Concessionaire/ H Tunnel	14	8
L1	Deputy General Director	Concessionaire/ L Uni.	17	11
L2	Project Manager	Concessionaire/ L Uni.	12	12
L3	Project officer	Concessionaire/ L Uni.	11	7

7.4.3 Background of the detailed case projects

Case studies, field studies, observation, and experimentation are available strategies for validation of any research project (Osei-Kyei 2017). To demonstrate the use of the proposed model in this study, two PPP investment projects were used as examples. The project names are used in abbreviated style in this chapter for confidential concerns. The projects' features are summarised in Table 7-18 below:

Table 7-18: Projects' information

No	Project name	Location	Project type
1	H project	Vietnam	Tunnel project
2	L project	Vietnam	University campus construction project

7.4.3.1 Case Project 1 – H Tunnel project

The National Highway 1 ('NH1') is the main corridor for passengers and freights between the North and South of Vietnam. Rehabilitation and upgrading have been performed along NH1 but have not been performed at the project site. There was also no other suitable alternative for vehicles. The project site features mountainous conditions, and is one of the worst sites along the whole itinerary. The project site probably experienced the most accidents of the North - South link. Another point is that the maintenance works of the existing road section were expensive, with extensive routine maintenance due to geometric constraints and the prohibitive cost of enlargement in a mountainous area. Thus, GoV has been paying special attention to the improvement of transport conditions in NH1, especially at the most critical sections. The only way to improve the transport capacity is to open another road, mostly parallel to the NH1, but with better geometric characteristics. This would compel the construction of a tunnel of substantial length.

A tunnel through the mountain would shorten the travel distance by about 8 km, to result in a new alignment of around 13 km instead of the current 21 km. The travel time will be significantly reduced, considering the better geometric characteristics and the elimination of a congested section during incidents. Saving in time will then increase sharply when congestion on existing roads is extended. In addition, the road would become usable and safe in all weather conditions.

The original proposed PPP scheme was BOT with the concession period of 36 years, and the total investment amount was around VND 4,000 billion (USD205 million). The public sector was responsible for the costs of compensation, site clearance and resettlement. These costs were included in the total investment capital of the project.

7.4.3.2 Case project 2 – L university campus

The project was initiated to construct a university campus to provide students with international standard classrooms and facilities on a land area of about 300,000 square metres. The total construction floor area is about 108,000 square metres, meeting the scale of training for 6,000 students. The project was divided into two phases, in which the first phase was to construct nearly a 45,000 square metre floor area. The project had 30 major modules divided into several functional areas including administrative area, library hall; classrooms and lecture halls; dormitory; housing area for faculty and staff; physical training and sports facilities. The project was expected to contribute greatly to the overall socio-economic development of the local area.

The original PPP scheme of the project was a BT. The PPP contract was worth VND$600 billion (about USD30 million). Under the BT contract, upon completion of the construction, the facility would be transferred to the State and the public sector will make payments to the investor under the agreement in the BT contract.

7.4.4 Project scheme selection

7.4.4.1 Case project 1 - H Tunnel project

a. Step 1: Select PPP family and proposing potential alternatives

The H tunnel project required significant private finance and the obligation to transfer the asset back to the government at the end of the concession period; hence, the scheme chosen for this project belongs to the Hybrid family. Moreover, because this is a new built tunnel, four potential alternatives were BOT, BTO, BLT and BOOT.

b. Step 2: Rate all selection criteria and computing scores of all alternative schemes

The interviewees rated each of the selection criteria against four potential alternatives, namely BOT, BLT, BOOT and BTO. The score on each criterion is shown in Table 7-19.

Table 7-19: The H tunnel project's overall score (W_{43})

Criteria	Final weights	H Tunnel project							
		BOT	Score	BLT	Score	BOOT	Score	BTO	Score
R1	0.0067	5	0.0337	4	0.0269	4	0.0269	2	0.0135
R2	0.0027	5	0.0136	4	0.0109	3	0.0082	2	0.0055
R3	0.0059	3	0.0178	4	0.0237	5	0.0297	5	0.0297
R4	0.0075	7	0.0523	5	0.0374	6	0.0448	5	0.0374
R5	0.0018	4	0.0070	4	0.0070	4	0.0070	4	0.0070
P1	0.0156	8	0.1246	3	0.0467	5	0.0779	3	0.0467
P2	0.0242	8	0.1939	6	0.1454	4	0.0969	4	0.0969
P3	0.0129	7	0.0903	6	0.0774	3	0.0387	3	0.0387
P4	0.0173	7	0.1209	5	0.0864	3	0.0518	3	0.0518
P5	0.0210	6	0.1262	4	0.0841	4	0.0841	4	0.0841
P6	0.0312	7	0.2184	5	0.1560	5	0.1560	5	0.1560
I1	0.0004	8	0.0032	6	0.0024	5	0.0020	5	0.0020
I2	0.0008	8	0.0066	6	0.0049	5	0.0041	5	0.0041
I3	0.0007	8	0.0054	6	0.0041	5	0.0034	5	0.0034
T1	0.0008	0	0.0000	0	0.0000	0	0.0000	0	0.0000
T2	0.0010	7	0.0072	6	0.0062	5	0.0052	4	0.0041
T3	0.0014	6	0.0084	4	0.0056	4	0.0056	4	0.0056
G1	0.0009	4	0.0037	4	0.0037	4	0.0037	4	0.0037
G2	0.0020	7	0.0143	5	0.0102	4	0.0082	4	0.0082
G3	0.0010	7	0.0070	5	0.0050	5	0.0050	5	0.0050
F1	0.0226	8	0.1812	5	0.1132	6	0.1359	4	0.0906
F2	0.0120	8	0.0962	5	0.0601	5	0.0601	3	0.0361
Total score			**1.3319**		**0.9175**		**0.8552**		**0.7301**

c. Step 3: Make final decision and result discussion

Table 7-19 indicated that BOT should be preferred over the others because the score was highest among prospective alternatives.

All interviewees agreed that BOT seemed a reasonable option for this project. Among all schemes, the score of BTO is the lowest. In Vietnam, BTO in transportation is not preferred (Doan 2017), as after transferring to the government, the facility becomes public property, which is subject to stricter control or management of the state. Compared to BTO scheme, the private sector will receive more flexibility in control or management over the facility if the project is carried out under BOT, BOOT or BLT. The second lowest score is BOOT. This scheme is currently not regulated in Vietnam and, because the total investment amount of this project was high, considering that the private party could not solely invest in this project, as a result, this scheme is not suitable. BLT was a scheme that received the second highest score from interviewees. Even though BLT is less risky by receiving the unitary lease amount from the public sector, however, the interview H2 confirmed that it was calculated and analysed by the private sector that the investment under BOT was the most profitable. This is consistent with a study (Kim, JH 2005) in that transport projects are not good candidates for BTL implementation. It was also calculated by the private sector that the investment amount would be recovered, and the private sector would derive a profit compatible with the cost of its capital if the toll revenues were obtained under an optimal toll structure (as in the economic feasibility analysis). Interview H1 emphasised that for this project, there was interest from the government that the private sector would take the responsibility for the design, construction and operation of the project. The reason was that the private sector might be in a better position to manage the corresponding risks such as delay, cost overrun and the use of innovative technology. The interviewee H3 also highlighted that this project received public authority support such as maximum toll collection, taxes exemptions, incentive interest rates, etc. Hence, BOT was decided to be the final decision.

7.4.4.2 <u>Case project 2 – L university campus</u>

a. Step 1: Select PPP family and proposing potential alternatives

Similar to the H tunnel project, the L University required significant private finance and the obligation to transfer the asset back to the state; hence, the scheme chosen for this project belongs to Hybrid family with four potential alternatives being BOT, BTO, BLT and BTL.

b. Step 2: Rate all selection criteria and computing scores of all alternative schemes

The score from interviewees on each criterion for the selection of PPP scheme of L University project is shown in Table 7-20.

Table 7-20: The L University project's overall score (W_{43})

Criteria	Final weights	The L University project							
		BOT	Score	BTO	Score	BLT	Score	BTL	Score
R1	0.0067	6	0.0404	7	0.0471	6	0.0404	7	0.0471

Criteria	Final weights	The L University project							
		BOT	Score	BTO	Score	BLT	Score	BTL	Score
R2	0.0027	6	0.0164	7	0.0191	8	0.0218	7	0.0191
R3	0.0059	4	0.0237	4	0.0237	4	0.0237	4	0.0237
R4	0.0075	3	0.0224	6	0.0448	8	0.0598	6	0.0448
R5	0.0018	2	0.0035	2	0.0035	2	0.0035	2	0.0035
P1	0.0156	4	0.0623	4	0.0623	5	0.0779	5	0.0779
P2	0.0242	5	0.1212	5	0.1212	8	0.1939	7	0.1696
P3	0.0129	4	0.0516	4	0.0516	4	0.0516	4	0.0516
P4	0.0173	6	0.1036	5	0.0864	3	0.0518	3	0.0518
P5	0.0210	7	0.1473	6	0.1262	3	0.0631	3	0.0631
P6	0.0312	3	0.0936	4	0.1248	6	0.1872	5	0.1560
I1	0.0004	4	0.0016	3	0.0012	4	0.0016	3	0.0012
I2	0.0008	1	0.0008	1	0.0008	1	0.0008	1	0.0008
I3	0.0007	4	0.0027	3	0.0020	3	0.0020	3	0.0020
T1	0.0008	6	0.0050	5	0.0041	8	0.0066	6	0.0050
T2	0.0010	0	0.0000	0	0.0000	0	0.0000	0	0.0000
T3	0.0014	0	0.0000	0	0.0000	0	0.0000	0	0.0000
G1	0.0009	3	0.0028	3	0.0028	6	0.0056	5	0.0046
G2	0.0020	5	0.0102	5	0.0102	4	0.0082	4	0.0082
G3	0.0010	3	0.0030	3	0.0030	6	0.0060	6	0.0060
F1	0.0226	4	0.0906	4	0.0906	6	0.1359	5	0.1132
F2	0.0120	5	0.0601	5	0.0601	7	0.0842	5	0.0601
Total score			**0.8628**		**0.8857**		**1.0256**		**0.9095**

c. Step 3: Make final decision and result discussion

Table 7-20 indicated that BLT should be chosen, because the score was highest among prospective alternatives. All respondents agreed that this proposed scheme appears suitable for this illustrated case project due to its nature social infrastructure in general. In BLT and BTL, the government (or third party) collects user fees and pays annual rents to the private sector (Bae, Damnjanoic & Kang 2019), hence, the government holds the revenue risks. The operation of the university is under responsibility of the public sector or a third party, as the private party (in this case project) does not have experience in the education sector. As a result, the operation of the new built university campus would not be transferred to the private party. This explained why criteria '*F1- Financial viability*', '*F2 - Financial attraction*', '*R2- Operating risk due to higher operating costs and maintenance costs*' and '*R4- Financial risks due to inaccurate forecast'* received higher scores for BLT and BTL schemes than BOT and BTO schemes, as the private party is not in the position to control the demand risk. For this reason, is the score of '*are highest among others*'. On the other hand, criteria '*P4- Regulatory/Political risks*' and ‘*P5- Mature legal system*’ received lower scores for BLT and BTL compared to BOT and BTO as the regulations on BOT and BTO are more adequate. Managers of this project thought that the size of the school is relatively small in comparison with other economic infrastructure projects; as a result, the unitary lease amount paid by the government would not create much pressure in public funding. The project managers also highlighted that in this project, it was impossible for the private party to recoup the investment cost through user-charges. By using the BLT scheme, the public sector would take on the demand and operational risk if there were a reduction in the student number and the use of teachers’ facilities. Thus, BOT and BTO were not suitable. The BTL scheme is similar to the original BT option, as it required the transfer of the project after completion of construction. However, the private sector had responsibility to maintain this project for five years after the completion of construction.

7.4.5 Integration of the framework

Figure 7-10 illustrates a systematic approach to identifying, determining and selecting the most appropriate PPP scheme.

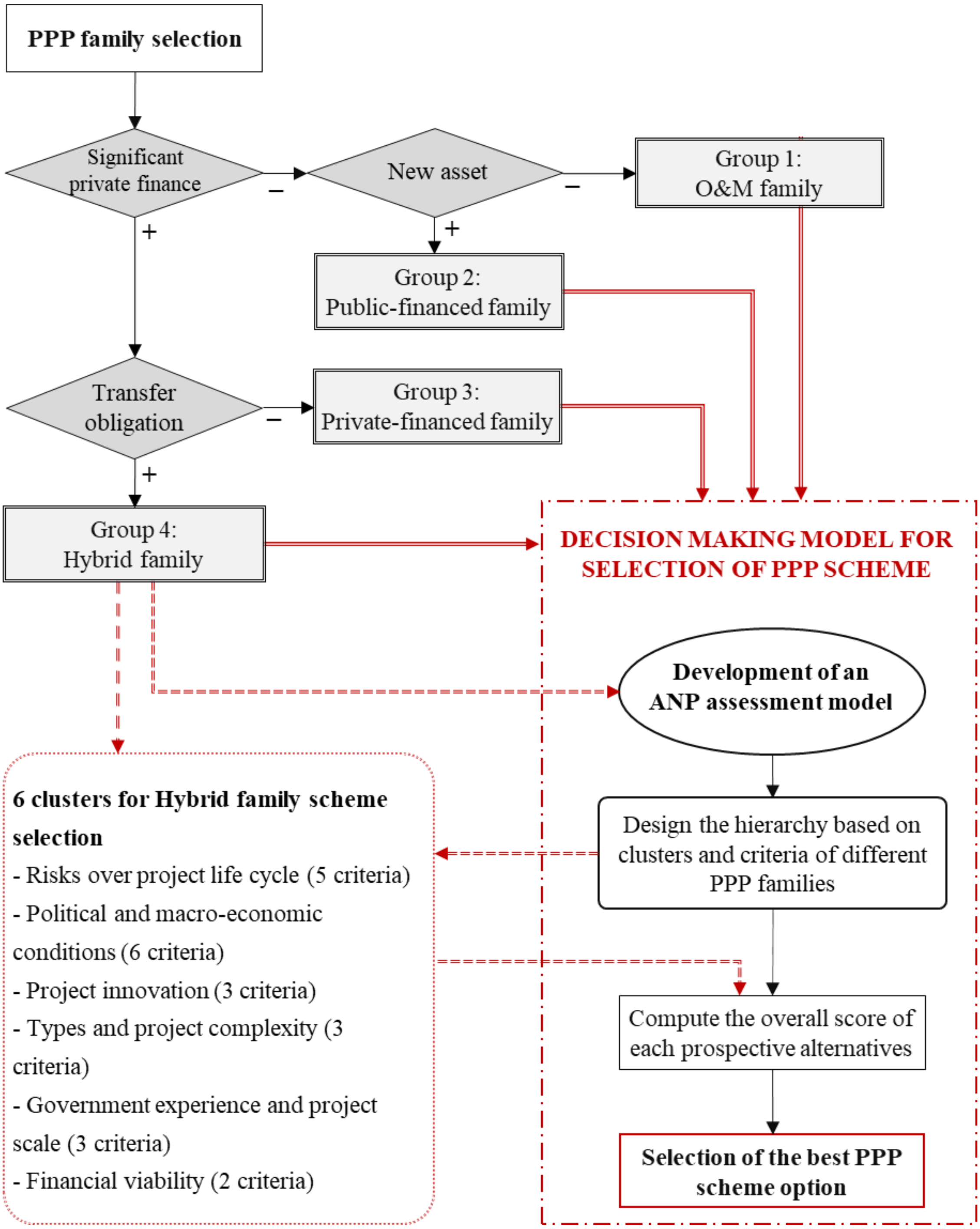


Figure 7-10: Integration of the framework – A step-by-step

7.5 VALIDATIING THE RESEARCH FINDINGS

The final stage of the research is to validate whether the quality of the developed model has achieved an acceptable standard. Validation measures the accuracy, adequacy, usability, precision, etc. of the system (Cheung, E 2009).

7.5.1 Validation of the Decision tree classifier

In the field of selection of PPP schemes, many studies have proposed several ways to categorise different schemes; however, most of the categorisations are not widely accepted, and some of the classifications even conflict to each other. This research proposed a decision tree classifier for selection of PPP family, which includes O&M family, Public-financed family, Private-financed family and Hybrid family. The validation of the Decision tree classifier (Figure 4-3 pg. 94) was performed in an early stage together with the development of the list of selection criteria and the profiles of interviewees were shown in Table 7-21.

Table 7-21: Profiles of interviewees for validation of Decision tree classifier

Code	Organization characteristics/ Roles in projects	Nationality	Years of experience in construction	Years of experience in PPPs	Major
IN01	Consultant and Researcher	Australia	30	30	Lead partner social infrastructure and PPP policy
IN02	International Consultant/ Project director	Japanese	31	17	Project director of many large-scale PPP and non-PPP infrastructure projects
IN03	Researcher and Concessionaire/ Vice General Director	Vietnam	21	10	Vice General Director of the SPV company of one toll road and four tunnel projects
IN04	Consultant	Vietnam	25	10	Project director of many large-scale PPP and non-PPP infrastructure projects
IN05	Concessionaire/ CTO	Vietnam	17	11	Investment and Technical Manager

The Decision tree classifier was presented to the experts. Then, to assess the appropriateness of this categorisation, the interviewees were asked for the comments on this decision tree, including:

- Are the classification rules adopted in the categorisation decision tree appropriate?
- Is the Decision tree classifier useful for practitioners to differentiate and compare different types of PPP schemes?
- Are there any other categories, which should be included in the Decision tree classifier?

All the experts agreed that the Decision tree classifier is applicable and adequate to include all existing PPP schemes in the infrastructure by providing a simple yet practical way to categorise them. Interviewee IN02 highlighted that instead of using only the term ‘concession contract’ with different financing structures, a particular PPP project can be classified more precisely by using terminology of the Decision tree classifier. Moreover, IN02 thought that it would be great if the design stage can be divided into 3 separate stages, namely conceptual design, basic design and detailed design. The purpose of this division is to utilise the advantages and experiences of private party to bring the most benefit to the project itself and the owner. Experts from Vietnam recognised that the terminology used in some PPP projects with regard to the reconstruction of National Highway 1 should be called ROT instead of BOT because the SPVs invested to rehabilitate, repair and maintain over the existing road, not to build a new one; then, the SPVs were allowed to collect tolls to recoup their investment. In general, the experts agreed that the classification framework provided a useful and comprehensive tool to label a PPP scheme.

7.5.2 Validation of the ANP-based framework for selection of PPP scheme

Six experts mentioned in Section 7.4.2, who helped to illustrate the use of the ANP-based decision-making framework, were asked to provide their feedback by completing a validation-scoring sheet based on a 5-point Likert scale. The respondents were asked to rate their degree of satisfaction with the framework where 1 represents ‘not at all’, 2 to ‘a little extent’, 3 to ‘some extent’, 4 to ‘a great extent’, and 5 to ‘a very great extent’. A score above ‘3’ would represent satisfactory performance. The results obtained from the validation sheets are shown in Table 7-22.

Table 7-22: Results of the validation-scoring sheet

Validation aspect	Respondents						Mean
	1	2	3	4	5	6	
Question 1: Do you think that the criteria for selection of PPP scheme helped you easier to choose the suitable PPP scheme?	4	5	3	3	4	5	4.00
Question 2: Do you think that the ANP-based model is a good technique to help you evaluating the suitable PPP scheme for a given particular project?	5	3	3	4	3	4	3.67
Question 3: Do you think that the rating of criteria for different PPP schemes of a particular project easy to follow?	5	4	4	3	2	3	3.50
Question 4: Do you think that group decision-making is more useful than individual decision-making in selecting a PPP scheme?	4	4	4	4	4	4	4.00
Question 5. How do you rate the degree of appropriateness of the proposed model?	3	4	5	4	3	5	4.00

Validation aspect	Respondents						Mean
	1	2	3	4	5	6	
Question 6. How do you rate the degree of objectivity of the proposed model?	4	5	3	3	4	4	3.83
Question 7. How do you rate the degree of practicability of the proposed model?	3	4	3	4	3	3	3.33
Question 8. How do you rate the overall reliability of the proposed model?	3	5	4	4	4	5	4.17

The results reflected a very positive attitude as all aspects were rated above '3'. All interviewees agreed that the selection of PPP scheme is a complicated process with many subjective judgements. There was an existing perception in Vietnam that BOT scheme is more familiar and both government and private party have more experience with BOT; hence, the majority of PPP projects are under BOT scheme. Hence, the establishment of the ANP-based decision-making is an appropriate and innovative approach that aid the decision maker to utilize the advantages of other schemes into a particular project. With respect to Question 1, the high mean value of 4.00 show that the list of criteria was practical for the selection of the PPP scheme. Regarding Question 2 and 3, respondents presented their interest on the ANP-based model with the mean value of 3.67 and thought that the rating of criteria for different PPP schemes of a particular project easy to follow (mean 3.50). In terms of Question 4, all respondents agreed 'to the great extent' that group decision-making is more useful than individual decision-making in selecting a PPP scheme (mean 4.00). The mean scores of the degree of appropriateness (question 5) and degree of objectivity (question 6) are 4.00 and 3.83 respectively, suggested that participants assessed that the model was of the standards set for the level. Most responses to Question 7 on 'Degree of practicality' were 'to some extent" and fewer responses were 'to a great extent' and the mean value of this question is the lowest among others (3.33). This is understandable as the model need to be further tested by some more case projects. The aspect rated highest was '*Overall reliability*' (question 8) with the mean score of 4.17 that shows the satisfaction of respondents with the results of this study. Therefore, it can be concluded that the framework was validated to be appropriate, objective, replicable, reliable and suitable for delivering PPP projects.

7.6 CHAPTER SUMMARY

This chapter uses ANP to develop a model to aid the problem-solving process. It focused on how to structure a hierarchical decision model (by breaking down the decision problem into levels) and how to weight the decision criteria (by means of pairwise comparisons). After obtaining judgements from experts, the relationships among criteria of the selection of PPP scheme were identified. Then, the ANP structure and final priorities of this system were built using the Super Decision software. Since the focus of this research is to develop a decision-making framework for the selection of PPP scheme in Vietnam, the Hybrid family is used to illustrate the development of the ANP model. Finally, validation was conducted to explore the practicability of the decision tree identifier and applicability of the framework. The findings presented in this chapter provide responses to research question 4.

Chapter 8

CONCLUSIONS

8.1 INTRODUCTION

This research focused on developing a framework that assists both public and private sector in effectively choosing the suitable PPP scheme for procuring a particular infrastructure project. This chapter presents the conclusions, research contributions, limitations and future research directions. The objectives of the study are reviewed and compared against the research findings to draw the conclusions. Next, the limitations encountered during the research study are highlighted and recommendations for future research are suggested.

8.2 OVERVIEW OF THE LITERATURE

The comprehensive literature review was conducted in Chapter 2 to explore PPP definitions, the rationale for adopting PPP, types of PPP schemes, V*f*M, PPP structure and parties involved in PPP projects, PPP process, payment mechanism and decision-making in PPPs. The literature review identified that currently, there is a lack of a systematic and widely accepted categorisation of PPP schemes considering that various forms of PPP schemes exist and are continuously being developed to suit project characteristics. The definitions and scope of PPP schemes are often used interchangeably or lead to confusion, which makes the PPP study and learning lessons more complex. This research also addressed a need for a commonly understood PPP definition and internationally accepted guidelines on the categorisation, transparency and other aspects of PPP schemes.

The literature confirms that a suitable PPP scheme is of significant contribution to the success of the project and can minimise the risk of problems occurring later. However, few studies have been conducted on how to develop a robust decision-making tool for choosing the most suitable procurement method. A comprehensive list of the criteria that assists the selection of PPP schemes has yet to be fully identified. It is therefore difficult for practitioners to objectively choose the most appropriate PPP scheme.

In Vietnam, the literature showed that regardless of the government’s effort to attract private and foreign investment, investors still hesitate to take risks in investing in PPPs. One of the reasons that lie within an immature legislation system is the selection of a suitable PPP scheme, which is too complicated and often confusing without proper guidelines.

8.3 CONCLUSIONS WITH RESPECT TO RESEARCH OBJECTIVES

The overall aim of this study was to develop a framework for selecting PPP schemes for infrastructure development projects in Vietnam. In order to achieve this goal, five research objectives were formulated as follows:

1. To categorise different types of PPP schemes into families, then to identify the characteristics and conduct a SWOT analysis between different types of PPP families.
2. To identify a set of criteria associated with the selection of PPP schemes.
3. To understand current PPP implementation in Vietnam
4. To develop a decision-making framework for selecting PPP schemes.
5. To validate the proposed framework in procuring infrastructure projects in Vietnam.

This research used mixed methods in data collection and analysis to address these objectives, as shown in Table 8-1.

Table 8-1: Methods used to achieve research objectives

	Data collection methods			
	Literature review	**Semi-structured interview**	**Questionnaire survey**	**Case study**
To categorise different types of PPP schemes into families, then to identify the characteristics and conduct a SWOT analysis between different types of PPP families.	✓			
To identify the set of criteria associated with the selection of PPP schemes	✓	✓	✓	
To understand current PPP implementation practice in Vietnam	✓	✓	✓	
To develop a decision-making framework for selecting PPP schemes.		✓		
To validate the proposed framework in procuring infrastructure project in Vietnam.			✓	✓

8.3.1 Objective 1: To categorise different types of PPP schemes into families, then to identify the characteristics and conduct a SWOT analysis between different types of PPP families.

This objective was addressed in Chapter 4. Different PPP schemes are categorised based on the project characteristics, the private sector’s involvement and obligations, investment responsibility and source of finance. This categorisation tries aims to avoid confusion about various types of PPP schemes such as similar structures that may use different terminologies, and dissimilar structures that may use similar terminology. The frequent use of different types of PPP schemes around the globe were classified into four different PPP families, namely O&M family, Public-financed family, Private-financed family and Hybrid family. Then the SWOT analysis of different PPP families was conducted.

- The O&M group consists of two schemes: O&M and OMM that covers only operation and maintenance stages. This group is used for existing assets. This type of contracts seems to be the simplest PPP contracts that help to prevent the assets' failure and avoid environmental and health hazards; however, there may be ambiguous assignment of rights and duties. O&M contracts can help to sustain overall profitability of a facility; at the same time, operators may face with design and construction defects as well as unsolvable problems of liability.
- The public-financed group includes schemes in which the investment responsibility and the ownership of the assets belong to the public sector. This type of PPP family seeks the use of innovative and cost-saving approaches. These types of contracts are shorter and simpler than contracts under Private-financed and Hybrid families. Such schemes can provide efficient and sustainable in economic terms with higher economic value potential; however, these contracts require longer tendering process, high tendering costs, limiting competition with possibility of order changes and cost overruns.
- The private-financed family comprises schemes where, as indicated in the name of the groups, the project is financed by the private party with no obligation to transfer the ownership to the government. These types of contract can help to attract finance from the private sector to complete projects with a whole-of-life costing approach and integrate the process of design, construction and maintenance with any operational aspects. Nevertheless, private-financed contracts can be more complex and more costly than other types of procurement contracts. The tendering process can be long. The treatments from political and cultural can make investors wary about entering into any long-term investments.
- The hybrid family includes schemes in which the concepts of design, build, operate and maintain are bundled and assigned to the private sector for a period of time. The private party owns the assets during concession and transfers the project back to the government when the contract ends. Key features of this group are that the investment responsibility can be partly or fully from private parties. These schemes can help to increase the participation of and contribution from various stakeholders, at the same time, reducing the financial pressures and operating responsibilities on the host government. They also help to reduce the cost and time overruns of projects, as well as inappropriate technology

applications. However, contracts are more complex, the tendering process can take longer and there is a threat of the facility being run down at the transfer stage. This family is expected to attract direct foreign investment into developing countries and reduce pressures on the government.

8.3.2 Objective 2: To identify a set of criteria associated with the selection of PPP schemes.

A comprehensive set of criteria (Chapter 2) was identified through an extensive and systematic literature review, as well as semi-structured interviews with experts, both academics and industry practitioners. The list consists of 25 criteria covering various aspects of the scheme selection, from the political and economic system, financial viability to risks in different stages of the project life cycle, innovation and types of infrastructure.

The selection criteria for a PPP scheme were tested internationally using questionnaire surveys, and Chapter 5 presents the key findings. Participants were asked to provide expert opinions on the selection criteria for all PPP families defined. For the majority of the PPP families, respondents ranked '*Stable politics and government system*', '*Financial attraction of project to investors*' and '*Mature legal system required to support PPP procurements*' as the most important criteria. Some criteria were considered as critical for one group but not for the others. For example, '*financial attraction of project to investors*' ranked the most important for O&M, Private-financed and Hybrid families but ranked the 8th for public-financed family. In contrast, '*stable politics and government system*' ranked as the most important for the public-financed family but ranked third for other PPP family groups.

The results from the ranking of the selection criteria based on their mean values and standard deviations, number of clusters and correspondingly criteria, which were extracted from factor analysis, are shown in Table 8-2.

Table 8-2: Summary of results from questionnaire survey

	Group 1: O&M	**Group 2: Public-financed**	**Group 3: Private-financed**	**Group 4: Hybrid**
No. of important criteria ranked by mean scores and standard deviations	22	22	23	25
No. of clusters extracted from factor analysis	6	5	4	6
No. of criteria resulted from factor analysis	18	19	22	22

By using mean values and standard deviations, the ranking of the selection criteria of PPP schemes was obtained. For each group of PPP family, certain criteria were removed from the final list of criteria. Group 1: O&M family, three criteria were excluded, which are '*Financial risks arising from exchange* *rate volatility, transaction costs and financing costs*', '*Innovation in management*' and '*Project design and construction complexity*'; Group 2: Public-financed family, three criteria related to innovation were considered as not important for selecting PPP scheme of this group. In Group 3: Private-financed family, two removed criteria were related to government experience in PPPs, as in this PPP family the private parties are encouraged to deliver an output without requiring detailed prescriptions on how to deliver the service. On the other hand, all criteria are considered as important in selecting a PPP scheme in the Hybrid family.

The comparisons between developed and developed countries were conducted to find the difference in perspectives of the two 'worlds' in order to understand the mechanism of choosing a PPP scheme. Even though the results reflect that the respondents share a certain degree of commonality with respect to the rankings of the selection criteria among different respondents, the priorities are groups' specific. For the O&M family, among 25 criteria, four have significant differences between developed and developing countries, except for '*Operating risk due to higher operating costs and maintenance costs*', which is ranked higher in developed countries but ranked lower in developing countries. The other three criteria that ranked higher in developing countries relate to innovation and government guarantee. For the public-financed family, six criteria were found with significant differences. Four out of six criteria were ranked higher in developing countries than in developed countries as respondents in developing countries with unstable macroeconomics and political systems have less experience in PPPs compared to their counterparts. These include '*Community/public support'*, '*Financial risks arising from exchange rate volatility, transaction costs and financing costs'*, '*Government guarantees'* and '*Experiences in O&M stage'*. On the other hand, 'Technical *risk'* and '*Project complexity in O&M'* are two criteria that received higher rank in developed countries than in developing countries. Respondents in the former understand that technical risk that appears at the beginning of the project life cycle can lead to other enormous risks in the following stages and the degree of complexity of the project in the O&M stage can be a reason for the lower expected revenue. In the private-financed family, nine criteria received differences in the perceptions of two groups of respondents. Respondents from both developed and developing countries agree that '*Financial attraction of project to investors*' is the most important; however, the mean score of the criteria from developed countries is much higher, compared to the mean score of respondents from developing countries. The remaining eight criteria with significant differences ranked higher in developed countries than in developing countries. These criteria include the '*Project scale and the amount of total investment*', '*Construction risk*', '*Operating risk*' '*Financial risks arising from inaccurate forecast*', '*Regulatory/political risks due to legal changes and unsupportive government policies*', '*Project design and construction complexity*', '*Alternative solutions which may affect the demand of the PPP project'* and '*Type of asset: social infrastructure'*. For the Hybrid family, all criteria are considered as important in selecting a scheme for a project to procure. In addition, the result from Mann-Whitney U test showed that there was a high consensus difference between respondents from developed and developing countries. The only one criterion that received a significant difference was '*financial attraction of project to investors*' which was ranked the first in developed countries, but ranked 3rd in developing countries.

The results from a factor analysis of four PPP families showed that 11 out of 25 criteria are critical to the scheme selection of all PPP families as they can be seen in all groups. The more stages that the PPP project covers during the project life cycle, the more number of criteria used for selection of PPP scheme. The least number of criteria are seen in O&M family (18 criteria) and more criteria are observed in Private-financed and Hybrid family (22 criteria). It is also observed that every group has some cluster similarities, however, there exists differences as well. For example, every group has risk-related cluster but the risks associated to Group 2 are construction risk, technical risk and operating risk, while there are five risks associated to Group 4.

8.3.3 Objective 3: To investigate the current PPP implementation in Vietnam

Through the comprehensive literature review and in-depth interviews with experts, the complete picture of PPP implementation practice in Vietnam is obtained. Even though there are continuing efforts made to attract and increase the confidence of private participation, Vietnam is facing challenges in defining a PPP-enabling framework and shows very limited success in implementing successful PPPs. First adopted in 1992 in Vietnam, PPPs are observed more in transportation and much less in other infrastructure projects such as energy, waste supply and wastewater treatment. Attempts have been made to attract foreign investors, but energy is the only sector that has received investment from foreign investors with the government assurance for power purchase agreements. PPPs in Vietnam are under a complicated management system, which is directly controlled under law and indirectly governed under broader laws and ministries. Some areas of the legal framework on PPPs are incomplete, overlap and most importantly, lack guidelines. Risks involved in large infrastructure PPP projects are categorised into five general groups: project preparation, design and construction risks, project finance risks, market risks, O&M stage risks, project external risks.

Semi-structured interviews were conducted to gain an in-depth understanding of the status quo of PPP implementation in Vietnam. Interview results observed that regardless of government efforts, private sectors still believe that undertaking PPP in Vietnam is quite risky and they generally lack confidence in investing. For foreign investors, the risk mainly comes from the immaturity of the legal system. Majority of the interviewees highlighted the implementation constraints in Vietnamese PPPs include '*legal and regulatory issues*', '*institutional and capacity issues*' and '*financial issues*'. Issues that related to legal and regulatory including complicated and overlapped PPP regulations and lack of guidelines or unclear guidelines were frequently mentioned by both public sector, private sector and consultant comprise inadequate legal systems, lack of guidelines, lack of competitive bidding and transparencies, superficial investment preparation works and weaknesses in forecasting as the major

PPP implementation barriers. The other issues observed by the interviewees are related to financing problems in which the government guarantee for foreign exchange rate, interest rate and minimum revenue mechanism was the most frequently mentioned responses. These findings are consistent with the results from the questionnaire survey, as the criteria '*mature legal system required to support PPP procurement*' was recorded the second most important consideration for a PPP project.

Seven types of PPP schemes and BT (which is considered as PPP in Vietnam) are currently regulated under the legal system in Vietnam. However, most projects have been executed mainly under the BOT scheme. Currently, the choice of selection of scheme both from government and within organisations was done without any guidelines. At present, in Vietnam, decision makers seek a guideline that can assist the selection of a suitable PPP scheme to achieve maximum results of a project. The Law on PPPs was also expected to provide clear guidance on risk allocation, a framework to implement different types of PPP schemes, standard project deeds for different types of projects and other bottlenecks. The upcoming law would increase the confidence of private investors and contribute to the successful implementation of PPP in Vietnam. All these observations signify the importance of introducing a structured guidelines and selection processes to identify the best procurement system.

8.3.4 Objective 4: To develop a decision-making framework for selecting PPP schemes.

The selection of the most suitable PPP scheme is a multi-criteria decision-making process. It requires the decision makers to objectively evaluate every PPP scheme against each identified selection criterion. The decision tree classifier for selection of PPP family is first proposed to help decision-makers to determine PPP family of a project. The decision is based on some key determinants such as involvement of significant private finance, new/existing asset and transfer obligation. After defining the PPP family of the project, decision-makers use the ANP-based decision-making framework to determine the PPP scheme for a given project. ANP is selected as it is regarded as the most suitable and simple technique for this problem. ANP allows interdependencies, outer dependencies and feedback among decision elements and can mix quantitative and qualitative aspects into a decision. The ANP model was composed of four levels and was developed based on six steps. The goal level is the selection of a PPP scheme. The control level comprises clusters obtained from the results of factor analysis in Chapter 5 of each PPP family. The net-level comprises sub-clusters (selection criteria). The fourth level contains alternatives, which are the schemes of each family.

Hybrid family is chosen to illustrate framework development since the focus of this research is to help practitioners in Vietnam to select the most appropriate PPP scheme for a given particular PPP project, and most of the available PPP schemes fall into a Hybrid family. As a result, a Hybrid family was used. PPP scheme selection criteria are a combination of tangible and intangible and the selection of a PPP scheme is a complex decision-making process that has a hierarchical structure. Six clusters were identified by using factor analysis for the formulation of the main body of the framework. They include risks over the project life cycle, political and macro-economic conditions, project innovation, types and project complexity, government experience and project scale and financial viability. Twenty-two criteria within these groups and their interrelations were identified.

The results from the ANP provide the local priorities within the criteria. The results from the ANP development shows that 'Cluster 6: Financial viability' is the most important characteristics and 'Cluster 2: Political and Macro-economic conditions' is the second important for the selection of a PPP scheme. In the top six most important criteria for selection of a PPP, four criteria belong to Cluster 2 and two are from Cluster 6. This framework is used to aid the decision-makers to choose the most appropriate PPP scheme for a given infrastructure project and the choice of a scheme depends on the project management team's decisions.

To illustrate the use of the proposed model in this study, two case projects: a tunnel and a university campus are used to demonstrate the functions of the framework (Chapter 7). When applied to the Case Projects, the decision-making framework is shown to be useful in facilitating a decision. Further discussions with interviewees also revealed that practitioners in Vietnam tend to use the schemes that they are familiar with. This restricted the opportunity to adopt and utilize the advantages of other PPP schemes. In addition, lack of guidelines from government is also explained why BOT is dominant in Vietnam.

8.3.5 Objective 5: To validate the proposed framework in procuring infrastructure project in Vietnam.

The ANP-based decision-making model for selection of PPP scheme is presented in Chapter 7. The criteria with higher priorities can be identified as more important in selecting a PPP scheme. Experts were invited to assess and investigate the validity of the framework by providing expert opinions. The validation results demonstrated the comprehensiveness, reliability, credibility, practicality and generalisability of the framework the selection of the PPP scheme.

8.4 RESEARCH CONTRIBUTIONS

The study contributes to the advancement of both theoretical and practical knowledge. Theoretical signify the contributions towards the field of research while practical represents the contributions towards the industry as discussed in the following sections:

8.4.1 Theoretical contributions

This study has contributed to new knowledge and improved understanding in the following areas:

The research study has developed a classification framework for different PPP schemes. The literature review confirmed that many forms of PPP scheme exist, such as O&M, DBO, DBFM and

BOT, and the number is on the rise. Nevertheless, different definitions of a PPP schemes exist and are often confusing. Although many classifications exist, however, there is no systematic categorisation. This research provided a simplified way to categorise various options of PPP into four different PPP families based on the project characteristics, sources of finance, tasks assigned to the private party and sources of revenue. Four categorisations of PPP families are presented including O&M, Public-financed family, Private- financed family and Hybrid family. The outcome of this classification increases the common understanding and encourages the lessons learned from similar exercises in selecting an appropriate PPP scheme for optimum execution of project delivery.

The research identified a completed list of 25 criteria for selection of the most optimum PPP scheme for an infrastructure project. The results from the comparative analysis between developed and developing countries provided an in-depth understanding of the differences and similarities of how a PPP scheme should be selected.

These findings have highlighted the current gaps in PPP scheme selection, the improvements to upgrade the current selection process and constraints in the legal system in implementing an efficient PPP project. These observations would help to attain better understandings, in order to effectively procure future PPP infrastructure projects in Vietnam.

Eventually a robust decision-making framework was developed for selecting the most suitable PPP scheme. While many studies have concentrated on project selection, an appropriate concessionaire or contractor selection, studies have seldom made attempts to comprehensively select the appropriate PPP schemes, both internationally and in Vietnamese context. Especially in the case of Vietnam, among the available schemes, the majority of them belong to the Hybrid family. However, there is no clear guideline as to how to select the best PPP scheme in Hybrid family for Vietnam. With this intention, the research developed a selection framework for the Hybrid family using ANP, which comprises of 22 criteria. The proposed model enables the decision-makers to cope with the selection of an appropriate PPP scheme.

8.4.2 Practical contributions

From a practical perspective, the research will benefit in two ways (i) a detailed SWOT analysis, which provides an efficient way to understand different PPP schemes; and (ii) an ANP-based model decision-making framework, which helps the government and the private sector to choose a suitable PPP scheme for procuring an infrastructure project in Vietnam. A framework for selection of PPP scheme using the ANP approach can be used as a practical tool that help decision-makers to assess and compare different PPP options, and choose the most suitable one. Since the focus of this study is on Vietnam, the framework used Group 4: Hybrid family for illustration, as most of the available schemes in Vietnam fall within this group. The decision-making framework can further improve into a user-friendly tool to aid decision makers to select the suitable PPP scheme and is also applicable to other developing countries that share similar characteristics with Vietnam.

The research also contributed in identifying the current state of the art implementation practice in Vietnam through a semi-structured interview. After investigating the status quo of PPP in Vietnam including definition and characteristics, legal framework, different types of schemes and related risks, the uniqueness and thorough picture of PPPs in Vietnam were obtained. Then, PPP implementation constraints were also identified. Based on the findings, it can be concluded that Vietnam has less experience in PPP procurement and practice. However, PPP is still an inevitable trend to develop infrastructure systems and public services, especially when the state budget is limited. The developed framework of this study is applicable to other developing countries that share similar characteristics to Vietnam. As this research was conducted at a global scale with various geographical areas, the proposed framework can be used as a general reference for projects from various sectors and countries.

8.5 RESEARCH LIMITATIONS

This research has made significant contributions; however, there are also some limitations. The major limitations are:

This research defined and explained all evaluation criteria but did not include exact values or limits for each one. This is because the values or weights for these criteria differ from country to country. An example is ‘the project scale and the amount of total investment’ with no minimum amount. The minimum scale of the project to implement under the form of PPP is $100 million in Canada, $50 million in Australia and Singapore (Australian Government 2015; Government of Singapore 2004) or GBP£20 million in the UK (equivalent to EUR€30 million euros). As a result, it will be hard for the participants to choose the amount if it is set by a specific number. In addition, PPP size limits may change from time to time as the government gains a better understanding of the size of projects that are suited to a PPP.

On the subject of decision-making framework development, due to difficulty in data collection and time constraints, the framework was developed only with the Hybrid family and applied in Vietnam. The ANP framework was developed through pairwise comparison based on group decisions in order to avoid bias. This was a time-consuming process and inconsistency might have happened. It is expected that the applications of the framework to different types of PPP families in different countries will help to improve its quality and applicability. At the same time, the study has not focused on identifying whether decision-making processes on the PPP scheme selection significantly differ between service sectors.

Thirdly, two case projects were used to illustrate the application of the proposed ANP framework. L University was completed, and H tunnel is under construction. This means that all schemes of the case projects were determined. Project managers of the corresponding projects estimated some data based on their knowledge and experience and hence further validation is required to justify the robustness of the responses.

8.6 RECOMMENDATIONS AND FUTURE RESEARCH

The above limitations provide an opportunity for future studies, whilst researchers are working their best to narrow the gap between theory and practice. Therefore, the following recommendations and future research efforts should be undertaken, on improving the quality of the current research, especially in the following areas:

- There are various types of PPP schemes that are currently available, however, there is a lack of criteria as well as a decision-making framework to select the best PPP scheme option. Many criteria should be put into consideration, and the framework should be a practical yet simple one that can help decision-makers to yield better solutions. More research should be carried out to refine the list of criteria.
- This research was conducted internationally with various geographical areas including Australia, the US, UK and other developed countries in addition to many developing countries in general and Vietnam in particular; hence different geographical areas along with different legal systems may have affected the opinions regarding the choice of criteria and their weights.
- The ANP is a powerful tool to provide an effective way of prioritising criteria by transferring the subjective judgements into meaningful weights and ratios that represent priorities of criteria and sub-criteria. The framework that was constructed based on the ANP model is easy to use. However, the framework is not applicable to any PPP families and any countries. Clusters of other PPP families are distinctive compared to the Hybrid family; hence, in the future, additional work will need be done to improve the comprehensiveness of the framework or to make it country-specific, simplified and more practical, adaptive and flexible. More focussed research would also concentrate on refining and validating of the framework as well as exploring significance criteria in different PPP families and sectors.

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APPENDIX

APPENDIX A: LIST OF SCHEME ABBREVIATIONS

BDO	Build, Develop, Operate
BLOT	Build, Lease, Operate, Transfer
BLO	Build, Lease, Own
BLT	Build, Lease, Transfer
BOFT	Build, Own, Finance, Transfer
BOO	Build, Own, Operate
BOLT	Build, Own, Lease, Transfer
BLOT	Build, Lease, Operate, Transfer
BOOT	Build, Own, Operate
BOT	Build Operate Transfer
BT	Build, Transfer
BTL	Build, Transfer, Lease
BTO	Build, Transfer, Operate
DB	Design, Build
DBF	Design, Build, Finance
DBFM	Design, Build, Finance, Maintain
DBFO	Design Build Finance Operate
DBFOM	Design, Build, Finance, Operate, Maintain
DBFOMT	Design, Build, Finance, Operate, Maintain, Transfer
DBFORM	Design, Build, Finance, Operate, Rehabilitate, Maintain
DBM	Design, Build, Maintain
DBO	Design, Build, Operate
DBOM	Design, Build, Operate, Maintain
DBOT	Design, Build, Operate, Transfer
DCFM	Design, Construct, Finance, Maintain
DCFOM	Design, Construct, Finance, Operate, Maintain
DCOM	Design, Construct, Operate, Maintain
MC	Management contract
MOM	Management, Operation and Maintain

O&M	Operate and Maintain
OMM	Operation, Maintain, and Management
PFI/PF2	Private Finance Initiative
ROO	Rehabilitate, Own, Operate
ROOT	Rehabilitate, Own, Operate, Transfer
ROT	Rehabilitate, Operate, Transfer
RTL	Rehabilitate, Transfer, Lease
RLT	Rehabilitate, Lease, Transfer
RLOT	Rehabilitate, Lease, Operate, Transfer
TOT	Transfer, Operate, Transfer

APPENDIX B: ETHICS APPROVAL

RMIT UNIVERSITY

College Human Ethics Advisory Network (CHEAN)
College of Science, Engineering and Health

Email: seh-human-ethics@rmit.edu.au
Phone: [61 3] 9925 4620
Building 91, Level 2, City Campus/Building 215, Level 2, Bundoora West Campus

13 September 2017

Associate Professor ______________
School of EngineeringRMIT University

Dear Associate ________________

SEHAPP 67-17 A decision-making framework to select the public-private scheme for infrastructure development inVietnam

Thank you for submitting your amended application for review.

I am pleased to inform you that the CHEAN has approved your application for a period of **1 Year and 3 Months** from the date of this letter to **31 December 2018** and your research may now proceed.

The CHEAN would like to remind you that:

All data should be stored on University Network systems. These systems provide high levels of manageable security and data integrity, can provide secure remote access, are backed up on a regular basis and can provide Disaster Recover processes should a large scale incident occur. The use of portable devices such as CDs and memory sticks is valid for archiving; data transport where necessary and for some works in progress. The authoritative copy of all current data should reside on appropriate network systems; and the Principal Investigator is responsible for the retention and storage of the original data pertaining to the project for a minimum period of five years.

Please Note: Annual reports are due on the anniversary of the commencement date for all research projects that have been approved by the CHEAN. Ongoing approval is conditional upon the submission of annual reports failure to provide an annual report may result in Ethics approval being withdrawn.

Final reports are due within six months of the project expiring or as soon as possible after your research project has concluded.

The annual/final reports forms can be found at:
www.rmit.edu.au/staff/research/human-research-ethics

Yours faithfully,

Chair, Science Engineering & Health
College Human Ethics Advisory Network

Cc Student Investigator/s:	Ms _____________, s_____________, School of Engineering
Other investigator/s:	Dr _____________, School of Property Construction & Project Management

APPENDIX C: QUESTIONNAIRE SURVEY FOR CRITERIA OF PPP SCHEME SELECTION

QUESTIONNAIRE SURVEY ON CRITERIA FOR THE SELECTION OF THE PUBLIC-PRIVATE PARTNERSHIPS SCHEME FOR INFRASTRUCTURE CONSTRUCTION PROJECTS

RMIT researchers are currently conducting an online survey on how to select the scheme for a specific Public-Private Partnerships (PPPs). Through this survey, we aim to identify the comprehensive set of criteria related to selection procedure practices and investigate the relationship between them and their indicators.

All information provided will be treated strictly CONFIDENTIAL and will be only used for research purpose. No information regarding any individual respondent or organization will be made public. In order to understand more about the research, please kindly read 'The Participant Information Sheet for Questionnaire Survey' here: *Participant Information Sheet for Questionnaire Survey*.

This survey is broken up into two sections:

1. Introduction
2. The criteria for selection of PPP scheme

In this Questionnaire Survey, the definition of PPP is adopted from The World Bank Reference Guide Version 3 (The World Bank Group 2017):

'*PPP is a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility and remuneration is linked to performance*.'

It would be very grateful if you could complete the questionnaire survey and kindly submit it on or before 15 January 2017.

Please answer ALL of the questions that are provided below. The survey should take about 25 to 30 minutes to complete.

SECTION 1: GENERAL INFORMATION

1. How many years of experiences in PPP project do you have?

   ☐ < 5 years ☐ 5 -10 years ☐ 10 -20 years ☐ > 20 years

2. Which primary role is your organisation participated in PPP projects: (Please tick any that apply)

☐ Public Sector

☐ Local Government ☐ Central Government

☐ Public Enterprise ☐ Other (please specify)

☐ Private Sector

☐ Concessionaire ☐ Main contractor ☐ Subcontractor ☐ Financier

☐ Designer only ☐ O&M contractor ☐ Consultant Supplier

☐ Other (please specify) ________________________________

☐ Researcher and others

☐ Researcher ☐ Policy maker ☐ Other (Please specify)

3. What type of PPP project has your organization being involved with? (Please select all that apply)

☐ Social infrastructure (provide basic services to households to improve the quality of life and welfare in the community such as hospital, education and training, water storage and treatment facilities, housing, sewerage and drainage pipes, institutions and so on)

☐ Economic infrastructure (provide key intermediate services to business and industry and its principal function is to enhance productivity and innovation initiatives such as road, highways, bridges, ports, railways, airports, public transport, telecommunications, etc.)

☐ Both

4. Which types of PPP project have you been involved in? (Please select all that apply)

☐ Group 1: O&M family includes but not limited to schemes such as O&M (Operation and Maintenance), OMM (Operation, Maintenance and Management)

☐ Group 2: Public-financed family includes but not limited to schemes such as DBO (Design, Build and Operate), DBM (Design, Build and Maintain), and DBOM (Design, Build, Operation and Maintain)

☐ Group 3: Private-financed family includes but not limited to schemes such as BOO (Build, Own, and Operate), ROO (Rehabilitate, Own and Operate), Design, Build, Finance, Operate and Maintain (DBFOM), Design, Build, Finance, Operation (DBFO), Design, Build, Finance, Maintain (DBFM)

☐ Group 4: Hybrid family includes but not limited to schemes such as BOT (Build, Operate, Transfer), BTO (Build, Transfer, Operate), BOOT (Build, Own, Operate, Transfer) and BLT (Build, Lease, Transfer), BTL (Build, Transfer, Lease), BLOT (Build, Lease, Operate, Transfer)

☐ None of above

☐ Others (please specify) ______________________________

5. Your experience in PPP projects (please provide briefly Statement):

____

____

End of Section 1. Please move to Section 2.

SECTION 2: CRITERIA FOR SELECTION OF PPP SCHEME

1. GROUP 1: THE O&M FAMILY

The O&M family includes but not limited to two (02) types of contracts: Operation & Maintenance (O&M) and Operation, maintenance and Management (OMM) in which the private party is responsible for the process of operation and maintenance to sustain the performance and profitability of the facility.

1.1 **Operation and Maintenance (O&M):** Under an O&M contract, a selected private sector is responsible for operating and maintaining a facility for a specified time. (WB 2007) The private party (also called the Operator) is also responsible for maintenance expenditure and is paid a fixed fee or a performance-based fee for the services. The ownership and overall management of the facility are responsibilities of the Public sector.

1.2 **Operation, Maintenance and Management (OMM)** (also called a Management Contract) is an agreement whereby a public agency contracts with a private party to operate, maintain, and manage the operation of a facility. Under this contract option, the public agency retains ownership of the facility, but the private party is responsible for management and operation of the facility, under a long-term contract. The private operator may invest some of its own capital, and will perform under the contract in order to recover the investment and earn a reasonable return. (The United States General Accounting Office-GAO 1999)

Types of contracts	Responsibility of Private sector						Ownership of the facility	Investment responsibility
	Design	Build	Operation	Maintenance	Management	Transfer		
O&M			✓	✓			Public	Private for maintenance expenses
OMM/Management contract			✓	✓	✓		Public	Public, Public/private

Please rate the criticality of each selection factor of Group 1: O&M family of PPP schemes below on a Likert scale of 1- 5 (where 1 = 'not important at all', 2= 'not very important', 3= 'neutral', 4= 'important' 5 = 'extremely important')

Criteria	Group 1: O&M, OMM				
	1	2	3	4	5
Stable politics and government system	☐	☐	☐	☐	☐
Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)	☐	☐	☐	☐	☐
Supportive political climate for PPP projects	☐	☐	☐	☐	☐
Community/Public support to PPP projects	☐	☐	☐	☐	☐
Mature legal system required to support PPP procurements	☐	☐	☐	☐	☐
Government experience in Operation and Maintenance	☐	☐	☐	☐	☐
Government experience in Project Management	☐	☐	☐	☐	☐
The project scale and the amount of total investment	☐	☐	☐	☐	☐
Financial attraction of project to investors	☐	☐	☐	☐	☐
Financial viability based on NPV and risk-adjusted present value	☐	☐	☐	☐	☐
Technical Risk due to engineering and design failures	☐	☐	☐	☐	☐
Construction risk, due to faulty construction techniques and cost escalation and delays in construction	☐	☐	☐	☐	☐
Operating risk due to higher operating costs and maintenance costs	☐	☐	☐	☐	☐
Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold.	☐	☐	☐	☐	☐
Financial risks arising from exchange rate volatility, transaction costs and financing costs	☐	☐	☐	☐	☐
Regulatory/Political risks due to legal changes and unsupportive government policies	☐	☐	☐	☐	☐
Innovation in technology	☐	☐	☐	☐	☐
Innovation in management	☐	☐	☐	☐	☐
Innovation in operation	☐	☐	☐	☐	☐
Government provides guarantees against financial risks, political/legal risk	☐	☐	☐	☐	☐
Project design and construction complexity	☐	☐	☐	☐	☐
The complexity in the operation and or maintenance stage	☐	☐	☐	☐	☐
Alternative solutions which may affect the demand of the PPP project	☐	☐	☐	☐	☐
Type of asset: Economic infrastructure	☐	☐	☐	☐	☐
Type of asset: Social infrastructure	☐	☐	☐	☐	☐

2. GROUP 2: THE PUBLIC-FINANCED FAMILY

This group includes but not limited to three (03) types of contracts, which are DBO, DBM, and DBOM. The feature of this group is that the project is financed by the public sector.

2.1 Design, Build and Operate (DBO): DBO is a form of PPP, in which the public sector provides finance for a capital investment project but the providers of the projects retain the design and construction and deliver some or all of the operational elements. (Grimsey, Darrin & Lewis, Mervyn K 2005)

2.2 Design, Build and Maintenance (DBM): the private party assumes the obligation to design, construct and maintain a facility under a long-term maintenance arrangement. The public sector retains ownership and operation of the infrastructure (Amade 2012).

2.3 Design, Build, Operation and Maintenance (DBOM): Under a DBOM contract, the private party is responsible for the design and construction of a facility, as well as its operations and maintenance for a specified period of time after construction. The project is financed by the public sector (GAO 1999).

Types of contracts	Responsibility of Private sector						Ownership of the facility	Investment responsibility
	Design	Build	Operation	Maintenance	Management	Transfer		
DBO	✓	✓	✓				Public	Public
DBM	✓	✓		✓			Public	Public
DBOM	✓	✓	✓	✓			Public	Public

Please rate the criticality of each selection factor of Group 2: Public-financed family of PPP schemes below on a Likert scale of 1- 5 (where 1 = ‘not important at all’, 2= ‘not very important’, 3= ‘neutral’, 4= ‘important’ 5 = ‘extremely important’)

Criteria	Group 2: Public – financed family				
	1	2	3	4	5
Stable politics and government system	☐	☐	☐	☐	☐
Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)	☐	☐	☐	☐	☐
Supportive political climate for PPP projects	☐	☐	☐	☐	☐
Community/Public support to PPP projects	☐	☐	☐	☐	☐
Mature legal system required to support PPP procurements	☐	☐	☐	☐	☐
Government experience in Operation and Maintenance	☐	☐	☐	☐	☐
Government experience in Project Management	☐	☐	☐	☐	☐
The project scale and the amount of total investment	☐	☐	☐	☐	☐
Financial attraction of project to investors	☐	☐	☐	☐	☐

Criteria	Group 2: Public – financed family				
	1	2	3	4	5
Financial viability based on NPV and risk-adjusted present value	☐	☐	☐	☐	☐
Technical Risk due to engineering and design failures	☐	☐	☐	☐	☐
Construction risk, due to faulty construction techniques and cost escalation and delays in construction	☐	☐	☐	☐	☐
Operating risk due to higher operating costs and maintenance costs	☐	☐	☐	☐	☐
Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold.	☐	☐	☐	☐	☐
Financial risks arising from exchange rate volatility, transaction costs and financing costs	☐	☐	☐	☐	☐
Regulatory/Political risks due to legal changes and unsupportive government policies	☐	☐	☐	☐	☐
Innovation in technology	☐	☐	☐	☐	☐
Innovation in management	☐	☐	☐	☐	☐
Innovation in operation	☐	☐	☐	☐	☐
Government provides guarantees against financial risks, political/legal risk	☐	☐	☐	☐	☐
Project design and construction complexity	☐	☐	☐	☐	☐
The complexity in the operation and or maintenance stage	☐	☐	☐	☐	☐
Alternative solutions which may affect the demand of the PPP project	☐	☐	☐	☐	☐
Type of asset: Economic infrastructure	☐	☐	☐	☐	☐
Type of asset: Social infrastructure	☐	☐	☐	☐	☐

3. GROUP 3: THE PRIVATE-FINANCED FAMILY

This group of PPP includes but not limited to two (02) types of contracts: BOO and ROO in which the main feature is that the project is financed by the private sector with no obligation to transfer ownership to the government (IMF 2004 and European Commission 2003).

3.1 Build, Own, Operate (BOO): Under the BOO, the private party is responsible for design, funding, construction, operation and maintenance of the facility during the concession period, with no provision for transfer of ownership to the government. At the end of the concession period, the original agreement may be renegotiated, a new agreement may be negotiated or the facility may be purchased by the government. (Grimsey and Lewis 2007).

3.2 Rehabilitate Own and Operate (ROO) is a variant of BOO and refers to a rehabilitation of an existing facility (PPIAF 2009)

3.3 Design, Build, Finance, Operate and Maintenance (DBFOM): Under the DBFOM approach, responsibility for designing, building, financing, operating and maintaining the asset are bundled together and transferred to the private party. (GAO 1999, WB 2017).

3.4 Design, Build, Finance, Operation (DBFO): DBFO is the contract where the private party is responsible for the design, construction, financing and operation of an asset. Operation refers to the provision of some or all of the services related to the asset's use. (Grimsey and Lewis 2007) Under a DBFO, the public party retains ownership of the facility and uses revenues generated from the operation of the facility (such as tolls) to repay the private and other financing used to construct it. (Rall et al. 2010)

3.5 Design, Build, Finance, Maintenance (DBFM): Under a DBFM approach, the private party is not responsible for "operations" of the asset (except for maintenance and some technical services) in the term of the agreement. (The WB Group 2017).

Types of contracts	**Responsibility of Private sector**						**Ownership of the facility**	**Investment responsibility**
	Design	**Rehabilitate**	**Build**	**Operation**	**Maintenance**	**Transfer**		
BOO	✓		✓	✓	✓		Private during concession	Private
ROO		✓		✓	✓		Private during concession	Private
DBFOM	✓		✓	✓	✓		Private during concession	Private
DBFO/PFI	✓		✓	✓			-	Private
DBFM/PFI	✓		✓		✓		-	Private

Please rate the criticality of each selection factor of Group 3: Private-financed family of PPP schemes below on a Likert scale of 1- 5 (where 1 = 'not important at all', 2= 'not very important', 3= 'neutral', 4= 'important' 5 = 'extremely important')

Criteria	**Group 3: Private-financed family**				
	1	**2**	**3**	**4**	**5**
Stable politics and government system	☐	☐	☐	☐	☐
Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)	☐	☐	☐	☐	☐
Supportive political climate for PPP projects	☐	☐	☐	☐	☐
Community/Public support to PPP projects	☐	☐	☐	☐	☐
Mature legal system required to support PPP procurements	☐	☐	☐	☐	☐
Government experience in Operation and Maintenance	☐	☐	☐	☐	☐

Criteria	Group 3: Private-financed family				
	1	2	3	4	5
Government experience in Project Management	☐	☐	☐	☐	☐
The project scale and the amount of total investment	☐	☐	☐	☐	☐
Financial attraction of project to investors	☐	☐	☐	☐	☐
Financial viability based on NPV and risk-adjusted present value	☐	☐	☐	☐	☐
Technical Risk due to engineering and design failures	☐	☐	☐	☐	☐
Construction risk, due to faulty construction techniques and cost escalation and delays in construction	☐	☐	☐	☐	☐
Operating risk due to higher operating costs and maintenance costs	☐	☐	☐	☐	☐
Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold.	☐	☐	☐	☐	☐
Financial risks arising from exchange rate volatility, transaction costs and financing costs	☐	☐	☐	☐	☐
Regulatory/Political risks due to legal changes and unsupportive government policies	☐	☐	☐	☐	☐
Innovation in technology	☐	☐	☐	☐	☐
Innovation in management	☐	☐	☐	☐	☐
Innovation in operation	☐	☐	☐	☐	☐
Government provides guarantees against financial risks, political/legal risk	☐	☐	☐	☐	☐
Project design and construction complexity	☐	☐	☐	☐	☐
The complexity in the operation and or maintenance stage	☐	☐	☐	☐	☐
Alternative solutions which may affect the demand of the PPP project	☐	☐	☐	☐	☐
Type of asset: Economic infrastructure	☐	☐	☐	☐	☐
Type of asset: Social infrastructure	☐	☐	☐	☐	☐

4. GROUP 4: THE HYBRID FAMILY

The Hybrid family includes but not limited to BOT, BTO, BOOT, BLT/BOLT in which a private sector designs, builds, operates, owns the facility for some period of time and transfers the facility back to the owner at the end of the concession period or at pre-specified time. The private partner may subsequently lease the asset to the government. The key feature of this group compared to other groups is that the project is transferred back to the government when the operating contract ends or at some other pre-specified time.

4.1 Build, Operate, Transfer (BOT): BOT is an agreement where a facility is designed, partly or fully financed, operated and maintained by the concessionaire for the period of the concession. (The WB Group 2017) The concessionaire assumes ownership of the infrastructure facilities for a specified period of time after completion of construction. Ownership is transferred to the government upon termination of the concession period. (Kim, J-H et al. 2011)

4.2 Build, Transfer, Operate (BTO): BTO is a contract in which the private party transfers the ownership to the public sponsor after construction is completed, and then is authorized to operate the facility for a period of time. This model also includes some private financing of the design, construction, operation and maintenance of a facility. (Rall et al. 2010)

4.3 Build, Own, Operate, Transfer (BOOT): BOOT is an arrangement whereby a facility is designed, constructed, financed, operated and maintained by a private company. Ownership rests with the private party until the end of the concession period, at which point ownership and operating rights are transferred to the government. (Grimsey and Lewis 2007)

4.4 Build, Lease, Transfer (BLT) or Build, Own, Lease, Transfer (BOLT): BLT or BOLT is a contract in which the private party constructs and owns the facility (design could be by either the public or private party), leases the facility to the public authority and/or others for a period of time over a long-term period, then at the end of the lease period, transfers ownership to the public party. (The WB Group 2017) The responsibility of operation and maintenance belongs to the public sector during the lease period.

4.5 Build, Transfer, Lease (BTL): Under a BTL, the private party makes an investment to build an asset then transfer the ownership to the public sector upon completion of construction, and after having received the right to management and operation for a given time, leases the facility to the public sector. The private party receives government payments (lease payment plus operational cost) based on operational performance (e.g., availability, service quality) for a specified period of time (Kim, J-H et al. 2011).

4.6. Rehabilitate, Operate, Transfer (ROT), Rehabilitate, Lease, Transfer (RLT) are variants of BOT, BLT and refers to a rehabilitation of an existing facility.

Types of contracts	**Responsibility of Private sector**						**Ownership of the facility**	**Investment responsibility**
	Design	**Rehabilitate**	**Build**	**Operation**	**Maintenance**	**Transfer**		
BOOT	✓		✓	✓	✓	✓	Private during concession	Private
BLT/BLOT	✓		✓			✓	Private during lease	Private
BOT	✓		✓	✓	✓	✓	Private during concession	Partly or 100% private
BTO	✓		✓	✓	✓	✓	Public	Partly or 100% private
BTL	✓		✓	✓		✓	Public	Partly or 100% private
ROT		✓		✓	✓	✓	Private during concession	Partly or 100% private

Types of contracts	Responsibility of Private sector						Ownership of the facility	Investment responsibility
	Design	Rehabilitate	Build	Operation	Maintenance	Transfer		
RLT		✓		✓	✓	✓	Private during concession	Partly or 100% private

Please rate the criticality of each selection factor of Group 4: Hybrid family of PPP schemes below on a Likert scale of 1- 5 (where 1 = ‘not important at all’, 2= ‘not very important’, 3= ‘neutral’, 4= ‘important’ 5 = ‘extremely important’)

Criteria	Group 4: Hybrid family				
	1	2	3	4	5
Stable politics and government system	☐	☐	☐	☐	☐
Stable macro-economic outlook during the project life cycle (stable economic growth, low and stable inflation rate, low unemployment, etc.)	☐	☐	☐	☐	☐
Supportive political climate for PPP projects	☐	☐	☐	☐	☐
Community/Public support to PPP projects	☐	☐	☐	☐	☐
Mature legal system required to support PPP procurements	☐	☐	☐	☐	☐
Government experience in Operation and Maintenance	☐	☐	☐	☐	☐
Government experience in Project Management	☐	☐	☐	☐	☐
The project scale and the amount of total investment	☐	☐	☐	☐	☐
Financial attraction of project to investors	☐	☐	☐	☐	☐
Financial viability based on NPV and risk-adjusted present value	☐	☐	☐	☐	☐
Technical Risk due to engineering and design failures	☐	☐	☐	☐	☐
Construction risk, due to faulty construction techniques and cost escalation and delays in construction	☐	☐	☐	☐	☐
Operating risk due to higher operating costs and maintenance costs	☐	☐	☐	☐	☐
Financial risks arising from inaccurate forecast or failure to extract resources, the volatility of prices and demand for products and services sold.	☐	☐	☐	☐	☐
Financial risks arising from exchange rate volatility, transaction costs and financing costs	☐	☐	☐	☐	☐
Regulatory/Political risks due to legal changes and unsupportive government policies	☐	☐	☐	☐	☐
Innovation in technology	☐	☐	☐	☐	☐
Innovation in management	☐	☐	☐	☐	☐
Innovation in operation	☐	☐	☐	☐	☐
Government provides guarantees against financial risks, political/legal risk	☐	☐	☐	☐	☐
Project design and construction complexity	☐	☐	☐	☐	☐
The complexity in the operation and or maintenance stage	☐	☐	☐	☐	☐
Alternative solutions which may affect the demand of the PPP project	☐	☐	☐	☐	☐

Criteria	Group 4: Hybrid family				
	1	2	3	4	5
Type of asset: Economic infrastructure	☐	☐	☐	☐	☐
Type of asset: Social infrastructure	☐	☐	☐	☐	☐

~ End of the questionnaire ~

Thank you for your time and effort taken in completing this questionnaire!

All information provided will be treated strictly confidential and no information regarding any individual respondent or organization will be made public.

It would be much appreciated that you forward the link to this Questionnaire Survey to someone else who you think is suited to this survey. If you would like to receive our survey result or wish to discuss with us, please email to s...@student...

Submitting your completed questionnaire is an indication of your consent to participate in the study. You can withdraw your responses any time before you have submitted the questionnaire. Once you have submitted it, your responses cannot be withdrawn because they are non-identifiable and therefore we will not be able to tell which one is yours.

By clicking SUBMIT, I am agreeing to participate in this project and the use of my data in this research project!

Thank you so much and all the best to you!

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APPENDIX D: EXPERTS' ANSWERS TO ANP MODEL'S PAIRWISE QUESTIONS

Appendix D.1: Experts' answers to ANP model's pairwise questions

Appendix D.1-1: Node comparisons

wrt	R1			R2																R3			R4							
Expert	R5 or R3	I3 or I2	G3 or G2	R3 or R1	R4 or R1	R5 or R1	R4 or R3	R5 or R3	R5 or R4	P4 or P3	P5 or P3	P5 or P4	I2 or I1	I3 or I1	I3 or I2	T2 or T1	G2 or G1	G3 or G1	G3 or G2	R2 or R1	I3 or I2	G3 or G2	R2 or R1	R3 or R1	R5 or R1	R3 or R2	R5 or R2	R5 or R3	P2 or P1	P3 or P1
A	9R3	7I2	8G2	2R3	3R1	4R1	3R3	5R3	2R5	4P4	3P5	1	5I1	2I1	5I3	2T2	5G2	4G3	2G2	8R1	4I2	6G2	6R1	1R1	5R1	4R3	3R5	4R3	2P2	6P3
B	9R3	7I2	9G2	3R3	3R1	3R1	2R3	5R3	2R5	6P4	2P5	1	3I1	1	5I3	1T2	4G2	5G3	2G2	5R1	6I2	5G2	6R1	2R1	6R1	5R3	4R5	5R3	2P2	6P3
C	7R3	7I2	7G2	2R3	4R1	3R1	3R3	5R3	2R5	5P4	3P5	1	4I1	3I1	4I3	3T2	5G2	3G3	3G2	6R1	5I2	6G2	7R1	3R1	4R1	5R3	3R5	3R3	2P2	5P3
D	8R3	6I2	7G2	3R3	3R1	3R1	3R3	7R3	2R5	5P4	3P5	1	4I1	2I1	4I3	1T2	4G2	4G3	2G2	6R1	6I2	7G2	7R1	1R1	7R1	6R3	3R5	6R3	3P2	5P3
GM	8R3	7I2	8G2	2R3	3R1	3R1	3R3	5R3	2R5	5P4	3P5	1	4I1	2I1	4I3	2T2	4G2	4G3	2G2	6R1	5I2	6G2	6R1	2R1	5R1	5R3	3R5	4R3	2P2	5P3

wrt	R4																						R5							
Expert	P4 or P1	P5 or P1	P6 or P1	P3 or P2	P4 or P2	P5 or P2	P6 or P2	P4 or P3	P5 or P3	P6 or P3	P5 or P4	P6 or P4	P6 or P5	I2 or I1	I3 or I1	I3 or I2	T2 or T1	T3 or T1	T3 or T2	G2 or G1	G3 or G1	G3 or G2	R2 or R1	R3 or R1	R3 or R2	P2 or P1	P3 or P1	P4 or P1	P5 or P1	P6 or P1
A	5P4	5P5	8P6	4P3	4P4	2P5	6P6	3P4	5P3	6P6	5P4	4P6	5P6	1I2	5I3	5I3	2T2	7T3	8T3	5G2	4G3	1G3	4R1	6R1	1	3P1	5P1	4P4	3P1	3P1
B	5P4	4P5	7P6	5P3	7P4	1	7P6	2P4	3P3	7P6	6P4	5P6	8P6	2I2	5I3	6I3	1T2	8T3	5T3	4G2	5G3	2G3	4R1	5R1	1	3P1	5P1	5P4	5P1	5P1
C	6P4	5P5	8P6	6P3	7P4	2P5	5P6	3P4	3P3	6P6	7P4	3P6	7P6	3I2	4I3	2I3	3T2	6T3	8T3	5G2	3G3	3G3	5R1	6R1	1	3P1	3P1	5P4	3P1	4P1
D	7P4	3P5	8P6	5P3	8P4	2P5	8P6	4P4	3P3	6P6	8P4	4P6	7P6	3I2	3I3	3I3	1T2	6T3	5T3	4G2	4G3	2G3	5R1	5R1	1	5P1	5P1	4P4	5P1	7P1
GM	6P4	4P5	8P6	5P3	6P4	2P5	6P6	3P4	3P3	6P6	6P4	4P6	7P6	2I2	4I3	4I3	2T2	7T3	6T3	4G2	4G3	2G3	4R1	5R1	1	3P1	4P1	4P4	4P1	5P1

Appendix C.1-1: Node comparisons (Cont)

wrt	R5																				P1									
Expert	P3 or P2	P4 or P2	P5 or P2	P6 or P2	P4 or P3	P5 or P3	P6 or P3	P5 or P4	P6 or P4	P6 or P5	I2 or I1	I3 or I1	I3 or I2	T2 or T1	T3 or T1	T3 or T2	G2 or G1	G3 or G1	G3 or G2	F1 or F2	P3 or P2	P4 or P2	P5 or P2	P6 or P2	P4 or P3	P5 or P3	P6 or P3	P5 or P4	P6 or P4	P6 or P5
A	3P3	5P4	4P2	3P2	5P4	4P3	6P3	8P4	9P4	2P5	1I1	1	1I3	3T2	4T1	6T2	1G1	1G3	4G3	9F1	5P3	2P4	4P5	5P6	5P3	3P3	3P3	2P5	3P4	2P5
B	3P3	4P4	4P2	4P2	5P4	3P3	5P3	6P4	9P4	3P5	2I1	2I3	2I3	1T2	1T1	4T2	3G1	2G3	5G3	9F1	7P3	3P4	5P5	4P6	7P3	6P3	6P3	1	2P4	3P5
C	4P3	5P4	3P2	2P2	4P4	2P3	3P3	6P4	7P4	3P5	3I1	2I3	4I3	1T2	2T1	4T2	4G1	2G3	5G3	7F1	5P3	4P4	4P5	2P6	5P3	4P3	5P3	2P5	2P4	2P5
D	3P3	7P4	3P2	4P2	6P4	4P3	4P3	7P4	8P4	1P5	1I1	1	1I3	3T2	1T1	3T2	5G1	4G3	4G3	8F1	6P3	3P4	4P5	6P6	5P3	6P3	5P3	3P5	3P4	4P5
GM	3P3	5P4	3P2	3P2	5P4	3P3	4P3	7P4	8P4	2P5	2I1	1	2I3	2T2	2T1	4T2	3G1	2G3	4G3	8F1	6P3	3P4	4P5	4P6	5P3	5P3	5P3	2P5	2P4	3P5

wrt	P1	P2																	P3										P4	
Expert	G3 or G2	R4 or R2	P3 or P1	P4 or P1	P5 or P1	P6 or P1	P4 or P3	P5 or P3	P6 or P3	P5 or P4	P6 or P4	P6 or P5	I3 or I2	T2 or T1	T3 or T1	T3 or T2	G2 or G1	F1 or F2	P4 or P1	P5 or P1	P6 or P1	P5 or P4	P6 or P4	P6 or P5	T2 or T1	T3 or T1	T3 or T2	G3 or G2	R4 or R2	R5 or R2
A	2G2	4R4	4P1	5P1	3P5	3P1	2P4	3P5	2P6	4P5	4P6	5P5	4I2	4T1	4T1	2T2	5G1	5F1	5P1	4P1	5P1	1	4P6	2P6	1	2T1	2T2	1G2	7R4	3R2
B	1G2	4R4	4P1	5P1	3P5	3P1	2P4	5P5	2P6	6P5	3P6	3P5	3I	4T1	5T1	3T2	4G1	4F1	6P1	6P1	3P1	1	5P6	2P6	1	1	2T2	2G2	5R4	2R2
C	1G2	4R4	3P1	4P1	3P5	2P1	2P4	3P5	3P6	5P5	4P6	3P5	5I2	5T1	6T1	3T2	4G1	6F1	5P1	8P1	4P1	1	4P6	3P6	1	1	2T2	1G2	6R4	2R2
D	6G2	3R4	4P1	5P1	3P5	3P1	3P4	4P5	2P6	4P5	3P6	3P5	5I2	4T1	4T1	2T2	3G1	3F1	8P1	8P1	5P1	4P4	4P6	5P6	1	2T1	3T2	2G2	7R4	1R2
GM	2G2	4R4	4P1	5P1	3P5	3P1	2P4	4P5	2P6	5P5	3P6	3P5	4I2	4T1	5T1	2T2	4G1	4F1	6P1	6P1	4P1	1	4P6	3P6	1	1	2T2	1	6R4	2R2

Appendix C.1-1: Node comparisons (Cont)

wrt	P4																		P5											
Expert	R5 or R4	P2 or P1	P3 or P1	P5 or P1	P6 or P1	P3 or P2	P5 or P2	P6 or P2	P5 or P3	P6 or P3	P6 or P5	T2 or T1	T3 or T1	T3 or T2	G2 or G1	G3 or G1	G3 or G2	F1 or F2	P2 or P1	P4 or P1	P6 or P1	P4 or P2	P6 or P2	P6 or P4	I3 or I1	T2 or T1	T3 or T1	T3 or T2	G2 or G1	F1 or F2
A	8R4	6P2	4P1	4P1	6P6	6P2	8P2	3P6	3P5	8P6	9P6	3T2	4T1	5T2	5G2	5G3	3G2	1	5P2	3P1	3P1	7P2	9P2	4P4	3I3	1	1	2T2	4G2	4F2
B	7R4	5P2	5P1	4P1	5P6	6P2	7P2	2P6	2P5	8P6	8P6	2T2	5T1	8T2	6G2	5G3	2G2	1	7P2	2P1	3P1	7P2	9P2	2P4	2I3	1	1	2T2	4G2	3F2
C	8R4	6P2	6P1	3P1	5P6	7P2	8P2	3P6	2P5	9P6	8P6	2T2	4T1	6T2	5G2	6G3	3G2	1	7P2	3P1	4P1	6P2	8P2	2P4	2I3	1	1	2T2	5G2	4F2
D	9R4	5P2	7P1	5P1	6P6	7P2	7P2	1P6	2P5	8P6	8P6	1T2	5T1	5T2	7G2	5G3	2G2	1	8P2	2P1	3P1	6P2	7P2	4P4	1I3	1	1	2T2	7G2	5F2
GM	8R4	5P2	5P1	4P1	5P6	6P2	7P2	2P6	2P5	8P6	8P6	2T2	4T1	6T2	6G2	5G3	2G2	1	7P2	2P1	3P1	6P2	8P2	3P4	2I3	1	1	2T2	5G2	4F2

wrt	P6																													
Expert	R2 or R1	R3 or R1	R4 or R1	R5 or R1	R3 or R2	R4 or R2	R5 or R2	R4 or R3	R5 or R3	R5 or R4	P2 or P1	P3 or P1	P4 or P1	P5 or P1	P3 or P2	P4 or P2	P5 or P2	P4 or P3	P5 or P3	P5 or P4	I2 or I1	I3 or I1	I3 or I2	T2 or T1	T3 or T1	T3 or T2	G2 or G1	G3 or G1	G3 or G2	F1 or F2
A	3R1	2R1	4R1	6R1	2R3	3R2	2R2	4R3	7R3	5R4	4P2	5P1	4P1	3P5	5P2	7P2	1	6P3	5P5	9P5	5I2	5I3	4I2	6T1	3T1	5T3	3G1	6G1	3G2	8F1
B	3R1	3R1	5R1	8R1	2R3	3R2	4R2	4R3	4R3	6R4	5P2	2P1	5P1	4P5	5P2	8P2	1	4P3	7P5	8P5	7I2	3I3	3I2	7T1	5T1	4T3	7G1	7G1	2G2	8F1
C	4R1	2R1	5R1	7R1	4R3	3R2	4R2	5R3	6R3	3R4	2P2	4P1	5P1	3P5	4P2	7P2	1	7P3	4P5	7P5	6I2	4I3	2I2	5T1	3T1	4T3	5G1	5G1	2G2	7F1
D	3R1	1R1	5R1	8R1	5R3	4R2	7R2	6R3	6R3	4R4	2P2	2P1	3P1	6P5	7P2	9P2	1	4P3	6P5	7P5	5I2	2I3	4I2	8T1	3T1	4T3	5G1	5G1	2G2	8F1
GM	3R1	2R1	5R1	7R1	3R3	3R2	4R2	5R3	6R3	4R4	3P2	3P1	4P1	4P5	5P2	8P2	1	5P3	5P5	8P5	6I2	3I3	3I2	6T1	3T1	4T3	5G1	6G1	2G2	8F1

Appendix C.1-1: Node comparisons (Cont)

wrt	I1																										I2			
Expert	R2 or R1	R3 or R1	R4 or R1	R5 or R1	R3 or R2	R4 or R2	R5 or R2	R4 or R3	R5 or R3	R5 or R4	P3 or P2	P4 or P2	P5 or P2	P6 or P2	P4 or P3	P5 or P3	P6 or P3	P5 or P4	P6 or P4	P6 or P5	I3 or I2	T3 or T2	G2 or G1	G3 or G1	G3 or G2	F1 or F2	R2 or R1	R3 or R1	R4 or R1	R5 or R1
A	4R2	3R3	5R1	4R1	3R3	4R2	5R2	6R3	8R3	3R4	4P3	2P4	3P5	3P6	3P4	3P5	3P6	1	3P6	3P6	3I3	3T3	3G1	8G1	3G2	5F1	3R1	4R1	7R1	4R1
B	3R2	3R3	3R1	4R1	6R3	5R2	5R2	5R3	8R3	3R4	3P3	2P4	5P5	4P6	4P4	3P5	4P6	1	5P6	5P6	4I3	4T3	5G1	7G1	6G2	4F1	3R1	4R1	7R1	6R1
C	3R2	4R3	3R1	4R1	3R3	4R2	4R2	4R3	5R3	5R4	4P3	4P4	5P5	5P6	3P4	3P5	3P6	1	3P6	4P6	3I3	3T3	4G1	8G1	3G2	3F1	4R1	3R1	6R1	7R1
D	4R2	5R3	3R1	5R1	5R3	4R2	7R2	4R3	7R3	3R4	3P3	4P4	6P5	4P6	3P4	5P5	7P6	1	7P6	6P6	1I3	6T3	3G1	7G1	2G2	6F1	2R1	2R1	8R1	8R1
GM	3R2	4R3	3R1	4R1	4R3	4R2	5R2	5R3	7R3	3R4	3P3	3P4	5P5	4P6	3P4	3P5	4P6	1	4P6	4P6	2I3	4T3	4G1	7G1	3G2	4F1	3R1	3R1	7R1	6R1

wrt	I2											I3																		
Expert	R3 or R2	R4 or R2	R5 or R2	R4 or R3	R5 or R3	R5 or R4	T3 or T2	G2 or G1	G3 or G1	G3 or G2	F1 or F2	R2 or R1	R4 or R1	R5 or R1	R4 or R2	R5 or R2	R5 or R4	P3 or P2	P5 or P2	P6 or P2	P5 or P3	P6 or P3	P6 or P5	I2 or I1	T2 or T1	T3 or T1	T3 or T2	G2 or G1	G3 or G1	G3 or G2
A	4R3	5R2	3R2	4R3	5R3	3R4	2T2	3G2	2G1	6G2	4F1	2R2	4R1	4R1	6R2	6R2	3R4	3P2	7P2	3P2	3P3	3P6	5P6	4I2	2T2	3T3	4T3	3G1	4G3	7G3
B	3R3	4R2	5R2	6R3	6R3	1R4	4T2	5G2	3G1	5G2	5F1	5R2	5R1	5R1	5R2	6R2	4R4	6P2	5P2	4P2	3P3	4P6	5P6	3I2	1	5T3	5T3	4G1	5G3	5G3
C	4R3	5R2	3R2	4R3	4R3	2R4	3T2	3G2	3G1	5G2	4F1	3R2	4R1	3R1	6R2	7R2	2R4	5P2	6P2	5P2	2P3	4P6	4P6	3I2	1	4T3	5T3	2G1	3G3	5G3
D	3R3	3R2	5R2	8R3	8R3	1R4	4T2	7G2	4G1	7G2	5F1	2R2	4R1	7R1	6R2	8R2	3R4	6P2	5P2	6P2	1	2P6	6P6	5I2	1	5T3	5T3	5G1	6G3	6G3
GM	3R3	4R2	4R2	5R3	6R3	2R4	3T2	4G2	3G1	6G2	4F1	3R2	4R1	5R1	6R2	7R2	3R4	5P2	6P2	4P2	2P3	3P6	5P6	4I2	1	4T3	5T3	3G1	4G3	6G3

Appendix C.1-1: Node comparisons (Cont)

wrt	I3	T1																	T2											
Expert	F2 or F1	R4 or R5	P1 or P2	P1 or P4	P1 or P5	P1 or P6	P2 or P4	P2 or P5	P2 or P6	P4 or P5	P4 or P6	P5 or P6	I1 or I3	T2 or T3	G1 or G2	G1 or G3	G2 or G3	F2 or F1	R4 or R5	P1 or P2	P1 or P3	P1 or P4	P1 or P5	P1 or P6	P2 or P3	P2 or P4	P2 or P5	P2 or P6	P3 or P4	P3 or P5
A	5F1	2R4	5P2	3P4	2P1	4P1	2P4	4P2	6P2	6P4	6P4	2P5	1	3T3	3G2	5G3	1	4F2	4R4	3P2	5P3	3P4	3P1	5P6	5P2	5P4	8P2	4P6	8P4	3P5
B	4F1	5R4	5P2	5P4	4P1	5P1	3P4	5P2	6P2	6P4	5P4	2P5	1	3T3	4G2	6G3	1	5F2	5R4	7P2	4P3	4P4	1	7P6	8P2	2P4	2P2	2P6	8P4	5P5
C	4F1	3R4	5P2	5P4	5P1	5P1	3P4	5P2	6P2	5P4	5P4	3P5	2I1	3T3	3G2	6G3	1	2F2	6R4	4P2	5P3	3P4	2P1	6P6	6P2	3P4	6P2	4P6	8P4	3P5
D	5F1	6R4	6P2	4P4	5P1	4P1	2P4	5P2	8P2	6P4	8P4	3P5	1	7T3	6G2	7G3	1	2F2	7R4	3P2	4P3	3P4	3P1	8P6	8P2	7P4	7P2	3P6	7P4	3P5
GM	4F1	4R4	5P2	4P4	4P1	4P1	2P4	5P2	6P2	6P4	6P4	2P5	1	4T3	4G2	6G3	1	3F2	5R4	4P2	4P3	3P4	2P1	6P6	7P2	4P4	5P2	3P6	8P4	3P5

wrt	T2											T3																G1		
Expert	P3 or P6	P4 or P5	P4 or P6	P5 or P6	I1 or I2	I1 or I3	I2 or I3	G1 or G2	G1 or G3	G2 or G3	F1 or F2	R3 or R4	R3 or R5	R4 or R5	P2 or P3	P2 or P4	P2 or P6	P3 or P4	P3 or P6	P4 or P6	I1 or I2	I1 or I3	I2 or I3	G1 or G2	G1 or G3	G2 or G3	F2 or F1	R2 or R4	R2 or R5	R4 or R5
A	7P6	8P4	1	4P6	3I2	2I3	1	3G2	3G1	7G2	9F1	3R4	3R3	7R4	6P2	7P2	3P2	3P4	5P6	2P6	3I2	3I1	4I2	3G2	3G3	3G2	6F1	5R2	4R2	1
B	9P6	8P4	1	5P6	5I2	5I3	3I3	3G2	2G1	5G2	6F1	3R4	4R3	5R4	8P2	6P2	4P2	5P4	4P6	2P6	4I2	2I1	2I2	4G2	4G3	2G2	7F1	4R2	4R2	1
C	8P6	6P4	1	8P6	3I2	3I3	1	3G2	5G1	5G2	9F1	5R4	3R3	5R4	7P2	6P2	3P2	3P4	5P6	2P6	4I2	2I1	2I2	4G2	3G3	3G2	5F1	3R2	4R2	1
D	9P6	7P4	1	8P6	7I2	7I3	1	4G2	3G1	7G2	7F1	6R4	3R3	6R4	7P2	6P2	3P2	3P4	5P6	1	3I2	3I1	3I2	5G2	5G3	2G2	6F1	3R2	4R2	1
GM	8P6	7P4	1	6P6	4I2	4I3	1	3G2	3G1	6G2	8F1	4R4	3R3	6R4	7P2	6P2	3P2	3P4	5P6	2P6	3I2	2I1	3I2	4G2	4G3	2G2	6F1	4R2	4R2	1

Appendix C.1-1: Node comparisons (Cont)

wrt	G1												G2															G3		
Expert	P3 or P2	P4 or P2	P5 or P2	P4 or P3	P5 or P3	P5 or P4	I3 or I2	T2 or T1	T3 or T1	T3 or T2	G3 or G2	F1 or F2	R5 or R4	P3 or P2	P4 or P2	P5 or P2	P4 or P3	P5 or P3	P5 or P4	I2 or I1	I3 or I1	I3 or I2	T2 or T1	T3 or T1	T3 or T2	G3 or G1	F1 or F2	R2 or R1	R3 or R1	R4 or R1
A	3P3	4P4	3P5	3P4	5P5	1	4I3	5T2	3T3	4T2	5G2	1	5R4	6P2	4P4	3P5	3P4	3P5	1	3I2	4I1	5I2	1	3T3	5T3	5G1	2F2	5R1	3R1	6R1
B	3P3	4P4	3P5	3P4	4P5	1	5I3	8T2	4T3	3T2	8G2	1	5R4	7P2	2P4	4P5	5P4	8P5	1	2I2	3I1	5I2	1	4T3	5T3	4G1	1	5R1	2R1	7R1
C	2P3	4P4	5P5	3P4	4P5	1	6I3	6T2	5T3	3T2	6G2	1	3R4	5P2	2P4	3P5	4P4	4P5	1	3I2	3I1	6I2	1	5T3	5T3	3G1	1	3R1	3R1	5R1
D	4P3	2P4	4P5	4P4	4P5	1	5I3	6T2	4T3	3T2	3G2	1	2R4	4P2	4P4	3P5	6P4	5P5	1	3I2	3I1	4I2	1	6T3	5T3	4G1	2F2	7R1	1R1	7R1
GM	3P3	3P4	4P5	3P4	4P5	1	5I3	6T2	4T3	3T2	5G2	1	3R4	5P2	3P4	3P5	4P4	5P5	1	3I2	3I1	5I2	1	4T3	5T3	4G1	1	5R1	2R1	6R1

wrt	G3																													
Expert	R5 or R1	R3 or R2	R4 or R2	R5 or R2	R4 or R3	R5 or R3	R5 or R4	P2 or P1	P3 or P1	P4 or P1	P5 or P1	P6 or P1	P3 or P2	P4 or P2	P5 or P2	P6 or P2	P4 or P3	P5 or P3	P6 or P3	P5 or P4	P6 or P4	P6 or P5	I2 or I1	I3 or I1	I3 or I2	T2 or T1	T3 or T1	T3 or T2	G2 or G1	F1 or F2
A	5R1	3R3	3R2	2R2	3R3	4R3	3R4	5P2	3P3	6P4	4P5	8P6	5P3	3P4	6P5	5P6	3P4	3P5	4P6	2P5	3P6	4P6	3I2	3I3	2I2	1	1	3T2	3G2	7F1
B	4R1	5R3	5R2	4R2	4R3	4R3	2R4	4P2	5P3	5P4	5P5	7P6	5P3	5P4	6P5	8P6	4P4	3P5	6P6	2P5	2P6	2P6	4I2	4I3	2I2	1	1	1	8G2	8F1
C	5R1	3R3	3R2	3R2	3R3	3R3	3R4	2P2	5P3	5P4	5P5	9P6	4P3	4P4	5P5	6P6	4P4	4P5	5P6	3P5	3P6	1P6	5I2	3I3	2I2	1	1	1	6G2	7F1
D	7R1	7R3	3R2	5R2	7R3	7R3	2R4	2P2	6P3	7P4	6P5	8P6	6P3	6P4	5P5	7P6	3P4	3P5	3P6	2P5	3P6	2P6	5I2	5I3	3I2	1	1	1	8G2	5F2
GM	5R1	4R3	3R2	3R2	4R3	4R3	2R4	3P2	5P3	6P4	5P5	8P6	5P3	4P4	5P5	6P6	3P4	3P5	4P6	2P5	3P6	2P6	4I2	4I3	2I2	1	1	1	6G2	7F1

Appendix C.1-1: Node comparisons (Cont)

wrt	F1																													
Expert	R1 or R2	R1 or R3	R1 or R4	R1 or R5	R2 or R3	R2 or R4	R2 or R5	R3 or R4	R3 or R5	R4 or R5	P1 or P2	P1 or P3	P1 or P4	P1 or P5	P1 or P6	P2 or P3	P2 or P4	P2 or P5	P2 or P6	P3 or P4	P3 or P5	P3 or P6	P4 or P5	P4 or P6	P5 or P6	I1 or I2	I1 or I3	I2 or I3	T1 or T2	T1 or T3
A	3R1	1R1	5R4	5R1	5R3	8R4	1	5R4	3R3	8R4	5P2	3P3	8P4	4P1	5P6	2P3	3P4	5P2	4P6	3P4	5P3	2P6	7P4	3P4	8P6	5I2	7I3	2I3	3T2	4T3
B	4R1	3R1	7R4	6R1	3R3	8R4	1	6R4	5R3	8R4	7P2	7P3	7P4	2P1	5P6	4P3	5P4	6P2	5P6	4P4	7P3	2P6	7P4	3P4	8P6	5I2	6I3	3I3	4T2	5T3
C	5R1	3R1	6R4	4R1	4R3	5R4	1	5R4	5R3	7R4	6P2	4P3	9P4	3P1	6P6	4P3	4P4	3P2	3P6	2P4	5P3	3P6	8P4	2P4	8P6	3I2	4I3	3I3	5T2	5T3
D	5R1	3R1	5R4	8R1	4R3	7R4	2R2	5R4	2R3	7R4	7P2	7P3	8P4	3P1	8P6	4P3	5P4	3P2	5P6	3P4	7P3	3P6	9P4	1P4	8P6	4I2	6I3	1I3	7T2	8T3
GM	4R1	2R1	6R4	6R1	4R3	7R4	1	5R4	3R3	7R4	6P2	5P3	8P4	3P1	6P6	3P3	4P4	4P2	4P6	3P4	6P3	2P6	8P4	2P4	8P6	4I2	6I3	2I3	5T2	5T3

wrt	F1				F2																									
Expert	T2 or T3	G1 or G2	G1 or G3	G2 or G3	R1 or R2	R1 or R3	R1 or R4	R1 or R5	R2 or R3	R2 or R4	R2 or R5	R3 or R4	R3 or R5	R4 or R5	P1 or P2	P1 or P3	P1 or P4	P1 or P5	P1 or P6	P2 or P3	P2 or P4	P2 or P5	P2 or P6	P3 or P4	P3 or P5	P3 or P6	P4 or P5	P4 or P6	P5 or P6	I1 or I2
A	3T3	3G2	4G3	3G3	5R1	4R1	6R4	6R1	3R2	5R4	4R2	7R4	3R3	8R4	5P2	7P1	1	4P1	8P6	7P2	1	8P2	3P6	6P4	4P3	8P6	4P4	3P6	7P6	6I2
B	2T3	5G2	7G3	2G3	5R1	6R1	4R4	6R1	2R2	6R4	5R2	8R4	2R3	7R4	5P2	4P1	1	5P1	7P6	6P2	1	8P2	2P6	6P4	2P3	7P6	4P4	7P6	8P6	5I2
C	1T3	4G2	5G3	2G3	5R1	6R1	7R4	5R1	3R2	5R4	4R2	8R4	3R3	6R4	6P2	5P1	1	6P1	7P6	6P2	1	7P2	3P6	5P4	3P3	8P6	4P4	5P6	8P6	6I2
D	2T3	8G2	6G3	2G3	6R1	5R1	5R4	8R1	2R2	7R4	3R2	8R4	2R3	7R4	5P2	5P1	1	4P1	8P6	8P2	1	8P2	2P6	5P4	4P3	8P6	4P4	5P6	8P6	7I2
GM	2T3	5G2	5G3	2G3	5R1	5R1	5R4	6R1	2R2	6R4	4R2	8R4	2R3	7R4	5P2	5P1	1	5P1	7P6	7P2	1	8P2	2P6	5P4	3P3	8P6	4P4	5P6	8P6	6I2

Appendix C.1-1: Node comparisons (Cont)

wrt	F2							
Expert	I3 or I1	I3 or I2	T2 or T1	T3 or T1	T3 or T2	G2 or G1	G3 or G1	G3 or G2
A	3I3	3I2	3T2	3T1	5T2	6G2	4G3	3G2
B	4I3	3I2	5T2	5T1	8T2	6G2	5G3	2G2
C	5I3	4I2	6T2	3T1	6T2	7G2	6G3	3G2
D	6I3	3I2	8T2	2T1	8T2	6G2	6G3	2G2
GM	4I3	3I2	5T2	3T1	7T2	6G2	5G3	2G2

Appendix D.1-2: Cluster comparisons

wrt	①															②														
Expert	① or ②	① or ③	① or ④	① or ⑤	① or ⑥	② or ③	② or ④	② or ⑤	② or ⑥	③ or ④	③ or ⑤	③ or ⑥	④ or ⑤	④ or ⑥	⑤ or ⑥	① or ②	① or ③	① or ④	① or ⑤	① or ⑥	② or ③	② or ④	② or ⑤	② or ⑥	③ or ④	③ or ⑤	③ or ⑥	④ or ⑤	④ or ⑥	⑤ or ⑥
A	1	5①	2①	2①	3①	4②	4②	3②	6②	3④	4⑤	5⑥	1	2⑥	5⑥	4②	7①	6①	5①	6①	6②	6②	6②	5②	2④	3⑤	3⑥	1	1	3⑤
B	3①	6①	4①	4①	4①	5②	4②	4②	5②	1	4⑤	6⑥	1	5⑥	6⑥	4②	8①	5①	4①	6①	8②	4②	4②	4②	3④	3⑤	4⑥	3⑤	3⑥	2⑤
C	2①	5①	4①	4①	2①	6②	3②	6②	4②	1	2⑤	4⑥	1	3⑥	5⑥	4②	8①	8①	6①	4①	8②	7②	5②	4②	3④	3⑤	4⑥	2⑤	1	1⑤
D	1	5①	5①	2①	3①	4②	5②	3②	5②	2④	3⑤	5⑥	1	2⑥	5⑥	3②	6①	6①	5①	4①	7②	6②	6②	4②	3④	3⑤	5⑥	3⑤	2⑥	2⑤
GM	2①	5①	4①	3①	3①	5②	4②	4②	5②	2④	3⑤	5⑥	1	3⑥	5⑥	4②	7①	6①	5①	5①	7②	6②	5②	4②	3④	3⑤	4⑥	2⑤	2⑥	2⑤

wrt	③															④														
Expert	① or ②	① or ③	① or ④	① or ⑤	① or ⑥	② or ③	② or ④	② or ⑤	② or ⑥	③ or ④	③ or ⑤	③ or ⑥	④ or ⑤	④ or ⑥	⑤ or ⑥	① or ②	① or ③	① or ④	① or ⑤	① or ⑥	② or ③	② or ④	② or ⑤	② or ⑥	③ or ④	③ or ⑤	③ or ⑥	④ or ⑤	④ or ⑥	⑤ or ⑥
A	3①	6①	1	4①	3⑥	5②	4④	4②	5⑥	3④	2⑤	5⑥	2④	4⑥	5⑤	6②	5①	4①	2⑤	6①	8②	7②	3②	5②	1	5⑤	3⑥	4⑤	2⑥	3⑤
B	3①	4①	3④	4①	4⑥	4②	4④	4②	5⑥	3④	3⑤	5⑥	4④	4⑥	5⑤	8②	3①	3①	4⑤	5①	8②	5②	2②	6②	2③	4⑤	5⑥	5⑤	4⑥	4⑤
C	3①	5①	1	4①	3⑥	3②	2④	3②	4⑥	4④	4⑤	6⑥	2④	3⑥	4⑤	7②	6①	5①	3⑤	6①	6②	6②	4②	7②	1	6⑤	3⑥	4⑤	1	2⑤
D	3①	5①	2④	4①	3⑥	3②	2④	2②	5⑥	3④	3⑤	5⑥	4④	2⑥	3⑤	8②	6①	5①	2⑤	5①	7②	6②	3②	7②	1	5⑤	3⑥	6⑤	2⑥	3⑤
GM	3①	5①	2④	4①	3⑥	4②	3④	3②	5⑥	3④	3⑤	5⑥	3④	3⑥	4⑤	7②	5①	4①	3⑤	5①	7②	6②	3②	6②	1	5⑤	3⑥	5⑤	2⑥	3⑤

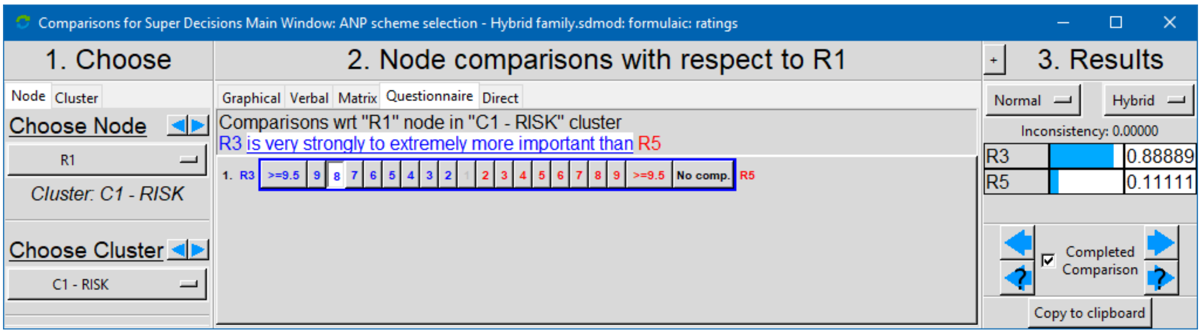
Appendix C.1-2: Cluster comparisons (Cont)

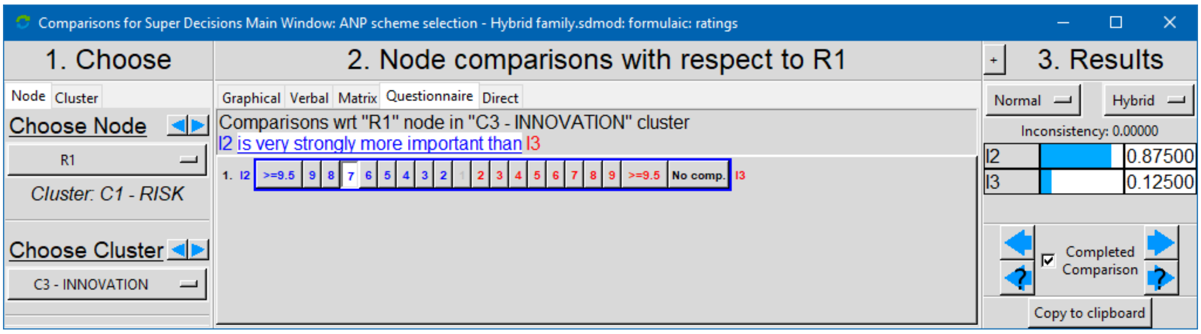
wrt	⑤														
Expert	① or ②	① or ③	① or ④	① or ⑤	① or ⑥	② or ③	② or ④	② or ⑤	② or ⑥	③ or ④	③ or ⑤	③ or ⑥	④ or ⑤	④ or ⑥	⑤ or ⑥
A	6②	3①	2④	4①	4①	6②	3②	4②	5②	3④	2⑤	4⑥	3④	4④	2⑥
B	4②	4①	4④	4①	4①	5②	4②	6②	5②	4④	1	3⑥	4④	4④	4⑥
C	7②	4①	3④	4①	4①	7②	4②	6②	6②	5④	1	4⑥	3④	3④	1
D	6②	4①	2④	4①	4①	5②	4②	5②	7②	3④	3⑤	3⑥	5④	2④	1
GM	6②	4①	3④	4①	4①	6②	4②	5②	6②	4④	2⑤	3⑥	4④	3④	2⑥

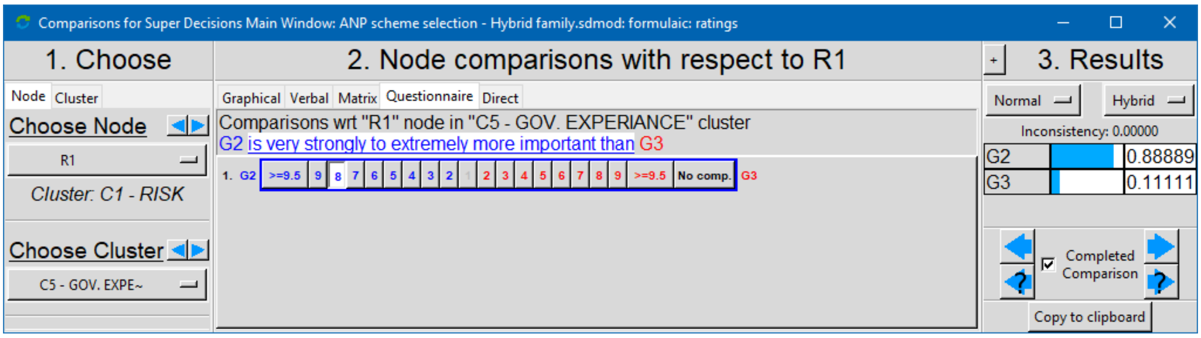
wrt	⑥														
Expert	① or ②	① or ③	① or ④	① or ⑤	① or ⑥	② or ③	② or ④	② or ⑤	② or ⑥	③ or ④	③ or ⑤	③ or ⑥	④ or ⑤	④ or ⑥	⑤ or ⑥
A	3①	2①	4①	5①	3①	4②	4②	4②	4②	4③	2③	1	3⑤	4④	4⑤
B	5①	5①	5①	4①	5①	4②	4②	2②	2②	2③	4③	2③	2⑤	2④	5⑤
C	2①	4①	6①	3①	2①	4②	4②	1	2②	2③	1	2③	1	3④	3⑤
D	2①	3①	5①	4①	2①	4②	4②	2②	3②	2③	2③	2③	1	3④	4⑤
GM	3①	3①	5①	4①	3①	4②	4②	2②	3②	2③	2③	2③	2⑤	3④	4⑤

Appendix D.2: Questions and answers of Node pairwise comparisons by Super Decisions

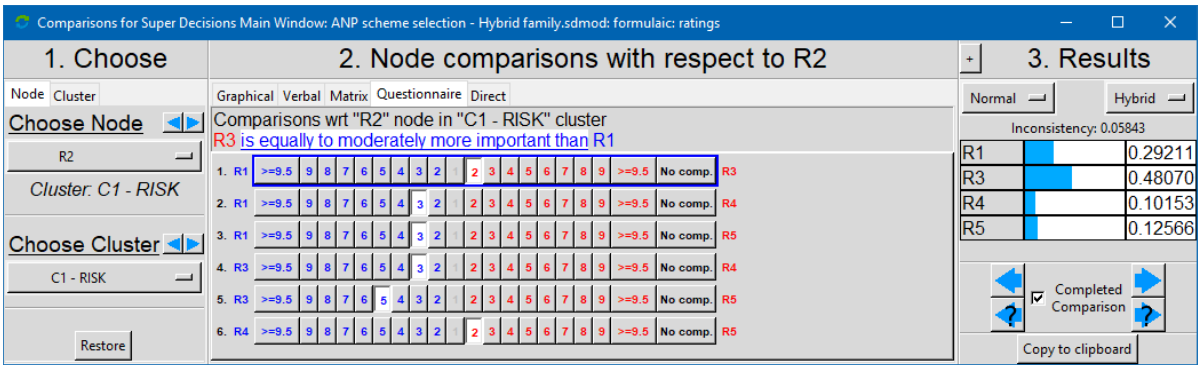
Appendix D.2-1: Node comparisons with respect to R1

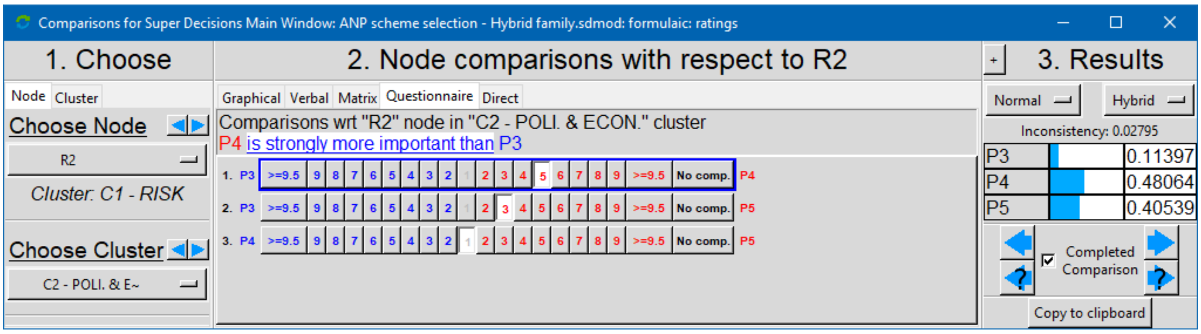


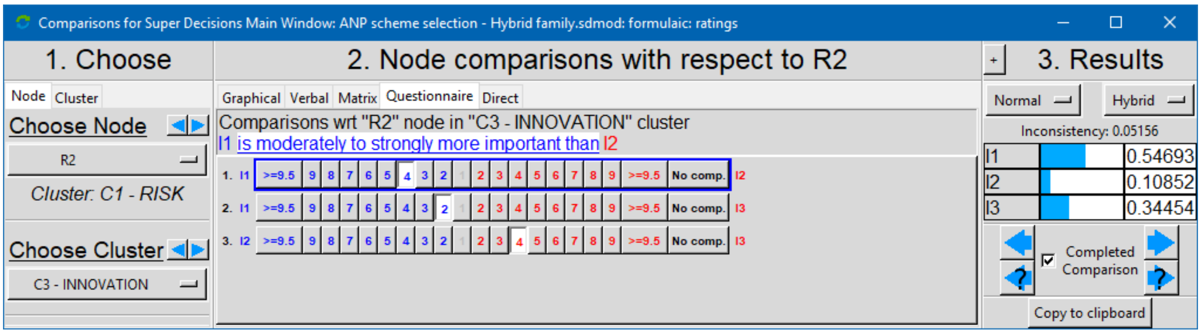


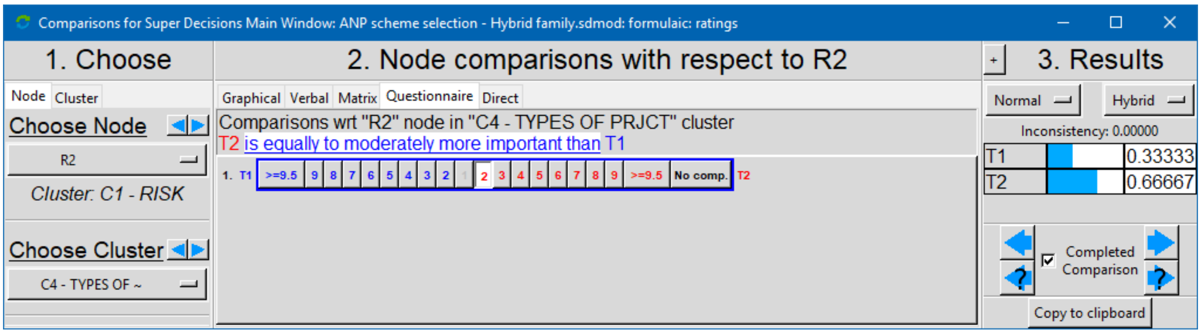


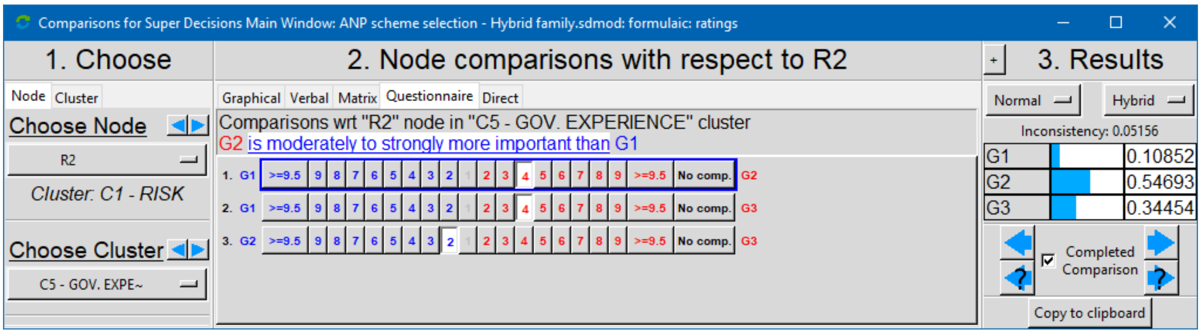
Appendix D.2-2: Node comparisons with respect to R2



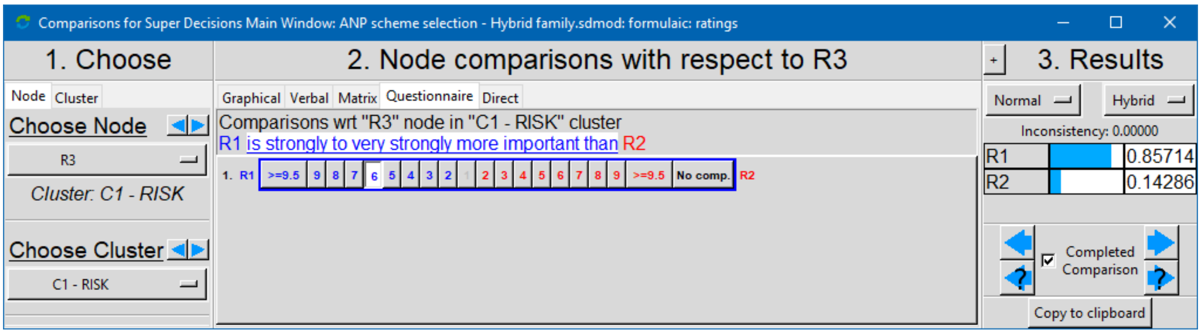


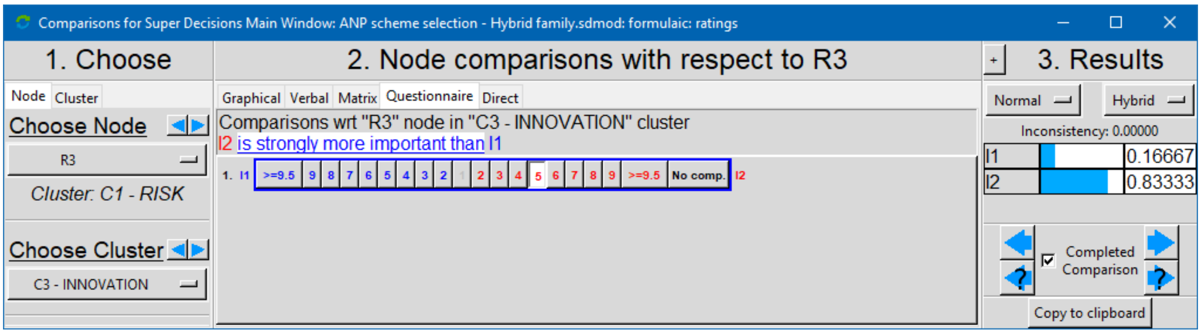


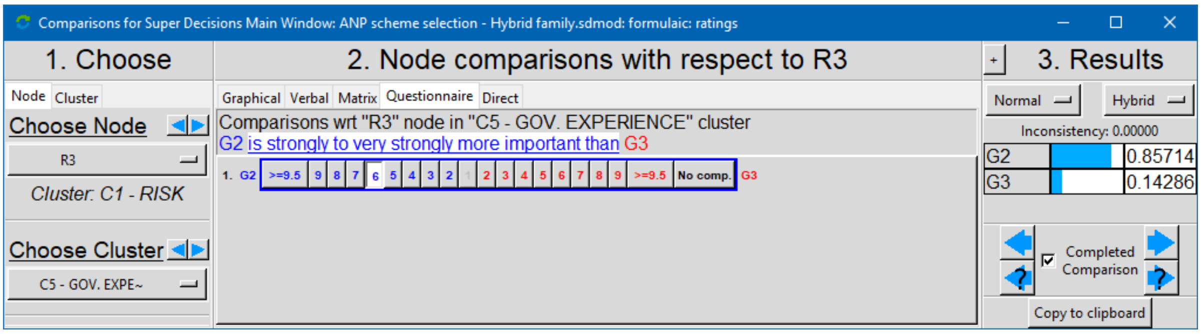




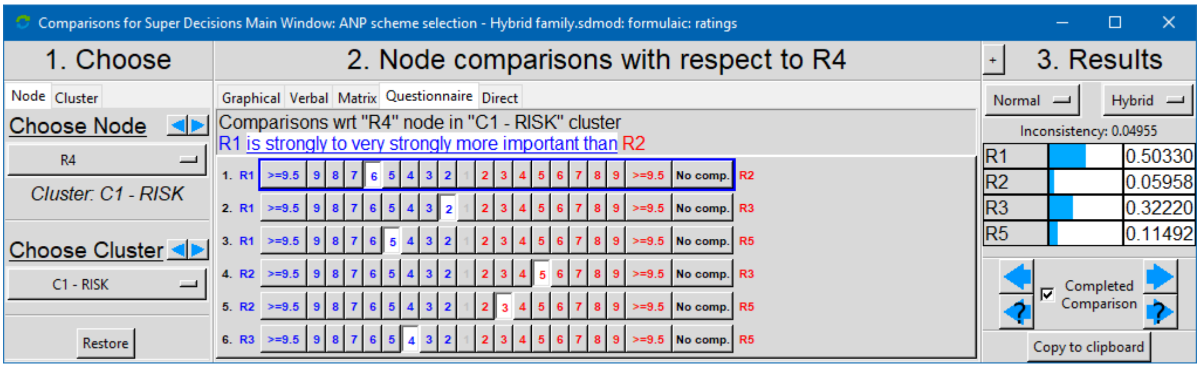
Appendix D.2-3: Node comparisons with respect to R3

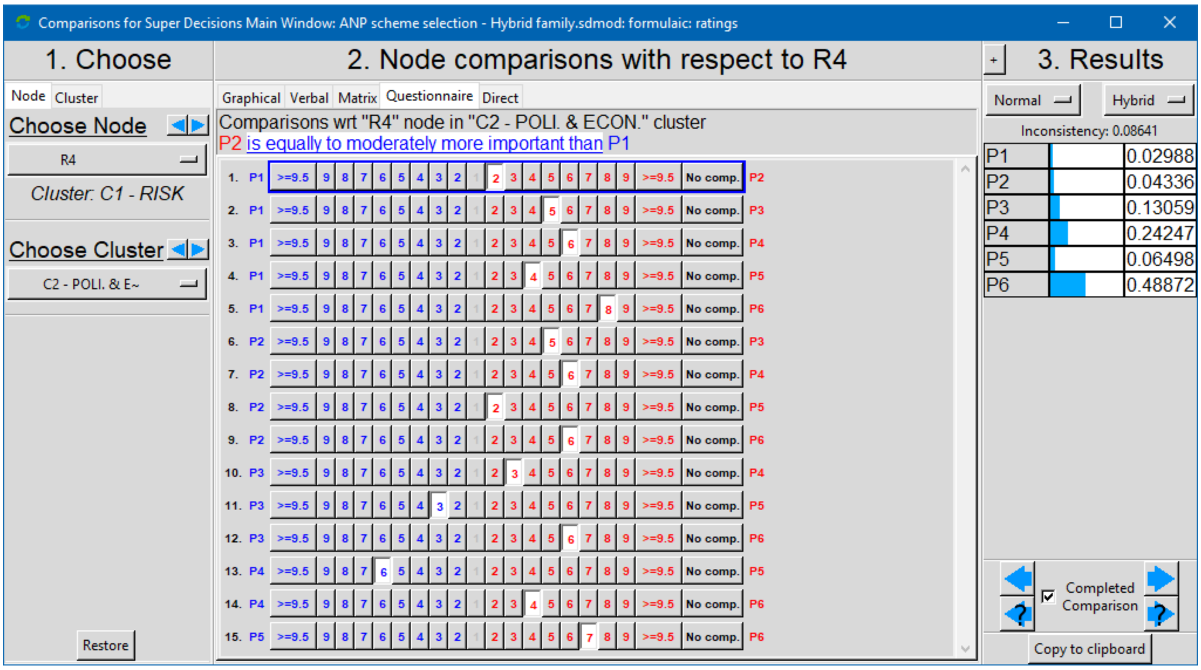


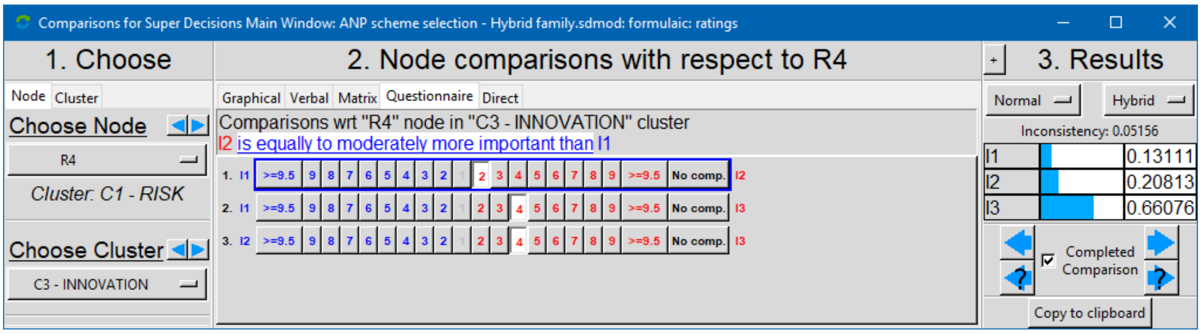


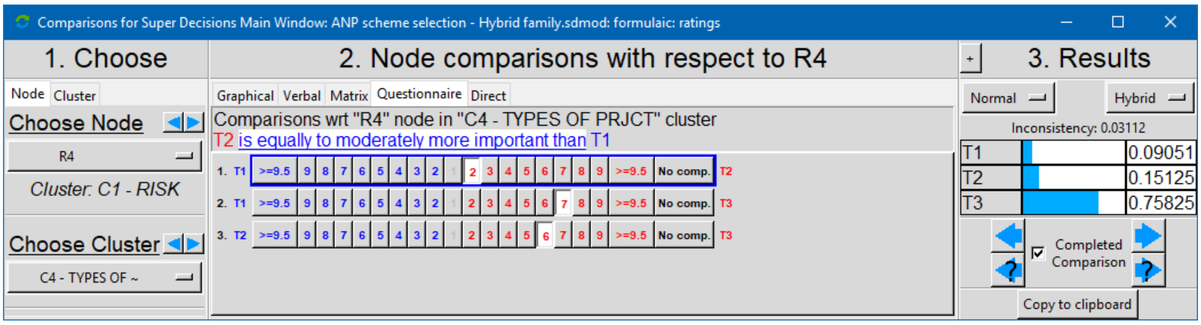


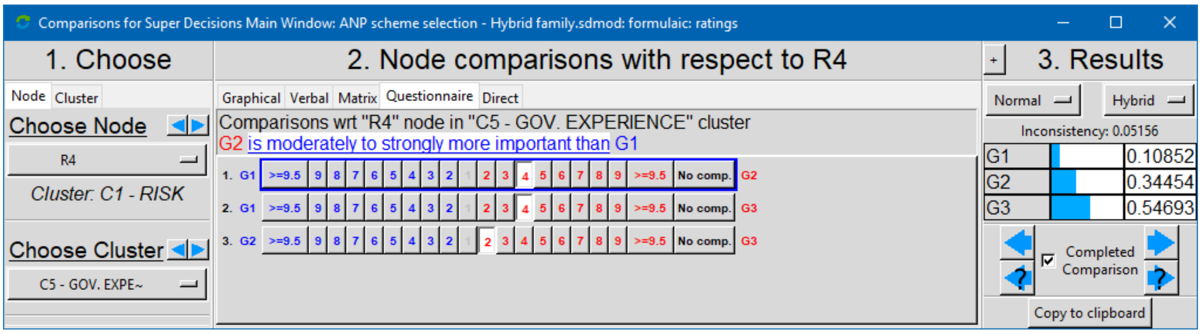
Appendix D.2-4: Node comparisons with respect to R4



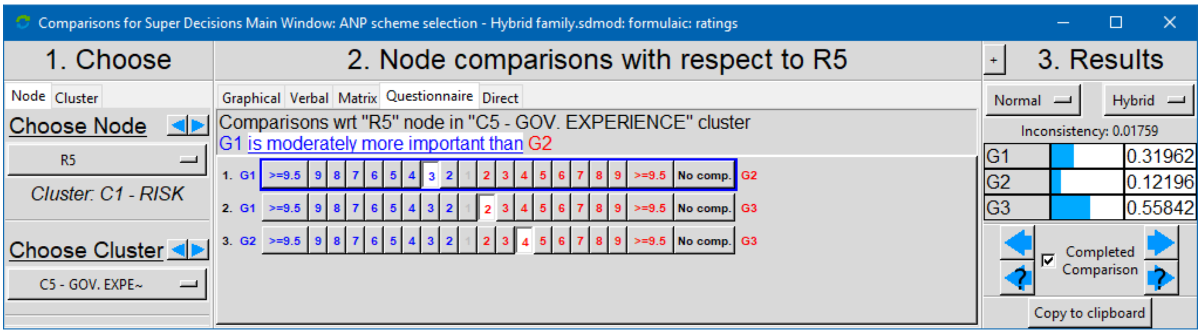


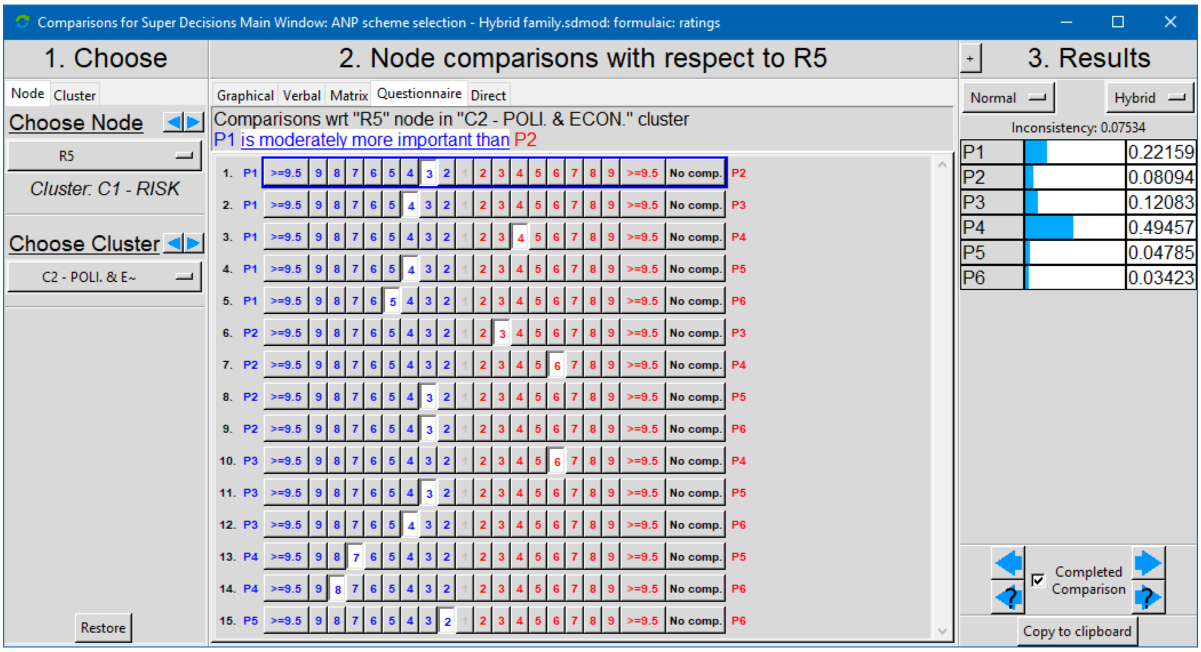


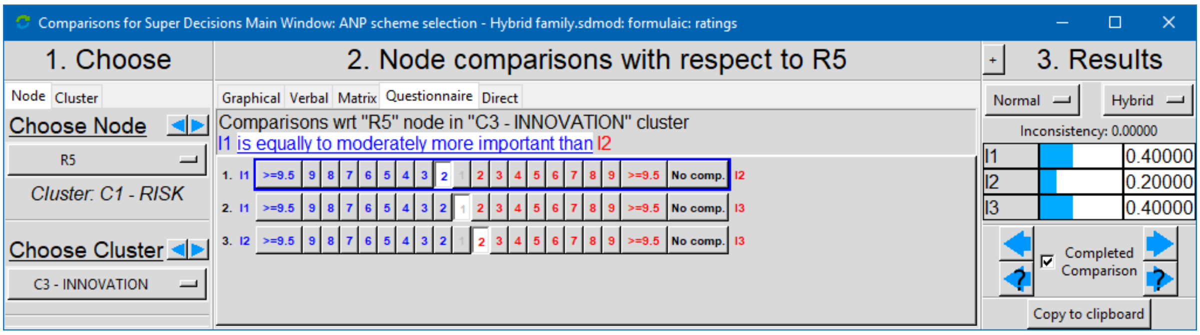


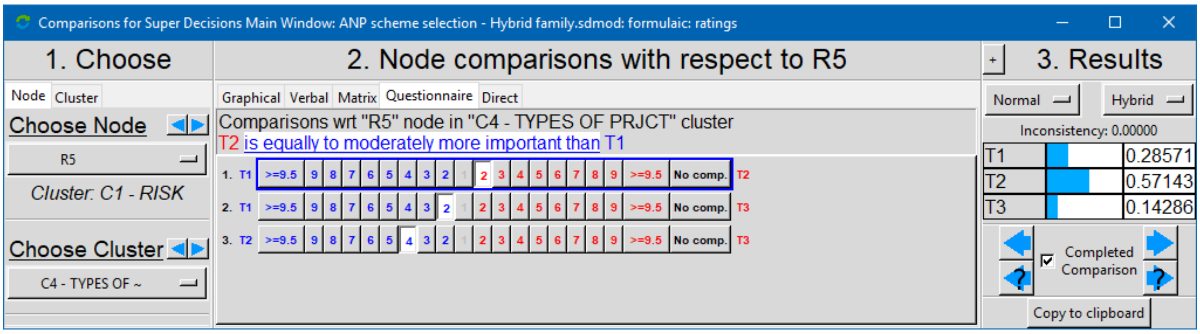


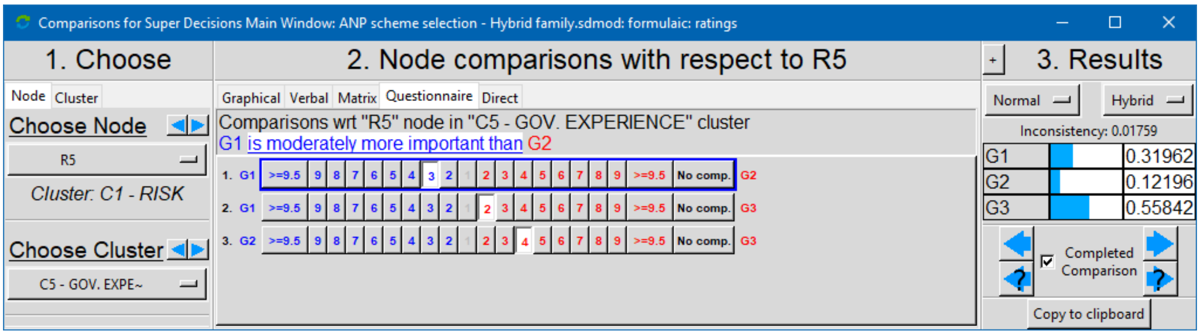
Appendix D.2-5: Node comparisons with respect to R5

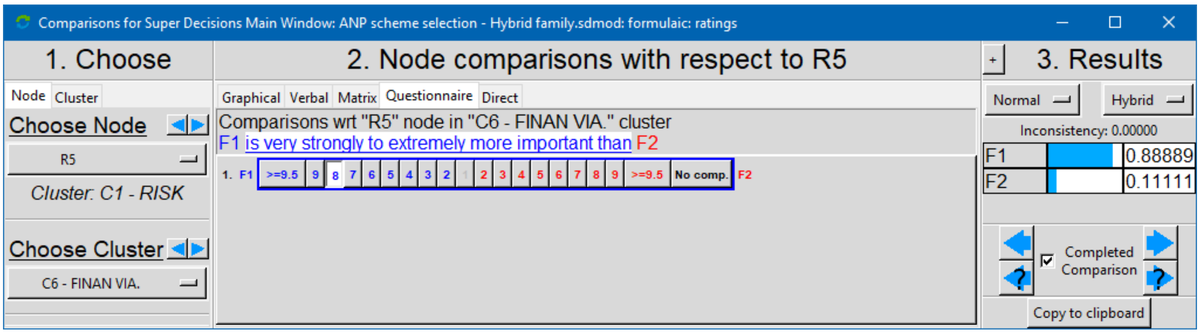



Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to R5
3. Results
Choose Node
R5
Cluster: C1 - RISK
Choose Cluster
C2 - POLI. & E~
Comparisons wrt "R5" node in "C2 - POLI. & ECON." cluster
P1 is moderately more important than P2
Inconsistency: 0.07534
P1 0.22159
P2 0.08094
P3 0.12083
P4 0.49457
P5 0.04785
P6 0.03423
Completed Comparison
Copy to clipboard
Restore

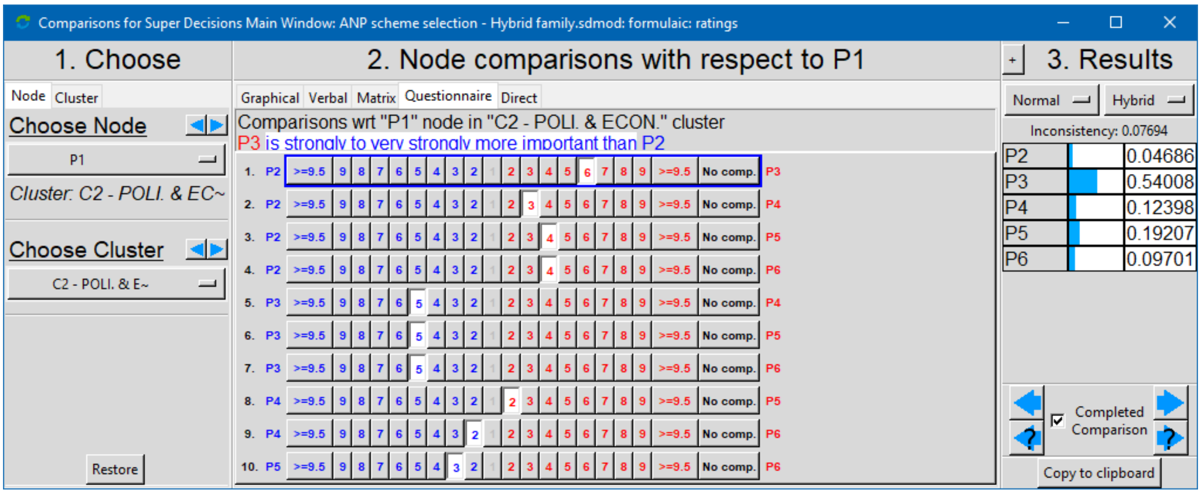

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to R5
3. Results
Choose Node
R5
Cluster: C1 - RISK
Choose Cluster
C3 - INNOVATION
Comparisons wrt "R5" node in "C3 - INNOVATION" cluster
I1 is equally to moderately more important than I2
Inconsistency: 0.00000
I1 0.40000
I2 0.20000
I3 0.40000
Completed Comparison
Copy to clipboard

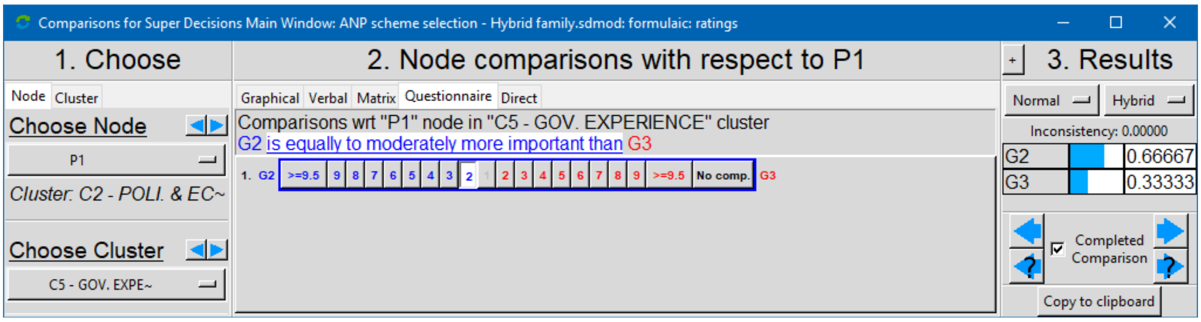

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to R5
3. Results
Choose Node
R5
Cluster: C1 - RISK
Choose Cluster
C4 - TYPES OF ~
Comparisons wrt "R5" node in "C4 - TYPES OF PRJCT" cluster
T2 is equally to moderately more important than T1
Inconsistency: 0.00000
T1 0.28571
T2 0.57143
T3 0.14286
Completed Comparison
Copy to clipboard


Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to R5
3. Results
Choose Node
R5
Cluster: C1 - RISK
Choose Cluster
C5 - GOV. EXPE~
Comparisons wrt "R5" node in "C5 - GOV. EXPERIENCE" cluster
G1 is moderately more important than G2
Inconsistency: 0.01759
G1 0.31962
G2 0.12196
G3 0.55842
Completed Comparison
Copy to clipboard

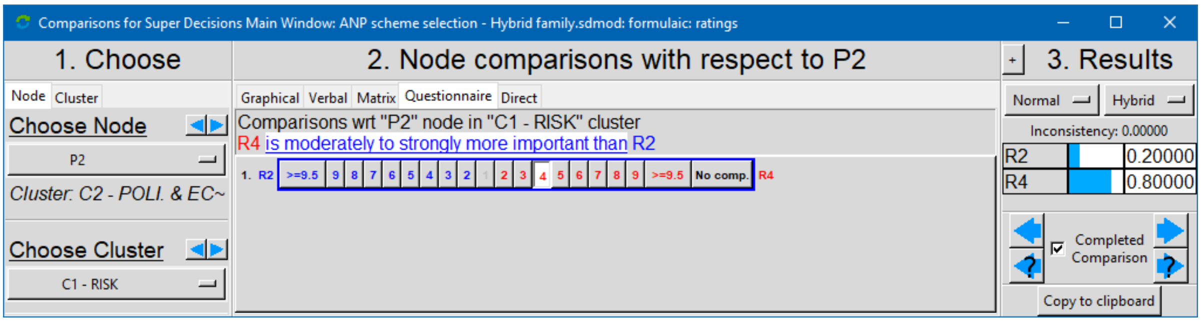


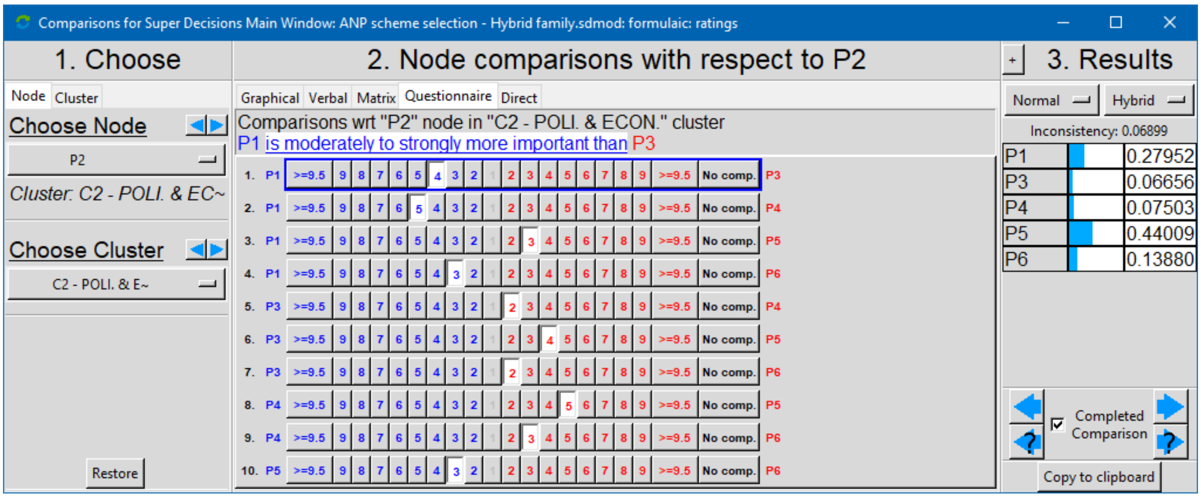
Appendix D.2-6: Node comparisons with respect to P1

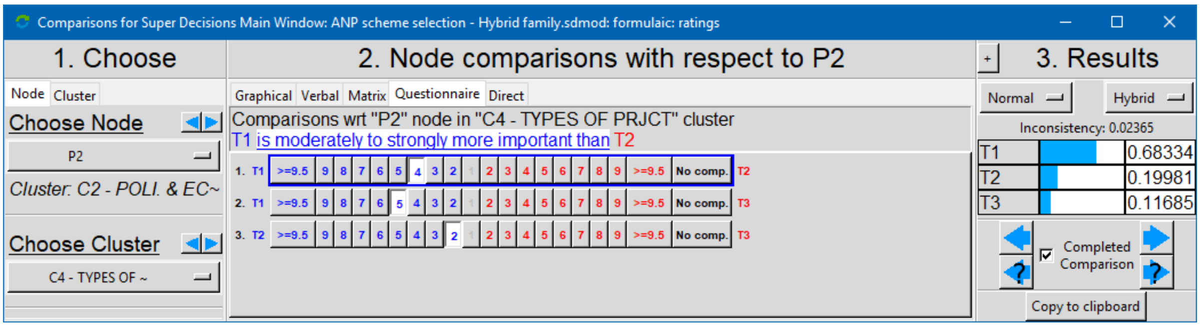


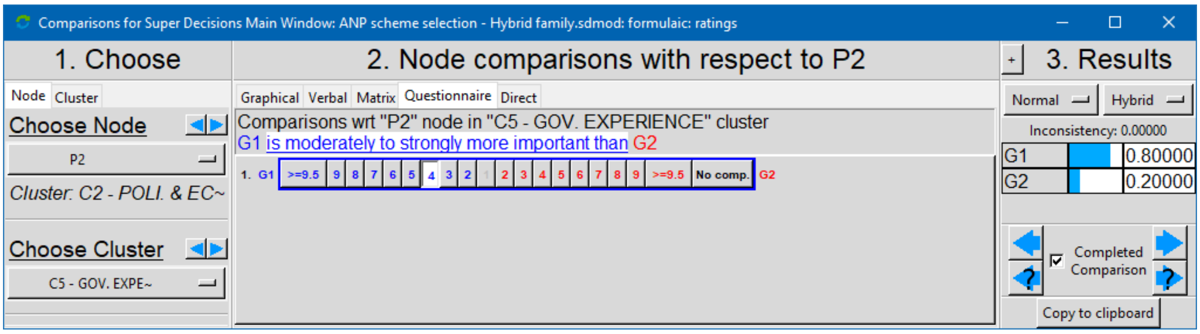


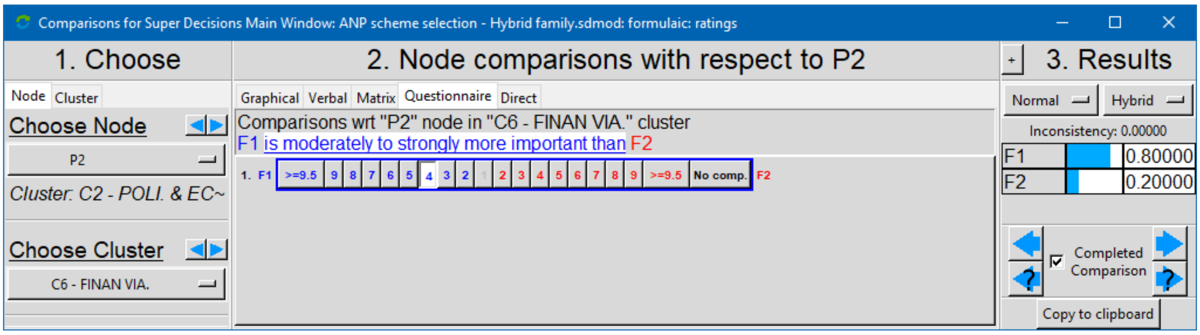
Appendix D.2-7: Node comparisons with respect to P2



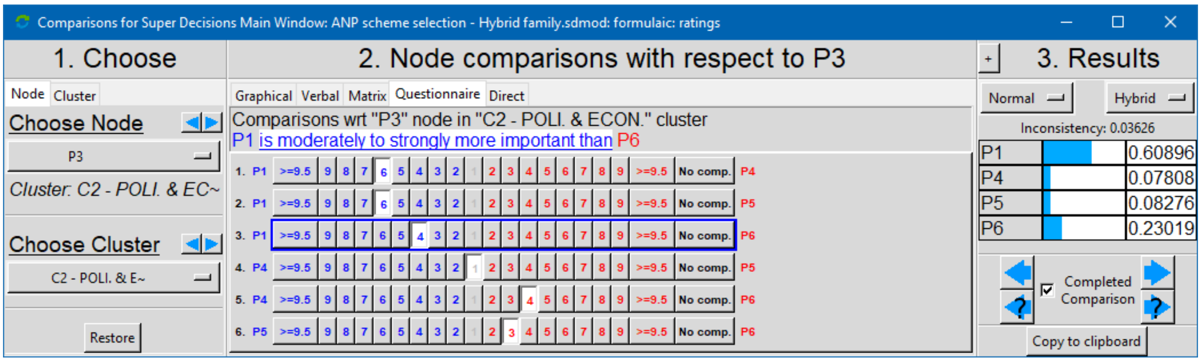

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to P2
3. Results
Node
Cluster
Choose Node
P2
Cluster: C2 - POLI. & EC~
Choose Cluster
C2 - POLI. & E~
Restore
Graphical
Verbal
Matrix
Questionnaire
Direct
Comparisons wrt "P2" node in "C2 - POLI. & ECON." cluster
P1 is moderately to strongly more important than P3
Normal
Hybrid
Inconsistency: 0.06899
P1 0.27952
P3 0.06656
P4 0.07503
P5 0.44009
P6 0.13880
Completed Comparison
Copy to clipboard

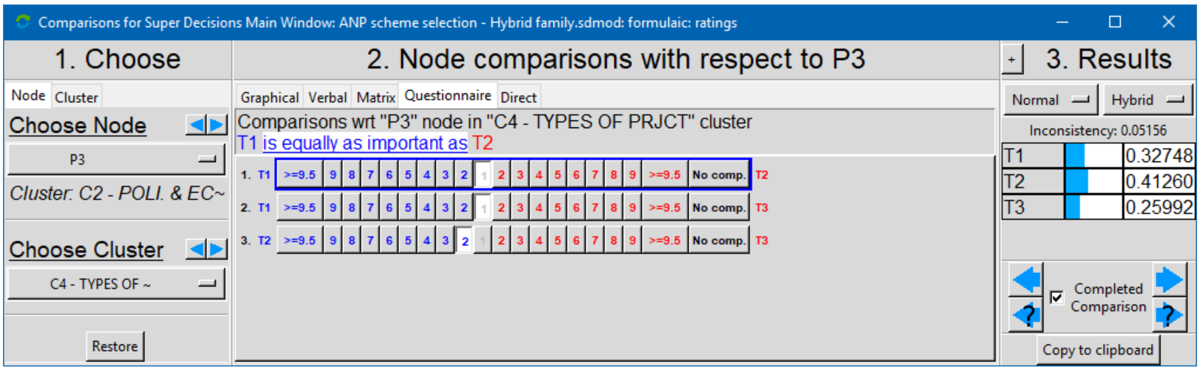

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to P2
3. Results
Choose Node
P2
Cluster: C2 - POLI. & EC~
Choose Cluster
C4 - TYPES OF ~
Comparisons wrt "P2" node in "C4 - TYPES OF PRJCT" cluster
T1 is moderately to strongly more important than T2
Inconsistency: 0.02365
T1 0.68334
T2 0.19981
T3 0.11685
Completed Comparison
Copy to clipboard

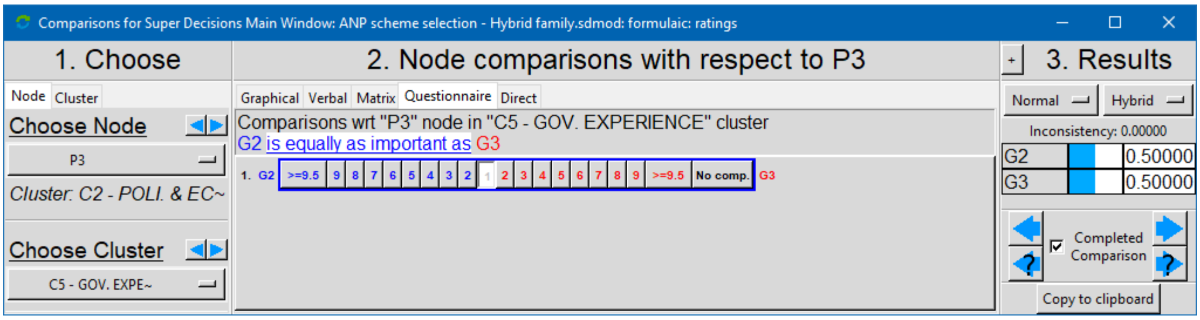

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to P2
3. Results
Choose Node
P2
Cluster: C2 - POLI. & EC~
Choose Cluster
C5 - GOV. EXPE~
Comparisons wrt "P2" node in "C5 - GOV. EXPERIENCE" cluster
G1 is moderately to strongly more important than G2
Inconsistency: 0.00000
G1 0.80000
G2 0.20000
Completed Comparison
Copy to clipboard


Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to P2
3. Results
Choose Node
P2
Cluster: C2 - POLI. & EC~
Choose Cluster
C6 - FINAN VIA.
Comparisons wrt "P2" node in "C6 - FINAN VIA." cluster
F1 is moderately to strongly more important than F2
Inconsistency: 0.00000
F1 0.80000
F2 0.20000
Completed Comparison
Copy to clipboard

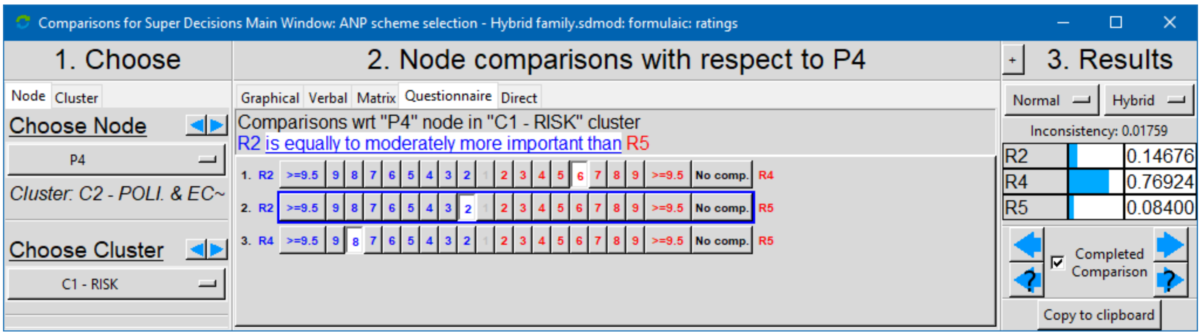
Appendix D.2-8: Node comparisons with respect to P3

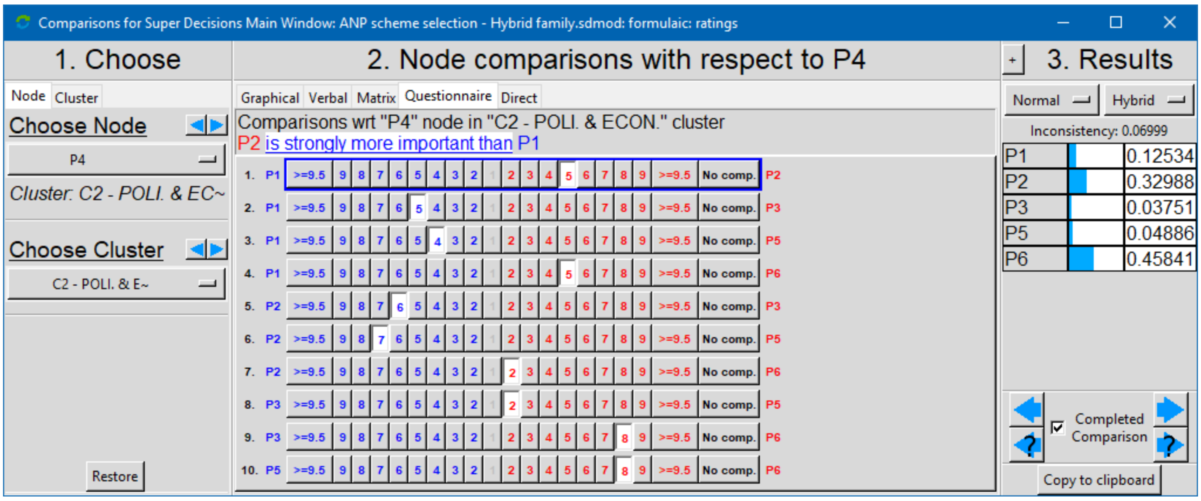


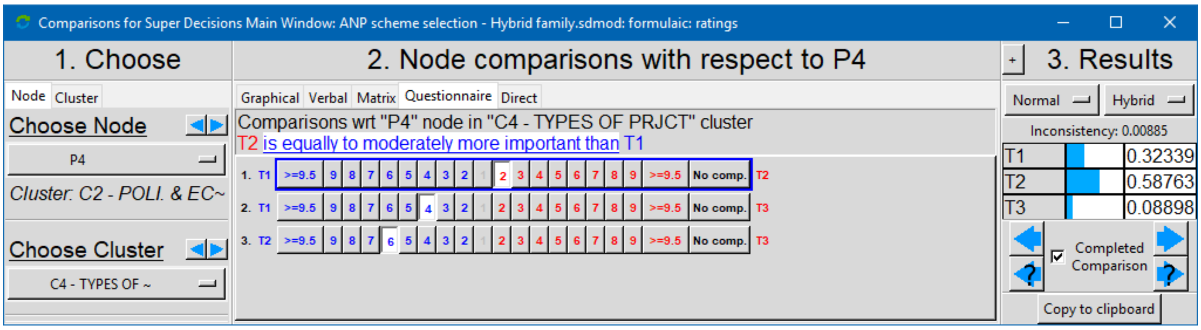


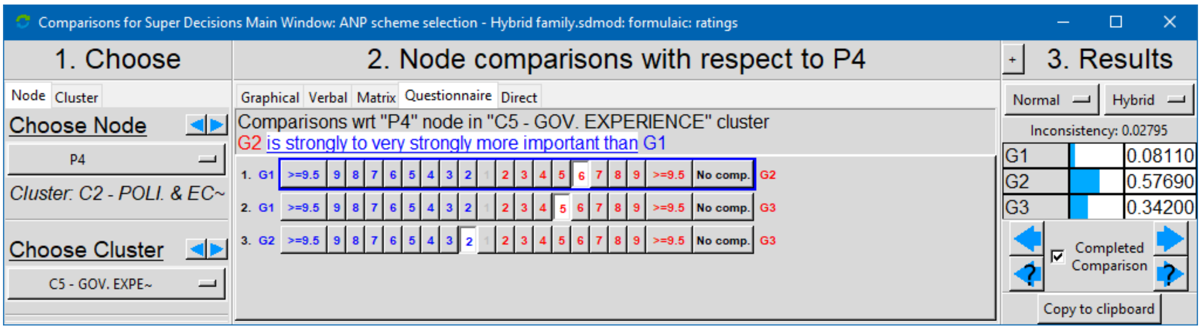


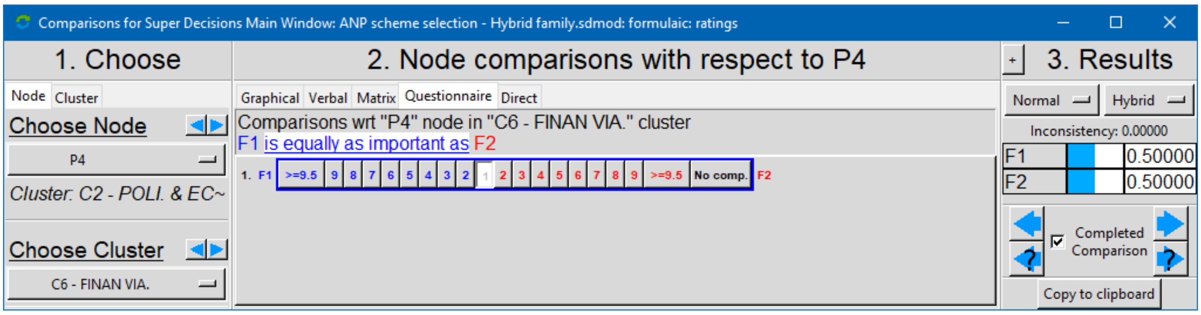
Appendix D.2-9: Node comparisons with respect to P4



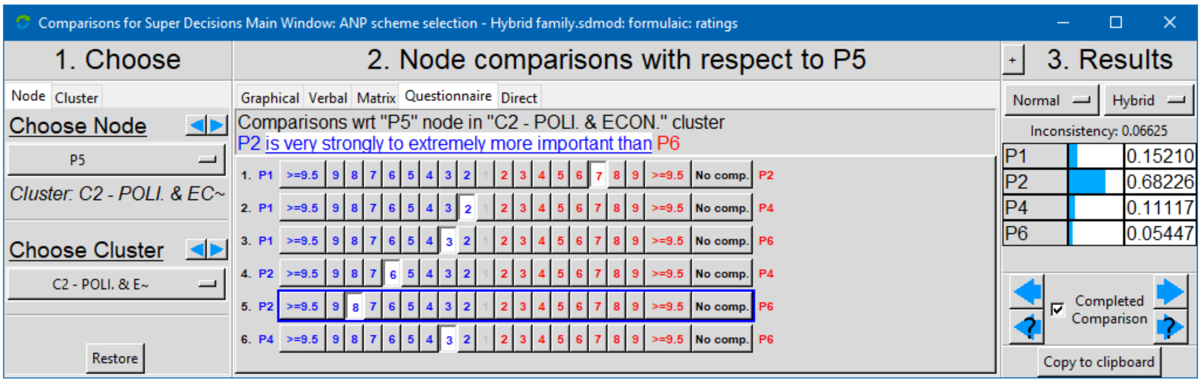

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to P4
3. Results
Choose Node
P4
Cluster: C2 - POLI. & EC~
Choose Cluster
C2 - POLI. & E~
Restore
Comparisons wrt "P4" node in "C2 - POLI. & ECON." cluster
P2 is strongly more important than P1
Inconsistency: 0.06999
P1 0.12534
P2 0.32988
P3 0.03751
P5 0.04886
P6 0.45841
Completed Comparison
Copy to clipboard

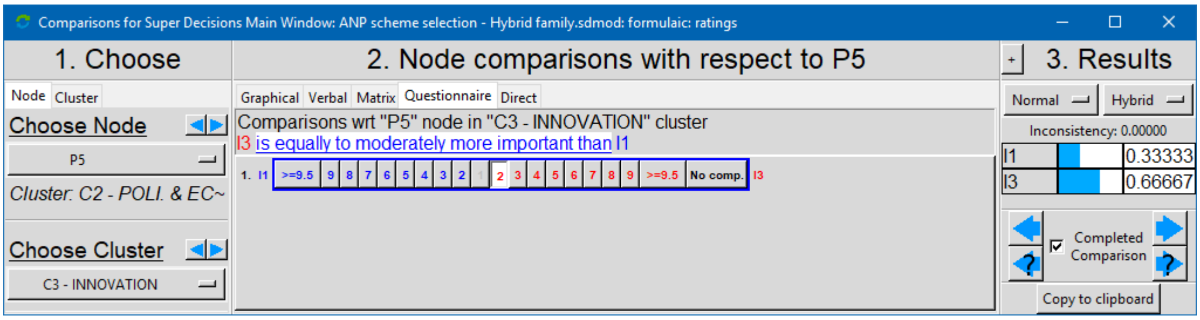

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to P4
3. Results
Choose Node
P4
Cluster: C2 - POLI. & EC~
Choose Cluster
C4 - TYPES OF ~
Comparisons wrt "P4" node in "C4 - TYPES OF PRJCT" cluster
T2 is equally to moderately more important than T1
Inconsistency: 0.00885
T1 0.32339
T2 0.58763
T3 0.08898
Completed Comparison
Copy to clipboard

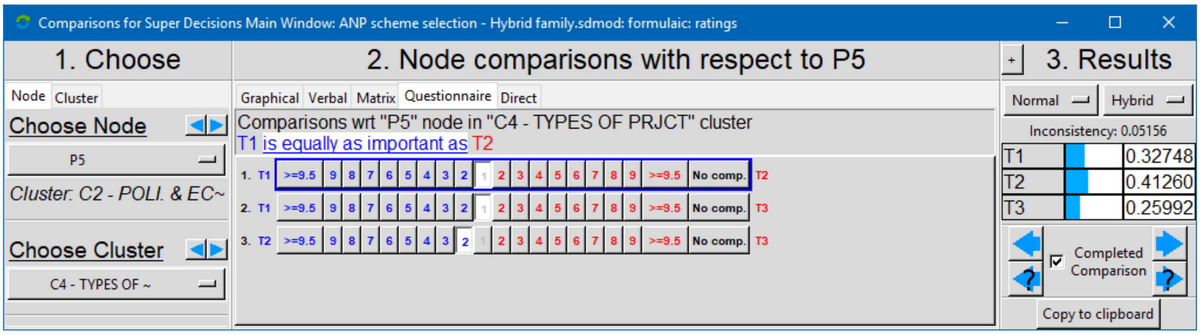

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to P4
3. Results
Choose Node
P4
Cluster: C2 - POLI. & EC~
Choose Cluster
C5 - GOV. EXPE~
Comparisons wrt "P4" node in "C5 - GOV. EXPERIENCE" cluster
G2 is strongly to very strongly more important than G1
Inconsistency: 0.02795
G1 0.08110
G2 0.57690
G3 0.34200
Completed Comparison
Copy to clipboard

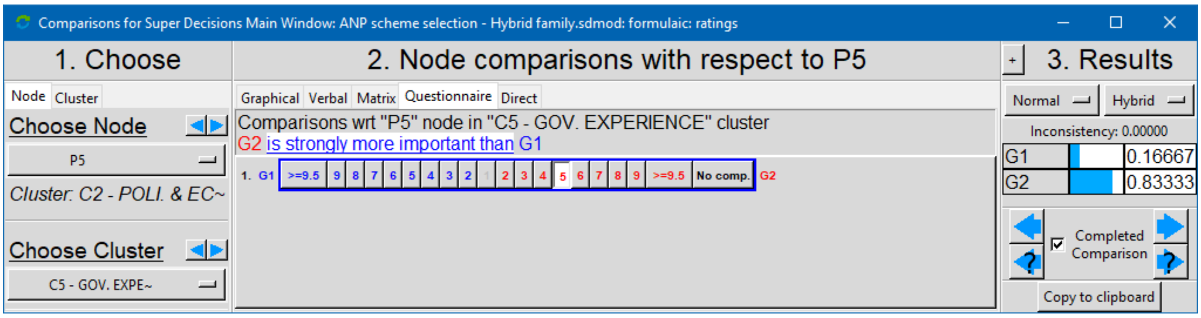

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to P4
3. Results
Choose Node
P4
Cluster: C2 - POLI. & EC~
Choose Cluster
C6 - FINAN VIA.
Comparisons wrt "P4" node in "C6 - FINAN VIA." cluster
F1 is equally as important as F2
Inconsistency: 0.00000
F1 0.50000
F2 0.50000
Completed Comparison
Copy to clipboard

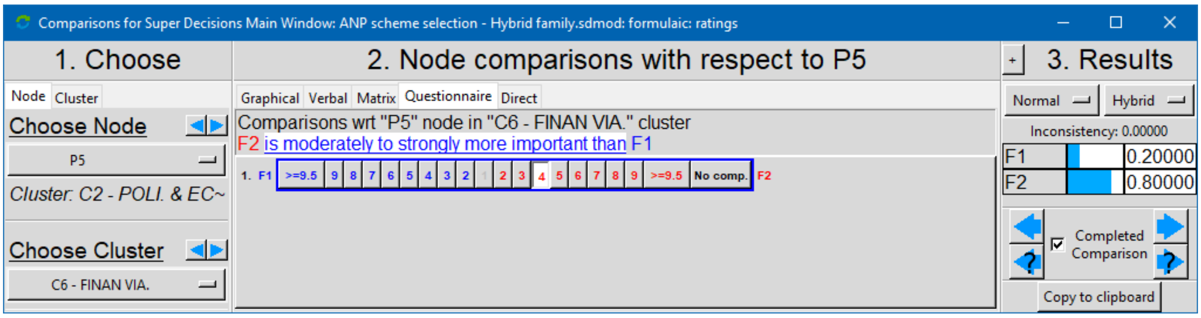
Appendix D.2-10: Node comparisons with respect to P5



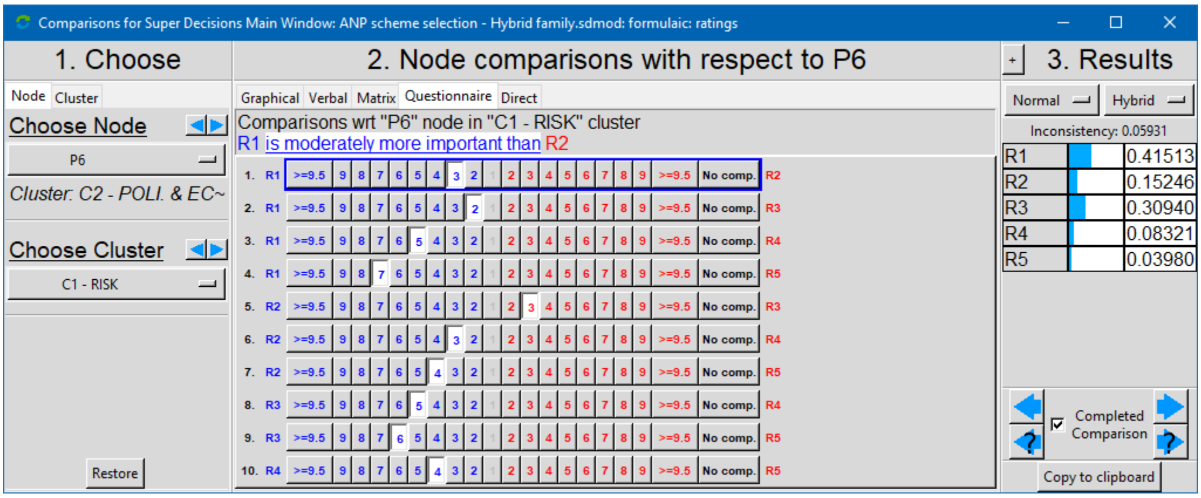


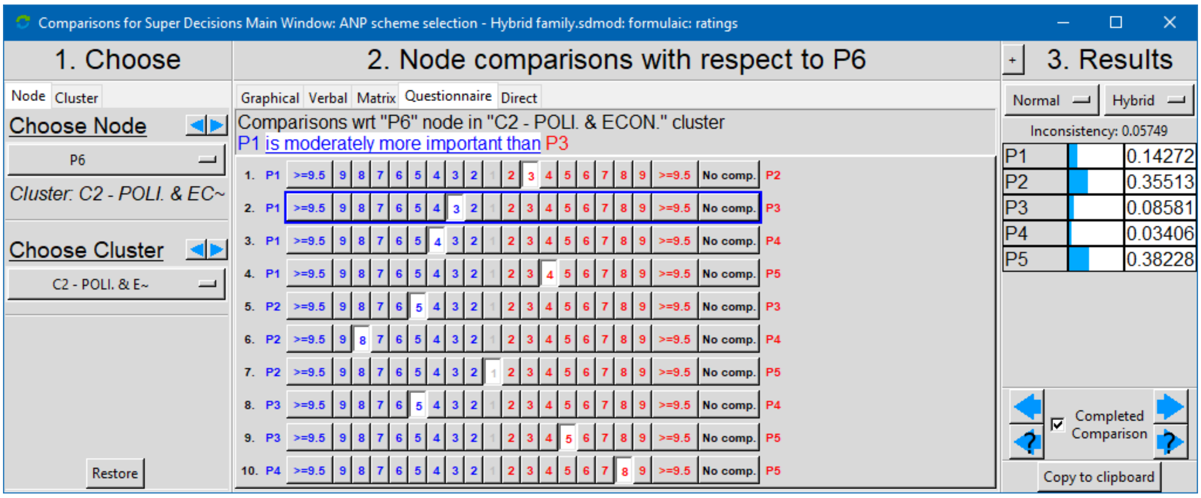


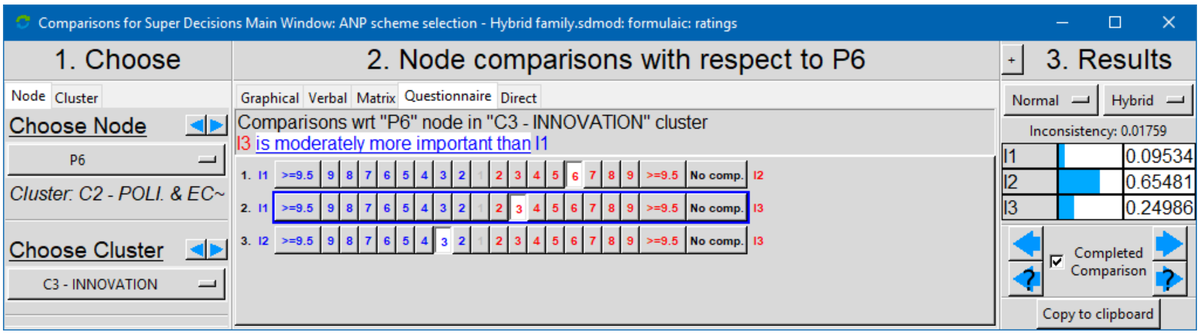


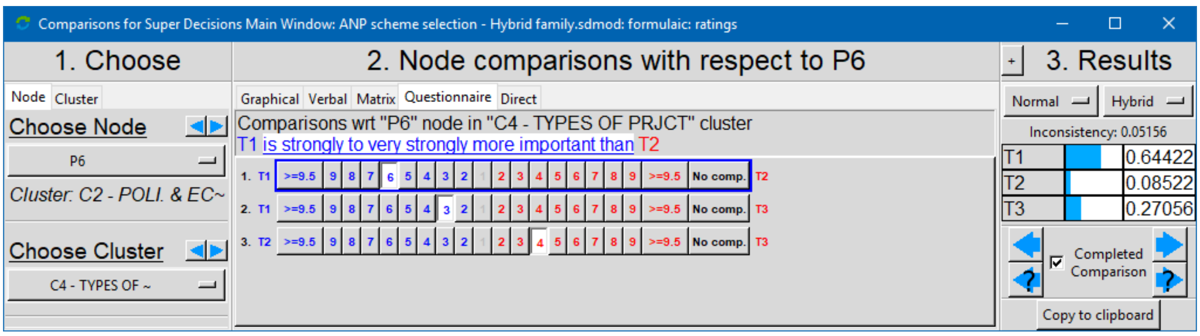


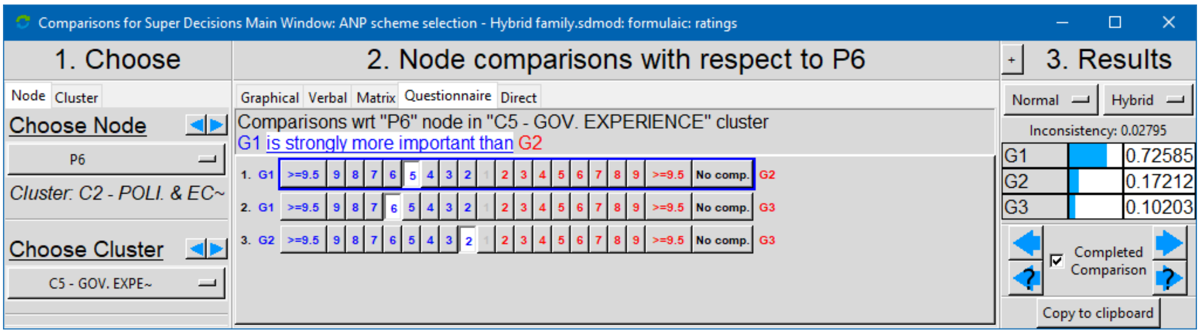
Appendix D.2-11: Node comparisons with respect to P6

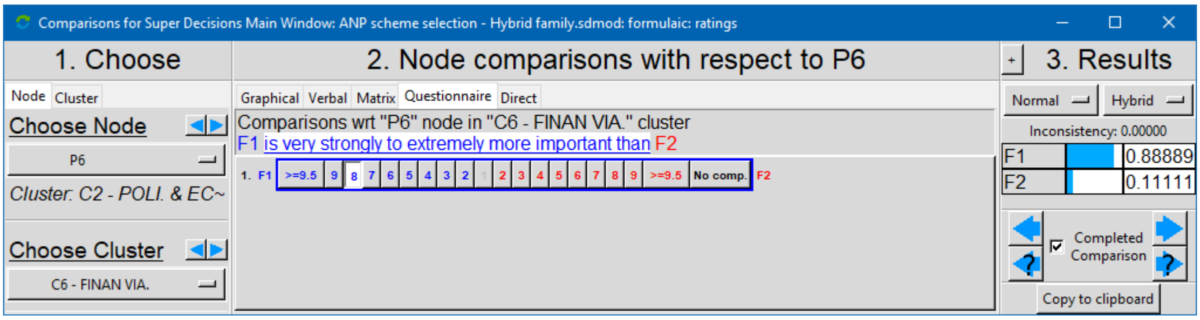




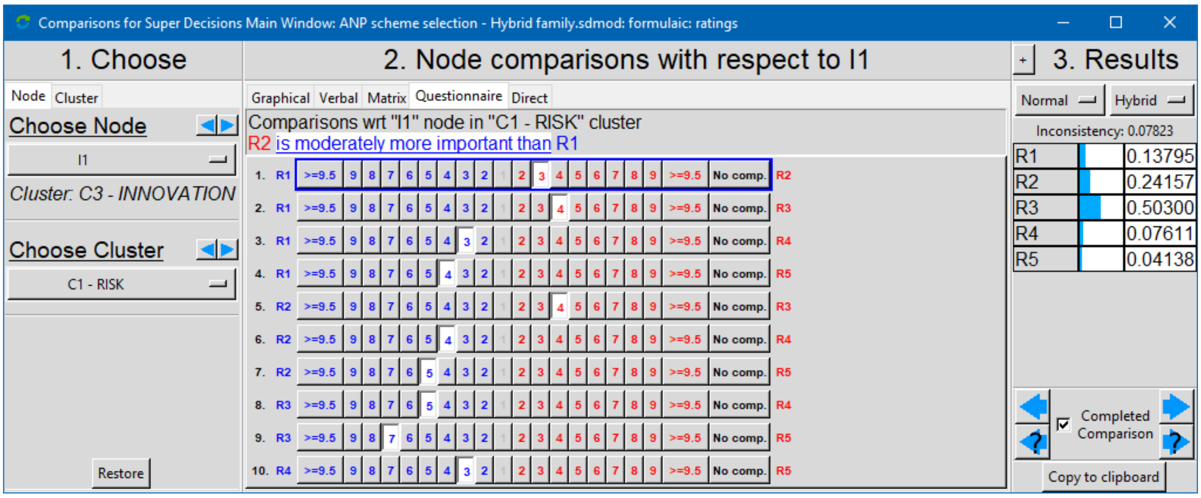


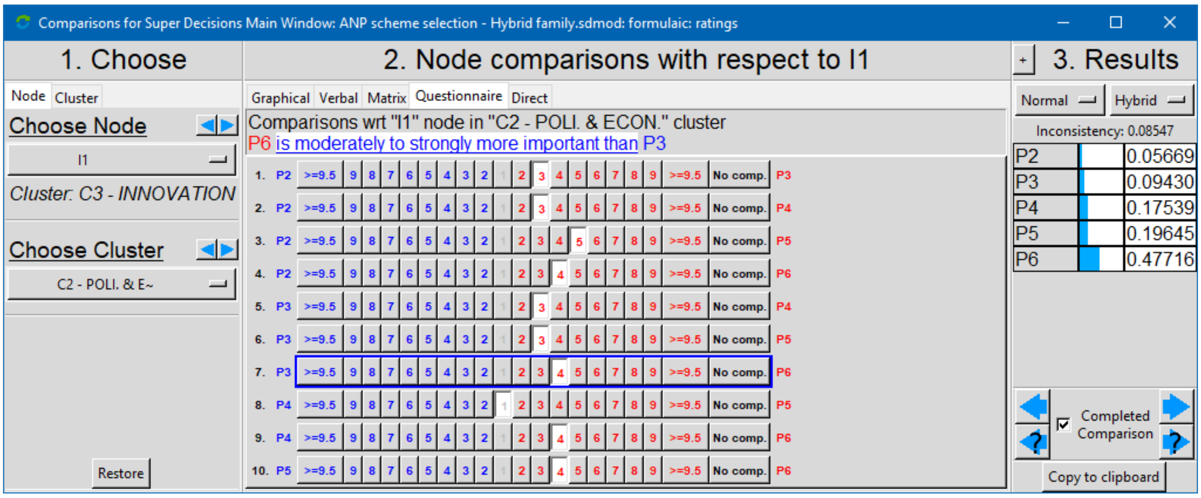


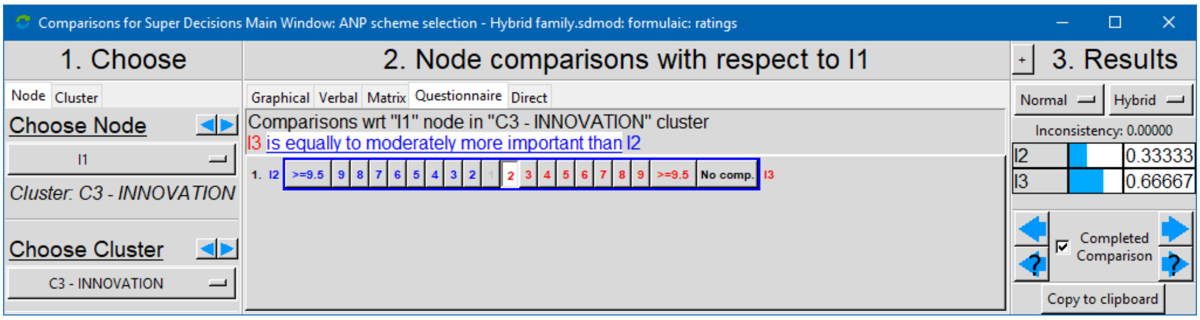


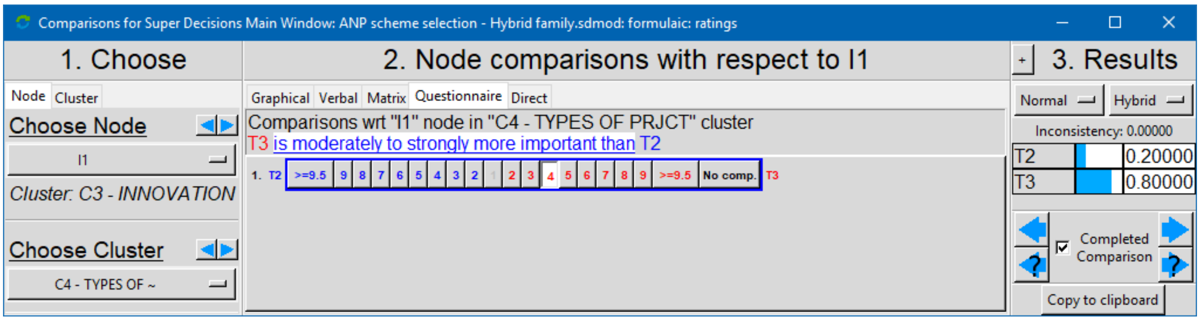


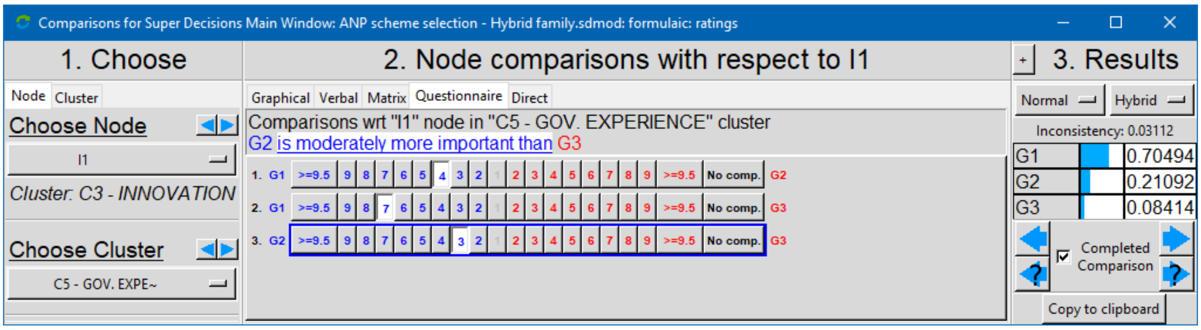
Appendix D.2-12: Node comparisons with respect to I1

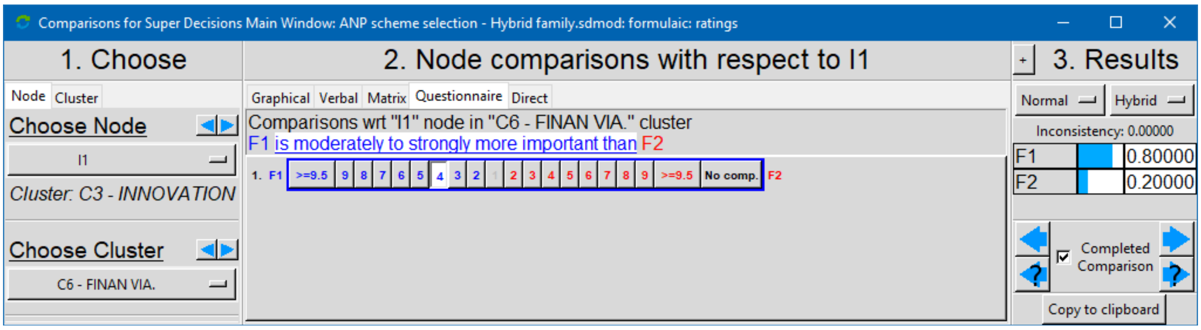




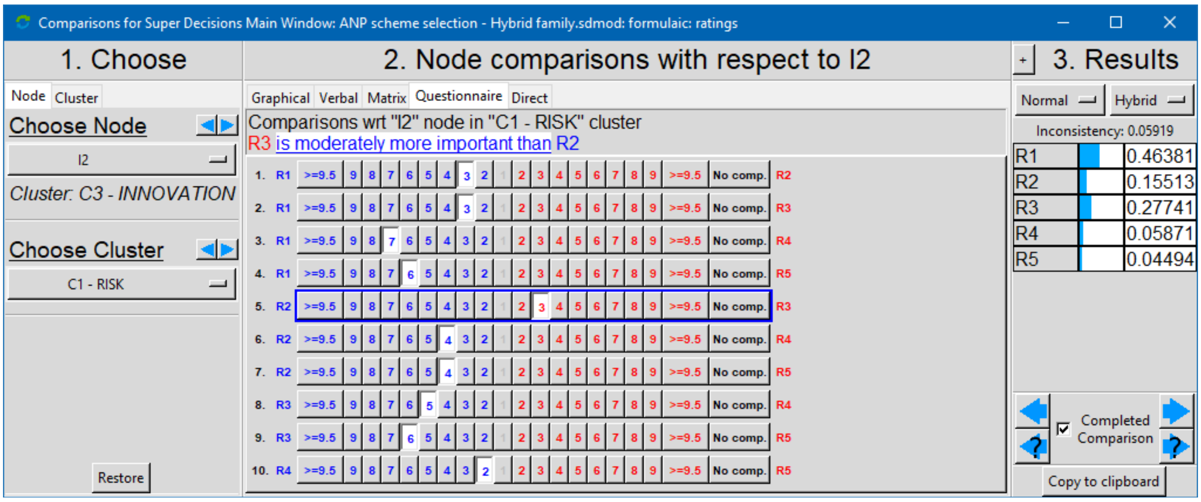

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to I1
3. Results
Node Cluster
Choose Node
I1
Cluster: C3 - INNOVATION
Choose Cluster
C3 - INNOVATION
Graphical Verbal Matrix Questionnaire Direct
Comparisons wrt "I1" node in "C3 - INNOVATION" cluster
I3 is equally to moderately more important than I2
1. I2 >=9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5 No comp. I3
Normal Hybrid
Inconsistency: 0.00000
I2 0.33333
I3 0.66667
Completed Comparison
Copy to clipboard

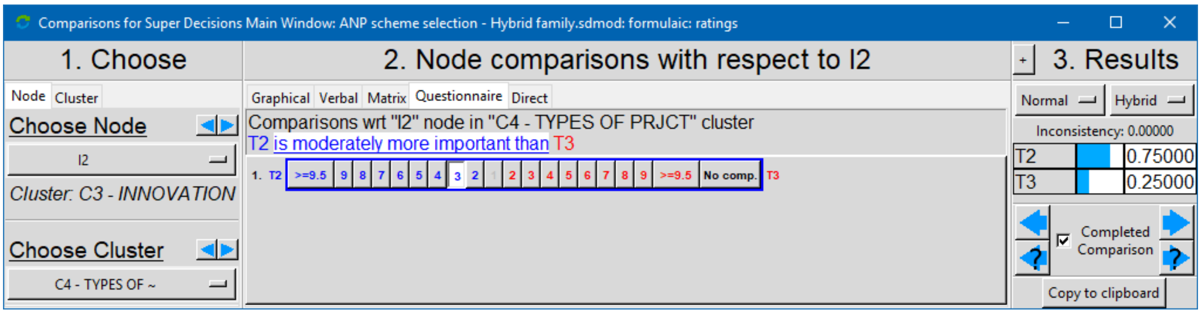

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to I1
3. Results
Node Cluster
Choose Node
I1
Cluster: C3 - INNOVATION
Choose Cluster
C4 - TYPES OF ~
Graphical Verbal Matrix Questionnaire Direct
Comparisons wrt "I1" node in "C4 - TYPES OF PRJCT" cluster
T3 is moderately to strongly more important than T2
1. T2 >=9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5 No comp. T3
Normal Hybrid
Inconsistency: 0.00000
T2 0.20000
T3 0.80000
Completed Comparison
Copy to clipboard

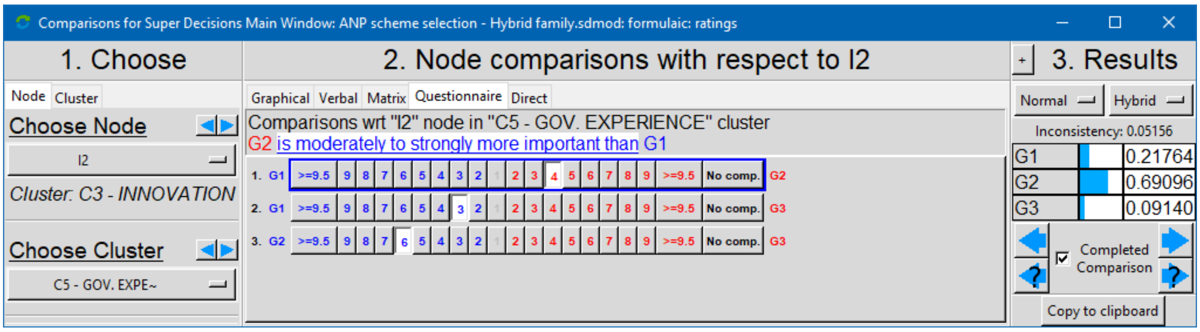

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to I1
3. Results
Node Cluster
Choose Node
I1
Cluster: C3 - INNOVATION
Choose Cluster
C5 - GOV. EXPE~
Graphical Verbal Matrix Questionnaire Direct
Comparisons wrt "I1" node in "C5 - GOV. EXPERIENCE" cluster
G2 is moderately more important than G3
1. G1 >=9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5 No comp. G2
2. G1 >=9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5 No comp. G3
3. G2 >=9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5 No comp. G3
Normal Hybrid
Inconsistency: 0.03112
G1 0.70494
G2 0.21092
G3 0.08414
Completed Comparison
Copy to clipboard

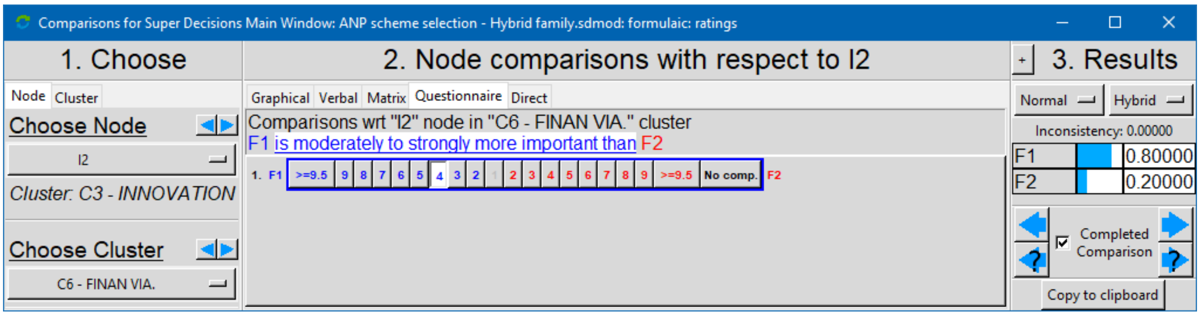

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to I1
3. Results
Node Cluster
Choose Node
I1
Cluster: C3 - INNOVATION
Choose Cluster
C6 - FINAN VIA.
Graphical Verbal Matrix Questionnaire Direct
Comparisons wrt "I1" node in "C6 - FINAN VIA." cluster
F1 is moderately to strongly more important than F2
1. F1 >=9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5 No comp. F2
Normal Hybrid
Inconsistency: 0.00000
F1 0.80000
F2 0.20000
Completed Comparison
Copy to clipboard

Appendix D.2-13: Node comparisons with respect to I2

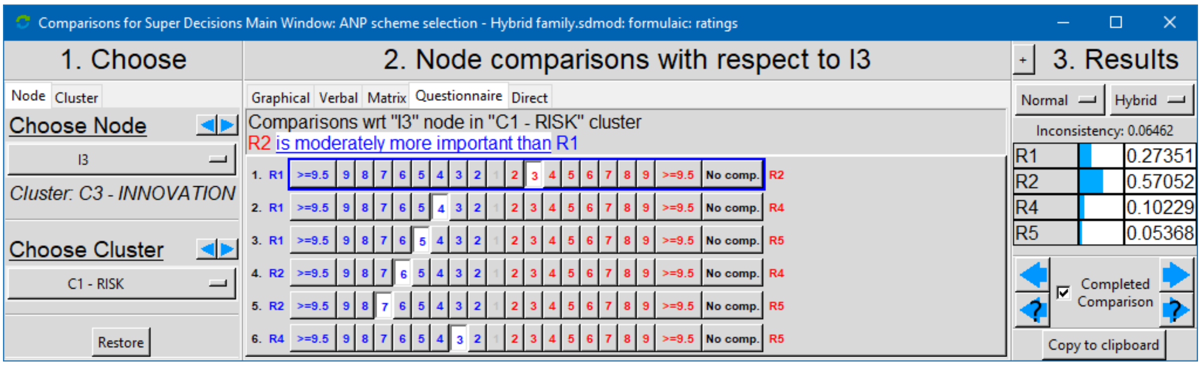


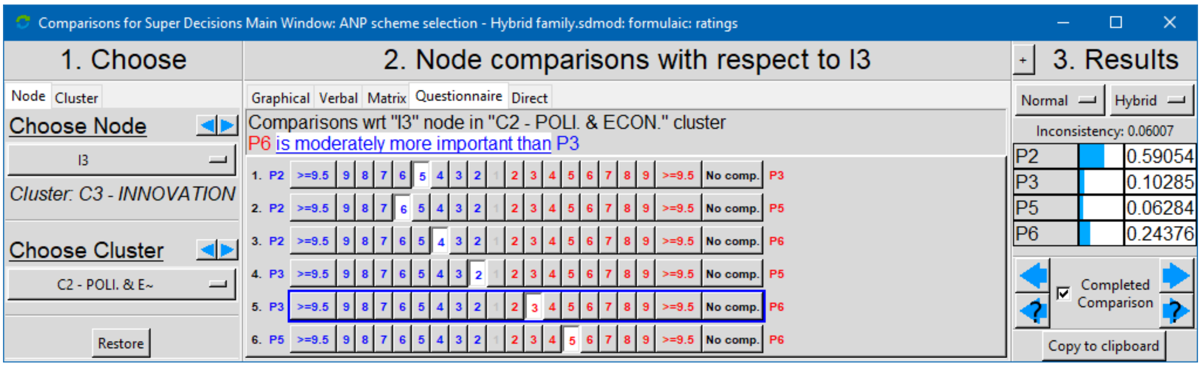


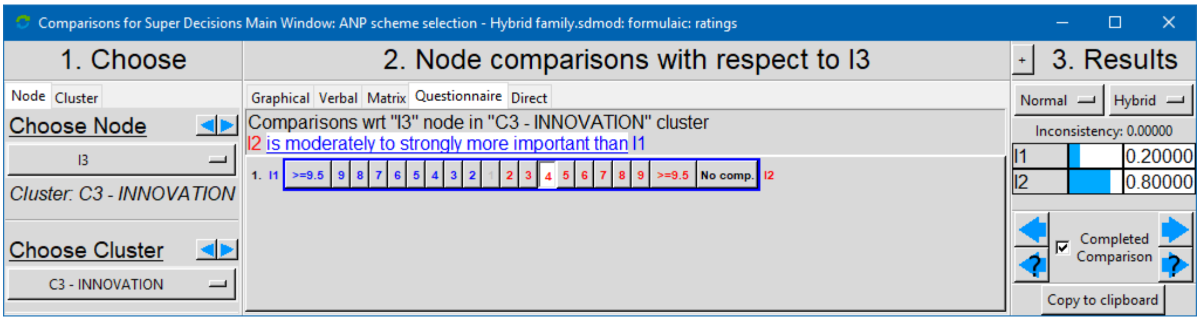


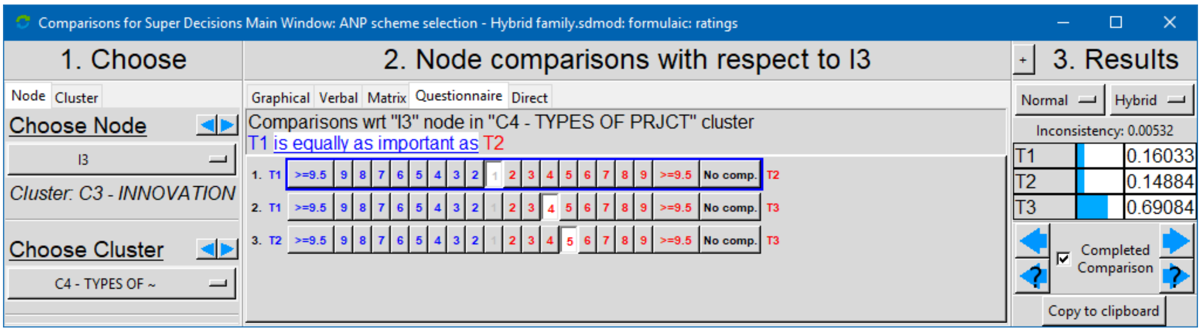


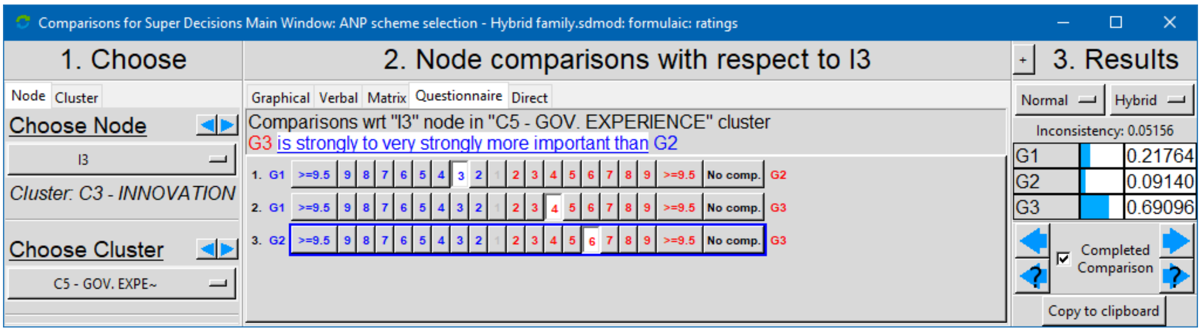
Appendix D.2-14: Node comparisons with respect to I3

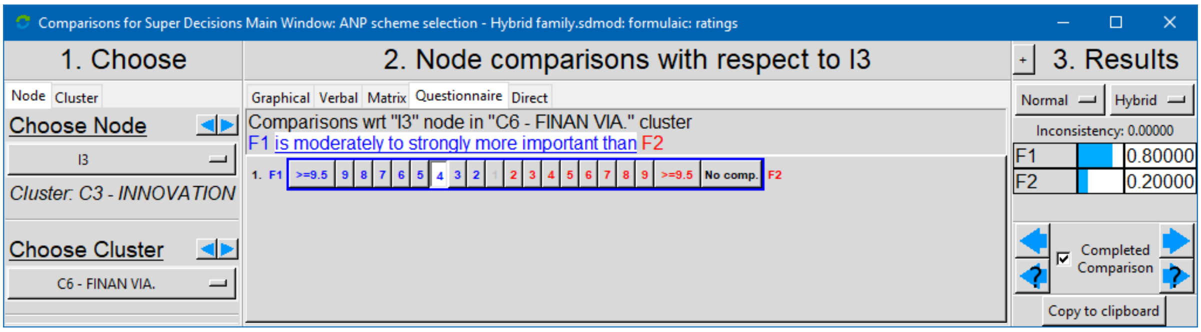




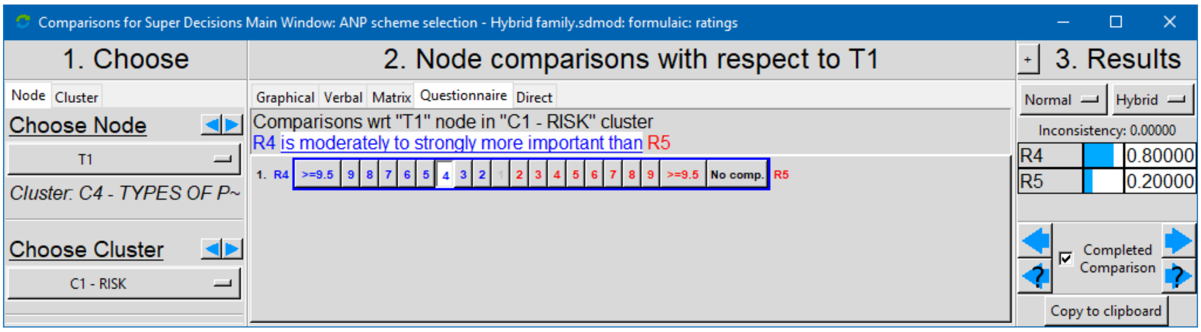


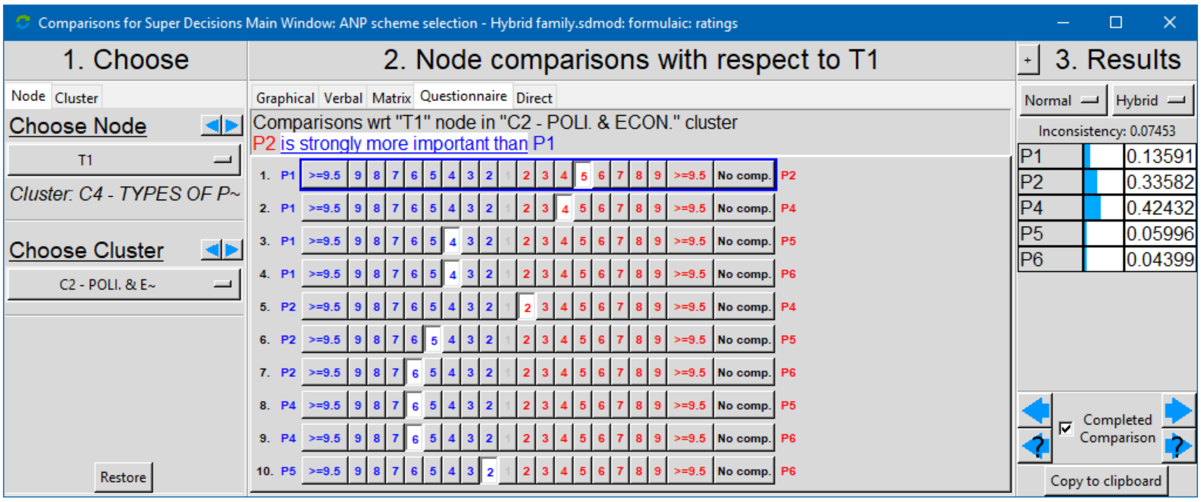


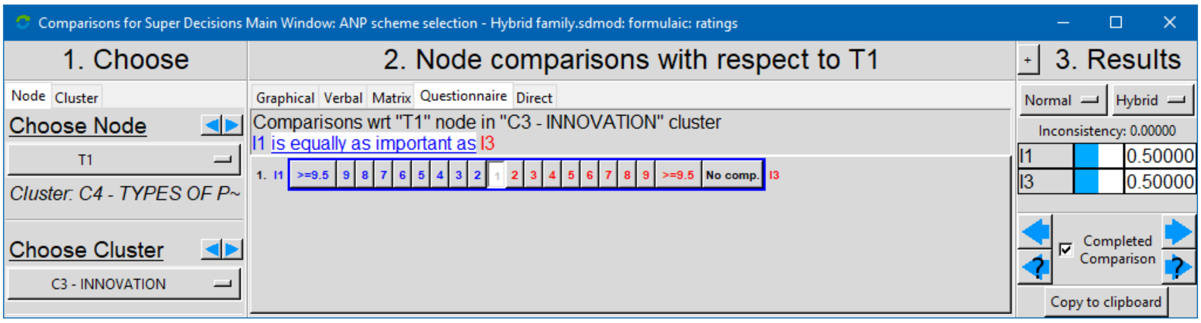


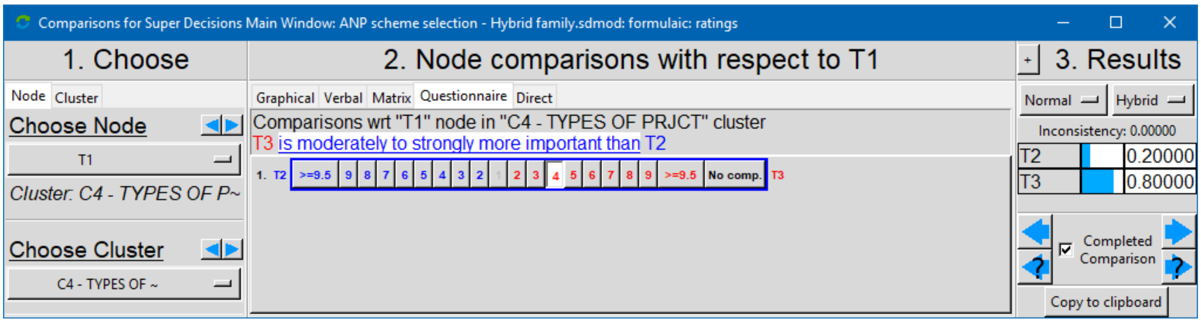


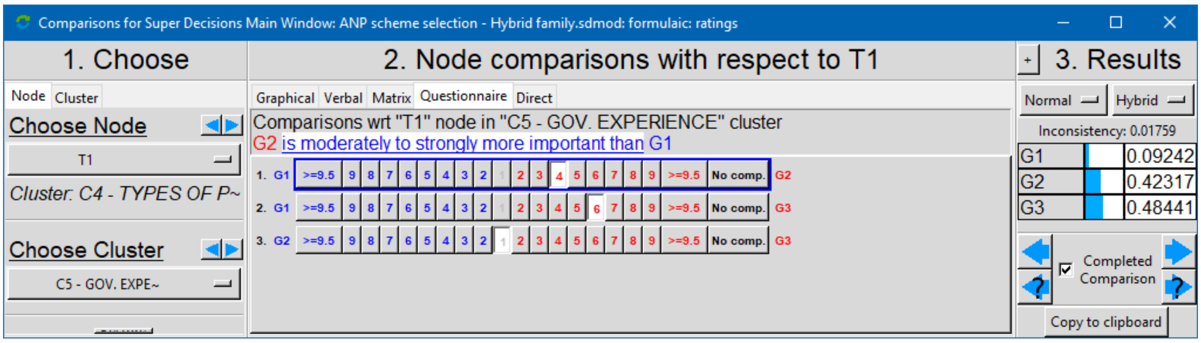
Appendix D.2-15: Node comparisons with respect to T1

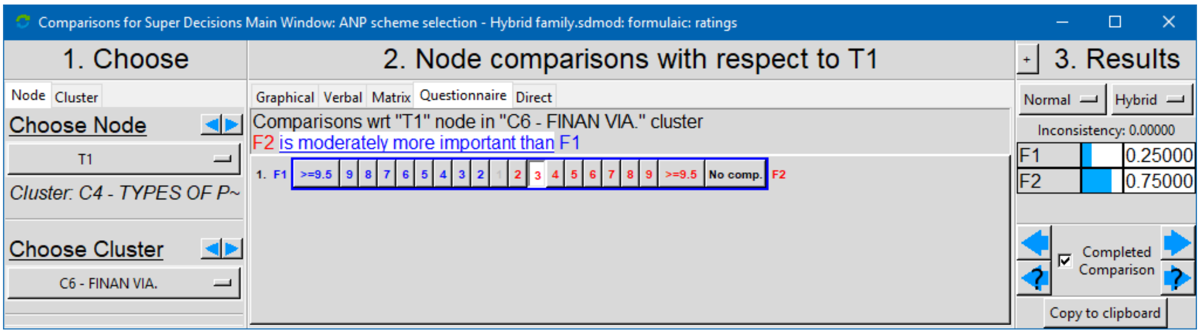




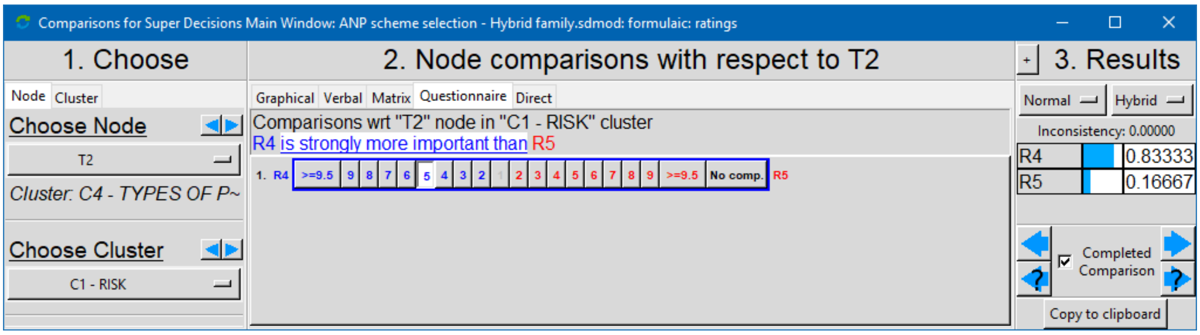


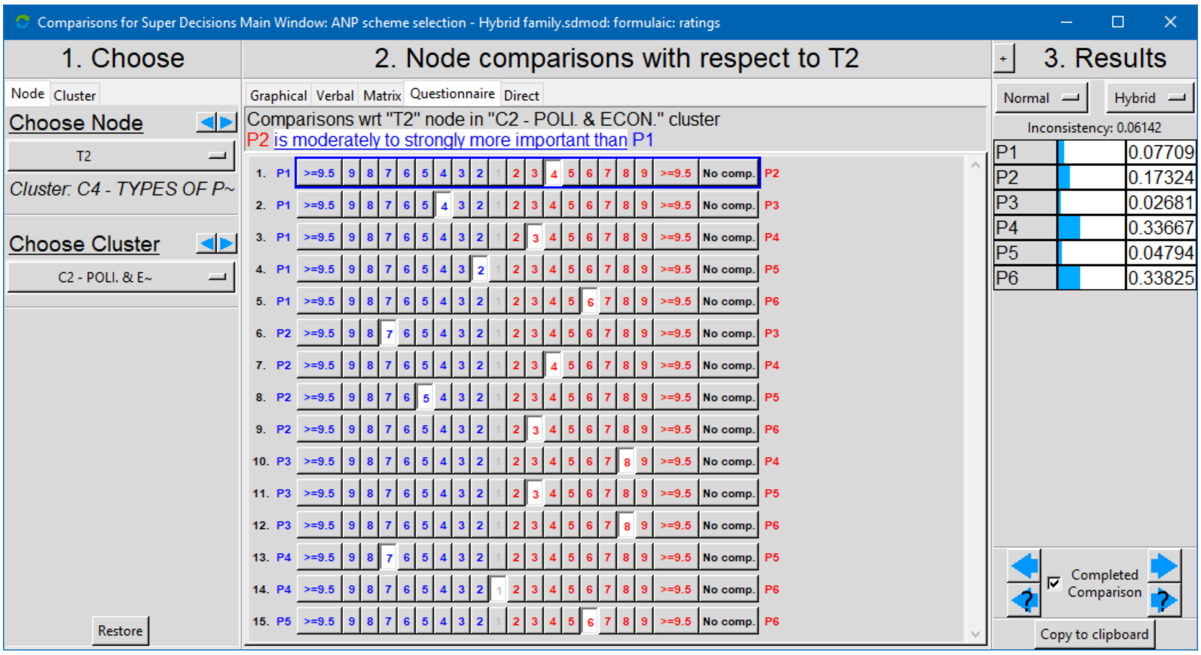


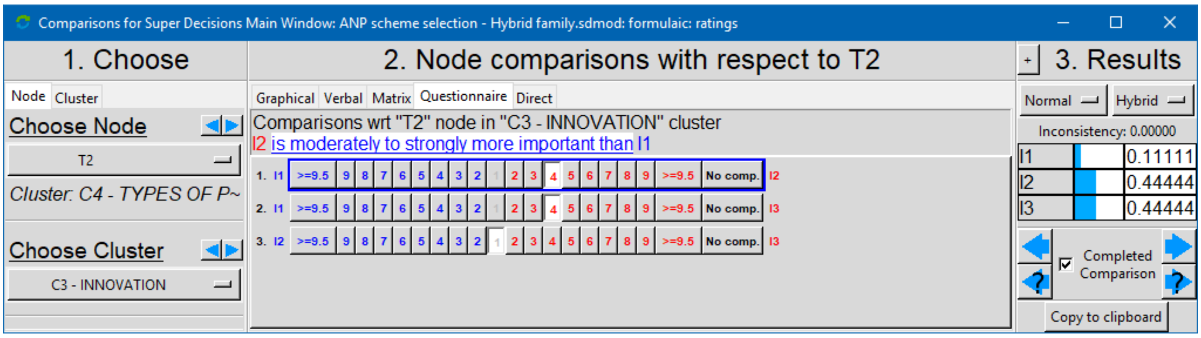


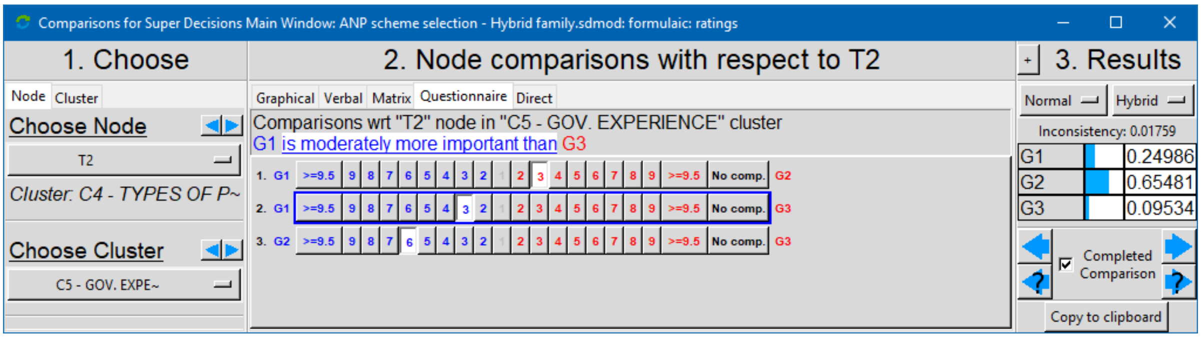


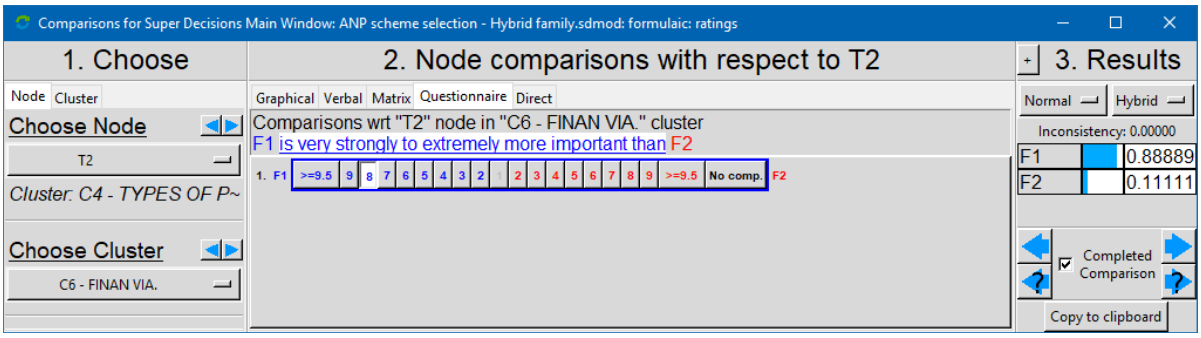
Appendix D.2-16: Node comparisons with respect to T2



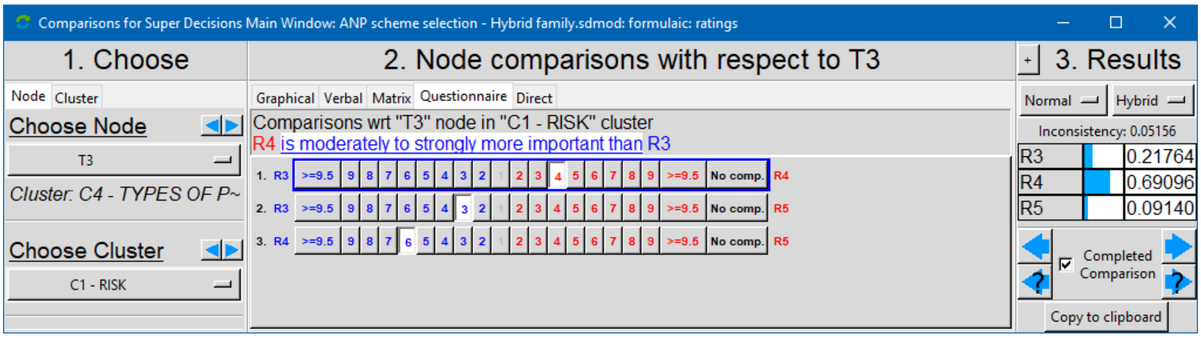

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to T2
3. Results
Choose Node
T2
Cluster: C4 - TYPES OF P~
Choose Cluster
C2 - POLI. & E~
Comparisons wrt "T2" node in "C2 - POLI. & ECON." cluster
P2 is moderately to strongly more important than P1
Inconsistency: 0.06142
P1 0.07709
P2 0.17324
P3 0.02681
P4 0.33667
P5 0.04794
P6 0.33825
Completed Comparison
Copy to clipboard
Restore

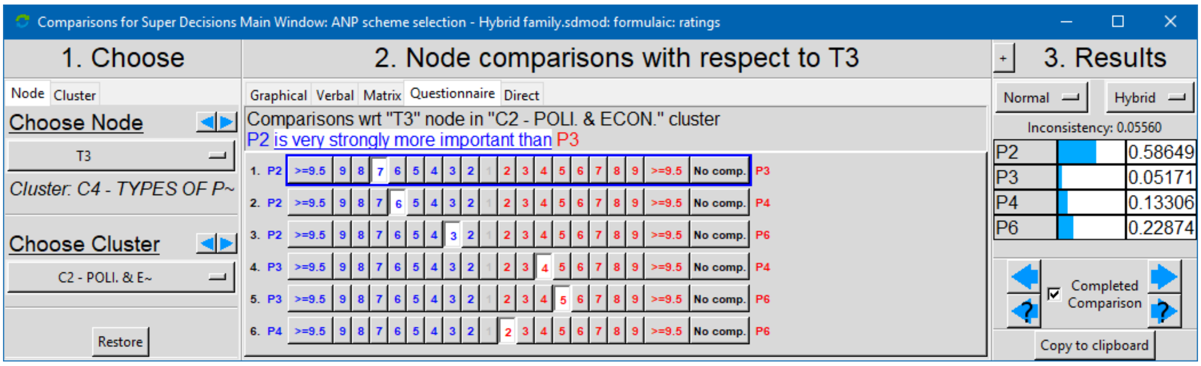

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to T2
3. Results
Choose Node
T2
Cluster: C4 - TYPES OF P~
Choose Cluster
C3 - INNOVATION
Comparisons wrt "T2" node in "C3 - INNOVATION" cluster
I2 is moderately to strongly more important than I1
Inconsistency: 0.00000
I1 0.11111
I2 0.44444
I3 0.44444
Completed Comparison
Copy to clipboard

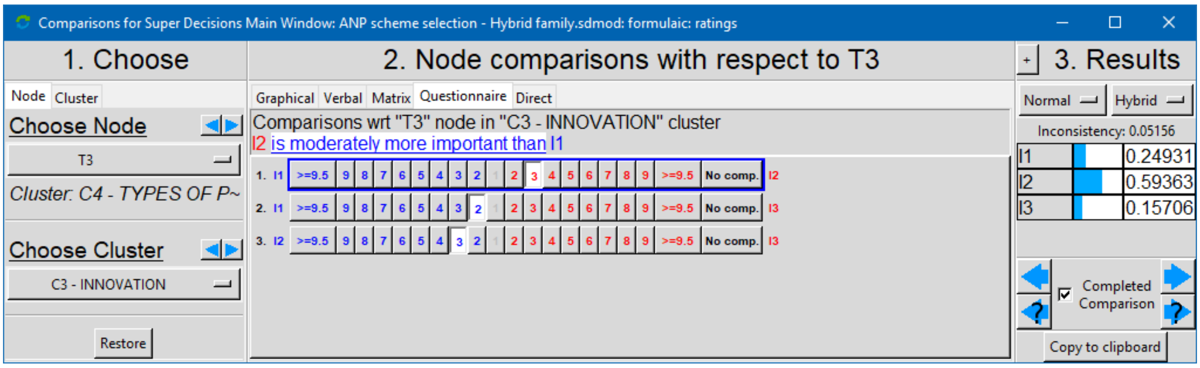

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to T2
3. Results
Choose Node
T2
Cluster: C4 - TYPES OF P~
Choose Cluster
C5 - GOV. EXPE~
Comparisons wrt "T2" node in "C5 - GOV. EXPERIENCE" cluster
G1 is moderately more important than G3
Inconsistency: 0.01759
G1 0.24986
G2 0.65481
G3 0.09534
Completed Comparison
Copy to clipboard

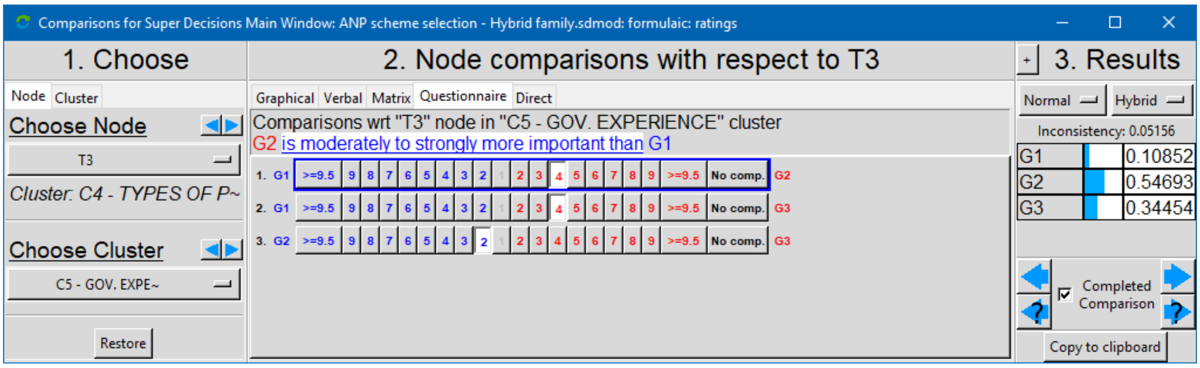

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to T2
3. Results
Choose Node
T2
Cluster: C4 - TYPES OF P~
Choose Cluster
C6 - FINAN VIA.
Comparisons wrt "T2" node in "C6 - FINAN VIA." cluster
F1 is very strongly to extremely more important than F2
Inconsistency: 0.00000
F1 0.88889
F2 0.11111
Completed Comparison
Copy to clipboard

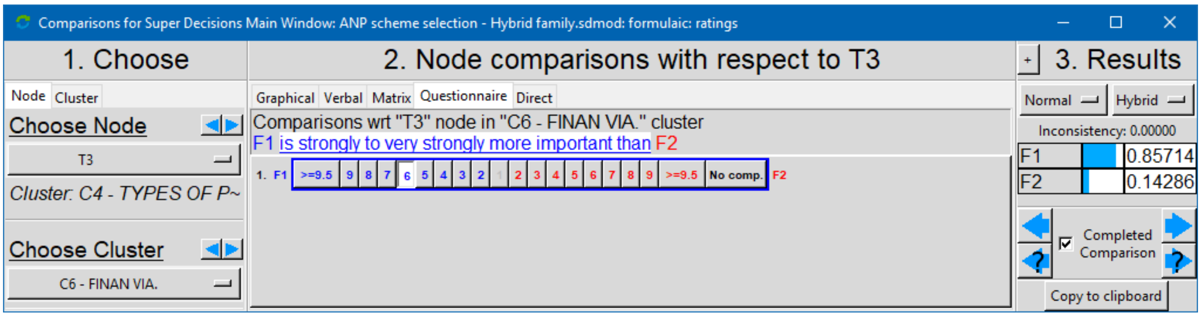
Appendix D.2-17: Node comparisons with respect to T3



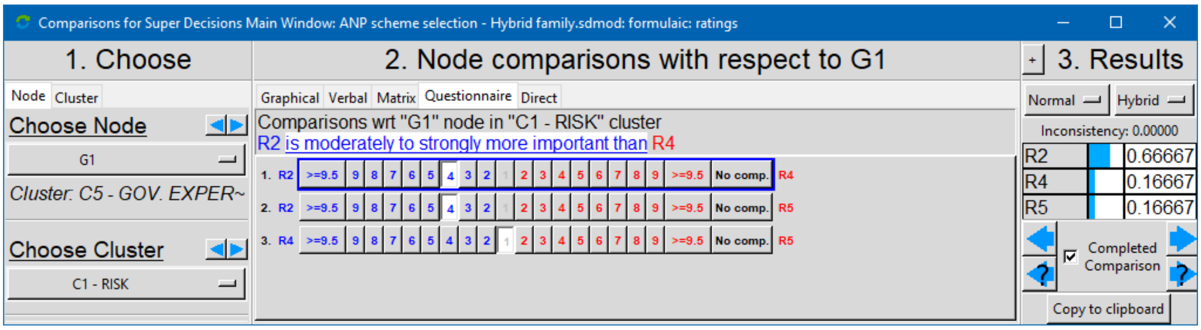


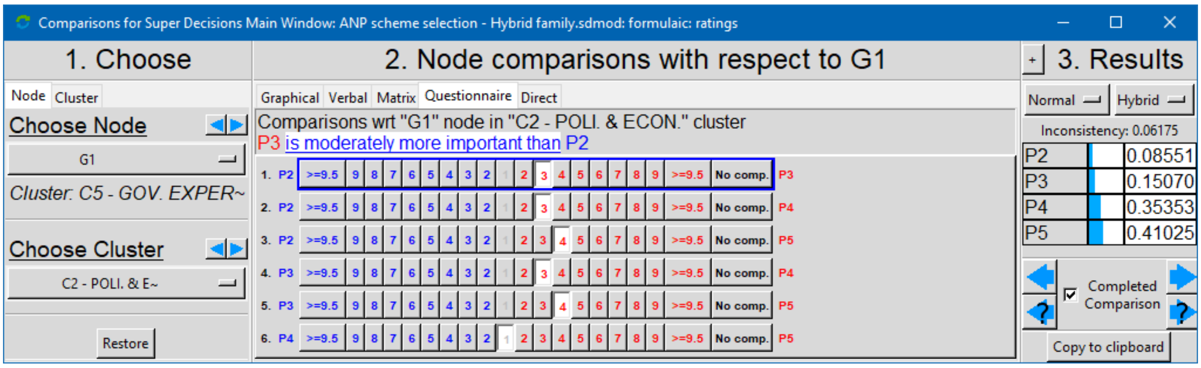


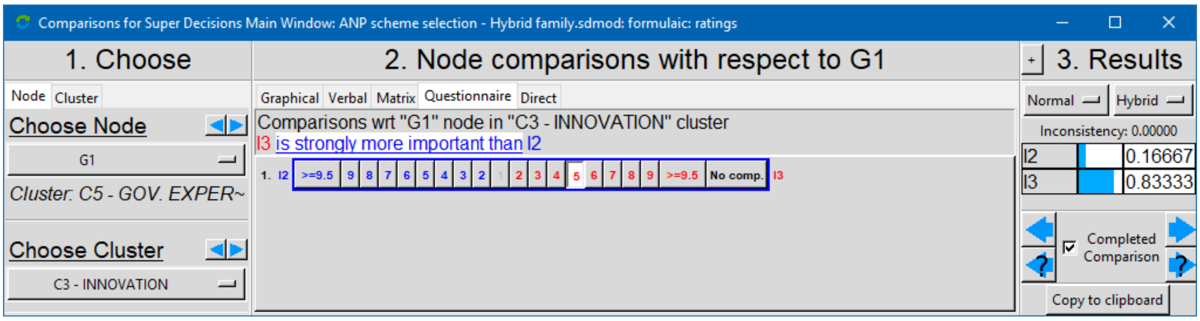


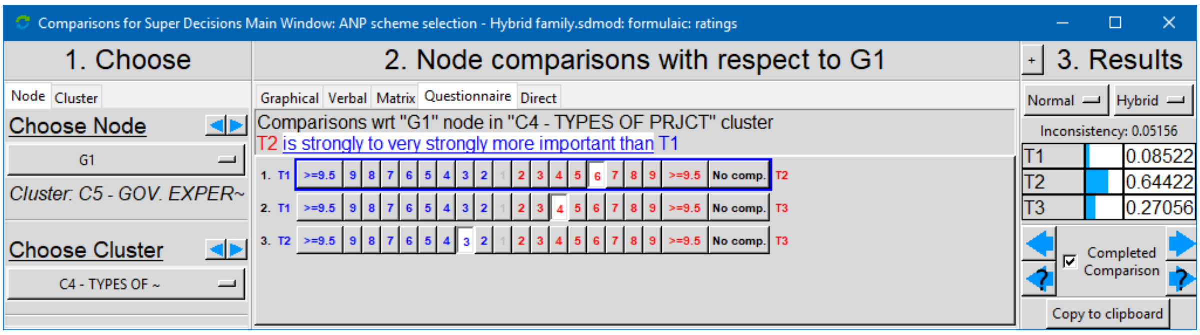


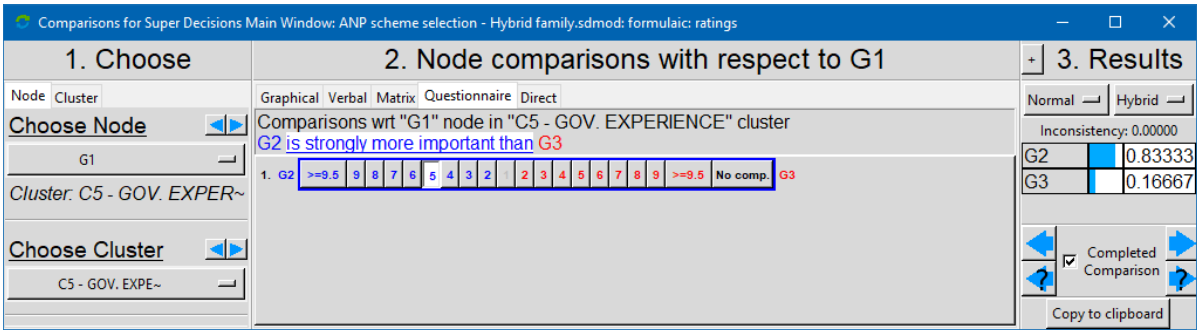
Appendix D.2-18: Node comparisons with respect to G1

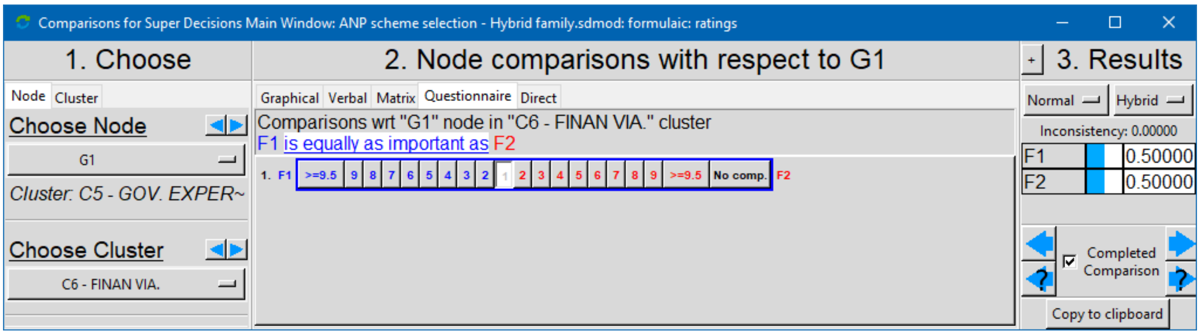




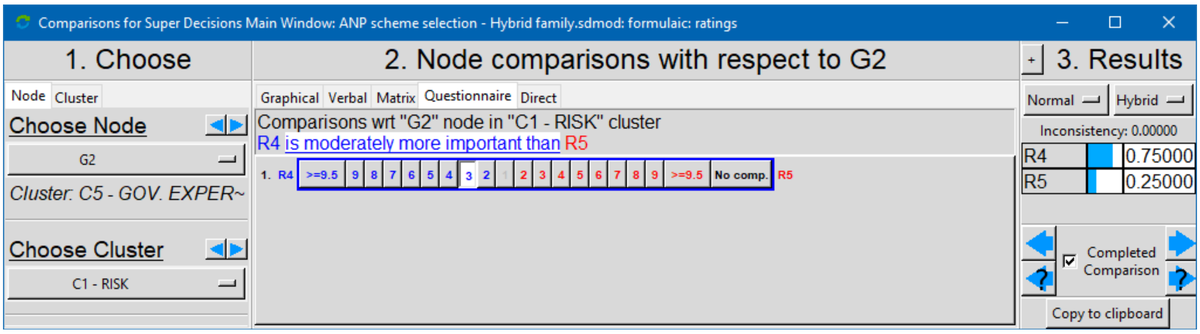


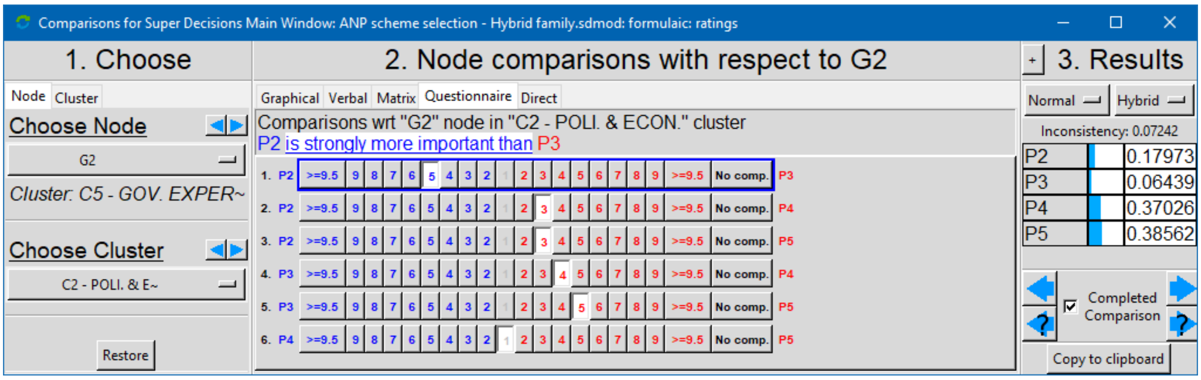


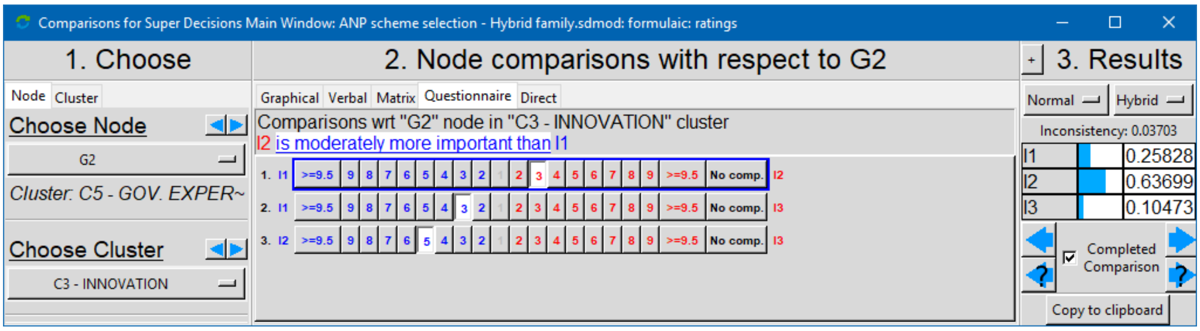


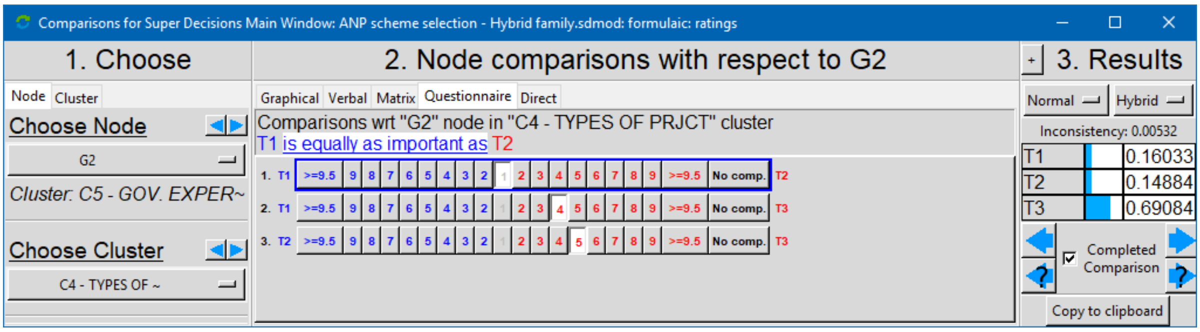


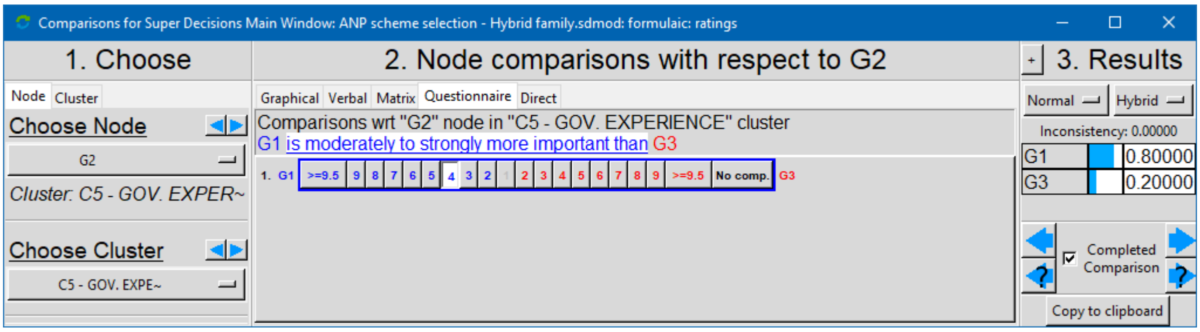
Appendix D.2-19: Node comparisons with respect to G2

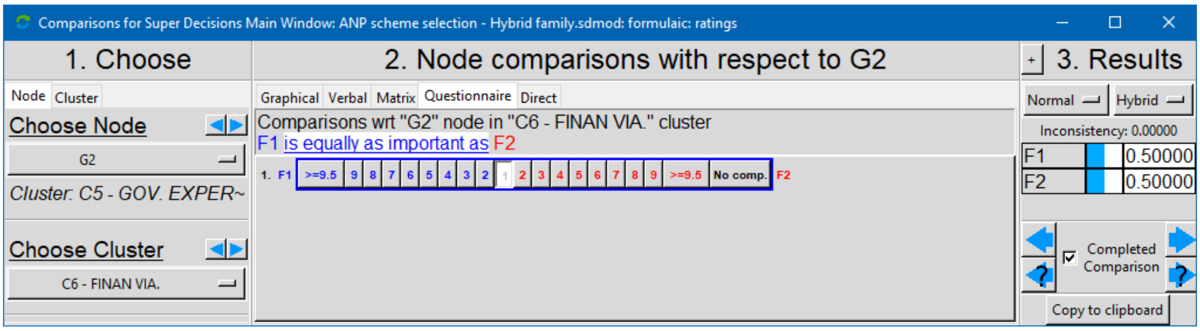




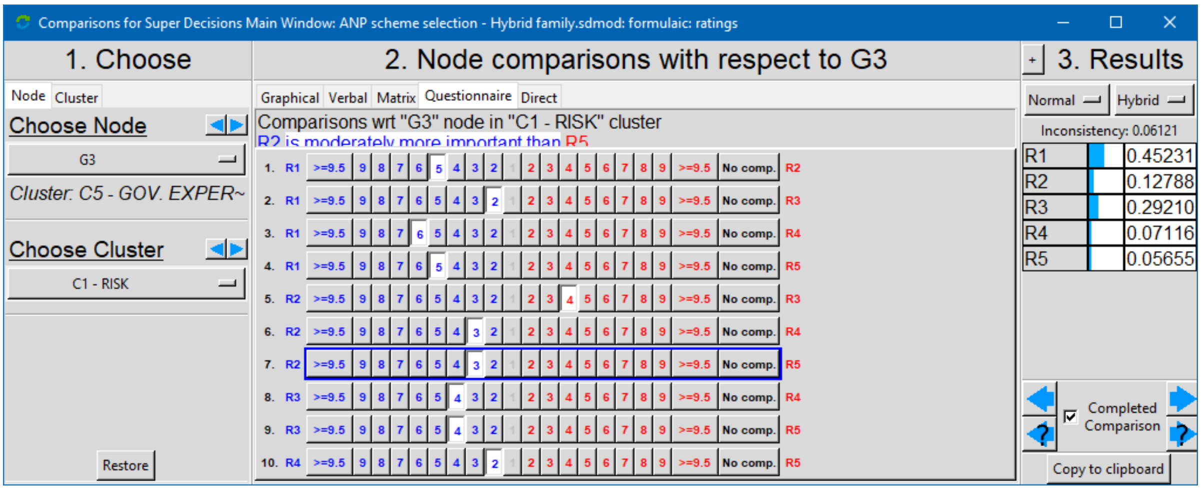

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to G2
3. Results
Choose Node
G2
Cluster: C5 - GOV. EXPER~
Choose Cluster
C3 - INNOVATION
Comparisons wrt "G2" node in "C3 - INNOVATION" cluster
I2 is moderately more important than I1
Inconsistency: 0.03703
I1 0.25828
I2 0.63699
I3 0.10473
Completed Comparison
Copy to clipboard


Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to G2
3. Results
Choose Node
G2
Cluster: C5 - GOV. EXPER~
Choose Cluster
C4 - TYPES OF ~
Comparisons wrt "G2" node in "C4 - TYPES OF PRJCT" cluster
T1 is equally as important as T2
Inconsistency: 0.00532
T1 0.16033
T2 0.14884
T3 0.69084
Completed Comparison
Copy to clipboard

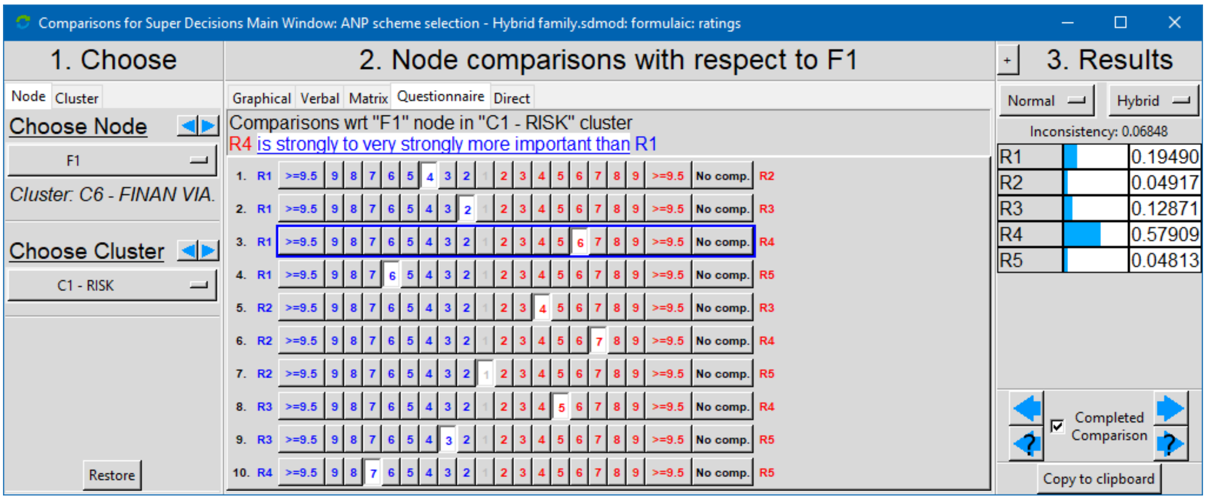

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to G2
3. Results
Choose Node
G2
Cluster: C5 - GOV. EXPER~
Choose Cluster
C5 - GOV. EXPE~
Comparisons wrt "G2" node in "C5 - GOV. EXPERIENCE" cluster
G1 is moderately to strongly more important than G3
Inconsistency: 0.00000
G1 0.80000
G3 0.20000
Completed Comparison
Copy to clipboard

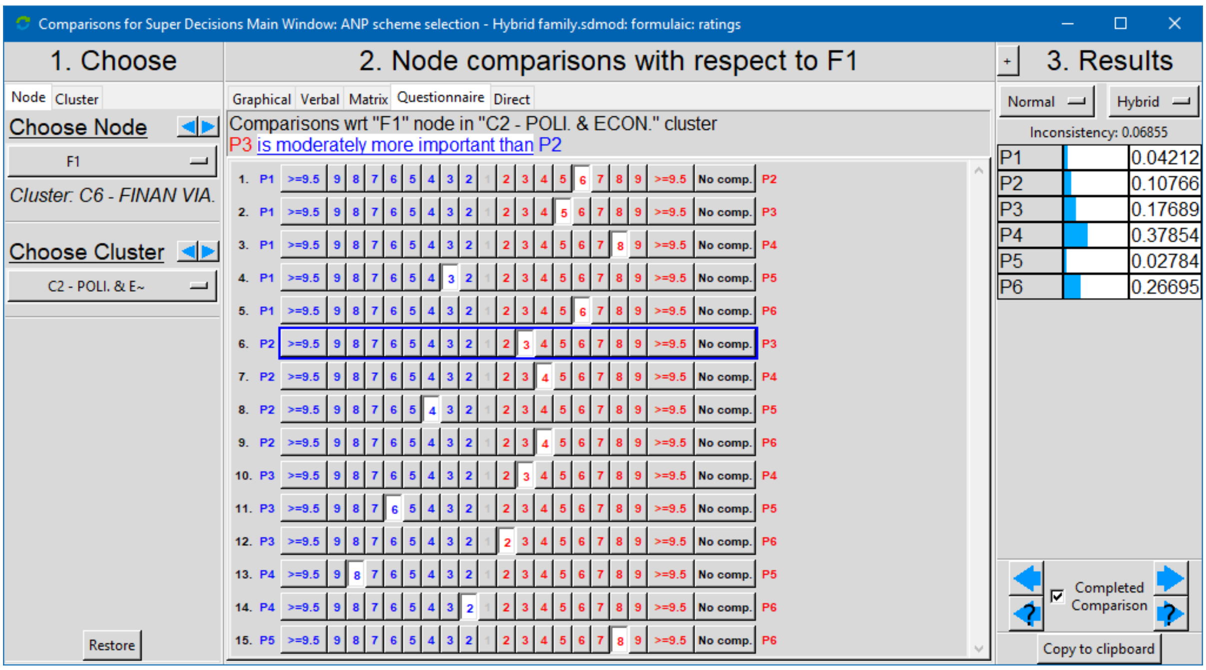

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to G2
3. Results
Choose Node
G2
Cluster: C5 - GOV. EXPER~
Choose Cluster
C6 - FINAN VIA.
Comparisons wrt "G2" node in "C6 - FINAN VIA." cluster
F1 is equally as important as F2
Inconsistency: 0.00000
F1 0.50000
F2 0.50000
Completed Comparison
Copy to clipboard

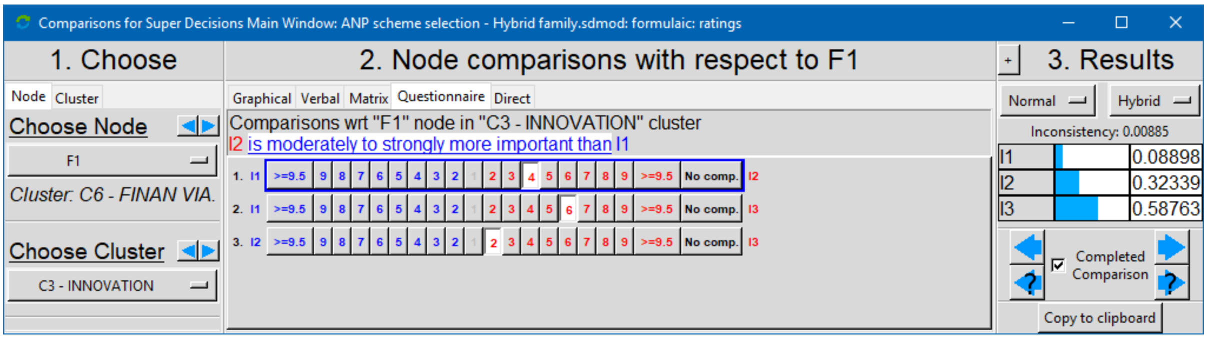
Appendix D.2-20: Node comparisons with respect to G3

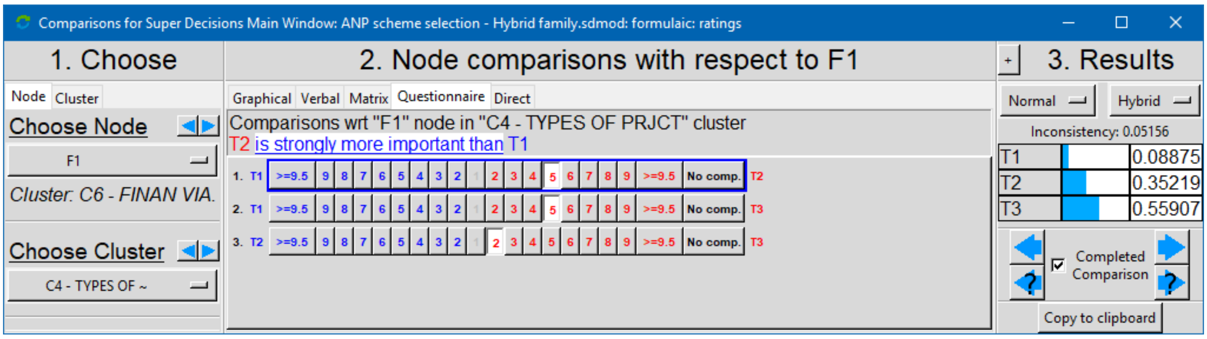


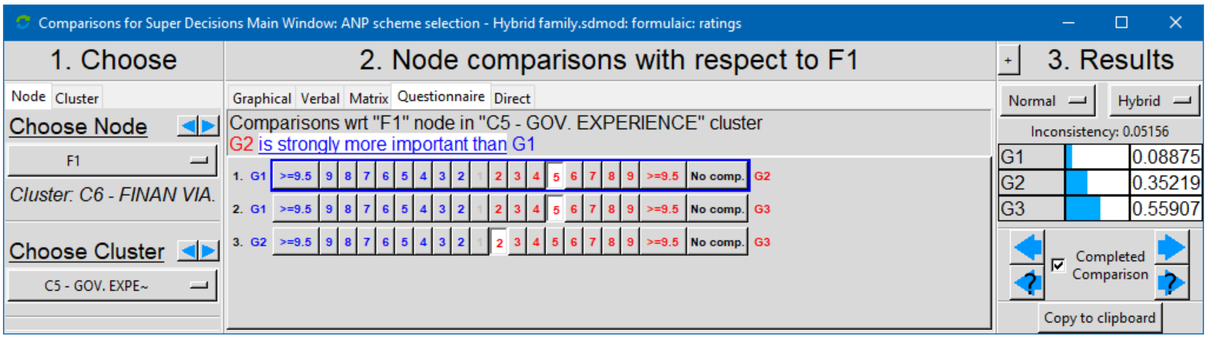
Appendix D.2-21: Node comparisons with respect to F1



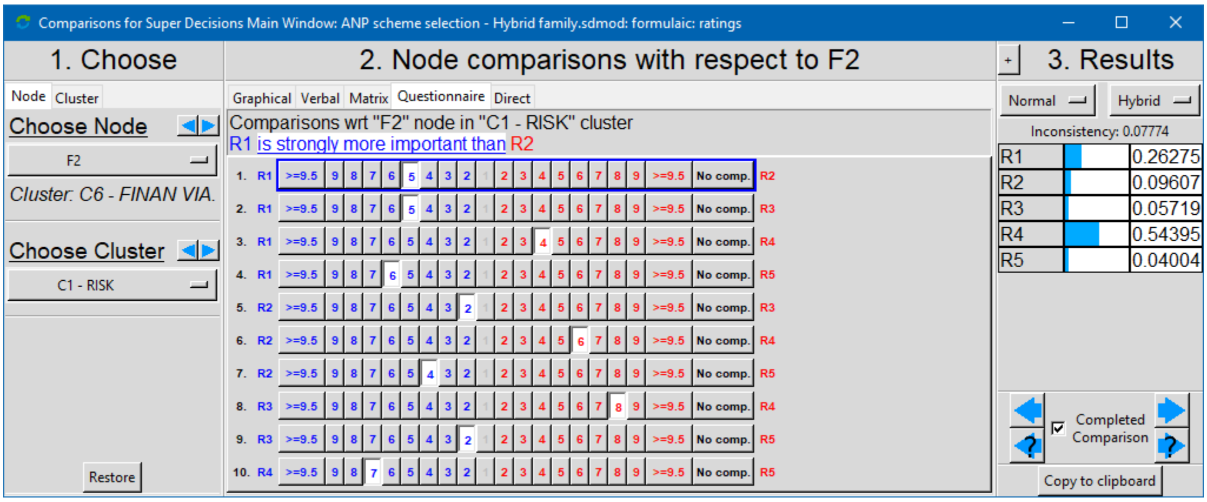


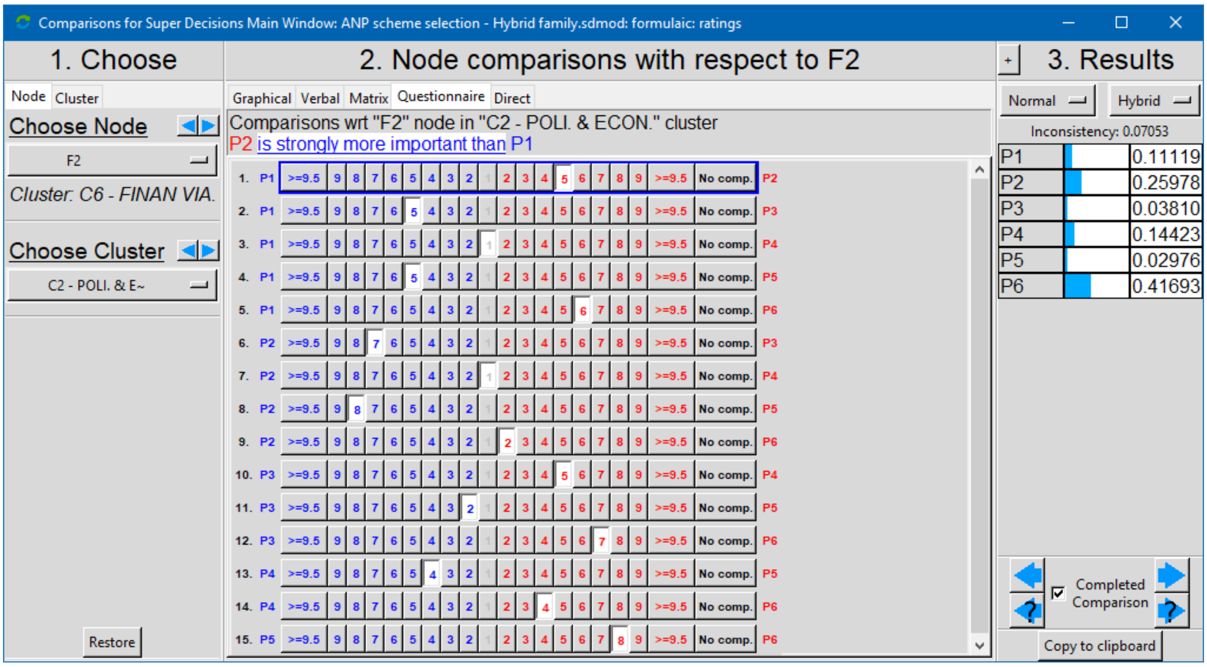


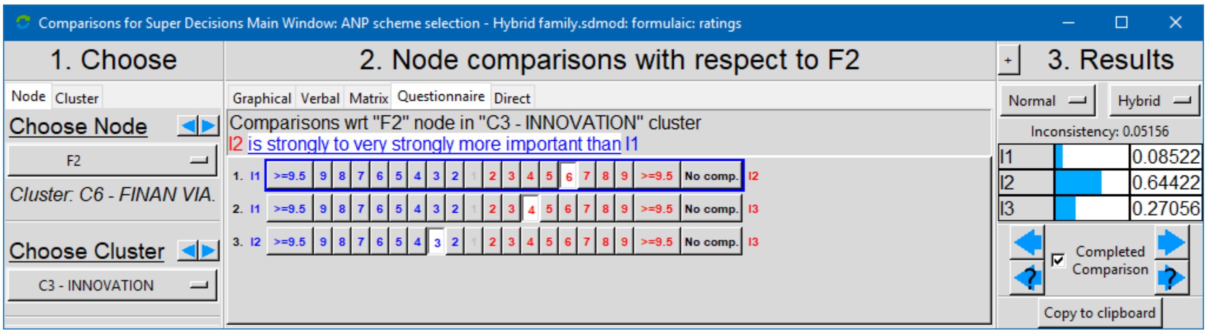


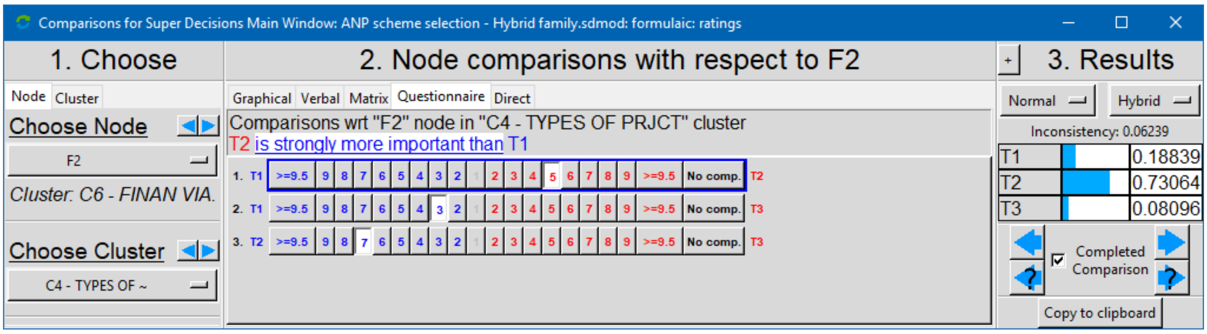


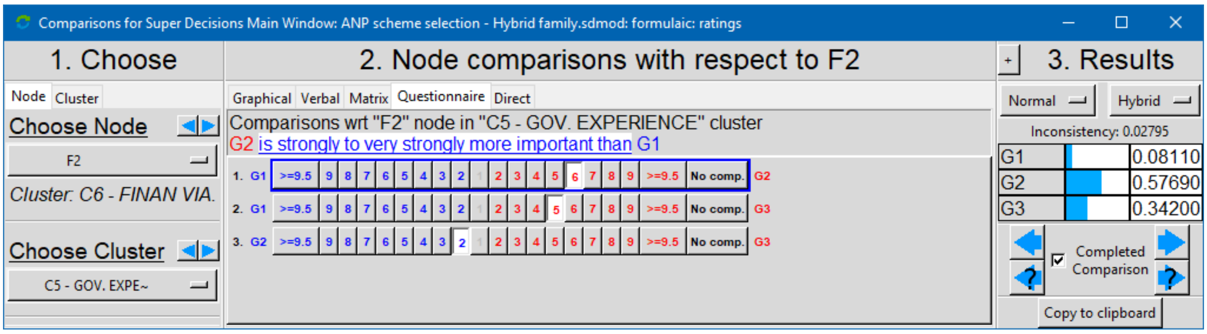
Appendix D.2-22: Node comparisons with respect to F2




Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to F2
3. Results
Choose Node
F2
Cluster: C6 - FINAN VIA.
Choose Cluster
C2 - POLI. & E~
Comparisons wrt "F2" node in "C2 - POLI. & ECON." cluster
P2 is strongly more important than P1
Normal
Hybrid
Inconsistency: 0.07053
P1 0.11119
P2 0.25978
P3 0.03810
P4 0.14423
P5 0.02976
P6 0.41693
Completed Comparison
Copy to clipboard
Restore

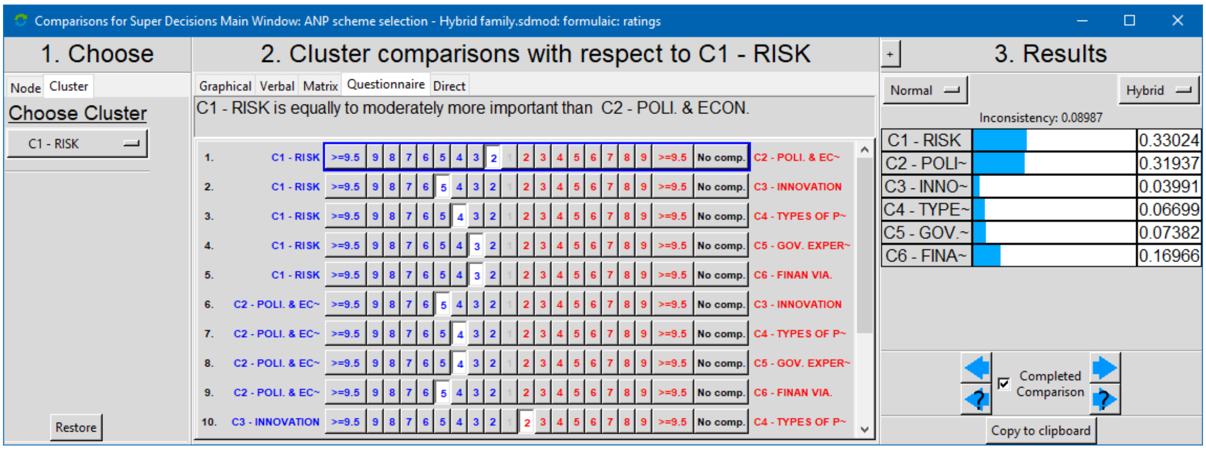

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to F2
3. Results
Choose Node
F2
Cluster: C6 - FINAN VIA.
Choose Cluster
C3 - INNOVATION
Comparisons wrt "F2" node in "C3 - INNOVATION" cluster
I2 is strongly to very strongly more important than I1
Normal
Hybrid
Inconsistency: 0.05156
I1 0.08522
I2 0.64422
I3 0.27056
Completed Comparison
Copy to clipboard

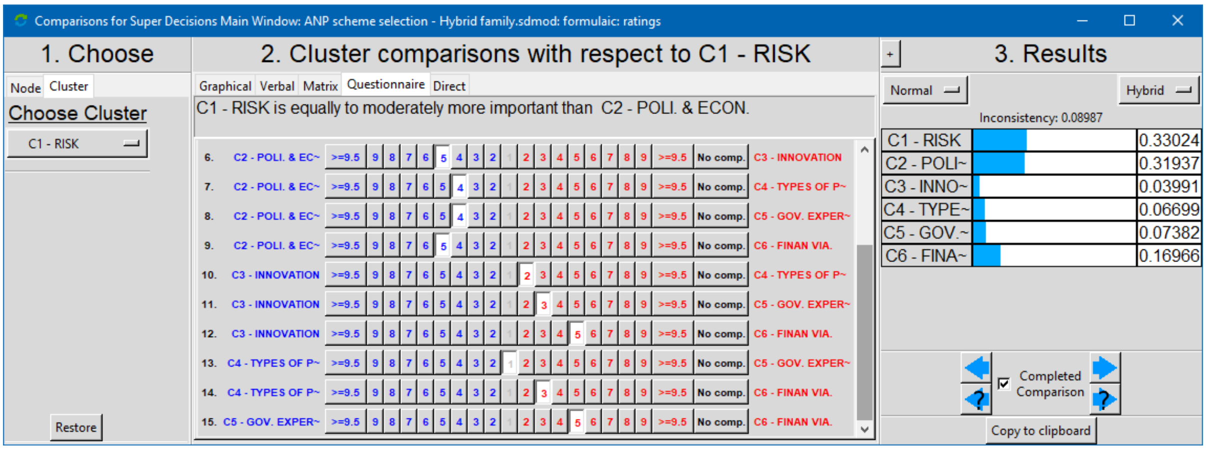

Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to F2
3. Results
Choose Node
F2
Cluster: C6 - FINAN VIA.
Choose Cluster
C4 - TYPES OF ~
Comparisons wrt "F2" node in "C4 - TYPES OF PRJCT" cluster
T2 is strongly more important than T1
Normal
Hybrid
Inconsistency: 0.06239
T1 0.18839
T2 0.73064
T3 0.08096
Completed Comparison
Copy to clipboard


Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Node comparisons with respect to F2
3. Results
Choose Node
F2
Cluster: C6 - FINAN VIA.
Choose Cluster
C5 - GOV. EXPE~
Comparisons wrt "F2" node in "C5 - GOV. EXPERIENCE" cluster
G2 is strongly to very strongly more important than G1
Normal
Hybrid
Inconsistency: 0.02795
G1 0.08110
G2 0.57690
G3 0.34200
Completed Comparison
Copy to clipboard

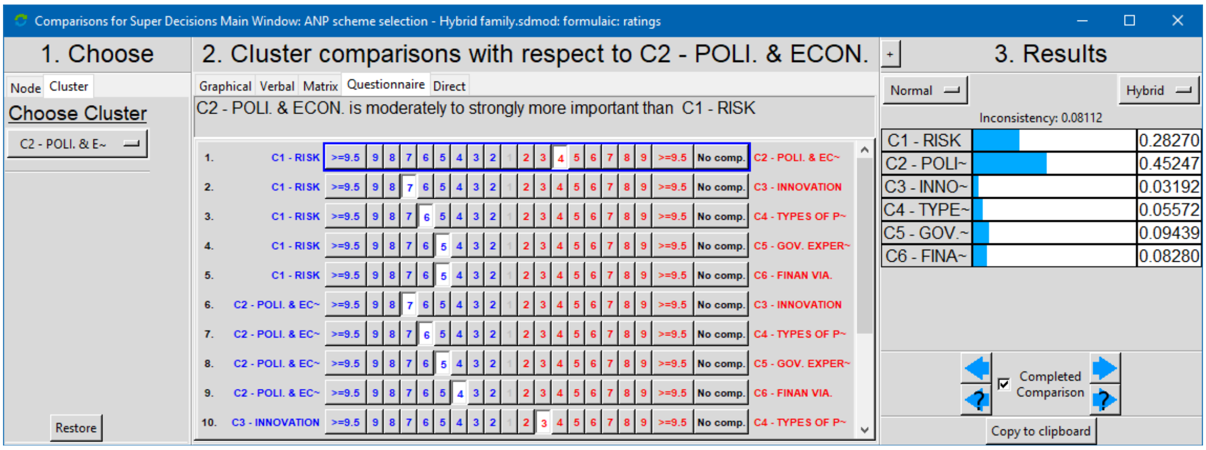
Appendix D.3: Questions and answers of Cluster pairwise comparisons by Super Decisions

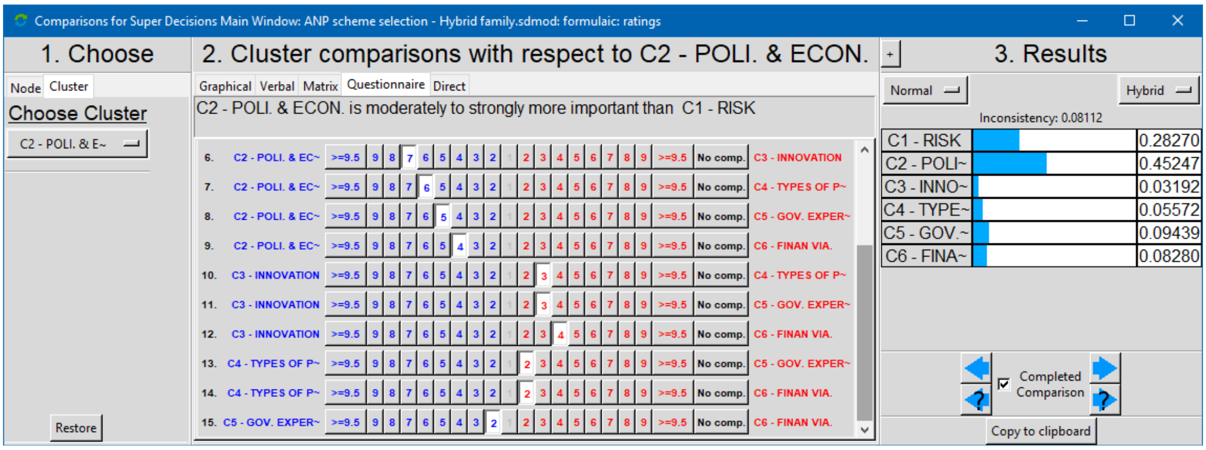
Appendix D.3-1: Cluster comparisons with respect to C1



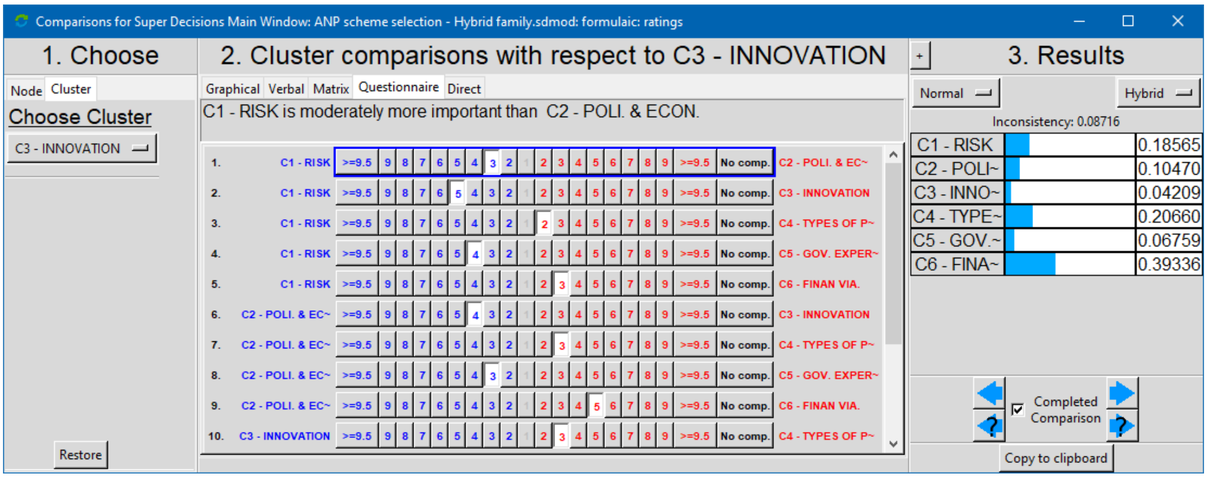


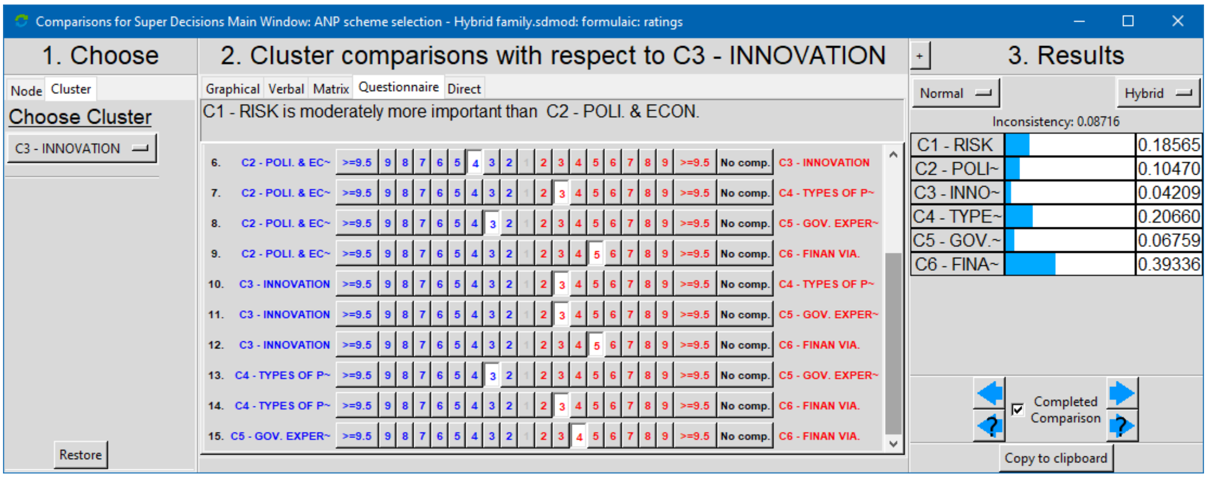
Appendix D.3-2: Cluster comparisons with respect to C2



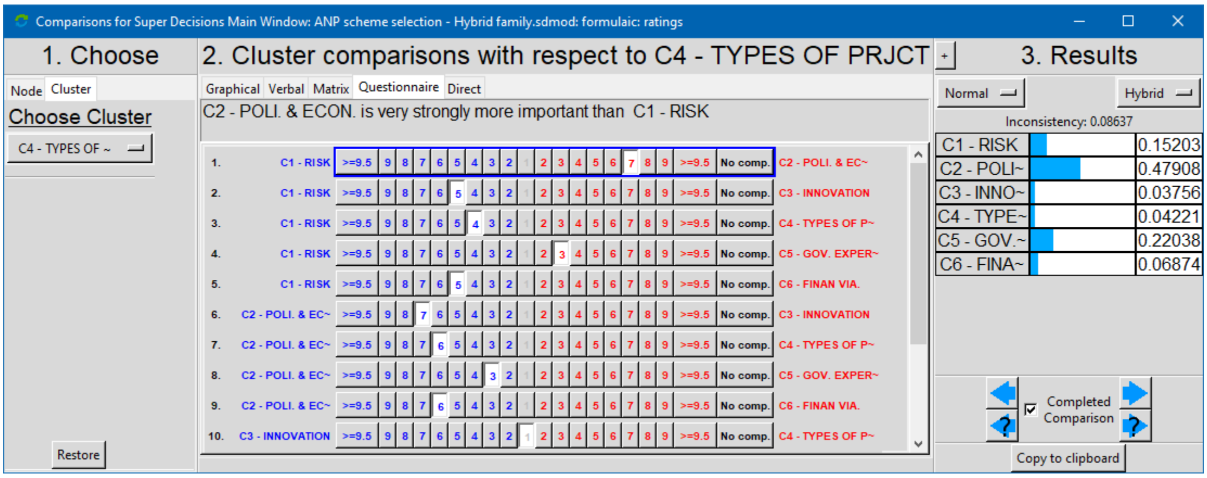


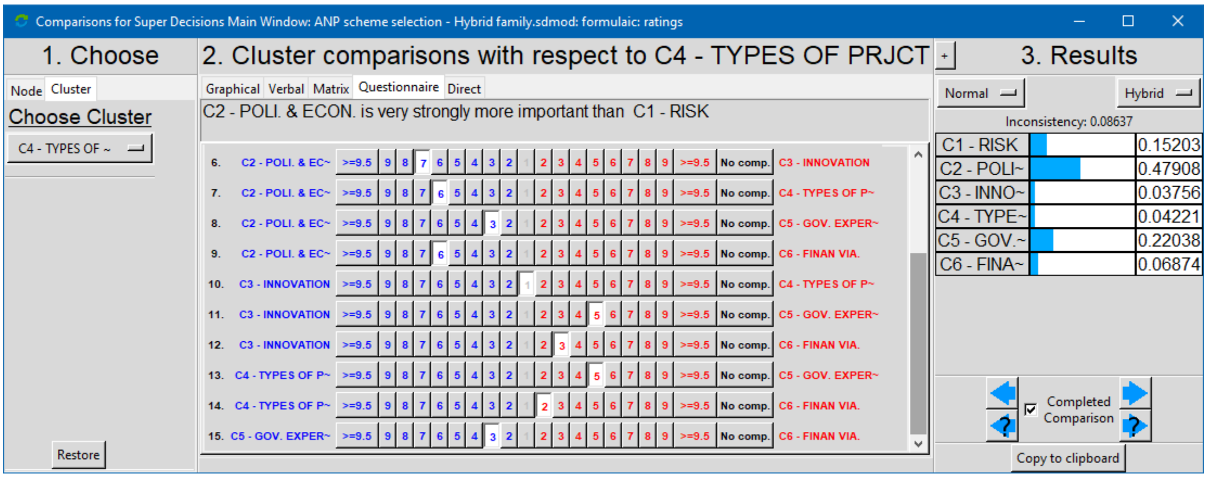
Appendix D.3-3: Cluster comparisons with respect to C3



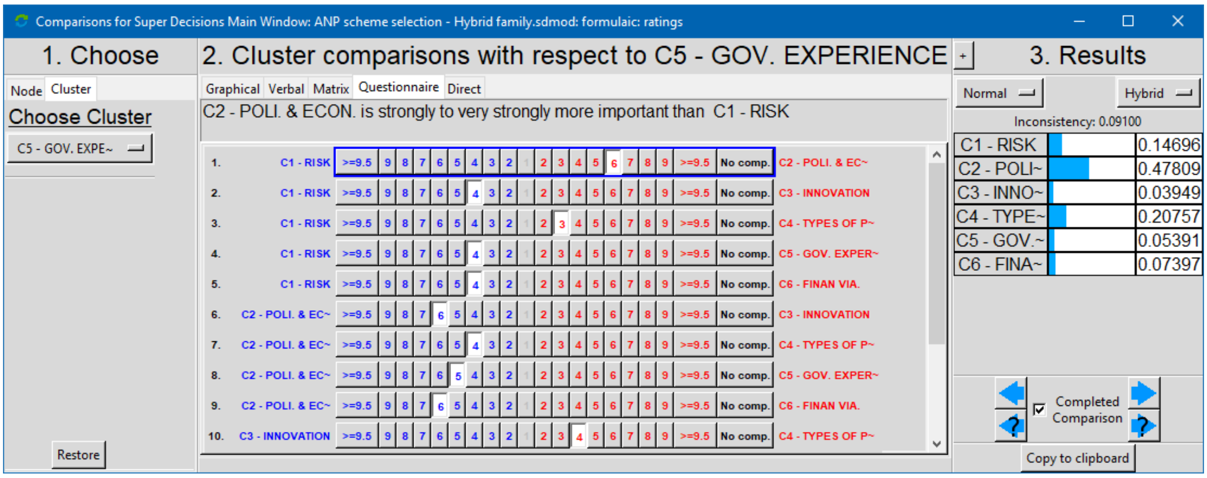


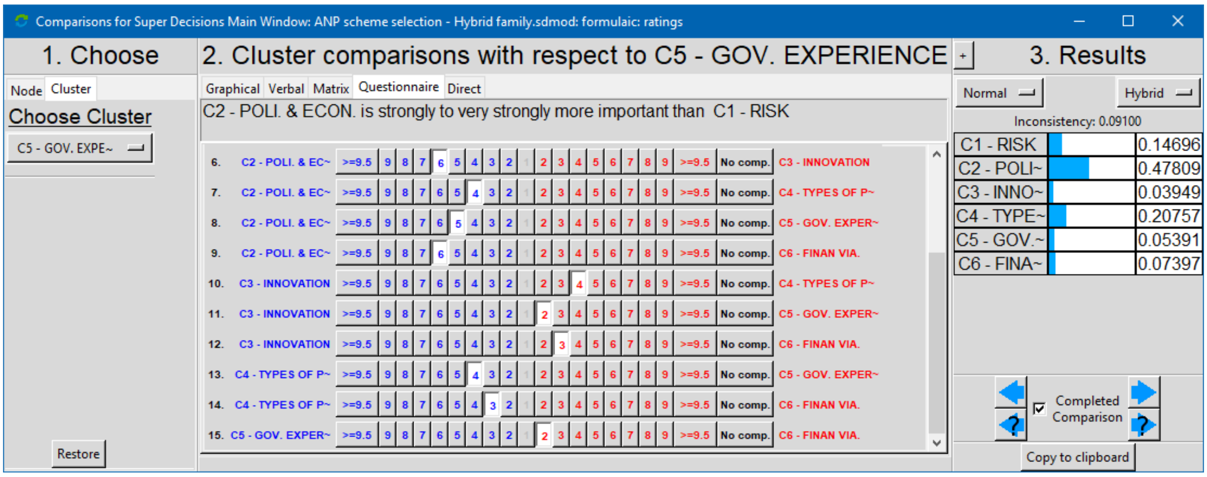
Appendix D.3-4: Cluster comparisons with respect to C4



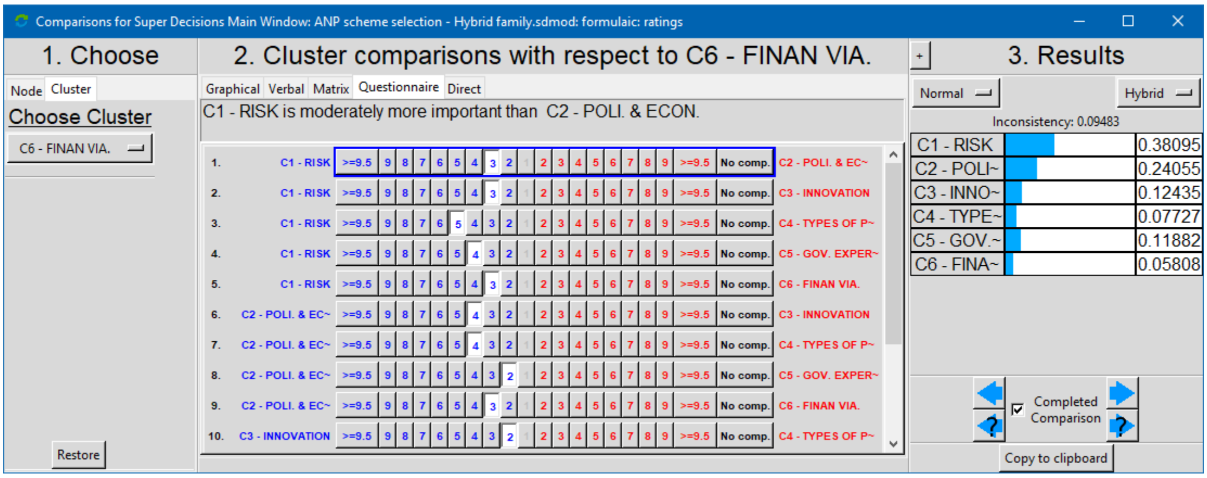


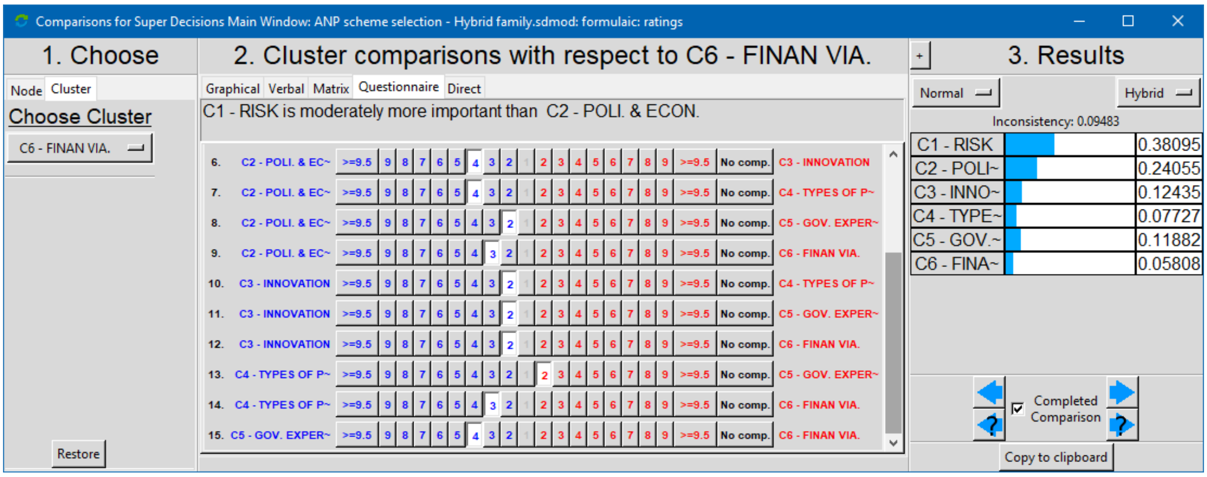
Appendix D.3-5: Cluster comparisons with respect to C5

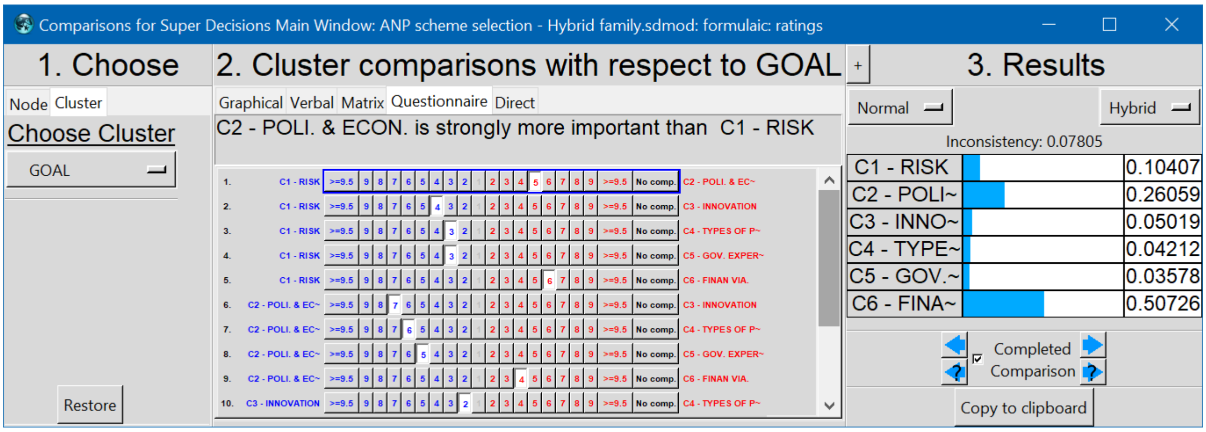


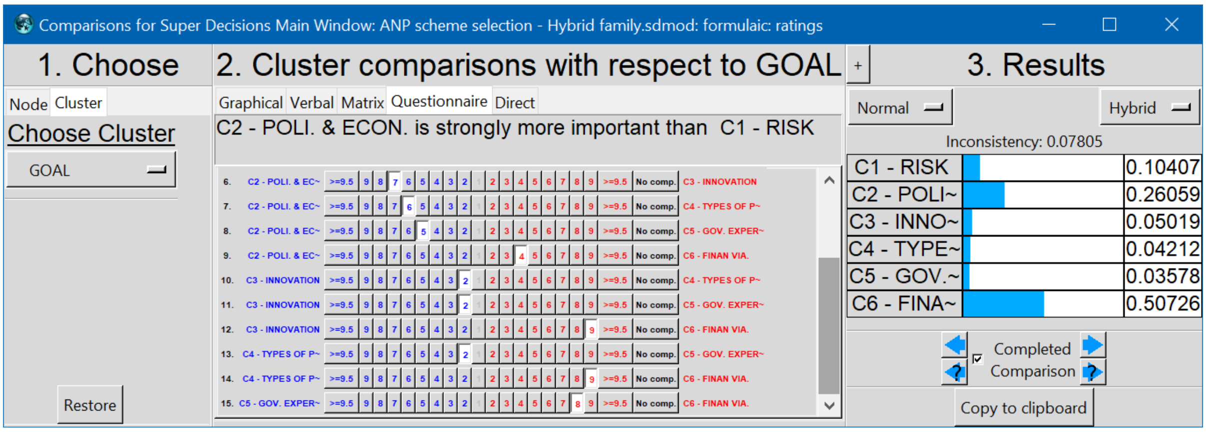


Appendix D.3-6: Cluster comparisons with respect to C6






Comparisons for Super Decisions Main Window: ANP scheme selection - Hybrid family.sdmod: formulaic: ratings
1. Choose
2. Cluster comparisons with respect to GOAL
3. Results
Node
Cluster
Choose Cluster
GOAL
Restore
Graphical
Verbal
Matrix
Questionnaire
Direct
C2 - POLI. & ECON. is strongly more important than C1 - RISK
Normal
Hybrid
Inconsistency: 0.07805
C1 - RISK
0.10407
C2 - POLI~
0.26059
C3 - INNO~
0.05019
C4 - TYPE~
0.04212
C5 - GOV.~
0.03578
C6 - FINA~
0.50726
Completed
Comparison
Copy to clipboard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