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Risk Evaluation in Public-Private Partnership Projects in the Transport Sector in Vietnam

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By

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Abstract

Many Public-Private Partnership Projects (PPPs) have failed because of risks occurring during operation and earlier studies have demonstrated a need for risk assessment and allocation methods for PPPs. Although researchers have been working in this area for years, the amount of empirical work is limited, especially when applied to developing countries, particularly to Vietnamese PPPs. This research attempts to design a framework using quantitative methods. Besides, qualitative methods are also used as supportive methods. The framework is proposed to identify risks, allocate risks, evaluate the project's riskiness and return, and optimize concession parameters. The proposed framework is based on two fundamental theories which are Analytical Hierarchy Process (AHP) and Risk Adjusted Decoupled Net Present Value (Risk Adjusted DNPV).

In AHP, the subjective evaluations are converted into numerical values and analysed to rank each alternative on a numerical scale. A pairwise comparison is then applied to the alternatives regarding specific criteria. Mathematical analysis is then used to create a comprehensive comparison of alternatives. Therefore, in this framework, first, critical risks are identified and evaluated based on their probability of occurrence and the degree of impact. After that, AHP is used to evaluate alternatives' (projects) riskiness. In addition, AHP is used to allocate critical identified risks with regards to the ability criteria of each party.

Risk adjusted DNPV in this framework is used to evaluate returns of the projects and to optimize the concession parameters. Currently, Net Present Value method (NPV) is being widely used to evaluate projects' returns because of its simplicity to investors. In the NPV method, risks are accounted for by adjusting a "risk-free rate" to form a risk-adjusted discount rate (RADR), and then the RADR is used to devalue cash flow with time. However, it has been argued that time and risk are different variables, and they should be separated in evaluating projects, otherwise evaluation errors can be generated, especially for projects which require long-term investment. PPPs typically demand long-term investments. Consequently, PPPs should be an environment in which the limitations of NPV are exposed. To minimize the limitations of NPV, Risk Adjusted Decoupled Net Present Value method (Risk Adjusted DNVP) has been developed as a new tool to assess projects. In Risk Adjusted DNVP, risks are decoupled from the time value, and they are quantified and treated as a cost to the project. Nevertheless, Risk Adjusted DNVP has not been applied to the area of PPPs. Therefore, this research attempts to use DNPV to evaluate projects' returns, and to optimize concession parameters.

This research also clarifies how the public and private sector can use the proposed framework. Case studies from five Vietnamese PPPs will be shown in the thesis to demonstrate the proposed framework.

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List of Abbreviations

ADB: Asian Development Bank

AHP: Analytical Hierarchy Analysis

ARR: Accounting Rate of Return

BIDV: Bank for Development and Investment of Vietnam

BOT: Build-Operate-Transfer

BT: Build-Transfer

BTO: Build-Transfer-Operate

CC1: Construction Corporation No. 1 Company Limited

SHB: Hanoi Commercial Joint Stock Bank

CIENCO 1: Civil Engineering Construction Cooperation No 1

CIENCO 4: Civil Engineering Construction Cooperation No 4

CIENCO 4: Civil Engineering Construction Cooperation No 4

CIENCO 8: Civil Engineering Construction Cooperation No 8

CPI: consumer price index

DB: Design – Build

DBFO: Design-Build-Finance-Operate

DNPV: Decoupled Net Present Value

DPB: Discount Pay Back

DRV: Directorate for Roads of Vietnam

DRV: Directorate for Roads of Vietnam

EPC: Engineering /Procurement / Construction

FDI: Foreign Direct Investment

GDP: Gross Domestic Product

HIFU: Ho Chi Minh City Investment Fund for Urban Development

IMF: International Monetary Fund

INVESTCO: Hanoi Construction Cooperation, Investment and Construction JSc

IRR: internal rate of return

JSC: Joint Stock Company

JV: The joint-venture

MAPE: Mean Absolute Percentage Error

MOP: Ministry of Planning and Investment

MOT: Ministry of Transport

NAV: Net Asset Value

NPV: Net Present Value

ODA: Official Development Assistance

PF2: Private Finance 2

PFI: Private finance initiative

PMC: Phu My Company

PPP: Public-Private Partnership

RMSE: The Root Mean Squared Error

SPV: Special Purpose Vehicle

SWOT: strengths, weaknesses, opportunities and threats

TLC: Thang Long Construction Corporation

TOPSIS: Technique for Order of Preference by Similarity to Ideal Solution

UK: United Kingdom

USA: United States of America

VDB: Vietnam Development Bank

VRA: Vietnam Road Administration (VRA)

CHAPTER 1: INTRODUCTION

1.1. Introduction

Risks can be found everywhere. In normal events in daily life we have to manage risks to survive. Indeed, mankind has attempted to manage risks in a number of fields of life. In the field of the construction industry, risk management has been an interesting area of research for years because of its influence on the time and cost of projects (Akintoye *et al*. 1997). The construction industry often faces a number of unexpected situations. Hence, in comparison with other industries, the construction industry has been plagued by risk more than others (Carr & Tah, 2001). As Lam *et al*. (2007) said, there is no construction project which is risk-free.

In respect of public-private partnership (PPP) projects, there are a number of definitions of PPP. For example, Boussabaine (2007, p.4) defined PPP as: "A generic term for the relationships formed between the private sector and public bodies often with the aim of introducing private sector resources and/or expertise in order to help provide and deliver public sector assets and services. The term PPP is used to describe a wide variety of working arrangements from loose, informal and strategic partnerships to design, build, finance and operate (DBFO) type service contracts and formal joint venture companies". The World Bank (2012, p.11) defined this type of project as: "A long-term contract between a private party and a government agency, for providing a public asset or service, in which the private party bears significant risk and management responsibility". Although the definition of PPP varies, they are all centred on the concept of risk (Boussabaine, 2013).

In fact, risk management in PPP construction projects has been attracting researchers because of their distinguishing characteristics. In practice, the PPP form is used to combine competitive advantages and flexible negotiations, and to apportion risk appropriately with an agreement between the public and private sectors (Li *et al.* 2005). However, many PPP projects have failed because of risks (Kwak *et al*. 2009).

Vietnam, like other countries in Asia, has experienced rapid economic development in recent years which has increased the demand for investment in infrastructure systems

(Thomas *et al*. 2003). However, the massive need to deliver transport infrastructure has put a strain on budgets of the Vietnamese government. Consequently, PPPs are becoming inevitable in Vietnam. PPP construction projects in Vietnam may also have to face many risks associated with PPPs in other nations. Thus, similarly to PPPs in other countries, effective management of risks can be seen as the core centre to achieve success of PPPs in Vietnam.

For that reason, the current research attempts to propose a framework which can assist practitioners in Vietnam to effectively evaluate risks in PPPs in the transport sector. The framework is a combination of previous models which have been applied in international contexts. One of these models (AHP) was adopted and specialized for the new purpose in a new market, while the other model (DNPV) was developed in this research to be a more effective model (Risk Adjusted DNPV) in order to be applicable to the PPPs in the transport sector in Vietnam.

1.2. Problem Statement

At present, researchers have been exploring risk management in PPP projects through various avenues. This includes research on using different technical methods and studying different types of risks such as, different attitudes, occupational risk assessment, or relational risk management (Boussabaine, 2007; Demirag *et al*. 2010; Ebrahimnejad *et al*. 2010). Other studies also have focused on risk acceptance criteria and early warning systems research, etc. (Zhaoa *et al*. 2011). Although there have been a number of studies attempting to assist practitioners to manage risks in international contexts, there is very limited research into the risk area in Vietnamese PPPs (Toan, 2008; Dong, 2009). In fact, although some researchers carried out studies on Vietnamese PPPs, their research just focused on identifying critical risks rather than actually proposing methods to evaluate them (Toan, 2008; Huyen, 2013; Parliament of Vietnam, 2013).

Besides, the previous research in Vietnam in PPPs has not focused on the transport sector (Toan, 2008), while the number of Vietnamese transport projects which have been conducted under PPP forms has been increasing (MOT, 2015). More details about the increasing number and the need of PPPs in the transport sector in Vietnam will be shown in chapter 2. Therefore, PPPs have not only delivered outstanding outputs in terms of transportation infrastructure, but also have demonstrated a need of further research in this area.

Importantly, previous research mainly focuses on a single aspect of the risk management process rather than on the framework (Leidel *et al*. 2010). Besides, from the literature review (see chapters 3, 4, and 5), it can be seen that current methods to evaluate projects' riskiness, to allocate risks, to evaluate projects' return, and to determine the concession period have limitations. From this point of view, the research is expected to develop a useful and practical framework for risk evaluation in PPP construction projects in Vietnam. Basically, the framework is based on risk identification, risk allocation based on AHP, project's riskiness evaluation based on AHP, return evaluation and concession period determination by Risk Adjusted DNPV. The details of these concepts will be provided in the following chapters.

1.3. Research Rationale and Significance

As mentioned, by doing this research, a practical framework to evaluate risks in PPPs in Vietnamese PPPs was proposed and tested. The research will add to the knowledge in the area of risk management both in terms of theory and practice. More specifically, this research will add theoretical knowledge to the area as previous models are adopted, specialized, and developed to overcome their limitations. For example, AHP is expected to be able to assist practitioners in evaluating project riskiness, and to be able to help practitioners allocate risks with regards to selected criteria. It should be noted that, AHP was not developed, but it was adopted and specialized for the new purposes which are riskiness evaluation and risk allocation, and for a new market which is the transport sector in Vietnam. Importantly, models to evaluate project returns and determine the concession period were also developed. In terms of practice, the results of this research project can bring advantages to the Vietnamese public and private sectors and improve the operation of PPP construction projects as it is focused on the Vietnamese market. Moreover, although this research project focuses on the Vietnamese construction industry, the results should be useful not only in this country, but also in other countries, particularly developing countries in South East Asia.

1.4. The Aim and Objectives of the Research

1.4.1. Aim of the Research

The aim of the research is to propose a framework to effectively evaluate risks in PPPs in the transport sector in Vietnam. The proposed framework is expected to be able to assist practitioners in identifying and assessing critical risks. It also is expected to be able to evaluate projects in regards to critical risks. The proposed framework also aims at being able to allocate risks based on selected criteria. Furthermore, it is also aims to be able to effectively evaluate project returns and optimize the concession parameters.

1.4.2. Objectives of the Research

In order to fulfil the aim of the research, the following objectives are proposed:

- Review research in risk in PPPs in international contexts.
- Review research in risk in construction areas and in PPPs in Vietnam.
- Identify possible risks which can happen in Vietnamese PPPs in the transport sector.
- Identify reasonable methods to assess risks.
- Understand clearly the seriousness of critical risks.
- Review possible methods to evaluate projects to critique and develop reasonable methods to evaluate PPPs in the transport sector in Vietnam.
- Review current methods of allocating risks in PPPs to propose a more effective method to allocate risks in PPPs in the transport sector in Vietnam.
- Review current methods in evaluating project returns to propose a more effective method to evaluate returns of PPPs in the transport sector in Vietnam.
- Review current methods in optimizing concession parameters of PPP, to propose a more effective method to evaluate returns of PPPs in the transport sector in Vietnam.

1.5. Research Questions

In order to fill the gaps mentioned in the problem statement section, several research questions need to be answered. These questions are:

- What are the most critical risks in PPPs in the transport sector in Vietnam?
- What is the suitable method to identify and assess critical risks in PPPs in the transport sector in Vietnam?
- Are there significant differences between perceptions of the private sector and the public sector about critical risks in PPPs in the transport sector in Vietnam?
- What is the method which can evaluate project's riskiness?
- What is the method which can effectively allocate risks in PPPs in the transport sector in Vietnam with respect to the provided criteria?
- What is the effective method to evaluate returns in PPPs in the transport sector in Vietnam?
- What is the effective method to determine the concession period for PPPs in the transport sector in Vietnam?
- How can we combine different effective methods in a framework to evaluate risks in PPPs in the transport sector in Vietnam?

1.6. Research Hypotheses

Before conducting the research, the following hypotheses are made:

H1. There are significant differences between perceptions of the public sector and the private sector about the criticality of risks. (Hypothesis was tested based on the findings provided in chapter 8).

H2. The proposed framework can evaluate projects with regards to critical risks by applying a model based on AHP (Hypothesis was tested based on the findings provided in chapter 9).

H3. Risk allocation strategies with regards to selected criteria can be found by using the proposed framework applied to allocation model based on AHP. (Hypothesis was tested based on the findings provided in chapter 9).

H4. Projects are more beneficial in the proposed framework's evaluation than in traditional NPV evaluation. (Hypothesis was tested based on the findings provided in chapter 10).

H5. The proposed framework using Risk Adjusted DNPV is more effective than NPV in evaluating project returns and therefore in optimizing the concession parameters. (Hypothesis was tested based on the findings provided in chapter 10).

1.7. Scope of the Research

Since risk in PPPs is an enormous area for researchers to study and there are a number of risk evaluation frameworks which contain a number of elements, the scope of this research is centred on the following aspects:

- Research only focuses on PPPs in the transport sector in Vietnam. More specifically, highway, national road and bridge PPP projects.
- The framework only focuses on main components, namely, Risk Identification and Assessment, Project' riskiness Evaluation, Risk Allocation, Return Evaluation, and Concession Determination.

1.8. Overview of Methodology

This section provides an overview of the methodology applied in this research. The details of the methodology are demonstrated in chapter 7.

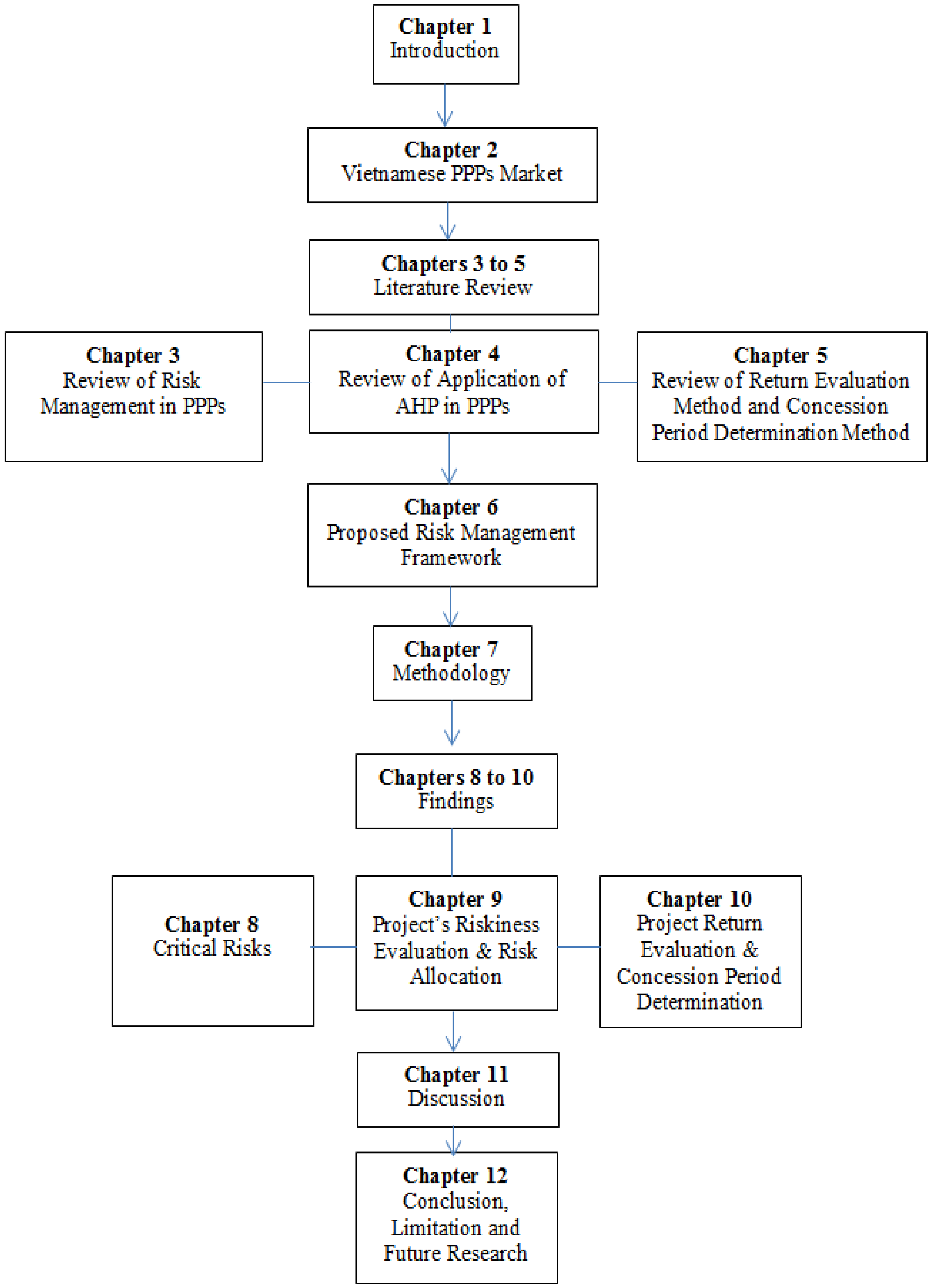
Fundamentally, quantitative approaches were applied with necessary supports of qualitative methods. Literature about risk in PPPs was reviewed (see chapters 3, 4, 5). By reviewing these previous studies, first, possible risks in Vietnamese PPPs were identified, and an assessment method was also proposed. Secondly, the literature review was also applied to identify current methods to evaluate projects' riskiness and to allocate risks, hence the literature was critiqued regarding their strengths and weakness. From here, models to evaluate projects' riskiness and to allocate risks were formed. Similarly, the literature review also provides a critique of current methods used to evaluate project returns and to determine the concession period. By critiquing these models, new models were developed, and combined to propose a risk evaluation framework (see chapter 6).

Data collection was done by questionnaires, interviews and a case study. More specifically, data for identifying risks, evaluating riskiness of the project, and allocating risks was collected from questionnaires and interviews. Data for models of evaluating project returns and the concession period was collected from the case study. Data then was analysed by selected methods (see chapter 7) together with software namely, SPSS, Easyfit, and Microsoft Excel. Findings were then discussed in relation to the hypotheses in order to provide conclusions.

1.9. Thesis Outline

Figure 1.1 shows the outline of the research. In the figure, each chapter is illustrated with their order and relation to other chapters.

Figure 1. 1 Structure of Thesis



Chapter 1: This chapter provides basic information about the research. Information such as the research area focused, research aim, objectives, research questions and research hypotheses are highlighted.

Chapter 2: An overview of the Vietnamese PPPs market is illustrated. The development of this market is provided with a specific focus on the transport sector.

Chapter 3: This chapter reviews the risk management in PPPs and related research about this area. By the end of this chapter, the researcher has come up with a list of possible risks in Vietnamese PPPs, a method of assessing these risks, and components of the proposed risk evaluation framework.

Chapter 4: A review of the application of AHP in PPPs area is provided. By the end of this review, a conclusion is made that AHP will be used to evaluate the riskiness of the project and to allocate risk.

Chapter 5: Current methods which have been used to evaluate project returns and to determine the concession period are reviewed. By the end of this chapter, an idea of using a new method in the proposed framework to evaluate returns and the concession period is made.

Chapter 6: The proposed risk evaluation framework is illustrated in detail. Information of how to apply the framework in practice is demonstrated.

Chapter 7: The research methodology is shown. Research methods and techniques which were used to carry out the research are demonstrated.

Chapter 8: Information about uncovering the critical risks in Vietnamese PPP is provided. Risk scores, risk ranking and the significant differences between perceptions of the public sector and the private sector are also highlighted.

Chapter 9: The findings about the application of AHP models in evaluating project riskiness and in allocating risks are provided.

Chapter 10: The findings about the application of risk adjusted DNPV models in evaluating project returns and in determining the concession period are illustrated.

Chapter 11: The findings provided in chapters 8, 9, 10 are discussed with research hypotheses, and with findings from previous studies. Compatibility and incompatibility of related research are also highlighted.

Chapter 12: This chapter shows the conclusion of the research. In addition, limitations of the current research are also revealed. Additionally, directions for future research are also recommended.

CHAPTER 2: OVERVIEW OF PUBLIC – PRIVATE PARTNERSHIP PROJECTS IN VIETNAM

2.1. Introduction

The focus of this research is on Vietnamese PPPs in the transport sector. Therefore, this chapter aims to provide basic information about the market in Vietnam. Firstly, the overview of the macro-economic environment is provided in order to assist the reader understanding the economic situation of Vietnam in recent years. Secondly, the progress of investment in the infrastructure system in Vietnam is demonstrated to show the need of participation of the private sector in this area. Thirdly, more information about Vietnamese PPPs' investment and PPPs in the transport sector will be illustrated.

2.2. Outline of Macro-economic Environment

Vietnam still remains a poor country with a population of over 90 million. However, this country has made impressive progress in recent years. According to BTI (2014), the percentage of the population living under the poverty line was 28.9 percent in 2002, and this number decreased by more than half to 14.2 percent in 2010, and further declined to 12.6 percent in 2012. However, BTI (2014) noted that the number may be underestimated. Table 2.1 reveals the main economic indicators in recent years.

Table 2. 1 Main economic indicators (World Bank, 2013)

Economic Indicator	2009	2010	2011	2012
GDP (£M)	63828.59	69901.74	81233.28	93049.09
GDP growth (%)	5.3	6.8	6.0	5.0
Inflation (CPI) (%)	7.1	8.9	21.3	9.1
Export growth (%)	11.1	14.7	12.2	11
Import 141669.1growth (%)	6.7	14.1	3.5	9.7
Public debt (% of GDP)	51.2	54.0	50.8	52.1
Government Consumption (% of GDP)	6.3	6.5	6.5	5.4

It can be recognized that, in recent years, the GDP growth rate of Vietnam has been around 6.0 percent. It increased from 5.3 percent in 2009 to 6.8 percent in 2010, and then gradually decreased to 6.0 percent in 2011 and to 5.0 percent in 2012. Another remarkable point from table 2.1 is the fluctuation of the inflation rate. The inflation rate went up from 7.1 percent in 2009 to 8.9 percent in 2010. This number then reaches the peak of 18.7 percent in 2011 before being brought under control to go down to 9.1 percent in 2012. The public debt was around 51 percent over the observed period.

In Vietnam, 43 percent of employment in the informal sector is in the manufacturing and construction area, 31 percent in trade and 26 percent in services. It should be noted that state-owned enterprises account for approximately 40 percent of the economic output of the country. The number of private companies in the top 500 largest companies in Vietnam increased from 103 in 2007 to 225 in 2012. However, BTI (2014) stated that barriers to the development of the private sector still remain significant. IMF (2012) observed that since 2012 the economy has begun to stabilize after the negative economic situation in 2010 and 2011. Nevertheless, significant vulnerabilities still continue. Therefore, the first priority of the Vietnamese government in the next few years will still be to stabilise the economy. The IMF (2012) also forecasted that due to the tight macroeconomic policies to stabilize the economy, the growth rate might slow down.

Table 2. 2 Number of registered contractors and breakdown by capital size (IMF, 2012)

Year	**2008**	**2009**	**2010**	**2011**
Number of registered contractors	23403	31584	39777	48753
Breakdown of registered contractor by size classification				
Largest (14.66 £ mil. and over)	103	133	305	514
2nd Largest (from 5.87 to 14.66 £ mil.)	224	255	681	875
3rd Largest (from 1.47 to 5.87 £ mil.)	768	878	2576	3392
4th Largest (from 0.29 to 1.47 £ mil.)	3163	5371	9195	14426
5th Largest (from 0.145 - 0.29 £ mil.)	3677	5855	9268	10182
Under 0.14 £ mil.	15468	19092	17752	19346

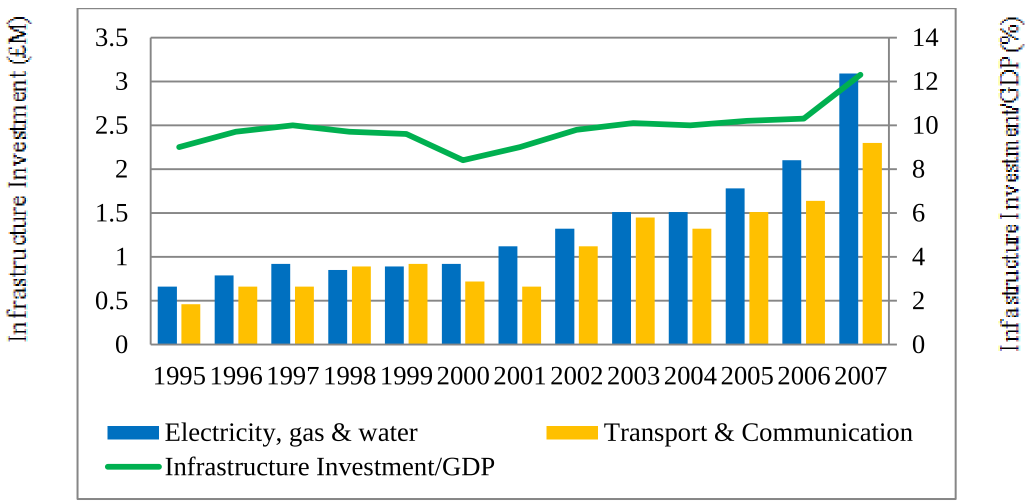
Regarding the construction industry, figures indicate that this industry has been steadily developing. Table 2.2 presents the development of registered contractors from 2008 to 2011 by capital size. From this table, it can be seen that the number of registered contractors more than doubled from over 23,000 units in 2008 to over 48,000 units in 2011. The increase is also represented in all sizes of the organization (Mai and Van, 2012). In fact, the statistics do not only increase in terms of the number of firms, but also increase with regards to the productivity in the construction area. The cost of construction also widely fluctuated during the period from 2008 to 2011. This was the effect of the fluctuation of the general product prices and the construction material prices. According to Mai and Van (2012), the construction materials' CPI went up from 12.58 percent in 2009 to 15.74 percent and 17.29 percent in 2010 and 2011, respectively.

2.3. Infrastructure Investment in Vietnam

2.3.1. General

As a result of the development of the economy, the level of investment into the infrastructure system has also been increasing. Figure 2.1 displays the investment in the infrastructure in Vietnam by sector as the percentage of GDP and it also illustrates the value of the investment by sector.

Figure 2. 1 Infrastructure Investment in Vietnam as the percentage of GDP (Thanh and Dapice, 2009)



Since 2001, the investment/GDP ratio increased gradually. It stood at around 6 percent in 2001 and increased to over 12 percent in 2007. The figure also highlights that the transport and communication system demonstrates the highest development. More specifically, in 1995 only more than 0.5 billion pounds was spent to improve the transport and communication system. However, this number went up steadily to more than 2 billion pounds in 2007 (Thanh and Dapice, 2009).

According to ADB (2013), the level of local and paved roads in Vietnam increased from 47.6 percent of the road network in 2007 to 85 percent of the network in 2013. Nhi (2014) observed more specifically to illustrate that around 43 percent of the road network is in good quality while 37 percent of them are considered to be in standard condition, and the rest are in a poor condition. It is also noted that provincial and local roads are worse than national roads as many of them are vulnerable to harmful weather conditions.

Other than road network, Vietnam has also made significant investment in other infrastructure networks. For example, significant efforts have been made to upgrade, repair and maintain the railways that have been built in the last decade. Another remarkable effort in developing the railway system is to build the high-speed train network that was planned in 2012. However, this master plan is still struggling with the issue of how to attract external financial resources. Currently, there is no deep-water port in Vietnam, and the effort of planning to build a deep-water port is also a notable factor to improve the infrastructure system. The Vietnamese government has also attempted to upgrade the airport system. Recent developments of Noi Bai, Da Nang, Tan Son Nhat, and Dong Nai airports have highlighted this effort. Furthermore, the energy system is also the area that investors both from the public sector and the private sector have been investing in. For example, the investment has been made to fulfil the dramatic increase of energy consumption from 98 KWh in 1990 to 1,035 KWh per capita in 2010. It is forecasted that the demand for energy increase is around 15 percent annually, and it is not any easy task for the country's government to service this increasing demand (Nhi, 2014).

2.3.2. Need of Infrastructure Investment

Although Vietnam has achieved a number of impressive developments regarding the infrastructure, experts still criticize that the infrastructure system in Vietnam remains in a poor condition, failing to support the high demand of the economy and social development (IMF, 2014). In fact, the insufficient infrastructure system is considered as one of the most serious reasons holding back the development of the economy and society (Giang and Pheng, 2015). Figure 2.2 discloses the ranking of the general quality of the infrastructure in Asian countries, while figure 2.3 demonstrates the quality of transport sectors in comparison with other Asian countries. As can be seen from figure 2.2 that the general quality of the Vietnamese infrastructure system is in the second last position, and its ranking is just higher than the rate for Indonesia. Similar situations are given when it comes to the transport sector, and this is illustrated in figure 2.3. In road, railway, port and airport areas, the rates for Vietnam are always near the bottom of the table (Toan, 2008). It should be noted that the red vertical line is to demonstrate the average score of 125 countries observed. Thus, the quality of the Vietnamese infrastructure system is under the average point.

Figure 2. 2 General Infrastructure Quality Comparison (World Competitiveness Report 2006-2007)

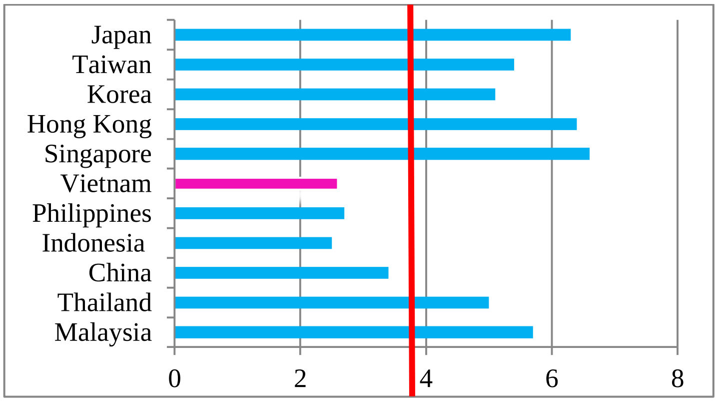
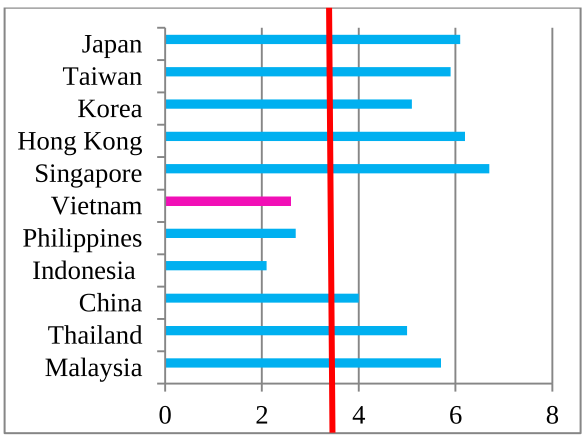
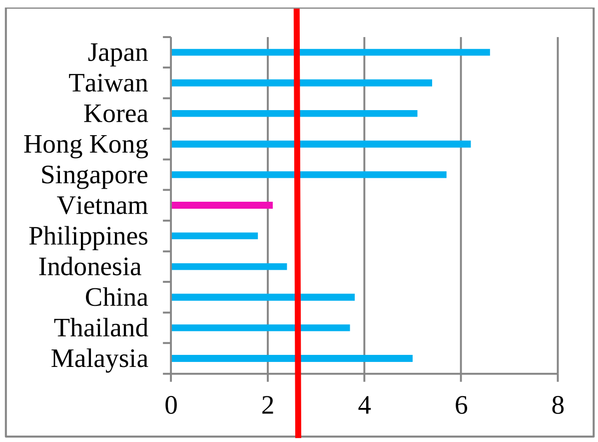


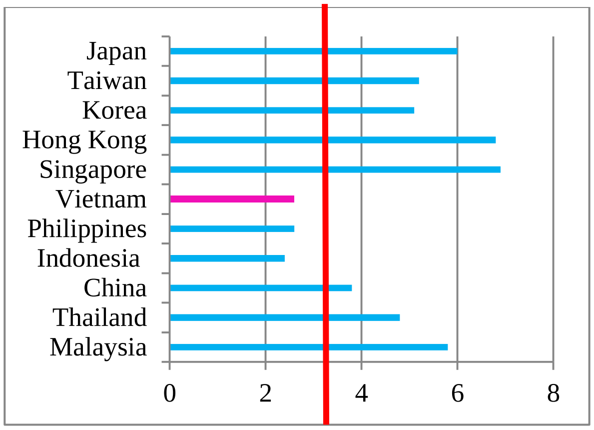
Figure 2. 3 Transport Infrastructure Quality Comparison (World Competitiveness Report, 2006-2007; Toan, 2008)



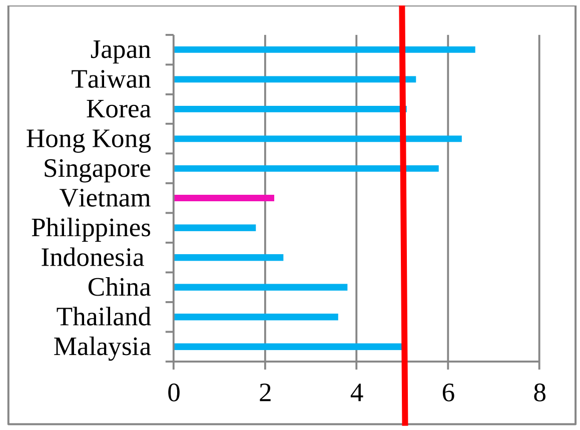


Roads

Railways



Ports

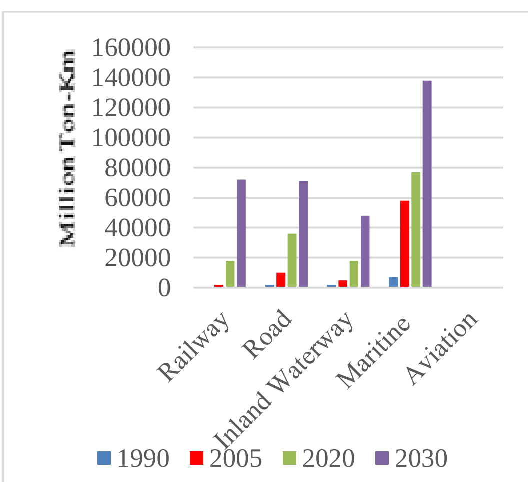


Air Transports

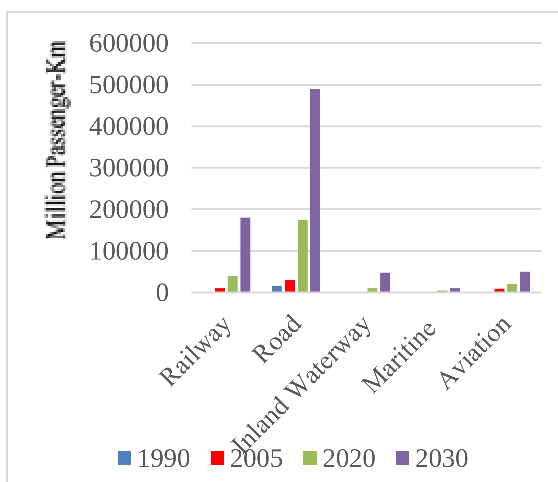
Together with the insufficient quality of the system, the dramatic increasing of demand is also the fundamental motivation for investing in the infrastructure system. For example, the economic growth has resulted in a significant increase in demand for electricity in Vietnam. It is measured that the average electricity demand growth is around 16 percent annually. In fact, the insufficiency of the electricity capacity has led to power cuts and electricity imports from China. It is estimated that in order to afford this increasing demand, the government of Vietnam should spend approximately £2.6 billion a year. In terms of the water sector, it is reported that safe drinking water has not yet been delivered to most of Vietnam's population. In terms of the water sector, it is reported that safe drinking water has not yet been delivered to most of Vietnam's population. Although it is estimated that around 60 percent –70 percent of citizens in major cities and 50 percent in medium-size provinces and around 30 percent in small provinces have access to water services. It is also estimated that in order to satisfy the water consumption in the two biggest cities, namely Hanoi and Ho Chi Minh, $2 billion needs to be invested (ADB, 2012).

In terms of the transport sector, it is highly likely that this is the sector requiring the biggest budget for improvement. Vietnam has shown rapid growth of transportation demand in recent years. It has been observed that the share of investment for the transport sector alone in the total budget for the infrastructure system has been rising in comparison with other sectors. The investment for upgrading the national highways for 2002–2010 was estimated to take around £5.7 billion from the country's budget. In fact, from 2005-2015, it has been estimated that £11.8 billion has been mobilized to invest in the transport systems in Hanoi and Ho Chi Minh City. For others transport routes, around £34 billion has been spent from 2010 to 2015 (Mekong Research Infrastructure Development, 2010). The port subsector also requires investment as the consequence of having no deep-water ports has led to higher ship transportation costs in comparison with other countries in the area. For example, ship transport in Vietnam is estimated to increase £1.1 billion per year because goods have to be transported through Singapore and Hong Kong (ibid.). Similarly, nearly £3.3 billion is needed to improve the railway system from 2011 to 2020, whereas the airport subsector requires nearly £1 billion to upgrade at the current time (ADB, 2012). Figure 2.4 presents the general picture of the forecasted demand for the transport sector beginning in 2030. In general, the growth rate of the rate of good transport demand is approximately 7.3 percent annually over the observed period, while the demand for passenger transport is round 12 percent annually (Dien, 2011). Figure displays that for good transport, the maritime is the transport mode in which the demand for good transport has been increasing at the highest levels, followed by the railway and road subsectors. In contrast, the road subsector is the area that has been showing the rapidest speed of growth, followed by the railway subsector, while figures show that the demand for the maritime subsector is in fact not significant. This is consistent with the observation that the number of vehicles has been increasing by 19-21 percent annually (Mekong Research Infrastructure Development, 2010).

Figure 2. 4 Transport Demand Forecasts (Dien, 2011)



Good Transport Demand Forecast



Passenger Transport Demand Forecast

The breakdown of investment requirements necessary to develop the transport infrastructure system up until 2020 is presented in Table 2.3. In this table, roads and railway subsectors require the highest budget and the budget for Hanoi and Ho Chi Minh City are much higher in comparison to requirements for other places. In contrast, sea transport, internal marine transport and airport subsectors require much lower investment. This plan is, in fact, consistent with the growth of each subsector as disclosed in figure 2.4.

Table 2. 3 Transport Infrastructure Investment Requirements (Toan, 2008)

£ Billion

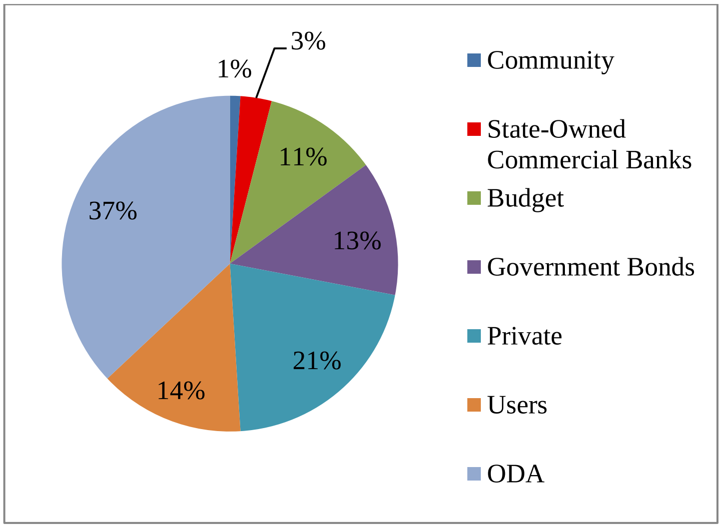
Type of Transport Infrastructure	2002-2010	2011-2020	Annual Average
1. Road	7.22	9.64	0.94
Highway	1.66	4.65	0.35
National Roads	4.09	3.67	0.43
regional Roads	1.47	1.32	0.15
2. Railway	6.42	11.55	1.00
High Railway	5.99	10.61	0.92
Normal Railway	0.43	0.94	0.08
3. Sea transport infrastructure	0.60	1.91	0.14
4. Internal Water transport infrastructure	0.14	0.13	0.01
5. Air transport	0.52	1.07	0.09
6. Transport in Hanoi and HCM city	5.75	12.69	1.01
Roads	3.80	6.50	0.57
Railway	1.66	5.68	0.41
Supporting transport	0.29	0.26	0.03
7. Rural road	2.54	2.28	0.27
Total	**23.18**	**39.01**	**3.46**

This rapid increase of transport demand has led to good opportunities for development of the transport sector, but also resulted in significant challenges for the budget of the Vietnamese government. As a result, a variety of financial resources have been sought out in order to meet the investment demand. The following section will clarify the main financial resources that Vietnam has been mobilizing to invest in the infrastructure system.

2.3.3. Sources of Infrastructure Investment

According to Nhi (2014), infrastructure capital comes from three main sources, namely, the public sector, private sector's investment and user charges, and loans and grants from international organizations. More specifically, the government budget accounts for 28 percent of the investment, while the private sector and user charges are responsible for 35 percent of capital, and the remaining 37 percent comes from loans and grants from overseas organizations. It is also noted that the capital from the government and overseas organizations is declining and the capital from the private sector is rising. The break down structure of financial sources for the Vietnamese infrastructure system is revealed in figure 2.5. This figure shows that the government budget accounts for only 11 percent, while the remaining 17 percent comes from mobilization. The one percent from the community reflects that local people finance the infrastructure system using their own money. For example, they can mobilize finances to build water supply systems in some rural areas.

Figure 2. 5 Infrastructure financing mechanism (World Bank, 2010)



More specifically, the infrastructure financing mechanism by sectors is shown in table 2.4. It can be recognized that the transport sector achieves the highest numbers. It also should be noted that the community and users' financing methods have not been used for the transport infrastructure system. This sector obtains 4.0 percent of the GDP to upgrade the system. The biggest budget for this sector comes from ODA while the private sector is responsible for only 0.2 percent (Nhi, 2014).

Table 2. 4 Infrastructure Financing Mechanism by Sector by percentage of GDP (Nhi, 2014)

Financial Source	Transport	Electricity	Telecom	Water	Total
Users		0.9	0.3	0.1	1.3
ODA	1.7	1.2	0.3	0.3	3.5
Budget	0.8	0.1		0.1	1
Government Bonds	1.2				1.2
SOCBs	0.1		0.2		0.3
Private	0.2	1.2	0.6		2
Community				0.1	0.1
Total	4	3.4	1.4	0.6	9.4

Comparing the movement of the financing sources, it can be realized that the budget from the government for infrastructure investment has been decreasing. Table 2.5 compares the general statistics about the financing mechanism in 2000 and 2008. Statistics illustrate that the state's budget decreased by around 50 percent over 8 years, while the finance from non-state sources increased by nearly 7 times. Similarly, it can be also seen that FDI financing increased by about 8 times over this period.

Table 2. 5 Infrastructure Financing Mechanism by Sector (%) (Nhi, 2014)

Type of Infrastructure	2000			2008		
	State	None-State	FDI	State	None-State	FDI
Transport	92.17	4.84	2.98	49.7	31.66	18.63
Electricity, gas	16.67	50.9	32.43	48.85	9.69	41.46
Water	96.6	0.56	2.84	15.51	25.18	59.32
Communication Services	95.67	0.09	4.25	35.08	44.65	20.27

From the above-summarized statistics, it can be recognized that private finance has become an essential financial source to develop the Vietnamese infrastructure system. However, Vietnam has been facing difficulties in attracting this type of finance. According to the World Bank (2007), private fund managers are still more interested in investing in other sectors such as consumer products, financial markets, and real estate etc. rather than the infrastructure sector.

2.4. PPP Investment in Vietnam

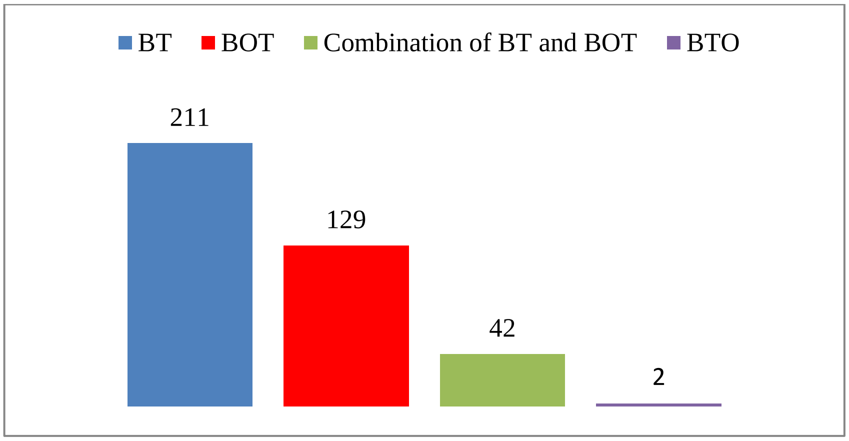
2.4.1. Infrastructure PPP Investment

Recognizing the important role of the private investors in developing the infrastructure system, the government of Vietnam has been building the legal framework to encourage the participation of this sector since 1987. In 1987, with Foreign Investment Law, the government clarified the participation of foreign investors in Vietnam, and this led the foundation to issue Decree 87/ND-CP in 23rd of November, 1993 to legalize the investment mechanism for BOT projects. In the following years, they issued other important documents namely, 77/ND-CP, 62/1998/ND-CP, 78/2007/ND-CP, 108/2009/ND-CP, and 71/2010/QD-CP. However, these documents have been criticized in that they do not make the distinction between different types of PPP investments, and this creates confusion for investors. In order to overcome this problem, the Vietnamese government has recently issued Decree 15/2015/ND-CP and Decree 30/2015/ND-CP. In the one hand, Decree 15/2015/ND-CP clarifies the areas of PPP investment, conditions, procedures, the mechanism of management of government budget in implementing PPPs, the promotion mechanism for PPPs, and the responsibility distribution mechanism. On the other hand, Decree 30/2015/ND-CP clarifies the mechanism to select investors in PPPs. These new documents are expected to improve the PPPs' environment in Vietnam.

Currently, Vietnamese PPPs are mainly BOT, BTO, and BT. The first PPP project was the Co May Project in the 51 highway in 1996. According to the original contract, investors have the right to collect tolls from June 1999 to July 2011 (Huyen, 2013). By the end of 2010, there were 384 PPPs with various sizes implemented. Amongst these projects, local governments are responsible for managing 342 projects while the Ministry of Transport manages 29 projects, and 13 projects are managed by the Ministry of Industry and Trade (Parliament of Vietnam, 2013).

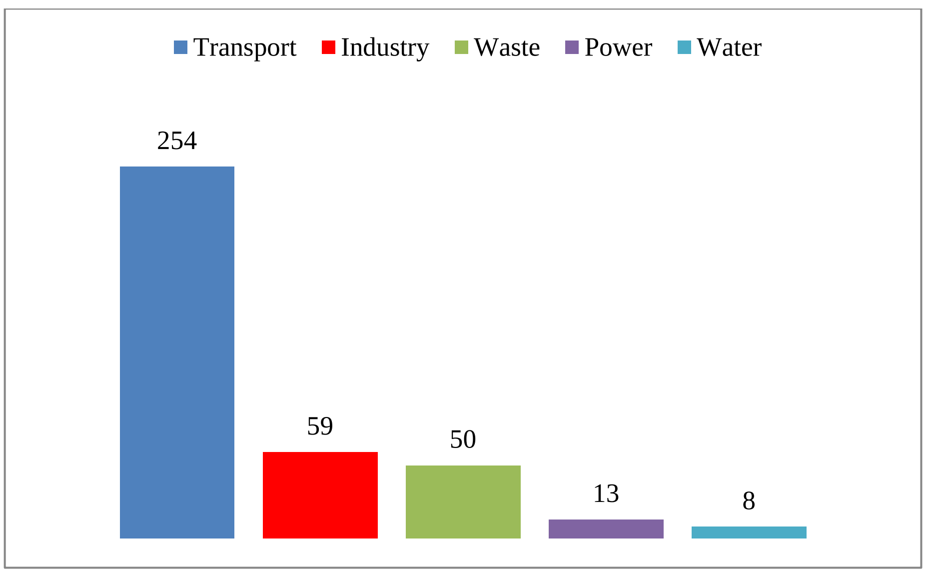
Figure 2.6 displays the PPP investment forms in Vietnam up until the end of 2010. Amongst current types of PPP in Vietnam, BT is the most common form with 211 projects, followed by BOT with 129 projects, and just 2 BTO projects. In contrast, the combination of BOT and BT was used in 42 projects.

Figure 2. 6 PPP investment forms in Vietnam (Parliament of Vietnam, 2013)



In terms of investment by sectors, the transport sector received the highest number, 254 projects, followed by the industry complex investment with 59 projects. There have been 50 waste projects, 13 power plants and 8 water supply projects implemented under PPP forms.

Figure 2. 7 PPPs in Vietnam by sector (Parliament of Vietnam, 2013)

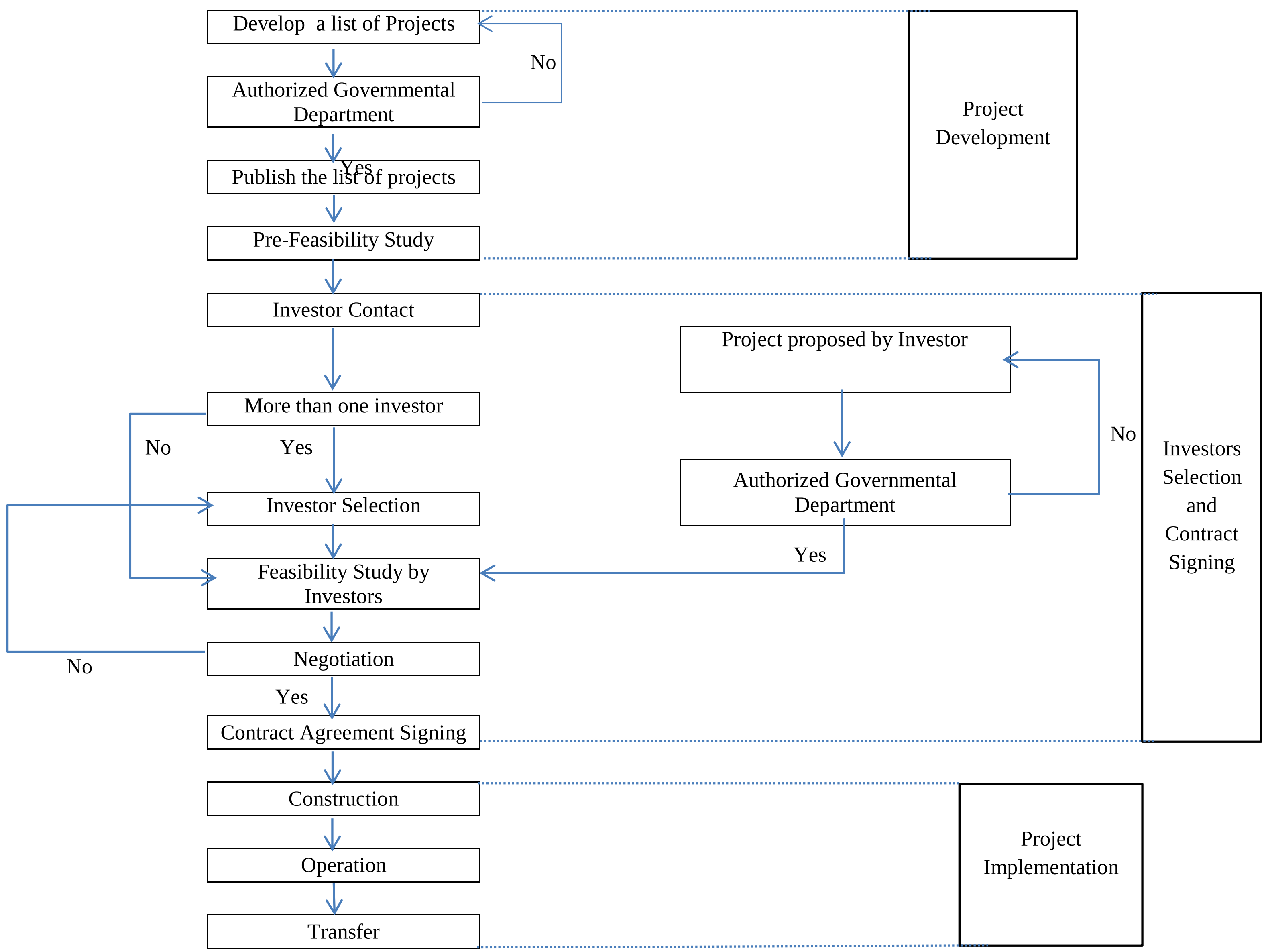


Reports from the local governments demonstrate that they have been preparing to select investors for 185 projects with a total investment of 14,216 billion pounds and propose 40 projects with 2.43 billion pounds. It can be noticed that after nearly 20 years, the PPP market in Vietnam has been remarkably developing both in terms of quantity and scales of projects. The transport sector has attracted the most number of private investors. The following section will give more detail about the participants of private investors in the transport sector.

2.4.2. Statistic about PPP Investment in the Transport Sector

As mentioned previously, this sector has attracted the biggest investment in comparison with other sectors. The number of PPPs in the transport sector accounts for 66.12 percent of the total number of PPPs with the investment accounted for around 50.52 percent of the total capital invested in PPPs (Nhi, 2014). Figure 2.8 below explains the process of a transportation PPP project.

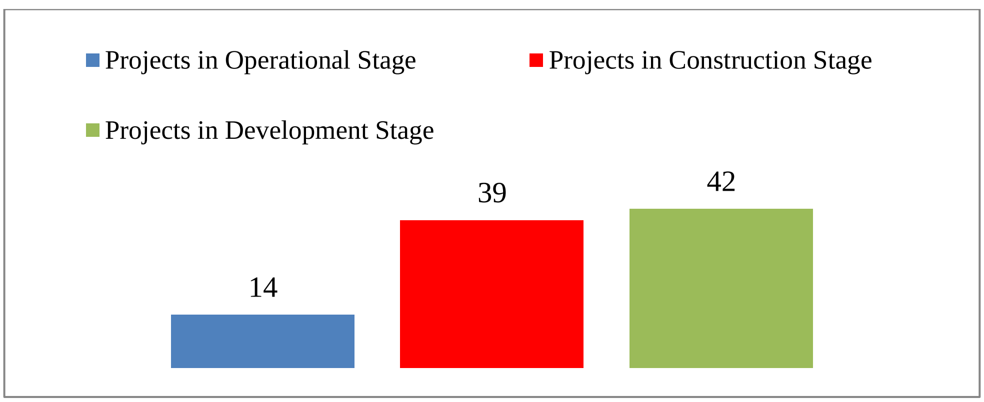
Figure 2. 8 Process of Implementing PPPs in Vietnam (Huyen, 2013; Toan, 2008, Vietnamese PPP Regulations)



As shown in figure 2.8, there are three stages, and the first two stages are mainly for preparation and negotiation while the last stage is for implementing the project. The risk analysis first needs to be carried out in the development stage, more specifically in pre-feasibility step and feasibility step in the second stage. In these steps risks are evaluated in order to evaluate their applicability and profitability.

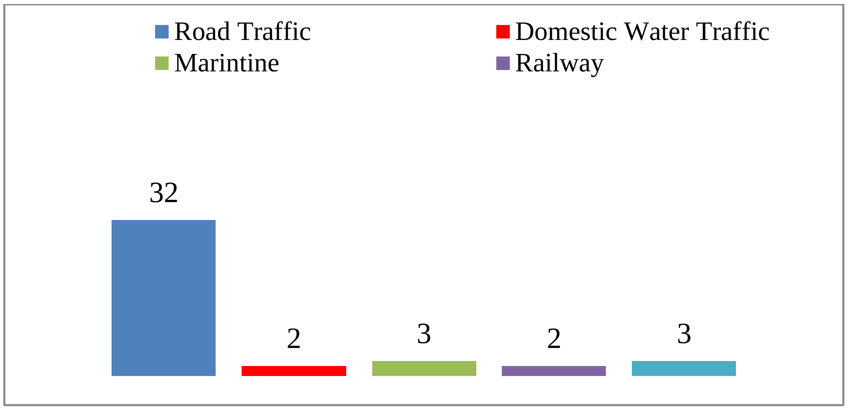
Except for small and medium-scale projects managed by local governments, all other transports are currently managed by the Ministry of Transport. The investment in transport projects are only implemented under BOT and BT forms. The number PPPs currently managed by the Ministry of Transport in different stages is compared in figure 2.8. Amongst projects which have been implemented, only Deo Ca Project and No 20 highway Bao Loc-Dalat are a combination of BT and BOT while the other projects are BOT form. Details of current and proposed PPP projects in the transport sector are provided in Appendix K.

Figure 2. 9 Current and Future Transport Project managed by Ministry of Transport



It should be noted that projects currently in the operational and construction stages are all road traffic projects. However, in 42 future projects, PPPs will be used for other subsectors of transport. Figure 2.10 shows the number of developing PPPs by subsector.

Figure 2. 10 Projects in Development Stage by sector (MOT, 2015)



In terms of the type of investors in this sector, they are mainly domestic investors, and there have been only a small number of foreign investors who participated in PPPs in transport sector. Many of the investors are well-known contractors in Vietnam. However, investors from banking sectors are also interested in this investment. It should be noted that Vietnamese bankers usually need to join contractors to set up SPV as they need to take advantage of the experience of contractors in this field.

In short, officials have pointed out that the implementation of PPP in the transport sector has been delivering significant achievement to this sector. The problems of project delays have been decreasing in PPPs in comparison with traditional forms. Critical national transport links have been upgraded mainly by PPP forms in recent years.

2.5. Summary

This chapter provided basic information about the market in Vietnam which is the market that the current research attempts to explore. In this chapter, the overview of the macro-economic environment was demonstrated. In addition, the attempt to develop the infrastructure system of Vietnam in recent years was also clarified. Furthermore, the development of the PPP market, and PPPs in the transport sector was also demonstrated. From the statistics provided in this chapter, it can be recognized that the massive need for transport system development is creating a huge financial burden on the limited budget of the public sector. Therefore, the PPP mechanism is playing an essential role in developing the transport system in Vietnam. Hence, this chapter also demonstrated the value of this research.

CHAPTER 3: RISK MANAGEMENT IN PUBLIC-PRIVATE PARTNERSHIP PROJECTS

3.1. Introduction

This research looks at the risk management area in PPPs. Therefore, it is essential to provide insights about risk management and research in this area. This chapter will firstly provide basic concepts about risks and uncertainty to demonstrate the concept that the research focuses on. Secondly, the risk management process in PPPs will be reviewed. In the review of the risk management process, the different point of views from the public and private sectors are also demonstrated. After that, previous studies about risk assessment, allocation and other important issues in risk management will be revised. At the end of this chapter, the elements of the proposed risk evaluation framework will be justified. In addition, the list of risks and allocation criteria will be also clarified at the end of this chapter.

3.2. Uncertainty and Risk Definitions review

Understanding the meanings of risk and uncertainty is essential in PPPs. Therefore, in this section, the concepts of risks and uncertainty will be reviewed. The definitions of these notions in previous literature are sometimes not clearly distinguished. Hence, the purpose of this section is to provide the clear meanings of these two notions. This, in turn, will clarify the area that the current research is focusing on.

3.2.1. Concept of Uncertainty

One of the first attempts to make the distinction between uncertainty and risk is the research by Knight (1921). In his opinion, risks can be seen as knowable probability distributions, while uncertainty cannot be quantified statistically. More specifically, Stephen and Larry (1987) analysed the definitions of risk and uncertainty of Knight (1921) where the definitions are based on three categories of unknown outcomes, namely, priori probabilities, statistical probabilities, and estimates. Stephen and Larry (1987) analysed that Knight's (1921) risk definition includes priori probabilities and statistically probabilities, whereas Knight's (1921) uncertainty definition includes the estimation category. Stephen and Larry (1987) disagreed with distinction between risk and uncertainty as they criticized that individuals are seen as being able to select consistency between outcomes as was stated in the definition of Knight (1921). However, individuals always have subjective probability (Stephen and Larry, 1987). Other authors, such as Walker *et al*. (2003, p.5) defined uncertainty as: “any deviation from the unachievable ideal of completely deterministic knowledge of the relevant system”. They further described uncertainty in three dimensions, namely, location of uncertainty, level of uncertainty, and nature of uncertainty. More specifically, the nature of the uncertainty can be classified into epistemic uncertainty and ontological uncertainty. Epistemic uncertainty appears from the imperfection of the risk model, processes, etc., while ontological uncertainty occurs because of natural imperfection of the initial condition of the system. The location of the uncertainty illustrates its position in any context. Uncertainty can be divided into three levels, namely statistical uncertainty, scenario uncertainty, and recognized ignorance. McManus and Hastings (2004, p.2) believe that things that are not known or are known unclearly can be seen as uncertainty. They explained that many of them are measurable and not always negative. In fact, they can be worse or better than is forecasted. Other researchers, such as Aven (2011), say that uncertainty can be seen as a way of classifying the consequence. Uncertainties simply mean events that individuals do not know exactly when they happen and what their consequences are (Aven, 2011). It has been recognized that in order to understand the concept of uncertainty, extensive literature debate has emerged. It has been also recognized that the calculable form of uncertainty can lead to the concept of risk (Boussabaine, 2014).

3.2.2. Concept of Risk

Similarly to the concept of uncertainty, there are a number of definitions that define risks. For example, the most popular points of view looking at risk can be Chance of Loss, Exposure, Hazard, and Probability of an Event’s occurrence.

More specifically, from the view of Chance of Loss, according to Boussabaine (2014), risk can be defined as:

$$Risk = Chance + Loss \qquad (3.1)$$

As shown in equation 3.1, risk is seen as a function of chance and loss. It should be noted that chance can be quantified. Oliver *et al*. (1999) said that Chance can be defined as the probability of occurrence of an event. However, according to Boussabaine (2014, p.38), in terms of this definition of risk, “chance is state of mind about what will happen rather than a quantifiable measurement of how likely a loss will happen”.

From the point of view of Hazard, the most popular definition, as Boussabaine (2014) stated, of risk can be expressed as:

$$Risk = Hazard \text{ x } Vulnerability \text{ x } Exposure \qquad (3.2)$$

Equation 3.2 shows that in contrast to other points of view, risk, here, is a function of hazard, vulnerability and exposure. Thus, any change in these items can lead to change in the risk level. Boussabaine (2014) criticized that hazard in this point of view depends on the magnitude, duration, spatial dispersion, and temporal spacing. Therefore, it is complicated to quantify the effect of hazard in this definition. Vulnerability is usually measured by the level of loss made by the consequence. In terms of exposure, the frequency distribution needs to be formed from quantitative data.

It has been observed that the most popular point of view of looking at risk, especially in the engineering market, is to see risk as a probability or likelihood of an event’s occurrence (Woodruff, 2005). More specifically, risk is measured as:

$$Risk = Probability \text{ x } Consequence \qquad (3.3)$$

The advantage of this point of view is that risk can be statistically measured and predicted. The probability of occurrence can be estimated by heuristic data. Furthermore, analysts observed that this definition can create advantages in converting uncertainty to risk (Boussabaine, 2014). Due its advantages, this research will look as risk as the function of probability or likelihood of an event’s occurrence and consequence as is shown above in equation 3.3.

3.3. Risk Management in PPPs from the Cross-sector Perspective

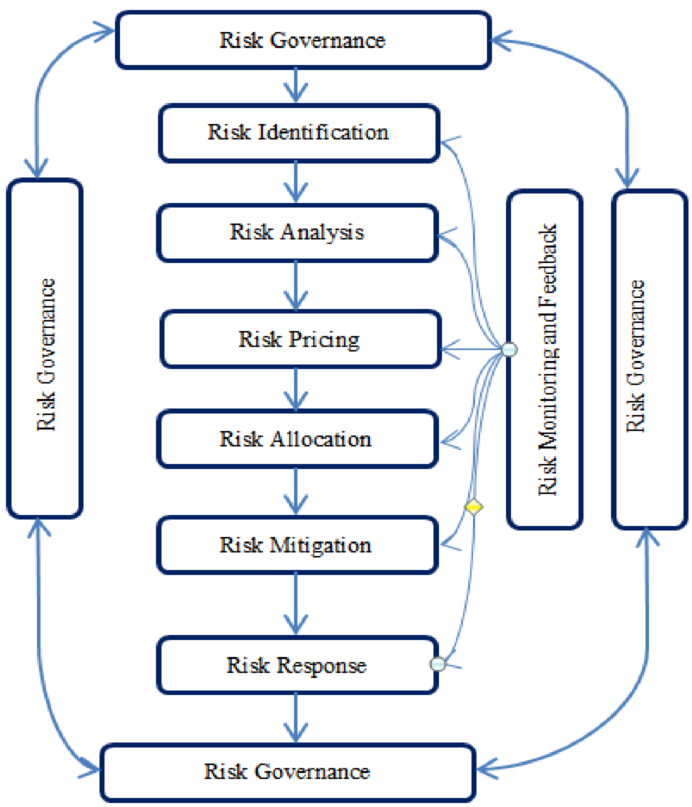
3.3.1. Risk Management Process

Due to inconsistency in defining risk, the definition of risk management also varies. According to Dawson (1997, p.15), risk management can be determined as a "continuous process by which the sources of uncertainties which could affect the objectives are systematically identified, their impact scientifically assessed, and their effect and likelihood managed to produce an acceptable balance between the risks and opportunities". However, he also noted that the definition can depend on the specific project.

In the construction area, formal and scientific approaches to manage risks have been developed over the last few decades. In these approaches, many models and techniques are combined to create the framework for risk control. One of the first processes proposed can be seen from the work by Perry and Hayes (1985). In their process, risks, firstly, need to be identified, then they need to be analysed, and finally, a response strategy can be formed. Arguing that the risks and mitigation strategies need to be monitored, Al-Bahar and Crandall (1991) added the monitor stage into the process. Aiming to create a detailed risk management process for construction projects, Chapman and Ward (2003) proposed a nine-phase risk-management process, and argued that this structure is more detailed than most specific methods. This nine-phase risk process includes the define phase, focus phase, identify phase, structure phase, ownership phase, estimate phase, evaluate phase, plan phase, and manage phase. In fact, more recent studies show preference towards the shorter processes which are similar to processes proposed by Perry and Hayes (1985), and by Al-Bahar and Crandall (1991). For example, ISO (2009) stated that effective process for risk management in construction projects should have risk planning, risk identification, risk assessment, risk analysis, risk response, risk monitor, and managing the process record. A shorter process, which is widely recognized, was more developed further by Nieto-Morote *et al*. (2011). They argued that an effective risk management process has four basic stages. The first stage is to identify and classify risks. Risks are then analysed by quantitative or qualitative techniques in the second stage. In the third stage, managers need to respond to these risks. Finally, risks need to be monitored through the project's life-cycle.

Similarly to risk management in general, construction projects, in relation to risk management in PPPs, have vital stages such as identification, evaluation, and the control stage which are required to be applied and these stages cannot be discrete (Akintoye *et al*. 2003). However, in contrast to the process of general construction, an important stage, namely, the risk allocation stage, needs to be added because it is one of the core advantages of the PPP form. For this purpose, Boussabaine (2007) proposed a risk management framework for PPPs. As displayed in the figure 3.1, risks are priced after being analysed, and after that risks need to be allocated to the right party.

Figure 3. 1 The life cycle of risk management in PFI/PPP project (Boussabaine, 2007, p.256)



Likewise, Zou *et al*. (2008) proposed the life cycle-oriented risk management framework for PPPs, and in this framework, risk allocation is also added and focused on. More specifically, they converted the risk allocation stage into preliminary risk allocation, detailed risk allocation and reallocation phases. A more recent study by Leidel *et al*. (2010) also mentioned that for PPPs, risks need to be allocated before any mitigation strategies can be made. In fact, there are a number of research studies that looked into the risk aspect of PPPs. However, previous research mainly focused on a single aspect of the risk management process rather than on the framework (Leidel *et al*. 2010).

3.3.2. Risk management in PPPs from the Public Sector's Point of View

From the public sector perspective, PPP is expected to be an effective form to deliver modern and high-quality public services. The criteria of PPPs from the public sector point of view are Value for Money, and Affordability. The concept of Value for Money refers to the comprehensive quality of service provided by a PPP, not just a single aspect of the service. According to OGC (2004b), Value for Money is "the optimum combination of whole-life costs and quality, to meet the user requirements". Others simplify that the concept of Value for Money is to illustrate the attempt to acquire the maximum benefit from minimum sources (ODPM, 2005; OGC 2004c). It should be noted here that, the investment from the public sector is service-driven more than market factor-driven (Boussabaine, 2007). In addition, in contrast to the commercial point of view, which is the private sector point of view that projects with highest NPV should be chosen, from the public sector point of view, projects with the least NPV are preferred because the potentially highest financial benefit can be gained (Boussabaine, 2007). Affordability refers to the tangible and intangible benefits from the project over its life cycle.

In this form of a construction project, the public sector takes the advantages of the managing and financing ability of the private sector. Their purpose is to transfer as many risks as possible to the private sector. Therefore, PPPs are expected to be flexible in order to allocate risks between the two sectors (Declercq, 1999). Hence, in PPPs, the public sector is not responsible for the main financial investment to build the asset. In fact, the contribution of the public sector and private sector in this investment is on a case-by-case basis. This helps the public sector to reduce the risks of financing the project. Moreover, to prevent the risks from occurring in the operational stage, the public sector can fix the payment schedules. Payment can be made from the government or directly from the end users. This, theoretically, prevents the public sector from the operational risk factors (Sarmento and Renneboog, 2014). In fact, in this form, the public sector is considered to carry fewer risks than the private sector in terms of investment (Sarmento, 2010).

Likewise, from the public sector's perspective, PPPs can bring certain risks that may not appear in a traditional construction project. For example, due to the small amount of contribution in the investment, the public sector may have less power in managing a project through its life cycle (Quiggin, 2005). This lower level of power creates difficulty in re-negotiation in case changes are needed. In fact, for this reason the British Government has established a new form of PFI called PF2, which requires a certain contribution from the public sector to retain a certain level of power in the project (HM Treasury, 2012). In addition, a high level of transaction cost associated with the complex system of PPP is also a risk that the public sector may face (Froud, 2002). In fact, from the point of view of the public sector of looking at risks, academics suggest that for the public sector the proactive strategy should be required in risk management in PPPs rather than a reactive method (Sarmento and Renneboog, 2014).

3.3.3. Risk Management in PPPs from the Private Sector's Point of View

It can be recognized that in the private sector perspective, risks in PPPs are mainly evaluated from the commercial aspect. This is a reasonable perspective as in a PPP project, the private sector is responsible for investing, constructing, and operating the project. It is assumed in PPP forms that the private sector is better at managing financial and operational risks because they are not biased in evaluating risks, and they have experience in risk management (Sarmento and Renneboog, 2014). Indeed, most significant risks in PPPs which are transferred to the private sector are associated with financial aspects (Akintoye *et al*. 2003). The private sector is also responsible for constructing the project. Therefore, most of the significant risks during the construction stage are transferred to the private sector. In this stage, many things can go wrong as it is a complex period. For example, planning permission can be refused, design features may not be consistent with others, or change in regulation can be applied. All these risks require time and money in order to be resolved (Akintoye *et al*. 2003).

The private sector in most cases set up the SPV and this SPV is a method of acquiring finances from different resources. The main part of the capital can come from the bank or other credit organizations, and this part is recovered since the project now comes into the operational stage, and starts to make revenue (Akintoye *et al*. 2003). This, in deed, is a way to spread risks to other partners. When the project comes to the operational stage, in theory, the private sector can recoup their investment. However, in this stage, they have to face other risks such as operational cost overrun risk, or low demand risk which is one of the most critical risks for PPPs (Akintoye *et al*. 2003). For the transportation project, toll schemes are fixed in the contract, and the private sector cannot change it even if the demand is lower than expected. In fact, they can only change the toll scheme or submit for compensation if there is evidence that the low demand is due to the action or inaction from the host government.

Inside the private sector, lenders are also the partners who are very risk averse. It is observed that risks are a greater concern of lenders rather than sponsors as the main capital comes from debt rather than equity. Lenders are concerned about the risk allocation between parties as if the project is considered as low risk, lower interest rates may be applied or vice versa (Sarmento and Renneboog, 2014). It can be recognized that the sponsors directly bear the risk of demand during the operational stage. However, lenders are the party which is also indirectly influenced by the demand risk as if the demand is insufficient, the sponsors can be bankrupt and therefore lenders are not repaid. In reality, some lenders may apply a certain requirement of debt-equity ratio to the sponsor to safeguard the obtainability of the debt service (Akintoye *et al*. 2003). In fact, certain PPP laws also require a maximum level of debt in the capital. The sponsors may have to satisfy the requirement from both the host government and lenders. It should be noted that from the point of view of sponsors, the project with lower equity is not always considered to be the riskier project (Sarmento and Renneboog, 2014).

It is essentially important to remark that in contrast to the public sector, from the private sector's point of view, the project with highest NPV is preferred as it shows that investors can acquire more returns from that project. They key of a PPP is that a long-term asset is being financed by a long-term investment (Carrick, 2000). However, from the private sector point of view, higher investment and a longer payback period may go with riskier situations (Sarmento and Renneboog, 2014). Therefore, an appropriate concession period needs to be determined by the investors. This concession period needs to be able to help investors to achieve the expected returns, and it also needs to have a reasonable length of time to minimize the movement of risk factors.

3.4. Risk Identification and Assessment

As criticized previously in the problem statement section in the chapter 1, previous studies mainly focused on some aspect of risks rather than the overall risk management framework (Leidel et al. 2010). In previous research, risk identification, risk assessment and risk classification are usually combined so these risks become clear to the practitioners (Bing *et al*. 2005).

Regarding risk identification, this is the first step of risk management in PPP projects. The purpose of this step is not only to discover events that may go wrong but also to identify the importance and potential opportunities from these events (Redmill, 2002). In this stage, uncertain events are classified based on the objectives of practitioners. Techniques such as check lists, brainstorming, interviews and questionnaires, cause - event-effects, Delphi, Brainstorming, Pin card, Gallery, Collective Note Book (CNB) and Nominal Group Technique (NGT) have also been used in the area of PPP construction projects for many years (Demirag *et al*. 2010). Amongst these techniques, academics have suggested to use approaches which require the directed-thinking approach such as interviews, brainstorming and checklists as these approaches are easy to use, and hence it is leads to sufficient results (Ebrahimnejad *et al*. 2010). After risks are identified, risks need to be assessed in order to optimize the value for money, to calculate risk adjustment, and to create and monitor mitigation strategies (Innovative Program Delivery, 2012).

In terms of risk assessment, in general, there are three methods to analyze risks, which are qualitative analysis, quantitative analysis, and hybrid analysis. Qualitative risk analysis is used to discover and rank risks for further strategies. They may assess its probability of occurrence and its impact on project outcomes. Other factors such as time to mitigate these risks and the relationship between these risks can also be measured. In this type of analysis, experts and professionals are required to use their professional judgment and experience to evaluate events. Past data from similar projects can be applied while conducting this technique (Innovative Program Delivery, 2012). On the other hand, quantitative methods can be employed after the risks are identified and assessed in the qualitative method. The examination in this method can compare the time and cost the projects need to spend to overcome the situation if a risk occurs and the time and cost if this risk does not occur. Value for money can be more deeply analyzed to create key contract conditions (Innovative Program Delivery, 2012).

A number of researchers have attempted to identify, assess and categorize risks in PPPs in the transport area. For example, in order to identify critical risks in BOT road projects in India, and determine the perception of stakeholders have about these key risks, Thomas *et al*. (2003) used a literature review to construct a list of potential risks which are likely to occur, which they then required participants to rate. They also conducted interviews with some of the participants to further discuss the answers that were collected. An all-India survey was ran, and the researchers considered this method to be a well-established technique for collecting data. Participants were then required to rank the criticality of these risks on a Likert Scale of 1 to 5. The criticality index was then calculated by the following formula:

$$Criticality\ Index = \frac{5n_1 + 4n_2 + 3n_3 + 2n_4 + 1n_5}{n_1 + n_2 + n_3 + n_4 + n_5} \qquad (3.4)$$

Where *n*1, *n*2, *n*3, *n*4 and *n*5 represent the number of participants who consider a risk as ‘most critical’, ‘very critical’, ‘critical’, ‘somewhat critical’ and ‘not critical’, respectively. Finally, the result illustrates traffic revenue, delay in land acquisition, insufficient demand, delay in financial closure, cost overrun, and poor debt servicing as the most critical issues in BOT road projects in India. Amongst these risks, traffic revenue risk is the most serious issue.

Similarly to Thomas *et al*. (2003), Ghosh *et al*. (2004) also focused on PPP projects in the transportation area. In this research Ghosh *et al*. aimed to find risks in rail projects in Thailand. Questionnaires were used to obtain research objectives, and they were designed based on a total of eight key risks located through a comprehensive literature review. These risks are classified into Financial and economic risk, Contractual and legal risk, Subcontractors related risk, Operational risk, Safety and social risk, Design risk, Force majeure risk, Physical risk, and Delay risk. The assessment technique used in this research is the same one used by Thomas *et al*. (2003). Finally nine key risks including financial and economic risk, contractual and legal risk, and sub-contractors related risk, operational risk, safety and social risk, design risk, force majeure risk, physical risk, and delay risk, were identified in this research. Table 3.1 shows a list of risks in the research of Ghosh *et al*. (2004).

Table 3. 1 Risks in PPPs used by Ghosh *et al*. (2004)

Financial and Economic Risk	Unavailability of funds
	Economic disaster
	Tendered Price
	Exchange rate fluctuation
	Inflation
	Financial failure of contractor
Contractual and Legal Risk	Delay in solving contractual issues
	Delay in solving disputes
	Change order negotiation
	Delay payment on contract and extras
Sub-contractors Related Risk	Sub-contractor failure
	Co-ordination of subcontractor
	Sub-contractor lack of adequate number of staff
	Financial failure of sub-contractor
Operational Risk	Equipment productivity
	Labour productivity
	System outage
	Treatment of material removed from site
Safety and Social Risk	Pollution and safety rules
	Accidents
	Damage to person or property
	Ecological constrains
	Public consultancy
Design Risk	Inadequate specification
	Conflict of document
	Scope of work definition
	Design change
Force Majeure Risk	Act of God
	War
	Fire and theft
Physical Risk	Subsurface condition of geology

	Subsurface condition of ground water
	Unforeseen site condition
Delay Risk	Construction delay
	Third Party delays

Although Ghosh *et al*. (2004) state that the design of the research is reliable and that the questionnaires were well-conducted, the focus of this research was on only one project which is the Chaloem Ratchamongkhon line, thus the results might not be generalizable. However, the advantage of this research is that the Chaloem Ratchamongkhon line is a large and complex project which may be rarely accessed by other researchers; therefore, this study can bring unique outcomes. Similarly, Ng *et al*. (2012) also employed this simple method to assess factors influencing the success of PPP projects at the feasibility stage in Hong Kong. The 7-point scale was applied. The level of scale can be different, but the principle behind it is similar. The mean score of these rankings was used to determine risk ranking in descending order of importance. Table 3.2 shows the success factor used in the research by Ng *et al*. (2012).

Table 3. 2 Success factor in PPPs used by Ng *et al*. (2012)

Technical	Project size is technically manageable by a single consortium
	Possibility of innovative solutions (e.g. leading to time/cost savings)
	Availability of government experience in packaging similar PPP projects
	Availability of experienced, strong and reliable private consortium
	Service quality can be easily defined and objectively measured
	Contract is flexible enough for frequent change in output specification
	Project is not susceptible to fast-paced change (e.g. technological change)
Financial and Economic	Project is more cost effective than traditional forms of project delivery
	Project can be substantially self-funded or on a non-recourse basis
	Project value is sufficiently large to avoid disproportionate procurement costs
	Project is of financial interest to private sector
	Project can attract foreign capital
	Project is bankable and profitability of the project is sufficient to attract investors and lenders
	Economic environment is stable and favourable
	Existence of a sound governmental economic policy
	Competition from other projects is limited
Social	There is a long-term demand for the products/service in the community

	The community is understanding and supportive
	Delivery of services is stable and reliable
	Level of toll/tariff is acceptable
	Project can create more job opportunities
	Project is environmentally sustainable
Political and Legal	Project is not politically sensitive
	Political environment is stable
	There is political support for the project
	The project is compatible with current statutory and institutional arrangements
	There is a favourable legal framework (mature, reasonable and predictable)
Others	Fairness of new conditions to employees
	Possibility of significant redundancy
	Existence of a resolution for any civil service staff redundancy
	Supportiveness and commitment of staff to the project
	Flexibility to decide appropriate risk allocation
	Support from the government (e.g. guarantee or loans) is available
	Authority can be shared between the public and private sectors
	Possibility of an effective control mechanism over the private consortium
	Matching government's strategic and long-term objectives

They observed that the acceptance level of tolls is the most critical factor in PPP projects in Hong Kong. This research also compares the different preference between the private and public sectors, and demonstrates useful conclusions. However, the research method used by Thomas *et al*. (2003) and Ng *et al*. (2012) may be easy to carry out, but it does not clearly show the level of probability of the occurrence of a risk, and its impact on project outcomes.

Another simple and popular method which can resolve the problem mentioned above can be seen in papers published by Akintoye *et al*. (1998) and Chan *et al*. (2011). These papers assess risks based on their probability of occurrence and impact on project outcomes. More specifically, the research by Akintoye *et al*. (1998) was run to investigate risk analysis and management in PFI projects in the UK, and to discover practitioners' perceptions on risks associated with these projects. In this program, the researcher also delivered participants with a list of risks designed by comprehensively reviewing the literature. They then asked that the participants to rank both the probability and impact of these risks on a scale of one to five. In this scale, five represents most likely and the biggest impact, and one denotes the least impact. Risk score is then computed as the multiplied value of Probability and Impact. Finally, high design and construction cost, poor performance, delay in construction, cost overrun, high operation and maintenance cost, high payment and tendering cost are the most critical risks, respectively (Akintoye, *et al*. 1998). In the same way, Chan *et al*. (2011) aimed to uncover and assess risks in PPP projects in China, and discovered a proper risk allocation strategy. A list of 34 risks was created and participants then rated the occurrence probability and impact of risks on a 5-point scale. The risk significance index was calculated as the multiplied value of Risk Probability and Risk Impact. One advanced point in the research of Chan *et al*. (2011) is that they also tested the difference between the perceptions of the public and private sectors.

Another research area on PPP risks identification and assessment, which has been discovered by a number of academics, is the area of fuzzy theory. Methods using this theory also assess the probability of occurrence and the impact of a risk on project outcomes with a more sophisticated process, and they are expected to provide more accurate outcomes. Academics in this field state that assessing risks in PPP projects is usually based on an expression of linguistic terms, and this requires the judgment of experts who may be biased, subjective and partial. Therefore, there is a need of a method to interpret these linguistic terms accurately, and fuzzy method is expected to perform this. Additionally, they argue that risks in PPP projects are usually fuzzy in nature, and thus evaluating these risks by using fuzzy methods may be an appropriate option. Taking the paper by Xu *et al*. (2010a) as an example, in this paper, a fuzzy synthetic evaluation model was introduced to assess risks in PPP highway projects in China through the judgement of four stakeholder groups. In this model, the literature review, Delphi techniques, factor analysis, mean scoring ranking technique, and fuzzy synthetic evaluation were employed. Amongst these techniques, the literature review, Delphi, and factor analysis were used in the first stage of the research to identify possible risks, then the mean scoring ranking technique and fuzzy synthetic evaluation were employed in the second stage. More specifically, risks were identified through the literature review and two rounds of Delphi techniques. They also needed to be categorised into different levels, and each of these level contains a specific number of risks. Table 3.3 shows the risks in PPPs used in the research of Xu *et al*. (2010a).

Table 3. 3 Risks in PPPs used by Xu *et al*. (2010a)

Government corruption
Government intervention
Public credit
Nationalization/ Expropriation
Third party delay/ Violation
Political/Public opposition
Inadequate law and supervision system
Legislation change
Interest rate fluctuation
Foreign exchange fluctuation
Inflation
Poor public decision-making process
Land acquisition
Delay in project approvals and permits
Conflicting or imperfect contract
Financing risk
Project/Operation changes
Completion risk
Material/labour non-availability
Unproven Engineering techniques
Unforeseen weather/ Geotechnical conditions
Operation cost overrun
Market competition
(Uniqueness)
Change in market demand
Price change
Expense payment risk
Lack of supporting infrastructure
Residual risk
Inadequate competition for tender
Inability of concessionaire
Force majeure
Organization and co-ordination risk
Change in tax regulation
Environment risk

These risks then are ranked based on the mean score technique, fuzzy set, and fuzzy synthetic evaluation. Xu *et al*. (2010a) concluded that government intervention and government maturity risk are the most critical risk groups. It is expected that this method can support practitioners to assess risks based on objective evidence rather than subjective judgment (Xu *et al*. 2010a). In a similar way, Ebrahimnejad *et al*. (2010) published a ranking model for BOT infrastructure projects. However, in contrast to the research by Xu *et al*. (2010a), more risk criteria are included in the research by Ebrahimnejad *et al*. (2010). Five risk criteria used in this research are Probability criteria, Impact criteria, Quickness of Reaction toward risk criteria, Event measure quantity criteria, and Event capability criteria. The reason to use these criteria is that the probability and impact criteria are not sufficient for ranking risks (Ebrahimnejad *et al*. 2010). In addition, the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) and Fuzzy Linear Programming Technique for Multidimensional Analysis of Preference (FLINMAP) are both used for ranking risks before establishing the final ranking. Li *et al*. (2012) also carried out fuzzy methods to identify and assess risks. In this research, the literature review, Delphi technique, factor analysis, mean score ranking and fuzzy synthetic evaluation were used. For the risk identification stage, a comprehensive literature review, Delphi technique, and factor analysis were used, then they used the mean score ranking and fuzzy synthetic evaluation in the risk assessment stage. The Delphi questionnaire survey was designed based on a total of 34 risk factors identified from the literature review. The keys to using the Delphi technique are the definition of experts, the number of rounds conducted, and the structure of the questionnaire. They state that this technique is best for research that needs consensus results and for when the historical data is insufficient. Risks then were classified in order to structure and evaluate the relationship between them. Similar to most of the studies, risks are classified based on the sources of risks, however, this research classified risks based on the life cycle perspective since Li *et al*. (2012) argue that the risk management process is a continuous progression which runs through the whole life of the project, not only at a specific moment. More detailed than most studies which only separate a project into 3 stages which are development, construction and operation, Li *et al*. (2012) divide the project more specifically into a feasibility study that has financing, design, construction, operation and transfer phases.

In short, it can be observed that the most popular methods to assess risk are using the Likert scale, the risk score which is the multiplied number of the probability and impact, and fuzzy techniques. Each of these methods has their own advantages and disadvantages. For example, the Likert scale cannot show the probability of occurrence and degree of impact, while the Fuzzy method may make it sophisticated and impractical to use in practice. Using the risk score seems to be the most popular method. However, this method might not show the relationship between risks.

3.5. Risk Allocation

Before taking any action to mitigate risks, risks need to be allocated to the right place. In fact, risk allocation can be seen as a way to respond to risks. Risk allocation is the core of PPP projects. This allocation is made between the public and private sectors. Although in conventional construction projects, risk allocation also needs to be implemented, risk allocation in PPP is different. For example, table 3.4 illustrates the typical risk allocation in different types of construction projects.

Table 3. 4 Risk allocation according to PPPs form (Boussabaine, 2013, p.20)

	Build Own Operate Contract (BOO)			DBFO Contract			Build Own Transfer Contract (BOT)			Design & Build		
	Public sector	SPV	Contractor	Public sector	SPV	Contractor	Public sector	SPV	Contractor	Public sector	SPV	Contractor
Financial Risk		☒		☒	☒		☒	☒		☒		
Construction Risk			☒			☒			☒			☒
Technological Risk			☒			☒			☒			☒
Sponsor Risk		☒						☒	☒	☒		
Environment Risk		☒			☒			☒		☒		
Commercial Risk		☒			☒			☒		☒		
Operating risk			☒		☒	☒			☒	☒		
Legal Risk	☒	☒		☒			☒			☒		
Regulatory Risk		☒			☒			☒		☒		
Political Risk	☒			☒			☒			☒		
Force Majeure	☒			☒			☒			☒		

According to Innovative Program Delivery (2012), risk transfer valuation in PPP can be counted for 60 percent of the total cost which can be saved under PPP, because risks are managed effectively by a certain party. The main idea of risk allocation is to allocate risk to the party which best manages it. However, with an optimal risk allocation, it is not only important which party is chosen to transfer the risk to, but it is also to identify how to transfer the risk, and what the best time to transfer the risk is (Abednego *et al*. 2006).

Risk allocation is not an easy task as it depends on many factors, for example on the attitude of managers or the capability to manage risks (Zhang *et al*. 2002). In addition, the public sector and the private sector may have different points of view about PPP. For the public sector, PPPs are considered as a system to transfer risks to private sectors, thus they may prefer to transfer many risks to partner parties. According to Chung (2008), the market competition is changing the process of risk transfer or risk guarantee from the government to risk dumping by the government. This may mean that the government may attempt to take full advantage of the competitive environment to transfer as much risk as possible to a private partner (Chung *et al*. 2010). On the other hand, for the private sector, they need to obtain a balance between risks and opportunities. This means that they need to acquire gains more than losses created by risks. The public sector may seek the lowest expenses for taxpayers while the private sector wants to maximize their profits (Innovative Program Delivery, 2012). Therefore, if too few risks are allocated to the private sector the value for money, which is the heart of PPPs, can be negatively affected. In contrast, if too many risks are transferred to the private sector, including risks that the private sector may not be able to manage, the value for money is also badly influenced. Moreover, this also can reduce the willingness of a private party to go further into projects, and if the private sector stops bidding, the final aims of the project can be seriously influenced (Innovative Program Delivery, 2012). In addition, risks should be theoretically transferred to the party having the strongest ability to manage it. However, in practice, the capability of risk management of each party is very complex to evaluate. Hence, this evaluation may be subjective (Lam *et al*. 2007). In practice, risk allocation in PPP projects is a flexible process and it depends on many factors and may vary following the circumstances of each project or each country.

Academics who look at risk allocation in PPPs usually investigate the risk perception of stakeholders in practice to form guidelines for practitioners in the negotiation process. For instance, a study by Chou *et al*. (2012) compares the PPPs between rail projects and general infrastructure projects to detect the difference in the risk allocation perception of stakeholders between these projects. The study found no difference amongst these types of construction regarding the risk allocation perception of stakeholders. More specifically, in both types of construction, land acquisition, change in law, and government reliability are critical risks that should be allocated to the public sectors, and delay in supply, operation cost overrun and technology risks should be managed by the public sector.

Similarly, Singh *et al*. (2006) identified a risk allocation strategy in eight BOT road projects in India to create a risk allocation framework. In this framework, most of the risks are allocated to public clients. They are, for example, pre-investment, resettlement and rehabilitation, permit/approval, delay in land acquisition, delay in payment of annuity and change of scope. On the other hand, the private partner is responsible for delays in financial close, time and cost overrun during the construction and operation period. With a similar aim to create a guideline for managers in PPPs in practice in the UK, Bing *et al*. (2005) ran a study to understand the risk allocation preference of stakeholders in these projects. Risks were gathered from the literature review and were then sent to stakeholders. In the analyzing process, if more than 50 percent of participants consider locating the risk to a party, then that risk is categorized as allocated to that party. If no majority is found of participants assigning a risk to a specific party, Bing *et al*. (2005) then categorized that risk needing more detailed information. In this research, Bing *et al*. (2005) found that stakeholders prefer the public sector to manage the political risks and site availability risks. This preference may reflect the fact that the government in the UK has been demonstrating a stable political situation, and thus they can manage these risks better with lower costs. In addition, the government in the UK has experience and a special legal framework for risks of site availability. Therefore, there is no surprise that these risks are chosen to be managed by the public sector. On the other hand, a majority of risks are allocated to the private sector. More specifically, 32 out of 46 risk factors are assigned to the private sectors. Comparing this finding to the research conducted in Hong Kong by other authors where only 20 percent of risk variables were allocated to the private sector (Zayed *et al*. 2008), it may be that the objectives of transferring risks to the private sector are considered to have been achieved in the UK. Some risks that need to be managed by both sectors such as tax regulation and inflation rate are shared between the two sectors. Surprisingly, Bing *et al*. (2005) found that the risk of low levels of public support, project approval and permit, contract variation, and lack of experience are risks that no party in this research has experienced managing. The conclusion about the objectives of transferring risks to the private sector in research by Bing *et al*. (2005) contradicts the findings by Ke *et al*. (2010) in China. In the research by Ke *et al*. (2010), no risk is chosen to be solely managed by the private sector. This may indicate that the objectives of transferring risks to the private sector have not been achieved.

Apart from discovering the risk allocation perception of stakeholders in practice, other researchers have also attempted to discover allocation strategies by applying other techniques. For example, the risk matrix is a simple and effective tool to develop risk response strategies when risk events have been identified and assessed. This tool was developed by Alexander *et al*. (2006), and Panthi *et al*. (2001) applied this tool in the area of PPP construction projects. Based on the probability and impact, a risk event is mapped in the risk matrix which forms the basis for formulation of the risk response strategies. This tool is considered as easy to use, to explain to participants, and to get participants involved in (Panthi *et al*. 2001). For applying this tool, a risk needs to be ranked based on its probability and impact. For instance, risk can be ranked by a 10-point scale, and then with their scale each risk will fit a position in the matrix and this position can guide practitioners on how to deal with that risk (Panthi *et al*. 2001).

In order to develop risk allocation strategies, Chan *et al*. (2011) required participants illustrate their perception by using a 3-point scale in which 1 denotes the public sector, 2 denotes that it is equally shared between the public and private sectors, and 3 denotes the private sector. However, they then use the following formula to assess allocation perception:

$$X_{10\%} = U +/- Z^{*}\delta \qquad (3.5)$$

Where, $X_{10\%}$ is the upper and lower value in which a risk will be allocated to a specific party. U represents the mean value of a population, and the corresponding Z and σ = population standard deviation.

In this paper, they use the value of Z as 0.125 and σ as 1. Thus, X ranges between 2.875 scores and 3.125 scores. This means if a risk has a score under 2.857, it will be allocated to the public sector, and if the score is over 3.125, it will be transferred to the private sector.

One of the limitations of above allocation methods is that criteria for risk allocation are not taken into account. In order to overcome this limitation, Xu *et al*. (2010) developed a model based on fuzzy theory to allocate risks in PPPs. Xu *et al*. (2010) expressed that this model can effectively interpret linguistic expressions into systematic quantitative analysis. In this model, first risks are identified through a comprehensive literature review and then critical risk allocation criteria are classified to evaluate the capability of managing risks of a party. Then the weighting for each risk allocation criteria is determined by the mean score, and the membership function for each risk allocation is also determined by fuzzy set theory. Finally, fuzzy evaluation is employed to create quantitative results of equitable risk allocation strategies. This model is expected to provide a comprehensive and systematic framework for risk allocation strategy and reduce bias from an individual's judgment. In this paper, Xu *et al*. (2010) also illustrated a case study as an example of this model to conclude that this model can effectively and objectively determine a risk allocation strategy for PPP projects in China. One of the advantages of this allocation method is that criteria for risk allocation are created. However, these criteria are not compared directly to one another. Instead, they are weighted using a Likert scale. It would be better if the pairwise comparison method was employed. Furthermore, the fuzzy technique is criticized as being sophisticated and hence, it may be difficult to use in practice.

3.6. Risk costing in PPP projects

Risk costing is the stage in which risks are considered to have an impact on the project's Capital Expenditure (CAPEX), and Operational Expenses (OPEX), and project revenue. Therefore, the first principle of risk costing is to identify these risks. The analyst then needs to evaluate these risks in terms of the probability of occurrence and degree of impact. It is suggested that the risks with the highest cost impact should be the top priority. However, analysts need to make the distinction between risks with a low probability of occurrence, but a high degree of impact, and vice versa. Researchers suggested that both project-specific risks and non-project specific risks need to be priced (Boussabaine, 2014).

One of the basic methods of risk costing is the Variance and Standard Deviation Method. In this method, a mean-variance utility function of a risk factor is proposed. After that the risk cost can be estimated in two cases, namely, Lower band state, and Upper band state. In the Lower band state, the lower boundary of the risk cost is presented with a probability. In other words, the risk cost cannot be below this level with a provided probability (P). In contrast, the Upper band state provides a higher boundary of the risk cost with the probability (1-P). After that, the expected volatility of the cost of risk also needs to be assumed. From these values, the risk cost can be estimated. The second basic method is the Expected Value Method. Basically, the risk cost is determined by the sum of all possible values for the cost and each value is multiplied by the probability of occurrence for that value. In other words, the cost of risks can be calculated as the sum of the cost of risk impact, the cost of the uncertainty of estimation, and any hypothetical cost as a consequence of risk (Boussabaine, 2014). Details of these strategies can be found from other literature such as that of Boussabaine and Kirkham (2004) and Boussabaine (2006).

3.7. Risk Bias

It is recognized that the risk assessment is influenced by the attitude of observers in a specific situation. In the area of PPPs, observers who carry out risk assessment are usually groups of experts, and their opinions may vary substantially (Boussabaine, 2014), and these variation can lead to bias. Bias can be defined as: “any systematic deviation from a normative criterion that affects thinking, often leading to errors in judgement” (Litvak and Lerner, 2009, p.89). They also clarified that judgement that lacks correlation with a criterion, or lacks correlation with other opinions, or is based on unreliable information can be seen as bias. As stated, risk assessment in PPPs is usually carried out by experts, and emotions of these experts can have an influence on assessment of the results (Han and Lerner, 2009). More specifically, authors clarified these emotions into expected emotion and immediate emotion. Expected emotion refers to the outcome of a past event that the observer experienced, while immediate emotion indicates the observer’s emotion at the time of assessing risks.

Regarding the sources of bias, a number of sources have been classified by academics. For example, Cho *et al*. (2010) said that Manageability is a source of bias. This source refers to the ability of the observer to achieve reliable outcomes and ignores the negative influence of their assessment (Boussabaine, 2014). Yudknowsky (2006) used the term Availability to refer to the source made from past experience which has influence on future results. Tversky and Kahneman (1974) stated that bias can occur when the observer starts from an anchor and modifies it until they meet the desired outcome. Authors classified this source as Anchoring. Confirmation is also a source of bias. This term refers to the situation that estimators only seek evidence that supports their belief, but ignore evidence that does not support their belief. Lloyd (2010) reported that Representativeness is an important source which needs to be considered when assessing risks. This source refers to the situation that sample size cannot reflect the status of a population. In addition, Optimism is also a source of bias. This refers to the case where an observer may have overconfidence in assumptions in the decision making process (Anderson and Galinsky, 2006). Moreover, Boussabaine (2013) also reported that the judgment about the level of risk associated with an event can also be a source of bias, namely, Scale. More specifically, observers may tend to refer to a large-scale event with a large risk. However, the level of risk is not always related to the scale of event.

In order to manage bias in assessing risks, some methods suggested from previous academics such as Boussabaine (2013) and Akintoye e*t al*. (2003) can be applied. For example, the risk estimation team should consist of people from different parties and different backgrounds. Experts in the field should also be invited to reduce bias. In addition, appropriate risk analysis techniques should be used. Furthermore, all assumptions and limitations must be clarified and cautiously checked. In addition, historical data should be used to check any errors and inconsistencies.

3.8. Risk Governance

Risk governance is the system to ensure that all parties involved in the projects fulfil their duties in managing risks that are identified. This system should be able to address which department is responsible for implementing, controlling and monitoring the mitigation strategies for risks. It can be seen from figure 3.1 that the governance needs to be carried out through the project's life cycle. In this system, clear roles and responsibilities of each duty in managing risks are provided. For example, the governance system can provide the guidance in allocating and pricing risks for partners. Guidelines can be provided in written format with clear examples or case studies to ensure that they are practical for involved partners.

3.9. Selection of Elements in the Proposed Framework

3.9.1. Elements of the Proposed Risk Evaluation Framework

Based on the literature review about risk management in the construction area as well as in PPPs, it is decided that the proposed risk evaluation framework should contain an identification function which can assess a risk from its probability of occurrence and degree of impact, and this function will be described in detail in section 6.2.1.1 in chapter 6. The proposed framework should also contain the function of evaluating the riskiness of a project, and allocating risks based on multiple criteria. The literature review about a specific theory (AHP) which can present these functions will be provided in chapter 4, and the application of this theory in the framework will be showed in sections 6.2.1.2 and 6.2.1.3 in chapter 6. In addition, the proposed evaluation framework should also have the function to evaluate the return and determine the concession period. The literature review about models which can play this role will be shown in chapter 5, and the application of the selected model (Risk Adjusted DNPV) will be shown in sections 6.2.2.2 and 6.2.2.3 in chapter 6.

3.9.2. Selection of Risks

From reviewing the literature, a list of risks was created. These risks are drawn from previous studies and from discussions with practitioners in the field. These risks will be assessed and priced with regard to the Vietnamese PPPs. After discussions with academic experts and practitioners, some of the risks used in other research were removed because they may not be suitable for transportation projects, and for a developing market in Vietnam. Table 3.5 shows the risks used in this research with their sources, and Table 3.6 shows the interpretation of these risks.

Table 3. 5 Risks Selected in Current Research

Risk Group	Risk	Source
Political Risks	P1. Concession termination by Government	Xenidis *et al*. (2005)
	P2. Political opposition	Ameyaw *et al*. (2015); Li *et al*. (2005)
	P3. Unstable government	Yuan *et al*. 2008; Li *et al*. (2005)
	P4. Corruption	Ling and Hoang (2010) Wang *et al*. (2000); Ke *et al*. (2010)
	P5. Public sector default	Toan and Ozawa (2008)
	P6. Public scepticism about the real benefits of PPP	Song *et al*. (2013); Yuan *et al*. 2008
	P7. Forced buy-out Risks	Toan and Ozawa (2008)
Legal Risks	L1. Disapproval of guarantees by the government	Discussion with Vietnamese practitioners
	L2. Revision of the contract clauses	Song *et al*. (2013)
	L3. Poor project approval and permit process	Ling and Hoang (2010); Ameyaw *et al*. (2015); Li *et al*. (2005)
	L4. Regulation Change	Singh *et al*. (2006); Thuyet *et al*. (2007); Li *et al*. (2005)
	L5. Restriction on tolls	Xenidis *et al*. 2005
	L6. Taxation risks	Ke *et al*. (2010)
Market Risks	M1. Lack of transparency	Ling and Hoang (2010)
	M2. Weak financial capacity of investor	Ke *et al*. (2010)
	M3. Difficulty in accessing finance from the banks	Discussion with Vietnamese practitioners
	M4. Inflation risk	Singh *et al*. (2006); Thuyet *et al*. (2007); Ameyaw *et al*. (2015); Xu *et al*. (2011); Li *et al*. (2005)
	M5. Fluctuation of Interest rate	Ling and Hoang (2010); Ameyaw *et al*. (2015); Li *et al*. (2005)
	M6. Foreign currency exchange fluctuation	Ameyaw *et al*. (2015)
	M7. Influence of negative economic events	Thuyet *et al*. (2007); Li *et al*. (2005)
	M8. Poor financial market	Chan *et al*. (2011)
	M9. Income streams are usually in local currency	Paolo Urio (2010)
	M10. Asset value less than predicted at the time of transferring	Yuan *et al*. 2008
Construction Risks	C1. Changes in industrial code of practices	Li *et al*. (2005)
	C2. Poor design	Thuyet *et al*. (2007)
	C3. Low quality products	Thuyet *et al*. (2007) Li *et al*.

		(2005)
	C4. Low site safety	Ke *et al*. (2010)
	C5. Unavailability of materials	Discussion with Vietnamese practitioners
	C6. Design changes	Ameyaw *et al*. (2015)
	C7. Difficulty in land acquisition and resettlement	Singh *et al*. (2006); Ameyaw *et al*. (2015) Li *et al*. (2005)
	C8. Impractical feasibility study	Thuyet *et al*. (2007)
	C9. Impractical requirements of progress of project	Discussion with Vietnamese practitioners
	C10. Delay in other infrastructures relating to the project	Li *et al*. (2005)
Operational Risks	O1. Operation cost overrun	Ameyaw *et al*. (2015); Yuan *et al*. (2008); Li *et al*. (2005)
	O2. Default of operator	Toan and Ozawa (2008)
	O3. Low quality of operation	Yuan *et al*. 2008
	O4. High maintenance cost	Yuan *et al*. 2008; Li *et al*. (2005)
	O5. Fluctuation of demand	Song *et al*. (2013); Ameyaw *et al*. (2015); Yuan *et al*. 2008 90
Relationship Risks	Re1. Inadequate experience in PPP of Private sector	Roumboutsos *et al*. (2008)
	Re2. Inadequate experience in PPP of Public sector	Roumboutsos *et al*. (2008)
	Re3. Inappropriate distribution of responsibilities and risks	Li *et al*. (2005)
	Re4. Low quality of cooperation between different partners	Thuyet *et al*. (2007) Li *et al*. (2005)
Other Risks	Ot1. Bad natural events	Thuyet *et al*. (2007); Ameyaw *et al*. (2015);
	Ot2. Force majeure events	Li *et al*. (2005); Ameyaw *et al*. (2015)

Table 3. 6 Risk Interpretation

P1. Concession termination by Government	The concession period is unpredictably terminated by the host government.
P2. Political opposition	Opposition of politicians about the need of constructing project under PPP form
P3. Unstable Government	Macro political changes in the government system or regime
P4. Corruption	Involved officials from any party demand unjust rewards
P5. Public Sector default	The host government cannot afford its financial ability. For example, annual payment to investors
P6. Public scepticism about the	The scepticism of citizens about benefits of project under PPP

real benefits of PPP	form
P7. Forced buy-out Risks	The SPV is forced to sell the franchise operation period to the host government
L1. Disapproval of guarantees by the government	The host government refuses to offer guarantee investors in terms to support investors accessing financial resources
L2. Revision of the contract clauses	High frequency of changes in contract clauses both because of public and private sector requirements
L3. Poor project approval and permit process	Time consuming, unclear and too many unnecessary documents are required in approval process
L4. Regulation change	The host government applies inconsistent regulations and laws, leading to unpredictable changes in new regulations and laws
L5. Restriction on tolls	The level of toll which is paid by end-user, is restricted by the host government
L6. Taxation risks	The tax levels are too high, or inconsistent changes in tax regime
M1. Lack of transparency	Lack of public information about the project during the project life cycle
M2. Weak financial capacity of investor	Private investors do not have sufficient financial capacity during construction time
M3. Difficulty in accessing finance from the banks	Banks demand too many procedures which make difficulties for investors to access credit sources
M4. Inflation risk	Wide and unpredictable fluctuation of inflation rate
M5. Fluctuation of interest rate	Wide and unpredictable fluctuation of Interest rate
M6. Foreign currency exchange risk	Wide and unpredictable fluctuation of foreign currency exchange fluctuation
M7. Influence of negative economic events	Occurrence of macro negative economic events such as global or national financial crisis, or specific sector crisis
M8. Poor financial market	Insufficiency of credit resources available for investors
M9. Income streams are usually in local currency	Revenue collected from end-user or from the host government is paid in Vietnam Dong
M10. Asset value less than predicted at the time of transferring	Assets transferred to the government at the end of the concession period have less value than forecasted
C1. Changes in industrial code of	The host government applies changes in technical

practices	requirements, and technical standards during the project life cycle
C2. Poor design	The quality of design is unsuitable both in terms of technical standards and citizens' use of benefits
C3. Low quality products	The technical quality of products is below par
C4. Low site safety	A lack of application of safety requirements, and lack of restrict monitoring about safety on site
C5. Unavailability of materials	Lack of material resources around construction site. The supplement of material is inefficient
C6. Design changes	High frequency of design adjusting required from the host government
C7. Difficulty in land acquisition and resettlement	The project land is unavailable, or delays in occupying land. Resettlement process is not accepted by citizens
C8. Impractical feasibility study	Over or under estimation about the benefits of the project
C9. Impractical requirements of progress of project	The host government requires impractical project's completion time
C10. Delay in other infrastructures relating to the project	Different work sections in relating projects are not constructed on time leading to the delays in current project. Delays of other construction projects around the construction areas
O1. Operation cost overrun	Management costs are higher than expected, excluding maintenance cost.
O2. Default of operator	Operator cannot afford the losses during the operation period and quit the project
O3. Low quality of operation	The quality of operation is below par for example, low quality of facility management, inadequate cooperation with other parties in identifying maintenance needs, and reducing overload vehicles
O4. High maintenance cost	Maintenance costs are higher than expected. Some reasons of unexpected maintenance are external to investors
O5. Fluctuation of demand	Traffic level widely fluctuates and is below forecasted levels
Re1. Inadequate experience in PPP of the private sector	Investors have not participated in many PPPs in the transport sector in Vietnam
Re2. Inadequate experience in PPP of the public sector	The host government does not have sufficient experience in PPPs in transport sector

Re3. Inappropriate distribution of responsibilities and risks	Both parties are too risk averse and risks are not transferred to the party which is the best to manage them
Re4. Low quality of cooperation between different partners	Parties in project do not show effective co-cooperation due to different working methods or bureaucratic system
Ot1. Bad natural events	Occurrence of nature events such as heavy rain, high temperature, floods, earthquakes, etc.
Ot2. Force majeure events	Occurrence of events such as war, terrorism, etc.

3.10. Summary

In this chapter, fundamental concepts about risks and uncertainty were explained to illustrate the concept that the research centres on. This chapter also reviewed literature about the risk management process in PPPs. Different perspectives of the public and private sectors were also displayed. Different essential issues in managing risks were also expressed in this chapter. At the end of this chapter the elements of the proposed risk evaluation framework were justified. More specifically, it is concluded that the proposed framework should contain functions of identifying risks, of evaluating the riskiness of projects, allocating risks based on multiple criteria, effectively evaluating project returns and determining the concession period. In addition, this chapter also illustrated a list of risks that will be used in this research. More specifically, 44 risks are chosen and these risks are categorized in seven groups.

CHAPTER 4: ANALYTIC HIERARCHY PROCESS IN EVALUATING PPP PROJECTS' RISKINESS

4.1. Introduction

This chapter clarifies the reasons for promoting Analytic Hierarchy Process (AHP) to be used in the proposed risk evaluation framework. For this purpose, firstly, fundamental principles of AHP are presented. Secondly, the application of AHP in a wide range of area is shown to demonstrate the variety of the application of this technique. Thirdly, a more detailed review is provided for application of AHP in the area of construction projects in international markets. Fourthly, the review is focused on the application of AHP in the PPP construction projects. The research about this application is reviewed and their advantages and disadvantages are criticized. After this, the justification for using the application of AHP in the proposed framework is presented. Finally, the main points of the chapter are summarized in the conclusion section.

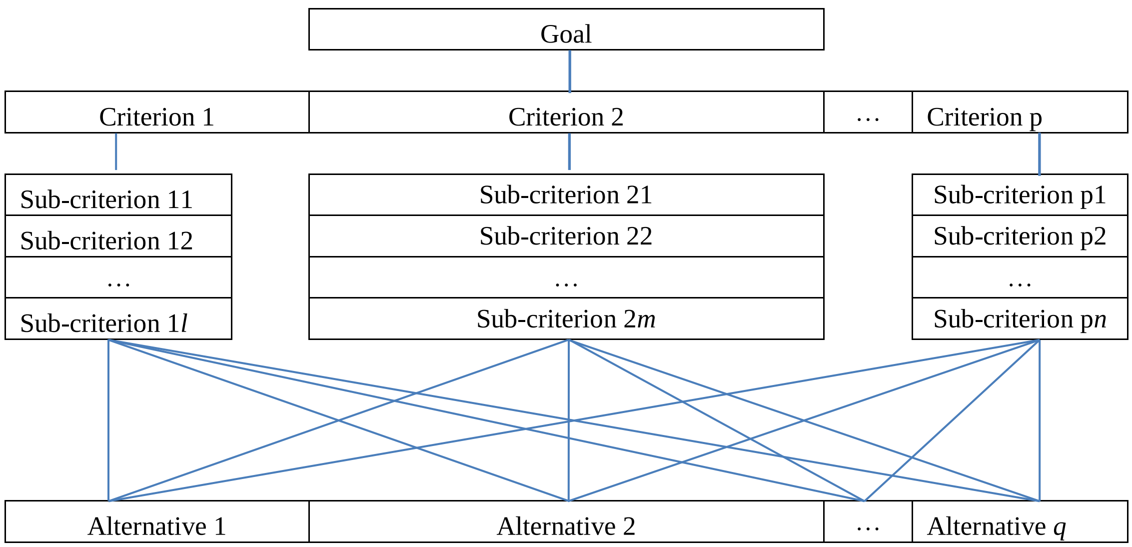
4.2. Analytic Hierarchy Process in Decision Making

4.2.1. Principles of Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a multiple criteria decision making method. This process was first introduced by Satty (1980). In this method, subjective evaluations are transferred to numerical values. Pairwise comparisons are made between criteria and alternatives. From these pairwise comparisons, mathematical analysis is used to create a comprehensive comparison of options (Bhushan and Rai, 2004). In Satty's process, small inconsistency was allowed because humans are not consistent at all times. It should be noted that the word inconsistency refers to the situation that the decisions of pairwise comparisons made by decision making are inconsistent. For example, decision maker may evaluate item i is more important than item j and item j is more important than item k, but item k is more important than item i. As stated Satty (1980) is aware that human are not consistent at all times by nature. Therefore, he provides an acceptable level of inconsistency. Basically, he illustrates how much inconsistency is accepted in AHP model. More detail about this test can be found in section 7.5.4.6 in chapter 7.

In order to make a decision based on AHP, first, decision makers need to identify the problem and the knowledge area that they need. After that, the hierarchy including the alternatives (options) and criteria (or sub-criteria) needs to be structured. The pairwise comparison needs to be built between alternatives, and between criteria (sub-criteria). Each element in a higher level in the hierarchy is used to compare elements in the lower level with regard to that higher level's element (Satty, 1980). Figure 4.1 shows an example of the hierarchy structure.

Figure 4. 1 Hierarchy structure and pairwise comparison (Bhushan and Rai, 2004)



To create a pairwise comparison, linguistic judgements need to be transferred to the numeric value. Table 4.1 below clarifies how linguistic comparison can be converted to the numeric value. In table 4.1, each linguistic judgment can be converted to a number from 1 to 9. The values of 1, 3, 5, 7, 9 are first considered, and the values of 2, 4, 6, 8 can be used if needed.

Table 4. 1 Linguistic Measures of Importance in AHP (Saaty, 1980)

Scale	Definition	Explanation
1	Equal	Two items contribute equally to the objective
3	Weak	One item is slightly more important than another
5	Strong	One is strongly more important than another
7	Very Strong	One is very strongly more important than another
9	Extremely Strong	One is extremely more important than another

By creating a pairwise comparison, the weight of criteria and matrix of option scores can be made. From here, the comprehensive comparison between alternatives can be made to create a decision.

4.2.2. Application of AHP in a Wide Range of Area

Since AHP was first introduced, there have been a number of applications of this theory to improve the quality of the decision making process. Indeed, the applications of this theory have spread over a wide range of areas.

For example, AHP was first applied in the social area in the research by Hegde and Tadikamalla (1990), Ahire and Rana (1995), Yurimoto and Masui (1995), Korpela and Tuominen (1996), Korpela *et al*. (1998), and Korpela and Lehmusvara (1999). More specifically, a paper by Hegde and Tadikamalla (1990) reported the application of AHP in selecting the location for a service terminal. In this selection, the location alternatives were compared based on multiple aspects (criteria) such as operating cost, availability of staff, capacity of dedication, and so on. The decision made in this report was concluded to be of reasonable quality with respect to all mentioned aspects. Similarly to Hegde and Tadikamalla (1990), a process for choosing the location for a warehouse was also modelled based on AHP in research by Korpela and Tuominen (1996). The finding of the research shows that the AHP-based selection process is flexible and systematic. They also concluded that this selection process is a significant improvement in comparison to other selection methods. In addition, the process is also said to be able to enable decision makers to select alternatives in an iterative manner as the hierarchy of elements can be adjusted. Also focusing on a warehouse network, Korpela and Lehmusvara (1999) designed a process to evaluate a warehouse network based on AHP with regards to customer requirements. They expected that the proposed framework was flexible in comparison with traditional selection methods based on cost and profit analysis alone. Research by Ahire and Rana (1995) proposed a model to assist managers in choosing the most effective business units for pilot testing of total quality management (TQM). The research was carried in the USA market, with focus on the hospital environment. The conclusion of the research was that the model can create a rational foundation to choosing business units. Research by Korpela *et al*. (1998) also presented a framework based on AHP to manage a logistics service. This framework has 7 steps which are systematically proposed based on AHP.

More recent research applying AHP to the social area can be attributed to Chiang (2013), Mishra *et al*. (2015), Uyan (2013), Bunruamkaew and Murayam (2011), Şeker and Özgürler (2012), Unjan *et al*. (2013), and Mani *et al*. (2014). AHP and GIS were combined to identify potential ecotourism sites in Thailand. The identification process was designed to assess multi-criteria of sites such as landscape, wildlife, topography, and accessibility features (Bunruamkaew and Murayam, 2011). Also in selection of the location, research by Uyan (2013) identified a suitable location for a solar firm in Turkey. The selection process was also designed based on AHP and GIS. They concluded that this selection process allows decision makers to consider the location both in terms of the economic aspect and environmental aspect. Similarly, research by Mishra *et al*. (2015) also used AHP combined with Geographic Information System to identify suitable land for an organic farm. They stated that this combination is very useful to identify suitable land for farms.

In research by Şeker and Özgürler (2012), AHP was combined with SWOT analysis to assess a Turkish consumer electronics company in terms of its strengths, weaknesses, opportunities and threats. In this study, a SWOT matrix was transferred to a hierarchy structure and this structure was analysed using the AHP method. An AHP tool was also used to analyse the positive and negative aspects of the area's expansion policy of oil palm in Thailand in a paper by Unjan *et al*. (2013). In this analysis income impacts and social impacts to the area were both considered by AHP. Similarly, AHP was also used to select a supplier in the research by Mani *et al*. (2014). In this research, social parameters such as equity, health, safety, wages, education, philanthropy, child labour and bonded labour were compared. Research was applied to three case studies to demonstrate the process and the respondents in this research were experts in the field.

Researchers have also attempted to apply AHP to the area of education. Research by Tadisna *et al*. (1991), Bryson and Mololurin (1997), Ereeş *et al*. (2013), can Chen *et al*. (2015) can be examples. More specifically, research by Tadisna *et al*. (1991) used AHP to set up a process to select a doctoral program. A case study was carried out with MBA students to illustrate the process. It was expected to improve the quality of selection by looking at the location of schools, infrastructure, quality of entering students, and reputation of schools. In Bryson and Mololurin's (1997) research, AHP was used to create a systematic action learning evaluation procedure (ALEP). A more recent study by Ereeş *et al*. (2013) evaluated simulation applications used in the education area by analysing opinions of experts and academicians using AHP. Ereeş *et al*. (2013) concluded that AHP makes it faster and more convenient to fill out the evaluations. Likewise, teaching performance is also evaluated using fuzzy AHP in the research by Chen *et al*. (2015). A case study was used to test the application. Chen *et al*. (2015) commented that this evaluation method can enable a consensus of decision makers and diminish uncertainty. Additionally, the evaluation was considered as scientific, accurate, and objective by using fuzzy AHP.

The manufacturing sector is also an area attracting the implementation of AHP. For example, in research by Shang *et al*. (1995), researchers combined AHP and Data Envelopment Analysis (DEA) to choose the most appropriate Flexible Manufacturing System (FMS). Shang *et al*. (1995) clarified that Flexible Manufacturing System has both tangible and intangible benefits. Intangible benefits include long-term goals, and AHP was used to examine the nonmonetary criteria influencing corporate goals and long-term aims. Research by Mohonty and Deshmukh (1998) also used AHP to propose a strategic model for learning and evaluating advanced manufacturing technology with a case study on an Indian electronics manufacturing enterprise. Mohonty and Deshmukh (1998) also stated that AHP was applied in this strategic model because of its ability to quantify intangible aspects. In a more recent study by Yang *et al*. (2009), an integrated performance measurement model was created based on AHP and an analytical network process (ANP) evaluation to manage strategy. Performance criteria from the literature review were used to create the hierarchy structure. The first level of criteria has 6 elements, namely quality, utilization, flexibility, employee, delivery dependence, and cost. In addition, 44 sub-criteria were also created. The results of this evaluation model were compared to results from financial reports, and the comparison showed that the combined AHP and ANP illustrate the real performance of a manufacturing system. A later research by Jovanović *et al*. (2015) attempted to analyse manufacturing sectors in Serbia. To prioritize these sectors AHP was applied to take the opinion of experts from the Serbian Chamber of Commerce and Industry. The application was evaluated as convenient in the research. Similarly, research by Gupta *et al*. (2015) presented an AHP-based model to evaluate sustainable manufacturing practices in the electrical industry. In this model, key practices of sustainable manufacturing were used to build the hierarchy structure. The model was deemed logical and as able to take into account both mathematical aspects and human psychology (ibid).

Researchers in the area of software engineering have also been attracted to this decision making technique. For example, Choi (1999) developed two optimization models based on AHP to evaluate Commercial Off The Shelf (COST) software products. Different COST software products were compared based on their functions and on financial criteria such as limited budget. Similarly, the selection of a multi-media authorizing system was also supported by AHP in the research by Lai *et al*. (2002). AHP was employed to analyse the opinions of six experts to compare different software with regards to quality, indirect benefits, practicality, satisfaction and financial aspects. Interestingly, the selection of AHP software was also tested in AHP in the research by Ossadnik and Lange (1999). In this evaluation, hierarchy was built by criteria from the international norm ISO/IEC 9126.

Additionally, scientists also made an effort using AHP to support political decision. For example, Carlsson and Walden (1995) used AHP to create a model to support Political Group Decisions. Carlsson and Walden (1995) explained that AHP was used to avoid inconsistency in decision making. A hierarchy of political criteria was built. This hierarchy contains 6 criteria and 21 sub-criteria. The government analysis was also supported by AHP in research by Li and Sherali (2003). In this paper, a model for analysing foreign direct investment opportunities was presented. To reach their goals, expert opinions were analysed by AHP. Furthermore, AHP was also applied to other areas such as industry, and banking, etc. (Vaidya and Kumar, 2006).

4.3. AHP in the Construction Area

4.3.1. AHP as a Single Approach in the Construction Area

One of the first studies of AHP that looked into the construction area was the study by Skibniewski and Chao (1992). By observing that intangible features of advanced construction technologies and of associated risks are difficult to quantify in traditional evaluation approaches, Skibniewski and Chao (1992) proposed a model based on AHP to assess intangible benefits of advanced construction technologies. They used this model to compare different alternatives of advanced construction technologies with regards to the final goals of decision makers. This was different from the traditional comparison methods which compared the financial aspects of the alternatives only. They also used a case study of a tower crane to illustrate the model. Later research by Kalamaras *et al*. (2000) used AHP as a single approach to select the best highway alignment, and five alignments were used to demonstrate the model. In this model, multiple aspects of the best alignment were chosen to compare alternatives. For example, they considered the impact of the highway on the environment, the functionality of the highway, construction time, construction cost, and the economic value of investment. In addition, for each of these criteria, sub-criteria were also given. Contractor selection was also supported by AHP in the research by Topcu (2004). The research was applied to the Turkish construction market. Researchers observed that in the bidding process in this market, the lowest bidder was the winner. However, they criticized that this type of selection is not appropriate. Consequently, their contractor selection model looked at three main concepts, namely, cost, time and quality of the project to select the most eligible contractor. They also advised that additional criteria such as health and safety, and environmental impact can be added in the making decision. Also looking at selecting contractors in a construction project, Mishra *et al*. (2015) applied AHP to prequalify contractors. The proposed model was expected to select contractors for design-build, cost plus time and warranty delivery methods. It was also expected that with support from AHP, only competent contractors with low-cost bidding can pass the prequalification process. However, in contrast to the model by Topcu (2004), the model by Mishra *et al*. (2015) has two stages and some aspects such as financial stability, manpower, and equipment were considered in the first stage only. As stated by the authors, this is to prevent large contractors from controlling the market. Looking at a different aspect of construction projects, Shapira and Goldenberg (2005) applied AHP to select equipment for a construction project. They argued that current models failed in evaluating soft factors together with cost aspects of the selection. Therefore an AHP-based model was proposed to resolve that issue. Four criteria and eighteen sub-criteria with regards to the final goals were hierarchized. Zhang *et al*. (2006) also applied AHP to evaluate expressway construction projects in China. They applied his model to seven expressway construction projects and concluded that his model using AHP is valuable both in terms of theory and practice. Lin *et al*. (2008) criticized the nine scale provided in AHP and proposed an improved AHP call A^3 to increase the consistency level of this method in applying into construction project. To demonstrate the improvement, they used a data from a bidding process of a construction project. The model was considered as cost effective, timeless and be able to improve the quality of selection.

More recently, AHP was used by Kim *et al*. (2010) to propose a technique to assess safety risks in construction projects. In their study, literature review and expert survey were first conducted. Then, AHP was employed to identify weight of each risk. Similarly in terms of assessing safety risks, Badri *et al*. (2012) also employed AHP combined with Expert Choice software to identify potential sources of safety risks. After testing this method by case studies, their method was evaluated as it can quickly prioritize risks and their causes. Moreover, they also suggested that this method is simple to practice without large investment.

With attempts to reduce the negative impact of construction activities to the environmental aspect and socio-economic features, Reza *et al*. (2011) used AHP to create a three level hierarchy to evaluate projects. Three main criteria, namely, environmental concerns, socio-political issues and economic concerns, and thirteen sub-criteria were included in this hierarchy. A flooring system in Tehran was used to demonstrate the model. However, they noted that the model is flexible and can be used in other building components in different geographical regions. Also considering the environment impact, Zhou *et al*. (2015) proposed a model to assess the environment impact of civil structures. The model supported decision makers to make an eco-friendly decision, and a steel box girder bridge and a pre-stressed concrete (PSC) box girder bridge were used to present the model. Zavadskas *et al*. (2011) proposed a method to determine the management strategies for construction projects. In this model, strength, weakness, opportunities and threats of a project were structured and analysed by AHP. A number of criteria were also created for SWOT based on the objectives and interests of stakeholders. They also used a case study to show the applicability of the proposed model. Kayastha *et al*. (2013) applied AHP to the Tinau watershed in Nepal to create a landside susceptibility map. Eleven factors were investigated based on availability of data for the region. They noted that although the model can be used in other areas however, the criteria factors need to be adjusted based on the specific region. Wankhade and Landage (2013) used AHP as one of the components in the non-destructive testing system which is used to detect internal defects and cracks in concrete structures, pavements, and metal testing. AHP was used to select the most appropriate repair method.

Attempting to improve the consistency of AHP, Li *et al*. (2013) attempted to keep the simplicity by modifying the conditions that experts indicated on questionnaires. In their improvement, similarly to the standard AHP, pairwise comparison was applied to the criteria, but instead of comparing two criteria by nine scales as in standard AHP, judgement between two criteria was instead sorted by the researchers (Li *et al.* 2013). This feature was expected to reduce the number of pairwise comparisons, thus increasing the consistency. However, the finding shows that IAHP is not applicable when the number of criteria is three or four. In addition, the consistency level is also not satisfied when the number of criteria is eight or nine.

4.3.2. AHP in Hybrid Approaches in the Construction Area

4.3.2.1. AHP and Fuzzy Set Theory

The combination of AHP and fuzzy set theory is the subject which has attracted a number of researchers. For example, Filippo *et al*. (2007) presented a procedure to evaluate highway restoration. In this model, AHP was combined with fuzzy theory to form a model called the Fuzzy Multi-Criteria Model to support the decision. The model was used to determine the work sections which need to be restored. The research was carried out with data from the Brazilian construction industry. A hierarchy structure was created for criteria namely, risk of accidents, economic meaning, environmental influence, and risk of erosion. Two highway segments were used to test the proposed model. Pan (2008) also used the combination of AHP and fuzzy set theory to select the best method to construct a bridge project. Pan (2008) stated that this combination can resolve the problem associated in mapping people's opinions with an exact number. The triangular, trapezoidal fuzzy numbers and α-cut concept were employed in the model. Similarly to conventional AHP, the input data is the hierarchy of criteria and pairwise comparisons. They stated that the model is faster and more efficient. Another notable study which tried to combine AHP and fuzzy theory was the study by Zayed *et al*. (2008). They combined fuzzy theory and AHP to compare the risk level in four Chinese highway projects. There is a difference in applying AHP in this research. For instance, they introduced the definition of the effect score, and instead of building the matrix of option scores, they find the effect score and then use this value as the matrix of option scores in AHP. This can make the computation much easier because in order to find the effect scores they just need to rank projects or companies regarding each risk in nine scales, then use the average score. Thus, a number of pairwise comparisons do not need to be made. However, they then ignored the benefit of pairwise comparison; that it can create a clear and direct comparison between each element.

Examining the contractor selection process, Jaskowski *et al*. (2010) used Fuzzy AHP to support the decision of selecting an appropriate contractor. Through the Fuzzy AHP model, the technical and economic ability of the contractors can be assessed (Jaskowski et al., 2010). It was expected that this model can enable the user to find a solution even if the pairwise comparisons are not totally completed by decision makers. However, they also admit that the proposed model is not complete because additional difficulties diminish the mean of deviations between values given by experts and the group's weight then appears. Observing the human resource aspect of construction projects, Shahhosseini and Sebt (2011) presented a fuzzy adaptive decision making model based on AHP. The purpose of researchers was to create a computing model which can take into account various candidate competencies. In this model, human resource was classified into 4 categories, namely, project manager, engineer, technician and labourer. Shahhosseini and Sebt (2011) uttered that the proposed model is a precise and useful tool. It was also suggested that the model can be used for firms with low experience in managing human resources. They also noted that the model is flexible in order to add more additional factors to the criteria in the hierarchy structure. It is also expected to reduce the hidden cost and time during the selection stage.

Li and Zou (2011) employed fuzzy AHP to construction projects in China to prove that fuzzy AHP is also practical in assessing and ranking risks in this type of construction project with improved accuracy and reduced subjectivity. They concluded that by combining fuzzy theory and AHP, researchers can reduce problems associated with uncertain judgements of experts. The model can bring more accurate risk assessment, and reduce the level of responding experts' subjectivity. The risk ranking order was not significant different compared to results made by AHP. However, it is considered that clearer orders were made. Nevertheless, the problems of a low inconsistency level was not resolved in this research and they suggested that to minimize the consistency, experts need to be selected based on experts in the field, high relevant experience, and management experience. In addition, the authors admitted that fuzzy AHP increases the number of computations. Ka (2011) combined Fuzzy AHP and ELECTRE II methods (Elimination ET Choice Translating Reality) to select the optimal dry ports construction projects. Ka (2011) say that this combination makes the process much more suitable in real situations of selecting dry ports. The weights of six influencing factors were determined by AHP. After that, these weights are analysed by ELECTRE II methodology to evaluate alternatives. With the purpose of improving the safety of the construction site, more specifically, preventing fire accidents, Hui *et al*. (2012) used AHP to determine the safety assessment indexes by collecting experts' opinions. Five single factors of the index system were structured and evaluated by fuzzy methods. The bidding process was also examined in the research by Chou *et al*. (2013). By observing that the bidding process is a complex decision making process containing numerous influential factors, and that previous bidding models have not been successfully developed in terms of determining the bid amount with a specific confidence level, in the research by Chou *et al*. (2013), fuzzy AHP was combined with regression based simulation to create a model supporting decision makers in the bidding process. Chou *et al*. (2013) go further into the combination of AHP and fuzzy theory. They used the Fuzzy Analytical Hierarchy Process (FAHP) with the Monte Carlo simulation (MCS) to propose a new bidding strategy. In this model, FAHP was used to weigh the factors influencing the cost of a project. After that, the cumulative distribution functions were created by a regression model in different confidence levels. The model was expected to assist bidders in deciding whether they should go to the bidding competition. It also was expected to help bidders in estimating the success of the bid level with a certain level of confidence. The model was tested in a bridge project in Taiwan. Fuzzy AHP in this model was used to weigh the criteria relating to the cost of the project. Moreover this model was used with the Monte Carlo simulation to create a cumulative distribution function of the winning bid level to assist bidders in the bidding process. However, in this model Chou *et al*. (2013) just looked at the cost aspect of the project.

A more recent study by Akadiri *et al*. (2013) criticized that the current models to select construction materials fail to take into account the sustainability principles, and the process of assessing relevant criteria. Therefore, they combine AHP and fuzzy theory to form the fuzzy extended analytical hierarchy process (FEAHP) model to select sustainable material for construction projects. Six relevant criteria, namely, environmental effect, competence of resource, reduction of waste, cost, quality and social profit were collected by using the triple bottom line (TBL) technique. They then are structured to be used in the FEAHP. However, they also have to admit that their model is complicated to use as it increases the number of calculations.

Additionally, the use of fuzzy AHP is also combined with TOPSIS which is also a multiple attribute decision making technique. Research by Golestanifar *et al*. (2011) and Chamzini and Yakhchali (2012) can be taken as examples. In research by Golestanifar *et al*. (2011), fuzzy AHP and TOPSIS methods were used to propose an approach to select the best tunnel excavation method. In this approach, preference order of attributes was determined by fuzzy AHP, and final rankings of the excavation methods were made by TOPSIS. A case study of the Ghomroud water conveyance tunnel in Iran was presented to illustrate the effectiveness of the model in assisting contractors. Also looking at tunnel projects, Chamzini and Yakhchali (2012) used fuzzy AHP and TOPSIS to select the Tunnel Boring Machine (TBM). Similarly in the research by Golestanifar *et al*. (2011), fuzzy AHP determined the weights of the evaluation criteria, and TOPSIS was used to make the final rankings of options.

4.3.2.2. *AHP in other Hybrid Approaches in the Construction Area*

Another hybrid method that should be mentioned is the combination of AHP and the VIKOR method. A paper by Liu and Yan (2007) presents a model based on the VIKOR method, which is also a multiple criteria decision making approach, and AHP to support decision makers in selecting the most preferred bidder in the construction bidding process. Authors revealed that VIKOR is used to resolve the problems of conflicting criteria. Similar to other AHP models, the weights of criteria, namely, quotation, construction design, company's capability, quality, and time, were determined by AHP. They also used a numerical example to show that the model is the correct method to use and is effective.

In addition, the Integrated Value Model for Sustainability Assessment (MIVES) was also combined with AHP in the construction project. For example, Lombera and Aprea (2010) used MIVES to define the sustainability criteria of industrial buildings. These criteria are environment, cost, functionality, society, safety and visual aspect. Industrial buildings are then evaluated by AHP with regards to these criteria. The final outcome of this combination is the Environmental Sustainability Index of the industrial buildings. Similarly, MIVES was also combined with AHP in the research by Pons and Aguado (2012) to determine the technology to build schools in Catalonia, Spain. MIVES, in this model, was also used to determine the most significant and discriminatory indicators to structure a hierarchy for the AHP process. Going further with the combination of AHP and MIVES, Caño *et al*. (2012) added the Monte Carlo simulation technique to the combination. The purpose of the proposed model is not only to provide the potential sustainability index, but also to take into account the uncertainty in achieving the sustainability goals. MCS was also applied to AHP in the paper by Gervásio and Silva (2012). However, this paper provided an additional technique, Preference Ranking Organization Method of Enrichment Evaluation (PROMETHEE), to their model. The use of MCS and PROMETHEE was expected to resolve the uncertainty of evaluating life-cycle based criteria, namely, environmental, economic and social aspects. This design was expected to enhance the quality of the decision making process.

Another outstanding mixed technique is the combination of AHP and Utility Theory (UT). Hsueh *et al*. (2007) combined AHP and UT to create an online evaluation system for Joint

Ventures (JVs) in evaluating international contractors. The purpose of this model was to determine the Expected Utility Value (EUV) of each scenario. For this purpose, AHP was used to analyse the information of international contractors while UT was employed to deal with risks of each scenario. Criticizing that using AHP alone cannot provide appropriate results if the number of criteria is more than fifteen, Wang *et al*. (2008) used the data envelopment analysis (DEA) method, and the simple additive weighting (SAW) method, together with AHP to propose a model to overcome this limitation. The values of the linguistic judgement were obtained thought the DEA while the SAW method was employed to deal with risks in each criterion. A numerical example was also provided to illustrate the combination.

A further interesting combination is that of AHP and Complex Proportional Assessment of alternatives with Gray relations (COPRAS-G). This combination was provided in the paper of Bitarafan *et al*. (2012) to determine sustainable development and safety regulations. In this combination, criteria with the grey relational grade were analysed by (COPRAS-G). The values of these criteria were then described in intervals.

A more recent paper by Aminbakhsh *et al*. (2013) introduced a system using the AHP and cost of safety (COS) model to prioritize safety risks to determine reasonable investment. In their system, AHP was used to reduce the inconsistent judgements made by participants. Three levels of risks were presented. There were three groups of risks in level 2 and in each risk group (level 3), there were 3 safety risks. It was concluded that they model was able to identify and rank safety risks in construction projects. However, there is confusion about the way in which pairwise comparisons are made. More specifically, risks in risk groups (level 3) are pairwise compared, and this is consistent to AHP theory. Therefore, according to AHP theory, risk groups in level 2, then, need to be pairwise compared regarding the risks in level 3. However, in the research by Aminbakhsh *et al*. (2013), these risk groups in level 2 are not compared with regards to risks in each group. Consequently, the final results of the comparison in level 2 cannot reflect the importance of risks in level 3. Moreover, as it is time-consuming, this is one weakness of this system as it requires a huge amount of pairwise comparisons (ibid.).

4.4. AHP in Risk Management in PPPs

Apart from application of AHP to the general construction area, some researchers have also utilized this decision making theory in managing risks in PPP construction projects. For example, research by Ababutain (2002) also used AHP as a tool to select the best proposal for a BOT project. Success factors for a BOT project were identified and structured as a hierarchy. Five criteria, namely, promoter qualifications, project qualifications, financial feasibility, implementation requirements, and socio-economic effects, were selected. A total of 25 successful factors were selected as sub-criteria. Focused on Joint Venture construction projects, Zhang and Zou (2007) used Fuzzy Analytical Hierarchy Process to create a quantitative assessment approach to assess the risk level of joint venture construction projects in China. In the risk hierarchy, the second level contains internal risks, project specified risks, and external risks. In the third level, fifteen risks are structured. Similar to the standard AHP, the weights of risk factors are determined. Then researchers used fuzzy set theory to build fuzzy evaluation matrixes. By discovering that the selections of the PPP financing model and risks influencing these models have fuzzy characters, research by Chang and Liu (2008) also used fuzzy AHP to select the financing method for PPP. Three criteria, namely, Good attributes of infrastructure, Object of private co-operator, and Consciousness and concept of the government, were decided. In addition, 8 sub-criteria were identified to create the hierarchy.

Another remarkable application in PPP is the research by Lie and Zou (2008). They observed that PPPs require large and long investments. Thus, they have associated this with unique and dynamic risks. They developed the risk identification and assessment framework based on fuzzy AHP from the project life cycle perspectives. In their model, risks are identified from the literature review; they then are classified into six categories which are the stages in the life cycle of the project, namely, Feasibility study, Financing, Design, Construction, Operation, and Transfer. Each risk group has a number of risks. A total of 23 risks were used to structure the risk hierarchy. AHP was used to make a pairwise comparison between risk groups. Then the fuzzy weighting of the pairwise comparison can be computed. Finally, the ranking of risk factors can be found by defuzzification of fuzzy weighting. One of the good points of this research is that using fuzzy AHP may resolve the problems which traditional AHP may face which is that the information of risk might be imprecise and uncertain in order to make crisp judgment (Wang *et al*. 2007). However, this model makes a pairwise comparison of 6 risk groups. This may increase the level of inconsistency as Li *et al*. (2013) observed that the number of elements should not be over five. In addition, one of the very important points to note is that the advantage of AHP is to be able compare alternatives (in this case, risk factors) regarding the multi criteria; however, in the research by Lie and Zou (2008), with the fuzzy AHP model, risk weightings are just determined from defuzzification of fuzzy weighting. In other words, risk factors are not being pairwise compared with respect to the decision makers' multi-criteria. It can be seen that risks are compared with respect to the consequence of the project, but no details of the consequence are provided. Hence, the advantage of this model in ranking risks, in comparison with other risk ranking techniques, is limited.

Research by Li and Zou (2011) also presented a fuzzy AHP model as a risk assessment technique for PPPs. Similar to the research by Lie and Zou (2008) mentioned previously, the purpose of Li and Zou's (2011) research is to rank risk factors associated in PPP. A hierarchy structure with three levels was created. The criteria were divided into 7 groups, namely, risks in the feasibility stage, risks in the tendering stage, risks in the financing stage, risks in the design stage, risks in the construction stage, risks in the operation stage, and risks in the transfer stage. The model was then demonstrated by a PPP expressway project from China. They also compared the ranking results made by traditional AHP and fuzzy AHP, and concluded that fuzzy AHP can make it easier to rank risks because weighting values created by traditional AHP are similar to each other. In addition, by introducing an index **α**, they expected that this model can reduce the responding experts' subjectivity which may appear in traditional AHP. However, they also admit that the rankings of risks are similar in both methods, and fuzzy AHP creates more computation than does traditional AHP.

Alternative remarkable application into PPPs that should be revised is the use of AHP by Raisbeck and Tang (2013). Different from the research by Lie and Zou (2008) and by Li and Zou (2011) mentioned in above paragraphs, by observing that the design stage is one of the keys of a PPP, Raisbeck and Tang (2013) looked further into a single stage of a PPP, namely, the stage of development of a design. The hierarchy structure has three levels. The second level shows that four criteria were formed, namely, Design (D) and Design Management (DM), which are exploratory distinctions, and Design Support (DS) and Design Infrastructure (DI), which are exploitative distinctions. In the third level, for each element in the second level, sub-criteria were created. A total of 36 sub-criteria were structured in the hierarchy. The comparisons were made by experts in the field. It should be noted that in contrast to the purpose of the research by Lie and Zou (2008), the purpose of the research by Raisbeck and Tang (2013) is to find the ranking of criteria in level 2. Thus, sub-criteria in level 3 can be seen as multi-criteria for comparing criteria in level 2, and this can use the advantages of the AHP method. However, similar to the limitation found by Lie and Zou (2008), there are too many sub-criteria in each criteria group. For instance, there are 10 factors in the Design (D) category, and 10 factors in the Design Infrastructure (DI) category. Thus, pairwise comparison between these sub-criteria can be inconsistent, or it can be too time-consuming to achieve an acceptable consistency level.

4.5. The Selection of AHP in The Proposed Risk Evaluation Framework

From the above review, it can be seen that there has been a number of studies which have applied AHP to the construction industry, and some of them have been applied in managing risks in PPP projects. However, it can be recognised that a majority of previous studies have just focused on identifying and ranking risks in projects. There is no application of AHP in evaluation of PPP projects with regards to critical risks. In addition, there is no research that applies AHP in allocating these critical risks in PPPs. Therefore, this research will apply AHP to evaluate riskiness in PPPs. This is beneficial in practice as in reality the host government has to select the most important projects to be implemented in PPP form. Moreover, AHP will be used to allocate critical risks to the party which is the best way to manage them because the allocating process is also a decision making process in which parties need to consider multiple important factors. The details of how to apply AHP in evaluating risk level of PPPs, and how to allocate critical risks by using the proposed framework will be provided in sections 6.2.1.2 and 6.2.1.3 in chapter 6.

Importantly, it should be remarked that a number of developments and combinations have been provided in using AHP. However, each developed model also comes with its own limitations as described. In fact, as Li *et al*. (2013) concluded although there have been many developments and combinations used for AHP to improve it ability, such as increasing the consistency in the comparison matrix, or improving the ability of dealing with subjective judgements, these improvements make AHP more and more complicated to use in practice. For that reason, the current research is going to use the standard AHP because of its simplicity and its satisfactory outcomes as stated by Lie and Zou (2008), Bitarafan *et al*. (2012), and Raisbeck and Tang (2013). The application of AHP in the risk evaluation framework is for the purpose of comparing different projects with regards to risks associated to a specific PPP market. Importantly, the standard AHP was used with the suggestions from previous studies in mind, such as that of Li and Zou (2011), by choosing participants who are experts in the field with high relevant experience, and who are in the management team, so the limitation of AHP can be minimized.

4.6. Summary

This chapter clarified the reason for using the AHP model and assessed the proposed risk evaluation framework by reviewing and critically analysing the application of AHP in a wide range of contexts. In this chapter, firstly, fundamental principles of AHP were provided. After that, the application of AHP in the construction area and PPP projects was provided. The literature review in this chapter showed that the advantage of AHP is the ability to compare different alternative with regards to multiple criteria. This chapter also demonstrated that there is no application of AHP in the evaluation of PPP projects' riskiness, and no research applying AHP in allocating critical risks in PPPs. AHP is combined in the proposed risk evaluation framework to firstly evaluate PPP's riskiness, and secondly to evaluate critical risks. In addition, this chapter also clarified the use of standard AHP because of its simplicity and suitability for the aim of this research.

CHAPTER 5: REVIEW OF INVESTMENT EVALUATION METHODS AND CONCESSION DETERMINATION METHODS FOR PPPs

5.1. Introduction

In this chapter, return evaluation methods, which have been used in assessment of PPPs, will be reviewed. First, the evaluation methods used to evaluate projects in all sectors in the international market will be examined. The popularity of these methods is also compared. After that, the most popular methods which have been used to evaluate PPPs will be considered. More specifically, the Payback method, IRR, and NPV-based methods will be reviewed in detail. The review will also provide the advantages and disadvantages of these evaluation methods. By critiquing the limitations of these methods, the chapter will clarify the reason why these methods do not accurately evaluate PPPs in the transport sector. Moreover, the developments which have been used to resolve the limitations of these methods are also represented. Finally, the basic ideas of Risk Adjusted DNPV will be presented with its advantages.

5.2. Investment Evaluation Methods

When planning to invest in a long-term project, it is important to evaluate the financial aspect of the project. In other words, investors need to ensure that the project is profitable. Because of this vital need, there have been many methods used by analysts to evaluate investments, for example, Payback period methods, Internal Rate of Return (IRR), Net Present Value-Based methods, PI-Index method, etc. Investors can either use one of these methods or combine them to make a sound decision. The popularity of these methods has been also recorded by a number of researchers. For example, John and Harvey (2001) carried out a survey amongst 392 CFOs in the USA about the evaluation methods that these CFOs frequently used at the end of 1990s. In their study, IRR, NPV, Hurdle Rate and Payback are the most popular methods used in the USA. In fact, IRR and NPV are by far the most popular methods according to their survey. Moreover, in their study, large firms are more likely to use NPV than small firms, and highly levered firms are more likely to use NPV and IRR than firms with small debt. They also stressed that there is no difference between growth and non-growth organizations.

More recent studies have also attempted to rediscover the popularity of evaluation methods amongst investors. Recent studies have shown different popularity of these techniques in different parts of the world. For instance, research by Ryan and Ryan (2002), Alkaraan and Northcott (2006), Truong *et al*. (2008), Bennouna *et al*. (2010), and Baker *et al*. (2011a) found that NPV is the most popular technique in the US, the UK, Australia, and Canada, respectively. More specifically, Ryan and Ryan (2002) conducted a survey of the Fortune 1000 Chief Financial Officers and discovered that analysts are more likely to use NPV in the US market. Similar to the research by John and Harvey (2001) mentioned previously, Ryan and Ryan (2002) also observed that firms with larger capital budgets use NPV and IRR more frequently. In terms of the UK market, Alkaraan and Northcott (2006) examined the use of analysis tools in large UK manufacturing companies. In this research, Alkaraan and Northcott attempted to find the most common methods amongst NPV, Payback, IRR, and ARR. The survey showed that large UK manufacturing companies used NPV as their first choice of evaluation. They also emphasized that the result is consistent for non-strategic and strategic projects. Similarly, Truong *et al*. (2008) also confirmed that projects were mostly evaluated by NPV in Australia, but the companies also use other methods combined with NPV. More precisely, respondents in their research indicated that they usually used NPV to evaluate projects with three to ten years' investment. In the Canadian market, Bennouna *et al*. (2010) conducted a survey of 88 large firms in Canada, and amongst these firms, NPV is used the most. However, one limitation of this research is that the research only focused on large firms. In order to resolve this limitation of the Canadian market, Bennouna *et al*. (2010) and Baker *et al*. (2011a) conducted a survey with a large sample size of Canadian firms and the result also confirmed that NPV was the most frequent approach used.

However, in the European market, IRR and Payback method have been more popular. For example, Brounen *et al*. 2004 carried out an international survey and confirmed that German organizations tend to use IRR and the Payback Method to evaluate their projects. In their study, small firms tend to use the Payback method to analyse projects. A later study by Sridharanand and Schuele (2008) of the German market also found that Payback and IRR were dominant methods used to analyse investment. Similarly, research by Sandahl and Sjögren (2003) about Swedish markets also discovered that Payback is the most common method that financiers used as the first choice of evaluation. It can be seen from their findings that the Payback method is by far the most frequently used technique with 39.1 percent of investors choosing it as the primary evaluation technique. Another study by Holmen and Pramborg (2009) into Swedish firms using foreign direct investments made a point that the use of the Payback method increases with the political risk and host country's growth. They clarify that with high political risk investors are reluctant to use traditional NPV. Similarly, the dominance of the Payback and IRR methods was also found in research by Iturralde and Maseda (2004) that looked into Spanish firms.

Similar to European market, Asian investors also tend to use Payback and IRR methods rather than NPV. Indeed, research by Shinoda (2010) into 250 investors at listed firms on the Tokyo Stock Exchange also found that the Payback method was the primary choice of investors followed by NPV. He made a point that investors in these firms usually used the payback method for short-term investment such as equipment investment or information system investment, while NPV was used for long-term investment analysis. In short, they used the combination of these methods to make their decision. Another research into the popularity of evaluation methods in Asia is the research by Hermes *et al*. (2007) into China's market. In their paper, 45 Chinese companies and 42 Dutch firms were investigated. The finding also shows the preference for ARR, Payback and IRR methods in Chinese firms. Moreover, investors from Hong Kong and Indonesian also prefer Payback and IRR methods (Leon *et al*. 2008). More recently, the popularity of evaluation techniques is reviewed by Andrés *et al*. (2015). Table 5.1 show the popularity of evaluation methods in each country based on the finding of Andrés *et al*. (2015).

Table 5. 1 The most popular investment evaluation methods by country

Country	Most popular methods
USA	NPV, IRR, Payback
Canada	NPV, IRR
UK	NPV, IRR, Payback
Netherlands	NPV
Germany	NPV, Payback
France	RO, NPV
Spain	Payback, IRR
Sweden	Payback
Australia	NPV
Hong Kong	Payback

Indonesia, Malaysia	NPV, Payback
Philippines, Singapore	Payback
South Africa	ROI
Argentina	NPV
Japan	Payback, IRR
China	IRR
Latin- America	NPV

It can be seen from table 5.1 that, although there is a difference in the first choice of investor for evaluation methods, NPV, Payback, and IRR methods are still the most popular approaches used. In fact, the table shows that these methods have been used in both developed and developing markets.

5.3. Payback Method

In this evaluation method, the project can be considered as acceptable if the project's payback is smaller than the time to recouple the maximum cost forecasted by investors. In addition, when comparing projects, investors should choose the project with the shortest payback period. Moreover, the investment should be continued if the payback period is longer than the specified period (Boussabaine and Kirkham, 2006). Boussabaine and Kirkham (2006) noted that when applying the payback method, there are high hurdle rates and long payback periods for large projects while small projects can be selected by low hurdle rates and short payback periods.

In explaining the popularity of the Payback method, researchers have shown a number of advantages of this approach. For instance, Weston and Brigham (1981) say that investors use the payback method to not be forced to use external financing. However, a later study by Holmen and Pramborg, (2009) says that they cannot find evidence to support Weston and Brigham's (1981) statement. Moreover, Mills and Herbert (1987) mentioned that this method is popular because it is easy to understand and easy to calculate. Thus, it is also useable for small firms. In addition, some have stated that the Payback method is popular because manager use it to benefit their self-interests. Additionally, the Payback method can act as communication role (Lefley, 1996). More specifically, Awomewe and Oundele (2008) clarified that the payback method allows investors to quickly examine how long it will take to obtain initial investments. In addition, it can be seen as a supplementary tool for investment analysis.

However, the Payback method has been also criticized for its disadvantages. For example, Lefley (1996) criticized that in this method, the returns after the payback period are not taken into account. In addition, they also criticized that the timing of returns is ignored in this method. Some people such as Hoskins and Mumey (1979) support the claim about the returns after the payback period, in that the pre-payback period can be the predictor for the post-payback period. However, Lumby (1994) says that the argument by Hoskins and Mumey (1979) is not valid because it seems to ignore the post-payback returns because they are difficult to forecast. Lumby also stressed that there are very limited situations when ignoring post-payback returns has a small effect on investment decision. Regarding the timing of returns in the payback method, a Discounted Paypack (DPB) method was improved to overcome this limitation. However, the DPB still ignores the returns after the payback period (Yard, 2000). Besides, the DPB method leads to another criticism about the rate that should be used to discount the cash flows. Awomewe and Oundele (2008) also criticized that using this method is difficult to distinguish projects with different sizes. Furthermore, it can overestimate the short-term profitability (Awomewe and Oundele, 2008). More importantly, this method does not take into account risks in systematic way. It can also contain bias against long-term projects, and it can also show the rejection of projects which have a positive NPV (Boussabaine and Kirkham, 2006).

Although the Payback method is also one of the most popular methods in evaluating projects, IRR and NPV are more frequently used in evaluating PPPs. The sections below criticise the use of IRR and NPV in PPPs.

5.4. Internal Rate of Return

Fundamentally, the Internal Rate of Return (IRR) measures the return on the equity of the capital invested. The IRR is the discount rate which changes the NPV of the cash flows to zero. The value of IRR can be from 10 to 30 percent depending on the risk of the country and risk of the project (Boussabaine and Kirkham, 2006). The equation below describes the idea of IRR. More details of how to calculate IRR can be found from other references such as Boussabaine and Kirkham (2004). Assuming that the project has cash flows CF_0, $CF_1,\ldots,CF_n$. IRR is the rate that:

$$CF_0 + \frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \ldots + \frac{CF_n}{(1+IRR)^n} = 0 \qquad (5.1)$$

In the rule of IRR, the project will be accepted if the appropriate discount rate for a project (r) is smaller than IRR, and the project will be rejected if IRR< r. In ranking projects, the project with higher IRR will be selected. However, it should be noted that if the projects are mutually exclusive, ranking by IRR cannot be used because the size of the project has influence on IRR in terms of time (Boussabaine and Kirkham, 2006).

According to previous research, IRR is commonly used because of its advantages. For example, in this method, future cash flows of the investment are taken into account. In addition, the timing of the money is also considered in this method. Furthermore, the opportunity rate of return, and riskiness of the projects are also considered (Osborne, 2010; Cuthbert and Cuthbert, 2012; Nábrádi and Szôllôsi, 2007).

However, IRR has also been criticized due to its drawback. For example, in order to calculate IRR the same rate of lending and borrowing needs to be assumed. In addition, the opportunity cost of the project is not considered. Changes in cash flows' timing can create many IRR because the cash flow direction is changed. Moreover, in the situations where refinance is needed, the new debt may not be considered. Also, any change in parameters during the operation stage will be difficult to rectify (Boussabaine and Kirkham, 2006; Nábrádi and Szôllôsi, 2007). As previously mentioned, it may make inaccurate comparisons between small projects and large projects.

In fact, Cuthbert and Cuthbert (2012), by reviewing PFI in the UK, concluded that using IRR alone in PFI projects is significantly misleading, and it is likely to understate the cost of PFI to the public sector and to grossly understate the profit of the private sector. They suggested that if IRR is quoted in PFI, parties need to use it in conjunction with statistics of outstanding debt (Cuthbert and Cuthbert, 2012).

5.5. Net Present Value-Based Methods

5.5.1. Standard Net Present Value

In the NPV method, all future cash flows are discounted with a given discount rate and then they are summed, subtracting the initial investment cost. It is considered that NPV which is above zero can guarantee that the project will generate a profit that is at least equal to the investment cost. The equation below shows how NPV is measured:

$$\text{NPV} = \text{CF}_0 + \frac{CF_1}{(1+r)} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n} \qquad (5.2)$$

Where,

CF_0: Initial Investment

NPV: Net Present Value

CF_i: Cash Flow generated in year t

r: Risk discounted rate

The risk discounted rate can be the sum of the risk free rate, (which is often considered as the government bonds), and a risk premium rate (to cover risks such as technical, commercial) (Doctor *et al*., 2001).

One of the key ideas of the NPV is that cash flow tomorrow is less valuable than cash flow today. Therefore, cash flows in the future need to be discounted by each time period "t". Thus, the discount rate is a core element in this approach. This rate considers the opportunities' cost of the project and hence varies following the variation of riskiness of the project. Therefore, NPV can be considered as a risk- adjusted approach (Gaily, 2011). The discount rate can be calculated as the weighted average cost of equity and debt used in the project or it can be assumed as the cost of capital of the whole company in small projects (Chiesa and Frattini, 2009). Another key point of NPV is that this approach takes into account all cash flows during the project lifecycle. All incomes and expenditure streams need to be discounted by the discount rate, and the final value of the project is the remaining value after subtracting the income stream from the expenditure stream. If the

NPV is positive, the project is considered as profitable and the rate of return will be higher than the minimum required rate of return, and vice versa. Consequently, projects with higher NPV can be considered to bring higher return (Žižlavský, 2014).

In general, the rules of the NPV method are that the NPV of the project needs to not be less than zero. If the NPV is negative the project is rejected. If the present value of the project shows the highest cost that investors would invest, the NPV shows the additional value of the project. In comparing projects, the project with the highest positive NPV should be chosen (Boussabaine and Kirkham, 2006).

In reality NPV is one of the most popular methods (Hanafizadeh *et al*. 2011) as this approach contains several attractive features for investors. For example, future cash flows are considered in this method, and timing of these cash flows is also taken into account. Moreover, it allows investors to compare different projects with different risk profiles, and usually higher discount rates are selected for riskier projects (Budnick, 1988). In addition, in this approach, projects are evaluated with regards to potential opportunities rather than the time period (Gaily, 2011). Likewise, some explicit arbitrary threshold for instance, payback time is not required in calculating NPV (Gaily, 2011). Additionally, it is also well-known for its simplicity (Espinoza and Morris, 2013).

On the other hand, the NPV approach has been also criticized in a number of aspects. For example, regarding the discounted rate, McSweeney (2006), observed that using a single discounted rate is fraught with drawbacks which can generate an incorrect estimation of a project. Moreover, the discount rate is criticized to be more concerned with the source of finance than the project itself, and it is difficult to account for specific risks in this discount rate (Pergler *et al*. 2008). Similarly, Doctor *et al*. (2001) also criticize that the use of WACC to calculate the risk discount rate only takes into account the financial risks and it seems to be not specific for each project. This can lead to unreasonable results which seem to be difficult to explain. In addition, NPV requires future cash flows to be discounted precisely in the long-term future by a discount rate, and this seems to be very difficult to do. Thus, NPV can appear to be unreasonable for long-term projects (Doctor *et al*. 2001). Consequently, this can lead to underestimation or overestimation. Furthermore, this method seems to make an unreasonable distinction between the risky project and the long-term project (Žižlavský, 2014). Also, equal risks are assumed for both cash inflows and cash outflows. Also, if the project requires refinance, the new debt is not considered. In addition, for mutually exclusive projects, NPV assumes that investment opportunities are independent. However, in real world situations this may not apply. Furthermore Warren (1982) criticized that the value of NPV is influenced by the size of the investment. Similar criticisms were also made by Helfert (2001).

5.5.1. Risk-adjusted NPV

In order to resolve the weakness of NPV, a number of developed methods have been modelled, for instance, risk-adjusted NPV by Stewart *et al*. (2001). In risk-adjusted NPV, costs, risks and time are taken into account to determine a real value of the project. In their model, revenues are multiplied with the current risk while associated costs are multiplied with the likelihood of having to pay each cost. The risk-adjusted value is calculated by subtracting the risk-adjusted payoff to associated costs. Therefore, the risk adjust NPV is the NPV of the risk adjusted revenue minus the sum of NPV of the risk-adjusted costs (Stewart *et al*., 2001). The risk-adjusted value is presented by Stewart *et al*. (2001) as:

$$rV = PR_0 - \sum_{i=0}^{n} C_i \; R_0/R_i \qquad (5.3)$$

Where,

rV: Risk-adjusted value

P: Payoff

R_0: Current risk

Ci: Associated cost for risk i

Ri: The risk that needs to be considered

From this equation, the risk-adjusted NPV can be calculated as:

$$rNPV = NPVPR_0 - \sum_{i=0}^{n} NPVC_i \; R_0/R_i \qquad (5.4)$$

Where,

rNPV: Risk adjusted NPV

$NPVPR_0$: NPV of the risk adjusted payoff

NPVCiR0/Ri = sum of the risk-adjusted costs of risk i

R_0: Current risk

Although these methods have been developed to resolve the weakness of NPV, one of the common features of these methods is the conjunction of the discounted rate for risk and time value (Halliwell, 2011). A number of researchers have stated that adding risk and time together cannot be a valid approach because they can be entangled (Zeckhauser and Viscusi, 2008).

5.5.2. Stochastic NPV

In terms of scholastic NPV, each component of the cash flow is considered as the distribution probability. Hence, NPV in this model can be displayed as a stochastic variable described by a probability distribution.

According to Chiesa and Frattini (2009), expected NPV can be modelled as:

$$E(NPV) = \sum_{t=0}^{n} \frac{E(NCFt)}{(1+r\quad)^{t}} \qquad (5.5)$$

Where,

E(NPV): Expected NPV

E(NCFt): Expected value of the net cash flow in year t

r: risk free rate

It can be seen from the equation 5.5 that the risk free rate is used instead of the risk discount rate.

In fact, the idea of calculating NPV with a separated risk and time was proposed by Robichek and Myers (1965, 1966) in Certainty Equivalent NPV.

5.5.3. Certainty Equivalent NPV

Basically, in this model, investors need to exchange a certain cash flow for a risk cash flow. This model uses the risk free rate instead of the risk discount rate, and the cash flows are added by a coefficient "α_t" varying from 0 to 1 (Chiesa and Frattini, 2009).

$$NPV_{CEQ} = \sum_{t=0}^{n} \frac{\alpha_t E(NCFt)}{(1+r)^t} \tag{5.6}$$

Where,

NPV_{CEQ}: Certainty equivalent NPV

E(NCFt): Expected Cash flows in year t

α_t: Coefficent in year t

r: risk free rate

According to Žižlavský (2014), the value of α_t can be received from some reference. For example, a table for α_t specially created for an R&D project was provided by Chiesa and Frattini (2009). By using the risk-free rate, this model can resolve some problems associated with the conjunction of a discounted rate for the risk and time value as Halliwell (2011) stated. In addition, this method is considered as more flexible and reliable than traditional NPV. However, this approach has been seldom applied, as there is no practical method to determine the value of the coefficient "α_t" (Espinoza and Morris, 2013). Moreover, determining input criteria for this model is also impractical (Espinoza and Morris, 2013).

5.5.4. Fuzzy Net Present Value

By criticizing that it is impossible to precisely assume some values in NPV methods, such as cash flows and discount rates, researchers have proposed Fuzzy NPV. They argue that cash flows and discount rates can be seen as fuzzy numbers. Basically, instead of predicting specific values in different periods of time, possible intervals can be considered.

For example, $[C_t + \varepsilon_t, C_t + \beta_t]$ and $[r_t + \theta_{t,} r_{t+} \varpi_t]$ can be used, where C_t and r_t are predicted cash flow and risk discount rate, whereas, ε, β, θ, ϖ are variable determined by decision makers (Wen and Lu, 2007). However, it is criticized by some researchers such as Cao *et al*. (2009), Ucal and Kuchta (2011), Kumar and Bajaj (2014), that, this method makes computation much more complicated.

5.6. Decoupled Net Present Value Method

In contrast to NPV methods, DNPV treats risk and time separately. Espinoza and Morris (2013) criticized that the limitations of NPV-based methods can be resolved if the time value of the uncertainty associated with future cash flows is separated. In this method, an investor is viewed as an insurance provider, and the investor forecasts synthetic insurance premiums as compensation for risks predicted. It should be recognized that the independent synthetic insurance product is assumed to exist. The value of compensation is seen as a synthetic insurance premium, and risks are treated as the cost of the project. According to Espinoza *et al*. (2013), DNPV can be measured as:

$$\mathrm{DNPVt} = \frac{(\tilde{\mathrm{V}}_t - \tilde{\mathrm{R}}_{vt}) - (\tilde{\mathrm{I}}_t - \tilde{\mathrm{R}}_{It})}{(1+\mathrm{r})^t} = \frac{(\tilde{\mathrm{V}}_t - \tilde{\mathrm{I}}_t) - (\tilde{\mathrm{R}}_{vt} + \tilde{\mathrm{R}}_{It})}{(1+\mathrm{r})^t} \qquad (5.7)$$

Or

$$\mathrm{DNPV} = \frac{\tilde{\mathrm{V}}_t - \tilde{\mathrm{I}}_t - \tilde{\mathrm{R}}_t}{(1+\mathrm{r})^t} \qquad (5.8)$$

Or

$$\mathrm{DNPVt}(\tilde{\mathrm{V}}\mathrm{t}, \tilde{\mathrm{I}}\mathrm{t}, \mathrm{r}, \tilde{\mathrm{R}}\mathrm{t}) = \mathrm{NPVt}(\tilde{\mathrm{V}}\mathrm{t}, \tilde{\mathrm{I}}\mathrm{t}, \mathrm{r}) - \frac{\tilde{\mathrm{R}}\mathrm{t}}{(1+r)^t} \qquad (5.9)$$

Where $DNPV_t$: Decouple Net Present value of a project at year t;

$\tilde{V}_t$:Revenue of the project at year t;

$\tilde{I}_t$: Expenditure of the project at year t;

r: risk-free rate,

$\tilde{R}V_t$: Loss due to the decrease of revenue

$\widetilde{R}_{It}$: Loss due to the increase of expenditure

$\widetilde{R}_t$: $\widetilde{R}V_t$ + $\widetilde{R}_{It}$ which presents the expected total cost of risk at time t. This can be forecasted as the sum of all sources of risks.

From the above equation, it can be seen that the value of DNPV is equal to NPV at the risk-free rate minus the present value of the cost of risks discounted by the risk-free rate.

From the equation, it can be recognised that it is crucial to estimate the value of $\widetilde{R}_{Vt}$; $\widetilde{R}_{It}$ which can be measured as:

$$\widetilde{R}_{Vt} = \eta_v \tilde{V}t \qquad (5.10)$$

$$\widetilde{R}_{It} = \eta_I \tilde{I}t \qquad (5.11)$$

where η_v and η_I are risk parameters presenting the riskiness of the project. More specifically, η_v is the parameter identifying the loss due to the decrease of revenue, and η_I is the parameter identifying the loss due to the increase of expenditure. Further details on how to determine these parameters will be provided in chapter 6. Espinoza *et al*. (2013) proposed three methods to estimate risk parameters. They are heuristic methods, probability-based methods, and stochastic methods (option pricing). In the simplest level, the heuristic method, the cost of risk is assumed by investors, and in reality it can be seen as the cost contingency assumed by investors. This cost contingency depends on investors' experience. For example, in the construction industry, it may not be uncommon that on the expenditure side, the cost overrun is usually assumed by investors. In addition, this parameter can also be taken from suggestions from literature, or previous studies about the targeting construction industry. For example, cost contingency can be found in some research such as those by Baccarini, (2004), Hanafizadeh *et al*. (2011), Paul *el al*. (2014), and Anastasopoulos, *et al*. (2014). The next method, the probability-based method, is more sophisticated. The value of η is estimated by using probability distribution. Basically from the data of revenue and expenditure, companies can create a distribution of these data. Some types of distribution such as triangular normal, log-normal, and beta distribution can be used. In the third method, real option pricing method bonds are used (Black and Scholes, 1973). These methods take into account the variation of revenues or expenditure. On the revenue side, the risk parameter can be seen as a put option, and on the expenditure side, it can be seen as a call option. Details of these methods will be described in chapter 6 about the proposed risk evaluation framework.

5.7. Selection of an Evaluation Model

Due to the previously mentioned criticism of current methods in evaluating PPPs, and advantages of DNPV, in this research, DNPV will be used as a model to evaluate Vietnamese PPPs in the transport sector. However, DNPV also contains limitations, and in this research, this limitation will be resolved by proposing Risk-Adjusted DNPV.

More specifically, although according to Espinoza and Morris (2013), DNPV is expected to resolve limitations of NPV, regarding the PPPs in the transport sector, DNPV has not taken into account the influence of other risk factors on the loss of the revenue side, and the loss on the expenditure side. In other words, other risks such as “Delay in other infrastructures relating to projects” and “Difficulty in Land acquisition and Resettlement” can have an influence on loss on the revenue side. Therefore, in this proposed framework, Risk-Adjusted DNPV is proposed. Based on the idea of DNPV, Risk-Adjusted DNPV also separates risk and time. In addition, risk factors which can have an influence on the loss on the revenue side and loss on the expenditure side can be taken into account. Basically, in Risk-Adjusted DNPV the risk-adjusted parameter ($\overline{\eta}$) is used instead of the risk parameter (η).The details of how to use Risk-Adjusted DNPV will be provided in section 6.2.2.2 in chapter 6 which is about the proposed risk evaluation framework.

5.8. Concession Parameters Based on Risk Adjusted DNPV

This section will clarify the use of Risk-Adjusted DNPV in optimizing concession parameters. In PPPs, the concession period refers to the period of construction and operation (Zhang, 2009). Determining the concession period in a BOT project is one of the most important tasks, since the concession period clarifies the time that the project will be transferred to the public agency. Therefore, it defines the responsibility and benefit of each sector in the project. The unreasonable concession period can lead to losses for the government or private investors. If the concession period is too short, the private sector can suffer from losses. In contrast, concession period that is too long can reduce the benefits of public agency. Hence, determining a reasonable concession period to protect the interests of both sectors has been an attractive feature to practitioners and academics.

A model, BOTCcM, was developed by Shen *et al*. (2002) to determine an alternative concession period for BOT contracts. BOTCcM can provide an interval for the concession period. On one hand, the starting point of the interval is to protect the interests of the private sector. On the other hand, the second point is to protect the interests of the public sector. The starting point of the interval can be determined by the idea that the Net Present Value during the concession period should not be less than the investor's expected return.

$$NPV^{(1)} = \sum_{t=1}^{T_c} NPV_t = \sum_{t=1}^{T_c} \frac{I_t - C_t}{(1+r)^t} \geq IcR \qquad (5.12)$$

The end point of the interval is determined based on the principle that the NPV from the transfer time to the end of the period should not be less than zero.

$$NPV^{(2)} = \sum_{t=T_c+1}^{n} NPV_t = \sum_{t=T_c+1}^{n} \frac{I_t - C_t}{(1+r)^t} \geq 0 \qquad (5.13)$$

Where,

$NPV^{(1)}$: Net Present Value during the concession period.

$NPV^{(2)}$: Net present value after the concession period.

NPV_t: Net present value at year t.

T_c: concession period which need to be determined.

I_t: Income in year t.

C_t: cost in year t.

r: discounted rate.

Many models have been developed to improve BOTCcM. For example, BOTCcM is criticized by Shen *et al*. (2005) that the model does not consider the impact of risks. Shen *et al*. (2005) present an additional risk model. The Monte Carlo simulation was used to simulate variables such as Annual Capital Investment (Ic), Construction Time (t_0), Toll price (p), Annual Traffic Volume (q), Annual discount rate (r), and Annual Maintenance Cost (C_m). The result of this developed model is also an interval of the concession period.

Moreover, it is criticized that one of the weakness of BOTCcM is that it cannot show a specific time span for the concession period. In order to determine a specific concession period, a BOT bargaining concession model (BOTBaC) was developed by Shen *et al*. (2007), and this new model is also an extension of BOTCcM. The BOTBaC takes into account the bargaining behaviour of both the private and public sectors. The bargaining theory is based on the principle that in negotiations, an individual's action depends on what others do (Shen *et al*. 2007). Based on the interval created by BOTCcM, investors and the government will bargain until they meet a specific concession period which balances the interests of both sectors.

Another model developed from BOTCcM is the model developed by Wu *et al*. (2012). Wu *et al*. (2012) criticized that BOTCcM does not take into account the net asset value (NAV) at the transfer time. They say that at the transfer time, the construction is transferred to the government, and the NAV at this time is greater than zero, and it can be seen as revenue for the government. Therefore, the NAV needs to be added in BOTCcM. From this ideal, the 2nd equation in BOTCcM is modified as:

$$\mathrm{NPV}^{(2)} = \sum_{t=T_c+1}^{n} \mathrm{NPV}_t = \sum_{t=T_c+1}^{n} \frac{I_t - C_t}{(1+r)^t} \geq \mathrm{NAV}_{T_c} \qquad (5.14)$$

Wu *et al*. (2012) also suggests that the risk concession model (Shen *et al*. 2005), and BOTBaC (Shen *et al*. 2007) have no consideration of the project's net asset value at the transfer time, and these models should add this item in order to determine a more reasonable concession period.

These models have been developed to reduce the limitations of each model. However, these models are based on the Net Present Value technique which has a number of limitations which have been mentioned previously.

In addition, one of the limitations of the model of Wu *et al*. (2012) is that the depreciation cost in the paper by Wu *et al*. (2012) is determined by straight-line depreciation. It is said that this method is simple. However, its limitation is that the asset is assumed to be used with the same frequency every year (Warrant *et al*. 2009). In fact, the demand for a transport construction changes every year. Therefore, to determine the depreciation cost, in this framework, the Unit of Production method is used. The idea of this method is that the asset is depreciated based on the unit of production used, and therefore it is suitable for assets relating to traffic levels (Queensland Competition Authority, 1999). The detail of how to calculate the depreciation cost will be mentioned in section 6.2.2.3 in chapter 6.

5.9. Summary

This chapter reviewed return evaluation methods that have been used in PPPs in international contexts, and reviewed the current methods in determining the concession period. The purpose of reviewing these methods is to, firstly, justify the reason for using Risk-Adjusted Risk DNPV in this research. The literature review demonstrated that a number of evaluation methods have been used to evaluate returns in PPPs. However, these methods have their limitations. For example, one of the most critical limitations is the conjunction of risk and time in one parameter. For this reason, DNPV will be applied in this research. However, this chapter also criticized that DNPV does not take into account the influence of other risk factors in losses on the expenditure and revenue side. Therefore, in this research, Risk-Adjusted DNPV is proposed. In addition, this chapter also criticized other previous models in determining concession periods. Hence, in this research a model to optimize the concession period will be also proposed based on the theory of Risk-Adjusted DNPV.

CHAPTER 6: PROPOSED RISK EVALUATION FRAMEWORK FOR VIETNAMESE PPPs IN THE TRANSPORT SECTOR

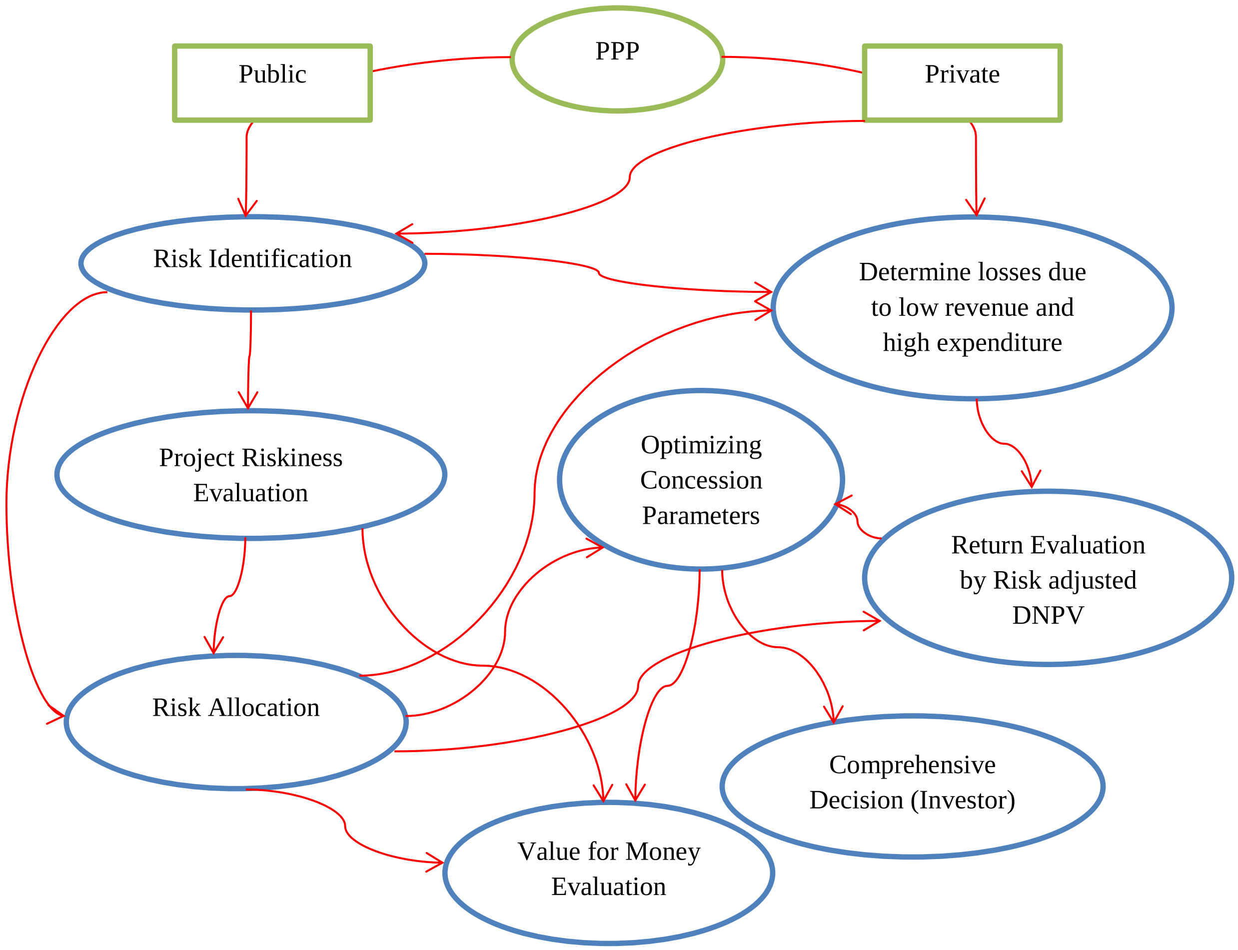
6.1. Introduction

As previously stated, the aim of the research is to propose a framework to evaluate risks in Public-Private Partnership projects (PPPs) in the transport sector in Vietnam. In this chapter, the details of the proposed framework will be introduced. Basically, the framework is a combination of Risk Identification Technique, Analytic Hierarchy Process (AHP) and Risk-Adjusted Decoupled Net Present Value (DNPV) theory. The framework is expected to be able to identify risks associated with Vietnamese PPPs in the transport sector. From this point, the framework is expected to be able to evaluate projects' riskiness, and to evaluate projects financially with regards to associated risks. As a result, the proposed framework is also expected to determine a reasonable franchise concession period for PPP projects. Furthermore, the framework is expected to allocate risks in Vietnamese PPPs to the party which is best able to manage them. In the following sections, firstly, the conceptual model of the framework will be explained, after that each component of the proposed framework with the principles and theory behind them will be demonstrated.

6.2. Conceptual Framework

Figure 6.1 shows the conceptual framework. As can be seen from the figure, there are 8 boxes in the conceptual framework which show different steps in evaluating risk in PPP. The arrows show the relationship amongst the steps. Each party can use this framework in different ways. For example, they can skip some boxes based on risks they are managing. Details on how each party can use this framework are presented in following sections.

Figure 6. 1 Conceptual framework

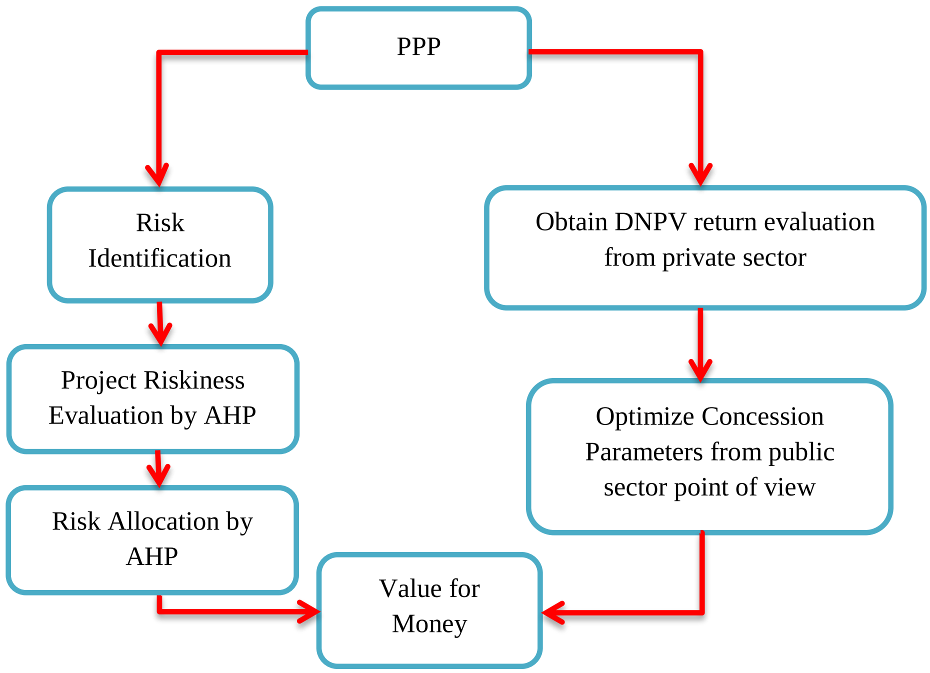


6.2.1. Public Sector

Figure 6.2 below demonstrates the process of applying the proposed framework for the public sector. From the figure, it can be seen that the first step for the public client is “Risk identification”. After that, the public sector can move to the next box, “Project Evaluation by AHP”. It should be noted that in this framework it is essential to use the risks identified in the first step to set up the AHP model. The details on how to set up this AHP model will be presented below. At the same time, the public sector receives the DNPV Return evaluation from the private sector, and after that they can optimize the concession parameters. It should be noted here that in this step they optimize concession parameters to protect the public sector’s benefits. Details of how to carry out this stage will be presented later. From the results of the optimizing concession parameters and the Project’s Riskiness

Evaluation, the public sector can make the decision for a value for money comparison. From that, they can make the final decision to implement the project under PPP or refuse it.

Figure 6. 2 Process of using the framework for the public sector



6.2.1.1. Risk Identification Use for the Public Sector

The first step of the model from the public point of view is to identify critical risks in PPPs in the transport sector in Vietnam. In this step risks are accessed by "Frequency of occurrence" and "Degree of impact". More details of this assessment can be found in chapter 7. The finding of this stage is the risk score for each risk, and risk ranking table. These risk scores and risk ranking table will be used as input data for other steps which will be clarified in the following sections.

From Figure 6.1, it can be seen that there are links between the "Risk identification" and "Project's Riskiness Evaluation", and "Return Evaluation by Risk-adjusted DNPV", and "Optimizing Concession Period Parameters". These links express the relationship between these items. However, in this model, from the public sector point of view, the result from the risk identification stage is only used to set up the AHP model. For example, from the result of the risk identification stage, the most critical risk that with the highest risk scores, may be chosen to set up AHP, risks with just the most frequent occurrence can be chosen or risks with just the highest degree of impact can be selected. The decision of choosing risks is based on the public sector for each specific project.

6.2.1.2. Project's Riskiness Evaluation

The purpose of "Project's Riskiness Evaluation" box in figure 6.2 is to evaluate different projects or one project with different forms of construction with regards to critical risks. Input data for this box comes from the "Risk Identification" box and from the range of project options that need to be considered. More specifically, critical risks from the outcome result of "Risk Identification" and the range of project options will be used to set up the AHP project evaluation. Outcome results of this box can be put into the "Risk allocation" box.

As stated previously in chapter 4, each criterion will have a weight based on the pairwise comparison made by decision makers. The more important criteria should have the higher weights. The options are scored with respect to each criterion. Finally, a global score for each option with respect to all criteria can be calculated by combining the weight of criteria and score of options. Figure 6.3 shows the AHP structure in project evaluation and Figure 6.4 shows the process of carrying out AHP when evaluating projects in this research.

Figure 6. 3 AHP structure in project's riskiness evaluation

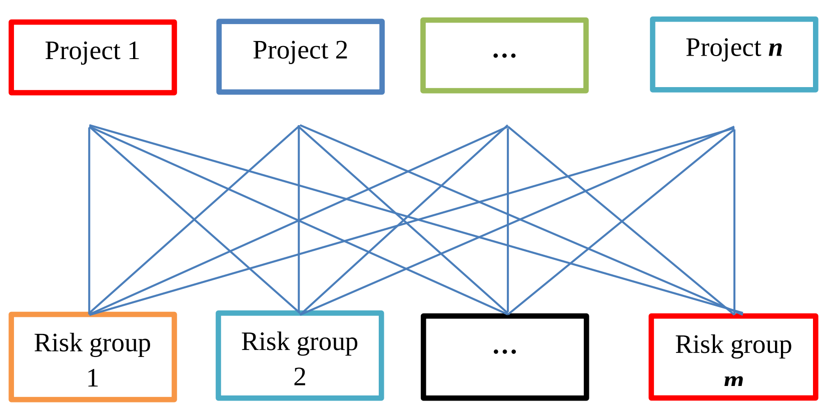
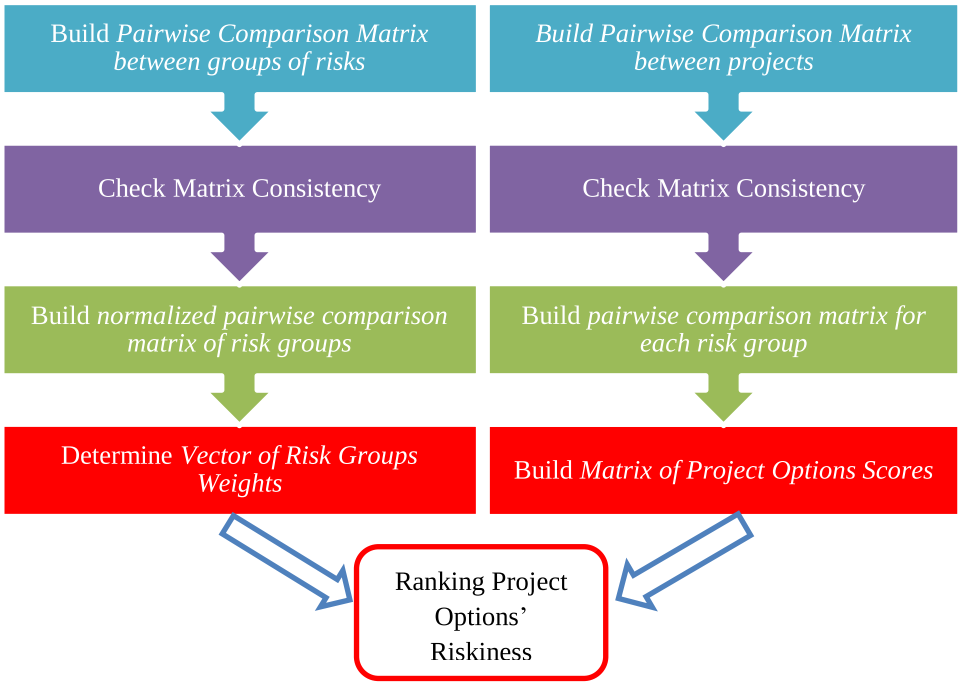


Figure 6. 4 Process of Carrying out AHP in Project's Riskiness Evaluation



a. Determining the Vector of Risk Groups Weights.

Assume that we have a set of risk groups which contains m risk group. A pairwise comparison matrix A needs to be built. A is an m x m real matrix.

$$A=\begin{bmatrix} 1 & a_{12} & \dots & a_{1m} \\ a_{21} & 2 & \dots & a_{2m} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & 1 \end{bmatrix}$$

Each member a_{ij} of the matrix A represents the importance of **i** risk group in comparison to ***j*** risk group. If a_{ij} >1, the risk group ***i*** is more important than ***j***, and if a_{ij} < 1, the risk group ***i*** is less important than the risk group ***j***. Importantly, each entry of the matrix **A** needs to satisfy the rule: $a_{ij} \times a_{ji} = 1$. The importance comparison is measured by following a scale ranked from 1- 9. The table below expresses the linguistic judgement in AHP.

Table 6. 1 Linguistic Measures of Importance in this research based on measurements made by Saaty (1980)

Scale	Definition	Explanation
1	Equal	Two risk groups contribute equally to the objective
3	Weak	One risk group is slightly more important than another
5	Strong	One risk group is more strongly more important than another
7	Very Strong	One risk group is very strongly more important than another
9	Absolute Strong	One risk group is extremely more important than another

Table 6. 2 Pairwise comparison made between risk groups

	Risk group 1	Risk group 2	…	Risk group *m*
Risk group 1	1			
Risk group 2		1		
…			1	
Risk group *m*				1

Tables 6.2 and 6.3 show the comparison made in applying AHP in project evaluation. From these tables, it can be seen that the number of comparisons made between risk groups is $\boldsymbol{m}(\boldsymbol{m}-1)/2$, and the number of pairwise comparisons made between project options is $\boldsymbol{n}(\boldsymbol{n}-1)/2$.

Table 6. 3 Pairwise comparison among project options

	Project 1	Project 2	…	Project n
Project 1	1			
Project 2		1		
…			1	
Project n				1

After building matrix **A**, a *normalized pairwise comparison matrix* **A***norm* can be built and each entry $\bar{a}_{ij}$ of the matrix **A** *norm* is computed as:

$$\bar{a}_{ij} = \frac{a_{ij}}{\sum_{h=1}^{m} a_{hj}} \quad (6.1)$$

Then the criteria weight vector can be calculated as:

$$W= \begin{pmatrix} W1 \\ W2 \\ W3 \\ \dots \\ W5 \end{pmatrix} \quad (6.2)$$

Where:

$$w_i = \frac{\sum_{h=1}^{m} \bar{a}_{ih}}{m} \quad (6.3)$$

In other words, the criteria weight vector can be built by first creating a new matrix in which each member in the new matrix is determined by dividing the corresponding member in matrix A to the sum of the column that the member is in. Secondly, $\boldsymbol{w_j}$ is calculated by averaging the members in each row of the new matrix.

b. Determining the Matrix of Option Scores

After the criteria weight vector is known, the matrix of option scores will be determined. The matrix of option score S is an **n x m** real matrix. Each member S_{ij} represents the score of ***i****th* option with respect to the ***j****th* criteria.

To determine S, first, it is necessary to build a pairwise comparison matrix B^j for each criteria. Where: j=1-m.

B^j is an **n x n** real matrix, where **n** is the number of options, and each member b_{ih}^{j} represents the evaluation of option ***h*** in comparison to option ***i*** with respect to the criteria *j* with (h =1 – n).

$$B^{(j)} = \begin{bmatrix} b_{11}^{j} & b_{12}^{j} & \dots & b_{1n}^{j} \\ b_{21}^{j} & b_{22}^{j} & \dots & b_{2n}^{j} \\ \dots & \dots & \dots & \dots \\ b_{n1}^{j} & b_{n1}^{j} & \dots & 1 \end{bmatrix} \quad (6.4)$$

According to Satty (1980):

$$b_{ih}^{j} \text{x} b_{hi}^{j} = 1 \quad (6.5)$$

Similarly, the value of b_{ih}^{j} can be measured by the scores showed in table 6.1.

After finding the matrix B, the method used to determine the criteria weight vector W will be used to calculate member s^i, (i = 1-m). Then S is determined as:

$$S = [s^1, s^2, \dots, s^m] \quad (6.6)$$

It should be noted that in this equation, s^i is the vector; therefore, S is a matrix.

c. Ranking the Options

Finally, the global vector v is determined as:

$$V = S .W \quad (6.7)$$

Each member of **V** represents the score of $\mathbf{i^{th}}$ project with respect to all risk groups. We have the project ranking by placing members in **V** in a descending or ascending order.

In order to make an aggregation of matrixes, the Weighted Arithmetic Mean Method was used with the equation:

$$\mathrm{PgAj} = \{\sum_{1}^{N} \mathrm{WiPi(Aj)}\} / \sum_{1}^{N} Wi \quad (6.8)$$

Where,

PgAj: Group priority of option A_j

Pi(Aj): The value made by member E_i in making pairwise comparison between risk groups, or options

W_i: Weight of member E_i

N: Number of member

In case all members of the group have an equal weight, which is the case in this research, we then have:

$$\mathrm{PgAj} = \sum_{1}^{n} \mathrm{Pi(Aj)}/\mathrm{n} \quad (6.9)$$

6.2.1.3. Risk Allocation

The “Risk allocation” box has links with “Project’s project riskiness evaluation”, “risk identification”, and “concession period parameters”. More specifically, critical risks from the risk identification stage can be used to set up the risk allocation AHP model. On the other hand, the risk allocation model can be set up after the Project’s Riskiness Evaluation is conducted. Outcomes of this allocation stage will define the risk allocated to each party, and one of these risks is the financial risk, which can be examined in the Return in Evaluation and Optimization of Concession period parameters.

In terms of application of AHP to allocate risks to the party which is best able to manage them, a set of criteria and a set of options also need to be established. In this risk allocation model, the set of criteria contains criteria by which decision makers want to evaluate each option. For example, criteria will be: "*The capability to foresee the risk*", *"The capability to control the probability of occurring"*, and *"The ability to bear the consequence"*. The set of options contains alternatives that the risk can be allocated to. For example, they can be: *"Public sector"*, *"share"*, or *"Private sector"*. Figure 6.5 shows the AHP allocation structure for risk ***i*,** and figure 6.6 shows the process of carrying out AHP in allocating risk ***i*.**

Figure 6. 5 AHP allocation structure for risk *i*

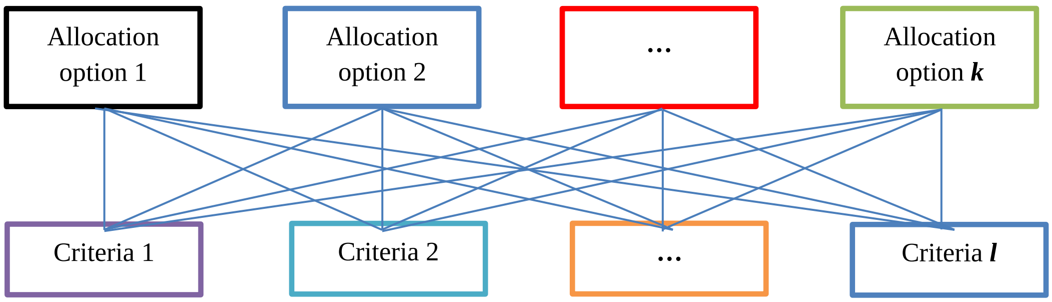
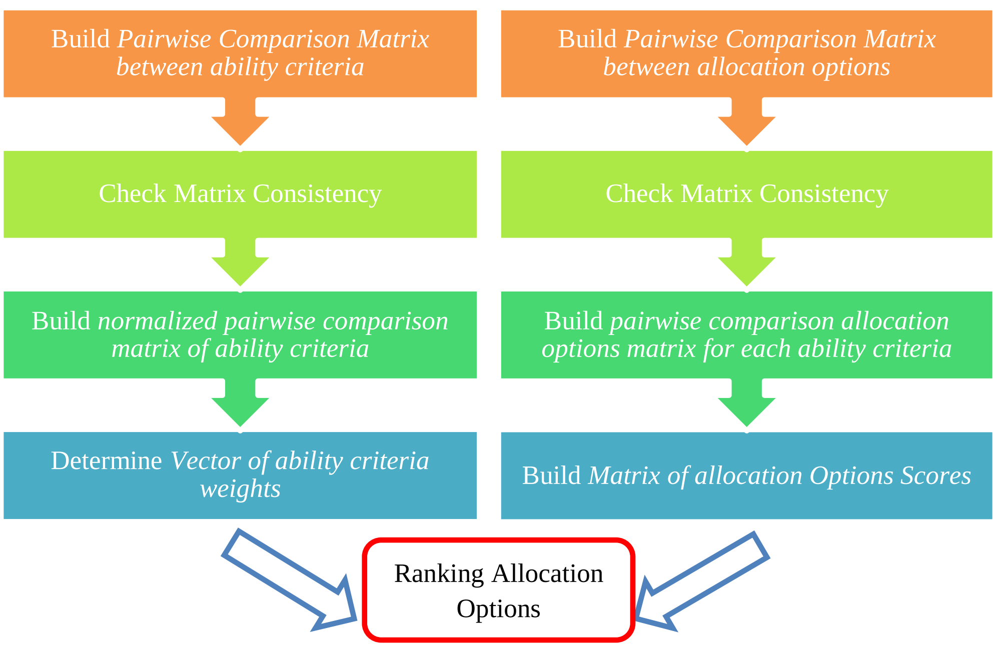


Figure 6. 6 Process of carrying out AHP in allocating risk *i*



A very important point to note here is that this allocation model is based on an assumption that the importance of criteria is the same for all risks. For example, "the capability to foresee the risk ***i***" is equally important to "the ability to foresee the risk ***j***". This is also one of the limitations of the research as in reality, they might not be equally important. For instance, for private investors, regarding the inflation risk, the ability to foresee the risk might be more important than the ability to control the probability of occurrence. However, for insufficient traffic volume risk, these abilities might be equal.

Similarly to the project riskiness evaluation process, the set of criteria weight and the matrix of option scores need to be formed. Also, a pairwise comparison matrix E needs to be built. E is an ***l*** x ***l*** real matrix described below.

$$E=\begin{bmatrix} 1 & e_{12} & \dots & e_{1l} \\ e_{21} & 1 & \dots & e_{2l} \\ \dots & \dots & \dots & \dots \\ e_{l1} & e_{l2} & \dots & 1 \end{bmatrix} \quad (6.10)$$

Each member e_{ij} of the matrix E represents the importance of ***i*** criteria in comparison to ***j*** criteria. If e_{ij} >1, the criteria ***i*** is more important than ***j***, and if e_{ij} < 1, the criteria ***i*** is less important than criteria ***j***. Similarly, each entry of the matrix **E** needs to satisfy the rule: e_{ij} x e_{ji} = 1, where ***i***, ***j*** = 1- ***l*.** The value of e_{ij} can also be determined from table 6.1.

Table 6. 4 Pairwise comparison made between ability criteria

	Ability criteria 1	Ability criteria 2	…	Ability criteria *l*
Ability criteria 1	1			
Ability criteria 2		1		
…			1	
Ability criteria *l*				1

Tables 6.4 and 6.5 show the comparison made in applying AHP in project evaluation. From these tables, it can be seen that the number of comparisons made between the ability criteria is $l\,(l-1)/2$, and the number of pairwise comparisons made between the allocation option is $k(k-1)/2$.

Table 6. 5 Pairwise comparison made between allocation options (parties)

	Allocation option 1	Allocation option 2	…	Allocation option *k*
Allocation option 1	1			
Allocation option 2		1		
…			1	
Allocation option *k*				1

After building matrix E, *normalized pairwise comparison matrix* E*norm* can be built where each entry $\bar{e}_{ij}$ $\bar{e}ik$of the matrix E *norm* is computed as:

$$\bar{\boldsymbol{e}}_{\boldsymbol{ij}} = \frac{\boldsymbol{e_{ij}}}{\sum_{\boldsymbol{h=1}}^{\boldsymbol{l}} \boldsymbol{e_{hj}}} \quad (6.11)$$

Then the criteria weight vector can be calculated as:

$$U = \begin{pmatrix} U1 \\ U2 \\ U3 \\ \ldots \\ U5 \end{pmatrix}$$

Where:

$$U_i = \frac{\sum_{h=1}^{l} \bar{e}_{ih}}{l} \quad (6.12)$$

Likewise, the matrix of allocation option scores Z needs to be determined. The matrix of option scores Z here is a *p* x *l* real matrix. Each member Z_{ij} represents the score of *ith* allocation option with respect to the *jth* criteria.

Similarly, a pairwise comparison matrix for each ability criteria $\mathbf{D^j}$ can be formed, where j=1-***l***.

$\mathbf{D^j}$ is a **k x k** real matrix, where **k** is the number of allocation options, as mentioned and each member d_{ih}^{j} represents an evaluation of option ***h*** in comparison to option ***i*** with respect to the criteria ***j*** with (h =1 – ***k***).

$$D^j = \begin{bmatrix} d_{11}^{j} & d_{12}^{j} & \ldots & d_{1k}^{j} \\ d_{21}^{j} & d_{22}^{j} & \ldots & b_{2k}^{j} \\ \ldots & \ldots & \ldots & \ldots \\ d_{n1}^{j} & d_{n1}^{j} & \ldots & 1 \end{bmatrix} \quad (6.13)$$

Members of this matrix also need to satisfy the rule: $d_{ih}^{j} \text{x}\, d_{hi}^{j} = 1$, and the value of d_{ih}^{j} can be measured by the scores showed in table 6.1.

After finding the matrix D, the method used to determine the criteria weight vector U will be used to calculate member Z^i, (i = 1-k). Then Z is determined as:

$$Z = [z^1, z^2,\ldots,z^l] \quad (6.14)$$

Finally, the global vector G is also determined as:

$$G = Z .U \quad (6.15)$$

Each member of **G** represents the score of the ***j****th* allocation option for risk ***i*** with respect to the ability criteria.

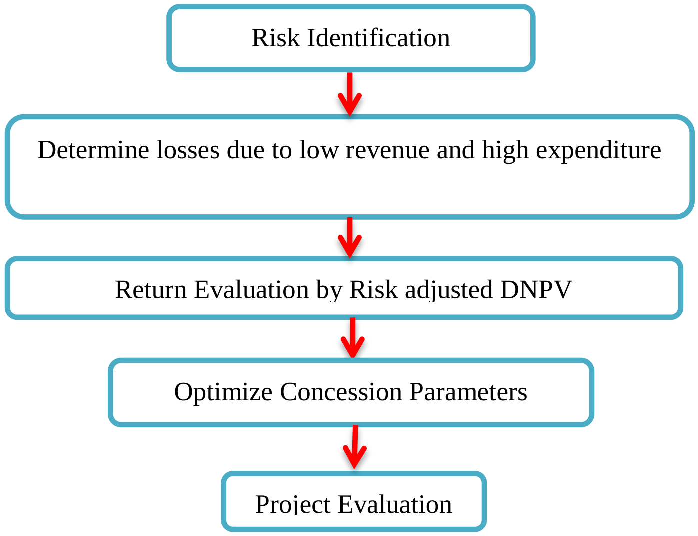
6.2.1.4. Value for money evaluation

It can be seen from figure 6.2 that the “Value for money evaluation” box is the final box in the application process for the public sector, and it is also the goal of the public sector. In this framework, the value for money evaluation can be made by analysing the project’s riskiness evaluation by AHP, risk allocation by using AHP, return analysis, and concession parameter optimized. From the findings of the previous steps, the public sector can determine whether public clients can have maximum benefit from the potential projects. For example, a project may be considered when it can bring the value for money if its riskiness is the lowest amongst the options, when few risks are retained by the public sector, when there is a less Risk Adjusted DNPV, and when there is a reasonable concession period to project the public sector’s interest.

6.2.2. Private Sector

Figure 6.7 shows that there are 4 steps of applying this proposed framework. The first step is also to identify the risks that can occur in the project. After that, the finding of the first step will be used to determine the losses because of low revenue and high expenditure. In the next step, return evaluation by risk-adjusted DNPV can be applied. From the analysis, in the return evaluation by the risk-adjusted DNPV, the private sector can optimize the concession parameters. It should be noted here that the private sector optimizes the concession parameters in order to protect their benefits. Finally, from this return evaluation and concession parameters optimization, the final project evaluation can be made.

Figure 6. 7 Process of applying proposed framework for the private sector



6.2.2.1. Risk Identification Use for the Private Sector

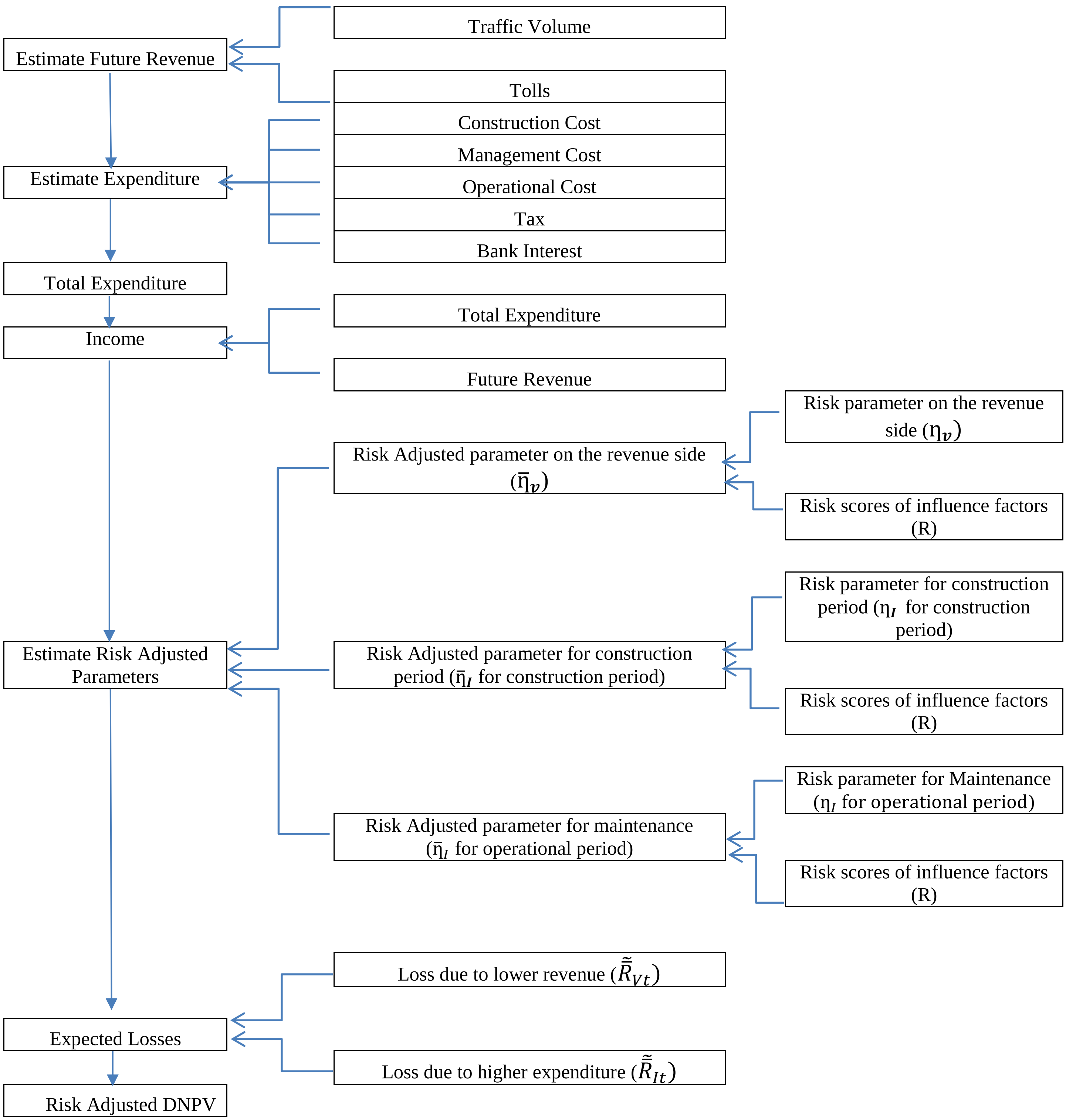
In terms of methods that can be used to identify risks for the private sector, they are similar to the methods described in chapter 3 and section ***6.2.1.1*** of this chapter. Risks are also evaluated by "*Frequency of Occurrence*" and "*Degree of Impact*".

However, it is very important to note that for the private sector, the outcome of this step, which will be used in other steps, must be the risk score. It is different from the application for the public sector in that the public sector can choose risks based on risk scores, or "*Frequency of Occurrence*" and "*Degree of Impact*" to be input data for other steps, but for the private sector, input data for other steps and received from "Risk Identification" must be the risk scores.

6.2.2.2. Return Evaluation by Risk Adjusted DNPV

Figure 6.8 shows that in order to apply the risk-adjusted DNPV, the private investors need to use the heuristic data about the revenue and expenditure to estimate the revenue and expenditure for the future. The heuristic data is also used to determine the construction cost distribution and the volatility of heuristic revenue. From this distribution and the volatility, the risk parameter $\boldsymbol{\eta}$ can be determined. After that, risk parameter $\boldsymbol{\eta}$ will be adjusted by using risk scores from the risk identification stage to form the risk-adjusted parameter $\bar{\eta}$. In the next step, the Risk-adjusted DNPV return evaluation can be analysed. After that, with the Risk-adjusted DNPV return evaluation, investors can optimize those concession parameters.

Figure 6. 8 Process of calculation of Risk adjusted DNPV to PPP in this research



More specifically, regarding the application of the risk-adjusted DNPV in this framework, data from Vietnamese PPPs will be used to determine the value of risk parameters by using three methods described in chapter 6 about DNPV evaluation which are the heuristic methods, probability based methods, and stochastic methods (option pricing). The sections below describe these three methods to determine the cost of risks.

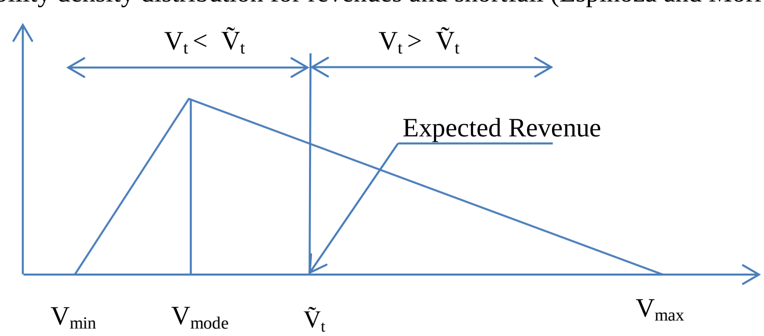
a. Heuristic method

In the simplest level, the heuristic method, the risk parameters, η_I and η_v can be assumed by investors, and in reality it can be seen as the cost contingency assumed by investors. This cost contingency depends on investors' experience. For example, in the construction industry, it may not be uncommon that on the expenditure side, the cost overrun is usually assumed by investors. In addition, this risk parameter can also be taken from suggestions in the literature, or previous studies about the construction industry. For example, cost contingency can be found in some research such as those by Baccarini, (2004), Hanafizadeh *et al*. (2011), Paul *el al*. (2014), and Anastasopoulos *et al*. (2014).

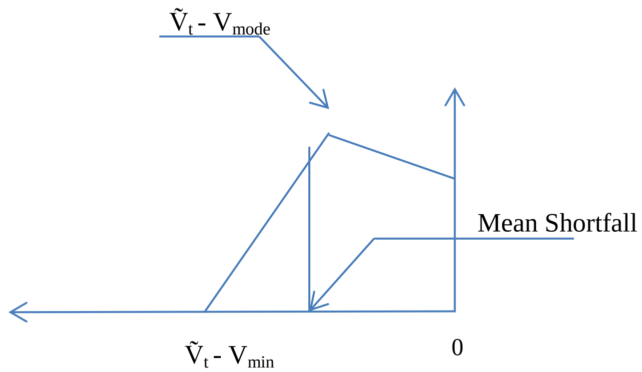
b. Probability-based method

The second method, the probability-based method, is more sophisticated. The cost of risk is estimated by using probability distribution. Basically from the data of revenue and expenditure, companies can create distribution of these data. Some types of distribution such as triangular normal, log-normal, and beta distribution can be used. Figures 6.9 and 6.10 bellow show the visual explanation of the idea of this method.

Figure 6. 9 Probability density distribution for revenues and shortfall (Espinoza and Morris, 2013, p.480)

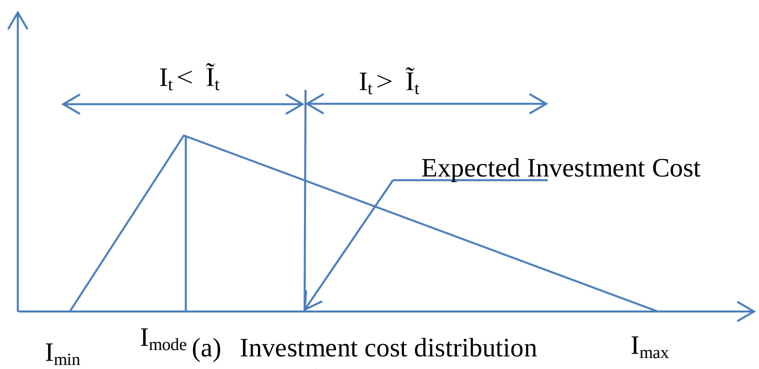


(a) Revenue Distribution

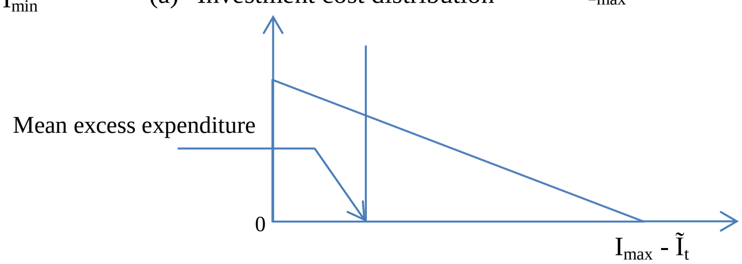


(b) Potential loss distribution due to revenue shortfall

Figure 6. 10 Probability density distribution for expenditure and shortfall (Espinoza and Morris, 2013, p.481)



(a) Investment cost distribution



(b) Potential loss distribution for expenditures

From these distributions, the cost of risk can be calculated by integrating these distributions, using the following equations by Espinoza and Morris (2013):

$$\widetilde{R}_{Vt} = \int_{-\infty}^{+\infty} \max(\tilde{V}t - Vt, 0) f(Vt) dVt \text{ x } \Pr[\tilde{V}t > Vt] \qquad (6.16)$$

$$\widetilde{R}_{It} = \int_{-\infty}^{+\infty} \max(It - \tilde{I}t, 0)\, f(It) dIt \text{ x } \Pr[It > \tilde{I}t] \qquad (6.17)$$

Where,

$\widetilde{R}_{Vt}$: Loss due to revenue is lower than estimated

$\widetilde{R}_{It}$: Loss due to expenditure is higher than expected

$\tilde{V}t$: Expected revenue

Vt: Actual revenue

$\tilde{I}t$: Expected expenditure

I_t: Actual expenditure

$Pr[\tilde{V}t > Vt]$: The probability that the actual revenue is lower than the expected revenue

$Pr[It > \tilde{I}t]$: The probability that the actual expenditure is higher than the expected expenditure.

In other words, risk parameters can be determined as:

$$\eta_I = Pr[It > \tilde{I}t] * (\tilde{I}_{excess} - \tilde{I}t)/ I_t \qquad (6.18)$$

$$\eta_v = Pr[\tilde{V}t > Vt] * (\tilde{V}t - \tilde{V}_{excess})/ \tilde{V}t \qquad (6.19)$$

Where,

$\tilde{V}t$: Expected revenue

$\tilde{I}t$: Expected expenditure

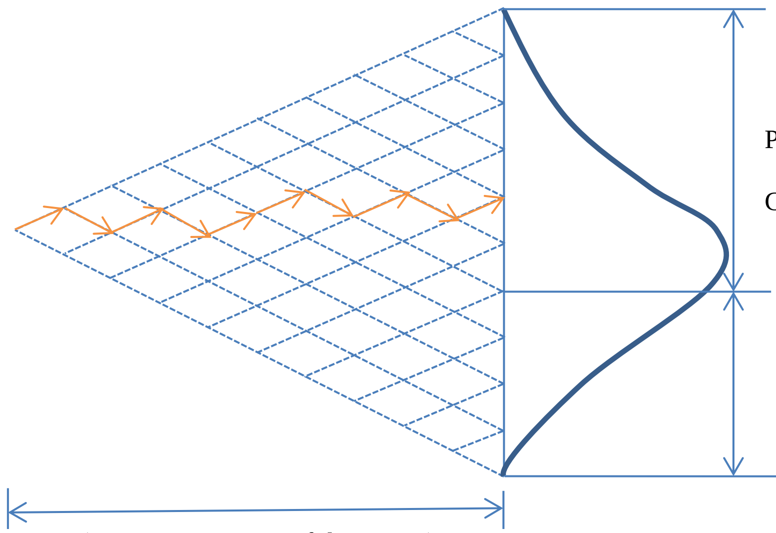
$\tilde{I}_{excess}$: Expected value of the expenditure in the truncated area

$\tilde{V}_{excess:}$ Expected value of the revenue in the truncated area

c. Real option pricing method

In the third method, the real option pricing method (Black and Scholes, 1973) is used. These methods take into account the variation of revenues or expenditure. Figure 6.11 shows the graphical presentation of options of the real option theory. It can be seen that each movement of the instrument can lead to different option, and real option theory takes into account this variation.

Figure 6. 11 Representation options by Real Option Theory (Espinoza, D., and Morris, 2013, p.482)



On the revenue side, the risk parameter can be seen as a put option, and on the expenditure side, it can be seen as a call option.

$$\eta_I = e^{\delta T} N(d_1) - \frac{X}{S} e^{rT} N(d_2) \quad (6.20)$$

$$\eta_v = \frac{X}{S} e^{rT} N(-d_2) - e^{\delta T} N(-d_1) \quad (6.21)$$

$$d_1 = \frac{ln\left(\frac{S}{X}\right) + ((r-\delta) + \frac{1}{2}\sigma^2\, T}{\sigma\sqrt{T}} \quad (6.22)$$

$$d_2 = d_1 - \sigma\sqrt{T} \quad (6.23)$$

Where,

S: Expected cash flows from the project.

X: The investment cost

T: Time to maturity

r: Risk free rate which can be determined as the government treasure bond rate

$\boldsymbol{\sigma}$: Volatility of the revenue based on the heuristic data δ: Dividend paid by the stock, bond, or other instrument. It can also be seen as the cost that investors have to pay to hold the option or to remove the competitors (Leslie and Michaels, 1997).

$N()$: Operator of the cumulative standard normal distribution function

d. Adjustment of risk parameters by influence factors

However, as criticized previously in chapter 5, it can be seen that the DNPV does not take into account other risks which can have an influence on the risk of lower revenue than expected, and to the risk of higher expenditure than expected. In other words, DNPV presented as by Espinoza and Morris (2013) and Espinoza and Rojo (2015), is not risk adjusted.

Therefore, in this research DNPV is improved by adding a method to take into account the risks which can have influence on the risk of lower revenue, and on the risk of higher expenditure. More specifically, the risk scores found from section 6.2.1.1. will be used to adjust the risk parameter $\eta_{\boldsymbol{v}}$ and $\eta_{\boldsymbol{I}}$, based on methods suggested by Cooper *et al.* (2005).

Risk adjusted risk parameter $\bar{\eta}_v$ and $\bar{\eta}_{\boldsymbol{I}}$ will be determined by the following equations:

$$\bar{\eta}_v = \eta_v + \eta_v R_i R_j \ldots R_k \quad (6.24)$$

$$\bar{\eta}_I = \eta_I + \eta_I R_h R_l \ldots R_t \quad (6.25)$$

Where,

$\bar{\eta}_{\boldsymbol{v}}$: Risk-adjusted parameter for loss due to lower revenue

$\bar{\eta}_{\boldsymbol{I}}$: Risk-adjusted parameter for loss due to higher expenditure

R_i, R_j, R_k: Risk Score of risk *i, j, k* which can have influence on the lower revenue

R_h, R_l, R_t: Risk Score of risk *h, l, t* which can have influence on the higher expenditure

From this risk-adjusted parameter, Risk Adjusted DNPV can be calculated as:

$$Risk\ Adjusted\ DNPV = \frac{\tilde{V}_t - \tilde{I}_t - \tilde{\bar{\tilde{R}}}_t}{(1+r)^t} \quad (6.26)$$

Where,

$$\tilde{\bar{\tilde{R}}} = \tilde{\bar{\tilde{R}}}_{Vt} + \tilde{\bar{\tilde{R}}}_{It}$$

$$\tilde{\bar{\tilde{R}}}_{Vt} = \bar{\eta}_v \tilde{V}_t \quad (6.27)$$

$$\tilde{\bar{\tilde{R}}}_{It} = \bar{\eta}_I \tilde{I}_t \quad (6.28)$$

Where,

$\tilde{\bar{\tilde{R}}}_{Vt}$: Loss due to revenue is lower than estimated adjusted by influence factors

$\tilde{\bar{\tilde{R}}}_{It}$: Loss due to expenditure is higher than expected adjusted by influence factors

$\tilde{V}t$: Expected revenue

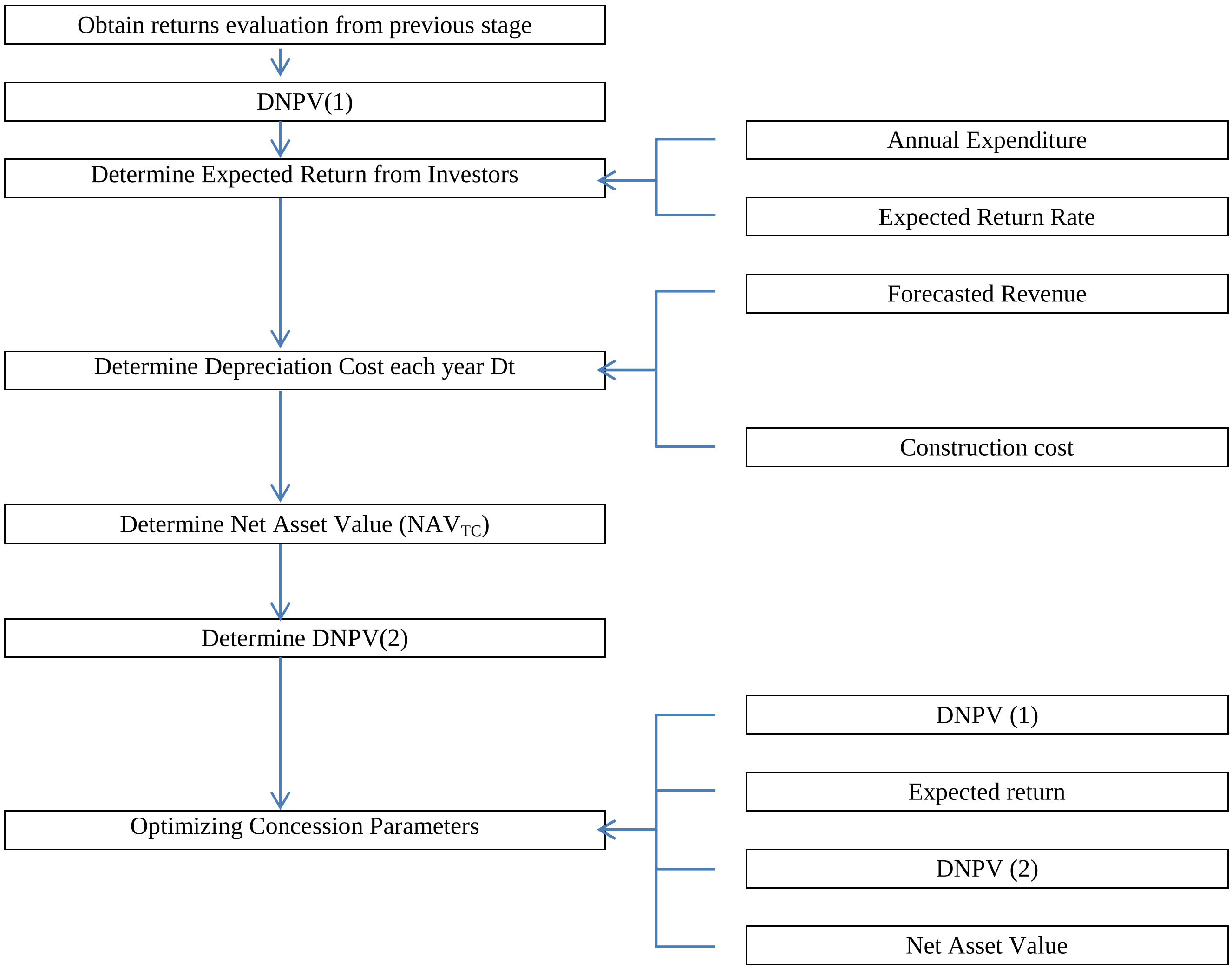
$\tilde{I}t$: Expected expenditure

6.2.2.3. Optimizing Concession Parameters

As demonstrated in the conceptual framework, outcomes from the return evaluation stage are the input data for the optimization of concession period parameters. The outcome of this optimization stage can be combined with outcomes from the Project Riskiness Evaluation by AHP to form the final project evaluation.

Figure 6.10 shows the process of optimizing concession parameters. After finding the return analysis from the previous step, the Depreciation cost $\tilde{D}_t$ in year t needs to be determined. After that, the Net Asset Value can be determined. From these analyses, concession parameters can be optimized. The details of how to optimize these parameters will be shown in the following sections.

Figure 6. 12 Process of optimizing concession parameters



In order to optimize the concession period parameters, the Risk-Adjusted DNPV is applied to the model developed by Wu *et al*. (2012) which is described in detail in chapter 5.

a. Optimization of concession parameters to protect the private sector's benefits

In this proposed framework, in order to protect investors' interests, the following equation must be satisfied:

$$Risk\ Adjusted\ DNPV^{(1)} \geq I_c R \tag{6.29}$$

Where,

I_c: Investor Capital investment

R: Expected return rate from investment

The equation (6.28) can be written as:

$$Risk\ Adjusted\ DNPV^{(1)} = \sum_{t=1}^{Tc} \frac{(\tilde{V}_t - \tilde{I}_t) - (\tilde{\tilde{R}}_{Vt} + \tilde{\tilde{R}}_{It})}{(1+r)^t} =$$

$$\sum_{t=1}^{T_{con}} \frac{(0 - \tilde{I}_t) - \tilde{\tilde{R}}_{Ict}}{(1+r)^t} + \sum_{t=T_{con}+1}^{Tc} \frac{(\tilde{V}_t - \tilde{I}_t) - (\tilde{\tilde{R}}_{Vt} + \tilde{\tilde{R}}_{Imt})}{(1+r)^t} \geq I_c R$$

(6.30)

or it can be simplified as:

$$\sum_{t=1}^{T_{con}} \frac{(0 - \tilde{I}_t) - \tilde{\tilde{R}}_{Ict}}{(1+r)^t} + \sum_{t=T_{con}+1}^{Tc} \frac{(\tilde{V}_t - \tilde{I}_t) - (\tilde{\tilde{R}}_{Vt} + \tilde{\tilde{R}}_{Imt})}{(1+r)^t} \geq I_c R \quad (6.31)$$

Where,

$\tilde{\tilde{R}}_{Ict}$: Loss on the expenditure side in construction period

$\tilde{\tilde{R}}_{Imt}$: Loss on the expenditure side in operational period

b. *Optimization of concession parameters to protect the public sector's benefits*

In this proposed framework, in order to protect investors' interests, the following equation must be satisfied:

$$Risk\ AdjustedDNPV^{(2)} \geq NAV_{T_c} \quad (6.32)$$

The equation (6.29) can be modified as:

$$Risk\ Adjusted\ DNPV^{(2)} = \sum_{t=Tc+1}^{n} \frac{(\tilde{V}_t - \tilde{I}_t) - (\tilde{\tilde{R}}_{Vt} + \tilde{\tilde{R}}_{Imt})}{(1+r)^t} \geq NAV_{Tc} \quad (6.33)$$

Where,

Tc: Transfer time

Tcon: Construction time

NAV_{Tc}: Net asset value of the project at its transfer time

$\tilde{\tilde{R}}_{Ict}$: Loss on the expenditure side in construction period

$\tilde{\tilde{R}}_{Imt}$: Loss on the expenditure side in operational period

As criticized in chapter 5, the NAV calculation method used in the paper by Wu *et al*. (2012) has weaknesses. Therefore, NAV_{Tc} in this model is determined as:

$$NAV_{Tc} = Original\ Cost - \sum_{t=T_c+1}^{n} \frac{\tilde{D}_t}{(1+r)^t} \qquad (6.34)$$

Where,

$\tilde{D}_t$: Depreciation cost in year t added risk parameter on the revenue side; r: risk-free rate.

According to the Unit of Production Method (Queensland Competition Authority, 1999), and (Wu *et al*. (2012), the depreciation cost can be measured as:

$$\text{Depreciation cost } = \frac{N_t}{N}(Original\ Construction\ Cost) \qquad (6.35)$$

Where,

N_t: Number of units produced in year t

N: Total number of units predicted though the economic life of the project

It should be note that in this framework the unit can be traffic demand. In addition, the tolls are fixed through the project's lifecycle.

Therefore,

$$\frac{\text{Nt}}{\text{N}} = \frac{Revenue\ in\ Year\ t\ without\ changing\ in\ tolls}{Total\ revenue\ without\ changing\ in\ tolls} \qquad (6.36)$$

Equation 6.36 can be used for situations where data about traffic demands is missing, but the data about tolls and changes in tolls is available.

It also should be noted that due to the application of DNPV, the construction cost is added by the risk-adjusted parameter on the expenditure side. Therefore, the calculated depreciation costs need to take into account the risk of changes construction cost. Therefore:

$$\widetilde{D}_t = \frac{N_t}{N}\left(\sum_{t=1}^{T_{con}} \frac{(\tilde{I}_t + \tilde{\tilde{R}}_{Ict})}{(1+r)^t}\right) \qquad (6.37)$$

Using equations 6.34 and 6.37, one can easily determine the NAV of the project at the specific year. From that, equations 6.29 and 6.32 can be solved to determine an interval of the concession period which can protect the interests of both sectors.

6.2.2.4. Comprehensive Project Evaluation for the Private Sector

It can be seen from figure 6.7 that the final step for the private sector is to make a Comprehensive Project Evaluation. This project evaluation can be made by analysing the findings from the Return Evaluation by Risk-Adjusted DNPV and optimization of the concession parameter. On one hand, the Return Evaluation by Risk-Adjusted DNPV allows investors to recognize the profit level of the project in each year. On the other hand, findings from the stage of optimization of concession parameters can allow investors to determine the transfer time which can protect the private sector’s interests. More specifically, the stage of optimization of concession parameters allows investors to recognize whether they can obtain the expected rate of return. In reality, this analysis can be used in the negotiation stage to balance the interests of both sectors.

6.3. Summary

In summary, the purpose of this chapter was to demonstrate the proposed framework to manage risks in PPPs in the Vietnamese transport sector. The framework is designed for both public sector and private sector use. The process of applying this framework for each sector was also presented.

For the interests of the public sector, this framework allows the public sector to consider different projects under one PPP form, and it can also allow public sectors to compare one project in different forms of PPP. This is very important in situations where the public sector needs to select one project amongst many. The evaluation made by the public sector by using this framework is the comparison of the quantitative, and qualitative evaluations. On the one hand, projects are compared with regards to critical risk by using the AHP model. This comparison is mainly based on quantitative analysis with supportively qualitative analysis. On the other hand, the concession period submitted by the public sector can be also be quantitatively evaluated by the Risk-Adjusted DNPV. Furthermore, the framework also enables the public sector to allocate the critical risks to the right party with regards to the selected ability criteria.

For the interest of the private sector, this framework is expected to enable investors to evaluate projects more accurately. More specifically, in this framework, returns are analysed by the new method, the risk-adjusted DNPV. The framework allows investors to estimate the loss of low revenue and high expenditure. In addition, concession parameters are also optimized to protect investors' interests. In short, this framework is expected to enable both sectors to evaluate risks in Vietnamese PPPs in the transport sector, and to balance the interests of both sectors.

The next chapter will illustrate the research methods which have been used to demonstrate the applicability and the robustness of the proposed framework.

CHAPTER 7: RESEARCH METHODOLOGY

7.1. Introduction

The purpose of research methods and techniques is to support researchers to carry out research and answer research questions. A good research design is essential to ensure the quality and validity of any research (Saunders *et al*. 2012). The purpose of this chapter is to show how research was carried out. This chapter, firstly, will discuss the basic concepts about research methodology. Secondly, research methods applied in this research will be described. Important information such as type of data, data collection, sampling size, and data analysis will be illustrated. In addition, difficulties faced while carrying out the research will also be forecasted, and strategies to overcome these difficulties will be proposed. The methods showed in this chapter are for the purpose of carrying out the research and proving the robustness of the proposed risk evaluation framework.

7.2. Concepts of Research Methodology and Research Methods

Before discussing the research methodology and research methods, the definition of research should first be addressed. According to Leedy (1989, p.5), research can be defined as: "A procedure by which we attempt to find systematically, and with the support of demonstrable fact, the answer to a question of the resolution of a problem". More specifically, Rajasekar *et al*. (2006, p.2) demonstrated that research is: "a logical and systematic search for new and useful information on a particular topic". Research can also be simply defined as a search for knowledge (Kothari, 2004).

Regarding the research method definition, this can be seen as the procedures, schemes, techniques that researchers used in their research study (Kothari, 2004). These methods assist researchers to collect, analyse, and find the solution for the problem (Rajasekar *et al*. 2006). Differently, research methodology refers to the philosophy of how research should be carried out (Saunders *et al*. 2012). It is a systematic way of resolving a problem. Research methodology shows the various steps that researchers use to study a research problem (Kothari, 2004).

7.3. Research Design

The research design is the preparation of conditions in which the data collection and analysis are carried out. This design needs to be in collation with the purpose of the research (Kothari, 2004). It is the structure of implementing the research. The research design should be able to demonstrate the area that the research will focus on. It also needs to provide the reason why the research is carried out. For example, it can address which sector the research is about. Other essential information such as, what type of data is needed, sampling size, where to collect the data, how to collect data, analysis techniques, etc., also need to be clarified in the design (Saunders *et al*. 2012). Some researchers may split the research design into four main aspects, namely, sampling design, observational design, statistical design, and operational design (Kothari, 2004). The Research design builds an essential foundation for carrying out the research, and it assists the research to be able to perform research work easily, systematically and scientifically. This step should be done before any actual work can be employed (Rajasekar *et al*. 2006).

7.4. Research Approach

Selecting the suitable research approach is essential for any research as the process of collecting and analysing data for specific research needs to be carried out in a suitable, scientific and systematic mode. One way of distinguishing the research approach is to clarify the research into qualitative research, quantitative research, or hybrid research. The following sections will summarize the fundamental points of these approaches.

7.4.1. Qualitative Approach

The qualitative approach is used to deal with qualitative phenomenon. It is expected to assist research to reach the aims of underlying motivations and causes by employing in-depth interviews. It is also carried out to discover people's perceptions about specific objects (Kothari, 2004). Fundamental characteristics of this approach can be non-numerical and descriptive using words. It aims to observe the feeling and to explain situations. Using this type of approach, data collected is non-numerical. These data can be obtained from the interviews, focus groups, observation, and collection of material such as letter, pictures, videos, and narratives. The data can be analysed in two levels with increasing levels of sophistication. In the first level, the analysis is mainly descriptive without any assumption, or forestation. In the second level, analysis is more interpretative, and it is used to understand the meaning of responses (Hancock, 2007).

One of the remarkable advantages of this approach is that it can take into account the complexity of the real world, including the complicated relationships between objects. In addition, it can be adopted to be suitable for local areas for specific situations (Hancock, 2007). However, it has also been criticized for its limitations such as it may be difficult to test the hypothesis and theories, and the data collection can be time-consuming. Also, the findings might not be generalized to other environments, and the findings can also be biased due to the personal behaviour of researchers or observers (Saunders *et al*. 2012).

7.4.2. Quantitative Approach

In contrast to the qualitative approach, the quantitative approach takes into account the measurement of quantity or amount, and this approach is applicable for research which requires expression in terms of quality (Kothari, 2004). It puts emphasis on the measurement, hypotheses, and course-effect relations between objects (Creswell, 2003). The fundamental characteristics of this method can be numerical and conclusive. In addition, it is a process which provides interactive evidence, and it can show findings which can be presented in table graphs. In the qualitative approach, analysis of data can contain measurement of the frequency of variables, differences between variables, and statistical significance of the findings (Hancock, 2007).

Some main advantages of this method are that it can be used for large populations and it can provide the results in terms of statistics. Also, this method allows researchers to compare the differences between groups, and to measure the trends of these differences. Additionally, the findings acquired from this method can be generalized to other populations in other environments (Sukamolson, 2007). However, it has been observed that one of the limitations of this method is that a large population is required in order to acquire accurate findings. Moreover, this approach might contain gaps in the information where provided in the data collection technique designed by the researcher (Saunders *et al*. 2012).

7.4.3. Mixed Approach

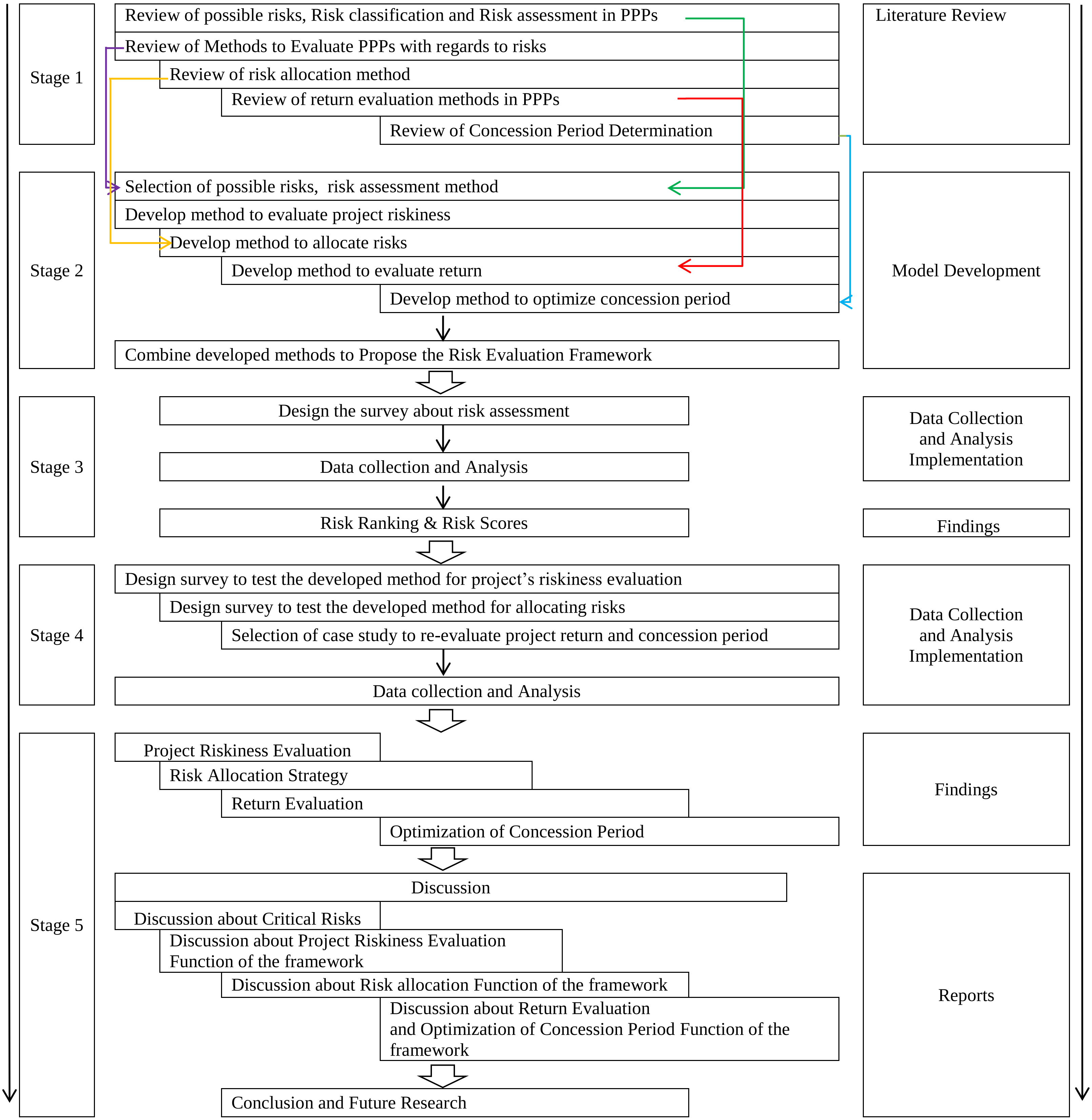
During recent years, the increasing trend of mix paradigms has been debated. Researchers have argued that it is more fruitful to look at the research from both qualitative and quantitative aspects rather than adhering to a single approach (Creswell, 2003). From this point of view, mixed methods have occurred as the third approach yielding to both the two traditional approaches (Bergmann, 2011; Molina-Azorı´n & Cameron, 2010; Walsh, 2012). Johnson *et al*. (2004, p.17) defined mixed methods research as “the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study”.

Saunders *et al*. (2012) suggested that researcher should think of the philosophy that is being applied as a continuum rather than as contrasting methods. Brannen (2005) further clarified that during implementation of the research, the researcher may be faced with different types of data in different stages of the study. Hence, they should bring different research methods to their work. Bryman (2001) noted that when combining the two methods, the domination of each method in each stage of the research should be taken into account to generate the best combination.

7.5. Implemented Research Methods

The previous sections demonstrated that the combination of approaches can bring advantages in conducting research. Therefore, in this research, a hybrid method was applied. In applying this method, a number of tasks were identified. These tasks include the literature review, survey and interview design, data collection, and data analysis. Figure 7.1 shows the outline of the tasks in their order. The following sections illustrate the details of each task and the relationship between tasks.

Figure 7. 1 Research Methodology Process



7.5.1. Literature Review

The two main reasons for reviewing the literature are, first, to help the researcher to generate and form research ideas, and secondly, to provide a critical review about related studies. These critical reviews are to demonstrate the knowledge of research in the field. It also clarifies the area that the research focuses on. Importantly, this part illustrates the limitations of previous research and proves the development made by researchers to resolve limitations (Sharp *et al*. 2002). Gall *et al*. (2006) highlighted that the first purpose of the literature review is to assist researchers in refining the research questions and objectives.

In this research, the literature review was used to identify possible risks that can occur in Vietnamese PPPs. For this purpose, previous studies about PPPs in international contexts were reviewed. Moreover, the literature review was conducted for the purpose of identifying assessment methods of risks in PPPs. Previous methods were examined with their limitations in order to find the appropriate method to assess risks in the risk evaluation framework. The literature review was also used to examine the previous studies which have applied AHP in managing risks in PPPs. From that point, a development of methods using AHP to evaluate projects, and using AHP to allocate risks was proposed as a part of the risk evaluation framework. Importantly, the literature review was used to examine the previous methods of evaluating project returns and determining concession periods. By critically analysing previous research, new approaches of evaluating project returns and optimizing concession periods was proposed.

All of these reviews demonstrate the area of the research, and the gaps that the research is attempting to fill, and how these gaps can be filled.

7.5.2. Case Study

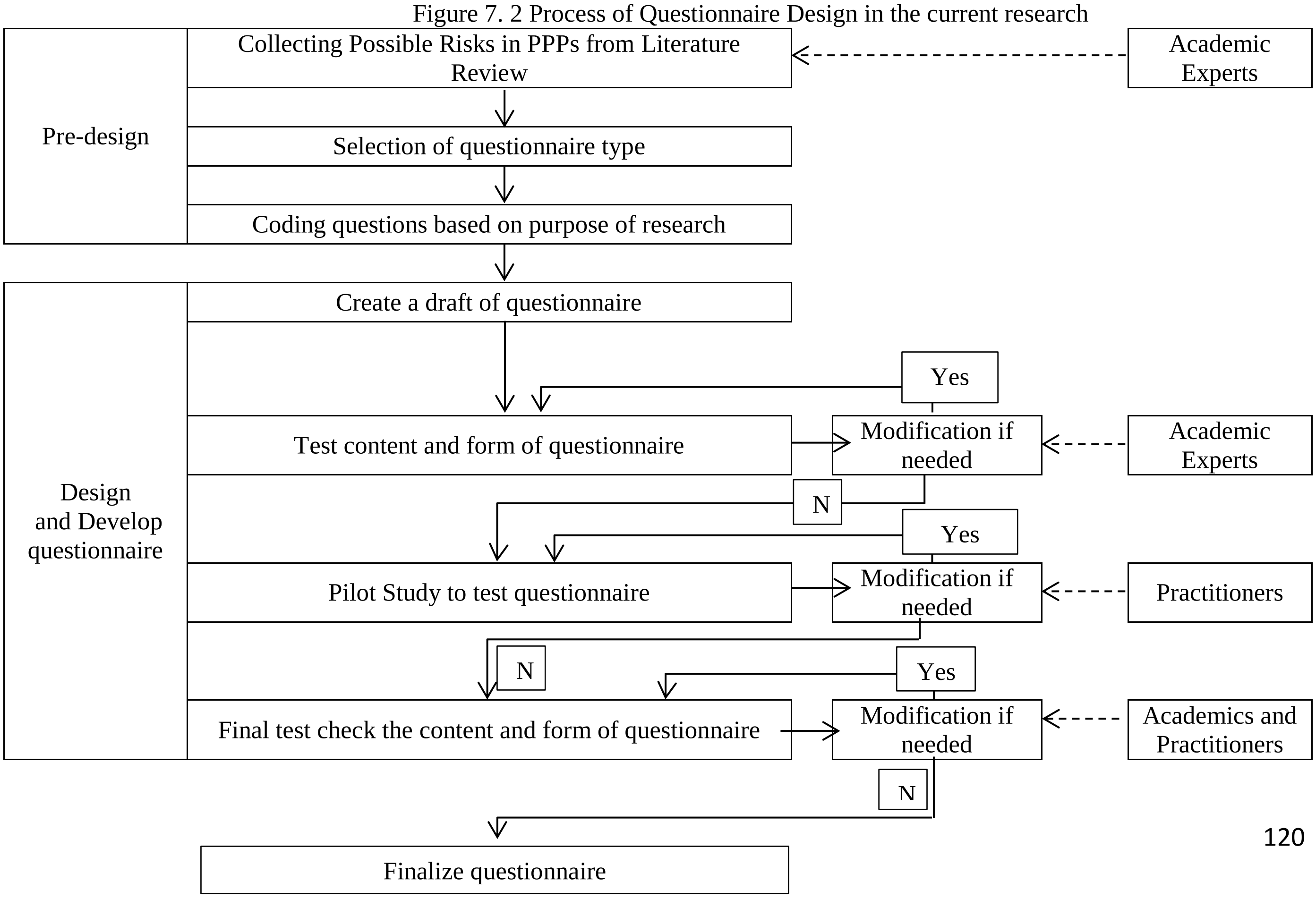
The case study method was applied in this research to demonstrate the AHP model in evaluating the project's riskiness, and to demonstrate the Risk-Adjusted DNPV model in analysing returns and optimizing concession periods. In terms of the AHP model, case studies were selected, and questionnaires were designed in regards to these case study. For the Risk-Adjusted DNPV model, secondary data was collected for the selected case study.

One of the beneficial advantages of the case study method is that it allows researchers to collect more data for each case and enables researchers to make a more critical and deeper analysis (Gomm *et al*. 2000). Selection of case studies was deeply discussed with academic experts and practitioners by looking at criteria for case studies. The description of these case studies is provided together with the findings in chapter 9. The purpose of this is to make it easier for the reader to follow.

7.5.3. Questionnaire Survey and Interview

The questionnaire survey and interview are popular methods in collecting data in management research as they are able to answer questions about who, what, where, how much and how many (Saunders *et al*. 2012). These methods can assist researchers in collecting data from a large population with a minimal economic budget. The data collected from these methods can be qualitative. However, researchers can quantitatively analyse the data using descriptive statistics. Moreover, by using these methods, the possible relationship between variables can also be predicted. Importantly, these methods assist the researcher in monitoring the research and data collection process. Figure 7.2 below shows the process of creating questionnaires in this research.

Figure 7. 2 Process of Questionnaire Design in the current research



In terms of interviews, interviewers were selected from participants participated in the questionnaire survey. Besides, participants who made unclear answers or outstandingly different in comparison with other respondents were also asked to have interviews.

7.5.3.1. Questionnaire and Interview Structure

a. Structure of questionnaire survey and interview for risk identification

As mentioned in the literature review, the risks will be assessed based on their probability of occurrence and degree of impact. Therefore, the questionnaire for this part was designed following this purpose. More specifically, for each risk, participants were asked to give their opinion about the probability of occurrence and the degree of impact. Five scales were provided namely, very low, low, medium, high, and very high. In terms of interviews, interviewers were selected from participants who participated in the questionnaire survey. In addition, participants who gave unclear answers or outstandingly different answers in comparison with other respondents were also asked to have interviews.

Table 7. 1 Sample of questionnaire to identify critical risks

Question: Please give your opinion about the probability of occurrence and the degree of impact of the Corruption Risk										
Risks	Frequency of Occurrence					Degree of Impact				
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High
Corruption risk										

b. Structure of questionnaire for project' riskiness evaluation

As mentioned in the literature review, there is a proposed risk evaluation framework. Projects will be evaluated by AHP, and data for this model was also collected from the questionnaires. Therefore, the questionnaire was designed based on this purpose. More specifically, the questionnaire was designed to enable participants to make a pairwise comparison between projects, and between groups of risks. Tables 7.2 and 7.3 show samples of the questionnaire for this part.

Table 7. 2 Sample of questionnaire for comparison between risk groups

Question	Equal	Slightly More Critical	Strongly more Critical	Very strongly more Critical	Extremely more critical
How critical is Construction Risk in comparison with Political and Legal Risks?					
How critical is Construction Risk in comparison with Market Risks?					
How critical is Construction Risk in comparison with Operation Risks?					

Table 7. 3 Sample of questionnaire for comparison between project options

With regards to Construction Risk please answer					
	Equal	Slightly Riskier	Strongly Riskier	Very strongly Riskier	Extremely Riskier
How risky is Yen Lenh Bridge Project in comparison with Phu My Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with New Dong Nai Bridge Project?					

For the purpose of making it easier to follow, more details about values that respondents put into the answers will be provided with explanation in section 6.2.1.1, chapter 6.

After the results of comparison were established, a smaller scale of questionnaires was created in order to observe the opinion of practitioners about the findings. The questionnaire contained only one question, which was to ask how the practitioners agreed with the findings made. Table 7.4 shows the sample of this questionnaire.

Table 7. 4 sample of questionnaire for collecting the practitioners’ opinion about finding of AHP

Please provide your opinion about provided results about comparison of project with regards to provided critical risks.				
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

c. Structure of questionnaire for risk allocation

Similarly, the literature review mentioned that risks are allocated by AHP. Therefore, the questionnaire was also designed based on this purpose. More specifically, the questionnaire was designed to enable participants to make a pairwise comparison between allocation abilities, and between parties for each risk. Tables 7.5 and 7.6 show the samples of the questionnaire for risk allocation.

Table 7. 5 Sample of questionnaire for comparison between allocation ability criteria

Question	Equal	Slightly More Important	Strongly more Important	Very strongly more Important	Extremely more Important
How important is **The ability to foresee** the risk in comparison with **The ability to control** the risk's probability of occurring?					
How important is **The ability to control the risk's probability of occurring** in comparison with **The ability to bear the consequence** of the risk?					
How important is **The ability to foresee** the risk in comparison with **The ability to bear the consequence** of the risk?					

Table 7. 6 Sample of questionnaire for comparison between party options

With Regards to the ability to foresee the risk of Low Quality Products					
	Equal	Slightly better	Strongly better	Very strongly better	Extremely better
How better is the public sector in comparison with the Share option?					
How better is the public sector in comparison with the private sector?					
How better is the public sector in comparison with the private sector?					

7.5.3.2. Sample size and data collection

In this research, a mixed method of delivering questionnaires and interviews was applied. More specifically, the questionnaire was delivered by online via internet, post mail and hand in. The reason for using this mixed method is that each method has its own advantages and disadvantages, and the combination of these methods can bring further strength.

There were 4 rounds of sending questionnaires in the current research. The first round was to collect expert opinions about critical risks in Vietnamese PPPs. The second round was to collect the experts' opinions about evaluating the project's riskiness. The third round was a small survey to collect the opinion of experts about the results of evaluating projects' riskiness by AHP. The fourth round was carried out to collect experts' opinions about risk allocation.

The number of risks and practitioners who have been working in PPPs in the transport sector in Vietnam is unknown. By conservative estimation, risks in transportation PPPs in Vietnam will be known by five percent of the practitioners. In addition, with the goal of obtaining a sampling error of within 5 percent with a 95 percent of confidence level, the minimum number of sample size was calculated as was suggested by Saunders *et al*. (2012) shown in equation 7.1. Besides, it should be noted that in this research, method by Saunders *et al*. (2012) was used to calculate the sample size. However, future research can use other techniques, for example, using Gpower suggested by other academics such as Faul *et al*. (2007), (Dattalo 2008), and Gardner (2010). The application of this technique will be recommended in the conclusion for future research.

$$n = p\% \times q\% \times \left[\frac{z}{e\%}\right]^2 \qquad (7.1)$$

Where,

n: Minimum sample sized required

p: Percentage of respondents belonging to the field

q: Percentage of respondents not belonging to the field

z: Value corresponding to the confidence level (obtained from table 7.7)

e%: Margin of error required

Table 7. 7 Z values (Saunders *et al*. 2012)

Level of confidence	**Z**
90% certain	1.65
95% certain	1.96
99% certain	2.57

Thus, the minimum sample size was measured as:

$$n= 5 \times 95 \times (1.96/5)^2 = 73$$

However, in order to increase the rate of response, the questionnaire was sent to 320 practitioners. For the first round, 151 questionnaires were returned. This shows that the rate of response was 47.18 percent. For the second round, only 57 valid questionnaires were received. In contrast, in round 3, questionnaires were sent to only 57 practitioners who participated in round 2. Because the questionnaire for this round contained only one question, 48 of practitioners, which is equivalent to having 84.21 percent answered. In round 4, 57 practitioners from round 2 were excluded. Therefore the questionnaires were sent to 263 practitioners, and 32 of them were returned. This brings the rate of response to 12.16 percent. It can be seen that the lowest response rate was 12.16 percent.

Regards to the response rate of 12.16 percent, as mentioned in section 7.5.3.2 for delivering questionnaires internet, post mail and hand in section were applied. However, it should be noted here is that the method “Internet” in this research means sending by email, rather than using “Internet website survey”. Therefore, the response rate may be lower than the response rate of the method in which researchers use the “Internet website survey”, and lower than the response rate for the method in which post mail and hand mail are not combined. Besides, according to Saunders *et al*. (2012), the response rate also depends on the specific field and population size. In the situation of this research, questionnaires were sent to the 320 practitioners who are experts in the field. Therefore, obtaining response from these experts might be more difficult. Other researcher, such as Nulty (2008) emphasised that with the number of questionnaire sent over 300, the answers from the response rate of more than 10 per cent can be used, but it can reduce the quality of the results analysed.

In fact, this is one of the limitations of this research, and this limitation will be reported in the final chapter and improving the response rate will be one recommended direction for the future research.

7.5.4. Data Analysis Methods

7.5.4.1. Reliability Test

In this research, reliability of data was tested using Cronbach's alpha test. This method is one of the most popular methods to measure reliability. In general, this method enables researchers to check the acceptable level of internal consistency. Theoretically, if α is equal to zero, there is no correlation amongst values, and if α is equal to 1, then there is a complete correlation amongst values. According to previous research, if α is from 0.6 to 0.7, there is an acceptable consistency. If α is from 0.7 to 0.9, there is good consistency and if α is greater than 0.9, there is an excellent consistency (Christmann and Van Aelst 2006; Kottner *et al*. 2010; Pinto *et al*. 2014).

7.5.4.2. Computation of Risk Score

As mentioned in literature review, risks will be seen as a function of probability of occurrence and the degree of impact. Therefore, linguistic judgements were converted to numeric values. More specifically, 5 levels of probability and impact were used which are 0.9 for "very high" and "very large"; 0.7 for "high" and "large", 0.5 for "medium", and 0.3 for "low", and 0.1 for "very low".

Risk score of risk I assessed by respondent j:

$$R_j^i = Fr_j^i \text{ x } \mathrm{Im}_j^i \tag{7.1}$$

- Fr_j^i: Frequency of occurrence of risk I assessed by respondent j
- Im_j^i: Degree of impact if risk i assessed by respondent j

Risk score of risk i:

$$R^i = \frac{\sum_{j=1}^{n} R^i{}_j}{n} \tag{7.2}$$

7.5.4.3.Mean Ranking

Mean ranking method was used to order risk scores. From that the most critical risks can be found. More specifically, risk with higher mean risk scores are considered as more critical. In order to use the mean ranking it was assumed in this research that all participants have the equal weight. In fact, research such as Thuyet *et al*. (2007), Li and Zou (2011) have proved that there is no significant difference between risk assessment results made by weighted participants and by non-weighted participants.

7.5.4.4. Standard Deviation (S.D)

Standard Deviation is used to quantify the level of variation of a set of values. In other words, it indicates how the value is distant to the mean. If a standard deviation close to 0, it demonstrates that the value point is close to the mean, while a high number of indicates that values are spread out.

7.5.4.5.One Way ANOVA

One Way ANOVA was used to test the significant difference between result from the private sector and from the public sector. This, in fact, is the way of testing one of the hypotheses that the perceptions of two parties are different with regards to risks. According to Saunders *et al*. (2012), One-way ANOVA can bring reliable result regarding to significant difference test. It is important to emphasise that in applying One-way ANOVA test, the assumption about homogeneity of variance needs to meet. Basically, this assumption refers to the requirement that the population variances or spread of scores in each group are equal (Fitzgerald and Flinn, 2000). This assumption is to ensure that the estimates of the population variance are good to analysis the mean (Hoffman, 2015). In carrying out this test, the ANOVA result will automatically show the results of testing homogeneity. Satisfied variables for this assumption will be selected from this result. Besides, in the case that the assumption was not meet, the Welch test was applied. Welch test was recommend by a number of research such as Reed and Stank (1988), Moder

(2010), and Jan and Shieh (2014). It should be noted that, the result of Welch was also automatically created together with ANOVA test by using SPSS.

7.5.4.6.AHP Data Consistency Test

As mentioned in chapter 4 and chapter 6, the AHP method was used to evaluate projects with regards to risks. The details of how to analyse these data were proved clearly in section 6.2.1 in chapter 6.

According to AHP, the consistency of input data can be checked. The data is consistent if the following equation is satisfied:

$$\frac{CI}{RI} < 1 \tag{7.3}$$

Where,

$$CI = \frac{\lambda - m}{m-1} \tag{7.4}$$

λ can be calculated by first a building *normalized pairwise comparison matrix*. Second is averaging each row of the *normalized pairwise comparison matrix*. Third, we multiply each member of this vector to the sum of each column. Finally, λ is equal to the sum of these multiplied results.

The random index RI can be used from table 7.8:

Table 7. 8 Random Index RI (Saaty, 1980)

M	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.51

In order to make an aggregation of matrixes, the Weighted Arithmetic Mean Method was used with the equation:

$$\text{PgAj} = \{\sum_{1}^{N} \text{WiPi(Aj)}\} / \sum_{1}^{N} Wi \tag{7.5}$$

Where,

PgAj: Group priority of option A_j

Pi(Aj): Value provided by member E_i in making comparison between risk groups or options

W_i: Weight of member Ei

N: Number of member

In case all members of the group have equal weight, which is the case in this research:

$$\text{PgAj} = \sum_{1}^{n} \text{Pi(Aj)}/\text{n} \qquad (7.6)$$

7.5.4.7. Financial Analysis by Risk Adjusted DNPV

The returns and concession parameters were analysed based on Risk Adjusted DNPV. The details of how to analyse and how to optimize the concession parameters were provided in sections 6.2.2.2 and 6.2.2.3 in chapter 6.

7.5.4.8. Root Mean Squared Error

The Root Mean Squared Error (RMSE) is a frequently used test to compute the difference between the values forecasted by a model and actual values obtained from reality. This test was used in this research to test the return analysis using the Risk-Adjusted DNPV and actual returns. According to Boussabaine and Elhag (1999), RMSE can be calculated as:

$$RMSE = \sqrt{\frac{\sum_{i}^{n}(\hat{x}_i - x_i)^2}{n}} \qquad (7.7)$$

Where,

RMSE: Root Mean Squared Error

x_i: Actual value

$\hat{x}_i$: Predicted value

$n =$ Total number of values (5 values)

7.5.4.9. Mean Absolute Percentage Error

The Mean Absolute Percentage Error is the test to measure the accuracy of a forecast model. In this research, this test was used to measure the accuracy of the Risk-Adjusted DNPV model in comparison with the NPV model. According to Boussabaine and Elhag (1999), MAPE can be calculated as:

$$\text{MAPE} = \left(\sum_{1}^{n} \frac{|x_i - \hat{x}_i|}{x_i} * 100\ \%\right)/\text{n} \qquad (7.8)$$

Where,

MAPE: Mean Absolute Percentage Error

x_i: Actual value

$\hat{x}_i$: Predicted value

$n =$ Total number of values (5 values)

From MAPE, Average Accuracy can be determined as:

$$\text{Average Accuracy \%} = 100\% - \text{MAPE} \qquad (7.9)$$

7.5.4.10. Analysis of Missing Data

Missing data in this research refers to the questionnaires which were not completely answered by participants, and to the data lacked in order to analyse returns by using Risk Adjusted DNPV. For the missing data collected from questionnaires, missing values were coded in the analysis software and the missing data was ignored, and only available data was analysed. For the missing data in return analysis, practitioners were re-contacted to acquire the missing data. If this strategy did not work, the assumptions about missing data were made and these assumptions were mentioned in the analysed results. These methods were expected to overcome the problems of missing data as is suggested by Higgins (2011), and Saunders *et al*. (2012).

7.6. Access and Research Ethics

From the previous sections, it can be easily recognized that the current research requires both primary and secondary data. Primary data was collected for input data of questionnaires and interviews, while secondary data relates to return analysis. Before carrying out this research, the researcher was totally aware of the difficulty in accessing data resources. In terms of primary data, the most common reason for not participating in the research can be the time required, concerns about confidentiality, and lack of understanding about the value of the research (Saunders *et al*. 2012). Regarding the secondary data, the concerns about confidentiality can be the main reason. In addition, in Vietnam's conditions, access the data can also be a problem because much of the data in the Vietnamese market is still reserved only in hard copy. This, in turn, can create difficulty in organizing and accessing data.

In order to overcome these difficulties, a number of strategies suggested by researchers such as Higgins (2011) and Creswell (2014) was applied. For example, a clear description about the research was provided for each practitioner. This description shows the reasons for and value of the research. In addition, the right of the participants was also illustrated clearly. Participants were shown that they have the right to withdraw from the research at any time, and they have the right to not answer any questions that they do wish not to. Moreover, the confidentiality of participants was also clearly described. Also, sufficient time was prepared to collect required data. Importantly, as suggested by Higgins (2011) and Creswell (2014), familiarity and understanding about organizations was developed, and advantages of existing contacts were fully used. Lastly, new contacts were also developed.

7.7. Summary

The purpose of research methods and techniques is to support researchers to carry out research and answer research questions. This chapter explained the research methods used in the research. More specifically, quantitative methods were implemented with supportive qualitative methods in order to answer the research questions and prove the research hypotheses. In this chapter, the process of collecting data was described in detail. Questionnaires and case studies were chosen to collect data. The selection of the sampling size and case studies were also justified in this chapter. Moreover, data analysis techniques for each function of the proposed framework were described. Lastly, this chapter also justified the methods applied to deal with ethical issues which may occur when carrying out research.

CHAPTER 8: CRITICAL RISKS IN VIETNAMESE PPPs

8.1. Introduction

As described in chapter 6, identifying critical risks is an important function of the proposed risk evaluation framework. The list of risks, justified in section 3.9 in chapter 3, was evaluated. This chapter, firstly, shows the ranking of critical risks in Vietnamese PPPs by applying the proposed framework. In addition, the difference between the perceptions of the private sector and public sector about these critical risks will also be demonstrated. Furthermore, the criticality of risks and the difference of perceptions between the two sectors will be analysed in-depth to bring a clear understanding to the findings. Finally, the selection of risks that will be used to test the applicability of AHP models in evaluating the project's riskiness and in allocating risks will be shown.

8.2. Survey Results

8.2. 1. Participants

From June 2014, 320 questionnaires were sent to practitioners who have worked in road and bridge PPP projects in Vietnam. Participants were sponsors, public clients, contractors, lenders, and inspectors. Participants from other sectors such as academics and researchers were also invited to take part in the survey. As mentioned previously in chapter 7, at the end of the survey, 151 questionnaires were answered, and this illustrates the rate of response of 47.18 percent. Table 8.1 and table 8.2 below demonstrate the profile of participants in the survey. After the analysis was made, the results were also discussed with some of the participants during interviews.

Table 8. 1 Participants' Area of Work

Sector	Participants	Number	Working Area
Public	Public Client	27	Transportation
Private	Domestic Investor, Contractor and Inspector	97	Transportation
Private	Foreign Investor, contractor and Inspector	9	Transportation
Others	Academic	11	Research and Education
Private	Lender	7	Banking
	Total	151	

Table 8. 2 Participants Information

Level of experience	More than 10 years	From 5 to 10 years	Less than 5 years
	101	35	15
Working position	Top Managers	Head of a department	Staff
	7	37	107
Education in risk management	Educated risk management in PPP	Educated risk management in construction projects	Not educated in risk management
	102	40	9

8.2. 2. Risk Ranking for Vietnamese PPP transportation projects

Table 8. 3 shows the reliability statistic. It can be seen that the Cronbach's Alpha is ranging from over 0.6 to 0.9. According to Christmann and Van Aelst (2006), and Kottner *et al*. (2010), and Pinto *et al*. (2014) these numbers show that the reliability of the input data is ranging from questionable level to very good level. Table 8.4 shows the risk ranking for Vietnamese PPPs in the transport sector. In general from table 8.4, it can be seen that the private sector is more risk averse in comparison to the public clients. In addition, the ranking made by the private sector is very close to the general ranking. One of the possible reasons is that the number of participants from the public sector is only 27 which is the minority in comparison to 119 participants from the private sectors who are the majority in this research. Also, it can be seen that there are 32 risks that are scored from the private and public sectors which shows a statistically significant difference. To deepen the analysis about critical risks displayed in table 8.4, the following sections draw insights about these risks and fundamental reasons are also speculated.

Table 8. 3 Reliability Statistic

Risks	Cronbach's Alpha	
	Public	Private
Construction Risks	0.917	0.830
Political Risks	0.773	0.782
Legal Risks	0.833	0.847
Market Risks	0.912	0.886
Operational Risks	0.901	0.653
Relationship Risks	0.653	0.679

Table 8. 4 Risk ranking for Vietnamese PPP transport projects

Code	Risks	General				Ranking by Sector					
						Public		Private		Others	
		Score	Ranking	St. d	p-value	Score	Ranking	Score	Ranking	Score	Ranking
C7	Difficulty in land acquisition and resettlement	0.502	1	0.121	0.551	0.489	1	0.5	1	0.563	1
L3	Poor project approval and permit process	0.463	2	0.106	0.293	0.485	3	0.465	2	0.395	4
M4	Inflation risk *	0.403	3	0.122	0.000	0.462	6	0.392	3	0.37	7
M7	Influence of negative economic events	0.378	4	0.070	0.897	0.38	12	0.377	5	0.386	5
O4	High maintenance cost	0.374	5	0.098	0.962	0.377	13	0.377	4	0.334	10
P4	Corruption	0.373	6	0.132	0.881	0.385	10	0.375	6	0.325	12
O5	Fluctuation of demand *	0.342	7	0.111	0.00	0.3	18	0.369	7	0.168	26
Re2	Inadequate experience in PPP of public sector	0.341	8	0.094	0.181	0.369	14	0.337	8	0.312	13
M2	Weak financial capacity of investor*	0.337	9	0.105	0.018	0.415	7	0.323	9	0.334	9
M1	Lack of transparency	0.336	10	0.101	0.149	0.363	15	0.315	10	0.454	2
C4	Low site safety *	0.324	11	0.112	0.000	0.469	5	0.289	20	0.414	3
L5	Restriction on toll *	0.318	12	0.107	0.032	0.395	9	0.309	12	0.228	19
M5	Fluctuation of interest rate *	0.314	13	0.107	0.000	0.41	8	0.295	16	0.306	14
M3	Difficulty in accessing finance from the banks *	0.311	14	0.104	0.000	0.486	2	0.267	26	0.33	11
C3	Low quality products *	0.31	15	0.100	0.002	0.383	11	0.293	17	0.339	8
C10	Delay in other infrastructures relating to the project	0.308	16	0.098	0.186	0.351	16	0.301	14	0.294	15
C8	Impractical feasibility study *	0.291	17	0.086	0.015	0.247	19	0.293	18	0.385	6
M8	Poor financial market *	0.286	18	0.098	0.000	0.178	23	0.314	11	0.221	20
L2	Revision of the contract clauses *	0.279	19	0.101	0.000	0.203	21	0.307	13	0.177	24
P1	Concession termination by government *	0.268	20	0.084	0.000	0.167	27	0.298	15	0.241	18
L1	Disapproval of guarantees by the government *	0.264	21	0.096	0.000	0.169	26	0.287	21	0.257	16
Re4	Low-cooperation between different partners *	0.258	22	0.089	0.000	0.211	20	0.277	24	0.183	23
M6	Foreign currency exchange fluctuation *	0.25	23	0.099	0.000	0.149	29	0.291	19	0.081	43
L4	Regulation change *	0.244	24	0.126	0.000	0.137	31	0.284	23	0.137	33
P3	Unstable government *	0.238	25	0.085	0.000	0.127	33	0.264	27	0.25	17
M9	Income streams are usually in	0.235	26	0.108	0.000	0.063	42	0.285	22	0.154	30

	local currency *										
P7	Forced buy-out risks *	0.23	27	0.097	0.897	0.082	39	0.274	25	0.148	31
Re3	Inappropriate distribution of responsibilities and risks *	0.229	28	0.143	0.000	0.473	4	0.169	40	0.219	21
C6	Design changes *	0.208	29	0.075	0.001	0.17	25	0.221	28	0.165	28
C5	Unavailability of materials	0.2	30	0.069	0.322	0.189	22	0.212	32	0.105	37
P6	Public scepticism about the real benefits of PPP *	0.193	31	0.065	0.000	0.128	32	0.219	30	0.088	42
C9	Impractical requirements of progress of project *	0.191	32	0.084	0.000	0.099	35	0.219	29	0.143	32
M10	Asset value less than forecasted at the time of transferring *	0.19	33	0.101	0.000	0.336	17	0.167	41	0.163	29
Re1	Inadequate experience in PPP of private sector	0.184	34	0.058	0.214	0.174	24	0.197	34	0.075	44
L6	Taxation risks *	0.184	35	0.082	0.000	0.083	38	0.213	31	0.111	35
C2	Poor design *	0.176	36	0.078	0.003	0.106	34	0.195	35	0.119	34
O1	Operation cost overrun *	0.174	37	0.103	0.000	0.046	43	0.206	33	0.097	38
Ot1	Bad nature events	0.172	38	0.064	0.055	0.14	30	0.176	38	0.208	22
P2	Political opposition *	0.159	39	0.085	0.000	0.037	44	0.191	36	0.097	39
O2	Default of operator *	0.158	40	0.064	0.000	0.084	37	0.18	37	0.11	36
C1	Changes in industrial code of practices	0.152	41	0.098	0.825	0.152	28	0.15	43	0.167	27
O3	Low quality of operation *	0.151	42	0.006	0.002	0.097	36	0.17	39	0.09	40
Ot2	Force majeure events *	0.136	43	0.077	0.002	0.077	41	0.151	42	0.172	25
P5	Public sector default *	0.032	44	0.002	0.000	0.078	40	0.012	44	0.088	41
	Average	0.261				0.245		0.268		0.227	

*: Significant difference between public and private sector at 95 percent confidence

8.3. Finding Analysis

Following sections will analysis findings of risk scores and risk ranking presented in table 8.4. Firstly, 10 risks with highest risk scores will be analysed. The reason for choosing this group of top 10 is recommended by academic experts and practitioners as it may show possible number of risks that investors need to focus as the first priority. In fact, the idea of in depth analysis top ten risks has been also used in a number of previous research such as Thuyet and Ogunlana (2007), Ling and Hoang (2010), and Xu *et al*. (2011). Secondly, a group of 6 six with lower scores in comparison with to 10 risks will be discussed. The reason for grouping these six risks is that although they are not in the top ten risks, but they still receive scores over 3.0 which are considered as a medium level compared to other scores in table 8.4. Thirdly, a group of 14 risks will be demonstrated. The reason for grouping these 14 risks is that they all have the risk scores ranging between 2.0 and 3.0 which is the second lowest level in the table 8.4. Lastly all risks with lowest scores which are under 2.0 will be analysed.

The method of grouping risks with similar scores is expected to bring readers and practitioners in the field better links amongst risks which obtain similar perception from participants. In fact, the idea of analysing risks by groups categorized based on purpose of researchers has been applied in previous research such as, Thomas *et al*. (2010), Zhao *et al*. (2013), and Song *et al*. (2013).

8.3.1. Top ten ranked risks

Table 8. 5 Top ten ranked risks

Code	Risks	General			Ranking by Sector					
					Public		Private		Others	
		Score	Ranking	St. D	Score	Ranking	Score	Ranking	Score	Ranking
C7	Difficulty in land acquisition and resettlement	0.502	1	0.121	0.489	1	0.500	1	0.563	1
L3	Poor project approval and permit process	0.463	2	0.106	0.485	3	0.465	2	0.395	4
M4	Inflation risk *	0.403	3	0.122	0.462	6	0.392	3	0.370	7
M7	Influence of negative economic events	0.378	4	0.070	0.380	12	0.377	5	0.386	5
O4	High maintenance cost	0.374	5	0.098	0.377	13	0.377	4	0.334	10
P4	Corruption	0.373	6	0.132	0.385	10	0.375	6	0.325	12
O5	Fluctuation of demand *	0.342	7	0.111	0.300	18	0.369	7	0.168	26
Re2	Inadequate experience in PPP of public sector	0.341	8	0.094	0.369	14	0.337	8	0.312	13
M2	Weak financial capacity of investor*	0.337	9	0.105	0.415	7	0.323	9	0.334	9
M1	Lack of transparency	0.336	10	0.101	0.363	15	0.315	10	0.454	2

8.3.1.1. Land acquisition

In table 8.5, "Difficulty in land acquisition and resettlement" (C7) stands at the first position with the mean risk score of 0.502. In the opinion of participants from all sectors, C7 is always the most serious risk. This finding is consistent with some of the previous studies about the Vietnamese construction market. For example, Toan and Ozawa (2008) and Thu and Perera (2011) also found in this study that Vietnam's construction market is facing a serious challenge about how to effectively resolve land disputes in construction projects, and their study evaluated this risk as the fourth most serious issue in Vietnamese BOT projects.

Table 8. 6 Complaints about land related issues (Thu and Perera, 2011)

Complaints	Number of complaints		Increase (%)
	1993-1995	1996-2005	
Old land claims	800	1224	53.00
Land acquisition	800	12,708	1488.50
Land dispute	200	1548	674.00
Accusation of violations of land laws	100	1800	1700.00
other	100	720	620.00
Total	2000	18,000	800.00

The conflicts in land acquisition usually contain three parties, namely the land user, the developer, and the host government. Table 8.6 compares the complaints in land in Vietnam from 1993 to 2005. The figures present that the conflicts in land acquisition increased from 800 from the period of 1993-1995 to 12,708 in the period of 1996-2005 (Thu and Perera, 2011). In fact, the regulations in Vietnam emphasized that it is the citizens' obligation to support the government in acquisition of land for a predetermined development plan. However, through negotiations, it was decided that the interests of involved parties would be protected. The expenditure for land acquisition in Vietnam consumes a large part of the total capital cost. For instance, in some projects the cost for this process can be a third of the total expenditure (The Asia Foundation, 2014). According to the law, land is owned by the state and the holders only have a land-use-certificate to use the land. In the case of land acquisition, the host government and developer need to negotiate with occupants on the price of acquiring land use rights. The decree 78/2007/ND-CP and the circular 03/2011/TT-BKHDT clarify that although the local government is responsibe for delivering land to the developer, the investors are in charge of the costs of acquisition. Therefore, investors need to negotiate with the land users about compensation rates unless the investors have a suffiecient budget to fulfill all requirements from land users, but investors’ financial budgets are, in fact, limited. In some special projects, the cost for land acquisition is compensated by the government and this expenditure is not counted in the total capital expenditure (Circular 03/2011/TT-BKHDT). The reason for this action is to motivate investment from the private sector. Partiticants from both sectors reveal that issued regulation documents do not clearly delineate how to apply the market price and state price, and the price structure is also not clarified. This causes difficulties for the officals who are responsible for land acquisition.

One of the dominant reasons underlying dissatisfaction and disputes in land acquisition in Vietnam is that there is a two-land-price system which consists of the market land price and the land price decided by the government. More specifically, the compensation given to the land-use-certificate holder is decided by the government and investors, and this price is criticized to be lower than the market price, and hence, does not reflect the land right. This law is expected to support investors in theory; however, in reality it has created conflicts in land acquisition since the citizens demand a fair compensation rate which is equivalent to the market rate (Thu and Perera, 2011). These conflicts can ignite if the negotiation is not able to protect the interests of citizens, the government and investors. Table 8.6 shows that the number of conflicts increased dramatically after the year 1996. In fact, from the year 1996, the difference in the two prices became significant.

In fact, as participants replied, in many cases, local citizens desire to provide investors with the land use right. The motive may be the urgent need of development and investment in the area, and that the compensation rate offered by the investors is sound. However, the disputes happen in the resettlement stage. More specifically, after being resetteled to a new accomodation, resetteled citizens perceive that the living condition in the resettled place is below par, and unlike what was promised by the developers. For example, the transport links in the new areas are poor, the basis of life security conditions is not satisfied, or the practice of traditional and cultural lifestyles is interrupted (Transparency International, 2011). According to the land law of 2013, investors must prepare two plans, namely: Compensation Assistance and Resettlement Plan and a Livelihood Restoration Plan. However, government officials from this study admitted that the local government and investors just tend to mainly focus on monetary compensation, without assisting land users to acquire new livelihoods. This, indeed, can make the life of citizens uncertain (Hansen, 2013).

Likewise, the need for having a conversation to express a citizen's opinion on the development of the area is not satisfied. During the land acquisition and resettlement process, land users are not provided with sufficient transparent information about projects, especially, after the land-use-right is transferred and the process goes into the resettlement stage. Additionally, academics made an important point that corruption can also be a motive causing obstacles in land acquisition since behind this process, the interests of involved groups can be dependent on some planners and politicians. In fact, if delays in land acquisition occur, the local government and investors lay the blame on others. Moreover, another fundamental reason which raises the level of land disputes is that there is inconsistency between the centre and local government's development plan. For example, the development plan of a province may not fit with the overall development plan of the region, and this demands adjustments in many layers of the government, and make the process time-consuming. Consequently, these undesirable images are gradually shaping negative attitudes about land acquisition and resettlement. This, in turn, generates more struggles in resolving this risk in other projects.

8.3.1.2. Poor project approval and permit process (L3)

The risk "poor project approval and permit process" (L3) expresses the situation in which involved parties suffer from delays acquiring project approvals and permits though the project life cycle. L3 stands in the second position in table 8.5 with the mean score of 0.463. The scores given by the public sector and private sector are 0.485 and 0.465, respectively.

The majority of interviewees in this study reported that L3 is not only a critical feature of PPPs, but is also a critical feature of the construction industry in Vietnam. This lengthy activity has caused higher investment costs and delays in all stages in general through the project's life cycle such as initial planning, design and implementation of construction, and completion. Even though in Vietnamese PPP laws, timing for the approval and permit process is revealed, in reality, longer time needs to be spent on this issue. Moreover, current issued documents come only from the time schedule for submissions from early stages such as selecting investors, contractors, and inspectors, etc. However, there is vague timing for the approval and permit practice during the project's life cycle which contains a number of procedures requiring collaboration with authorities or agencies. In addition, respondents' complaint that there is no inspection timing for the approval and permit process, especially for technical issues, resulting in long-lasting delays from technical departments.

One of the primary causes that was discovered is the complicated and unclear administrative system in Vietnam. For instance, it is criticized that there are various layers of government authorities and technical departments, and the project approval process must go through relevant authorities from the commencement to the completion phase of their projects. Even in many cases, the regulations in each authority layer are not consistent. For example, the regulation of the central government might conflict with the regulation of the province or district. Sponsors reported that sometimes in the planning stage, obtaining the government's approval can take several years. More seriously, the government authorities even cancel approvals that had been granted previously. Take the approval for the design as an example, where in case a 1/500 scale design needs to be approved, any small conflict with the local government plan can force the design process to be restarted from the beginning. Some interviewees commented that a project in which the design process took three months to finish drawing documents, can take one year to get approved from the government departments.

In addition, executives interviewed replied that the unclear distribution of the responsibility of staff and government agencies is also a fundamental reason underlying the seriousness of this issue. The power of decision makers is separated, and they are not authorized to have enough power to make a quick and productive decision in some cases, and consequently, there are multitudes of licenses or decisions from higher levels that are required, and the responsibility can be unclear. Furthermore, the approval process in initial submissions is sometimes not carefully assessed for some projects which had not been cautiously evaluated in the feasibility stage. Hence, during implementation of construction, conditions which need to be adjusted occur. For example, the capital plan, bidding plan, and process of choosing involved partners had not been wisely analyzed in the feasibility stage, and this, in turn, delays the approval process in the future implementation of the work.

Contractors also stated that the inconsistency between requirements from sponsors and public clients is also an underlying reason for delays in the approval and permit process. For example, requirements for the bidding process can be different between government agencies and private investors' perceptions. More specifically, for large international projects, there are a limited number of domestic contractors who can go into the bidding process because some robust domestic contractors are state-owned organizations and this is not accepted by sponsors, and this conflict, in fact, may also produce an unfair bidding process. Practitioners criticized that even sometimes, higher government agencies reprimand project managers if they follow requirements from sponsors which conflict with the government's benchmark.

The appearance and seriousness of L3 seem to have worsened over time. Indeed, because the approval process requires longer time, when it has been achieved, many critical aspects in the agreement such as capital expenditure are not appropriate for current time. Consequently, these proposals need to be corrected again, and the adjusted plans must also go through the approval and permit process. Perhaps this risk is considered as serious because it seems to be external to many private organizations, and it is portraying an undesirable picture about the Vietnamese PPP market, turning away many potential investors (Thuyet *et al*., 2007). Indeed, Qui Hao, (2002) said that in his study, 20 percent of foreign investors refused to invest in Vietnam again because of the long approval process. However, the findings of the interviews also confirm the statement by Ling and Hoang (2010) that it appears to be faster for bigger international investors to obtain approvals and permits. The reason of this difference is that in order to prevent reselling project approvals, the host government demands proof of financial status and a deposit which can be kept for 1-2 years (Ling and Hoang, 2010), and this can be more affordable for strong financial investors than for small and medium sponsors.

8.3.1.3. Inflation rate fluctuation (M4)

"Inflation Rate Fluctuation" (M4) is categorised in the market risk group. The mean score for M4 is 0.403 and this risk stands in the 3rd position in table 8.5. There is a statistically significant difference between opinions of public clients and private practitioners as participants from public sectors give this risk the score of 0.462 with the 6th position, whereas private sectors put this risk into the 3rd rank with a mean score of 0.392.

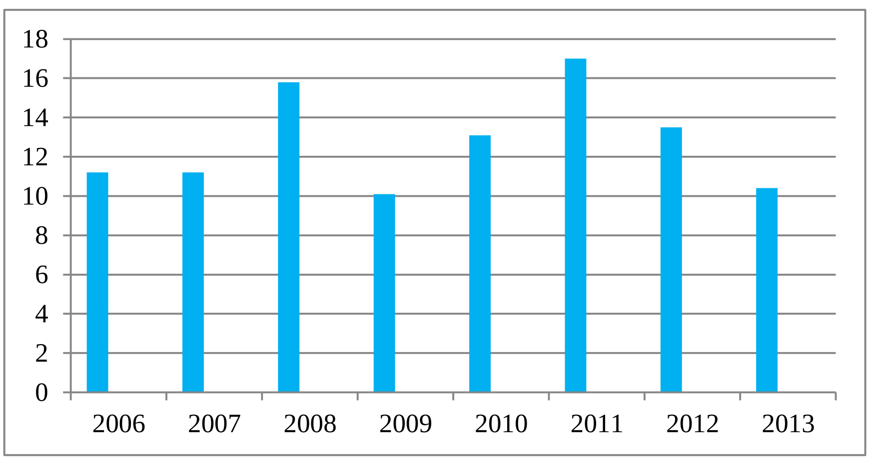
The finding from interviewees reveals that investors are more concerned about inflationary conditions in PPPs than in conventional construction projects since a PPP form usually lasts for a long period. Consequently, considered over a long period, the inflation rate is more challenging to use to predict the future changes and it also has a heavier effect. It is worth noting that although the inflation rate in Vietnam has been declining in the current years, the fluctuation of this parameter is still threatening investors. From table 8.7 below, it is worth noting that the annual inflation rate fluctuates dramatically from 6.2 percent in 2009 to peak at the rate of 21.3 percent in 2011, then collapsing to 4.8 percent in 2013. Participants declared that the wide fluctuation of the inflation rate in previous years has given a very negative impression about the Vietnamese market to investors.

Table 8. 7 Annual Inflation Rate Comparison (World Bank, 2014)

Country	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
China	3.8	7.6	7.8	-0.6	6.6	7.8	2	1.7
Japan	-1.1	-0.9	-1.3	-0.5	-2.2	-1.9	-0.9	-0.6
Thailand	5.2	3.5	3.9	1.9	3.7	4.2	0.2	2.8
United Kingdom	2.9	2.3	3.2	2.2	3.1	2.3	1.1	1.7
United States	3.1	2.7	2	0.8	1.2	2	1.7	1.5
Vietnam	8.6	9.6	22.7	6.2	12.1	21.3	10.9	4.8

The fluctuation of this parameter is highly correlated with a number of other negative consequences. For instance, material cost, interest rate, currency exchange rate, and wages can possibly change following the fluctuation of inflation. Indeed, the fluctuation of inflation generally flows into the real price behaviour of materials, especially materials for transport construction such as asphalt, steel, and concrete (Lindsey *et al*. 2011). For example, during the period from 2006 to 2013, the construction material prices in Vietnam showed a wide fluctuation, particularly, in the years of 2010 and 2011, which are the periods with the highest fluctuation of inflation rate ever recorded (VP Bank Securities, 2014). Regarding the impact on the interest rate, figure 8.1 below presents the interest rate in Vietnam from 2005 to 2014. Obviously, the pattern of fluctuation in the interest rate shows a marked movement, on the same basis with the pattern of inflation fluctuation. An infrastructure project usually requires an enormous capital expenditure, and in the case of Vietnamese PPPs, the investors usually mobilise less than 30 percent of the total expenditure from equity, and the rest is debt from credit organizations. Consequently, a wide interest rate leads dramatically to additional costs to the project, and vice versa. For example, according to interviewees' answers, after the steep decline of the inflation rate in 2012, the lending interest rates gradually came down, and this has been helping all involved parties to save annual expenses. Furthermore, the inflation rate can devaluate the currency value of the host country, and this can bring out financial losses for foreign investors who have debts from international banks.

Figure 8. 1 Lending Interest Rate by percentage in Vietnam (Source: World Bank, 2014)



In fact, by reviewing Vietnamese PPP contracts, it can be recognized that parties have cited the contingency budget for reasons for inflation. For example, in No 18 highway Uong Bi – Halong BOT contract, the contingency budget for operational costs was 13 percent for 2012 and 10 percent from 2013 forward, and contract clauses also clarify that if the inflation rate fluctuates by over 2 percent from the assumed level, these budgets can be renegotiated. However, the adjustments in renegotiation are usually the extension of the concession period, and this also means involved parties have to face this factor for a longer period. Additionally, the wide fluctuation of this factor can also cause pressure on the social effects, negatively influencing any business performance. For example, a high inflation rate in 2007 in Vietnam stood behind the aggressive behaviour of employers leading to 541 strikes, with many of them aimed at foreign construction organizations, even though this issue had very rarely happened in Vietnam previously (Long, 2008).

8.3.1.4. Influence of negative economic events (M7)

"Influence of negative economic events" (M7) is categorized in market risks. M7 refers to very negative circumstances of the economy such as a financial crisis, or crisis of a specific industry. In general, M7 is ranked into the 4^{th} position with the mean score of 0.378. There is no statistically significant difference at the level of 95 percent accuracy between rankings by private and public sectors.

The finding appears differently from previous research. For example, in the research by Toan and Ozawa (2008) about BOT power plant and transport projects, this risk was ranked in the 46^{th} position out of 52 risks. Hence, it seems to not be a serious risk in this study by. Similarly, in research by Thuyet *et al*. (2007) about oil and gas construction projects, this risk was only ranked in the 26^{th} position. The inconsistency between these findings can be because these research projects were conducted before the financial crisis in 2008. However, in the current research, the negative consequence of this crisis has still been creating a psychological effect on investors. In fact, investment and capital mobility and the financial market were seriously influenced by that crisis (Thanh, 2008). It can be clearly recognized in table 8.7 that inflation rates were very high during the crisis, and the rate of Foreign Trade Investment to Vietnam also decreased after the year 2008. In fact, from 2008 to 2012, the rate of return for investors in the construction industry in Vietnam dramatically decreased. From 2012, the rate has been increasing, but market conditions however seem to be unfavourable for investors and the private sector still is cautious about any movement of the market (VP Bank Securities, 2014). Academics from in-depth interviews of this study reported that the real estate segment is the most important and has a large influence on the infrastructure construction segment. However, from 2008 to 2012, the Vietnamese real estate sector decreased dramatically. Therefore, the infrastructure segment was also affected.

Vietnam has also been more cautious by tightening credit sources of the infrastructure industry (VP Bank Securities, 2014). In infrastructure investment, debts build a major portion of capital expenditure. Hence, the tightened policies from the government also generate obstacles for private sponsors. According to academics from this study, the credit resource will be still tightened in the future because of the high rate of bad debt in the banking system. In some large projects, investors may seek credit resources from the international market. However, they need to consider the value of the currency. as the value of Vietnamese currency is low in comparison with other countries' currency, and the revenue is received in local currency.

8.3.1.5. High maintenance cost (O4)

"High Maintenance Cost" (O4) is in the operational risk group. It expresses the negative situations in which investors have to maintain the construction with a higher cost than was forecasted during the franchise operation period. O4 is ranked in the 5th position with the mean score of 0.374 in general, and public and private sectors do not show significantly different opinions about this risk.

Investors responded that they usually employ a maintenance contract from another partner, and this partner also needs to be approved by the public agency. Because maintenance expenditures contribute a large part of the annual expenses on road and bridge infrastructures, operational authorities are continuously trying to enhance the maintenance efficiency and diminish related costs. According to interviewees, there is no fixed financial plan for maintenance, but the financial plan for maintenance must not conflict with the decree10/2010/TT-BGTVT (MOT, 2014). For example, table 8.7 below indicates the annual maintenance budget for No 18 Highway during the franchise operational stage. It can be seen from table 8.8 that the maintenance budget for the road and drain system is 0.55 percent of the total expenditure which is needed for road construction work, and the maintenance budget for bridge construction is 0.1 percent of the total construction cost of the bridge. However, sponsors admitted that the maintenance budgets are set up based on their experience because the frequency and costs of maintenance may depend on certain locations of construction.

Table 8. 8 Annual Maintenance Budget for No 18 Highway

Construction	Budget
Road and Drain System	0.55% of expenditure for road surface construction
Bridge	0.1% of expenditure for bridge construction

There is a difference between the two sectors about the core reasons for this issue. The public clients were concerned about the quality of the roads and bridges, whereas the private sector complained about the damage from overloaded vehicles. In the former case, they criticized that the real quality of construction cannot sustain the actual traffic demand. Also, they criticized that due to limited investment budgets, investors can possibly select road and bridge material and equipment with low initial costs, and they ignore the fact that these can lead to a raise in maintenance costs in the future. For the opinion about overloaded vehicles, which is still a controversial debate in the Vietnam transport sector, participants from private sectors replied that the damage generated by overloaded vehicles is becoming more serious in recent times. Many vehicles transport loads are over-designed for the capacity for each type of construction. In some cases, drivers transport loads which are more than 2 times higher than the designed capacity, and the designed material structures are dramatically damaged. In their opinion, resolution of this issue appears to be beyond their ability. In addition, they commented that it is problematic to resolve this obstacle since there is a lack of CCTV systems in Vietnam, and it is challenging for police officers to identify and fine overloaded vehicles. Moreover, participants reported that corruption can occur around this issue, which makes O4 more complicated to resolve. Some participants revealed the fact that, as a consequence of the high price of transporting and other factors such as petrol price, drivers accept being fined, and then add the fines to the cost of transportation. Interestingly, another possible complaint is that there is the conflict between the capacity of the construction in Vietnamese roads and bridges with the international standard design of vehicles. Consequently, if drivers use 100 percent of the designed capacity of vehicles, the construction can be overloaded.

In addition, it should be worth noting that due to the long time it takes to run the projects and the irresistibly decreasing quality of the construction over its service life, if O4 occurs, investors might need to spend more costs on this risk in the future.

8.3.1.6. Corruption (P4)

Corruption (P4) expresses the circumstance that any involved officials from any party demand bribes and unjust rewards. It stands in the 6th position in table 8.5 with the mean score of 0.373.

Table 8.9 below compares the level of corruption in different countries. It can be seen that Vietnam is in the 116th position out of 177 countries. According to interviewees, P4 remains problematic in any stage in a PPP from development and implementation of construction to completion and the franchise operation period. However, in Vietnam, the stage in which this risk is the most serious, both in terms frequency of occurrence and degree of impact is the development stage. The development stage is a favourable environment for P4 since at this time a number of approval permits need to be obtained, and the process of selecting investors, contractors, inspectors and other partners is carried out. Indeed, private investors replied that unfair selection of investors, contractors and other partners can be one of the most frequent issues. In fact, results from a survey by the World Bank (2012) found that in the Vietnamese construction industry, the public client is the most corrupted sector amongst involved parties. Interviewees also reported the recent case of the Hanoi city rail project which is under investigation. In this case, the Japan Transportation Consultants Company is being accused of providing bribes of more than £500,000 to get the consulting contract (MOT, 2014).

Table 8. 9 Corruption Ranking (Transparency World, 2014)

Rank	**Country**	**Score in 2013**	**Score in 2012**
14	United Kingdom	76	74
18	Japan	74	74
19	United States	73	73
22	France	71	71
26	Austria	69	69
46	South Korea	55	56
80	China	40	39
102	Thailand	35	37
114	Indonesia	32	32

116	Vietnam	31	31
140	Laos	26	21
160	Cambodia	20	22

Many reasons for this issue were revealed by respondents, for example legal framework, poor transparency, weak enforcement of the laws, cash using cultures, and low income of practitioners. In fact, according to Global Integrity (2009), the anti-corruption legal framework in Vietnam in 2009 was considered amongst the best anti-corruption legal frameworks in Asia. However, the results of the current study did not show consistent findings. The majority of participants from all parties responded that they did not consider the anti-corruption legal framework in Vietnam as an effective framework, and that it is still a vast challenge to improve this framework. More specifically, the legal and supervision system is criticized as having many loopholes which can be exploited. As stated, there are too many unnecessary and overlapping documents and procedures, and from the private sector's perspective, more unnecessary and overlapping are documents required, in which a serious environment for corruption can be generated. In addition, there is also a lack of sufficient mechanisms for making involved officials accountable for their activities. This finding seems to support the findings of the World Bank (2012) that the laws are too general, formalistic, and out of date, and there are no serious sanctions that have been implemented. Similarly, other experts also observed that the result of the anti-corruption fight in Vietnam is still limited, and the reason is the lack of implementation, weak enforcement of the laws, and the actual work of anti-corruption departments still is not transparent (Freedom House, 2011; US Department of State Investment Climate Statement, 2011; Martini**,** 2012).

As a consequence of corruption, the low financial ability of investors and contractors can be selected. P4 can also negatively influence the effectiveness of inspectors and consultants. In comparison with conventional projects in which P4 falls within the relationship between the public and private sectors, in PPP, corruption trends can also take place but inside the private sector, such as amongst private sponsors, contractors and consultants. Some participants from the private sector confess that now many practitioners have accepted a certain level of corruption in order to smooth their work. The cost for this is accepted as an invisible portion in total expenditure. A small number of participants disclosed that in some cases, the budget, which needs to be sent to corrupted officials can be assumed as an unacknowledged percentage of the total capital expenditure.

However, interviewees also admitted that in recent years, corruption trends have been changing, and P4 has been minimized. For example, with the recognition of the fact that the process of selection of investors and contractors is the most favourable environment for corruption, in 2014 the government issued the decree 63/2014/NĐ-CP in order to escalate transparency and competitiveness. Also, the development of the social media is also one factor mitigating this risk since this system can disclose more information to the public and make the public pay attention to the projects. This, in turn, can require parties to publish more details about projects. Indeed, social media can raise the public's understanding and awareness of the anti-corruption fight. Moreover it can also give pressure and chase cases that might otherwise have died out (World Bank, 2012). Nevertheless, some respondents from the current surveys also expressed concern about the social media freedom in Vietnam, and that social media can be devaluated by the over-control from the host government. Respondents disclosed that in big projects, it is less serious than in small and medium projects as these projects achieve more attention from the public, but it is still a massive challenge in investigating corruption in small and medium projects.

8.3.1.7. Fluctuation of Demand (O5)

"Fluctuation of Demand" (O5) is in the operational risk category. It refers to the circumstance in which the number of vehicles using toll roads or bridges is higher or under the forecasted level. If the demand is higher than predicted, the interests of the public clients are not protected, whereas if the demand is lower than an estimated level of investors may face losses. Participants ranked this risk in 7th position with the mean score of 0.342. There is a statistically significant difference between scores given by the public and private sectors. The private sector graded this risk at 0.369 with the 7th position while public clients marked this risk 0.300 in the 18th position.

Variation of demand is one of the most critical risks which directly decrease the revenue stream of a PPP project, possibly leading to project failure. According to Chou *et al*. (2012) and EAIC Advisory (2013), in social infrastructure projects, prices of services are often set up based on pre-agreed tariff mechanisms. Therefore, the price variation is not considered as critical, but fluctuation of demand is the core element. According to projects' agreements collected during the fieldwork, in Vietnamese PPPs, the fluctuation of demand is always embedded in the contract. Basically, if the demand varies widely, the contract could be renegotiated. For example, in No 18 Highway Uong Bi-Halong project, if the demand alters by more than 5 percent of the predicted demand, the contract will be revised. Although this risk and its mitigation strategies are embedded in the contract, parties can still be seriously harmed. For instance, because of the pre-agreed level on tolls, investors cannot raise the toll level significantly, and then they need to stay in a longer franchise operation period, and all financial return plans might be changed. In addition, a longer contract may result in more unpredicted uncertainties for all parties. Also, an unpredicted demand can also lead to unpredicted maintenance costs which account for a high proportion of the total expenditure.

It is criticized that the inaccurate demand forecast in Vietnamese PPPs is because the method of forecasting is unsystematic, unreliable, and not comprehensive. The first fundamental reason investigated is the unreliability of historical data about traffic demand. It is pointed out that forecasting future traffic flows can be a huge challenging exercise with the absence of reliable historical data. Without these data, revenue shortfalls can be generated because of overestimation of the traffic level. Another essential reason underlying this issue is that the infrastructure development plan of the country is not scheduled for a long-term period. For this reason, participants referenced the case of Yen Lenh bridges. In this project, the demand varied widely because of the appearance of new transport routes which had not been forecasted in the original feasibility study. As a result of the failure, the SPV had to transfer the project to the government. Some academics also declared their concern about the current 1A highway project which is the main transportation link though the country. This highway is now being constructed under BOT and BT arrangements. However, there is a Ho Chi Minh free highway which is parallel to the current No 1 highway project. Consequently, they are worrying that when the 1A highway starts to collect tolls, drivers would go to the Ho Chi Minh free highway and this can undesirably cut the demand for the 1A highway. Investors also talked about the Phu My bridge project. This bridge was first constructed in 2007 and in was in the operation stage in 2010. However, in 2011 Phu My Construction Company which is the SPV also had to return the project to the Ho Chi Minh City government. They complained that the local government did not organize traffic flows and delayed in constructing other support infrastructures. This, in turn, dramatically decreased the vehicle level for the bridge. In fact, the failures of these projects have made heavy financial burdens for the Vietnamese government. The first financial burden comes from the financial gap made by the loss of demand. The second financial burden comes from the fact that investors did not provide the required equity, but they borrowed from the bank and the government had to pay back this amount including its interest.

From the feedback of investors, it is also recognized that credit organizations are likewise concerned about the reliability of traffic demand forecasting. Thus, lenders who are usually risk averse, are correspondingly concerned about the creditworthiness of the project, since they are worried that with an actual revenue stream, investors will be unable to repay their financial obligations. Thus, they may require further backup from the host government. This, in turn, can make it difficult for investors in mobilising capital. Nevertheless, it is recommended that in this case, if an off-take agreement is used, it may be easier for investors to access financial resources (EAIC Advisory, 2013). Additionally, academics in the in-depth interviews in this study criticized that demand forecasting is also the responsibility of investors, and the public sector should be only responsible for losses made by action or inaction of the governments, and apart from these governmental faults, investors should be in charge for the losses created by reduction of demand. It is, however, criticized that with the current regulation in Vietnamese PPPs, investors can escape and shift risks to the government, and this is a loophole in the PPP legal system in Vietnam.

8.3.1.8. Inadequate experience in PPP of public sector (Re2)

"Inadequate experience in PPP of public sector" (Re2) is placed at the 8th position with the mean score of 0.341. The private sector grades Re2 the score of 0.337 with the 8th position while the public sector gives this risk the score of 0.369 with the 14th position.

A majority of participants including people from governmental agencies admitted that the host government is lacking sufficient experience in managing PPP arrangements. More specifically, they criticized the experience of building the environment for bankable PPP projects, such as the ability in carrying out about competitive bids for PPPs, evaluating the feasibility study, and the trouble with resolving cases of dispute during the project life cycle. For example, academics also made a strong argument that the host government should clearly recognise that some domestic investors are state-owned organizations, and debts that they have are from the National Bank of Vietnam. Therefore, it is mainly the government's budget, and in any case of default, the public party may face losses. This argument seems to support the consideration in ADB (2012) that the widespread dominance of state-owned organizations as investors can create confusion about risk allocation and the transparency issues. More seriously, it is criticized that some existing PPPs in which investors are state-owned organizations usually have negotiated a direct appointment contract rather than a competitively bid agreement (Ibid).

Furthermore, interviewees cited that the government is lacking adequate experience to deal with cases in which investors are domestic bankers. In these cases, bankers do not have standard abilities and experience in the construction industry. Therefore, they demand to invite other contractors into SPV, and they then present a number of additional costs which dramatically raise the total expenses. According to participants' experiences, in these cases investors attempt to be successful in the tendering process in order to achieve the PPP contract, then during the contract time they will seek explanations to increase the total expenditure which had been embedded in the agreement. Academics made a point that investors usually claim causes for increasing the total expenditure at the time the construction has been constructed by around 50 percent, and in this condition the government is usually reluctant to agree to take the requirement from the sponsors. One of the potential causes here is that there is no clear responsibility and accountability commitment for each party and for managers in each project. Therefore, the requirement for adjustment of total expenditure is likely accepted.

Additionally, there are limited opportunities to create mechanisms in which the public sector can have certain power in dealing with investors in SPV. According to Vietnam PPP regulations, there is no limitation about the maximum proportion of equity provided by investors. The Vietnamese government believes that this can take full advantage of the financial ability and management skills of the private sectors. However, from the experience of PFI in the UK and P3 in the USA, this may also reduce the control power of the public sector in monitoring and supervising projects (HM, 2012). For this reason, in new PF2 regulations, the UK government requires a certain level of public contribution in mobilizing capital (ibid).

8.3.1.9. Weak Financial Capacity of Investor (M2)

"Weak Financial Capacity of Investor" (M2) is in the market risk category. Participants placed M2 in the 9th position with the score of 0.337. The private sector gave this risk the score of 0.323 with the 9th position, whereas the public sector put this risk in the 7th rank with the grade of 0.415. The test showed that there is a statistically significant difference between perceptions of the two parties.

Financial ability of the investor is one of the most critical considerations in application of a PPP arrangement as investors will be responsible for the project for a long-term period which is usually more than 20 years in the case of a Vietnamese PPP. A transportation project usually requires massive expenditure. Hence, if the investor defaults at any time, other parties' interests can be seriously damaged. According to Vietnam PPP laws, in order to go into the bidding process, investors must submit a clear report about their financial ability. This report also demonstrates projects which investors have been investing in. The Vietnamese government has also issued regulations about criteria for accessing the financial ability of investors in PPP. In case investors are investing in different projects, investors' financial ability must be examined regarding all projects. In addition, the financial plan in which investors will mobilize capital also needs to be clearly verified. For instance, details about resources that provide debts for investors need to be disclosed. However, practitioners criticized that the instrument to examine the financial ability and the financial plan of investors is not efficient, and consists of many loopholes. Also, the instructions on how to apply these regulations are not detailed. It was stated that investors can use financial tricks to better their financial report. For instance, low financial ability investors can join with well-known investors. However, the actual contribution of the well-known investors is usually very rare, and the work is mostly done by the low ability companies. For example, Chinese companies sometimes join with Japanese companies.

Nevertheless, after the PPP agreement is achieved, almost all of the work is done by the Chinese companies, and Japanese companies seem to disappear during the construction time. Furthermore, it also appears that in some circumstances, investors do not contribute the required equity, and they then acquire debts from the other financial sources instead. Vietnamese PPP laws usually require investors to have no less than 30 percent of total expenditure made by investors' equity, except in some very special cases. However, in some cases, investors just contributed 10 percent to 20 percent of total expenditure and the rest is borrowed from other sources which are not revealed in the agreement. This, obviously, increases the total expenditure for the project as the interest payments are added in.

Theoretically, if investors have an investment license, this means that their financial ability is approved by the public sector. However, there are many cases in which the government has to stop some running projects because of the low financial ability of investors. This indicates that the ability of investors had not been carefully examined in the bidding stage. Investors sometimes pass responsibility to other parties to cover their low financial ability. For instance, in the land acquisition stage which costs a big share of the total expenditure, some BOT projects are delayed because investors do not have adequate funds to compensate land users. Consequently, citizens are not willing to provide the land use right. However, investors justify themselves due to the local government not providing documents which mention the agreed price of land. However, these documents cannot be issued until the investors accept the compensation price. From these explanations, it can be recognized that the confusion is due to the unaccountability of project investors.

8.3.1.10. Lack of transparency (M1)

"Lack of transparency" (M1) is in the legal risk category and it is the last risk in the top ten risk group. M1 has the general score of 0.336. It might be true that the lack of transparency is one of the main reasons leading to other obstacles such as corruption. In fact, previous research such as that of Greve and Hodge (2011) proved that PPPs usually bring greater transparency in comparison with conventional projects. However, participants in this study stated that it very difficult to determine the level of the lack of transparency in any project.

In this study, from the private sector's point of view, participants stated that the process that they desire to increase the level of transparency the most is the project approval process. They expressed their need for a system in which investors can track their approval process. This system must be able to show investors which stage their projects are in and the exact time schedule for when decisions are made. From the government agency's opinion, they stated that there is a need to have an annual report with detailed information of all PPP projects. These reports need to contain information about current financial details of the project and the forecast for future returns also needs to be published. In addition, the condition of the asset and how the assets are being managed need to be provided. In fact, regulations from other countries such as regulation for PF2 in the UK reveal that one of the approaches to increase transparency is that the government should contribute a certain part to the financial expenditure of the special purpose vehicle. This can bring more control power to the government and may make sure that the public and private sectors have the same access to the source of information.

However, the statements above are just about increasing the transparency in the relationship amongst stakeholders. Academics interviewed in this research made a point that the public clients and investors should cooperate to publish basic relevant information to the taxpayer. For example, the condition of the asset and basic financial status of the project company should be provided to the public. This can possibly make the taxpayer confident about the PPP mechanism and the value for money of projects.

8.3.2. Medium Ranked Risks

Table 8. 10 Medium Ranked Risks

Code	Risks	General			Ranking by Sector					
					Public		Private		Others	
		Score	Ranking	St.d	Score	Ranking	Score	Ranking	Score	Ranking
C4	Low site safety *	0.324	11	0.112	0.469	5	0.289	20	0.414	3
L5	Restriction on toll *	0.318	12	0.107	0.395	9	0.309	12	0.228	19
M5	Fluctuation of interest rate *	0.314	13	0.107	0.41	8	0.295	16	0.306	14
M3	Difficulty in accessing finance from the banks *	0.311	14	0.104	0.486	2	0.267	26	0.33	11
C3	Low quality products*	0.310	15	0.100	0.383	11	0.293	17	0.339	8
C10	Delay in other infrastructures relating to the project	0.308	16	0.098	0.351	16	0.301	14	0.294	15

Table 8.9 presents the second group of 6 risks. “Low site safety” (C4) and “Restriction on tolls” (L5) stand at the top of the table with the mean scores of 0.324 and 0.318 respectively. On the other hand, “Low Quality products” (C3), and “Delay in other infrastructure relating to the project” (C10) are in the bottom of the group with the mean scores of 0.322, and 0.309, respectively. Other risks such as “Fluctuation of Interest rate” (M5), and “Difficulty in accessing finance from the bank” (M3) are placed in the middle. In general, all of these risks received scores which are above 0.300. There are 5 risks, namely “Restriction on toll”, “Low site safety”, “Fluctuation of Interest rate”, “Difficulty in accessing finance from the bank”, and “Low quality products” having statistically significant differences in rankings between the public and private sectors.

Regarding “Low site safety”, the public sector graded this risk 0.469 in the 5th position which is much higher than that given by the private sector, 0.289 in the 20th position. Public agency complained that this is a common problem in the construction area in Vietnam including road and bridge PPP projects. According to the Ministry of Labour of Vietnam (2014), around 30 percent of the total number of accidents at work cases in 2014 comes from construction projects. It should be noted that the risks are not restricted to those working on sites, but also to citizens, since the construction activities in living areas are not sufficiently controlled. In fact, the government of Vietnam has issued regulations about site safety such as the 48/2010/NĐ-CP. However, it is criticized that investors and contractors are breaking the law by providing insufficiently safe protections on site. The public agencies expressed that there are cases in which investors collude with contractors to minimize the financial expenditure, and then during the franchise operation period, they will defend them by providing reasons such as natural disasters or overloaded vehicles. In fact, HSE (2006) recommends that investors and contractors should not ignore the fact that accidents at work also have financial costs, and they can result in poor business performance. In fact, from contract agreements collected, it can be documented that contract clauses about site safety are too generally stated, without referencing any site safety laws.

Also, private investors claimed that tolls and any changes in toll mechanisms need to be approved by the government. “Restriction on tolls” sometimes forces them to stay longer in the franchise operation period. However, members from the public department replied that the level of tolls should be kept in order to be appropriate with the living standards of the citizens. This is also a strategy to minimize the risk of opposition from politicians and citizens. They made a point that previous experience in Vietnam has shown that transportation costs can strongly increase following the rise of the tolls. This, in turn, raises the price of other products in the market affecting citizens' lives.

Interestingly, the public sector considered "Fluctuation of Interest rate", and "Difficulty in accessing finance from the bank" riskier than the private sector did. More specifically, these risks stand at the 2nd and 8th positions in the public sector's point of view, whereas they are in 26th and 16th position in the private sector's opinion. From these scores, it might be seen that the public sector considers that the banking systems are creating serious troubles for investors. Public agencies from interviews in this research said that they have received a number of complaints from their partners that there are too many requirements and procedures from credit organizations, and that the government is not willing to provide guarantees in a number of cases. Also, in the past, investors could not mortgage the future revenue from the project to the credit organizations, and this built more barriers in accessing credit resources. However, general results from this study do not show that the private sector considers this risk as critical. In fact, private investors clarified that "Fluctuation of Interest rate" can seriously affect their project; however, they consider this risk as external to the organization. Actually, in PPP mechanisms, the private sector is indeed the party which mainly bears these risks. Therefore, it might not be serious if the public sector ranks this risk in a high position.

8.3.3. Low Ranked Risks

Table 8. 11 Low Ranked Risks

Code	Risks	General			Ranking by Sector					
					Public		Private		Others	
		Score	Ranking	St.d	Score	Ranking	Score	Ranking	Score	Ranking
C8	Impractical feasibility study *	0.291	17	0.086	0.247	19	0.293	18	0.385	6
M8	Poor financial market *	0.286	18	0.098	0.178	23	0.314	11	0.221	20

L2	Revision of the contract clauses *	0.279	19	0.101	0.203	21	0.307	13	0.177	24
P1	Concession termination by government *	0.268	20	0.084	0.167	27	0.298	15	0.241	18
L1	Disapproval of guarantees by the government *	0.264	21	0.096	0.169	26	0.287	21	0.257	16
Re4	Low-cooperation between different partners *	0.258	22	0.089	0.211	20	0.277	24	0.183	23
M6	Foreign currency exchange fluctuation *	0.25	23	0.099	0.149	29	0.291	19	0.081	43
L4	Regulation change *	0.244	24	0.126	0.137	31	0.284	23	0.137	33
P3	Unstable government *	0.238	25	0.085	0.127	33	0.264	27	0.25	17
M9	Income streams are usually in local currency *	0.235	26	0.108	0.063	42	0.285	22	0.154	30
P7	Forced buy-out risks *	0.23	27	0.097	0.082	39	0.274	25	0.148	31
Re3	Inappropriate distribution of responsibilities and risks *	0.229	28	0.143	0.473	4	0.169	40	0.219	21
C6	Design changes *	0.208	29	0.075	0.17	25	0.221	28	0.165	28
C5	Unavailability of materials	0.2	30	0.069	0.189	22	0.212	32	0.105	37

This group of 14 risks contain risks which have scores ranging from 2.00 to under 3.00, and from the 17th position to the 30th position. In this group, “Impractical feasibility study” (C8), “Poor financial market” (M8), and “Revision of the contract clauses” (L2) are at the top. In contrast, “Inappropriate distribution of responsibilities and risks” (Re3), “Design changes” (C6), and “Unavailability of materials” (C6) are placed at the bottom.

In fact, there are 13 risks amongst 14 risks in this risk group that have statistically significant difference in scores made by the public clients and the private sector. One of the remarkable differences can be seen in the risk “Inappropriate distribution of responsibilities and risks” (Re3). While the public sector put this risk at the 4th position with the score of 0.473, the private sector placed it at the 40th position with the score of 0.169. Interviewees from government agencies stated that the risk allocation is not clearly stated in the contract agreement, especially regarding the future traffic demand. This can create a number of disputes when implementing projects which reduces the core effectiveness of the PPP arrangement.

Another significant difference comes from the risk “Project Termination by Government” (P1). “Project Termination by Government” refers to circumstances in which projects are internally stopped by the host government. While private sectors believe that this circumstance likely occurs by giving it the 15th position, the public sector only ranks this risk into the 27th position. Participants from the public sector explained that termination is only employed if during the project life the investors do not show sufficient proficiency in running projects. They said that many projects have been delayed by low financial and management inabilities of sponsors, and in these cases, replacing investors is the compulsory strategy used to rescue the project.

“Disapproval of guarantees by the government” is also the risk stressed by the participants. It also received significantly different scores between the two sectors. More specifically, participants from public departments put this “Disapproval of guarantees by the government” into the 26th position, whilst in the private sector’s view, it is in the 21st position. Public agencies defended that guarantees can be provided in special cases. Indeed, the decree 108/2009/ND-CP demonstrates that investors can request for loan guarantee for projects in “A Project” category which have a total expenditure of no less than around $77 million. However, sponsors complained that the level of expenditure required is high. The 8th position is given for the risk “Regulation Change”. Interviews showed that one of the main reasons for the changes of regulation is that some regulations and legal documents are issued due to the urgent needs in the industry without long-term plan consideration. In addition, the feasibility of these regulations is also questioned as some of them are made without a feasibility study (Huong, 2014).

“Forced Buyout Risks” (P8) also had a notable difference in scores. This risk refers to the condition in which the project is in the operation stage but the concession period is forced to be bought out by the government. It was ranked in a very low position by public clients; 39th. However, the private sector put this risk into the 25th position. One of the possible reasons that was revealed is the change in the development plan of the country or the area. For example, due to the development plan, the government may need to manage selected projects in selected areas in a consistent mechanism. However, the majority of participants including those from the private sector also revealed that some buyout cases had been employed with warm acceptance from sponsors as the projects were in circumstances of financial burden.

8.3.4. Very Low Ranked Risks

This group contains 14 risks which have scores of less than 0.20 and stand at the bottom of table 8.4. Table 8.12 expresses that 10 risks among these 14 risks have scores with statistically significant differences.

Table 8. 12 Very Low Ranked Risks

Code	Risks	General			Ranking by Sector					
					Public		Private		Others	
		Score	Ranking	St. d	Score	Ranking	Score	Ranking	Score	Ranking
P6	Public scepticism about the real benefits of PPP *	0.193	31	0.065	0.128	32	0.219	30	0.088	42
C9	Impractical requirements of progress of project *	0.191	32	0.084	0.099	35	0.219	29	0.143	32
M10	Asset value less than forecasted at the time of transferring *	0.19	33	0.101	0.336	17	0.167	41	0.163	29
Re1	Inadequate experience in PPP of private sector	0.184	34	0.058	0.174	24	0.197	34	0.075	44
L6	Taxation risks *	0.184	35	0.082	0.083	38	0.213	31	0.111	35
C2	Poor design *	0.176	36	0.078	0.106	34	0.195	35	0.119	34
O1	Operation cost overrun *	0.174	37	0.103	0.046	43	0.206	33	0.097	38
Ot1	Bad nature events	0.172	38	0.064	0.14	30	0.176	38	0.208	22
P2	Political opposition *	0.159	39	0.085	0.037	44	0.191	36	0.097	39
O2	Default of operator *	0.158	40	0.064	0.084	37	0.18	37	0.11	36
C1	Changes in industrial code of practices	0.152	41	0.098	0.152	28	0.15	43	0.167	27
O3	Low quality of operation *	0.151	42	0.005	0.097	36	0.17	39	0.09	40
Ot2	Force majeure events *	0.136	43	0.077	0.077	41	0.151	42	0.172	25
P5	Public sector default *	0.032	44	0.001	0.078	40	0.012	44	0.088	41

These scores reflect that these risks are not critical in Vietnamese PPPs both in terms of frequency of occurrence and the degree of impact. Table 8.11 shows that “Public scepticism about the real benefits of PPP” (P6), “Impractical requirements of progress of project” (C9), and “Asset value less than forecasted at the time of transferring” (M10), stand at the top of the table, and opinions of the public and private sectors are significantly different regarding these risks.

One of the noticeable differences can be seen from the risk Asset value less than forecasted at the time of transferring (M10). In fact, public clients rated this risk with a high score, 0.336, with the 17th position while participants from the private sector gave this risk only 0.167 with the 41st position. M10 does not only imply the transfer which happens at the end of the operation stage, but it also includes any reluctant transfers at any time during the project's life. More specifically, the price that the government has to pay is higher than the actual value of the project at the transferring time in case of buying out, or the asset has less economic value at the end of the operation period than was estimated. One reason might be that the project is overestimated in the feasibility study in the planning stage. Consequently, at the beginning, the value of the project is already low in comparison with its actual asset value.

8.4. Selection of Risks for AHP models

Based on the risks analysis, ten risks from table 8.4 were selected to demonstrate the use and applicability of AHP models in the proposed framework in evaluating a project's riskiness and in allocating risks. Table 8.13 shows the selected risks.

It should be noted that, there are several main reasons for selecting these result. Firstly, in order to reduce the number of questionnaires, and with a limited timeframe and financial resources, only ten risks were used to test the applicability of the framework, and these risks are re-categorised as shown in table 8.13. However, in reality, the number of risks can be selected based on the specific situation of the projects.

Secondly, the risks are not selected only based on scores provided in the table 8.4, but the selection is also discussed with academics experts and especially practitioners in these projects. This is because the list of risk provided in table 8.4 is for the whole market, while the situation of each project can be different. Therefore, the selection needs to be recommended by practitioners from these projects. According to practitioners, this selection was recommended because it also can evaluate projects from different aspects. In other words, different risk groups are considered. In fact this is also a point which can show the flexibility of the proposed model. Figure 8.2 shows basic process of selecting risks for AHP from risk scores provided in table 8.4.

Figure 8. 2 Process of selecting risks for AHP from Risk Scores and Ranking Result

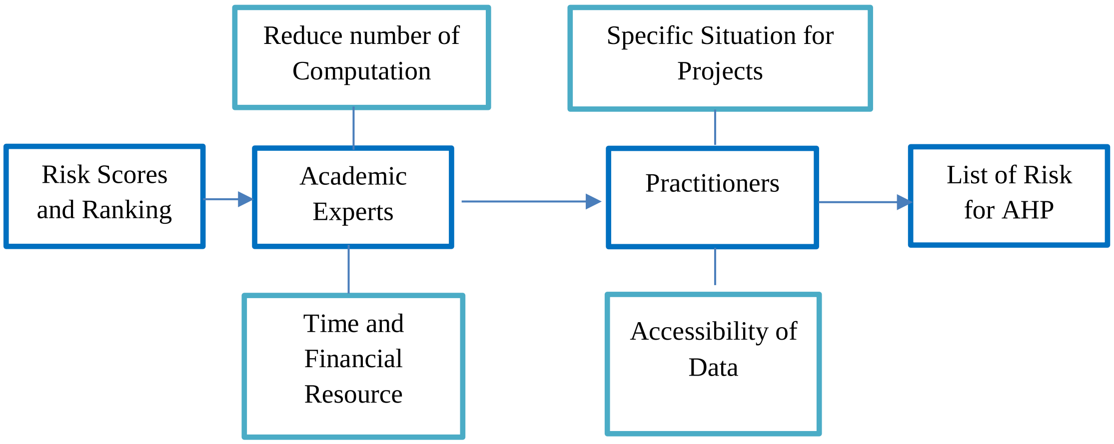


Table 8. 13 Risks used in AHP models in this research

Construction Risks	C3. Low quality products
	C7. Difficulty in land acquisition and resettlement
Political and legal risks	L3. Poor project approval and permit process
	P5. Corruption
Market risks	M2. Weak financial rapacity of investors
	M4. Inflation risk
Operational risks	O4. High maintenance cost
	O6. Fluctuation of demand
Relationship risks	Re3. Inappropriate distribution of responsibilities and risks
	Re4. Non-cooperation between different partners

It can be recognized that risks are re-categorized. The reason for doing this is to reduce the number of pairwise comparisons. Risks are re-categorized in 5 groups, namely, Construction, Political and Legal, Market, Operation, and Relationship.

8.5. Summary

Risk identification plays an important role in the proposed risk evaluation framework because critical risks need to be identified before any further actions can be made. This chapter shows the critical risk ranking in Vietnamese PPPs in the transport sector. In general, the private sector is more concerned about these risks than is the private sector. Risks such as, Difficulty in Land acquisition and Resettlement (C7) and Poor project approval and permit process (L3) are the most critical risks in Vietnamese PPP. The in-depth analysis about the findings was also provided to offer a clear insight into these risks. In addition, the findings show that the perceptions of the private sector and the public sector are statistically significantly different among 32 of the 44 mentioned risks. The reasons for this difference were also speculated and analysed. Moreover, this chapter also clarifies risks that will be used to demonstrate the applicability of the AHP models in the proposed framework.

CHAPTER 9: CASE STUDIES AND FINDINGS FOR THE AHP MODEL

9.1. Introduction

Evaluation of the project's riskiness and allocation of critical risks are important functions of the proposed risk evaluation framework in this research. In this framework these functions are carried out by developed AHP models. In order to illustrate the applicability of AHP for these tasks, AHP models were carried out in Vietnamese PPPs. This chapter shows the findings of application of AHP to evaluate riskiness of the projects, and it also illustrates the allocation strategies found by the developed AHP model. Firstly, findings of riskiness evaluation are shown with in-depth analysis of real situations in the case studies. After that, risk allocation strategies found by AHP are also revealed with the analysis. Finally, a summary of the chapter will be provided.

9.2. Project's Riskiness Evaluation

As mentioned in chapter 4 and chapter 6, the advantage of AHP is the ability to evaluate different options with regards to multiple criteria. Therefore, in order to test the applicability of this model in Vietnamese PPPs, a set of options and a set of criteria need to be built. With the purpose of evaluating the riskiness of different projects, Vietnamese PPPs were used as options and critical risks were used as criteria. Options are the Yen Lenh Bridge project, Phu My Bridge project, Co Chien Bridge project, New Dong Nai Bridge project, and No 18 Highway Uong Bi – Ha long project. Table 9.1 illustrates basic information about 5 case studies. In terms of criteria, 10 critical risks, identified in chapter 8, were chosen to set up the criteria.

Table 9. 1 Summary of Case study

Case study	Name	Location
Project 1	Yen Lenh Bridge	Ha Nam Province
Project 2	Phu My Bridge	Ho Chi Minh City
Project 3	No 18 Uong Bi – Ha Long Highway	Quang Ninh Province
Project 4	New Dong Nai Bridge	Dong Nai Province
Project 5	Co Chien Bridge	Tra Vinh and Ben Tre Province

This re-category is illustrated in table 8.13. Hence, the number of criteria here was five, and the set of options consists of 5 mentioned projects, thus the number of alternatives was also five. The final results will show the riskiness ranking of these projects regarding selected critical risks.

9.2.1. Project Description

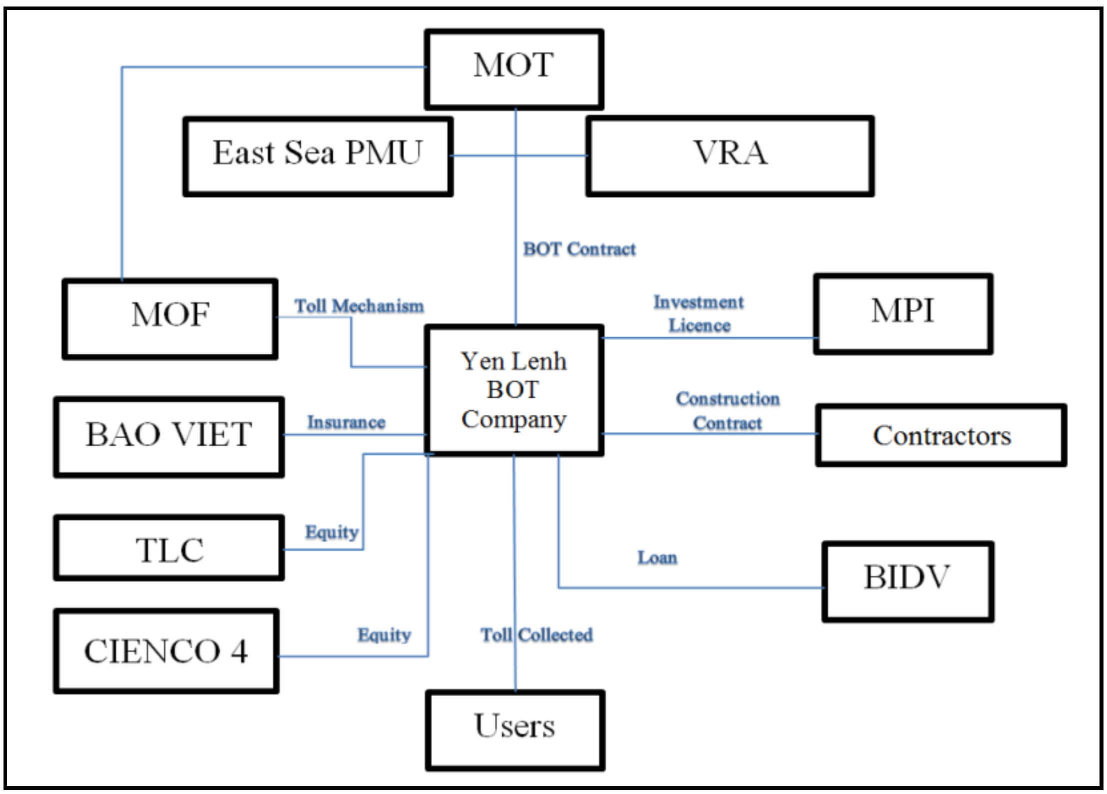
a. Project 1: Yen Lenh Bridge Project

Yen Lenh Bridge is located on the No 38 national highway, and it crosses the Red River connecting Ha Nam Province and Hung Yen Province. The bridge is 2229.95m long and 15m wide, and clearance for ships is 80m wide and 10m high. It has two approach systems and a main bridge. The feasibility of the project was approved in August 2001, and the East Sea Project Management Unit of Vietnam was authorized by the Ministry of Transport (MOT) to conduct the project. The project was planned to use financial resources both from the government and private investors. More specifically, two approach systems were constructed by the government's financial budget, and the main bridge was constructed under the BOT contract, and the operation stage was planned to last 17 years and one month at the first time of signing the contract in 2002.

Figure 9. 1 Yen Lenh Bridge

The joint venture (JV) of Thang Long Construction Corporation (TLC) and Civil Engineering Construction Cooperation No 4 (CIENCO 4) were selected under the bidding process. This was the first time they were in a BOT mechanism, and in this joint venture, TLC owns 52 percent of the stake and CIENCO 4 owns 48 percent of the stake. It can be seen that they are contractors for two approach bridges, but they are also sponsors for the main bridge. In BOT's investment role, the equity budget is £1.44 million which is equivalent to 30 percent of the total BOT investment, and the debt from the Bank for Development and Investment of Vietnam (BIDV) is £3.36 million (Yen Lenh Contract Agreement, 2002). The construction started in June 2002 and finished in September 2004, which was 10 months earlier than scheduled.

Figure 9. 2 Arrangements of Yen Lenh BOT Bridge Project (Toan, 2008)



From figure 9.2, it can be seen that the Yen Lenh BOT contract was signed between MOT and the Yen Lenh BOT Company. However, the East Sea Project Management Unit of Vietnam was authorized by MOT to manage the project as the role of public client in conducting the bidding process and selecting investors, and during the construction stage. On the other hand, Vietnam Road Administration (VRA) was authorized by MOT to play the role of the public sector in the operational stage. The Investment license was provided by the Ministry of Planning and Investment (MOP). Toll arrangements needed to be negotiated between the Ministry of Finance (MOF) and MOT, and then they needed to be approved by the Prime Minister. It also can be seen that BIDV is the only bank which provides investors with debt, and the insurance contract was signed with BAOVIET insurance company.

b. Project 2 - Phu My Bridge Project

Phu My Bridge is the largest cable-stayed road bridge in Vietnam, crossing Sai Gon River in Ho Chi Minh City. It is 705 meters across the river, with a main span of 380 meters, and approach structures on two sides of the river are roughly 758m and 638m long. The main bridge is 27m wide with 4 lanes. The project was planned since 2002 together with the development plan of Ho Chi Minh City. It was expected to smooth the belt-line road system.

Figure 9. 3 Phu My Bridge

In July 2003, the process was conducted and investors were chosen by the Ho Chi Minh City people’s committee. Investors are Hanoi Construction Cooperation, Investment and Construction JSc (INVESTCO), Ho Chi Minh City Infrastructure Investment Joint Stock Company (CII), 620 Chau Thoi Concrete JSc (Beton 6), and Thanh Danh Limited

Liability and Commerce Joint Stock Company (Thanh Danh JSc). They together set up the Phu My Company (PMC) which is the SPV of the project. In November 2004, the Prime Minister approved the final decision about the right to invest in the project. On the 4th of February 2005, an investment license was issued by Ho Chi Minh City people's committee, and on the 7th of February 2005, BOT was signed between Ho Chi Minh City people's committee and PMC. The project began construction in September 2005 and finished in February 2009, which was 4 months faster than scheduled, and PMC started to collect tolls in April 2010 (Thanh, 2013).

Figure 9. 4 Arrangements of Phu My Bridge Project (Thanh, 2013)

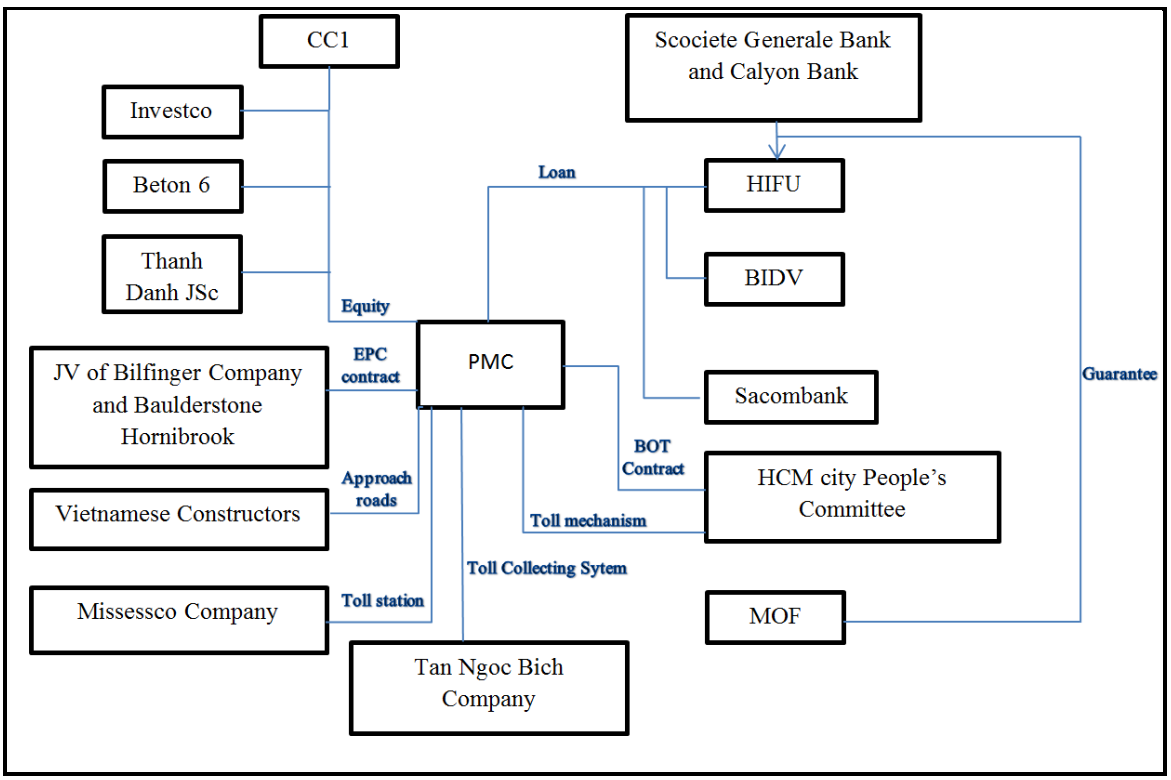


Figure 9.4 clarifies that Ho Chi Minh City People's committee was authorized to play the role of public client in this project. The investment required was £55.6 million excluding loan interest and VAT. Private investors are responsible for 30 percent of the total required investment by equity. The 70 percent that was remaining was loans from Société Générale bank in France, Calyon bank in France, Bank of Investment and Development of Vietnam (BIDV), and Ho Chi Minh City Investment Fund for Urban Development (HIFU). It is important to note that MOF was the guarantor for HIFU to get loans from Société Générale

bank and Calyon bank, and then HIFU lent the loans to the PMC. In terms of contractors, PMC had an EPC contract with a joint venture of Bilfinger Company from Germany and Baulderstone Hornibrook Company from Australia. This joint venture was responsible for building the bridge, and other domestic contractors were employed to construct other works such as approach roads and a toll collecting station. The toll mechanism was set up by the people's committee of Ho Chi Minh City.

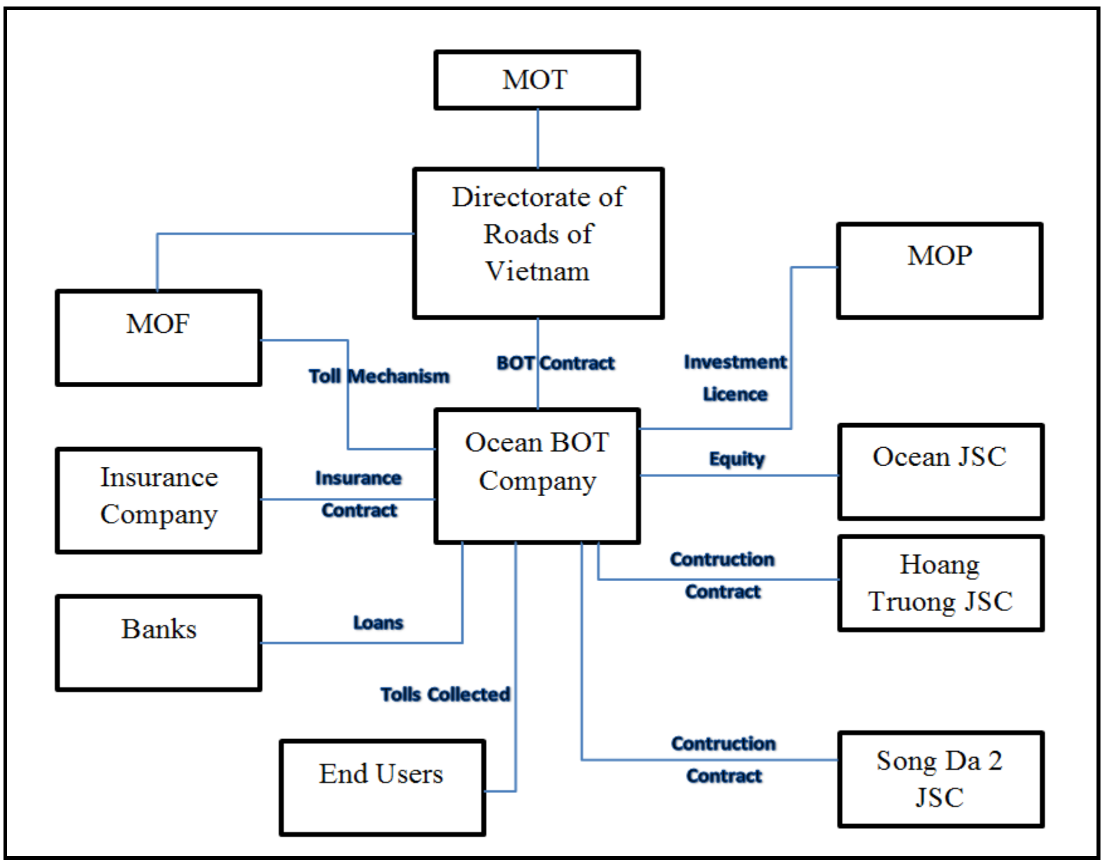
c. *Project 3 - No 18 highway Uong Bi – Ha Long Project.*

The No 18 highway Uong Bi-Ha Long is a 30.1km long highway from Km77+300 (Uong Bi city) to Km107+400 (Ha Long city). This is an important link between Hanoi, Bac Ninh, Hai Duong and Quang Ninh. The demand for this highway is very high as it connects the capital to the border gate in Quang Ninh Province. There have been serious traffic jams, especially during vacation time. However, the quality of the old No 18 highway has been downgraded, and the demand for upgrading the road is urgent. The project is to upgrade the No 18 highway.

Figure 9. 5 No 18 Uong Bi – Ha Long Highway

The project was planned in 2010 and the contract was first signed in August 2011. The authorized state body in the contract is Directorate for Roads of Vietnam (DRV) and the SPV is Dai Duong BOT Company which is set up by Dai Duong JSc. Dai Duong JSc is a private company investing in many areas including infrastructures in Vietnam. Currently, they have been in a BOT contract with No 18 highway and 5B highway. The contractors are joint ventures of Song Da 2 and Hoang Truong Construction Company. The total required investment planned was £33.33 million. The investors' equity is equal to 15 percent of the BOT planned expenditure, and debt is equivalent to 85 percent of the BOT planned investment. The construction started on October 2011 and finished on April 2014, which was 6 months earlier than planned. The project was planned to collect tolls for 22 years from 1st of May 2014 to 6th of November 2037. However, the start of the toll collection was delayed until the 19th of October 2014.

Figure 9. 6 Arrangements of No 18 highway Uong Bi-Halong project



As mentioned above, the project was supported by the MOT by providing funds for land acquisition and resentment. Moreover, another toll collecting station which is Pha Lai station was also granted to BOT Dai Duong Company from 1st of October 2011 which was

3 year earlier than the operation of the toll collection station of the project. Tolls collected from Pha Lai station are considered as government's support for the BOT Company.

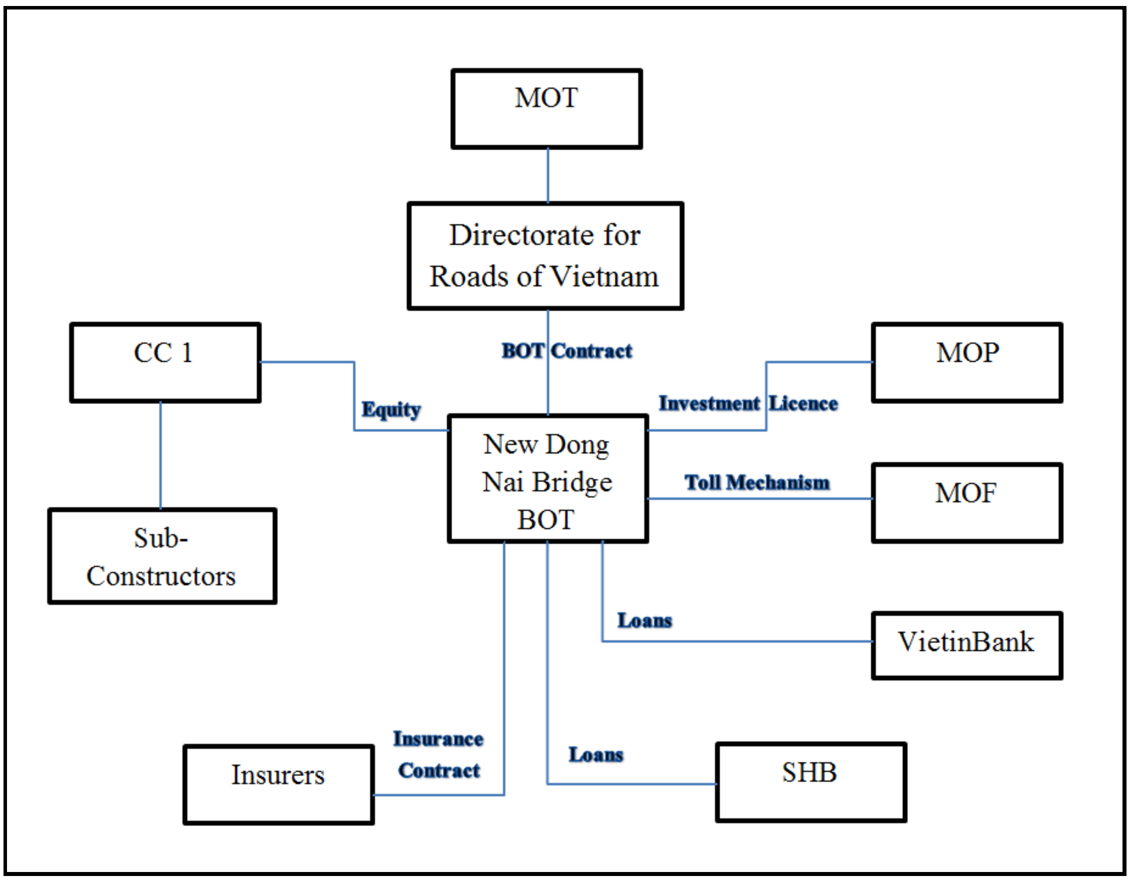
d. Project 4 - New Dong Nai Bridge

At the time of planning the New Dong Nai Bridge project, the old Dong Nai Bridge was in poor condition, and three provinces including Dong Nai, Binh Duong, and Ho Chi Minh City were in collaboration for reducing traffic flow through Old Dong Nai Bridge. For example, over 30 tons of trucks were guided to go to Hoa An bridge on No 1K highway. However, the effort was just able to reduce around 40 percent of the traffic demand. The local government of Dong Nai Province had been proposing an upgrade for the Old Dong Nai Bridge since 2005; however, the work was slow, and seemed to be ineffective. Therefore, the demand for building a new bridge was necessary. The BOT mechanism was proposed, and on May 2008, the BOT contract was sign between Directorate for Roads of Vietnam and Construction Corporation No. 1 Company Limited (CC1). The directorate for Roads of Vietnam is authorized by MOT to play the role of the public sector in this contract. CC1 set up the Dong Nai Bridge BOT JSc, which is the SPV of the project.

Figure 9. 7 New Dong Nai Bridge

The required investment is around £51 million. The investors' equity is equal to 30 percent of the required investment and the rest is debt from banks. The loans were agreed to be provided by Vietnam Joint Stock Commercial Bank for Industry and Trade (VietinBank) and Hanoi Commercial Joint Stock Bank (SHB). The arrangement of this project is provided in figure 9.8. The construction started in June 2008 and it was planned to finish in June 2010. The main bridge was inaugurated in September 2009 which was 3 months faster than scheduled. However, by the end of 2014 only the main bridge was finished. Other work sections in Tan Van and Vung Tau crossroads have not been finished.

Figure 9. 8 Arrangements of New Dong Nai Bridge project



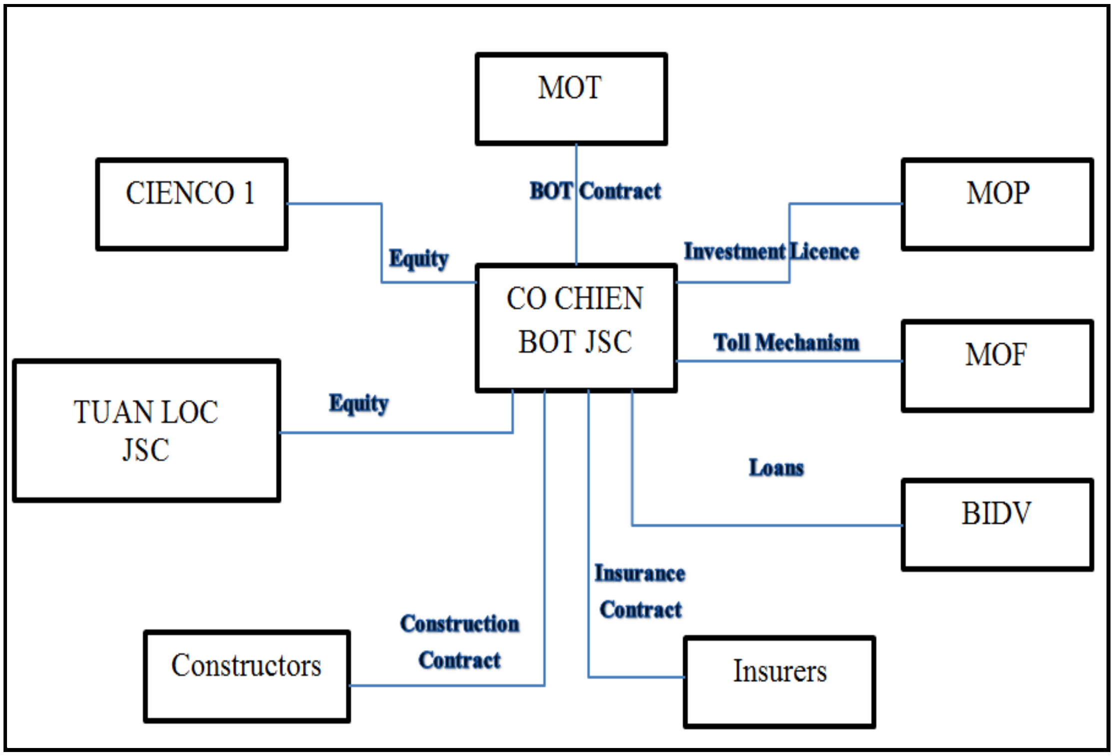
e. Project 5 - Co Chien Bridge

Co Chien Bridge is located in No 60 Highway in Tra Vinh and Ben Tre Province. It is expected to shorten the distance between Tra Vinh Province and Ho Chi Minh City by around 70km. The total length of the construction is 1619.1m. The main spans are 630m long and 16m wide. Designed loading capacity is HL93 truckloads and the clearance for ships is 120m wide and 25m high.

Figure 9. 9 Co Chien Bridge

In 2010, the Co Chien Bridge project was approved by the MOT (decision 3053/QD-BGTVT- 22/10/2010). The project has two works. The first work is to build the Co Chien Bridge and the second work is to build the approach road system. The project is the combination between the government's budget and the investors' budget. The first work section was been built under a BOT mechanism with 45.3 percent of investment from MOT and the rest from investors, and the second work section was built by the budget from the MOT. According to the contract agreement, Civil Engineering Construction Cooperation No 1(CIENCO 1), and Tuan Loc Construction Company were selected. They set up Co Chien Bridge Company which is the SPV of the project. In September 2013, the BOT contract for the first work was signed between MOT and Co Chien Bridge Company.

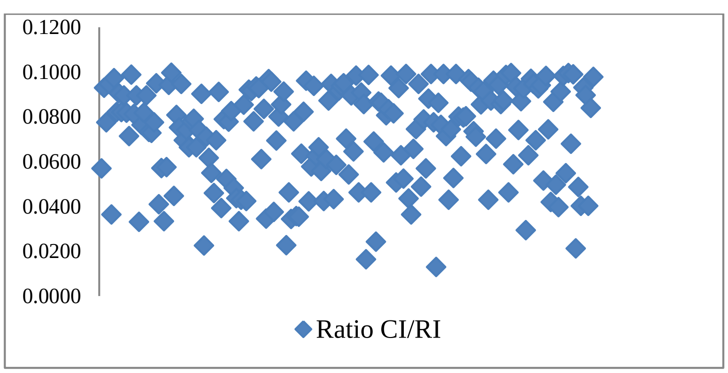
Figure 9. 10 Arrangements of Co Chien Bridge project



The total investment required is around £71 million in which funds from the government budget is £32.135 million and the investor's fund is about £38 million. The government's fund is for constructing the main spans and 3 main bridge piles. The investors' budget is for building the rest of the construction as well as the operational cost. In the investor's budget, 15 percent is equity and 85 percent is a loan from BIDV. The project started on 2nd of August 2013, and is expected to finish in 2015. According to the contract, the investor will have the right to collect tolls for 18 year and 3 months, starting from August 2015.

9.2.2. Riskiness Rankings of Five Selected Projects

Figure 9. 11 Ratio CI/RI of consistent matrices



With a total of 57 participants' answers, 57 matrices were made in determining the weight of the risk group where 54.39 percent of them are consistent, and 285 matrices were made in determining matrices of option scores where 49.82 percent are consistent. Based on the consistency test provided in section 7.5.4.5 of chapter 7, all inconsistent data was removed and the final result is only based on consistent data.

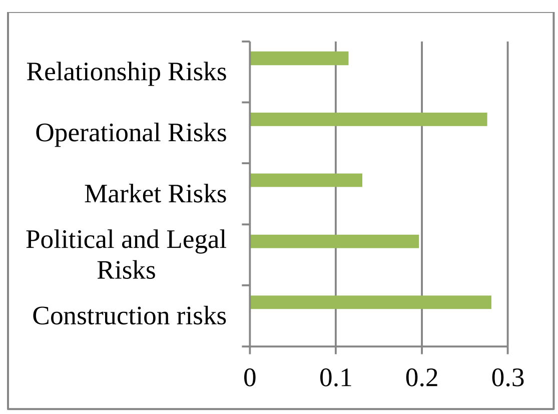
It is worth noting that in the AHP proposed by Satty (1980), there are no rules for the minimum number of consistent matrix. More specifically, the AHP system works right after the first consistent matrix is formed. Therefore, in applying this theory, researchers need to remove inconsistent matrix and use all consistent matrixes formed (Satty, 1980). Figure 9.11 shows the ratio CI/RI of consistent matrices. It should be noted that the lower the ratio is, the more consistent the matrix is, and the matrix can be accepted if this ratio is not higher than 1 (Satty, 1980).

a. Vector of Criteria Weights (w)

From the data collected from participants, using the method described in chapter 6, the Vector of Criteria Weights (w) is determined as shown in figure 9.12.

Figure 9. 12 Vector of criteria weights

Construction Risks	0.276
Political and legal risks	0.199
Market risks	0.136
Operational risks	0.270
Operational risks	0.119



b. Matrix of Option Scores

Similarly, using data collected from participants with the method described in section 6.2.1.2 in chapter 6, the Matrix of Option Scores (S) is determined as shown in Figure 9.13.

Figure 9. 13 Matrix of Option Scores

$$\begin{pmatrix} 0.153 & 0.251 & 0.104 & 0.289 & 0.227 \\ 0.080 & 0.367 & 0.059 & 0.404 & 0.288 \\ 0.240 & 0.188 & 0.403 & 0.068 & 0.153 \\ 0.264 & 0.115 & 0.291 & 0.167 & 0.198 \\ 0.263 & 0.079 & 0.144 & 0.072 & 0.134 \end{pmatrix}$$

Table 9.2 below clarifies the weight of each group in each project options. This table can bring more details in evaluating projects.

Table 9. 2 Risk group weight for each project

Project	Risk Groups				
	Construction Risk	Political and Legal	Market risks	Operational risks	Relationship Risks
Yen Lenh	0.153	0.251	0.103	0.289	0.227
Phu My	0.080	0.367	0.059	0.404	0.288
No 18 Highway	0.240	0.188	0.403	0.068	0.153
New Dong Nai	0.264	0.115	0.291	0.167	0.198
Co Chien	0.263	0.079	0.144	0.072	0.134

c. The global vector V is determination

$$V = S.\ W$$

$$V = \begin{pmatrix} 0.153 & 0.251 & 0.103 & 0.289 \\ 0.080 & 0.367 & 0.059 & 0.404 \\ 0.240 & 0.188 & 0.403 & 0.068 \\ 0.264 & 0.115 & 0.291 & 0.167 \\ 0.263 & 0.079 & 0.144 & 0.072 \end{pmatrix} \begin{pmatrix} 0.276 \\ 0.199 \\ 0.136 \\ 0.269 \\ 0.119 \end{pmatrix} = \begin{pmatrix} 0.211 \\ 0.246 \\ 0.195 \\ 0.204 \\ 0.143 \end{pmatrix}$$

Figure 9. 14 Project riskiness level ranking

Score	Project	Ranking
0.211	Yen Lenh	2
0.246	Phu My	1
0.195	No 18 Highway	4
0.204	New Dong Nai	3
0.143	Co Chien	5

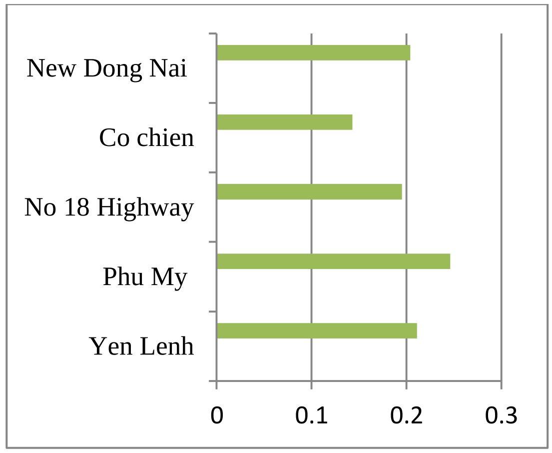


Figure 9. 15 Graphical representation of projects' risk level ranking regarding all risk groups

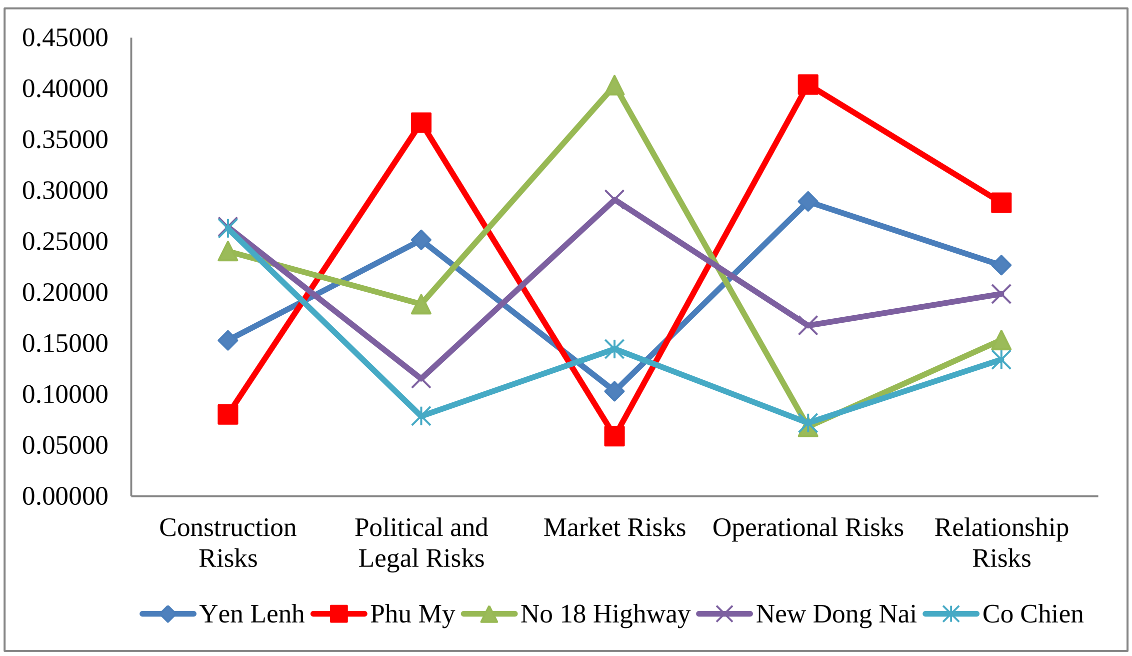
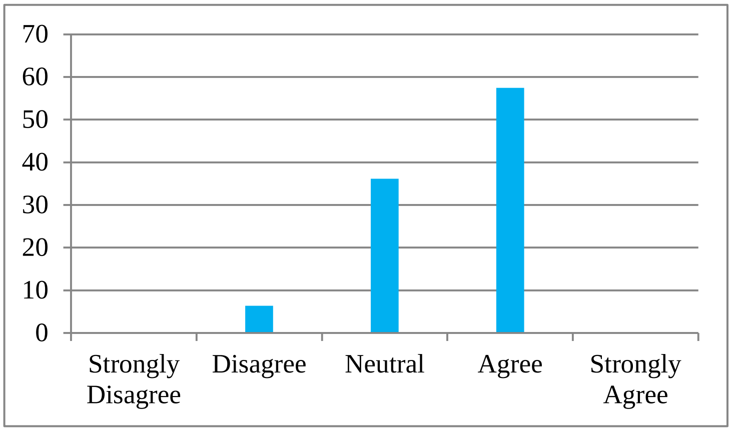


Figure 9.14 show the general riskiness ranking of the five mentioned projects, and figure 9.15 shows the graphical representation of projects' riskiness level ranking regarding each risk group. According to this result, Phu My Bridge project is the riskiest project, and Yen Lenh Bridge project is the second riskiest. New Dong Nai Bridge project is in third position. No 18 Highway Uong Bi – Ha long project and Co Chien Bridge project are in the 4th and 5th positions, respectively. This result was sent again to a small group of 57 practitioners who are experts knowing about these projects and have worked in these

projects. Practitioners were asked to say whether they agreed with the finding. Figure 9.16 shows practitioners' opinions about the analyzed result.

Figure 9. 16 Opinion of officers about the finding

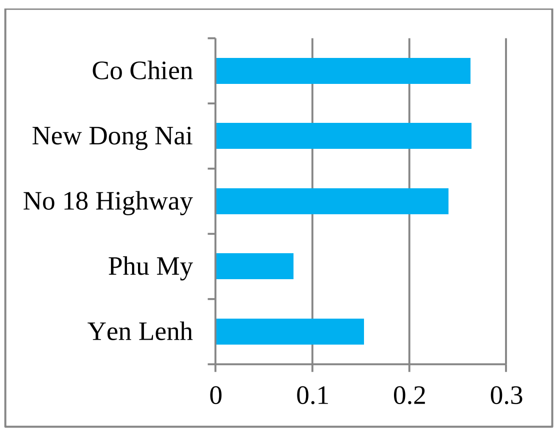


9.2.3. Analysis of Projects' Situation

a. Construction Risks

Figure 9. 17 Weight of different projects regarding Construction risks

Score	Project	Ranking
0.153	Yen Lenh	4
0.080	Phu My	5
0.240	No 18 Highway	3
0.264	New Dong Nai	1
0.263	Co Chien	2



This section will discuss projects' ranking regarding construction risks, including Low Quality Products (C3) and Difficulty in Land acquisition and Resettlement (C8). Figure 9.17 demonstrates the comparison of selected projects, regarding "Low Quality Product Risk", and "Difficulty in Land Acquisition and Resettlement". It can be seen that Dong Nai, Co Chien, and No 18 Highway are in 1st, 2nd, and 3rd positions, respectively. On the other hand, Yen Lenh and Phu My bridges are considered to have lower levels of "Low Quality Product" and "Difficulty in Land Acquisition and Resettlement".

In terms of New Dong Nai Bridge Project, as mentioned, the project consists of building a new bridge and two support infrastructure systems. The construction started in June 2008 and it was planned to finish in June 2010. The main bridge was inaugurated in September 2009 which was 3 months faster than was scheduled. After that, the time for inauguration of the whole project was delayed to June of 2014. However, by the end of 2014, only the main bridge had been finished. Other work sections in Tan Van and Vung Tau crossroads have not been finished, and the investor has submitted a petition to reschedule the time of inauguration of the approaching system to early 2015. Practitioners stated that the quality of the project is expected to high quality since the quality of the finished main bridge is high. In fact, the contractor, CIENCO 1, has been qualified as a high quality contractor. Indeed, the main bridge work section, which is the main work section, was offered the gold medal for quality in 2009 (MOT, 2010). However, land acquisition has been a serious problem in this project. The main bridge work section finished earlier than scheduled as this work section is not criticized for the land acquisition and resettlement, but in order to build approaching systems, investors must have land-use right from land users. The main reason for difficulty in land acquisition in this project is the disagreement amongst land users, investors, and the local government about the price for compensation. The responsibility for acquisition of land, in this project, belongs to the local government. The expenditure for land acquisition is supported by MOT, and the people's committee of Dong Nai Province is in charge of negotiating with land users. However, interviewees from the local government justify that the government's financial support is insufficient to offer compensation at the level that is required by land users. Investors responded that the delay in land acquisition is negatively influencing their income. More specifically, according to the contract of this project, investors have the right to collect tolls in two toll stations, namely, Song Phan toll Station and Dong Nai Bridge toll Station (New Dong Nai Bridge Contract, 2010). The Song Phan toll station has been operating since 2009 after the main bridge was finished. However, because of the delays in beginning construction, the second toll station, Dong Nai Bridge Station, was not in operation by the end of 2014 which was 4 years later than was scheduled.

Co Chien Bridge Project is considered as the second most risky project with regards to the previously mentioned construction risks. Indeed, for this project requirements were not met in terms of land acquisition. As mentioned, Co Chien Bridge construction started in 2011, and it had to stop for 2 years and was restarted in 2013. According to practitioners in this project, one of the factors that led the temporary shutdown of the project was land acquisition and resettlement. Regarding land acquisition and resettlement, the government's budget was used for building the approach road systems, and these work sections contained most of the land acquisition acts in the project. The people's committee of Tra Vinh and Bentre Province were responsible for this issue. In fact, land acquisition and resettlement works were done in 2011 before the project was temporary stopped. However, there were many difficulties during the land acquisition stage as the financial schedule for land acquisition was delayed by the local government. In addition, the technical quality of the bridge was also strongly criticized by experts. For example, there were many sinkholes and cracks in the asphalt surface of the approaching roads. However, it was said by private investors that one of the problems comes from overloaded vehicles.

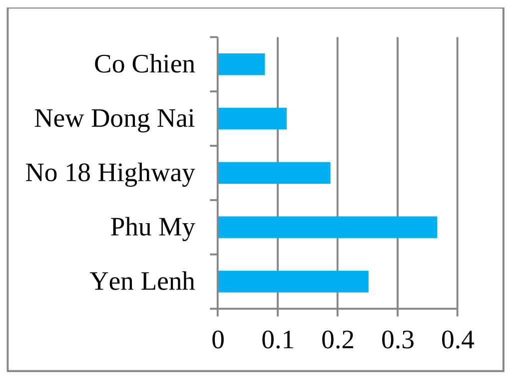
In No 18 highway project, the MOT reported that the quality of asphalt concrete was highly poor and hence, the responsibility of all partners was under investigation. Finally, two consultant companies, namely Newline Investing and Designing JSC, and Sao Khue Investing and Constructing JSC, as well as the contractor, Hoang Truong Constructing and Transporting limited liability Company, and the asphalt supplier, Hong Lac Company, have been forbidden to take part in any transportation construction project in Vietnam for 3 years. The collecting toll right was suspended until technical problems were resolved. On the 17th of October 2014 the MOT agreed with the investor to collect tolls for the highway (Decision 3937/QD-BGTVT, 2014). Regarding land acquisition and resettlement issues, interviewees stated that this process was considered as an effective process. Similarly to many other domestic PPPs in Vietnam, the expenditure for land acquisition and resettlement in this project is provided by MOT and the local government is responsible for negotiating and transferring land-use rights to investors. The people's committee of Quang Ninh province authorized the land acquiring power to cities in the area construction, namely Halong city, Uong Bi city, and Quang Yen Town, and these cities were very effective in fulfilling their responsibility. This, in turn, helped the project to be finished earlier than scheduled. In addition, participants demonstrated that another factor helping the local government in this process was the helpfulness of the citizens around the construction area since the overcharged old highway had created traffic jams and air pollution in the areas.

Construction Risks in Phu My project and Yen Lenh project are less serious compared to the previously mentioned projects. In Yen Lenh Project, the local governments in Ha Nam and Hung Yen Province are also responsible for Land Acquisition and Resettlement. Participants responded that the Land Acquisition and Resettlement process in Yen Lenh Bridge also met the required progress because of the effective collaboration of MOP, local governments, and investors. This, in turn, led the project to be completed 10 months earlier than scheduled. Also, after 10 years of use, respondents did not report any problem regarding the poor technical quality of the project. This finding is in contrast to the finding of Alfen *et al*. (2009). They carried out a case study on Yen Lenh Bridge and they found that Land Acquisition and Resettlement was considered as one of the most serious risks in this project. In Phu My Project, according to interviewees, the resettlement process in this project also faced difficulty. The expected date to start constructing the project was the 31st of December 2004, but the construction did not start until 2005 because of the delays in the resettlement process. The finding shows that this delay did not appear because of the conflict in the price offered, but occurred during the resettlement stage. In fact, land users were aware of the value for their land according to the market price. Therefore, the price that was proposed was accepted. However, at that time the land users complained, they were confused about why there was no long-term plan made for the project development. Therefore, when the land users were brought together, there was no place to resettle the citizens. Also, participants from the People's committee of Ho Chi Minh City responded that, land users were promised that they would have the right to buy low price flats. However, the citizens did not receive detailed and transparent information about their new place, such as price, size and location. Therefore, they refused to give the land users to the local government. Moreover, the land acquisition process was difficult because there were seven companies in the area of construction and their land also needed to be cleared. According to a retired participant from the Department of Finance in the People's committee of Ho Chi Minh City, companies required compensation of 100 percent of the value of the land and 100 percent of the value of the built assets, as well as compensation for the losses of their business. However, the local government only provided 60 percent of the built assets because of devaluation, the losses of businesses were not accepted at the required cost, and they were not compensated for their land. This respondent explained that the land was provided by the government, and companies were forced to transfer land use to the city for public services. In terms of the technical quality of the project, the project was finished earlier than scheduled. However, during the operational stage, the approaching road systems were also criticized because of damages. However, both the local government and investors admitted that there was too many overloaded vehicles traveling on the route, and as local government could not control overloaded vehicles, they therefore had to be in charge of maintaining the damaged parts.

b. Political and Legal Risks

Figure 9. 18 Weight of different projects regarding Political and Legal Risks

Score	Project	Ranking
0.251	Yen Lenh	2
0.367	Phu My	1
0.188	Co Chien	3
0.115	Dong Nai	4
0.079	No 18 Highway	5



Political risks in this section include “poor project approval and permit process” (L3), and Corruption (P5). From figure 9.18, it can be seen that Phu My Bridge is the most risky project. In terms of corruption risks, no specific and detailed information was revealed from participants. However, participants speculated that corruption is the issue that is dominated the construction industry in Vietnam. Therefore, it is highly likely that this risk occurred in these PPP projects in some procedures such as selecting investors, contractors, sub-contractors, and verifying the quality of the product. In particular, the largest concern for the corruption risk was given for projects in which all parties involved were domestic.

In terms of Phu My Project, interviewees responded that the risk of having a long approval process appeared in the whole life cycle of the project. For example, the project plan was developed by people’s committee of Ho Chi Minh City in 2002, and it was approved by the

Prime Minister in the same year. However, the contract was not signed until the 7th of February 2005. The project had to go through approval processes for 3 years. Further, investors have responded that one of the main problems which led to the failure of Phu My project was the delays in approving traffic flow organizing strategies from the local government. They said that the bridge was finished in 2009. However, in 2010, the plan for traffic flow organization had not been approved. Participants from Ho Chi Minh City people's committee said that according to the procedure, firstly, the Department of Transport in the People's committee received the request form from investors, and then the request needed to be approved by the Department of transport and Department of finance. After that, the request also needed to be approved by the Ho Chi Minh City people's council, and finally the request also needed to be approved by the People's committee of the city.

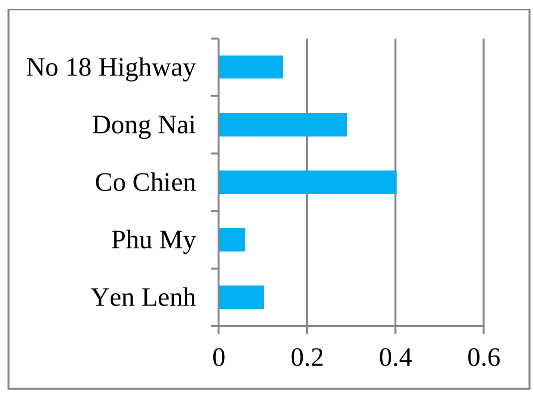
Yen Lenh Bridge project also received strong criticism of participants. The project was planned in 2000, and on the 21st of August 2001, the feasibility study was approved by MOT. On the 5th of December 2001, the project was approved by the Prime Minister to be built under the BOT form. In April 2002, investors were chosen and the project began construction on the 1st of June 2002. Interviewees said that Yen Lenh Bridge Project is one of the earliest PPP projects in Vietnam. Therefore, the legal system at that time was ineffective. Moreover, individual government officials were also not qualified as there were many of them who had not been specifically trained about PPP mechanisms. These are the reasons which led to the poor approval process. These statements are consistent with the results in the research by Alfen *et al*. (2009). They found that many unnecessary documents were created in Yen Lenh Project, and some of these were just about general cases. Therefore, more detailed documents needed to be issued. They also found that because many of the documents were quickly issued without first conducting a feasibility study, amendments usually needed to be made, and these amendments interrupted the approval process. Additionally, some approvals were also canceled. This, in turn, also lengthened the approval process.

Amongst the five selected projects, No 18 highway project, Dong Nai Bridge project, and Co Chien project did not receive many complaints about the poor approval process in comparison with Yen Lenh and Phu My projects. Although interviewees also complained about some problems such as unnecessary procedures, too many layers of the government, and decentralized authorized power of government agencies, these problems seemed to be general problems happening in a majority of projects in Vietnam. It is possible that political risks in these projects were considered as less serious than in other projects probably because the legal system had been improved in recent years. Interviewees cited the 2-year delay in Co Chien Bridge Project but they also stated that the political risks should not be blamed for this delay. Instead, the reasons included difficulty in accessing financial resources. Similarly, in Dong Nai Bridge Project, investors also revealed information about the long approval process to disburse the budget for land acquisition and resettlement. However, investors emphasized that the root cause of this long approval process came from insufficient financial resources.

c. Market Risks

Figure 9. 19 Weight of different projects regarding Market Risks

Score	Project	Ranking
0.1029	Yen Lenh	4
0.0587	Phu My	5
0.4031	Co Chien	1
0.2910	Dong Nai	2
0.1444	No 18 Highway	3



Market risks in this section refer to “Weak Financial Capacity of Investor” (M2), and “Inflation Risks” (M4). On the top of figure 9.19, Co Chien Bridge project is considered as the most risky project regarding market risks. As mentioned, the project started in 2010. However, it still has not been completed. The reason for the delay is the delay of the first work section. In 2010, the Co Chien Bridge project was approved by the MOT. The project has two work sections. The first section is to build the Co Chien Bridge and the second part is to build the approach road systems. It was mentioned earlier that the second work section was built using the government’s budget and the first part was built by BOT in which the government gave a contribution. In fact, in the original plan, the first work section was planned to be built under the BOT mechanism with 100 percent of the investment coming from private investors. In 2011, CIENCO 1, CIENCO 4, CIENCO 8 and 577 JSC were selected as investors. However, the mechanism to build the first work of the project was changed due to financial reasons. This is because originally selected investors could not provide sufficient equity to set up the SPV. Therefore, the government had to financially contribute to the first work section. On the 5th of July 2013, MOT decided that new investors should be reselected for this project, and hence, CIENCO 1 and Tuan Loc Construction JSC were selected (Decision 1930/QD-BGTVT, 2013). In this project, the contribution of the government budget was 45.3percent which is higher than the level regulated in laws which is 30 percent. This refers to the fact that the financial difficulties in this project were very high and the government had to create special strategies to overcome these difficulties. Nevertheless, according to interviewees, at the current time, this risk is still high. The financial contributions from the private investors are sufficient since private investors have not found a stable financial resource from BIDV. Additionally, the financial contribution of the government is lacking. An interviewee from MOT revealed that the financial budget from MOT for 2014 has run out and that MOT had to ask the central government to advance the budget for 2015, and it is this budget that is being used for this project. These delays reflect the weakness of investors, both from the view of the public clients and private sectors. Participants from public agencies defended that the financial contribution from MOT was not planned in the original agreement, but it was made to resolve the difficulties that occurred from the private investors. Therefore, the budget disbursement was not continuous. However, the public sector should be responsible for selecting financially weak investors. This reflects that the process of selecting investors was not cautiously carried out, and the financial ability of investors was not cautiously verified.

In Dong Nai Bridge Project, market risks also seem to be serious as it stands at the 2nd position. More specifically, at the beginning, loans were to initially be provided by VDB. However, during the construction time, negotiations failed because of conflicts regarding the disbursement plan, mortgage assets, and interest rate, VDB stop providing loans for the SPV. Participants from Construction Corporation No 1 Company Limited (CC1) claimed that they had doubts about the financial ability of VDB. However, participants from VDB defended VDB by saying that because of the negative obsession of bad debt in previous periods, banks now require organizations to provide more mortgage assets, such only investing in practical projects. In September 2013, VietinBank and SHB agreed to provide investors with new loans of 36.9 million pounds, and the project has continued to progress. Weak financial ability of investors also negatively influenced the land acquisition and resettlement process of this project. In detail, the government provided a current budget for land acquisition; however, investors responded that the provided budget had not been sufficient for acquiring land. Investors and the people's committee of Dong Nai Province also required MOT to provide more funds. MOT agreed to support the project with more money. However, the disbursement plan was time-consuming. MOT criticized that investors must have strong financial ability to advance money before MOT disbursed their money. On the one hand, investors have blamed delays in land acquisition on their financial ability. Nonetheless, according to participants, after land had been cleared, many work sections were still put on hold, especially the work section in the Tan Van and Vung Tau intersection area because of financial difficulties of investors.

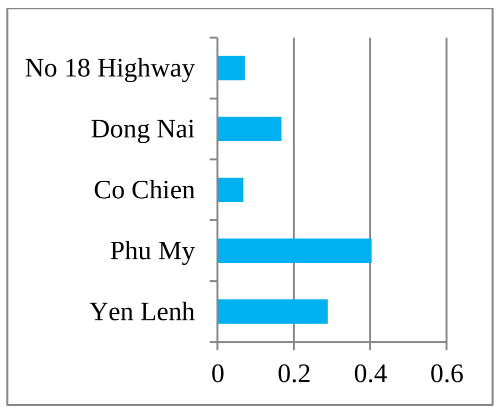
Regarding No 18 highway project and Yen Lenh Bridge project, these projects did not receive strong criticism from experts as did the previously mentioned projects. In No 18 highway project, the financial ability of investors was not strongly criticized. However, the inflation rate was a serious issue. This project just started to collect tolls in October 2014, and during the construction period, the financial ability of Ocean Company was not criticized. In addition, inflation rates since the project was developed were too high, at 21.3 percent in 2011, 9.1 percent in 2012 and 4.8 percent in 2013. Nevertheless, the project was mainly constructed in 2012 and 2013 and the preparation for a high inflation rate was also carefully mentioned in the contract. In terms of Yen Lenh Bridge, Cienco 4 and TLC were evaluated as having sufficient financial ability, and the inflation rate was also not high during the construction period and during the first years of the operation stage. However, similar to No 18 Highway project, high inflation rates since 2009 to 2012 had a negative impact on the operational and maintenance cost of this project.

Cau Phu My Project is the least risky project with regards to market risks. However, practitioners also revealed some problems created by market risks. For example, due to the insufficient financial ability of the investors, the people's committee of Ho Chi Minh City had to accept the debt/equity ratio which is different from PPP regulations. More specifically, the equity/debt ratio was 23.6/76.4 instead of 30/70. Moreover, PMC did not have the required ability to loan debts from international banks. Therefore, Ho Chi Minh City People's Committee had to authorize the Ho Chi Minh City Investment Fund for Urban Development (HIFU) to get loan from Société Générale bank and Calyon bank under the guarantee from MOF, then HFIU loaned these debts to PMC. From this mechanism, it can be seen that the Vietnamese government had provided favours to PMC with the expectation of a good bridge. However, this mechanism in fact has led to some disputes which will be discussed shortly.

d. Operational Risks

Figure 9. 20 Weight of different projects regarding Operational Risks

Score	Project	Ranking
0.2891	Yen Lenh	2
0.4039	Phu My	1
0.0679	Co Chien	5
0.1674	Dong Nai	3
0.0718	No 18 Highway	4



Operational risks here refer to High Maintenance Cost (O4) and Fluctuation of Demand (O6). Each participant made comparisons about the five selected projects regarding this risk group. From the table, it can be seen that Phu My Bridge project and Yen Lenh Bridge project stand at the top of the table.

In terms of Phu My Bridge Project, participants responded that "Fluctuation of Demand" is a main factor leading to the failure of the project. Table 9.3 below demonstrates the forecasted traffic volume and the actual traffic volume in 2012.

Table 9. 3 Traffic Volume in 2012 comparison (Thanh, 2013)

Type of Vehicle	Forecasted traffic demand (thousand units)	Actual traffic demand (thousand units)	Percentage Rate
Motorcycle	10,430	7,294	69.94
Three-wheeler	0	61	0
Car	1,350	933	69.17
Bus and coach	630	0	0
Truck under 1.5 tons	440	304	69.17
Van	1,240	336	27.18
Heavy Truck	1,210	872	72.11
Container	300	216	7211

From table 9.3 it can be seen that the actual traffic volume in Phu My Bridge was much lower than it was predicted. The total actual highest traffic volume was only 72.11 percent of the forecasted volume. In particular, traffic volume for bus was dramatically different since the predicted volume was 630 units, but there was no bus traveling through the bridge. The reason for this reduction of traffic volume is the poor condition of the supporting infrastructure systems. According to respondents, the traffic demand for Phu My project was influenced by the traffic volume in the No 2 Belt-line road since the No 2 belt-line road connects vehicles from different areas in Ho Chi Minh City to Phu My Bridge. Participants stated that the people's committee of Ho Chi Minh City was responsible for completing the No 2 Belt Road in 2009. The Department of Transport was authorized by Ho Chi Minh City's People's committee to be the investor of the project of No 2 Belt Road, and the project started in 2006. However, by 2013, the road was not finished. This reduction has dramatically influenced the income of the project. According to Thanh (2013), the income of the project in 2010 and 2011 was about 1.84 million pounds, and in 2012, it was 3.077 million pounds. However, the payable debt is around 10.77 million pounds annually. Therefore, it is clear that PMC does not have the ability to pay the loan. From the above analysis, it can be seen that People's committee of Ho Chi Minh City needs to bear full responsibility for the reduction of the traffic volume. PMC submitted the requirements to extend the time for paying the loan. However, this is not practical as the actual volume is still not sufficient to pay the annual debts. Moreover, according to the contract, people's committee of Ho Chi Minh City has to take the project back and compensate for PMC's expenditure investment. Therefore, in September 2012, People's committee of Ho Chi Minh City accepted to take the project back. However, the next stage is to determine the value that investors can be compensated for, and this stage has not yet been completed.

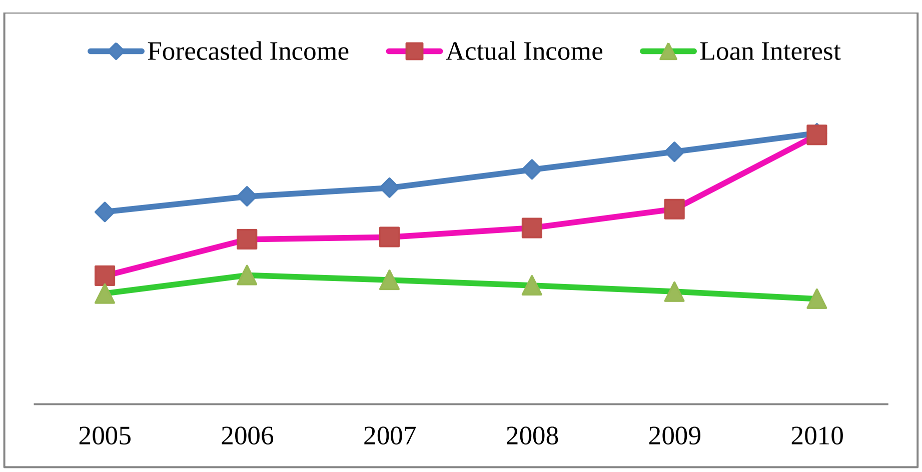
Regarding Yen Lenh Bridge project, participants responded that this bridge was faced with "High maintenance cost", and especially "High Fluctuation of Demand" which is the main problem leading to the unsuccessfulness of the project. Table 9.4 shows the forecasted traffic volume in Yen Lenh Bridge.

Table 9. 4 Forecasted traffic volume in Yen Lenh Bridge (Contract, 2002)

Vehicle type	Traffic Volume					
	2005	2006	2007	2008	2009	2010
Motorcycles	338,667	365760	395021	426623	460753	497613
Car under 12 seats	127,621	137831	148857	160766	173627	187517
Car 30-40 seats	93,853	101361	109470	118228	127686	137901
Truck over 10 tons	161,885	174836	188823	203928	220243	237862
Containers	27,312	29497	31857	34405	37158	40130

Figure 9.21 below demonstrates the difference between forecasted income and real income in this project. It can be seen that the real income is much lower than the forecasted income.

Figure 9. 21 Comparison between forecasted income and actual income (Contract agreement, 2002; and Contract agreement renegotiated, 2012)



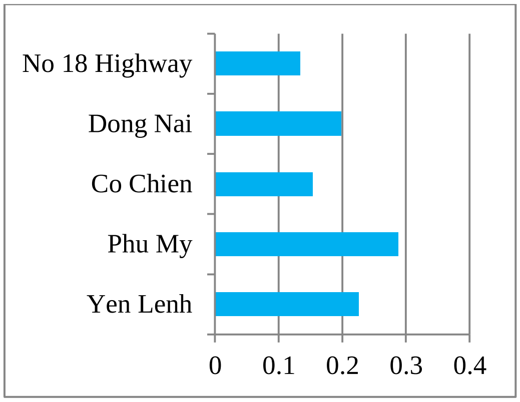
The first reason for the insufficient traffic volume is the over-optimistic forecast for the development of Hung Yen and Ha Nam province. Therefore, this led to a bias in traffic demand forecast of the areas. The second reason was that there have been other alternative transport routes for drivers around the construction area. More specifically, the bridge was expected to attract drivers delivering products from Hai Phong port to Hung Yen and Ha Nam without going through Hanoi City. However, Hung Yen and Ha Nam provinces have their own ferry. Therefore, the demand for this type of driver dramatically reduced. Moreover, the traffic demand was predicted based on the traffic demand on No 1 and No 5 highways as the bridge is in No 38 highway which links No 1 and No 5 highways. Nevertheless, the bridge was designed without considering future infrastructure development plans. More specifically, Vinh Tuy Bridge was built in 2005 and Thanh Tri Bridge was built in 2006. Two these bridges also link No 1 and No 5 highways. This, also in turn, reduces traffic demand for the Yen Lenh Bridge. According to Toan (2008), Thanh Tri Bridge reduced the demand for Yen Lenh Bridge from 2.62 percent to 8 percent in 2007. Moreover, participants responded that the No 38 highway quality was not upgraded; therefore, it could not attract large trucks and containers as it was expected to do. Furthermore, the demand for the bridge was also reduced because of the rejection of collecting tolls from motorbike users in 2006. In short, the insufficient demand for this project was caused by the overestimation about the economic development of provinces, by the inconsistency between the project land and the future development plan of the areas, and by the rejection of collecting tolls from motorbike users. According to Alfen *et al*. (2009), these causes may be the consequences of the insufficient number of research studies about the construction industry area, and inconsistency of strategies in the central government departments.

In terms of New Dong Nai Bridge Project, Co Chien Bridge Project and No 18 Highway Uong Bi- Ha Long, these projects were not heavily criticized by experts. New Dong Nai Bridge Project started to collect tolls in July 2014. According to participants, they have not received any announcement about reduction of traffic volume for this project. Similarly, No 18 Highway started to collect tolls in October 2014, and the traffic volume is considered as sufficient. Moreover, as mentioned, investors of No 18 highway have been favored by the MOT to collect tolls in Pha Lai toll Station during the construction period from 2011 to support the project. According to participants from Ocean Company, the income in Pha Lai Toll station is slightly fluctuating around the forecasted demand. Although Pha Lai toll Station is not in the area of the project, it is also in No 18 Highway. Therefore, participants revealed an optimistic demand for this project. Regarding the Co Chien Bridge project, this project is still in the construction stage and it is expected to finish in August 2015, and both statistical results and interviews show that experts seem to be optimistic about the operation of this bridge.

e. Relationship Risks

Figure 9. 22 Weight of different projects regarding Relationship Risks

Score	Project	Ranking
0.227	Yen Lenh	2
0.288	Phu My	1
0.153	Co Chien	4
0.198	Dong Nai	3
0.134	No 18 Highway	5



This section will analyze the comparison of selected projects regarding the risks of "Inappropriate distribution of responsibilities and risks" (Re3), and "Non-cooperation between different partners" (Re4). From Figure 9.22, it can be seen that the difference between scores for different projects are not remarkable in comparison with scores of projects in other risk groups. This may indicate that they are on a similar level of risk regarding Re3 and Re4. In fact, interviewees responded that they are all in the high level regarding relationship risks. In terms of "Inappropriate distribution of responsibilities and risks", interviewees stated that the mechanism to distribute risks in Vietnamese PPPs is not effective. More specifically, they said that in all PPP contracts, there are clauses distributing risks to party. Despite the fact that the distribution is not suitable, the contract clauses about risk distribution are also not clear. For example, contract clauses may say that a party needs to responsible for this risk, but they do not specify the clear procedures which all parties need to follow if the risk occurs and there are disputes.

Phu My Bridge Project and Yen Lenh Bridge project are considered as the most risky in terms of these risks. Interviewees responded that the contract clauses in these projects are very loose, and they mainly mentioned the technical issues. For example, the contract does not mention risk distribution. Therefore, when risks and disputes occurred, it was very difficult for resolve issues. They considered that inappropriate distribution of risks and responsibilities is one of the main reasons leading to the failure of Phu My project. More specifically, the risk of "Delays of supporting infrastructure" was distributed to public clients. However, the mechanism to monitor the process of minimizing this risk was not mentioned, and the responsibility to prevent this risk was not clearly distributed to all layers of the local government. Therefore, the public client was unable to control this risk, and the risk in fact did contribute to the failure of the project. However, it was mentioned that the investors were able to claim their compensation. Nevertheless, the mechanism to obtain compensation was not clearly mentioned, and disputes about accounting for the compensation for this project have been taking place. In Yen Lenh Project, according to participants from private sectors, "Land acquisition and resettlement" and "Insufficient traffic volume" are two risks that investors desire to have detailed risk distribution. However, in Yen Lenh Bridge project, "insufficient traffic volume" was not mentioned in the contract. Therefore, participants evaluated that private investors lost money in this project when the risk occurred but there was no mechanism to claim the compensation. "Land acquisition and resettlement" was mentioned in the contract. Nonetheless, the responsibility of each party for when the risk occurs was not clarified.

In New Dong Nai bridge project, Co Chien Bridge project, and No 18 Highway Uong Bi-Ha Long project, interviewees responded that contracts are more detailed, and risks are more clearly allocated. They stated that both private investors and public clients have more experience working in these types projects than they had with the Yen Lenh Bridge Project and Phu My Bridge project. Nevertheless, "Non-cooperation between different partners" was also mentioned many times during the interviews for all selected projects. Participants from the private sector clarified that this non-cooperation can come from the micro level in each procedure during the project, but it also can come from the macro level when the petition of the private sector in many projects is not satisfied. For example, in the micro level, New Dong Nai Bridge Project was mentioned as an example of non-cooperation between the local government and investors in the land acquisition and resettlement stage. In this stage, both private investors and the local government were not responsible in terms of how they responded to one another. In terms of the macro level, they state that according to the PPP regulation, the toll mechanism for a project will be submited to MOF only after the construction is done, and then MOF will consider the toll mechanism. In addition, each time the tolls need to be adjusted, then the adjusting plan needs to be submited to MOF (Circular 159/2013/TT-BTC, 2013). Private investors criticized that they need to have a clear toll plan including the toll adjustment plan being approved before the construction starts since this can help them in mobilizing capital from the banks as the banks may worry about the financial plan and may not approve the loan requirement, or they can provide loans with a higher interest. However, investors in many projects have submitted the requirements to the government but the requirements have not been accepted. They believe that this shows the non-cooperation of the government in sharing risks with investors.

9.3. Risk Allocation Using AHP

This section shows the findings of application of proposed allocation model developed in section 6.2.1.3 in chapter 6. As mentioned in chapter 8, in this application, AHP was used to allocate 10 chosen risks which were also used in evaluating the riskiness of the projects. Table 9.5 below shows these risks. It should be noted that the reason for choosing these risks to test the allocation model is that these risks are in depth analysed in section 9.2. Therefore, the advantages of understanding these risks were employed. However, it should be noted that when applying the proposed framework in reality, other risks can be chosen by decision makers based on specific situations.

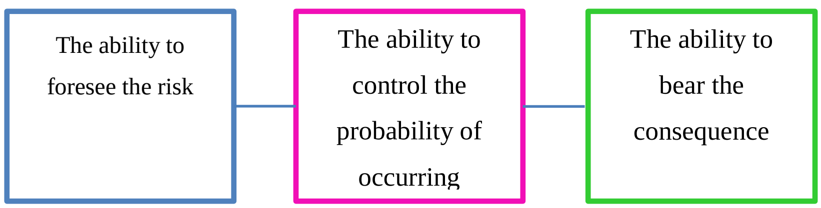
Table 9. 5 Risks Selected to demonstrate Allocation Model

C3. Low Quality products (R1)
C8. Difficulty in Land acquisition and Resettlement (R2)
L3. Poor project approval and permit process (R3)
M2. Weak Financial Capacity of Investor (R5)
M4. Inflation risk (R6)
O4. High maintenance cost (R7)

O6. Fluctuation of demand (R8)
P5. Corruption (R4)
Re3. Inappropriate distribution of responsibilities and risks (R9)
Re4. Non-cooperation between different partners (R10)

Similar to the evaluation of the riskiness of projects, a set of allocation options and a set of allocation criteria need to be built. Figure 9.23 shows the set of allocation criteria. It should be noted that in the scope of this research, three allocation criteria were selected based on discussions with academics and practitioners. However, in reality other criteria can be selected based on specific projects.

Figure 9. 23 Set of allocation criteria

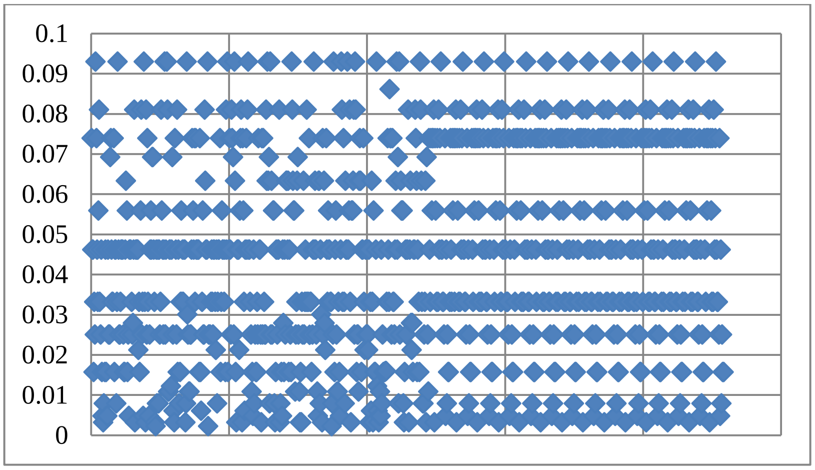


In terms of the set of allocation options, figure 9.24 shows the set of allocation options. Similarly, in reality other options can be selected based on specific projects. It should be noted that "Share" option reflects option that both private and public sector have to be responsible for the risk.

Figure 9. 24 Set of allocation option

With a total of 32 practitioners participating in the study, in determining the Vector of Criteria Weights (w), 32 matrices were made and in determining the Matrix of Option Scores, 872 matrices were made. The consistency of data was tested by the method provided in section 7.5.4.5, chapter 7. In determining the Vector of Criteria Weights 71.88 percent of matrices are consistent, while 68.42 percent of matrices in determining the Matrix of Option Scores are consistent. Figure 9.25 shows the graphical presentation of the ratio CI/RI of consistent matrices. Obviously, the rate of consistency in this round was higher than in section 9.1 in this chapter which was for ranking the risk level of the project. A possible reason is that the number of criteria and the number of options in this round was only three, which can increase the consistency. In fact, with three items, a pairwise comparison can obtain consistent data at the easiest level.

Figure 9. 25 Ratio CI/RI of consistent matrixes in risk allocation



The details of the matrix of allocation options and weight of criteria, and the Global score for each risk are shown in table 9.6. From these scores, the final decision about risk allocation strategy can be made. From table 9.6, it can be seen that three risks are allocated to the private sector, three risks are allocated to the public sector, and four risks are shared between the two sectors.

Table 9. 6 Allocation Strategies Based on AHP

Risks	Matrix of allocation Options			Weight of allocation Criteria		Global G			Final Results		
C3	0.270	0.346	0.210	0.180		0.297	Public		0.546	Private	1
	0.118	0.094	0.319	0.558		0.157	Share		0.297	Public	2
	0.613	0.560	0.471	0.262		0.546	Private		0.157	Share	3

C8	0.470	0.498	0.446	0.180		0.479	Public		0.479	Public	1
	0.374	0.337	0.364	0.558		0.350	Share		0.350	Share	2
	0.157	0.166	0.190	0.262		0.170	Private		0.170	Private	3
L3	0.583	0.609	0.548	0.180		0.588	Public		0.588	Public	1
	0.288	0.279	0.209	0.558		0.262	Share		0.262	Share	2
	0.130	0.113	0.243	0.262		0.150	Private		0.150	Private	3
P5	0.284	0.249	0.323	0.180		0.275	Public		0.510	Share	1
	0.537	0.515	0.482	0.558		0.510	Share		0.275	Public	2
	0.179	0.237	0.195	0.262		0.215	Private		0.215	Private	3
M2	0.167	0.111	0.165	0.180		0.135	Public		0.464	Share	1
	0.471	0.463	0.463	0.558		0.464	Share		0.401	Private	2
	0.362	0.427	0.372	0.262		0.401	Private		0.135	Public	3
M4	0.479	0.465	0.465	0.180		0.468	Public		0.468	Public	1
	0.406	0.435	0.421	0.558		0.426	Share		0.426	Share	2
	0.115	0.100	0.114	0.262		0.106	Private		0.106	Private	3
O4	0.319	0.255	0.201	0.180		0.252	Public		0.570	Private	1
	0.154	0.178	0.196	0.558		0.178	Share		0.252	Public	2
	0.527	0.568	0.604	0.262		0.570	Private		0.178	Share	3

O6	0.137	0.110	0.207	0.180		0.141	Public		0.476	Private	1
	0.316	0.472	0.244	0.558		0.384	Share		0.384	Share	2
	0.547	0.419	0.549	0.262		0.476	Private		0.140	Public	3
Re3	0.242	0.232	0.241	0.180		0.236	Public		0.621	Share	1
	0.590	0.634	0.617	0.558		0.621	Share		0.236	Public	2
	0.168	0.135	0.143	0.262		0.143	Private		0.143	Private	3
Re4	0.308	0.263	0.226	0.180		0.262	Public		0.574	Share	1
	0.507	0.570	0.630	0.558		0.574	Share		0.262	Public	2
	0.185	0.167	0.144	0.262		0.164	Private		0.164	Private	3

9.3.1. Risks allocated to the private sector

Risks which are allocated to the private sector are “Low Quality Products” (C3), “High Maintenance Cost” and “Fluctuation of Demand”. Regarding the “Low Quality Products”, participants stated that in current Vietnamese PPPs, this risk is now shared between the two sectors. Public sector officials responded that the responsibility of the public and private sectors are now described in the decree 15/2013/ND-CP. Before this decree was issued, responsibilities of parties were allocated based on the decree 209/2004/ND-CP. According to the decree 209/2004/ND-CP, in PPPs, the responsibility of controlling the quality of the project was allocated to the private sector and the public sector has very little power over controlling the quality of these products during the construction phase. However, according to the new decree 15/2013/ND-CP, investors have to submit reports to the public sector periodically, and the public sector has the right to monitor the quality of products as well as the right to ask for repairs or maintenance if there are any problems, and the construction can only be operated if the quality of the products is approved by the public sector. However, some of the participants from the private sector responded that sometimes the public sector has control during the constructing process, and these participants said that the public sector should only test the final outcome of the construction before it can be operated. They said that now the public sector has too much control in controlling the quality of products, such as the design needs to be approved by the public sector and that the contractors must be one of the contractors recommended by the public sector. They say that this may reduce the value of the PPP form which is to take advantage of the private sector. Similarly, “High maintenance cost” (O4) is also allocated to the private sector by the majority of participants. However, investors responded that the cause of the damage should be clearly mentioned in the contract clause. For example, if the damage is due to the weak macro management from the government, the government should be responsible for that. In fact, the maintenance issue has been a disputed issue in many Vietnamese PPPs. The perception of participants about allocation of the risk “Fluctuation of Demand” is different from the perception about allocation of the two risks mentioned above. Although “Fluctuation of Demand” is also allocated to the private sector, the scores for the “Private” option and for the “Shared” option are not significantly different. This reflects the fact that there are a number of participants who allocated this risk to both parties. Investors say that they cannot predict the circumstances in which the demand is dramatically changed by a macro development plan of the government. Therefore, they can only retain this risk if the contract clauses mention external situations which influence the demand.

These findings about risk allocation have some similarities in comparison with previous research such as research by NTSA (2004) and Li *et al*. (2005). The findings of these studies show similarities to the findings of the current research regarding “Low Quality Products” (C3) and “High Maintenance Cost”. More specifically, in these previous studies these risks are also allocated to the private sector by the majority of the private sector. In terms of “Fluctuation of Demand”, the findings of the current research seem to be more similar with findings from studies in developing countries rather than research on developed countries. More specifically, research by Lam *et al*. (2007) states that in a developed environment, almost participants allocated “Fluctuation of Demand” to the private sector. However, research by NTSA (2004) and Ke *et al*. (2009) about developing markets concludes that this risk should be equally shared. Therefore, although in this research this risk is allocated for the private sector, the scores for the “Private” option and “Shared” option are not significantly different, and this seem to be more similar to the results in which this risk is equally shared. The difference is probably because in developed countries the development plan of the area can be planned for a long-term period. Therefore, the risk of "Fluctuation of Demand" is not influenced by the unpredicted development plan, which is the main reason that participants think that the risk should be shared.

9.3.2. Risks allocated to the public sector

Risks allocated to the public sector in this research are "Difficulty in Land acquisition and Resettlement" (C8), "Poor Project Approval and Permit Process" (L3), and "Inflation Risk" (M4). Regarding "Difficult in Land acquisition and Resettlement", from the table it can be seen that the first choice of participants is the public sector and the second choice is to share this risk between the two sectors. The majority of the participants want this risk to be allocated to the public sector but there are also a number of respondents who allocated this risk to both parties. Participants from the private sector responded that the public sector should be responsible for the entire Land Acquisition and Resettlement process including providing expenditure and negotiations. In fact, this mechanism has been used in some selected PPPs, and this mechanism follows the instruction of decree 108/2009/ND-CP. However, public sector officials say that the government's budget is limited, and this mechanism is only used in some very important projects. In other projects, investors provide the cost for land acquisition and resettlement, and the local government will be responsible for negotiations. However, the private sector said that the compensation for any delays should be clearly embedded in the contract, so the responsibility of each party can be investigated in any difficult cases. Investors say that usually if the delay of land acquisition is because of the public sector, the concession period can be extended. However, investors say that they prefer immediate financial compensation rather than extending the concession period as they still have to pay the loan interest every month. This finding is consistent with the findings of Ke *et al*. (2009). In this study, it was suggested that this risk be solely or mostly allocated to the private sector.

In terms of "Poor Project Approval and Permit Process", and "Inflation Risk", participants say that these risks are in the country level and they seem to be external to the investors. Therefore, they should be managed by the public sector. Indeed, the main problem of the poor project approval and permit process is possibly the ineffective legal system, and this ineffective system should be improved by the government. Some of participants also say that the compensation for this risk should also be embedded in the contract. For example, if there are delays due to the poor project approval and permit process, the investors should have the right to claim their compensation. However, others say that it is difficult to define the responsibility of each party when this risk occurs. In fact, investors say that there are no contract clauses mentioning this risk in current Vietnamese PPPs. Compared to previous studies, the finding contradicts some of the other findings such as research by Ng and Loosemore (2007). This research says that "Poor Project Approval and Permit Process" should be allocated to both parties. In contrast, Li *et al*. (2005) suggested that the allocation of "Poor Project Approval and Permit Process" should strongly depend on specific circumstances and there should be no fixed allocation for this risk.

Regarding the "Inflation Risk", some of the participants said that the private sector should be able to forecast the inflation fluctuation. They can cooperate with financial institutions to forecast inflation rates. In terms of the public sector, officials said that the inflation rate of a country heavily depends on the macro strategies of the host country's government, but it also strongly depends on the international situation. In fact, this finding is inconsistent with many previously mentioned studies, such as Arndt (1998), Wang and Tiong (2000), VDTF (2001), and Li *et al*. (2005). Amongst these studies, only the study by Li *et al*. (2005) allocated this risk to the private sector and the rest allocated this risk to both parties. Interviewees say that the reason why this risk is allocated to the public sector is probably because in this research participants only compared parties regarding the "The ability to foresee the risk", "The ability to control the probability of occurring", and "The ability to bear the consequence". More specifically, they said that amongst these criteria, the public sector and the private sector may have similar levels of "The ability to foresee the risk" and "the ability to bear the consequence". However, the public sector should dominate in "The ability to control the probability of occurring". Therefore, they chose the option "Public Sector". In addition, many of the participants say that they wanted this risk to be shared between both parties, but mostly allocated to the public sector. Nevertheless, there is no option for "Mainly allocated to the public sector". Therefore, they had to choose the option "Public Sector". This, indeed, reflects a limitation of the proposed framework.

9.3.3. Risks Shared between the two sectors

Risks allocated to both parties are “Corruption” (P5), “Weak Financial Capacity of Investor” (M2), “Inappropriate Distribution of Responsibilities and Risks” (Re 3), and “Non-cooperation between Different Partners” (Re 4). In terms of the corruption risk, we can see that the score for the option “Share” dominated scores for other options; this reflects that a majority of participants think that this risk should be shared between the two sectors. This result seems to be inconsistent with other research such as that of Lam *et al*. (2007) and Li *et al*. (2005). In these studies, “Corruption” is allocated to the public sector. The reason is probably because in the previous studies, the corruption risk is defined as the action corrupting the governments. However, in the current research, the “Corruption Risk” is defined as an action corrupting any parties involved in the project. Corruption now occurs not only between the public and private sectors, but also amongst the private sector and public sector, especially in PPP forms, where investors have the right to decide contractors and other partners. This condition creates a favourable environment for corruption. Participants said that the public sector should create transparent processes, and simplify the legal system, which should be able to mitigate the risk.

Regarding the “Weak Financial Ability of Investors”, from the scores in the table, it can be seen that there are a number of participants who think that the private sector should be responsible for this risk. However, a majority of respondents still think that “Weak Financial Capacity of Investor” should be shared between both sectors. In other research, they generalized this risk as the financial risk and allocated this risk to the private sector (Ng and Loosemore, 2007). Explaining this choice in the current study, participants say that the private sector should be mainly responsible for this risk. However, the responsibility of evaluating the financial ability of investors also belongs to the government. On the one hand, the private sector must create clear reports about their financial capacity during the tendering period. Nevertheless, this can only be done under the effective requirement, evaluating and monitoring system and the responsibility to create an effective mechanism to evaluate the financial capacity of investors should belong to the government. This mechanism can be one of the most important strategies to mitigate this risk.

In terms of “Inappropriate Distribution of Responsibilities and Risks” (Re3), and “Non-Co-operation between Partners” (Re4), participants say that these risks come from the working partnership between the two sectors. Therefore, neither the public sector nor the private sector can effectively manage them without cooperation from partner parties. Li *et al*. (2005) also mentioned that “Inappropriate Distribution of Responsibilities and Risks” should be shared between the two sectors. In their research, “Inappropriate Distribution of Responsibilities and Risks” (Re3), and “Non-Co-operation between Partners” (Re4) are categorized in the micro level which mainly includes risks occurring in stakeholder relationships due to the difference in working methods between parties. In contrast, in research by Ke *et al*. (2009), the authors mention the “Coordination Risk” and this risk is solely located to the private sector. However, in the study by Ke *et al*. (2009), the “Coordination Risk” only refers to the ineffective cooperation inside the private organizations. Nevertheless, in this research, “Non-Co-operation between Partners” refers to the non-cooperation amongst all parties involved in the project.

9.4. Summary

This chapter shows the findings of application of AHP to evaluate the riskiness of the projects and it also illustrates the allocation strategies found by the developed AHP model. In terms of the project’s riskiness evaluation, this research found that Phu My Project is the riskiest case and Yen Lenh Bridge Project is the second riskiest case. No 18 Highway Uong Bi-Halong stands at the last position, while New Dong Nai Bridge Project and Co Chien Bridge Project stand in the third and fourth positions, respectively. More details about the riskiness of projects with regards to each risk group are also provided. In addition, this chapter also shows that the majority (57.45 percent) of practitioners agreed with this riskiness ranking. Furthermore, this chapter also shows risk allocation strategies found by the AHP model. In general, “Low Quality Products” (C3), “High Maintenance Cost” and “Fluctuation of Demand” are allocated to the private sector, and “Difficulty in Land acquisition and Resettlement” (C8), “Poor Project Approval and Permit Process” (L3), and “Inflation Risk” (M4) should be managed by the public clients. In contrast, both parties should share the responsibility in managing “Corruption” (P5), “Weak Financial

Capacity of Investor" (M2), "Inappropriate Distribution of Responsibilities and Risks" (Re 3), and "Non-cooperation between Different Partners" (Re 4).

CHAPTER 10: RETURNS EVALUATION AND OPTIMIZATION OF CONCESSION PARAMETERS BY USING RISK-ADJUSTED DNPV

10.1. Introduction

In order to demonstrate the applicability of risk-adjusted DNPV in the proposed risk evaluation framework, three case studies were used. Due to the availability and reliability of data collected, three projects amongst the five projects are used to demonstrate the model. They are Yen Lenh Bridge Project, No 18 Uong Bi-Ha Long Highway Project, and New Dong Nai Bridge Project. No 18 Uong Bi Ha Long Highway project and New Dong Nai Bridge are currently in the operation stage and construction stage. Hence, one of the aims of this research is to demonstrate the application of the risk-adjusted DNPV model to highlight the different stages of the project's life cycle. This chapter, firstly, shows the return evaluation of Yen Lenh Bridge Project. Secondly, No 18 Uong Bi-Ha Long Project's return evaluation and concession parameters optimization will be demonstrated. Finally return evaluation and concession parameters optimization of New Dong Nai Bridge Project will be illustrated.

10.2. Yen Lenh Bridge Project

As described in chapter 9, Yen Lenh Bridge Project is a BOT project. The operation stage was planned to last 17 years and one month at the time of signing the contract in 2002. The construction started in June 2002 and finished in September 2004. However, in 2012, the project was renegotiated because investors reported that from 2005 to 2012, the revenues were under estimation and the main reason that was identified was that the traffic demand was insufficient. After the negotiation, it was accepted that the operation period could extend until 2026 which is 4 years longer than what was stated in the original contract in 2002.

It is important to note that in 2012 the project was also re-evaluated by the government using NPV, and in this paper, the project was re-evaluated by using risk-adjusted DNPV.

Table 10. 1 Risk Management Analysis in Yen Lenh Bridge Project

Source	Parameter	Potential Risk	Influence factors	Risk mitigation
Revenue	Demand	Lower demand than expected	M7. Influence of negative economic events L5. Restriction on toll and tariff C10. Delay in other infrastructures relating to the project	Using real heuristic data to forecast the demand Obtain government guarantee to extend the contract
Expenditure	Maintenance cost	Higher maintenance cost than forecasted	M4. Inflation risk M7. Influence of negative economic events M5. Fluctuation of Interest rate	Assume the cost contingency by investor Define clearly responsibility for reasons of damages in the contract

Table 10.1 shows a part of the risk management analysis of this project. With the analysis from table 10.1, in this research, on the revenue side, the risk adjusted parameter was calculated for the risk of lower demand than was expected, and on the expenditure side, the risk adjusted parameter was calculated for maintenance cost. The historical data of traffic volume and cash flows from 2005 to 2012 is available, and this data is audited. Thus, the risk premium was determined by using the real option method described in chapter 6. Figure 10.1 shows the yearly variation of demand from 2006 to 2012 which creates the annualized standard deviation of 16.87 percent.The statistics from 2005 to 2012 are audited, and from 2013 to 2030 are forecasted.

Figure 10. 1 Annual variation of demand from 2006 to 2012 in Yen Lenh Bridge

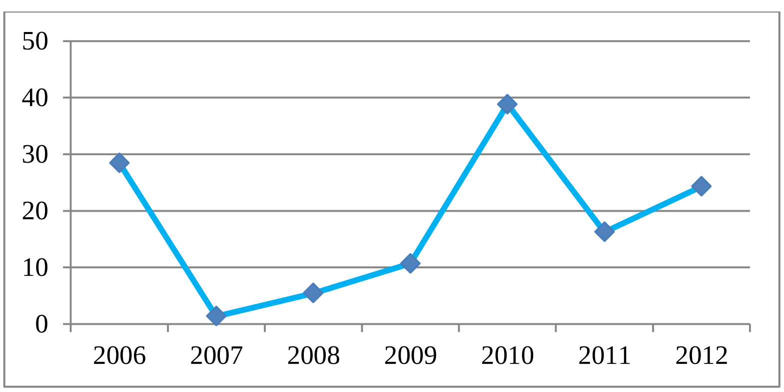
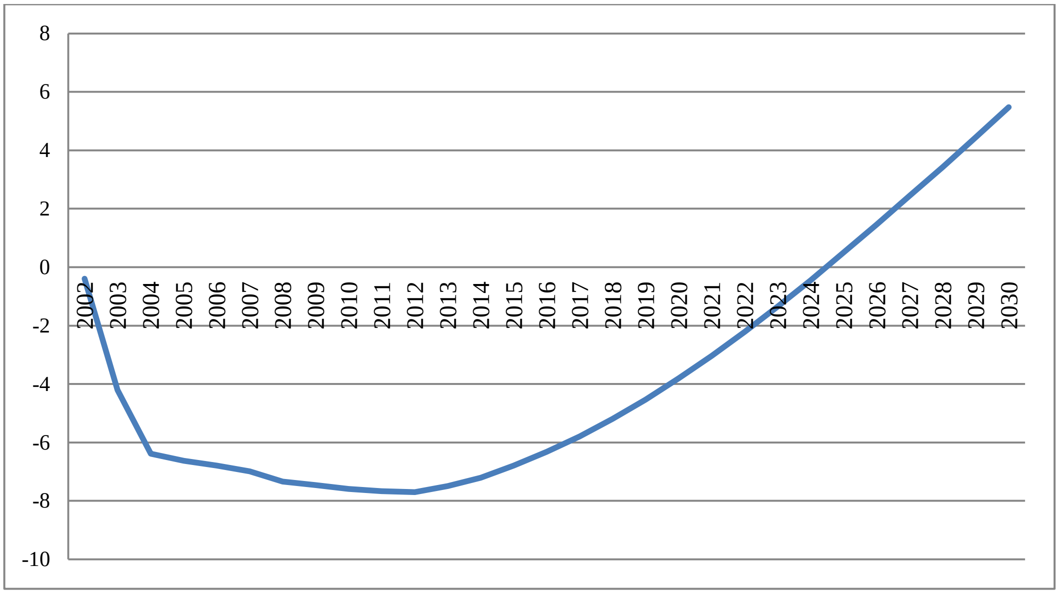


Figure 10.2 shows the NPV calculated in the re-negotiated contract in 2012. It can be seen that in this scenario, the project is profitable and it will start to make profit in the year 2024. The figure shows a decrease until 2012, followed by a rapid increase until 2030At the last year of the forecasted period, 2030, investors can obtain nearly 6 million pounds.

Figure 10. 2 NPV from Re-Negotiated Contract in 2012 in Yen Len Bridge Project



However, it is extremely important to point out that the NPV in Figure 10.2 is not an appropriate calculation because the government and investors used the inappropriate risk discount rate (ɍ) in re-evaluating this project in 2012. More specifically, the time in which the cash flows were concerted is the year 2005. However, the parties still used the risk discount rate, 6 percent, used in the contract in 2002 to convert the cash flows. In fact, according to MOF (2014) and PG Bank (2012), the risk-free rate in 2005 was 6.875 percent. The risk discount rate must be higher than risk free rate. Therefore, the risk discount rate that was used should have been higher than 6.875 percent. However, in the renegotiated contract, parties used the risk discount rate of 6 percent. This, indeed, led to the overestimation of the valuation of the project. In fact, the unfair evaluation in figure 10.2 also shows how the incorrect selection of the discount rate can lead to an extremely incorrect evaluation. In other words, the NPV shown in the renegotiated contract in 2012 is an inappropriate evaluation overestimating the value of the project. Due to the stated reason, the section below makes another demonstration of the risk-adjusted DNPV and NPV. In this demonstration NPV, was recalculated.

In order to make an appropriate demonstration of the risk-adjusted DNPV and NPV, the cash flows were in the year 2012 which was the time of the renegotiated contract, and the discount rate is re-determined. The discount rate used to calculate NPV is 12.3 percent which was assumed in other Vietnamese BOT projects in 2012.

10.2.1. Determination of risk adjusted parameter on the expenditure side

In terms of the risk-adjusted parameter on the expenditure side, the heuristic method described in chapter 6 was used for this project. The finding from previous research by Paul *et al*. (2014) was applied. In the research, they found that the cost contingency for maintenance infrastructure in Vietnam was 35 %. Thus, $\eta_I = 0.35$.

Using this finding, together with table 10.15 and equation 6.24, the risk-adjusted parameter for the operation period of this project can be measured as:

$$\bar{\eta}_I = \eta_I + \eta_I * R_{M4} * R_{M5} * R_{M7}$$

Where,

RM4: Risk score for the inflation risk

RM5: Fluctuation of interest rate

RM7: Risk score for influence of negative economic events

Thus,

$$\bar{\eta}_I = 0.35 + 0.35*0.403*0.378*0.314 = 0.3667$$

10.2.2. Determination of risk adjusted parameter on the revenue side

In terms of the risk-adjusted parameters on the revenue side, due to the value of the cash flows having been converted to their value in 2012 and the variation of T being different, the risk-adjusted parameters on the revenue side were re-calculated. The variation of traffic volume is 16.87 percent. The government bond interest rate in 2012 was 9.5 percent. Thus, the risk-free rate used is 9.5 percent. Using above variables together with the equation

6.22 in chapter 6, the risk parameter on the revenue side without taking account of influential factors, can be determined. Risk scores for risk factors in table 10.1 were applied to the equation 6.24. These risk scores can be taken from table 8.1 in chapter 8. Therefore, the risk adjusted parameter can be calculated as:

$$\bar{\eta}_{v} = \eta_v + \eta v * R_{M7} * R_{L5} * R_{C10}$$

$$\bar{\eta}_{v} = \eta_v + \eta_v * 0.378 * 0.318 * 0.308$$

Table 10.2 below shows the risk adjusted parameters on the revenue side in risk adjusted DNPV in 2012. The parameters are shown in different years during the concession period. The details of variables used to calculate η_v are shown in Appendix G.

Table 10. 2 Risk Adjusted parameters on revenue side in Yen Lenh Bridge

Year	Risk Parameter on the revenue side ηv	Risk factor 1 (M7. Influence of negative economic events)	Risk factor 2 (L5. Restriction on toll and tariff)	Risk factor 2 (C10. Delay in other infrastructures relating to the project)	Risk Adjusted Parameter on the revenue side $\bar{\eta}_{v}$
2012	0.2286	0.3780	0.3180	0.3080	0.2371
2013	0.2713	0.3780	0.3180	0.3080	0.2813
2014	0.3092	0.3780	0.3180	0.3080	0.3206
2015	0.3423	0.3780	0.3180	0.3080	0.3550
2016	0.3723	0.3780	0.3180	0.3080	0.3860
2017	0.4008	0.3780	0.3180	0.3080	0.4156
2018	0.4293	0.3780	0.3180	0.3080	0.4452
2019	0.4590	0.3780	0.3180	0.3080	0.4760
2020	0.4909	0.3780	0.3180	0.3080	0.5090
2021	0.5259	0.3780	0.3180	0.3080	0.5453
2022	0.5649	0.3780	0.3180	0.3080	0.5858
2023	0.6088	0.3780	0.3180	0.3080	0.6314
2024	0.6586	0.3780	0.3180	0.3080	0.6830
2025	0.7153	0.3780	0.3180	0.3080	0.7417
2026	0.7798	0.3780	0.3180	0.3080	0.8087

From these new risk-adjusted parameters, return analysis can be made. Table 10.3 shows risk adjusted DNPV and re-calculated NPV in this scenario.

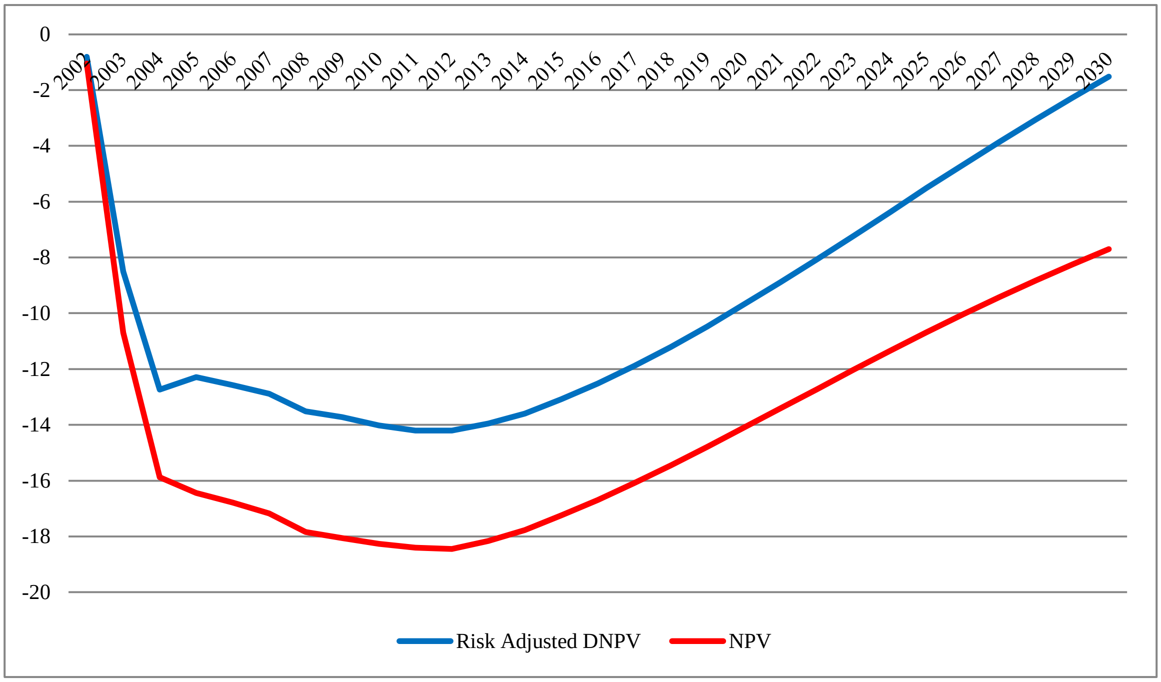
Table 10. 3 Return Analysis by Risk Adjusted DNPV and re-calculated NPV with $\bar{r}$: 12.3%, r: 9.5%

Year	Revenue (£, million)	Expenditure						Income (£, million)	$\bar{\eta}_{v}$ (For lower revenue)	$\bar{\eta}_{I}$ (for higher expenditure)	$\tilde{\tilde{R}}_{It}$	$\tilde{\tilde{R}}_{It}$	Risk adjusted DNPV	NPV
		Operational Cost	Maintenance	Tax	Investment	Bank Interest	Total (£, million)							
	1	2	3	4	5	6	(7)=(2)+(3)+(4)+(5)+(6)	(8)=(1)-(7)	10	11	(12)=10x (1)	(13)=11 x(7)	16	17
2002					0.30	0.02	0.33	-0.33					-0.81	-1.05
2003					3.12	0.28	3.40	-3.40					-8.50	-10.70
2004					1.60	0.45	2.05	-2.05					-12.74	-15.88
2005	0.41	0.03	0.01	0.04	0.08	0.48	0.65	-0.25					-12.29	-16.44
2006	0.52	0.04	0.01	0.05		0.59	0.70	-0.18					-12.57	-16.79
2007	0.53	0.04	0.01	0.05		0.63	0.74	-0.21					-12.89	-17.17
2008	0.56	0.05	0.01	0.06		0.86	0.98	-0.42					-13.52	-17.84
2009	0.62	0.05	0.01	0.06		0.64	0.77	-0.15					-13.72	-18.06
2010	0.86	0.07	0.01	0.09		0.86	1.03	-0.17					-14.02	-18.27
2011	0.99	0.08	0.02	0.10		0.90	1.10	-0.11					-14.20	-18.40
2012	1.24	0.11	0.02	0.20	0.10	0.86	1.29	-0.05					-14.21	-18.45
2013	1.40	0.12	0.03	0.22		0.70	1.07	0.33	0.0000	0.3667	0.00	0.0538	-13.95	-18.16
2014	1.58	0.13	0.03	0.25		0.67	1.09	0.49	0.0002	0.3667	0.00	0.0608	-13.60	-17.77

2015	1.74	0.15	0.03	0.28		0.55	1.00	0.74	0.0007	0.3667	0.00	0.0637	-13.08	-17.25
2016	1.91	0.16	0.04	0.31		0.51	1.02	0.89	0.0015	0.3667	0.00	0.0735	-12.52	-16.69
2017	2.10	0.18	0.04	0.34		0.47	1.03	1.07	0.0025	0.3667	0.01	0.0809	-11.89	-16.09
2018	2.31	0.20	0.05	0.37		0.43	1.04	1.27	0.0037	0.3667	0.01	0.0890	-11.21	-15.45
2019	2.54	0.22	0.05	0.41		0.38	1.05	1.49	0.0052	0.3667	0.01	0.0979	-10.48	-14.79
2020	2.80	0.24	0.04	0.45		0.32	1.05	1.75	0.0069	0.3667	0.02	0.1025	-9.69	-14.10
2021	3.02	0.26	0.06	0.48		0.26	1.06	1.96	0.0089	0.3667	0.03	0.1163	-8.89	-13.41
2022	3.26	0.28	0.07	0.52		0.20	1.06	2.20	0.0112	0.3667	0.04	0.1256	-8.07	-12.72
2023	3.52	0.30	0.07	0.56		0.13	1.06	2.46	0.0139	0.3667	0.05	0.1356	-7.23	-12.03
2024	3.80	0.32	0.08	0.61		0.06	1.07	2.74	0.0170	0.3667	0.06	0.1465	-6.38	-11.35
2025	4.11	0.35	0.06	0.66			1.07	3.04	0.0208	0.3667	0.09	0.1507	-5.51	-10.68
2026	4.44	0.38	0.09	0.71			1.18	3.26	0.0252	0.3667	0.11	0.1709	-4.68	-10.04
2027	4.79	0.41	0.10	0.77			1.27	3.52	0.0304	0.3667	0.15	0.1845	-3.86	-9.42
2028	5.18	0.44	0.10	0.83			1.37	3.80	0.0365	0.3667	0.19	0.1993	-3.06	-8.83
2029	5.59	0.48	0.11	0.89			1.48	4.11	0.0439	0.3667	0.25	0.2152	-2.28	-8.25
2030	6.04	0.51	0.12	0.97			1.60	4.44	0.0526	0.3667	0.32	0.2324	-1.52	-7.70

In table 10.3, all evaluations by DNPV and NPV show that the project is not profitable. More specifically, NPV at the end of the operational period is -7.7 million pounds while DNPV is -1.52 million pounds. Both evaluations suggest that the project should not be implemented under the PPP mechanism. However, it is very important to recognize that there is a remarkable difference between the two evaluations. Figure 10.3 reveals that Risk-Adjusted DNPV and NPV follow a similar trend, however, Risk-Adjusted DNPV is always higher than NPV. This difference is discussed in more detail in chapter 11.

Figure 10. 3 Risk Adjusted DNPV and NPV of Yen Lenh Bridge Project



10.3. Case study 2 - No 18 Uong Bi – Ha Long Highway Project

10.3.1. Return Analysis

As described previously in chapter 9, No 18 highway Uong Bi-Ha Long is a 30.1km long highway. The project was planned in 2010 and the contract was signed in August 2011. The authorized state body in the contract is Directorate for Roads of Vietnam (DRV) and the SPV is Dai Duong BOT Company which is set up by Dai Duong JSc. The construction started on October 2011 and finished on April 2014 which was 6 months earlier than planned. The project was planned to collect tolls from 1st of June 2014 to 5th of October 2030. However, the start of the toll collection was delayed until the end of 2014.

Table 10.4 shows the risk analysis and mitigation strategies planned by investors in this project. From this table, it can be seen that the revenue and expenditure of the project are influenced by traffic demand, maintenance cost and construction cost. Therefore, for this case study, risk-adjusted DNPV was used to take into account losses by lower demand than were expected, a higher maintenance cost, and construction cost overrun. Table 10.4 also demonstrates factors which can have an influence on demand and expenditure, and Risk-Adjusted DNPV took these factors into account.

Table 10. 4 Risk Management Analysis by Investors in No 18 Uong Bi – Ha Long Highway Project

Source	Parameter	Potential Risk	Influence factor	Risk Mitigation
Revenue	Demand	Lower demand than expected	M7. Influence of negative economic events L5. Restriction on toll and tariff C10. Delay in other infrastructures relating to the project	Using real heuristic data to forecast the demand Obtain government guarantee to extend the contract
Expenditure	Maintenance cost	Maintenance cost is higher than predicted	M4. Inflation risk M7. Influence of negative economic events M5. Fluctuation of Interest rate	Assume the cost contingency by investor Specify the maximum fluctuation of cost in the contract
	Construction cost	Cost overrun	M4. Inflation risk M7. Influence of negative economic events M5. Fluctuation of Interest rate (C7. Difficulty in Land acquisition and Resettlement)	Assume the cost contingency by investor

a. Determination of Risk-Adjusted parameter on the expenditure side for maintenance cost

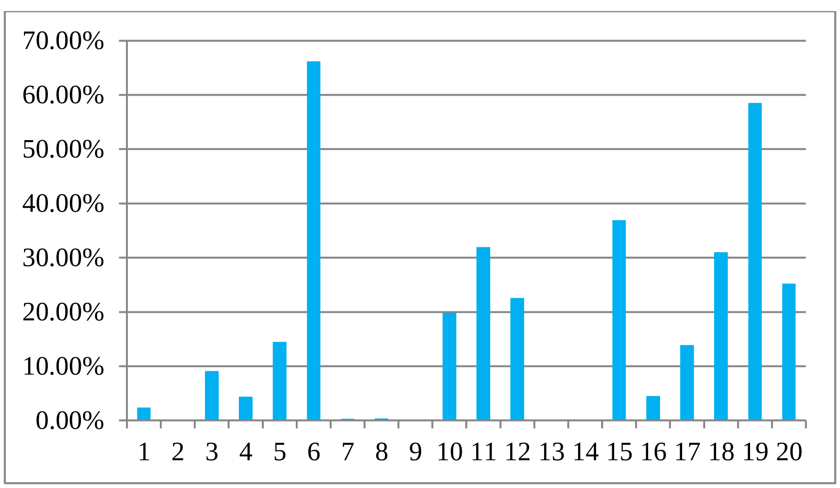
Similarly with case 1, for the risk-adjusted parameter on the expenditure side for maintenance cost, the heuristic method described in chapter 6 was also applied. The finding by Paul *et al*. (2014) was also applied. Thus, η_{Im} = 0.35.

It can be seen from table 10.4 that similar influence factors in Yen Lenh Bridge Project were used in adjusting risk parameters. Therefore, in this case, the risk adjusted parameter for maintenance cost is also 0.3667.

b. Determination of Risk Adjusted parameter on the expenditure side for Construction period

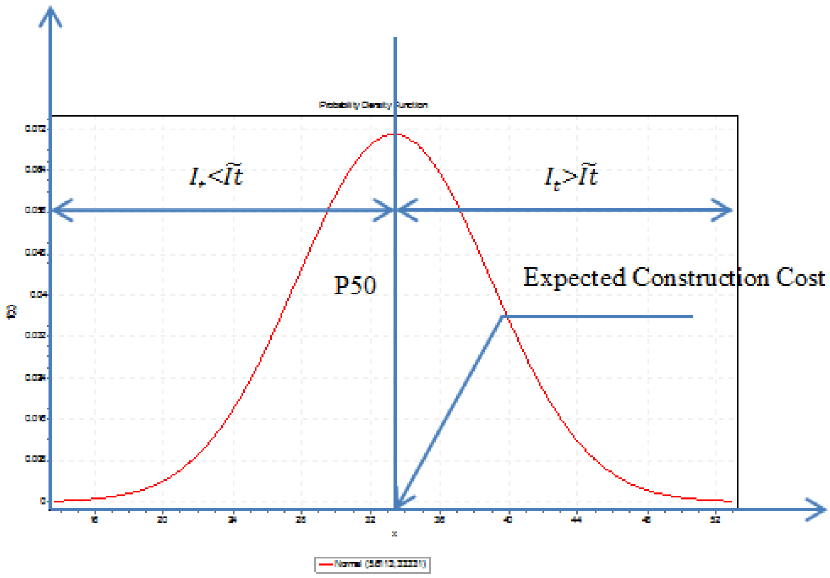
In this project, to determine the risk parameter for the construction cost overrun, the probability-based method was applied. Currently, the Ministry of transport of Vietnam is managing 21 PPP projects which have finished their construction period. The cost overrun statistics of 20 of these projects were collected. Although the number of projects is only 20, the total number of Vietnamese PPPs which finished their construction period is only 21. Therefore, the figure presents the general situation of the current cost overrun in current Vietnamese PPPs. Figure 10.4 presents the construction cost overrun in 20 out of 21 finished Vietnamese PPPs.

Figure 10. 4 Construction Cost overrun in 20 Vietnamese PPPs (%) (MOT, 2014; General Statistics Office of Vietnam, 2014; MOF, 2014)

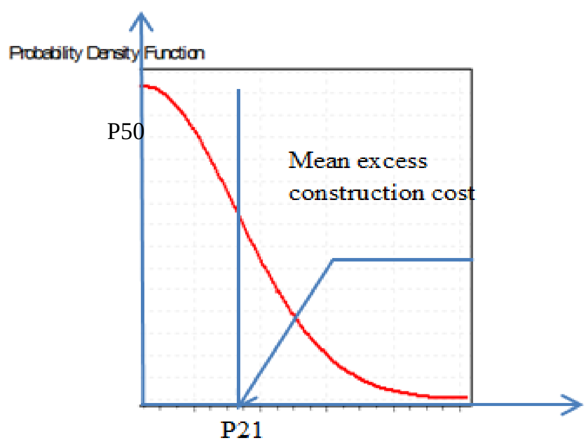


Using figure 10.4, the distribution for construction cost of this project is shown in figure 10.5. For the purpose of simplicity, a normal distribution was employed in this research.

Figure 10. 5 Potential loss distribution due increase of construction cost in No 18 Highway Uong Bi – Ha Long Project



(a) Construction Cost Distribution



(b) Potential Loss distribution for construction expenditure

From figure 10.5, it can be seen that the expected value was located at P50, the potential loss for expenditure is on the right side part of P50, and the value of loss is located at the centre of gravity of the truncated area which is the location of P21. The value of P21 can be determined by using the Inverse Normal Distribution function with the mean of 33.33 and the standard deviation of 5.613. Using equation 6.17, the risk parameter on the expenditure side for construction period can be determined as:

$$\eta_{Icon} = \frac{\Pr[It > \tilde{I}t] * (P21 - P50)}{(P50)} = \frac{0.5 * (37.86 - 33.33)}{33.33} = 0.0679$$

After having the risk parameter η_I together with table 10.4, equation 6.25 can be used to adjust this risk by using the influence factors. Thus,

$$\bar{\eta}_{Icon} = \eta_{Icon} + \eta_{Icon} * R_{M4} * R_{M5} * R_{M7} * R_{C7}$$

where,

R_{M4}: Risk score for Inflation risk

R_{M5}: Risk score for Fluctuation of interest rate

R_{M7}: Risk score for Negative economic events

R_{C7}: Risk score for Difficulty in Land acquisition and resettlement

Thus,

$$\bar{\eta}_{Icon} = 0.746 + 0.746 * 0.502 * 0.403 * 0.378 * 0.314 = 0.0695$$

c. Determination of the risk adjusted parameter on the revenue side

Because the heuristic data about the variation of traffic demand in this highway is available, the option pricing method was used. Figure 10.6 shows the annual variation of traffic demand from 2003 to 2010. This figure shows the standard deviation of 15.53 percent.

Figure 10. 6 Annual traffic variations from 2003 to 2010 by percentage (MOT, 2014; General Statistics Office of Vietnam, 2014)

Table 10.5 shows the expected revenues and expenditures from the contract of this project. In that table, the year of evaluation is 2011 which was the year of signing the contract. It should be noted that the risk-free rate is r: 9.5 percent (PG Bank, 2012); $\boldsymbol{\delta}$:

Zero; T: 1→30. Using these numbers together with table 10.4 and equations 6.20, 6.21, 6.22, and 6.24, the risk parameter on the revenue side can be determined. Table 10.6 shows the risk parameters on the revenue side in different years. Details of the calculations are provided in Appendix H.

Table 10. 5 Expected revenues and expenditure from No 18 Uong Bi – Halong Highway project

Year	Revenue (mil. pounds)	Expenditure (mil. pounds)	Year	Revenue (mil. pounds)	Expenditure (mil. pounds)
2011	0.19	1.4	2026	8.55	13.31
2012	0.82	13.6	2027	9.24	1.11
2013	0.91	11.38	2028	9.97	1.21
2014	1	5.03	2029	10.77	2.41
2015	5.13	0.18	2030	11.63	3.6
2016	4.64	0.63	2031	11.52	1.43
2017	4.88	0.66	2032	12.44	1.55
2018	5.36	1.42	2033	13.43	1.68
2019	5.9	1.01	2034	14.51	5.9
2020	5.4	0.64	2035	15.67	1.97
2021	5.89	0.7	2036	15.38	1.98
2022	6.42	2.35	2037	16.62	2.15
2023	7	0.83	2038	17.94	40.89
2024	7.63	1.25	2039	19.38	3.96
2025	8.31	0.99	2040	20.93	2.5

Table 10. 6 Risk parameters on the revenue side in different years in No18 Highway Project

Year	Risk Parameter on the revenue side η_v	Year	Risk Parameter on the revenue side η_v	Year	Risk Parameter on the revenue side η_v
2011	0.0000	2021	0.0035	2031	0.0216
2012	0.0000	2022	0.0043	2032	0.0256
2013	0.0000	2023	0.0053	2033	0.0303
2014	0.0002	2024	0.0064	2034	0.0359
2015	0.0004	2025	0.0077	2035	0.0425
2016	0.0007	2026	0.0092	2036	0.0503

2017	0.0011	2027	0.0109	2037	0.0595
2018	0.0016	2028	0.0130	2038	0.0705
2019	0.0022	2029	0.0154	2039	0.0835
2020	0.0028	2030	0.0183	2040	0.0989

After placing the risk parameters on the revenue side (η_v), the risk-adjusted parameters can be determined by using equation 6.24 and table 10.4 and table 10.6.

$$\bar{\eta}_v = \eta_v + \eta_v * R_{M7} * R_{L5} * R_{C10}$$

Where,

R_{M7}: Risk score for Influence of Negative economic events

R_{L5}: Risk score for Restriction on tolls

R_{C10}: Delay in other infrastructures relating to the project

Thus,

$$\bar{\eta}_v = \eta_v + \eta_v * R_{M7} * R_{L5} * R_{C10} = \eta_v + \eta_v * 0.378 * 0.318 * 0.308$$

Risk adjusted parameters on the revenue side are shown in table 10.7. In this table, the risk scores for influence factors are also shown.

Table 10. 7 Risk adjusted parameters on the revenue side for different year in No 18 Highway Project

Year	Risk Parameter on the revenue side η_v	Risk factor 1 (M7. Influence of negative economic events)	Risk factor 2 (L5. Restriction on toll and tariff)	Risk factor 2 (C10. Delay in other infrastructures relating to the project)	Risk Adjusted Parameter on the revenue side $\bar{\eta}_v$
2011	0.0000	0.378		0.308	0.00000
2012	0.0000	0.378		0.308	0.00000
2013	0.0000	0.378		0.308	0.00005
2014	0.0002	0.378		0.308	0.00018
2015	0.0004	0.378	0.318	0.308	0.00043
2016	0.0007	0.378	0.318	0.308	0.00076
2017	0.0011	0.378	0.318	0.308	0.00118
2018	0.0016	0.378	0.318	0.308	0.00167

2019	0.0022	0.378	0.318	0.308	0.00224
2020	0.0028	0.378	0.318	0.308	0.00289
2021	0.0035	0.378	0.318	0.308	0.00364
2022	0.0043	0.378	0.318	0.308	0.00450
2023	0.0053	0.378	0.318	0.308	0.00548
2024	0.0064	0.378	0.318	0.308	0.00663
2025	0.0077	0.378	0.318	0.308	0.00796
2026	0.0092	0.378	0.318	0.308	0.00951
2027	0.0109	0.378	0.318	0.308	0.01134
2028	0.0130	0.378	0.318	0.308	0.01347
2029	0.0154	0.378	0.318	0.308	0.01599
2030	0.0183	0.378	0.318	0.308	0.01895
2031	0.0216	0.378	0.318	0.308	0.02244
2032	0.0256	0.378	0.318	0.308	0.02657
2033	0.0303	0.378	0.318	0.308	0.03145
2034	0.0359	0.378	0.318	0.308	0.03722
2035	0.0425	0.378	0.318	0.308	0.04406
2036	0.0503	0.378	0.318	0.308	0.05215
2037	0.0595	0.378	0.318	0.308	0.06175
2038	0.0705	0.378	0.318	0.308	0.07313
2039	0.0835	0.378	0.318	0.308	0.08661
2040	0.0989	0.378	0.318	0.308	0.10261

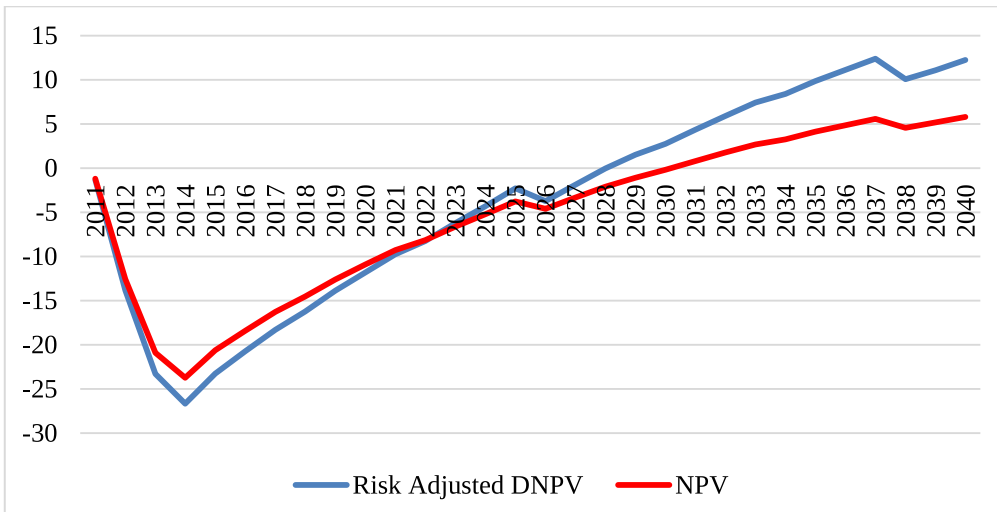
From these risk adjusted parameters, losses which can be made because of lower revenue and higher expenditure can be determined. From that the return analysis can be made. Table 10.8 shows the details of the return analysis by the risk-adjusted DNPV and NPV for this project, while figure 10. 7 presents the trend of risk-adjusted DNPV and NPV. It is important to note that from the contract agreement, it can be seen that SPV is responsible for the annual maintenance and comprehensive maintenance. The comprehensive maintenance is made in the frequency stated in the contract, and in this research, it is assumed that the risk-adjusted parameters for comprehensive maintenance is also the risk-adjusted parameters for construction work.

Table 10. 8 Return analysis by risk adjusted DNPV and NPV for No 18 Uong Bi-Halong Highway Project

Year	Revenue (million pounds)	Expenditure (million pounds)					Income	$\bar{\eta}_v$	$\bar{\eta}_{Icon}$ (for Construction period)	$\bar{\eta}_{Im}$ (for Maintenance)	$\tilde{\tilde{\boldsymbol{R}}}_{vt}$	$\tilde{\tilde{\boldsymbol{R}}}_{It}$	Risk adjusted DNPV	NPV
		Management Cost	Maintenance	Tax	Investment	Total								
2011	0.19	0.03	0.0051	0.00369	1.36	1.40	-1.21		0.0695			0.09	-1.31	-1.21
2012	0.82	0.11	0.0228	-0.10682	13.58	13.60	-12.78		0.0695			0.94	-13.84	-12.59
2013	0.91	0.12	0.0251	-1.20693	12.44	11.38	-10.47		0.0695			0.86	-23.30	-20.90
2014	1.00	0.14	0.0345	-1.10228	5.96	5.03	-4.03	0.00018	0.0695	0.3667	0.0002	0.41	-26.68	-23.74
2015	5.13	0.55	0.0608	-0.43564		0.18	4.95	0.00043		0.3667	0.0022	0.02	-23.26	-20.63
2016	4.64	0.47	0.0669	0.09205		0.63	4.01	0.00076		0.3667	0.0035	0.02	-20.73	-18.39
2017	4.88	0.49	0.0736	0.09681		0.66	4.22	0.00118		0.3667	0.0057	0.03	-18.30	-16.28
2018	5.36	0.54	0.7838	0.09946		1.42	3.95	0.00167		0.0695	0.0090	0.05	-16.24	-14.53
2019	5.90	0.59	0.3038	0.11499		1.01	4.89	0.00224		0.0695	0.0132	0.02	-13.89	-12.60
2020	5.40	0.43	0.0979	0.10709		0.64	4.77	0.00289		0.3667	0.0156	0.04	-11.81	-10.92
2021	5.89	0.47	0.1077	0.11672		0.70	5.19	0.00364		0.3667	0.0214	0.04	-9.74	-9.29
2022	6.42	1.09	1.1476	0.11692		2.35	4.07	0.00450		0.0695	0.0289	0.08	-8.28	-8.16
2023	7.00	0.56	0.1303	0.13865		0.83	6.17	0.00548		0.3667	0.0384	0.05	-6.23	-6.62
2024	7.63	0.61	0.4893	0.14765		1.25	6.38	0.00663		0.0695	0.0506	0.03	-4.30	-5.21
2025	8.31	0.67	0.1577	0.16470		0.99	7.33	0.00796		0.3667	0.0662	0.06	-2.28	-3.77
2026	8.55	0.68	12.5816	0.04521		13.31	-4.76	0.00951		0.0695	0.0814	0.87	-3.74	-4.60
2027	9.24	0.74	0.1908	0.18280		1.11	8.12	0.01134		0.3667	0.1047	0.07	-1.88	-3.33
2028	9.97	0.80	0.2099	0.19738		1.21	8.77	0.01347		0.3667	0.1344	0.08	-0.05	-2.11
2029	10.77	0.86	1.3453	0.20199		2.41	8.36	0.01599		0.0695	0.1722	0.09	1.53	-1.08

2030	11.63	0.93	2.4600	0.20808		3.60	8.04	0.01895		0.3667	0.2204	0.90	2.76	-0.19
2031	11.52	0.92	0.2794	0.22756		1.43	10.09	0.02244		0.3667	0.2585	0.10	4.35	0.80
2032	12.44	1.00	0.3073	0.24571		1.55	10.89	0.02657		0.3667	0.3305	0.11	5.90	1.75
2033	13.43	1.07	0.3381	0.26530		1.68	11.76	0.03145		0.3667	0.4225	0.12	7.42	2.67
2034	14.51	1.16	4.4990	0.24519		5.90	8.60	0.03722		0.0695	0.5401	0.31	8.38	3.27
2035	15.67	1.25	0.4091	0.30930		1.97	13.70	0.04406		0.3667	0.6904	0.15	9.84	4.11
2036	15.38	1.23	0.4500	0.30319		1.98	13.40	0.05215		0.3667	0.8024	0.17	11.12	4.85
2037	16.62	1.33	0.4950	0.32736		2.15	14.46	0.06175		0.3667	1.0260	0.18	12.38	5.56
2038	17.94	1.44	39.4863	-0.03597		40.89	-22.94	0.07313		0.0695	1.3122	2.75	10.05	4.56
2039	19.38	1.55	2.0441	0.36716		3.96	15.42	0.08661		0.3667	1.6786	0.75	11.07	5.16
2040	20.93	1.43	0.6588	0.412		2.5	18.43	0.10261		0.3667	2.1478	0.24	12.23	5.80

Figure 10. 7 Risk Adjusted DNPV and NPV for No 18 Uong Bi-Halong Highway Project



From table 10.8 and figure 10.7, it can be seen that the project is profitable in both evaluations. In general, in Risk-adjusted DNPV Evaluation, investors will start to make a profit in 2029, whereas, in NPV evaluation, they can make a profit beginning in 2032. Because the project is beneficial, concession parameters can be optimized. The section below shows how parties can optimize concession parameters.

10.3.2. Optimization of concession parameters

The concession parameters which are subjected to optimization include the concession period, and returns obtained during the concession period. The concession period should be able to protect the interest of both sectors, as mentioned clearly in chapter 6.

As stated in chapter 6, in order to optimize the concession parameter, the expected return from the investor (IcR), depreciation cost of the project ($\widetilde{Dt}$), and net asset value of the project (NAV_{TC}) needs to be determined. From the contract, it is shown that the expected rate of return for investors (R) is 12.83 percent. Using this number together with the forecasted expenditure, the expected return each year can be determined.

It is important to note that in the contract, there is no mention about the economic life of the project. However, according to Shen *et al*. (2002), economic life of a transportation project can be 50 years. Therefore, in this project, it is assumed that the economic life of the project is 50 years. Together with assumptions about increasing the rate of the traffic level from the contract agreement, table 10.9 is formed. Table 10.9 shows the tolls of the project until the end of its economic life without increasing its toll price.

Table 10. 9 Tolls of the project through its economic life without increasing its toll price.

Year	Tolls (No Increase of Price)	Year	Tolls (No Increase of Price)	Year	Tolls (No Increase of Price)
1	0.1870	18	7.4806	35	10.3462
2	0.8229	19	8.0791	36	9.5185
3	0.9052	20	8.7254	37	8.7570
4	0.9957	21	8.6382	38	8.0565
5	3.8445	22	9.3292	39	7.4120
6	3.4771	23	10.0756	40	6.8190

7	3.6579	24	10.8816	41	6.2735
8	4.0237	25	11.7521	42	5.7716
9	4.4261	26	11.5385	43	5.3099
10	4.0525	27	12.4615	44	4.8851
11	4.4172	28	13.4585	45	4.4943
12	4.8148	29	14.5351	46	4.1347
13	5.2481	30	15.6980	47	3.8040
14	5.7205	31	14.4421	48	3.4996
15	6.2353	32	13.2867	49	3.2197
16	6.4134	33	12.2238	50	2.9621
17	6.9265	34	11.2459		

Using equation 6.34, and 6.35 and 6.36 and 6.37 the value of IcR, $\widetilde{Dt}$ and NAV_{Tc} can be determined. Table 10.14 shows the details of the return analysis for optimizing the concession parameters.

It should be noted that the Risk-adjusted DNPV $^{(1)}$ and NPV $^{(1)}$ are obtained from the return analysis part in table 10.8. The risk-adjusted DNPV $^{(2)}$ and NPV $^{(2)}$ are inversed with DNPV $^{(1)}$ and NPV $^{(1)}$. In other words, Risk adjusted DNPV $^{(2)}$ and NPV $^{(2)}$ are cumulative from the 40th year to the 1st year.

Table 10. 10 Return analysis for optimizing concession parameters

Year	Revenue (million pounds) Revenue	Expenditure (million pounds)	Income	Risk Adjusted DNPV(1)	IcR	$\widetilde{D}_t$	NAV_{Tc}	Risk Adjusted DNPV $^{(2)}$
2011	0.19	1.40	-1.21	-1.31	0.19			
2012	0.82	13.60	-12.78	-13.84	1.90			
2013	0.91	11.38	-10.47	-23.30	3.21			
2014	1.00	5.03	-4.03	-26.68	3.74	0.08	23.30	35.52
2015	5.13	0.18	4.95	-23.26	3.76	0.16	21.22	38.91
2016	4.64	0.63	4.01	-20.73	3.81	0.50	19.16	35.48
2017	4.88	0.66	4.22	-18.30	3.86	0.80	17.33	32.95

2018	5.36	1.42	3.95	-16.24	3.96	1.11	15.66	30.53
2019	5.90	1.01	4.89	-13.89	4.02	1.46	14.13	28.47
2020	5.40	0.64	4.77	-11.81	4.06	1.84	12.74	26.12
2021	5.89	0.70	5.19	-9.74	4.10	2.19	11.49	24.04
2022	6.42	2.35	4.07	-8.28	4.22	2.57	10.35	21.96
2023	7.00	0.83	6.17	-6.23	4.25	2.99	9.31	20.51
2024	7.63	1.25	6.38	-4.30	4.30	3.44	8.37	18.46
2025	8.31	0.99	7.33	-2.28	4.34	3.93	7.50	16.52
2026	8.55	13.31	-4.76	-3.74	4.81	4.47	6.71	14.50
2027	9.24	1.11	8.12	-1.88	4.84	5.03	6.00	15.97
2028	9.97	1.21	8.77	-0.05	4.88	5.62	5.35	14.11
2029	10.77	2.41	8.36	1.53	4.94	6.27	4.76	12.28
2030	11.63	3.60	8.04	2.76	5.04	6.97	4.23	10.70
2031	11.52	1.43	10.09	4.35	5.08	7.72	3.74	9.46
2032	12.44	1.55	10.89	5.90	5.11	8.47	3.30	7.88
2033	13.43	1.68	11.76	7.42	5.14	9.27	2.91	6.33
2034	14.51	5.90	8.60	8.38	5.24	10.14	2.55	4.80
2035	15.67	1.97	13.70	9.84	5.27	11.08	2.22	3.84
2036	15.38	1.98	13.40	11.12	5.30	12.09	1.92	2.39
2037	16.62	2.15	14.46	12.38	5.33	13.09	1.66	1.10
2038	17.94	40.89	-22.94	10.05	5.81	14.17	1.42	-0.15
2039	19.38	3.96	15.42	11.07	5.86	15.33	1.21	2.18
2040	20.93	2.5	18.43	12.23	5.88	16.23	1.04	1.15

Using table 10.10 and equations 6. 29 and 6.32, the concession period can be found to protect interests of both sectors. The benefit of the private sector can only be protected if equation 6.29 is satisfied. More specifically, according to equation 6.29, investors can get the expected return if the project is transferred to the government from 2032 to 2040. The profit that investors can obtain increases from 5.9 million pounds at the end of 2032 to 12.23 million pounds at the end of 2040. During this period, the expected return (IcR) is always smaller than the Risk-Adjusted DNPV. This means investors can obtain more than expected. There is one year that investors should consider, which is the year 2038. This is because in the maintenance plan for that year, there will be a large amount of comprehensive work and if the project is transferred after this year, the investors have to be responsible for this work, and their benefit will reduce remarkably.

It can be seen that the profit decreases from 12.38 million pounds at the end of 2037 to 10.05 million pounds at the end of 2038. On the other hand, to protect the interest of the public sector, using equation 6.32, the project can be transferred to the government, except the year 2037 and 2038. As mentioned previously, the government will be responsible for a large amount of comprehensive maintenance if they get the project in 2038. This brings a drop from 1.01 million pounds from 2037 to - 0.15 million pounds in 2038. The government must be aware that the easier project that is being transferred, the more profitable it is for the public sector. Table 10.11 shows the determined concession period which can protect the interests of both sectors. The table shows that the transfer time should be from 2032 to 2037 or 2039. The difference between concession periods in the actual contract, and in other models will be discussed in chapter 11.

Table 10. 11 Concession period for Uong Bi – Halong Highway project based on Risk adjusted DNPV

Evaluation Technique	To protect investors' interests	To project the government interests	Concession period determined
Risk Adjusted DNPV	From 2032 to 2040	Any year, except 2037 and 2038	From 2032 to 2036, or 2039

It should be noted that, in this research an interval of the concession period is determined, and the specific time of transferring is left to the negotiation based on the results of this model. The suggestion to carry out further research to find a specific transfer time will be provided in chapter 12 when discussing future research

10.4. New Dong Nai Bridge Project

10.4.1. Return Evaluation

As described in chapter 9, for New Dong Nai Bridge Project the BOT mechanism was proposed in May 2008. The required investment is around £50.71 million. The investors' equity is equal to 30 percent of the required investment and the rest is debt from banks. The main bridge was inaugurated in September 2009.

It should be noted that the first contract agreement of the New Dong Nai Bridge project was signed in 2008. However, in December 2013 the contract was revised. Therefore, for this project, the evaluation was recalculated with regards to the cash flows' value in 2013. Data from 2008 to 2013 has been audited. These data include the traffic volume, construction cost, and expenditure cost from 2008 to 2013. Therefore, the risk parameters were not applied to the period from 2008 to 2013.

Table 10. 12 Risk Management Analysis for New Dong Nai Bridge Project

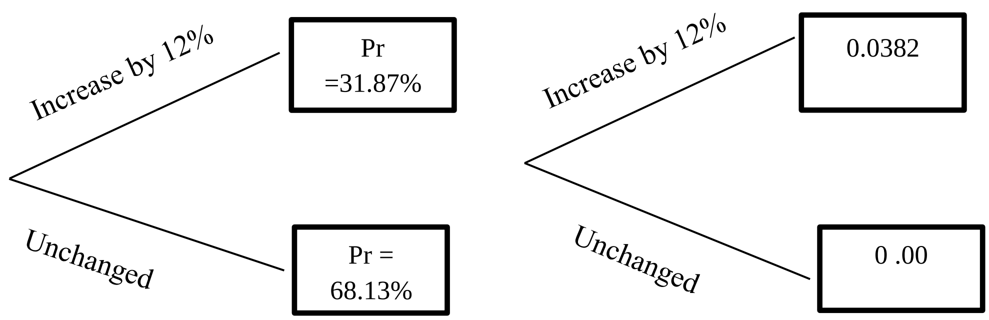
Source	Parameter	Potential Risk	Influence factor	Risk Mitigation
Revenue	Demand	Lower demand than expected	M7. Influence of negative economic events L5. Restriction on toll and tariff C10. Delay in other infrastructures relating to the project	Using real heuristic data to forecast the demand Obtain government guarantee to extend the contract
Expenditure	Maintenance cost	Maintenance cost is higher than predicted	M4. Inflation risk C3. Low quality product	Using Maintenance Contract
	Construction cost	Cost overrun	M4. Inflation risk M7. Influence of negative economic events M5. Fluctuation of Interest rate	Assume the cost contingency by investor

a. Determination of Risk Parameter for Maintenance Cost

From Table 10.12 above, it can be seen that the loss of the high maintenance cost (O2) will happen if the maintenance contract is broken and then the investors will have to sign a new contract with other maintenance provider at a with higher cost.

From the findings in the Risk Identification Finding in chapter 8, the probability of this risk (O2) happening is 0.3187 percent. In addition, in the contract agreement, the maintenance cost overrun also mentions that if the maintenance cost increases by over 12 percent, the contract will be revised. Therefore, in this paper, the loss made by the maintenance cost increase is assumed to be 12 percent. In fact, in other projects, if the data about all of the maintenance providers is available, the loss can be determined as the difference between the chosen provider and unsuccessful providers (Espinoza and Rojo, 2015). Figure 10.8 below demonstrates the risk profile because of the broken maintenance contract based on the assumption of the actual project.

Figure 10. 8 Maintenance Risk Profile



From figure 10.8, the risk parameter for maintenance can be determined as:

$$\eta_{Im} = 0.12*0.3187 + 68.13*0 = 0.0382$$

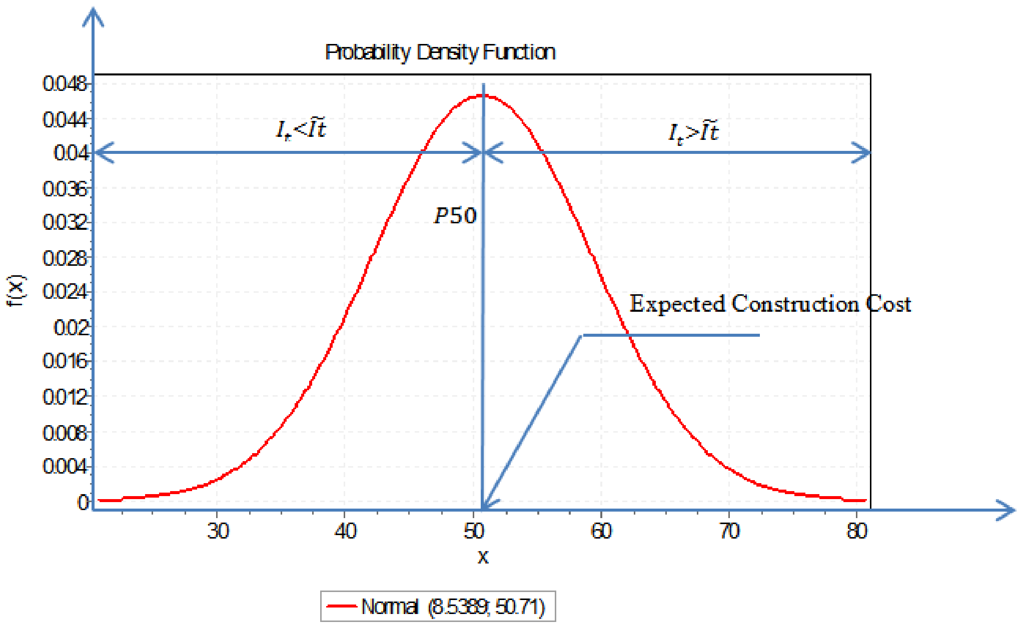
Also, from table 10.12 it can be seen that there are two risks which can have an influence on the default of the operator which are the inflation risk and risk of Low Quality products. Thus,

$$\bar{\eta}_{Im} = \eta_{Im} + \eta_{I} * R_{M4}*R_{C3} = 0.0382 + 0.0382*0.402*0.31 = 0.043$$

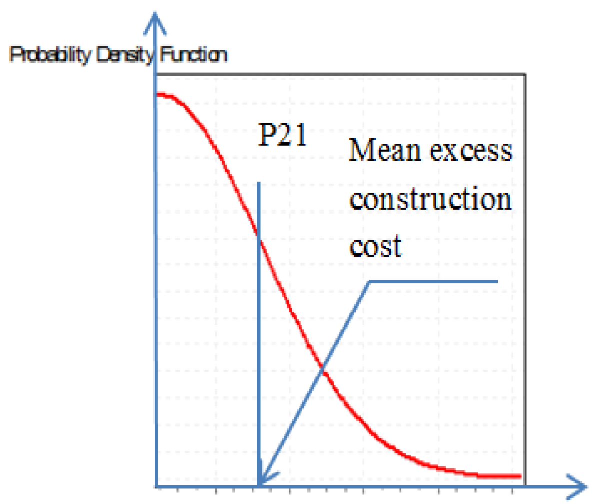
b. Determination of risk parameter for construction period

Similarly to No 18 Highway project, data from the construction cost of 20 out of 21 previous PPPs in Vietnam and the proposed construction cost for this project were used. The distribution about the construction cost for New Dong Nai Bridge is presented in figure 10.9.

Figure 10. 9 Potential loss distribution due increase of construction cost



(a) Construction Cost Distribution



(b) Potential Loss distribution for construction expenditure

It can be recognized that the construction cost distribution for New Dong Nai Bridge Project has similar a trend compared to the construction cost distribution for No 18 Highway Uong Bi – Ha Long Project. One of the reasons is that the same data for the construction cost in Vietnamese PPPs was used to create the construction cost distribution.

In fact, the risk parameter without taking into account the influential factors is slightly different to the one in case 2. More specifically, using equation 6.17, and figure 10.9, the risk parameter on the expenditure side for the construction period for this project can be determined as:

$$\eta_{Icon} = \frac{\Pr[It > \tilde{I}t] * (P21 - P50)}{(P50)} = \frac{0.5 * (57.596 - 50.71)}{50.71} = 0.0679$$

Where,

η_{Icon} : Risk parameter on the expenditure side for the construction period

However, from table 10.12, it can be seen that risks used to adjust the risk parameter η_{Icon} are different. Using equation 6.25, the risk-adjusted parameter $\bar{\eta}_{Icon}$ can be determined as:

$$\bar{\eta}_{Icon} = \eta_{Icon} + \eta_{Icon} * R_{M4} * R_{M5} * R_{M7}$$

where,

R_{M4}: Risk score for Inflation risk

$R_{M5:}$ Risk score for Fluctuation of interest rate

$R_{M7:}$ Risk score for Negative economic events

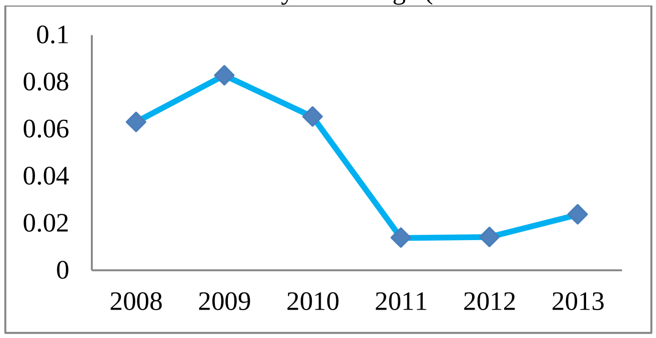
Thus,

$$\bar{\eta}_{Icon} = 0.679 + 0.679 * 0.314 * 0.403 * 0.378 = 0.0711$$

c. Determination of Risk Adjusted Parameter on the revenue side

As mentioned, the project was re-evaluated with the data audited in 2013. Data from 2007 to 2013 was used to determine the risk parameter on the revenue side. Figure 10.10 below shows the variation of the traffic volume from 2007 to 2013. It should be noted that this figure shows the variation of traffic volume, and does not just showing the traffic volume by itself. Therefore, in figure 10.10, it does not mean that the traffic volume in 2011 dropped dramatically, but it just means that the traffic volume in 2011 is just slightly higher than it was in 2010.

Figure 10. 10 Annual Traffic Variations by Percentage (Data was collected from MOT 2014)



From this figure, the standard deviation can be determined as 2.75 percent. The risk-free rate was determined as 8.9 percent as it was the average of the interest rate of the government bond in 2013 (PG Bank, 2013). In this project T = 1→17 (from 2013 to 2030). $\boldsymbol{\delta}$: Zero. Table 10.13 below shows the expected revenue and expenditure for New Dong Nai Bridge Project to determine the risk parameter on the revenue side.

Table 10. 13 Expected Revenue and Expenditure for New Dong Nai Bridge Project (Revised Contract Agreement, 2013)

Year	Revenue	Expenditure	Year	Revenue	Expenditure
2008	1.646	3.42	2020	12.585	3.06
2009	1.823	7.25	2021	12.597	3.59
2010	1.95	2.65	2022	12.61	3.39
2011	1.973	1.93	2023	12.622	6.53
2012	2.286	0.97	2024	12.635	3.76
2013	8.466	20.8	2025	12.648	3.97
2014	11.739	19.03	2026	12.66	5.33
2015	11.901	2.81	2027	12.673	4.88
2016	12.066	2.74	2028	12.686	4.71
2017	12.232	2.62	2029	12.698	4.93
2018	12.401	2.76	2030	12.698	5.3
2019	12.572	3.14			

Using these numbers and equations 6.21, 6.22, 6.23, and 6.24 from chapter 6, risk parameters on the revenue side (η_v) can be found. The details of calculating (η_v) are provided in Appendix I. After placing the risk parameters on the revenue side (η_v), risk-adjusted parameters on the revenue side ($\bar{\eta}_v$) can be determined by using equation 6.24 and table 10.13. More specifically,

$$\bar{\eta}_v = \eta_v + \eta_v * R_{M7} * R_{M5} * R_{C10}$$

$$\bar{\eta}_v = \eta_v + \eta_v * 0.378 * 0.318 * 0.308$$

Table 10.14 below shows the details of the risk adjusted parameters ($\bar{\eta}_v$) on the revenue side in different years.

Table 10. 14 Risk adjusted parameters ($\bar{\eta}_v$) on the revenue side in different years.

Year	Risk Parameter on the revenue side (η_v)	M7 (Influence of negative economic events)	L5 (Restriction on toll and tariff)	C10 (Delay in other infrastructures relating to the project)	Risk Adjusted Parameter on the revenue side ($\bar{\eta}_v$)
2013	0.000000000000	0.378	0.318	0.308	0.000000000
2014	0.000000000717	0.378	0.318	0.308	0.000000001
2015	0.000000011972	0.378	0.318	0.308	0.000000012
2016	0.000000035853	0.378	0.318	0.308	0.000000037
2017	0.000000055052	0.378	0.318	0.308	0.000000057
2018	0.000000060689	0.378	0.318	0.308	0.000000063
2019	0.000000055481	0.378	0.318	0.308	0.000000058
2020	0.000000045229	0.378	0.318	0.308	0.000000047
2021	0.000000034246	0.378	0.318	0.308	0.000000036
2022	0.000000024686	0.378	0.318	0.308	0.000000026
2023	0.000000017210	0.378	0.318	0.308	0.000000018
2024	0.000000011726	0.378	0.318	0.308	0.000000012
2025	0.000000007866	0.378	0.318	0.308	0.000000008
2026	0.000000005222	0.378	0.318	0.308	0.000000005
2027	0.000000003443	0.378	0.318	0.308	0.000000004
2028	0.000000002261	0.378	0.318	0.308	0.000000002
2029	0.000000001481	0.378	0.318	0.308	0.000000002
2030	0.000000000970	0.378	0.318	0.308	0.000000001

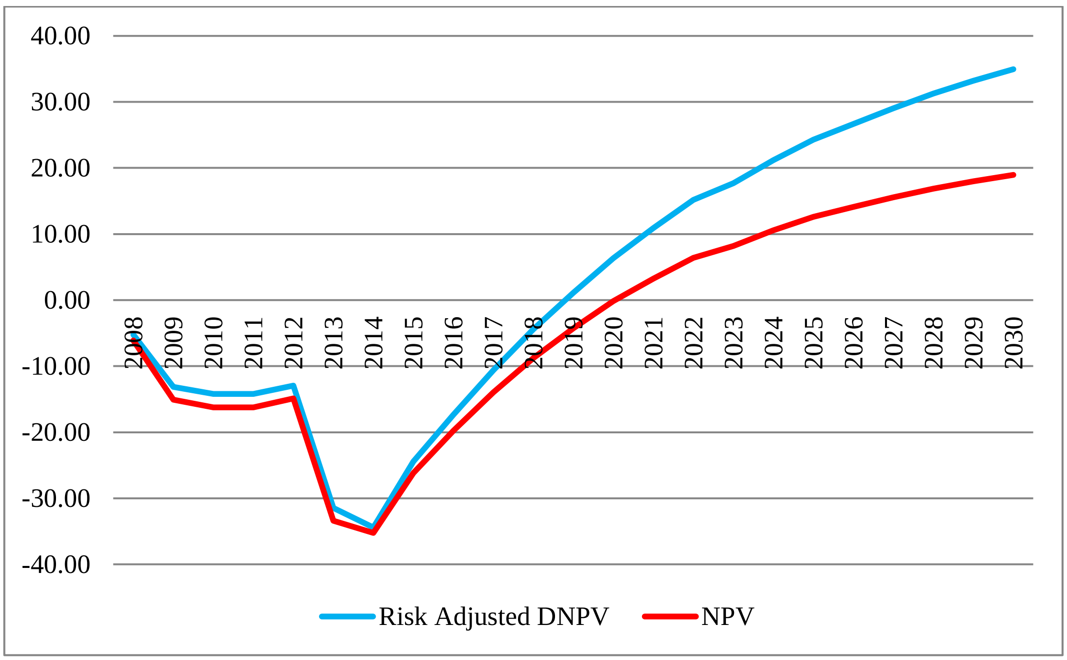
It can be recognized that the risk-adjusted parameters on the revenue side are very small. This illustrates that the predicted level of transport demand shown in the contract will not fluctuate in the future. One of the reasons that caused this tiny fluctuation is that the standard deviation is very small at 2.75 percent. This means that the traffic levels in this route in recent years are stable. This, in deed, creates advantages for the government and the investors in forecasting demands. In fact, in the contract, it is assumed by investors that the increasing level of demand after 2015 is only 1 percent. From these risk-adjusted parameters, loss in the revenue and expenditure side can be shown using equation 6.28 and 6.29, from that the return analysis can be found. Table 10.15 shows the return analysis by NPV and Risk-adjusted DNPV.

Table 10. 15 Return analysis by NPV and Risk Adjusted DNPV

Year	Revenue	Expenditure					Income	$\bar{\eta}_{v}$	$\bar{\eta}_{Im}$ (for Maintenance)	$\bar{\eta}_{Icon}$ (for Construction period)	$\bar{\tilde{\bar{R}}}_{It}$	$\bar{\tilde{\bar{R}}}_{It}$	NPV	Risk adjusted DNPV
		Investment	Tax	Management	Maintenance	Total								
2008		3.42	0.00			3.42	-3.42						-6.13	-5.24
2009	1.823	6.91	0.15	0.20		7.25	-5.61						-15.06	-13.13
2010	1.950	2.24	0.17	0.21	0.03	2.65	-0.83						-16.24	-14.20
2011	1.973	1.47	0.18	0.25	0.04	1.93	0.02						-16.22	-14.18
2012	2.286	0.46	0.18	0.27	0.04	0.96	1.16						-14.87	-12.92
2013	8.466	20.25	0.21	0.29	0.16	20.91	-18.51						-33.38	-31.43
2014	11.739	15.96	0.77	1.03	0.24	18.00	-2.10	0	0.0430	0.071	0.00	1.14	-35.22	-34.40
2015	11.901		1.07	1.89	0.04	3.00	11.86	0	0.0430		0.00	0.01	-26.16	-24.41
2016	12.066		1.08	2.04	0.04	3.17	9.16	0	0.0430		0.00	0.01	-19.77	-17.33
2017	12.232		1.10	2.20	0.22	3.52	9.44	0	0.0430		0.00	0.00	-13.94	-10.61
2018	12.401		1.11	2.38	0.05	3.55	9.47	0	0.0430		0.00	0.00	-8.75	-4.43
2019	12.572		1.13	2.57	0.35	4.04	9.26	0	0.0430		0.00	0.01	-4.26	1.12
2020	12.585		1.14	2.78	0.06	3.98	9.51	0	0.0430		0.00	0.00	-0.17	6.35
2021	12.597		1.14	3.00	2.20	6.34	9.00	0	0.0711		0.00	0.03	3.26	10.88
2022	12.610		1.15	3.24	0.07	4.46	9.21	0	0.0430		0.00	0.00	3.26	15.16
2023	12.622		1.15	3.50	0.08	4.72	6.08	0	0.0430		0.00	0.13	6.38	17.69
2024	12.635		1.15	3.78	0.98	5.91	8.87	0	0.0711		0.00	0.01	8.20	21.16
2025	12.648		1.15	4.08	0.41	5.64	8.67	0	0.0430		0.00	0.00	10.56	24.27
2026	12.660		1.15	4.41	0.10	5.65	7.32	0	0.0430		0.00	0.05	12.60	26.67
2027	12.673		1.15	4.76	0.10	6.01	7.78	0	0.0430		0.00	0.02	14.13	29.02
2028	12.686		1.15	5.14	0.06	6.36	7.96	0	0.0430		0.00	0.01	15.57	31.24
2029	12.698		1.15	5.55	1.18	7.88	7.76	0	0.0430		0.00	0.00	16.87	33.22
2030	12.698		1.15	6.00	0.13	7.28	7.40	0	0.0430		0.00	0.01	18.00	34.96

Table 10.15 and figure 10.11show that the project is profitable in both evaluations. However, the evaluation by the Risk-Adjusted DNPV is always higher than the evaluation by NPV. It can be seen in NPV evaluation that the project will start to make a profit in the year 2020, while the Risk-Adjusted DNPV shows that the project can make a profit beginning in 2019. It should be noted that the investors have collected tolls since 2009 from Song Phan toll station. The government has shown initiative support for the investors. Therefore, in NPV evaluation project becomes profitable after 12 years while, in with the Risk Adjusted DNPV it becomes profitable after 11 years.

Figure 10. 11 Trends of NPV and risk adjusted DNPV



Because the project is profitable in the Risk-adjusted DNPV, concession parameters can be optimized. The section below shows how concession parameters (concession period and return in concession period) can be optimized.

10.4.2. Optimization of Concession Parameters

Similarly to case 2, the expected return from the investor (IcR), depreciation cost of the project ($\widetilde{Dt}$), and net asset value of the project (NAV_{TC}) need to be determined. From the contract, it can be determined that the expected rate of return for investors(R) is 15 percent.

Using this number together with the forecasted expenditure, the expected return each year can be determined.

Similarly, in this project, it is assumed that the economic life of the project is 50 years. Assume that at the last 10 years of the economic life the traffic demand decreases because of the new roads. By using assumptions about fluctuation rates of the traffic level mentioned from the contract agreement, which is 1 percent each year, the revenue from 2038 to 2057 can be forecasted. Table 10.16 shows the revenue of the project until the end of its economic life without increasing its toll price.

Table 10. 16 Revenue of the project through its economic life without increasing in toll price (mil. pounds)

Year	Revenue	Year	Revenue	Year	Revenue
2014	7.83	2029	8.47	2044	8.31
2015	7.93	2030	8.47	2045	8.23
2016	8.04	2031	8.47	2046	8.15
2017	8.15	2032	8.47	2047	8.06
2018	8.27	2033	8.47	2048	7.98
2019	8.38	2034	8.47	2049	7.90
2020	8.39	2035	8.47	2050	7.83
2021	8.40	2036	8.47	2051	7.75
2022	8.41	2037	8.47	2052	7.67
2023	8.41	2038	8.47	2053	7.59
2024	8.42	2039	8.56	2054	7.52
2025	8.43	2040	8.65	2055	7.44
2026	8.44	2041	8.57	2056	7.37
2027	8.45	2042	8.48	2057	7.29
2028	8.46	2043	8.40		

Using table 10.16 and equations 6.34, 6.66 and 6.37, $\widetilde{D}_t$ and the Net Asset Value (NAV_{TC}) can be found. From these values, concession parameters can be determined. Table 10.17 shows the details of the return analysis that is used to optimize concession parameters. It should be noted that the Risk-adjusted DNPV $^{(1)}$ is obtained from the return analysis part, and DNPV $^{(2)}$ is the opposite of DNPV $^{(1)}$. In other words, DNPV $^{(2)}$ is cumulative from the year 30^{th} to the 1^{st} year.

Table 10. 17 Return analysis to optimize concession parameters

Year	Revenue	Expenditure	Income	DNPV[1]	IcR	$\widetilde{D}_t$	NAV	DNPV[2]
2008		3.42	-3.42	-5.24	0.514			
2009	1.647	7.25	-5.61	-13.13	1.601			
2010	1.820	2.65	-0.83	-14.20	2.000			
2011	1.950	1.93	0.02	-14.18	2.289			
2012	2.127	0.97	1.16	-12.92	2.435			
2013	2.286	20.91	-18.63	-31.55	5.572			
2014	16.93	19.22	-2.29	-34.70	8.46	1.79	48.86	66.58
2015	14.67	2.63	12.04	-24.55	8.85	1.55	43.57	69.73
2016	11.90	2.49	9.41	-17.27	9.22	1.26	39.03	59.58
2017	12.07	2.79	9.28	-10.67	9.64	1.27	34.94	52.29
2018	12.23	2.75	9.48	-4.48	10.05	1.29	31.24	45.70
2019	12.40	3.19	9.22	1.03	10.53	1.31	27.90	39.51
2020	12.57	3.06	9.52	6.27	10.99	1.33	24.89	34.00
2021	12.58	5.35	7.24	9.85	11.79	1.33	22.19	28.76
2022	12.60	3.38	9.22	14.13	12.30	1.33	19.76	25.18
2023	12.61	3.55	9.05	17.99	12.83	1.33	17.58	20.90
2024	12.62	4.65	7.98	21.08	13.53	1.33	15.62	17.04
2025	12.64	4.28	8.36	24.08	14.170	1.33	13.86	13.94
2026	12.65	4.18	8.46	26.87	14.80	1.33	12.29	10.95
2027	12.67	4.43	8.23	29.37	15.46	1.34	10.88	8.16
2028	12.67	4.64	8.03	31.60	16.16	1.34	9.62	5.66
2029	12.69	6.03	6.66	33.29	17.06	1.34	8.49	3.43
2030	12.70	5.29	7.41	35.03	17.86	1.34	7.48	1.74

Using table 10.17 and equations 6.29 and 6.32, the concession period for New Dong Nai Bridge can be found. In order for investors to obtain the expected return, the equation 6.29 must be satisfied. From table 10.17 it can be seen that DNPV [1] starts to be higher than IcR in the year 2022. Thus, from 2022 the equation 6.29 will be satisfied. It can also be recognized that the difference between the DNPV [1] and IcR becomes bigger from 2022 to 2030. This means that from 2022 to 2030, the longer the concession period is, the higher return investors get. On the other hand equation 6.32, which is to protect the government's interest, can only be satisfied before the year 2026. It can be observed that if the project is transferred to the government at the beginning of 2025, the government will get a total of

13.94 million pounds while the NAV at that year is 13.83. Therefore, the interest of the government can be protected. Beginning in 2025, the DNPV (2) will decrease faster than the NAV because the income will decrease faster. For the investors, closer the transfer time is to 2030, the higher return the investors can achieve. In contrast, closer the transfer time is to 2030, the lower the benefit government will obtain. Table 10.18 shows the concession period determined by the Risk Adjusted DNPV to protect the interests of both sectors. It can be seen that in order to protect both of the sectors, the project should be transferred from 2022 to 2025.

Table 10. 18 Concession Period of New Dong Nai Bridge Project determined by Risk Adjusted DNPV

Evaluation Technique	To protect investors' interests	To project the government interests	Determined Concession Period
Risk Adjusted DNPV	From 2022 to 2030	Before 2026	From 2022 to 2025

Similarly to No 18 Uong Bi- Halong Project, in the scope of this research, only the interval of the concession period is concluded. The specific transfer time is left for negotiation between the two sectors. The difference between the concession period determined in this research, the one in the contract, and the one determined by other models will be discussed in chapter 11.

10.5. Summary

The return evaluation and optimization of the concession parameters are essential functions of the proposed framework. This chapter showed the findings of application of the Risk-Adjusted DNPV in evaluating the return and optimizing concession parameters. More specifically, Yen Lenh Bridge project, No 18 Uong Bi – Ha Long project, and New Dong Nai Bridge Project were applied. The findings show that Yen Lenh bridge project is not profitable, and it should not be implemented. Therefore, concession parameters for this project do not need to be optimized. On the other hand, No 18 Uong Bi – Ha Long project is beneficial in this evaluation. Evaluation shows that this project can make a profit beginning in 2029. It was also found that this project should be transferred to the government from 2032 to 2037, or in 2039. Furthermore, the evaluation also demonstrates that New Dong Nai Bridge is profitable, and investors can make a positive return beginning in 2019. For this project, the transfer time was determined to be from 2022 to 2026.

CHAPTER 11: DISCUSSION OF RESEARCH FINDINGS

11.1. Introduction

This chapter discusses the findings of this research shown in chapters 8, 9 and 10. These findings are discussed in relation to the hypotheses described in chapter 1 in order to show whether the hypotheses are proved or not. First, the findings from the risk identification function of the framework shown in chapter 8 will be discussed. Secondly, the results of the project's riskiness ranking by AHP are discussed. Thirdly, the use of AHP to allocate risks in Vietnamese PPP is discussed. Fourthly, the findings of project returns and the concession parameter's optimization using the Risk-Adjusted DNPV are also discussed

11.2. Critical Risks in Vietnamese PPPs

11.2.1. Construction Risks

As mentioned previously in the literature review in chapter 3, research into the risks in PPPs does not usually focus on construction risks but rather on political risks. Previous research such as that of Thuyet *et al*. (2007) Xu *et al*. (2010), Xu *et al*. (2011), and Song *et al*. (2013) discovered that construction risks are not the most critical risks in PPPs. Similarly, in this research, it can be seen that there is only one construction risk, C7, in the top ten risks, and four construction risks at the bottom of the top 20 risks (C4, C3, C10, C8). In fact, this result supports some of the other research in the Vietnamese construction industry such as research by Toan and Ozawa (2008). However, it should be noted that although there is a small number of construction risks at the top of the risk ranking, as long as they are at the top of the table, they have a by far higher score in comparison to other risks. For example C7 in this research is the most critical risk with the highest score, and it also stands at the 4th position in research by Toan and Ozawa (2008) about Vietnamese BOTs.

According to the findings analysis, across the different groups of respondents (public sector and private sector), there were significant differences regarding the risk score of construction risks. As was shown in chapter 8, this disagreement can be seen in 6 out of 10 construction risks. This significant difference can be because of different points of view of each sector regarding the risks. More specifically, the results from the test show that Poor Design got the significant difference between groups as determined by Welch's F (1, 23.676) = 11.038, $p < 0.05$. Similarly, Low Quality Products also got the significant difference in risk scores (Welch's F (1, 22.468) = 22.677, $p < 0.05$). Findings also demonstrate that perception of two sectors are statistically significant different for the risk Low Site safety (Welch's F (1, 28.608) = 67.582, $p < 0.05$). The next risk which received the significant different result is Design Changes (Welch's F (1, 41.169) = 11.989, $p < 0.05$). Additionally, the risk Impractical Feasibility Study (Welch's F (1, 35.599) = 6.55, $p < 0.05$) is also considered as a risk that obtained the significantly different perception. The final risk in this risk group which was given the significant difference in result is the risk Impractical Requirements of Progress of Project (Welch's F (1, 39.764) = 65.112, $p < 0.05$).

The possible reasons for this difference were presented in chapter 8 together with the findings of the risks' identifications. This difference may suggest that identifying and observing risks are based on the role of each party involved in PPPs. Table 11.1 below shows the hypothesis result together with the research questions.

Table 11. 1 Research Questions about the Construction Risks and Hypothesis Test Result

Research question	Is there a significant difference between the public and private sector regarding the risk score of construction risks?
Hypothesis	*Ha_0 ($p>0.05$): There is no significant difference between the public and private sector regarding construction risks.*
Results	The results indicated that: There were significant differences between the public sector and private sector regarding the risk score of 6 construction risks, namely, C2. Poor design ($p < 0.05$). C3: Low Quality Products ($p < 0.05$). C4. Low Site safety ($p < 0.05$). C6. Design changes ($p < 0.05$). C8. Impractical feasibility study ($p < 0.05$). C9. Impractical requirements of progress of project ($p < 0.05$).
Researcher's observations	• Construction risks were identified from the literature review in chapter 3.

	• The public sector and private sector have different perceptions about the 6 mentioned risks. • The possible reason can be the difference in their responsibility in implementing a PPP. • In general, the private sector is more concerned about 6 these risks than the public sector, and one of the possible reasons is that the private sector is the party who bears most of these risks.
Conclusion	The null hypothesis Ha_0 was rejected for these risks.

11.2.2. Legal Risks

Legal risks in this research contain risks relating to legal and regulation issues. In fact, these risks can be seen as macro factors as they influence all sectors and seem to be external to the private investors. Legal risks are one of the main areas that researchers about PPPs often focus on (Tang *et al*. 2010). From the findings in chapter 8, it can be seen that there is only one legal risk in the top ten risks and three legal risks in the top 20 risks. The legal risk that got the highest risk score amongst the legal risks is L3 (Poor project approval and permit process). In fact, L3 also stands at the 2nd position in the general risk-ranking table. This finding supports research by Thuyet *et al*. (2007) and Toan and Ozawa (2008) about the Vietnamese construction industry as well as that of Yuan *et al*. (2008) and Xu *et al*. (2011) who conducted research about the China market.

The test shows that there were significant differences between the public and private sectors regarding 5 out of 6 legal risks. More specifically, the opinions of two sectors are significant difference for the risk Disapproval of Guarantees by the Government (Welch's F (1, 50.048) = 61.702, p <0.05). The second risk which obtained significant difference from the test is the risk Revision of the Contract Clauses (Welch's F (1, 33.782) = 24.307), p < 0.05). The third significant difference of perceptions of two sectors for this risk group comes from the risk Regulation Change (Welch's F (1, 79.835) = 71.813, p < 0.05). Similarly, opinions of two sectors are also significant different with regards to the risk Restriction on Tolls (Welch's F (1, 25.635) = 5.119, p < 0.05). The last significant difference was determined for the Taxation Risk (Welch's F (1, 26.121) = 39.455, p < 0.05).

The possible reasons for these differences were provided in chapter 8 in accordance with the results. Table 11.2 summarizes the research question about the legal risk group and hypothesis test.

Table 11. 2 Research question about Legal Risks and Hypothesis test result

Research question	Is there a significant difference between the public and private sectors regarding the risk score of legal risks?
Hypothesis	*Ha_0 ($p>0.05$): There is no significant difference between the public and private sector regarding legal risks.*
Results	The results indicated that: There were significant differences between the public sector and private sector regarding the risk scores of 5 legal risks, namely, L1. Disapproval of guarantees by the government ($p < 0.05$). L2. Revision of the contract clauses ($p < 0.05$). L4. Regulation Change ($p < 0.05$). L5: Restriction on Tolls ($p < 0.05$). L6. Taxation risks ($p < 0.05$).
Researcher's observations	The list of construction risks was identified from the literature review in chapter 3. • The public sector and private sector have different perception on 5 out of 6 mentioned risks. • In general, the private sector is more concerned about 5 of these risks than is the public sector.
Conclusion	The null hypothesis Ha_0 was rejected for these risks.

11.2.3. Market Risks

This group of risks contains 10 risks referring to the market situation which can have an influence on the financing plan of the project. It can be seen from the list of risks mentioned in chapter 4 that this risk group contains the risks both in the macro level and in the project level. Project level risks such as weak financial ability of the investors can be resolved by investors. However, risks such as Inflation Risk or Interest Exchange can only be resolved by the public sector. Moreover, for the risk of negative economic event, sometimes this risk is influenced by the world economic situation and in that case, it seems to be external to the host government.

In fact, the findings chapter shows that market risks are highly evaluated by respondents as there are 4 market risks that are in the top 10 risks and 7 market risks in the top 20 risks. This finding can assist some of other findings such as those by Zayed and Chang (2002) and Schaufelberger *et al*. (2003). In research by Zayed and Chang (2002), the market risk group is the second most critical group amongst 8 groups, while Schaufelberger *et al*. (2003) stated that the majority of projects observed in their research had high market risks. In fact, research in the developed market such as that of Akintoye *et al*. (2003a) suggests that the market risks can directly lead to the high cost of PFI projects.

Findings from the test indicate that the perceptions of two sectors are significantly different regarding to the risk Weak Financial Capacity of Investor (Welch's F (1, 21.153) = 6.596, $p < 0.05$). The second risk in this group which received the significant difference is the Inflation Risk (Welch's F (1, 95.569) = 17.421, $p < 0.05$). Significant difference was also found in the risk Difficulty in Accessing Finance from the Banks (Welch's F (1, 30.914) = 178.780, $p < 0.05$). The public and the private sector also illustrated that their perceptions are significantly different with regards to the risk Poor Financial Market (Welch's F (1, 27.162) = 37.429, $p < 0.05$). The next significant difference comes from the risk Foreign Currency Exchange Fluctuation (Welch's F (1, 32.731) = 44.796, $p < 0.05$). Similarly, statistics also demonstrate that significant difference also can be found in the statistics for the risk Poor Financial Market (Welch's F (1, 27.162) = 37.429, $p < 0.05$). The last risk in this group that result shows the significant difference is the risk Income Streams are usually in Local Currency (Welch's F (1, 32.021) = 179.322, $p < 0.05$). Possible reasons for these differences can be found in chapter 8 in accordance with the results. Table 11.3 shows the research question about market risks and the hypothesis test.

Table 11. 3 Research question about market risks and hypothesis test

Research question	Is there a significant difference between the public and private sectors regarding the risk score of market risks?
Hypothesis	*Ha_0 ($p>0.05$): There is no significant difference between the public and private sectors regarding market risks.*

Results	The results indicated that: There were significant differences between the public sector and private sector regarding the risk score of 6 out of 10 market risks, namely, M2: Weak Financial Capacity of Investor ($p < 0.05$). M3. Difficulty in accessing finance from the banks ($p < 0.05$). M4. Inflation risk ($p < 0.05$). M6. Foreign currency exchange fluctuation ($p < 0.05$). M8. Poor financial market ($p < 0.05$). M9. Income streams are usually in local currency ($p < 0.05$).
Researcher's observations	The list of market risks was identified from the literature review in chapter 3 • The public sector and private sector have different perceptions on 6 out of 10 mentioned risks • In general, the public sector is more concerned about 6 of these risks than is the private sector.
Conclusion	The null hypothesis Ha_0 was rejected for these risks.

11.2.4. Operational Risks

This risk group has 5 risks referring to difficulties that investors can have during the operational stage of the project. From the findings in chapter 8 it can be seen that there are only two risks, namely O4 (High maintenance cost) and O5 (Fluctuation of demand stand) in the top ten group. Other risks in the Operational risk group have low scores and stand at the bottom of the general risk ranking table. This seems to be consistent with the general situation of PPPs as the World Bank (2015) also mentions that the traffic volume risk is one of the greatest challenges in PPP highway projects in many countries. In addition, the finding of the current research can also be supported by some research in developing markets such as that of Jung (2011) and Lee (2011). In fact, while others may have influence on the expenditure or indirect influence on the income of the project, O4 and O5 can have a direct influence on the income of any PPP.

Findings indicate that there are significant differences between perceptions of two sectors with regards to 4 risks in this risk group. More specifically, the first risk which obtains the significant difference is the risk Operation Cost Overrun (Welch's $F(1, 91.316) = 206.584$, $p < 0.05$). The second risk in this group is the risk Default of Operator (Welch's F (1, 67.852) = 136.005, p < 0.05). Two sectors also gave significant different opinion to the risk Low Quality of Operation (Welch's F (1, 32.013) = 11.143, p < 0.05). The last risk which is considered as receiving different perception from the public and the private sector is Fluctuation of Demand (Welch's F (1, 60.842) = 15.223, p < 0.05). Reasons for these differences are discussed in chapter 8 in accordance with the finding. Table 11.4 below shows the research question about operational risks and the hypothesis test.

Table 11. 4 Research question about operational risks and hypothesis test

Research question	Is there a significant difference between the public and private sectors regarding the risk score of operational risks?
Hypothesis	*Ha_0 (p>0.05): There is no significant difference between the public and private sectors regarding operational risks.*
Results	The results indicated that: There were significant differences between the public sector and private sector regarding the risk score of 4 out of 5 operational risks, namely, O1. Operation cost overrun (p < 0.05). O2 Default of operator (p < 0.05). O3. Low Quality of operation (p < 0.05). O5. Fluctuation of demand (p < 0.05).
Researcher's observations	The list of market risks was identified from the literature review in chapter 3. • The public sector and private sector have different perception on 4 out of 5 mentioned risks. • In general, the private sector is much more concerned about 5 of these risks than is the public sector.
Conclusion	The null hypothesis Ha_0 was rejected for these risks.

11.2.5. Political Risks

This risk group has 7 risks which refer to the political situation of the host country. The findings indicate that only the corruption risk (P4) stands in the top ten risks, and there is one more risks P1 (Concession Termination by Government), in the top 20 risks. Other political risks have lower scores and stand at the bottom of the risk ranking level shown in the findings in chapter 8. This finding may suggest that Corruption is the only political risk that respondents are concerned about in Vietnamese PPPs. This finding can support previous research by such as Sachs *et al*. (2007) who found that in China, Bangladesh, Cambodia, India, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Taiwan, Thailand, and Vietnam that Corruption is the most critical risk amongst political risks. Indeed, the research by Toan and Ozawa (2008) also suggested this about Vietnamese BOT. In fact, this finding is also consistent for the Vietnamese Construction Market as Ling and Hoang (2010) and Thuyet *et al*. (2007) also found this in construction projects that were observed.

The significant difference test proves that there are 6 risks in this group which obtain significant difference scores from two sectors. More specifically, the opinion of two sectors are significant different regarding to the risk Concession Termination by Government (Welch's F (1, 32.833) = 57.682, $p < 0.05$). Similarly, the risk Political Opposition (Welch's F (1, 96.739) = 351.617, $p < 0.05$) also obtained the significantly different opinion from two sectors. The next risk that the opinions of two sectors are significant different is the risk Unstable Government (Welch's F (1, 37.227) = 83.695, $p < 0.05$). The statistics also point out that the risk Public Sector Default (Welch's F (1, 50.285) = 14.259, $p < 0.05$). Likewise, results presented that another significant difference comes from the risk Public Scepticism about the Real Benefits of PPP (Welch' F (1, 46.453) = 71.756, $p < 0.05$). The last risk in this group that achieved the significantly different result is Forced Buy out Risks (Welch's F (1, 34.405) = 163.824, $p < 0.05$). Table 11.5 below summarizes the hypothesis test for this risk group.

Table 11. 5 Research question about political risks and hypothesis test

Research question	Is there a significant difference between the public and private sectors regarding the risk score of political risks?
Hypothesis	*Ha_0 ($p>0.05$): There is no significant difference between the public and private sectors regarding political risks.*
Results	The results indicated that: There were significant differences between the public sector and private sector regarding the risk score of 6 out of 7 political risks, namely, P1. Concession Termination by Government ($p < 0.05$). P2. Political opposition ($p < 0.05$). P3. Unstable government ($p < 0.05$).

	P5: Public sector default ($p < 0.05$). P6. Public scepticism about the real benefits of PPP ($p < 0.05$). P7. Forced Buy out Risks ($p < 0.05$).
Researcher's observations	The list of political risks was identified from the literature review chapter 3. • The public sector and private sector have different perception on 6 out 7 mentioned risks. • In general, the private sector is much more concerned about 7of these risks than is the public sector.
Conclusion	The null hypothesis Ha_0 was rejected for these risks.

11.2.6. Relationship Risks

The relationship risk group contains 4 risks referring to the difficulties that both sectors can have in dealing with other parties. The findings show that only Re2. Inadequate experience in PPP of the Public sector stands in the top 20 critical risks. Other risks have low scores.

In fact, in previous studies about Vietnam such as those by Thuyet *et al*. (2007), Sachs *et al*. (2007), Toan and Ozawa (2008) and Ling and Hoang (2010), these relationship risks are not mentioned. However, the findings of the current research is that the public sector does not have enough experience in implementing PPP which can be found in some research in the emerging market such as that of Castalia Strategic Advisors (2007), Farquharson *et al*. (2011), and Mohammed (2012). In fact, there are many researches that categorize relationships into different areas which do not relate to the research into risks. These types of research have been done by Erridge and Greer (2002), Ysa (2007), Chan *et al*. (2003), Consoli (2006), Vazquez and Allen (2004), Henisz (2006) and El-Gohary *et al*. (2006). These researches focus on the factors that can facilitate or inhibit the relationship between sectors. Table 11.6 below shows the research question and hypothesis test for relationship risks.

Findings of the significant difference test show that there are only two risks that received significantly different results from the public and the private sectors. More specifically, the first risk to mention is the risk Inappropriate Distribution of Responsibilities and Risks (Welch's $F(1, 27.418) = 123.122$, $p < 0.05$). Similarly, Low-cooperation between

Different Partners also found significant different results (Welch's F (1, 46.584) = 16.227, $p < 0.05$). Table 11.6 summarizes the results of the test.

Table 11. 6 Research question about relationship risks and hypothesis test

Research question	Is there a significant difference between the public and private sectors regarding the risk score of relationship risks?
Hypothesis	*Ha_0 ($p>0.05$): There is no significant difference between the public and private sectors regarding relationship risks.*
Results	The results indicated that: There were significant differences between the public sector and private sector regarding the risk score of 2 out of 4 relationship risks, namely, Re3. Inappropriate distribution of responsibilities and risks ($p < 0.05$). Re4. Low-cooperation between different partners ($p < 0.05$).
Researcher's observations	The list of political risks was identified from the literature review in chapter 4. • The majority of risks in this group have a low risk score. • The public sector and private sector have different perceptions on only 2 out of 4 mentioned risks. • The public sector is more concerned about this risk than is the private sector.
Conclusion	The null hypothesis Ha_0 was rejected for these risks.

11.3. Project's Riskiness Evaluation and Risk Allocation by AHP

11.3.1. Project's Riskiness Evaluation

The discussion about the situation of cases was provided in section 9.2 of chapter 9 together with the statistical findings in order to make it easier for readers. Findings in this section also show that 57.45 percent of the practitioners agreed with the riskiness ranking of the projects, while 36.17 percent gave a neutral opinion, and the rest disagreed. These rates indicate that the majority of participants agreed that the evaluation using the AHP method can reflect the real situation. Together with in-depth qualitative analysis about real status of projects provided in chapter 9, these prove the hypothesis **H3** that project evaluation based on AHP can indicate the real situation of Vietnam at a reasonable level.

However, in the scope of this research, the reason that 36.17 percent of practitioners gave a neutral opinion and 6.38 percent disagreed was not explored. In addition, it should be noted that practitioners gave the opinion about the riskiness ranking with regard to all risk groups, not only to a single group.

It can be seen from section 9.1 in chapter 9 that the consistency level of input data in project evaluation is around 50 percent. In this evaluation, the number of options and the number criteria are all 5. In fact, this level of consistency is higher than some of the other simulations conducted in previous research. For example, in research by Li *et al*. (2013), random AHP simulation was carried out 45 times with the number of elements being 5 and the rate of consistency only 8.89 percent. One of the fundamental reasons is that the simulation in the research by Li *et al*. (2013) was made randomly, while in this research all participants have certain knowledge about PPPs, and about 5 cases chosen. In fact, Li and Zou (2011) suggested that by choosing participants who are experts in the field, with high relevant experience, and in the management team, the consistency of standard AHP can be improved. The level of consistency in standard AHP can also be improved if all respondents carefully compare alternatives (Cheng and Li, 2003; Banuelasy and Antonyz, 2004). In reality, the carefulness of respondents is highly likely to be higher as there is the pressure of responsibility. Therefore, it is expected that in the real situation in Vietnamese PPPs, the rate of consistency can be higher

11.3.2. Risk Allocation

The similarities and differences of the allocation strategies found by AHP, in comparison with findings from previous studies, are provided together with findings in section 9.3 of chapter 9 to make it easier for readers. The findings prove the hypothesis **H4** that AHP can be used to allocate risk with regards to selected criteria. In fact, previous studies only show the allocation strategy based on single criteria that “the risk should be transferred to the party which is best to manage it”. This criterion seems to be unclear, and it can make it difficult for experts to judge. However, in this study, the manageability of each option can be evaluated clearly based on selected criteria.

In terms of the consistency level of the pairwise comparison matrix, the findings in section 9.3 in chapter 9 show that the consistency level was around 70 percent. It can be seen that the consistency level is higher than that in the project evaluation section as the number of elements is only three. In fact, simulation from research by Li *et al*. (2013) finds that the consistency level is around 90 percent. As mentioned previously, the consistency level can be improved by choosing participants who are experts in the field, with high relevant experience, and who are in the management team.

11.4. Return Evaluation and Optimization of Concession Parameters by Risk-Adjusted DNPV

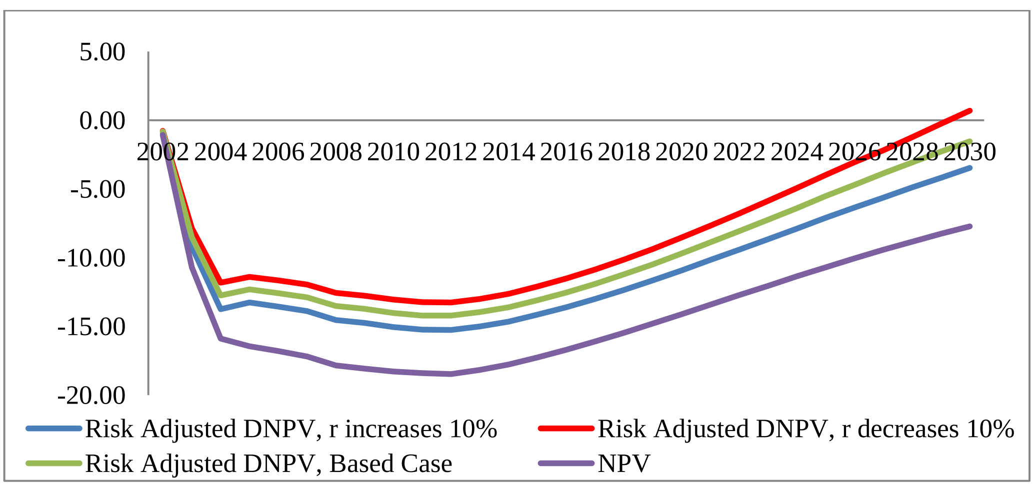
11.4.1. Return Evaluation

11.4.1.1. Risk-Adjusted DNPV in comparison with NPV

This section will discuss about the difference between evaluation by Risk Adjusted DNPV and NPV. Findings from three cases in chapter 10 are used.

Figure 11.1 compares the NPV evaluation with Risk adjusted DNPV in the based case and in three scenarios in which the risk-free rate increases and decreases by 10 percent in Yen Lenh Bridge Project. It should be noted that this is the re-calculated NPV shown in section 10.2.2 in chapter 10. Figure 11.1 shows that all evaluations show the negative values. In fact, this is one of the failed PPP projects in Vietnam. It can be seen that although the trend of the Risk adjusted DNPV and NPV are similar, NPV is lower than the Risk-Adjusted DNPV in all scenarios. This figure also shows that the Risk-Adjusted DNPV follows the opposite trend of the risk free rate.

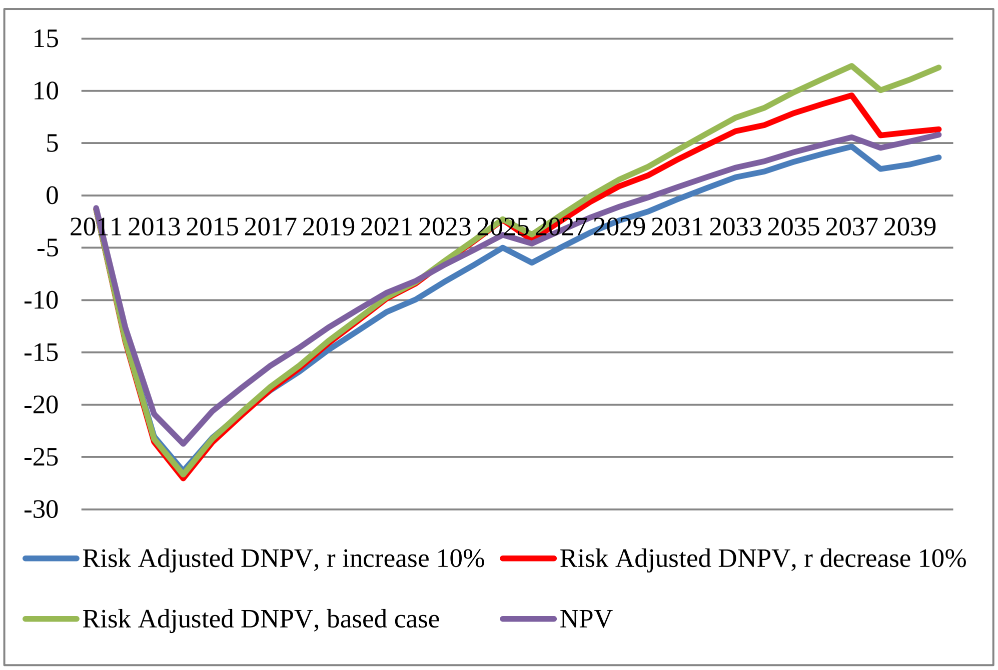
Figure 11. 1 NPV and Risk Adjusted DNPV in different risk free rates in Yen Lenh Bridge project



It can also be seen in this figure that the difference between the Risk-Adjusted DNPV and NPV becomes bigger when it comes closer to the end of the observed period. Although the data from 2002 to 2012 was audited, and this period was not added to the loss on the revenue side and on the expenditure side, the difference is still remarkable. This difference comes from the difference between the risk-free rate used in Risk-Adjusted DNPV and the risk discount rate (higher than the risk-free rate) used in NPV. This figure proves the hypothesis H5 that in the observed cases, projects are more beneficial in the Risk-Adjusted DNPV evaluation than in NPV evaluation.

In terms of No 18 Uong Bi-Ha Long Highway Project, Risk-adjusted DNPV in different scenarios of the risk-free rate is also compared to NPV state in the contract agreement. Figure 11.2 shows the comparison. Similarly to Yen Lenh Bridge Project, NPV is only higher than the Risk Adjusted DNPV if the risk-free rate increases 10 percent.

Figure 11. 2 NPV and Risk Adjusted DNPV in different risk free rates in No 18 Uong Bi-Ha Long highway project

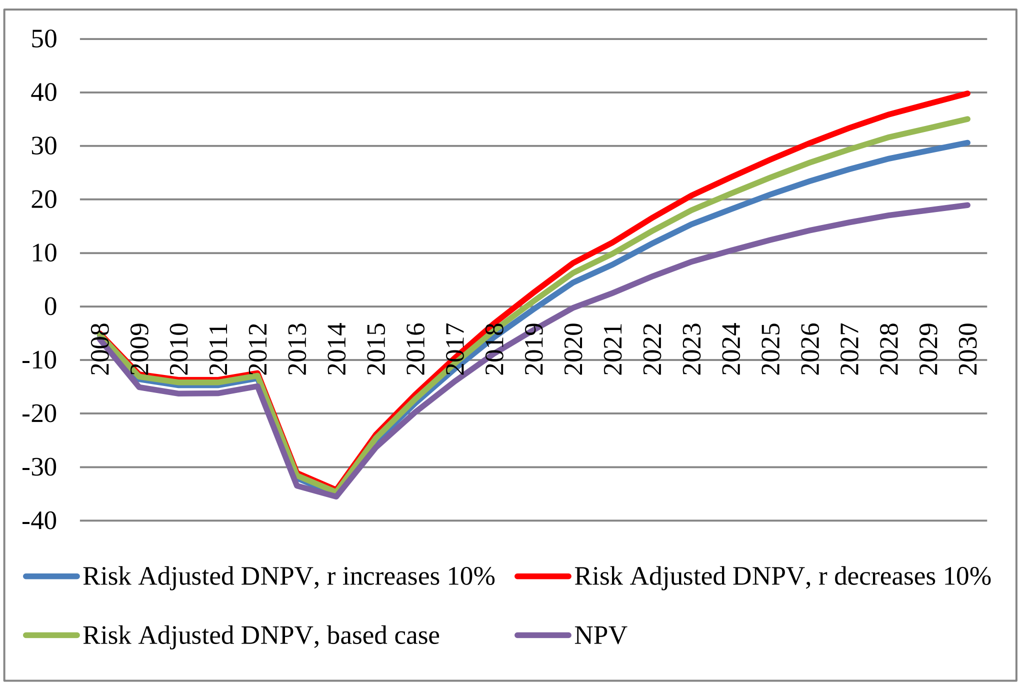


In fact, in the first 12 years, NPV is higher than all DNPV. However, after the 13th year, the Risk-Adjusted DNPV increases faster than NPV, except in the scenario where the risk-free rate increases by 10 percent. Remarkably, since the project makes a profit, the difference between the Risk-Adjusted DNPV and NPV becomes more significant.

According to the based case of the risk-Adjusted DNPV, at the end of the concession period, investors can obtain 12.23 million pounds while NPV shows that they will get only 5.8 million pounds. This again proves the hypothesis H5 that the project is more profitable in Risk-Adjusted DNPV evaluation.

Similarly, in New Dong Nai Bridge Project, NPV is lower than Risk-Adjusted DNPV in all scenarios. From 2008 to 2020, which is the time period the project does not make a profit, the difference between these evaluations is smaller, especially from 2008 to 2013. One of the reasons the difference between evaluations made during this period only comes from the difference between the risk-free rate and risk discount rate is because the data from 2008 to 2013 is audited. However, after 2013, the difference is also contributed by the loss on the revenue side and on the expenditure side that is calculated in the Risk-Adjusted DNPV. Again hypothesis H5 is supported by the New Dong Nai Bridge project.

Figure 11. 3 NPV and Risk Adjusted DNPV in different risk free rates in New Dong Nai Bridge project



In summary, in all cases 1, 2, 3, the Risk-Adjusted DNPV in the based case is always higher than the NPV, except on the scenario where the risk-free rate increases by 10 percent in No 18 Uong Bi Halong Project. However, it is important to note that if the risk-free rate increases, the risk discount rate also increases. As a result, the NPV will decrease. In the scope of this research the movement of NPV based on the movement of the risk-free rate is not modelled. Basically, the difference between the Risk-Adjusted DNPV and NPV comes from the difference between the risk-free rate and the risk discount rate, and from losses that were calculated. Therefore, if the difference made by the risk-free rate and the risk discount rate is smaller than the loss on the revenue and expenditure side, the Risk-Adjusted DNPV and NPV come closer to each other, and vice versa. These findings support previous criticism by academics that investors are obtaining excessive returns in PPP (NCHRP, 2009; House of Commons, 2011; National Audit Office, 2012; Vecchi *et al*. 2013).

11.4.1.2. Generalized trend of Risk adjusted DNPV

This section attempts to generalize the trend of the loss on the revenue side, the loss on the expenditure side, and the Risk-Adjusted DNPV for three cases. The generalized trend of NPV is also provided. This generalization is to observe whether these parameters in these projects can be predicted.

a. Yen Lenh Bridge

Figure 11.4 below shows the loss in the revenue side in Yen Lenh Bridge Project. It can be seen that the loss in the revenue side increases gradually, and this increase can be presented by the polynomial line with the equation: $0.0017x^2 - 0.0175x + 0.0366$ with $R^2 = 0.9743$. On the other hand, the loss on the expenditure side in Yen Lenh Bridge can be presented by an exponential line with the equation: $y = 0.052e^{0.0848x}$ with $R^2 = 0.9957$. It can be seen that both trend lines show a good fit with the data that was analyzed. These good fits indicate that since 2013, losses in Yen Lenh Bridge are more predictable.

Figure 11. 4 Trend lines for losses in Yen Lenh Bridge Project

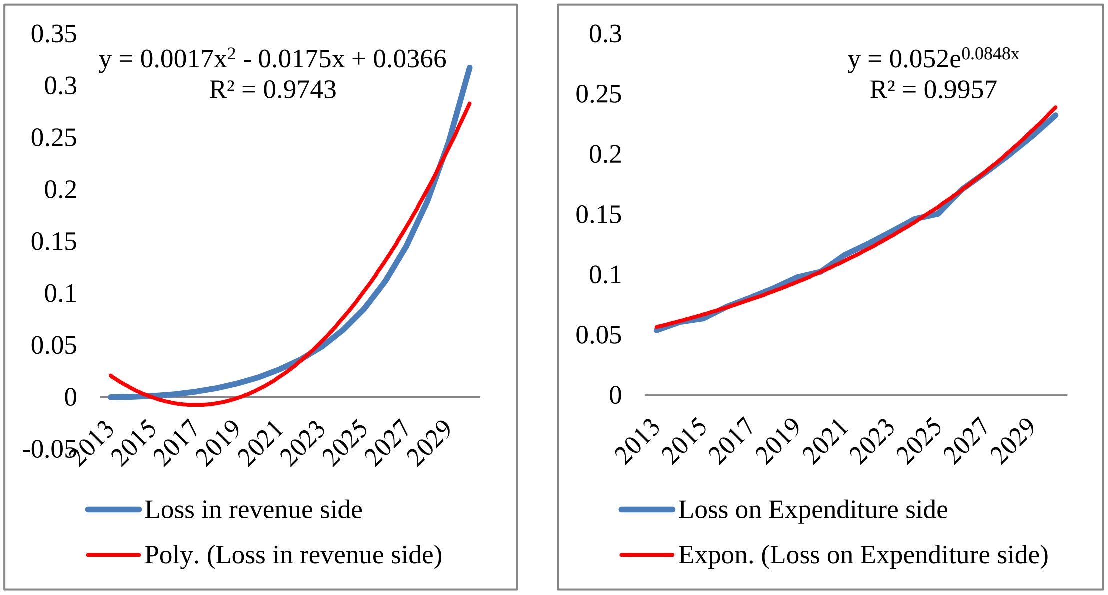
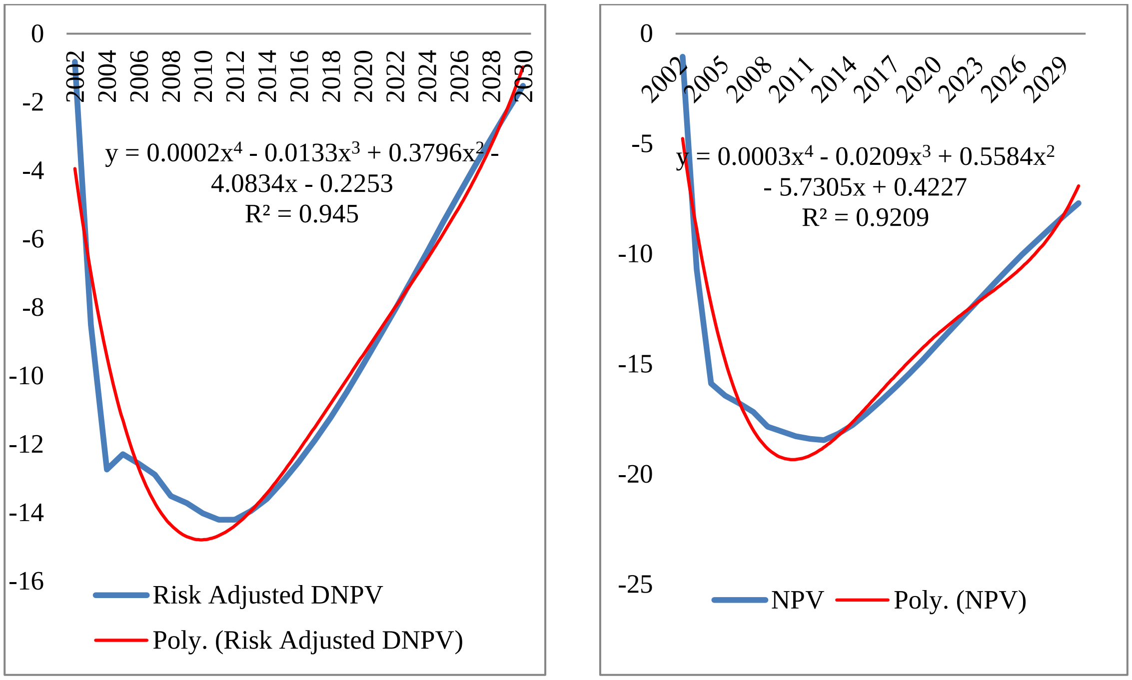


Figure 11.5 shows the Risk-Adjusted DNPV and NPV in this project with their fitted trend lines. It can be seen that the figures for Risk-Adjusted DNPV can be presented with the polynomial line by equation: $y = 0.0002x^4 - 0.0133x^3 + 0.3796x^2 - 4.0834x - 0.2253$ with $R^2 = 0.945$. On the other hand, figures for NPV can be presented by the line with the equation: $y = 0.0003x^4 - 0.0209x^3 + 0.5584x^2 - 5.7305x + 0.4227$ with $R^2 = 0.9209$. It can be observed from the figure that the lines show a better fit since the numbers increase after the year 2012, especially for Risk-Adjusted DNPV. One of the reasons is that the forecast for Risk-Adjusted DNPV is based on actual statistics from 2002 to 2012. Therefore, the actual movement of returns is taken into account in the Risk-Adjusted DNPV technique. Thus, there is a greater possibility to predict in Risk-Adjusted DNPV. In fact, the calculation was set at the year 2012. Therefore, this brings the advantage to investors to predict the future returns from 2012.

Figure 11. 5 Trend Lines for Risk Adjusted DNPV and NPV in Yen Lenh Bridge Project



b. No 18 Uong Bi – Ha Long Project

Figure 11. 6 Trend Lines for Loss in No 18 Uong Bi – Ha Long Project

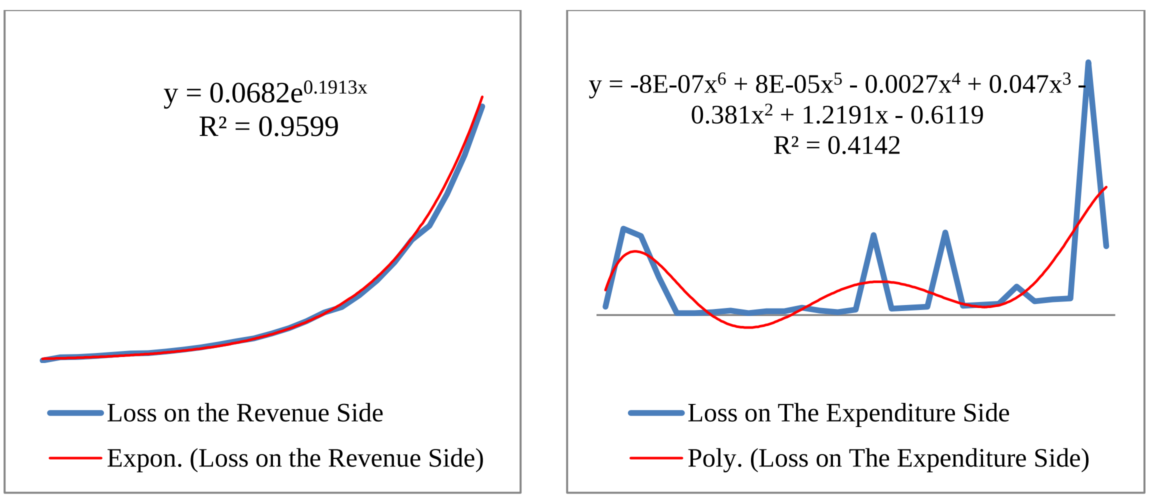
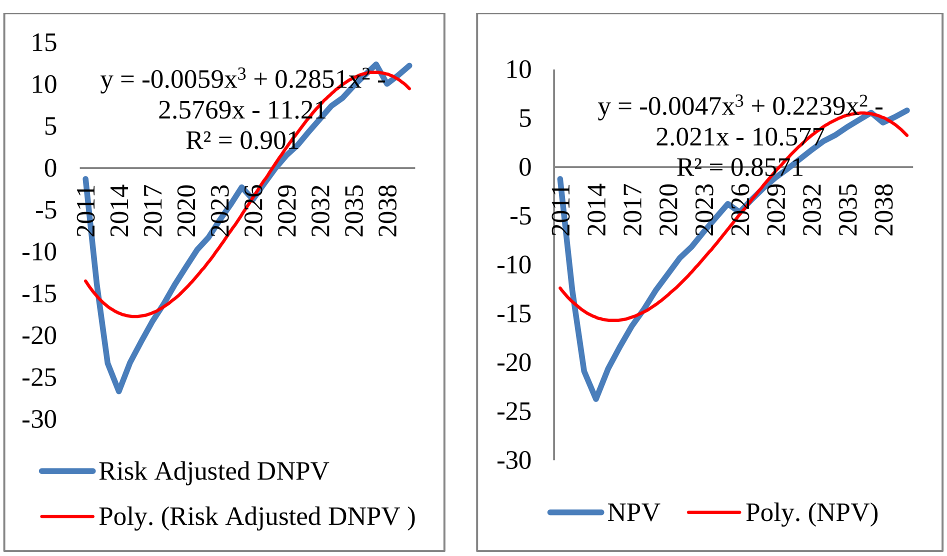


Figure 11.6 shows the loss on the revenue side, and on the expenditure side in the No 18 Uong Bi – Ha Long highway project. In terms of loss on the revenue side, the figure also shows the estimated curve generated from the data. It can be seen that the loss on the revenue side is fitted into an exponential trend line described by the equation: y =

$0.0682e^{0.1913x}$, the curve follows the general trend of the loss on the revenue side with a good fit. It can be seen from the figure 11. 6 that there is a small difference between two lines, however, with the $R^2 = 0.9599$, the curve is well-fitted to the data. From this estimated curve, investors can forecast the trend of the loss on the revenue side by using the exponential trend line. Differently, figures for the loss on the expenditure side do not really fit to an estimated curve. The curve that fits the data the most is the polynomial line described by the equation: $8E\text{-}07x^6 + 8E\text{-}05x^5 - 0.0027x^4 + 0.047x^3 - 0.381x^2 + 1.2191x - 0.6119$. However, it fits $R^2 = 0.4142$ only. It means there are many time points in which the data is very different from the estimated curve.

In terms of the Risk-Adjusted DNPV, and NPV, figure 11.7 shows the Risk-adjusted DNPV and NPV of the No 18 Uong Bi Ha Long highway project with different estimated curves. It can be seen that that the polynomial trend line is the most fitted line, and this line can be described by the equation: $y = -0.0059x^3 + 0.2851x^2 - 2.5769x - 11.21$ with $R^2 = 0.901$ for Risk Adjusted DNPV. On the other hand, NPV can be presented by the line with the equation: $y = -0.0047x^3 + 0.2239x^2 - 2.021x - 10.577$ with $R^2 = 0.8571$. Statistics show that the Risk-Adjusted DNPV is more fitted to the line than is NPV. It can be suggested from this figure that the returns from 2017 to 2038 are more predictable than returns in other years.

Figure 11. 7 Risk Adjusted DNPV and NPV in No 18 Uong Bi – Ha Long Project and estimated curves

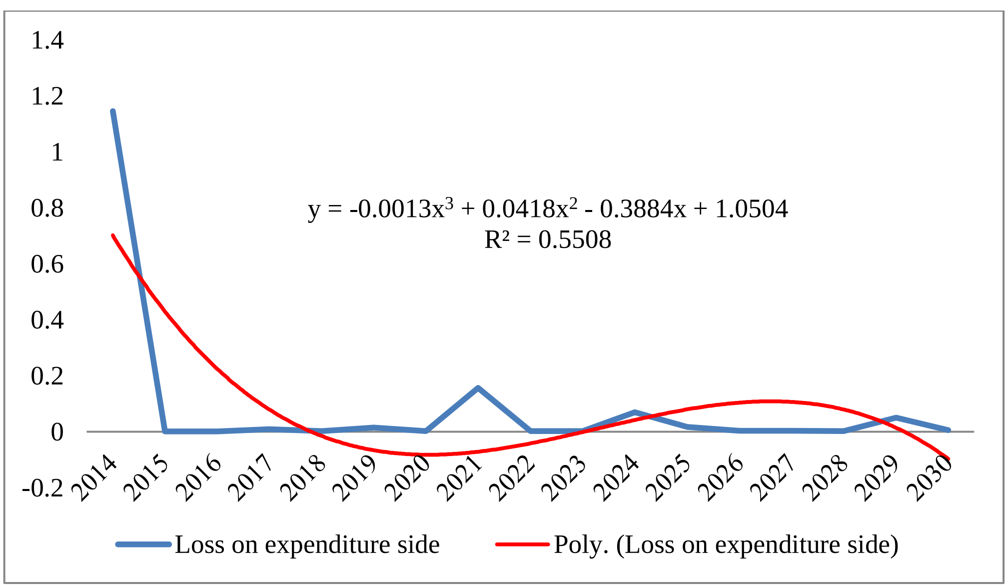


The general trend of the estimated curves follows the trend of the data of Risk-Adjusted DNPV and NPV. However, there are some points in which the estimated curve is far from the line of the Risk-Adjusted DNPV and NPV. For example, this is the case from 2011 to 2017. However, with the R^2 of 0.901 and of 0.8571 for the Risk Adjusted DNPV and NPV, respectively, these lines can be considered as good fitted lines showing reasonable prediction ability.

c. New Dong Nai Bridge Project

As can be seen from section 10.4 in chapter 10, the predicted loss on the revenue side for this project is too small. Therefore, only the loss on the expenditure side is generalised. Figure 11.8 shows that the data of the loss on the expenditure side for New Dong Nai Bridge project can be fitted to the polynomial line which can be described as $y = -0.0013x^3 + 0.0418x^2 - 0.3884x + 1.0504$. However, this is not a good fit as $R^2 = 0.5508$. After the dramatic drop in the first period, the numbers seem to be more stable, but it is still unpredictable.

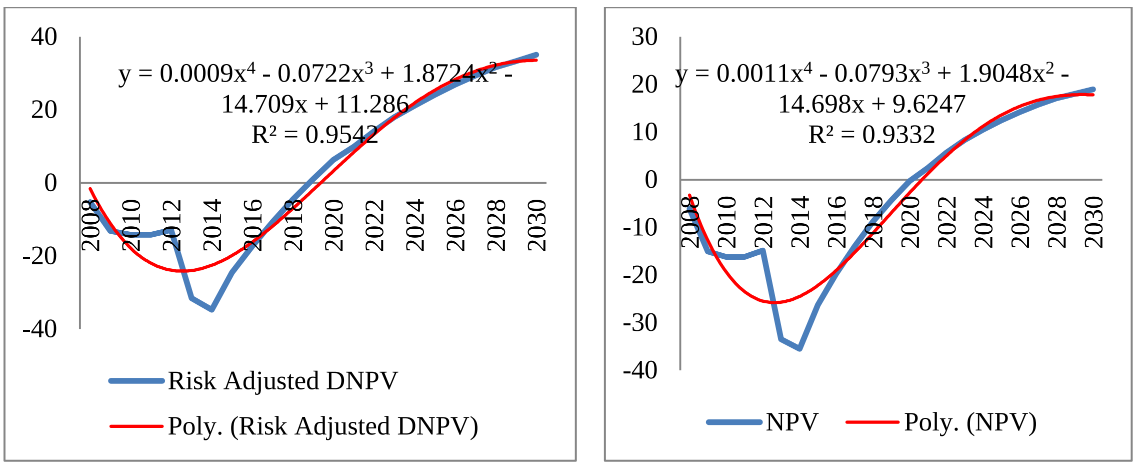
Figure 11. 8 Trend lines for Loss on the expenditure side in New Dong Nai Bridge project



In terms of the Risk-adjusted DNPV and NPV, similar to other cases, the Risk-adjusted DNPV and NPV of New Dong Nai Bridge can also be described by estimated curves.

Figure 11.9 shows the Risk-adjusted DNPV, and NPV of New Dong Nai Bridge with the most fitted curve. It can be recognized that the polynomial line is also the line that fits the data the most. The polynomial line for Risk-Adjusted DNPV can be described as $y = 0.0009x^4 - 0.0722x^3 + 1.8724x^2 - 14.709x + 11.286$ with $R^2 = 0.9542$, whereas, the trend of NPV can be described by the equation: $y = 0.0011x^4 - 0.0793x^3 + 1.9048x^2 - 14.698x + 9.6247$ with $R^2 = 0.9332$. In general, the line for Risk-Adjusted DNPV looks to be more fitted.

Figure 11. 9 Risk adjusted DNPV, and NPV in New Dong Nai Bridge Project and estimated curves



In this project, returns in both evaluations can be more predictable from 2016. It can be seen in both evaluations that the red lines are closer to the green lines during this time, whereas, for other years, especially from 2011 to 2014, the difference becomes more significant. The project is expected to collect tolls from 2015, and it can be recognized that in the future returns are more foreseeable for this project.

11.4.2. Concession Parameters

This section will discuss the concession period found from the Risk-Adjusted DNPV models, namely the BOTCcM Model and BOTCcM Net Asset value Model (described in chapter 5) in comparison with the actual concession period agreed upon in the contract agreement. In addition, the concession period found from other NPV-based models will be also discussed. As mentioned in chapter 10, the concession period is only optimized for No 18 Uong Bi-Ha Long Project and New Dong Nai Bridge Project.

Table 11.7 shows the comparison of concession parameters determined by the Risk-Adjusted DNPV and NPV in No 18 Uong Bi-Ha Long Project, while table 11.8 compares different concession periods concluded from Risk Adjusted DNPV models and other NPV based models.

Table 11. 7 Comparison of Concession parameters in Risk-Adjusted DNPV and NP V in No 18 Uong Bi-Ha Long Project

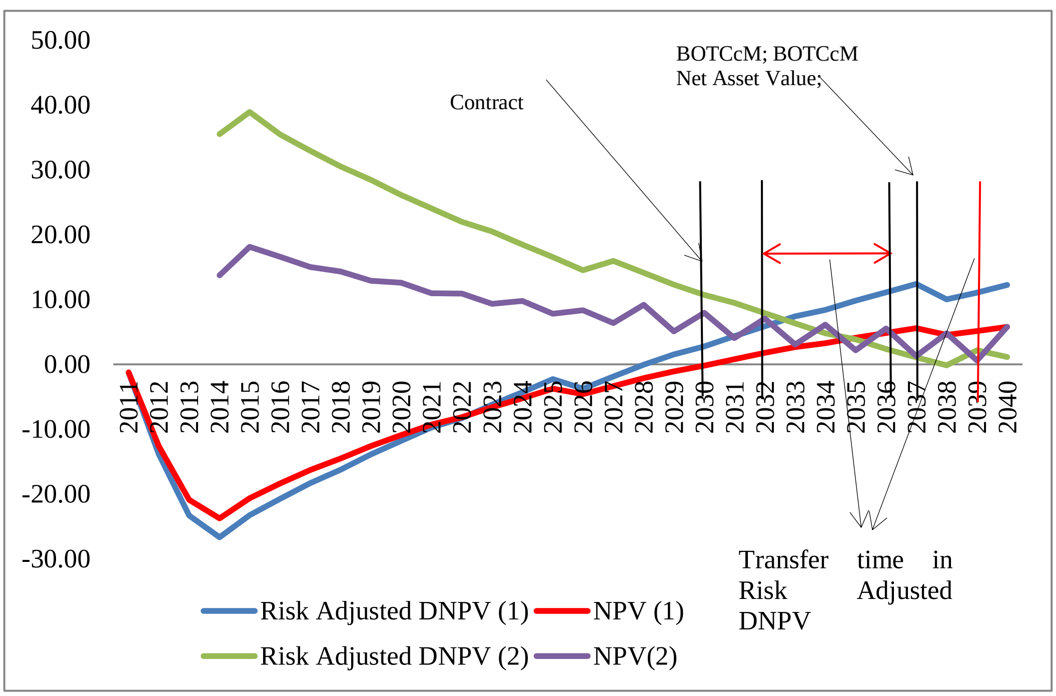
Year	DNPV(1)	NPV(1)	IcR	NAV_{Tc} for Risk adjusted DNPV model	NAV_{Tc} for NPV based models	DNPV (2)	NPV (2)
2011	-1.31	-1.21	0.19				
2012	-13.84	-12.59	1.90				
2013	-23.30	-20.90	3.21				
2014	-26.68	-23.74	3.74	23.30	21.60	35.52	26.69
2015	-23.26	-20.63	3.76	21.22	19.18	38.91	29.54
2016	-20.73	-18.39	3.81	19.16	16.89	35.48	26.43
2017	-18.30	-16.28	3.86	17.33	14.89	32.95	24.18
2018	-16.24	-14.53	3.96	15.66	13.12	30.53	22.08
2019	-13.89	-12.60	4.02	14.13	11.55	28.47	20.33
2020	-11.81	-10.92	4.06	12.74	10.15	26.12	18.39
2021	-9.74	-9.29	4.10	11.49	8.93	24.04	16.72
2022	-8.28	-8.16	4.22	10.35	7.84	21.96	15.09
2023	-6.23	-6.62	4.25	9.31	6.88	20.51	13.95
2024	-4.30	-5.21	4.30	8.37	6.03	18.46	12.42
2025	-2.28	-3.77	4.34	7.50	5.27	16.52	11.01
2026	-3.74	-4.60	4.81	6.71	4.60	14.50	9.56
2027	-1.88	-3.33	4.84	6.00	4.01	15.97	10.40
2028	-0.05	-2.11	4.88	5.35	3.48	14.11	9.13
2029	1.53	-1.08	4.94	4.76	3.02	12.28	7.91
2030	2.76	-0.19	5.04	4.23	2.62	10.70	6.87
2031	4.35	0.80	5.08	3.74	2.25	9.46	5.99
2032	5.90	1.75	5.11	3.30	1.94	7.88	4.99

2033	7.42	2.67	5.14	2.91	1.67	6.33	4.04
2034	8.38	3.27	5.24	2.55	1.42	4.80	3.12
2035	9.84	4.11	5.27	2.22	1.21	3.84	2.53
2036	11.12	4.85	5.30	1.92	1.02	2.39	1.68
2037	12.38	5.56	5.33	1.66	0.86	1.10	0.94
2038	10.05	4.56	5.81	1.42	0.72	-0.15	0.24
2039	11.07	5.16	5.86	1.21	0.596	2.18	1.24
2040	12.23	5.80	5.88	1.04	0.499	1.15	0.64

Table 11. 8 Concession periods for No 18 Uong Bi-Ha Long Project based on different models

Model	To Project Investors' Interests	To Project Public clients' Interests	Transfer time
Contract Agreement	2030	Not mentioned	2030
BOTCcM	2037	Not mentioned	2037
BOTCcM Net Asset Value	2037	Any Year Except 2038	2037
From 2032 to 2040	From 2032 to 2040	Any year, except, 2037 2038	From 2032 to 2036, or 2039

Figure 11. 10 Transfer Time in different models for No 18 Uong Bi – Ha Long Project



In the contract agreement, the project will be transferred to the government on 05/10/2030. More specifically, it shows that the contract agreement cannot protect the interests of any sector in any models. In order to protect both sectors' interests, the BOTCcM model and BOTCcM Net Asset Value model say that the project should be transferred to the government in 2037. Nevertheless, according to risk-adjusted DNPV in this research, the project should be transferred to the government from 2032 to 2036, or in 2039. The figure shows that if the project is transferred to the government in 2037 the profit obtained by the investor is high (see the Risk-Adjusted DNPV $^{(1)}$ and NPV $^{(1)}$ lines) as there is a peak in this year. However, as shown in the Risk-Adjusted DNPV $^{(2)}$ and NPV $^{(2)}$ lines, the benefit the government can get in this year is very small. Risk Adjusted DNPV gives both sectors more options which can balance their interests.

Table 11.9 shows the comparison of concession parameters determined by the Risk-Adjusted DNPV and NPV in New Dong Nai Bridge Project, and different concession periods are shown in table 11.10. Figure 11.11 show the graphical representation of the concession period in different models.

Table 11. 9 Comparison of Concession parameters in Risk Adjusted DNPV and NPV in New Dong Nai Bridge Project

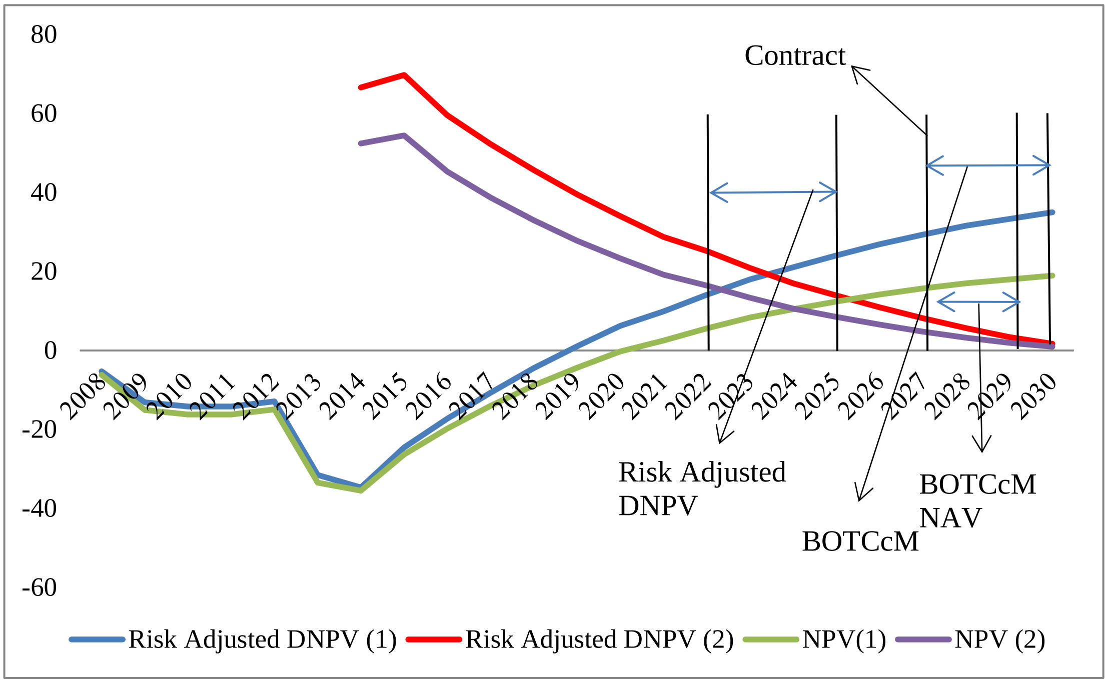
Year	$NPV^{(1)}$	$DNPV^{(1)}$	IcR	NAV_{Tc} for risk adjusted DNPV	NAV_{Tc} for NPV models	$NPV^{(2)}$	$DNPV^{(2)}$
2008	-6.13	-5.24	0.514				
2009	-15.06	-13.13	1.601				
2010	-16.24	-14.20	2.000				
2011	-16.22	-14.18	2.289				
2012	-14.88	-12.92	2.435				
2013	-33.50	-31.55	5.572				
2014	-35.50	-34.70	8.455	48.864	42.713	52.463	66.58
2015	-26.30	-24.55	8.850	43.566	33.289	54.463	69.73
2016	-19.75	-17.27	9.223	39.034	27.194	45.263	59.58

2017	-14.01	-10.67	9.641	34.939	21.578	38.704	52.29
2018	-8.82	-4.48	10.053	31.241	17.104	32.973	45.70
2019	-4.35	1.03	10.531	27.904	13.543	27.782	39.51
2020	-0.25	6.27	10.990	24.894	10.711	23.309	34.00
2021	2.51	9.85	11.791	22.188	8.463	19.214	28.76
2022	5.62	14.13	12.298	19.758	6.681	16.454	25.18
2023	8.34	17.99	12.831	17.577	5.269	13.335	20.90
2024	10.46	21.08	13.528	15.619	4.150	10.621	17.04
2025	12.43	24.08	14.170	13.864	3.266	8.502	13.94
2026	14.19	26.87	14.797	12.291	2.567	6.533	10.95
2027	15.72	29.37	15.462	10.881	2.014	4.766	8.15
2028	17.04	31.60	16.158	9.620	1.579	3.242	5.66
2029	18.00	33.29	17.063	8.492	1.235	1.924	3.43
2030	18.96	35.03	17.856	7.484	0.965	0.956	1.74

Table 11. 10 Concession periods for New Dong Nai Bridge based on different models

Model	To Project Investors' Interests	To Project Public clients' Interests	Transfer time
Contract Agreement	2027	Not mentioned	2027
BOTCcM	From 2027 to 2030	Not mentioned	From 2027 to 2030
BOTCcM Net Asset Value	From 2027 to 2030	Before 2030	From 2027 to 2029
Risk Adjusted DNPV	From 2022 to 2030	Before 2026	From 2022 to 2026

Figure 11. 11 Transfer Time in different models for New Dong Nai Bridge project



In the contract, it is agreed that the project will be transferred to the government in 2027. The BOTCcM model says that it should be transferred from 2027 to 230. However, according to the BOTCcM NAV model it should be transferred from 2027 to 2029. There is one year, 2027, which satisfies the contract and these models. However, the result of this research shows that the project should be transferred from 2022 to 2025. This is a more reasonable period as there are some points where both sectors can obtain equal returns. For example, in year 2033, the Risk-Adjusted DNPV (1) and Risk-Adjusted DNPV (2) cross each other, and this means both sectors receive equal returns. However, this specific transfer time also depends on negotiations. It is just suggested in this research.

11.4.3. Testing the accuracy of Risk-Adjusted DNPV and NPV

This section shows the accuracy test of the Risk-Adjusted DNPV in comparison with DNPV. Due to the availability of the actual financial report, the test will apply values of (a) the actual income of Yen Lenh Project in 2013, (b) the actual income of Yen Lenh Project in 2014, (c) Expenditure in No 18 Highway Project in 2011, (d) Expenditure in No 18 Highway Project in 2012, (e) Expenditure in No 18 Highway Project in 2013, (f) Expenditure in No 18 Highway Project in 2014, and (g) the actual construction cost of

New Dong Nai Bridge Project. In order to test this accuracy, the Root Means Squared Error, expressed by equation 7.7 and the Mean Absolute Percentage Error described by equation 7.8, and the Average Accuracy described by equation 7.9 were applied. Table 11.11 shows the data to use in the test, while table 11.12 summarizes the test results.

Table 11. 11 Actual data and Forecasted Data by Risk Adjusted DNPV and NPV

Items	Actual Values (mil. Pound)	Predicted by DNPV (mil. Pound)	Predicted by NPV (mil. Pound)
Income in Yen Lenh Project in 2013	0.24	0.28	0.29
Income in Yen Lenh Project in 2013 2014	0.38	0.43	0.39
Expenditure in No 18 Highway Project in 2011	1.36	1.50	1.40
Expenditure in No 18 Highway Project in 2012	8.81	14.71	15.44
Expenditure in No 18 Highway Project in 2013	13.46	13.50	15.92
Expenditure in No 18 Highway Project in 2014	22.38	8.68	8.76
Construction Cost in New Dong Nai Bridge	57.75	53.36	53.01

Table 11. 12 Summary of the testing result

Description	Risk Adjusted DNPV	NPV
Root Mean Squared Error	5.87	6.08
Mean Absolute Error (%)	24.91	27.25
Average Accuracy (%)	75.09	72.75

Table 11.12 shows that the Risk-adjusted DNPV made smaller error in evaluating projects. When 7 values were tested, Risk adjusted DNPV produced the error of 5.87 million pounds, while, NPV produced the error of 6.08 million pounds. In fact, it can be seen in table 11.11 that the high error comes from the actual expenditure for No 18 highway project in 2014. The actual cost for this year is 22.38 while the Risk-Adjusted DNPV estimated that it should be 8.68 and NPV estimated about 8.76. This massive increase in the actual cost results in high error value. In addition, the table also demonstrates that risk-adjusted DNPV obtains the average accuracy of 75.09 percent while the NPV only shows the result of 72.75 percent. These numbers improve the hypothesis H5 that Risk-Adjusted DNPV is more effective than NPV in evaluating the project returns, therefore it is also more effective in optimizing concession parameters.

11.5. Summary

This chapter discussed the findings shown in chapters 8, 9, and 10 with reflections on the research hypotheses. The purpose of the discussion was to show how the findings can prove the hypotheses, and therefore prove the robustness of the framework. The discussion shows that hypothesis H1 is proved by the findings illustrated in chapter 8. Hypotheses H2 and H3 about the applicability of the AHP model in this framework can be proved by the findings in chapter 9. This chapter also shows that H4 is proved statistically by the findings in chapter 10. Moreover, hypothesis H5 is also proved by findings in chapter 10 together with the statistical tests that were carried out. In addition, this chapter also showed the application of the framework in reality. The notifications for flexibly applying each function were also demonstrated.

CHAPTER 12: CONCLUSION, LIMITATIONS AND FUTURE WORKS

12.1. Introduction

In order to fulfil a need of the scientific and systematic approach to manage risks in PPPs in the transport sector in Vietnam, this research proposed a framework to effectively manage critical risks. The proposed framework was expected to be able to identify and assess critical risks. It also was designed to be able to evaluate the riskiness of the project and to allocate critical risks. In addition, the proposed framework was also designed to evaluate project returns and to determine the concession period. The proposed framework was tested by using real data from PPPs in the Vietnamese transport sector.

In this final chapter of the thesis, a summary of the research is provided. Firstly, findings are summarized. Secondly, the proofs of the hypotheses are demonstrated. Also, the contribution of the research is also highlighted. In addition, this chapter also shows the limitations of the research and the direction for future works.

12.2. Summary of findings

Before summarizing the findings of the research, it should be noted that, the findings are to prove the hypotheses about the proposed framework. Therefore, the final purpose of the research is to use the findings to prove the applicability of the proposed framework rather than only show the findings.

12.2.1. Risk identification and ranking by the proposed framework

The analysis of data shows that the ten most critical risks in PPPs in the transport sector in Vietnam are (C7) Difficulty in Land acquisition and Resettlement, (L3) Poor project approval and permit process, (M4) Inflation risk, (M7) Influence of negative economic events, (O4) High maintenance cost, (P4) Corruption, (O5) Fluctuation of demand, (Re2) Inadequate experience in PPP of Public sector, (M2) Weak Financial Capacity of Investor, and (M1) Lack of transparency (see chapter 8 for other risks' rankings). In addition, amongst the 44 risks that were identified, there are 32 risks where the public and the private sectors significantly differ in their perceptions.

12.2.2. Project's riskiness evaluation by the proposed framework

The analysis of the data showed that amongst the five projects selected, namely, Yen Lenh Bridge Project, Phu My Bridge Project, No 18 highway Uong Bi – Ha Long Project, Co Chien Bridge, and New Dong Nai Bridge, with regards to all selected risks, the most risky project was the Phy My Bridge project. The second most risky project was the Yen Lenh Bridge Project. New Dong Nai Bridge Project, Co Chien Project, and No 18 highway Uong Bi – Ha Long Project stand at 3rd, 4th, and 5th position, respectively. This riskiness ranking was agreed by 57.45 percent of participants, while 31.91 percent of them gave a neutral opinion.

12.2.3. Risk allocation strategies by the proposed framework

The findings in section 9.2.1 in chapter 9 showed that amongst the 10 selected risks to test the AHP allocation model, three risks, namely Low Quality Products (C3), High Maintenance Cost (O4) and Fluctuation of Demand (O5) are allocated to the private sector. Difficulty in Land acquisition and Resettlement (C8), Poor Project Approval and Permit Process (L3), and Inflation Risk (M4) are allocated to the public sector. In contrast, Corruption (P5), Weak Financial Capacity of Investor (M2), Inappropriate Distribution of Responsibilities and Risks (Re 3), and Non-cooperation between Different Partners (Re 4) where allocated to the private sector.

12.2.4. Project Returns Evaluation by the proposed framework

From the findings from chapter 10, it can be seen that the function of the return evaluation of the proposed framework was demonstrated in three cases, namely Yen Lenh Bridge Project, No 18 highway Uong Bi – Ha Long Project, and New Dong Nai Bridge.

In terms of Yen Lenh Bridge Project, the findings show that the project is not beneficial. In other words, the project should not have been conducted. Regarding the No 18 highway Uong Bi – Ha Long Project, the proposed framework shows that the project is beneficial and the return that the private sector can achieve at the end of the signed concession period is higher in the framework's evaluation than in the signed contract evaluation. Similarly in terms of New Dong Nai Bridge Project, analysis shows that the project is beneficial and the private sector can achieve a return at the end of the signed concession period that is higher in the framework's evaluation than in the signed contract evaluation. More details were provided in chapter 10.

12.2.5. Concession Period determined by the proposed framework

The concession period was determined for No 18 highway Uong Bi – Ha Long Project and New Dong Nai Bridge Project. The findings in chapter 10 show that for No 18 highway Uong Bi – Ha Long Project, the concession period should be ended between the years of 2032 and 2036, or in 2039, whereas, for New Dong Nai Bridge Project, the concession period should be ended between the years of 2022 and 2025. More details about returns that investors can obtain in each year of these periods can be found in chapter 10.

12.3. Proving the hypotheses

As mentioned in chapter 1, the research had the following hypotheses:

H1. There are significant differences between perceptions of the public sector and the private sector about the criticality of risks (Hypothesis was tested based on the findings provided in chapter 8).

H2. The proposed framework can evaluate projects with regards to critical risks by applying a model based on AHP (Hypothesis was tested based on the findings provided in chapter 9).

H3. Risk allocation strategies with regards to selected criteria can be found by using the proposed framework applying an allocation model based on AHP (Hypothesis was tested based on the findings provided in chapter 9).

H4. Projects are more beneficial in the proposed framework's evaluation than in traditional NPV evaluation (Hypothesis was tested based on the findings provided in chapter 10)

H5. The proposed framework using Risk-Adjusted DNPV is more effective than NPV in evaluating project returns and in determining the concession period (Hypothesis was tested based on the findings provided in chapter 10 and tests in chapter 11)

After analysing the applicability of the framework from the finding chapters (chapter 8, 9, 10) and discussion chapter (chapter 11), following conclusion can be drawn:

- The proposed framework can identify and rate critical risks in PPPs in the transport sector in Vietnam. Moreover, risks with higher risk scores are considered as more serious (see findings in chapter 8).
- There are significant differences between perceptions of the public sector and the private sector about critical risks (see findings in chapter 8).
- The proposed framework can evaluate PPPs with regards to critical risks and the evaluation results can reasonably reflect the real situation (see chapter 9).
- By using the proposed framework, allocation strategies for critical risks can be found with regards to selected criteria (see chapter 9).
- Projects are more beneficial in the proposed framework's evaluation than in traditional NPV evaluation.
- The proposed framework can be more accurate in evaluating project returns than traditional NPV methods. This, in turn, leads to a more reasonable concession period.

12.4. Verification and Validation

12.4. 1. Verification

a. Verification of the structure of the framework

The contents and structure of the framework was checked and verified by using the literature review and the opinions of academic experts. The purpose of this verification is to find and correct any discrepancies, errors and consistencies with published research. Since the development of each element of the framework, the content was submitted to academic experts. Due to the unwillingness of the practitioners, the development of each element of the framework in the early stage was only verified by previous literature and academic experts. However, the final structure of the framework again was submitted to both academic and practitioner experts. Their comments and suggestions were applied when applicable. Comments and suggestions from academics and practitioners were both analysed before applying any corrections. The purpose of doing this was to make the structure of the framework reasonably applicable to the research area.

b. Verification for consistency

The purpose of this verification was to test whether the same input data would create the same output data and the same conclusion through the proposed framework. Different components of the framework were tested for their consistency by using different sets of data to test the logics of the movement. In fact, the consistency of each element was supported by the literature review (see chapters 3, 4, and 5). Therefore, with this consistency, it is highly likely that the framework combined with these elements can provide consistent results. However, the repetition of different data sets was still applied. The result of the repetition test described that the framework is syntactical and logical as the result is the same if the same data set was applied. On the other hand, different sets of data create different findings through the proposed framework.

12.4. 2. Validation

a. Validity of input data

The purpose of this validity is to ensure that the input data is reasonably correct. As mentioned previously, data was collected from questionnaires and case studies. While the questionnaire was for collecting data for risk identification, and AHP models, case studies were applied to collect financial data. In order to test the validity of the data in the questionnaire, analysis software was applied, such as SPSS. The consistency of the input data for the AHP model collected from the questionnaire was also tested by using a consistency test provided by Satty (1980) (see chapter 9). In terms of financial data for return evaluation and concession parameter optimization, the validity of the data was ensured by collecting data from financial reports, signed contract agreements, and other reliable sources.

b. Validity of the robustness of the framework

It should be noted that the purpose of this research is to propose a risk evaluation framework. For this purpose, a number of hypotheses relating to the robustness of the framework were proposed (see chapter 1). Consequently, the robustness of the framework can be proved if these hypotheses are proved. The first method of validating the framework was to validate each component by using literature review. Published research has suggested that these components are robust to use. Therefore, the robustness of the framework was also supported by the literature review. In addition, it should be recognized that the application this framework used in case studies in Vietnam is also the method to test the robustness. Through the findings of the application in chapters 8, 9, 10, and 11 it can be seen that the hypotheses about the applicability of the framework was statistically proved. Hence, the robustness of the proposed framework in Vietnamese PPPs context was proved.

12.5. Generalizability, applicability and Implication

12.5. 1. Generalizability and applicability

Regarding the application of the framework to the real world, the framework is flexible for practitioners to apply in different projects. The result of the risk identification can be used in any PPPs in the transport sector in Vietnam without adaptation. Risk scores can be used to price risks in other projects. In addition, the different perceptions between the public sector and the private sector regarding these risks can also be applied. In terms of applying the function of AHP to rank the riskiness of the project, the government can use this method to select the less risky project to consider PPP forms. Also, it should be noted that in this research, in order to reduce the number of questionnaires and increase the rate of response, the pairwise comparisons were not made for sub-criteria (risks). In real world situations where it is the responsibility of the expert to compare the projects, the sub-criteria (risks) can be compared. However, it should be noted that the weight of sub-criteria must take into account the weight of the criteria. Also, in this research two risks were chosen for each risk group. However, in practice the government can choose as many risks as they want. However, according to Li *et al*. (2013), the number of elements for each comparison should not be over 5. Thus, the number of projects, number of groups, and number of risks in each risk group should not be over 5. Similarly, in applying AHP to allocate risks in reality for specific projects, up to 5 criteria and 5 allocation options can be applied, and the procedure of statistically analysing data is still similar to the procedure shown in this study In addition, both sectors can use the Risk-Adjusted DNPV function of this framework to evaluate other PPPs in the transport sector. In order to effectively apply this function of the framework, some data must be collected. For example the traffic level of the routes used in the past can be collected. Data about construction cost overrun in other PPPs in the transport sector needs to be analysed. It should be noted that in this research the general risk scores were used to price risks. However, some risk scores are statistically different, therefore, in reality, the score made by each sector can be used in specific situations, and the reason for use of the scores made by one party needs to be clarified in negotiations to prevent conflicts of interest.

12.5. 2. Implications

Although this research attempts to fill gaps in previous studies, it also creates an attractive area which requires further investigation. The investigation may focus on a single aspect of the framework or the entire framework as a whole. In general, the main implications can be divided into the research implication and the practice implication. More specifically, from the research perspective, development of scientific methods to criticality evaluate risks, the ability to manage risks, the riskiness of the project and project return will minimize the gap between theory and practice. This is not only essential in the area of PPPs but also in the general construction industry. For example, previous research has shown that construction projects have been mainly evaluated by NPV. However, the findings of this research demonstrate that NPV has its own weaknesses, and these weaknesses can be resolved by the proposed method in this research. This finding can lead to implication of discovery in research in project evaluation in the construction industry. In terms of the practice perspective, the conclusion of this research may affect the operation of PPPs' scheme in reality. The practice of PPPs in Vietnam can be changed to protect the interest of both sectors rather than only private investors. The different perception of each sector with regard to risk can be taken into account in negotiation process. Furthermore, legal aspects of PPPs can be considered to structure the legal framework to evaluate the riskiness of PPPs while implementing the project

12.6. Contribution to knowledge

This research attempts to fill some gaps in knowledge with regards to the area of Public-Private Partnership. Following contributions can be concluded:

- Firstly, this research fills a gap in the knowledge in that there is very limited research about PPPs in the transport sector in Vietnam, and the previous studies about this market were just about identifying critical risks rather than proposing methods to evaluate them. This research can be seen as providing a foundation for further research in this area in Vietnam.

- Secondly, this research aims to propose a framework rather than focusing on a single element of risk management like most of the previous studies have done. Therefore, framework is expected to be able to evaluate risks in PPPs from different perspectives.

- Thirdly, in this research AHP was applied with new purposes, namely, project's riskiness evaluation, and risk allocation. These functions of AHP have not been tested in the area of PPPs before. Hence, future application of AHP regarding to project's riskiness evaluation, and risk allocation can be further explored.

- Importantly, a new method of return evaluation, DNPV, was developed in this research by proposing a Risk-Adjusted DNPV method. The development of the Risk-Adjusted DNPV method in this research is one of the first developments of the DNPV method in the area of PPP in the international context. Furthermore, a new model to determine concession was also developed by applying Risk-Adjusted DNPV, and by overcoming the limitations of measurement of Net Asset Value in previous models.

- In terms of practice, the research provides understanding about the critical risks in Vietnamese PPPs in the transport sector. The deep understanding about the situation of selected case studies is also revealed. Moreover, by using the proposed framework, practitioners both from the public and the private sectors can both quantitatively and qualitatively evaluate projects with regards to critical risks. Moreover, although this research project focuses on the Vietnamese construction industry, the results should be useful, not only in this country but also in other countries, particularly in developing countries in South East Asia where critical risks might have similar features.

12.7. Limitations

The proposed framework was created by developing previous models and systematic combinations of these models. In order to develop the models, several assumptions were created (details of these assumptions are shown accordingly with each findings section). Thus, limitations may be created by these assumptions.

The first limitation of this research is the computation of the risk score. More specifically, the risk score is multiplied by the result of the probability of occurrence and the degree of impact. This might lead to the situation that risks with very high degrees of impact and very small probabilities of occurrence can get a moderate score (Cooper *et al*. 2005).

The second limitation of the research is in the function of the project's riskiness evaluation by AHP. As criticized in the literature review about AHP in chapter 4, AHP should be used only if the number of criteria (or sub-criteria) is not over five. Thus, it might limit the number of risks in each level of the hierarchy structure.

The third limitation of the framework is in the model to allocate risks. More specifically, it is assumed that the importance of criteria is the same for all risks. For example, "The capability to foresee the risk ***i***" is equally important to "The ability to foresee the risk ***j***". This is also one of the limitations of the research as in reality, they might not be equally important. For instance, for private investors, regarding the inflation risk, the ability to foresee the risk might be more important than the ability to control the probability of occurrence. However, for the insufficient traffic volume risk, these abilities might be equal. Also, due to limited time and financial resources, these developed AHP models were tested with respect to 10 risks out of a total of 44 risks.

The fourth limitation of this research is that the low response rate of in testing AHP for allocation strategy may reduce the quality of the result analysed, and this rate needs to be increased in the future research.

The fifth limitation of the research belongs to the function of the Risk-adjusted DNPV. Previous academics such as Chiesa and Frattini (2009), Halliwell (2011), Boussabaine (2013), and Espinoza and Morris (2013) suggested that the risk-free rate should be used instead of the risk discount rate. However, the risk-free rate can also fluctuate, and in this research the fluctuation of the risk-free rate was not modelled.

The sixth limitation in this proposed framework is that the variation of the risk score of the risk factor over a long period is not modelled. For example, the probability of occurrence and degree of impact of risk ***i*** may be different in the future.

The seventh limitation of this research is about the assumption of the economic life of a project. It is assumed that the economic life of a transport project is 50 years as this has been suggested by experts such as Shen *et al*. (2002). However, this might be the case for specific projects.

Another limitation of this research is that the framework can only show an interval of the concession period. In fact, the fixed concession period is left for the negotiation stage.

12.8. Future works

Based on the findings and discussion of this research, other researchers can carry out future work following these suggestions:

- Future work can improve the computation of the risk score. More specifically, although the risk score is still the function of the probability of occurrence and the degree of impact, it can be computed as suggested by Cooper *et al*. (2005):

  Risk Score = *the probability of occurrence* + *the degree of impact* + *the probability of occurrence* **x** *the degree of impact*

  This can overcome the first limitation of this research, mentioned in the limitation section.

- Future works can explore this area by overcoming the limitations of this research. For example, future research can improve the risk allocation model by proposing a new model which can take into account the difference between the appropriate ability criteria for each risk. Besides, a new test for AHP risk allocation model needs to be carried out with higher response rate obtained to more effective show the applicability of risk allocation model.
- Furthermore, future research can retest the riskiness evaluation model and risk allocation model with regards to all risk factors. This must be done in a very specific type of research with more investment on time and financial resources.
- Future research can also develop the risk-adjusted DNPV model by modelling the fluctuation of the risk-free rate and the fluctuation of other risk factors. This may be done by using the Monte Carlo Simulation, and then a distribution of the Risk-Adjusted DNPV may be created based on distribution of the risk-free rate and other risk factors.
- Moreover, future research can also attempt to propose a method to determine a specific time to transfer the project to the government. For example, the Bargaining-Game Theory proposed by Shen *et al*. (2007) can be combined with the concession determination model in this framework to identify a specific time for project transfer.

- Additionally, future research can retest this research by using other advanced methods in determining the required sample size of the questionnaires. One of the recommended methods can be the application of Gpower as this method was evaluated by Faul *et al*. (2007), (Dattalo 2008), and Gardner (2010) as powerful and reliable technique.

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Appendixes

Appendix A: Questionnaire for Risk Identification

Dear sir/madam,

I am Nguyen Minh Nhat, a research student at the University of Liverpool, United Kingdom, currently conducting a PhD project about "Risks Evaluation in PPP projects in the Transport Sector in Vietnam". I am conducting a survey to investigate risks occurring in Vietnamese PPPs. I am inviting you to participate in my research by completing a questionnaire on the topic. The questionnaire should take approximately 15 minutes, and it will mean a lot for my research, which would be incomplete without the questionnaire. Following completion of the questionnaire you might also be asked to participate in a short interview to explore issues in more depth. The interview should take approximately 15 minutes. Both the survey and the interview are entirely voluntary and you will be asked to complete a consent form before doing each of them.

Please be aware that all of your personal details will be kept anonymous and you can decline to answer any questions or withdraw completely from the process at any time. You should feel free to add any additional remarks to my survey or leave sections blank. In addition, please contact me if you have any trouble answering certain questions.
Thank you very much in advance for your cooperation.

Yours faithfully,

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BASIC INFORMATION ABOUT RESPONDENTS						
1. Which Party Do You Work for?	Public	Investor	Lender	Contractor	Academic	
2. Level of Experience in Construction Areas	Under 5 years	From 5 to 10 years	More Than 10 years			
3. Level of Experience in PPP projects (PPP, PFI, P3)	Under 5 years	From 5 to 10 years	More Than 10 years	More Than 10 years		
4. Working position	Managers	Head of a department	Staff			
5. Have you been trained about PPP projects:	Yes	No				
6. Email Address						

RISK EVALUATION

I. Political Risks

Risks	Frequency of Occurrence					Degree of Impact				
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High
P1. Concession Termination by Government										
P2. Political opposition										
P3. Unstable government										
P4. Corruption										
P5. Public sector default										
P6. Public scepticism about the real benefits of PPP										
P7. Forced Buy out Risks										

II. Construction Risks

Risks	Frequency of Occurrence					Degree of Impact				
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High
C1. Changes in industrial code of practices										
C2. Poor design										
C3. Low Quality products										
C4. Low Site safety										
C5. Unavailability of materials										

C6. Design changes										
C7. Difficulty in Land acquisition and Resettlement										
C8. Impractical feasibility study										
C9. Impractical requirements of progress of project										
C10. Delay in other infrastructures relating to the project										

III. Operation Risks

Risks	Frequency of Occurrence					Degree of Impact				
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High
O1. Operation cost overrun										
O2. Default of operator										
O3. Low Quality of operation										
O4. High maintenance cost										
O5. Fluctuation of demand										

IV. Market Risks

Risks	Frequency of Occurrence					Degree of Impact				
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High
M1. Lack of transparency										
M2. Weak Financial Capacity of Investor										
M3. Difficulty in accessing finance from the banks										
M4. Inflation risk										
M5. Fluctuation of Interest rate										
M6. Foreign currency exchange fluctuation										
M7. Influence of negative economic events										
M8. Poor financial market										
M9. Income streams are usually in local currency										
M10. Asset value less than predicted at the time of transferring										

V. Legal Risks

Risks	Frequency of Occurrence					Degree of Impact				
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High
L1. Disapproval of guarantees by the government										
L2. Revision of the contract clauses										
L3. Poor project approval and permit process										
L4. Regulation Change										
L5. Restriction on tolls										
L6. Taxation risks										
VI. Relationship Risks										
Risks	Frequency of Occurrence					Degree of Impact				
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High
Re1. Inadequate experience in PPP of Private sector										
Re2. Inadequate experience in PPP of Public sector										
Re3. Inappropriate distribution of responsibilities and risks										
Re4. Low quality of cooperation between different partners										
VII. Other risks										
Risks	Frequency of Occurrence					Degree of Impact				
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High
Ot1. Bad natural events										
Ot2. Force majeure events										
Other risks that you want to mention										
Risks	Frequency of Occurrence				Degree of Impact					
	Very Low	Low	Medium	High	Very High	Very Low	Low	Medium	High	Very High

Appendix B: ANOVA Significant Difference Test

Robust Tests of Equality of Means

		Statistic[a]	df1	df2	Sig.
C1	Welch	.050	1	32.921	.825
	Brown-Forsythe	.050	1	32.921	.825
C2	Welch	11.038	1	23.676	.003
	Brown-Forsythe	11.038	1	23.676	.003
C3	Welch	11.677	1	22.468	.002
	Brown-Forsythe	11.677	1	22.468	.002
C4	Welch	67.582	1	28.608	.000
	Brown-Forsythe	67.582	1	28.608	.000
C5	Welch	1.017	1	28.989	.322
	Brown-Forsythe	1.017	1	28.989	.322
C6	Welch	11.989	1	41.169	.001
	Brown-Forsythe	11.989	1	41.169	.001
C7	Welch	.359	1	71.017	.551
	Brown-Forsythe	.359	1	71.017	.551
C8	Welch	6.550	1	35.599	.015
	Brown-Forsythe	6.550	1	35.599	.015
C9	Welch	65.112	1	39.764	.000
	Brown-Forsythe	65.112	1	39.764	.000
C10	Welch	1.856	1	23.485	.186
	Brown-Forsythe	1.856	1	23.485	.186
L1	Welch	61.702	1	50.048	.000
	Brown-Forsythe	61.702	1	50.048	.000
L2	Welch	24.307	1	33.782	.000
	Brown-Forsythe	24.307	1	33.782	.000
L3	Welch	1.126	1	56.637	.293
	Brown-Forsythe	1.126	1	56.637	.293
L4	Welch	71.813	1	79.835	.000
	Brown-Forsythe	71.813	1	79.835	.000
L5	Welch	5.119	1	25.635	.032
	Brown-Forsythe	5.119	1	25.635	.032
L6	Welch	39.455	1	26.121	.000
	Brown-Forsythe	39.455	1	26.121	.000
M1	Welch	2.203	1	28.593	.149

	Brown-Forsythe	2.203	1	28.593	.149
M2	Welch	6.596	1	21.153	.018
	Brown-Forsythe	6.596	1	21.153	.018
M3	Welch	178.780	1	30.914	.000
	Brown-Forsythe	178.780	1	30.914	.000
M4	Welch	17.421	1	95.569	.000
	Brown-Forsythe	17.421	1	95.569	.000
M5	Welch	44.796	1	32.731	.000
	Brown-Forsythe	44.796	1	32.731	.000
M7	Welch	.017	1	23.144	.897
	Brown-Forsythe	.017	1	23.144	.897
M8	Welch	37.429	1	27.162	.000
	Brown-Forsythe	37.429	1	27.162	.000
M9	Welch	179.322	1	32.021	.000
	Brown-Forsythe	179.322	1	32.021	.000
M10	Welch	29.142	1	19.633	.000
	Brown-Forsythe	29.142	1	19.633	.000
O1	Welch	206.584	1	91.316	.000
	Brown-Forsythe	206.584	1	91.316	.000
O2	Welch	136.005	1	67.852	.000
	Brown-Forsythe	136.005	1	67.852	.000
O3	Welch	11.143	1	32.013	.002
	Brown-Forsythe	11.143	1	32.013	.002
O4	Welch	.002	1	36.574	.962
	Brown-Forsythe	.002	1	36.574	.962
O5	Welch	15.223	1	60.842	.000
	Brown-Forsythe	15.223	1	60.842	.000
OT1	Welch	3.856	1	47.240	.055
	Brown-Forsythe	3.856	1	47.240	.055
OT2	Welch	26.662	1	54.320	.000
	Brown-Forsythe	26.662	1	54.320	.000
P1	Welch	57.682	1	32.833	.000
	Brown-Forsythe	57.682	1	32.833	.000
P2	Welch	351.617	1	96.739	.000
	Brown-Forsythe	351.617	1	96.739	.000
P3	Welch	83.695	1	37.227	.000
	Brown-Forsythe	83.695	1	37.227	.000
P4	Welch	.058	1	28.963	.811

	Brown-Forsythe	.058	1	28.963	.811
P5	Welch	14.259	1	50.285	.000
	Brown-Forsythe	14.259	1	50.285	.000
P6	Welch	71.756	1	46.453	.000
	Brown-Forsythe	71.756	1	46.453	.000
P7	Welch	163.824	1	34.405	.000
	Brown-Forsythe	163.824	1	34.405	.000
Re1	Welch	1.614	1	29.946	.214
	Brown-Forsythe	1.614	1	29.946	.214
Re2	Welch	1.869	1	34.059	.181
	Brown-Forsythe	1.869	1	34.059	.181
Re3	Welch	123.122	1	27.418	.000
	Brown-Forsythe	123.122	1	27.418	.000
Re4	Welch	16.227	1	46.584	.000
	Brown-Forsythe	16.227	1	46.584	.000
M6	Welch	44.796	1	32.731	.000
	Brown-Forsythe	44.796	1	32.731	.000

a. Asymptotically F distributed.

Appendix C: Questionnaire for Project Riskiness Evaluation

How critical is Construction Risk in comparison with Political and Legal Risks?	Equal	Slightly More Critical	Strongly more Critical	Very strongly more Critical	Extremely more critical
How critical is Construction Risk in comparison with Market Risks?					
How critical is Construction Risk in comparison with Operation Risks?					
How critical is Construction Risk in comparison with Relationship Risks?					
How critical is Political and Legal Risks in comparison with Market Risks?					
How critical is Political and Legal Risks in comparison with Operation Risks?					
How critical is Political and Legal Risks in comparison with Relationship Risks?					
How critical is Market Risks in comparison with Operation Risks?					
How critical is Market Risks in comparison with Relationship Risks?					
How critical is Operation Risks in comparison with Relationship Risks?					
With regards to Construction Risk please answer	Equal	Slightly riskier	Strongly riskier	Very strongly riskier	Extremely riskier
How risky is Yen Lenh Bridge Project in comparison with Phu My Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					
How risky is Phu My Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Phu My Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Phu My Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is Co Chien Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Co Chien Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is New Dong Nai Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					

With regards to Potilical and Legal Risks please answer					
How risky is Yen Lenh Bridge Project in comparison with Phu My Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					
How risky is Phu My Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Phu My Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Phu My Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is Co Chien Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Co Chien Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is New Dong Nai Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					
With regards to Market Risks please answer					
How risky is Yen Lenh Bridge Project in comparison with Phu My Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					
How risky is Phu My Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Phu My Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Phu My Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is Co Chien Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Co Chien Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is New Dong Nai Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					

With regards to Operational Risks please answer					
How risky is Yen Lenh Bridge Project in comparison with Phu My Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					
How risky is Phu My Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Phu My Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Phu My Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is Co Chien Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Co Chien Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is New Dong Nai Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					
With regards to Relationship Risks please answer					
How risky is Yen Lenh Bridge Project in comparison with Phu My Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Yen Lenh Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					
How risky is Phu My Bridge Project in comparison with Co Chien Bridge Project?					
How risky is Phu My Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Phu My Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is Co Chien Bridge Project in comparison with New Dong Nai Bridge Project?					
How risky is Co Chien Bridge Project in comparison with No 18 Highway Uong Bi - Ha Long Project?					
How risky is New Dong Nai Bridge Project in comparison with No 18 Highway Uong Bi-Ha Long Bridge Project?					

Appendix D: Example of AHP Computation for Riskiness Evaluation

CR Value = 0.057 OK

Pairwise comparisons

Item Number	Item Number	1	2	3	4	5	6	7	8	9	10					
	Item Description	Project 1	Project 2	Project 3	Project 4	Project 5						5th Root	Eigenvector	A w	Lambda Vector	Lambda Max
1	Project 1	1.000	0.333	1.000	1.000	1.000						0.803	0.149	0.808	5.422	5.255
2	Project 2	3.000	1.000	3.000	1.000	1.000						1.552	0.288	1.490	5.173	
3	Project 3	1.000	0.333	1.000	0.333	0.333						0.517	0.096	0.497	5.173	
4	Project 4	1.000	1.000	3.000	1.000	2.000						1.431	0.266	1.393	5.246	
5	Project 5	1.000	1.000	3.000	0.500	1.000						1.084	0.201	1.059	5.262	
	Sum	7.00	3.67	11.00	3.83	5.33										

STANDARDIZED MATRIX

		Project 1	Project 2	Project 3	Project 4	Project 5						Weight	
1	Project 1	0.143	0.091	0.091	0.261	0.188						15.461%	YL
2	Project 2	0.429	0.273	0.273	0.261	0.188						28.448%	PM
3	Project 3	0.143	0.091	0.091	0.087	0.063						9.483%	CC
4	Project 4	0.143	0.273	0.273	0.261	0.375						26.484%	DN
5	Project 5	0.143	0.273	0.273	0.130	0.188						20.125%	18.0000

	100.0%
Count	5.000
Lambda max	5.255
CI	0.064
CR	0.057
Constant	1.120

Appendix E: Questionnaire for Risk Allocation Evaluation

	Equal	Slightly More Important	Strongly more Important	Very strongly more Important	Extremely more Important
How important is The ability to foresee the risk in comparison with The ability to control the risk's probability of occurring?					
How important is The ability to control the risk's probability of occurring in comparison with The ability to bear the consequence of the risk?					
How important is The ability to foresee the risk in comparison with The ability to bear the consequence of the risk?					
With Regards to the ability to foresee the risk of Low Quality Products	Equal	Slightly better	Strongly better	Very strongly better	Extremely better
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the probability of occurring of the risk Low Quality Products					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the bear the consequence Low Quality Products					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to foresee the risk of Difficulty in Land acquisition and Resettlement					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the probability of occurring of the risk Difficulty in Land acquisition and Resettlement					
How better is public sector in comparison with Share option?					

How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the bear the consequence Difficulty in Land acquisition and Resettlement					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to foresee the risk of Poor project approval and permit process					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the probability of occurring of the risk Poor project approval and permit process					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the bear the consequence Poor project approval and permit process					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to foresee the risk of Corruption					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the probability of occurring of the risk Corruption					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the bear the consequence Corruption					
How better is public sector in comparison with Share option?					

How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to foresee the risk of Weak Financial Capacity of Investor					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the probability of occurring of the risk Weak Financial Capacity of Investor					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					
With Regards to the ability to control the bear the consequence Weak Financial Capacity of Investor					
How better is public sector in comparison with Share option?					
How better is public sector in comparison with the private sector?					
How better is public sector in comparison with the private sector?					

Appendix F: Example of AHP calculation sheet for Risk Allocation

Risk 5 C3	CR Value =	0.046	OK

Pairwise comparisons

Item Number	Item Number	1	2	3					
	Item Description	Public	Share	Private	5th Root	Eigenvector	A w	Lambda Vector	Lambda Max
1	Public	1.00	0.50	3.00	1.145	0.333	1.015	3.054	3.054
2	Share	2.00	1.00	3.00	1.817	0.528	1.612	3.054	
3	Private	0.33	0.33	1.00	0.481	0.140	0.426	3.054	
4									
5									
	Sum	3.33	1.83	7.00					

STANDARDIZED MATRIX

		Public	Share	Share	Weight
1	Public	0.300	0.273	0.429	33.377%
2	Share	0.600	0.545	0.429	52.468%
3	Private	0.100	0.182	0.143	14.156%
4					
5					
					100.0%

Size of Matrix	3
Lambda max	3.054
CI	0.027
CR	0.046
Constant	0.580

Appendix G: Computation of Risk Adjusted Parameters on the revenue side of Yen Lenh Bridge

Year	δ	r	T	σ	S	X	d1	d2	N(d1)	N(d2)	N(-d1)	N(-d2)	Risk Parameter on the revenue side ηv	Risk factor 1 (M7. Influence of negative economic events)	Risk factor 2 (L5. Restriction on toll and tariff)	Risk factor 2 (C10. Delay in other infrastructures relating to the project)	Risk Adjusted Parameter on the revenue side $\bar{\eta}_v$
2012	0	0.095	1	0.17	65.83	33.58	4.64	4.55	1.000	1.000	1.77E-06	2.7E-06	0.0000	0.378	0.318	0.308	0.00000
2013	0	0.095	2	0.17	65.83	33.58	3.74	3.57	1.000	1.000	9.33E-05	0.00018	0.0000	0.378	0.318	0.308	0.00002
2014	0	0.095	3	0.17	65.83	33.58	3.42	3.17	1.000	0.999	3.08E-04	0.00076	0.0002	0.378	0.318	0.308	0.00021
2015	0	0.095	4	0.17	65.83	33.58	3.29	2.95	1.000	0.998	5.02E-04	0.00158	0.0007	0.378	0.318	0.308	0.00070
2016	0	0.095	5	0.17	65.83	33.58	3.23	2.81	0.999	0.998	6.15E-04	0.00248	0.0014	0.378	0.318	0.308	0.00147
2017	0	0.095	6	0.17	65.83	33.58	3.21	2.71	0.999	0.997	6.53E-04	0.00338	0.0024	0.378	0.318	0.308	0.00248
2018	0	0.095	7	0.17	65.83	33.58	3.22	2.63	0.999	0.996	6.39E-04	0.00426	0.0036	0.378	0.318	0.308	0.00372
2019	0	0.095	8	0.17	65.83	33.58	3.24	2.57	0.999	0.995	5.94E-04	0.00513	0.0050	0.378	0.318	0.308	0.00519
2020	0	0.095	9	0.17	65.83	33.58	3.27	2.51	1.000	0.994	5.34E-04	0.00598	0.0066	0.378	0.318	0.308	0.00689
2021	0	0.095	10	0.17	65.83	33.58	3.31	2.47	1.000	0.993	4.68E-04	0.00684	0.0086	0.378	0.318	0.308	0.00887
2022	0	0.095	11	0.17	65.83	33.58	3.35	2.42	1.000	0.992	4.04E-04	0.00771	0.0108	0.378	0.318	0.308	0.01118
2023	0	0.095	12	0.17	65.83	33.58	3.39	2.38	1.000	0.991	3.44E-04	0.0086	0.0134	0.378	0.318	0.308	0.01387
2024	0	0.095	13	0.17	65.83	33.58	3.44	2.34	1.000	0.991	2.90E-04	0.00953	0.0164	0.378	0.318	0.308	0.01703
2025	0	0.095	14	0.17	65.83	33.58	3.49	2.31	1.000	0.990	2.43E-04	0.0105	0.0200	0.378	0.318	0.308	0.02076
2026	0	0.095	15	0.17	65.83	33.58	3.54	2.27	1.000	0.989	2.02E-04	0.01153	0.0243	0.378	0.318	0.308	0.02515
2027	0	0.095	16	0.17	65.83	33.58	3.59	2.24	1.000	0.987	1.67E-04	0.01262	0.0293	0.378	0.318	0.308	0.03036
2028	0	0.095	17	0.17	65.83	33.58	3.64	2.20	1.000	0.986	1.38E-04	0.01379	0.0352	0.378	0.318	0.308	0.03654
2029	0	0.095	18	0.17	65.83	33.58	3.69	2.17	1.000	0.985	1.13E-04	0.01504	0.0423	0.378	0.318	0.308	0.04388
2030	0	0.095	19	0.17	65.83	33.58	3.74	2.13	1.000	0.984	9.29E-05	0.01639	0.0507	0.378	0.318	0.308	0.05262

Appendix H: Computation of Risk Adjusted Parameters on the revenue side of No 18 Uong Bi – Ha Long Project

Year	δ	r	T	σ	S	X	d1	d2	N(d1)	N(d2)	N(-d1)	N(-d2)	Risk Parameter on the revenue side ηv	Risk factor 1 (M7. Influence of negative economic events)	Risk factor 2 (L5. Restriction on toll and tariff)	Risk factor 2 (C10. Delay in other infrastructures relating to the project)	Risk Adjusted Parameters on the revenue side ($\bar{\eta}_v$)
2011	0	0.095	1	0.1553	277.5	137.4	5.22	5.14	1.000	1.000	0.0000	0.0000	0.0000	0.3780	0.3180	0.3080	0.0000
2012	0	0.095	2	0.1553	277.5	137.4	4.18	4.02	1.000	1.000	0.0000	0.0000	0.0000	0.3780	0.3180	0.3080	0.0000
2013	0	0.095	3	0.1553	277.5	137.4	3.81	3.57	1.000	1.000	0.0001	0.0002	0.0000	0.3780	0.3180	0.3080	0.0000
2014	0	0.095	4	0.1553	277.5	137.4	3.64	3.33	1.000	1.000	0.0001	0.0004	0.0002	0.3780	0.3180	0.3080	0.0002
2015	0	0.095	5	0.1553	277.5	137.4	3.57	3.18	1.000	0.999	0.0002	0.0007	0.0004	0.3780	0.3180	0.3080	0.0004
2016	0	0.095	6	0.1553	277.5	137.4	3.54	3.07	1.000	0.999	0.0002	0.0011	0.0007	0.3780	0.3180	0.3080	0.0008
2017	0	0.095	7	0.1553	277.5	137.4	3.53	2.99	1.000	0.999	0.0002	0.0014	0.0011	0.3780	0.3180	0.3080	0.0012
2018	0	0.095	8	0.1553	277.5	137.4	3.55	2.93	1.000	0.998	0.0002	0.0017	0.0016	0.3780	0.3180	0.3080	0.0017
2019	0	0.095	9	0.1553	277.5	137.4	3.58	2.88	1.000	0.998	0.0002	0.0020	0.0022	0.3780	0.3180	0.3080	0.0022
2020	0	0.095	10	0.1553	277.5	137.4	3.61	2.83	1.000	0.998	0.0002	0.0023	0.0028	0.3780	0.3180	0.3080	0.0029
2021	0	0.095	11	0.1553	277.5	137.4	3.65	2.80	1.000	0.997	0.0001	0.0026	0.0035	0.3780	0.3180	0.3080	0.0036
2022	0	0.095	12	0.1553	277.5	137.4	3.69	2.76	1.000	0.997	0.0001	0.0029	0.0043	0.3780	0.3180	0.3080	0.0045
2023	0	0.095	13	0.1553	277.5	137.4	3.74	2.73	1.000	0.997	0.0001	0.0032	0.0053	0.3780	0.3180	0.3080	0.0055
2024	0	0.095	14	0.1553	277.5	137.4	3.79	2.70	1.000	0.997	0.0001	0.0035	0.0064	0.3780	0.3180	0.3080	0.0066
2025	0	0.095	15	0.1553	277.5	137.4	3.84	2.67	1.000	0.996	0.0001	0.0038	0.0077	0.3780	0.3180	0.3080	0.0080
2026	0	0.095	16	0.1553	277.5	137.4	3.89	2.65	1.000	0.996	0.0001	0.0041	0.0092	0.3780	0.3180	0.3080	0.0095
2027	0	0.095	17	0.1553	277.5	137.4	3.94	2.62	1.000	0.996	0.0000	0.0044	0.0109	0.3780	0.3180	0.3080	0.0113
2028	0	0.095	18	0.1553	277.5	137.4	3.99	2.59	1.000	0.995	0.0000	0.0048	0.0130	0.3780	0.3180	0.3080	0.0135

2029	0	0.095	19	0.1553	277.5	137.4	4.04	2.57	1.000	0.995	0.0000	0.0051	0.0154	0.3780	0.3180	0.3080	0.0160
2030	0	0.095	20	0.1553	277.5	137.4	4.09	2.54	1.000	0.995	0.0000	0.0055	0.0183	0.3780	0.3180	0.3080	0.0189
2031	0	0.095	21	0.1553	277.5	137.4	4.15	2.52	1.000	0.994	0.0000	0.0059	0.0216	0.3780	0.3180	0.3080	0.0224
2032	0	0.095	22	0.1553	277.5	137.4	4.20	2.49	1.000	0.994	0.0000	0.0064	0.0256	0.3780	0.3180	0.3080	0.0266
2033	0	0.095	23	0.1553	277.5	137.4	4.25	2.46	1.000	0.993	0.0000	0.0069	0.0303	0.3780	0.3180	0.3080	0.0314
2034	0	0.095	24	0.1553	277.5	137.4	4.30	2.44	1.000	0.993	0.0000	0.0074	0.0359	0.3780	0.3180	0.3080	0.0372
2035	0	0.095	25	0.1553	277.5	137.4	4.35	2.41	1.000	0.992	0.0000	0.0080	0.0425	0.3780	0.3180	0.3080	0.0441
2036	0	0.095	26	0.1553	277.5	137.4	4.40	2.38	1.000	0.991	0.0000	0.0086	0.0503	0.3780	0.3180	0.3080	0.0522
2037	0	0.095	27	0.1553	277.5	137.4	4.45	2.36	1.000	0.991	0.0000	0.0093	0.0595	0.3780	0.3180	0.3080	0.0618
2038	0	0.095	28	0.1553	277.5	137.4	4.50	2.33	1.000	0.990	0.0000	0.0100	0.0705	0.3780	0.3180	0.3080	0.0731
2039	0	0.095	29	0.1553	277.5	137.4	4.55	2.30	1.000	0.989	0.0000	0.0107	0.0835	0.3780	0.3180	0.3080	0.0866
2040	0	0.095	30	0.1553	277.5	137.4	4.60	2.27	1.000	0.988	0.0000	0.0116	0.0989	0.3780	0.3180	0.3080	0.1026

Appendix I: Computation of Risk Adjusted Parameters on the revenue side of New Dong Nai Brigde Project

Year	δ	r	T	σ	S	X	d1	d2	N(d1)	N(d2)	N(-d1)	N(-d2)	Risk Parameter on the revenue side (ηv)	Risk factor 1 (M7. Influence of negative economic events)	Risk factor 2 (L5. Restriction on toll and tariff)	Risk factor 2 (C10. Delay in other infrastructures relating to the project)	Risk Adjusted Parameters on the revenue side ($\bar{\eta}_v$)
2014	0	0.089	1	0.0275	£229.0	£119.0	27.0	27.0	1	1	2.14E-161	3E-161	0.00000	0.378	0.318	0.308	0.0000
2015	0	0.089	2	0.0275	£229.0	£119.0	21.4	21.4	1	1	4.13E-102	7E-102	0.00000	0.378	0.318	0.308	0.0000
2016	0	0.089	3	0.0275	£229.0	£119.0	19.4	19.3	1	1	7.21E-84	1.6E-83	0.00000	0.378	0.318	0.308	0.0000
2017	0	0.089	4	0.0275	£229.0	£119.0	18.4	18.3	1	1	6.81E-76	1.9E-75	0.00000	0.378	0.318	0.308	0.0000
2018	0	0.089	5	0.0275	£229.0	£119.0	17.9	17.8	1	1	5.00E-72	1.7E-71	0.00000	0.378	0.318	0.308	0.0000
2019	0	0.089	6	0.0275	£229.0	£119.0	17.7	17.6	1	1	3.23E-70	1.4E-69	0.00000	0.378	0.318	0.308	0.0000
2020	0	0.089	7	0.0275	£229.0	£119.0	17.6	17.5	1	1	1.40E-69	7.6E-69	0.00000	0.378	0.318	0.308	0.0000
2021	0	0.089	8	0.0275	£229.0	£119.0	17.6	17.5	1	1	1.11E-69	7.7E-69	0.00000	0.378	0.318	0.308	0.0000
2022	0	0.089	9	0.0275	£229.0	£119.0	17.7	17.6	1	1	2.87E-70	2.6E-69	0.00000	0.378	0.318	0.308	0.0000
2023	0	0.089	10	0.0275	£229.0	£119.0	17.8	17.7	1	1	3.37E-71	3.9E-70	0.00000	0.378	0.318	0.308	0.0000
2024	0	0.089	11	0.0275	£229.0	£119.0	18.0	17.8	1	1	2.23E-72	3.4E-71	0.00000	0.378	0.318	0.308	0.0000
2025	0	0.089	12	0.0275	£229.0	£119.0	18.1	18.0	1	1	9.59E-74	1.9E-72	0.00000	0.378	0.318	0.308	0.0000
2026	0	0.089	13	0.0275	£229.0	£119.0	18.3	18.1	1	1	2.96E-75	7.8E-74	0.00000	0.378	0.318	0.308	0.0000
2027	0	0.089	14	0.0275	£229.0	£119.0	18.5	18.3	1	1	7.06E-77	2.5E-75	0.00000	0.378	0.318	0.308	0.0000
2028	0	0.089	15	0.0275	£229.0	£119.0	18.7	18.5	1	1	1.37E-78	6.4E-77	0.00000	0.378	0.318	0.308	0.0000
2029	0	0.089	16	0.0275	£229.0	£119.0	18.9	18.7	1	1	2.23E-80	1.4E-78	0.00000	0.378	0.318	0.308	0.0000
2030	0	0.089	17	0.0275	£229.0	£119.0	19.2	18.9	1	1	3.18E-82	2.8E-80	0.00000	0.378	0.318	0.308	0.0000

Appendix K: Current and Future PPPs in Transport sector in Vietnam

	Project	Investors	Length	Expenditure (billion Vietnam Dong)								Construction Time		Toll Collection	Toll Collection Station
				Total	Construction	Land Acquisition and resettlement	Investors' Investment			Public sector' contribution		Start	Finish	Start	
							Total	Equity	Debt	Public ' budget	BT form				
				481,481	260,314	32,864	206,837	22,280	127,902	75,758	7,466				
I	**Projects in Operation Stage**			11,641	6,392	627	9,359	1,367	6,969	1,734	-				
1	No 2 Highway Noi Bai – Vinh Yen	BOT QL2	22	755			416			339				Aug-08	Km12+400 ;Km26+400
2	Deo Ngang highway tunnel	Song Da Cooperation	495m tunnel; 2114m Road	150								Nov-02	Nov-04	Nov-04	Deo Ngang
3	No 1 highway (Thanh Hoa city bypass road)	BOT Thanh Hoa	10.035	897	773	125	756	137	544	141		Feb-05	Jan-09	Jan-09	Tao Xuyen
4	No 1 highway (Vinh city bypass road)	CIENCO 4	25	378	348	30	378	113	265			Jun-03	Apr-06	Apr-06	Ben Thuy
5	No 1 highway (Ha Tinh bypass road)	Song Da Cooperation	16.3	458	319	66	456	137	319	2		Nov-05	Dec-08	Jan-09	Cau rac
6	No 1 highway (Dong Hoi city bypass road)	BOT Dong Hoi	19.46	657			596	89	507	61		Dec-05	Oct-10	Oct-10	Quan Hau
7	No 1 highway Hoa Cam- Hoa Phuoc, and Tu Cau – Vinh Dien	545 JSc.,	13	931			750	113	638	181		Sep-07	Nov-12	Nov-09	Nam Hai Van – ha Phuoc

8	No 1 highway Phan Rang – Thap Chap	Company 577 & CII	10	548	470	78	548	110	438			Apr-09	Dec-12	May-13	Cam Thinh
9	No 20 highway (Km76 - Km206)	Hung Phat and Hai Phat Companies	21.3	282	255		282	56	226			Oct-08	Jan-11	Jan-11	Tan Phu Km74+760 ,91 và Bao Loc Km108+557
10	No 51 highway, Km 0+900-Km73+600	BVEC	72,7	3,971	3,709	262	3,971	397	3,574			Aug-09	Aug-12	Aug-12	2 stations
11	Rach Mieu Bridge	Rach Mieu BOT company	8.2	1,304	519	66	519	155	362	785		Apr-02	Jan-09	Apr-09	Rack mieu Bridge
12	Yen Lenh Bridge	Thang Long Company & CIENCO4	2.2	297			156	59	97	141		Jun-02	2004	2004	Yen Lenh
13	No 2 Highway (Vinh Yen city bypass road)	BOT Vietracimex 8	10.6	615			531			84				Jan-11	Bac Thang Long – noi Bai
14	No 1K highway	CIENCO 6 & Pho Tha	11	397								Jun-03	2006	2007	1K Station
II	**Projects in Construction Stage**			104,734	86,582	11,358	97,582	13,584	83,995	3,002	7,236				
II.1	**On No 1 highway from Thanh Hoa – Can Tho**			53,827	46,253	5,219	48,659	7,396	41,263	1,145	4,509				
1	No 1 highway Nghi Son (Thanh Hoa) – Cau Giat (Nghe An)	CIENCO4 and Company 319	34	3,627	3,137	490	3,463	421	3,042	164	-	2013	2015	2015	Cau Giat
2	No 1 highway Nam Ben Thuy – Ha Tinh city	CIENCO4	35	2,434	1,829	415	2,364	311	2,053	70	-	2012	2015	2015	Ben Thuy I and II

3	No 1 highway Km597+549 - Km605; Km617-Km641, Quang Binh Province	Tasco	29.2	2,005	1,850	155	2,005	275	1,729			Apr-13	Dec-15	Jan-16	Km601
4	No 1 highway Km672+600 - Km704+900, Quang Binh Province	Truong Dinh Company	33.1	983	942	41	983	147	835			Jun-13	Jun-15	Jul-15	Quan Hau
5	No 1 highway Km741+170 - Km756+705, Quang Tri Province	Truong Dinh and Truong Son Company	15.5	1,068	940	128	1,068	160	908			Jun-13	Dec-15	Jan-16	Dong Ha Km763+800
6	No 1 highway Dong Ha – Quang Tri Town	Truong Dinh Company	13	1,030	886	144	1,030	155	876	144		Oct-08	Dec-13	Jan-14	Km763+800
7	No 1 highway Km791A+500÷ Km848+875, Thu Thien Hue Province	Trung Phuong	31.3	2,209	1,981	228	2,209	296	1,913			May-13	May-15	Jun-15	Tu Ha
8	Phuoc Tuong-Phu Gia Highway Tunnel	Hung Phat + Q.K.L + Company 669 + Viet Thanh Company	357m+ 4,2km và 447m+ 2,6km	1,743	1,683	60	1,743	262	1,481			May-13	Dec-14	Jan-15	Km867
9	No 1 highway, Km947- Km987, Quang Nam Province	Company 545	30	1,487	1,317	170	1,259	189	1,070	228		Dec-13	Dec-15	Jan-16	Hoa Phuoc
10	No 1 highway Km987÷ Km1027, Quang Nam Province	CIENCO 5	40	1,626	1,410	216	1,626	238	1,388			Mar-13	Dec-15	Feb-16	Tam Ky

11	No 1 highway Km1063+877 ÷ Km1092+577, Quang Ngai Province	Thien Tan + Thanh An Company	29.4	2,139	1,006	312	2,139	289	1,850			Jun-13	Dec-15	Jan-16	Km1072+200
12	No 1 highway Km1125÷ Km1153, Binh Dinh Province	Thanh An + Bac Ai + Long Trung Son + VInaconex PVC	28.7	1,644	843	194	1,644	239	1,405			Jun-13	Dec-15	Jan-16	Km1148+1300
13	No 1 highway Km1212+400 ÷ Km1265, Binh Dinh, Phu Yen	Hoang Son + Kien Long company	40.7	2,045	1,072	235	2,043	279	1,764			Mar-13	Dec-15	Jan-16	Km1212+550
14	Deo Ca highway tunnel	BOT Deo Ca	13,4	15,603	15,064	539	10,555	2,111	8,444	539	4,509	Nov-12	Jul-17	11/2012 và 7/2017	Thach Ban + Deo Ca
15	No 1 highway Km1374+525 - Km1392 and Km1405 - Km1425, Khanh Hoa Province	Deo Ca + Vietinbank + Hai Thach	37.7	2,644	2,328	316	2,644	339	2,305			May-13	2015	2016	Km1424
16	No 1 highway Km1488 - Km1525, Khanh Hoa Province	Company 194	36.1	2,700	2,321	379	2,700	345	2,355			Jun-13	2015	2016	Cam Thinh
17	No 1 highway Km1642-Km1692, Binh Thuan	BOT Binh Thuan	44.7	2,608	2,293	315	2,608	336	2,272			Jun-13	2015	2016	Km1661+600
18	Upgrade road, Phan Thiet-Bien Hoa	Company 319	113.7	2,086	2,067	19	2,086	284	1,802			Apr-13	2014	2015	Song Phan
19	No 1 highway (Bien Hoa city bypass road)	Dong Thuan Company	12.2	1,255	890	365	1,255	251	1,004			Jul-10	Mar-14	May-14	Km1841+912

20	No 1 highway, Can Tho – Phung Hiep, Km2078-Km2100	Thi Son + No 9 Construction Company	21.6	1,494	1,262	232	1,837	259	1,578			Aug-13	2015	2016	Km2079+535
21	Lai Cay, Tien Giang bypass road	BVEC-TRICO	38.5	1,398	1,133	265	1,398	210	1,188	-	-	Feb-14	2015	2016	Km1999+900
II.2	**Projects in Tay Nguyen area**			4,601	2,917	235	4,574	734	3,840	26	-				
1	No 14 highway Pleiku-bridge 110 (Km542 - Km607+850)	Duc Long Gia Lai - Company	57.6	1,776	1,046	100	1,776	267	1,509			Jun-13	Dec-15	Jan-16	Km1610+800 and Km1667+470
2	No 14 highway Km678+734 - Km704, Dak Lak	Quang Duc + Dong Hung Gia Lai +Se San 4A	25.5	836	520	22	836	125	711			Jun-13	Dec-15	Jan-16	Km 1747+040
3	No 14 highway Km734+600 - Km765, Dak Nong	Toan My 14 + Bang Duong	29.3	1,021	565	87	1,021	153	868			Jun-13	Dec-15	Jan-16	Km1813+650
4	No 14 highway Km921+025-Km962+331, Binh Phuoc Province	Duc Thanh Company	39.5	968	786	26	942	188	753	26		Apr-10	Sep-14	Oct-10	Km957+400QL14
II.3	**Other projects**			46,306	37,413	5,904	44,349	5,454	38,892	1,831	2,727				
1	Ha Noi- Hai Phong highway	VIDIFI	105.5	24,566	23,070	1,496	24,566	3,000	21,566			2008	2015	2015	No 15 highway
2	No 10 highway – Tan De Bridge – La Uyen Bridge	TASCO	5.5	715	352	363	594	89	505	121		2009	Jun-14	Apr-09	Tan De Bridge
3	New Dong Nai Bridge and approaching roads	No 1 Construction Company	3.87	1,648	1,444	204	1,648	330	1,318			Jul-08	Jun-14	Jan-09	Song Phan, Dong Nai

4	No 18 Uong Bi – Ha Long	OCEAN cooperation	30.1	1,727	1,083	644	1,083	162	921	644		Oct-11	Apr-14	May-14	Km97
5	Co Chien Bridge	CIENCO1+Tuan Loc company	1.6	2,308	2,308		1,264	190	1,074	1,044		Aug-13	Aug-15	Sep-15	Co Chien Bridge
6	Viet Tri Bridge	CIENCO1+ Yen Khanh + Thai Son	3.1	1,900	113	1,787	1,900	265	1,635			Nov-13	Nov-15	Dec-15	Km52
7	No 19 highway Km17+027-Km50 Binh Dinh, and Km108-Km131+300 Gia Lai	Company 36	56	2,045	1,284	125	2,045	280	1,765			Dec-13	Dec-15		Km55+900, Km124+160
8	My Loi Bridge (No 50 highway)	Phat Dat + 620 Long An	2.691	1,438	1,388	50	1,313	197	1,116			Jan-14	Aug-15	Sep-15	Km34+826
9	No 20 highway Bao Loc – Da Lat, Lam Dong	319 Yen Khanh + Thai Son Company	124.77	4,110	2,839	459	4,110	207	3,903		2,727				Bao Loc
10	No 1 highway Ha Noi – Bac Giang	Ocean + Vinaconex + 319 + Van Phu	46	4,213	2,503	168	4,213	496	3,716			Feb-14	Jun-16	Jul-16	Km152+00
11	No 91 highway Km14 - Km50+889	KCN+ Cuong Thuan + IDICO	28.15	1,579	971	607	1,579	233	1,346			Sep-14	Dec-15	Jan-16	Km14+770
III	**BT Projects in construction stage**			16,075	11,377	776	10,369	1,112	9,257	1,117	-				
1	No 20 highway Dong Nai – Lam Dong	BT Cuu Long	117	4,589	154	513			250 triệu USD			Oct-11	31/12/2015		

2	Highway La Son – Tuy Loan	TNXP Truong Son + No 1 Construction company + Van Tuong + Truong Son construction company (Ministry of defense) + No 8 transportatio n constuctuion company + Truong thinh + Son Hai	82	11,486	11,223	263	10,36 9	1,112	9,257	1,117		Dec-13	2016		
IV	**Projects in Development Stage**			349,032	155,962	20,103	89,52 7	6,218	27,68 1	69,904	230				
IV.1	**Road sub-sector**			112,694	31,056	4,971	28,70 8	5,373	23,03 5	5,385	-				
1	Dau Giay-Phan Thiet Highway	Bitexco + NĐT2	98.7	17983	16161	1822	10364	3150	7214	5385		Quý III/2 015	2019	2019	Shadow toll
2	No 18 Bac Ninh- Uong Bi	Ocean Company	40	1,400	950	450	1,400	210	1,190			2014	2016	2016	Pha Lai (Km26)
3	No 6 highway and Hoa Lac – Hoa Binh	No 36 Company (Ministry of Defense)	66.3	3,200								2014	2016	2015 (QL6)	Ky Son
4	Upgrade Phap Van – Cau Gie highway	Not decided yet	30	7269	5620	1649	7269	877	6392			2014	2019	2019	Shadow toll
5	No 32 Nhon – Son Tay Highway	Not decided yet		1,400											

6	Ninh Binh – Nghi Son highway	Not decided yet		17,000											
7	Bien Hoa- Vung Tau Highway	Not decided yet		11,600											
8	Trung Luong – My Thuan highway	Not decided yet		12,000											
9	Belt road III Ho Chi Minh city, Tan Van – Nhon Trach	Not decided yet	17.85	9,200											
10	No 1 Lang Son- Bac Giang	Not decided yet		10,000											
11	Upgrade No 1 highway: Phung Hiep – Soc Trang – Bac Lieu – Ca Mau	Not decided yet		2,000											
12	No 22B Go Dau – Xa Mat, Tay ninh province	Not decided yet	84.16	1,200											
13	No 27 highway Km0-Km88, Dac Lack Province	Not decided yet		2,130											
14	No 27 highway Km88-Km174 Lam Dong Province	Not decided yet		2,500											
15	No 26 highway	Not decided yet		772											
16	Dai Ngai Bridge on no 60 Bridge	Not decided yet													
17	Upgrade no 6 highway Km78+300-Km303+790	Not decided yet		1,865											

18	Upgrade no 15 highway	CIENCO4+Tuan Loc Company	13Km	375	325	50	375	56	319			2014	2016	2016	
19	Upgrade no highway 28B		69Km	1,500											
20	No 38 highway (connect No 1 highway and no5 highway)	Not decided yet	32.8	1300	950	350	1300	156	1144			Jun-14	2016	2016	
21	Crossroad (No 46 highway and North – South railway)	Cienco 4	0.75	420	380	40	420	50.4	369.6			Apr-14	Oct-15	Oct-15	Ben Thuy
22	Crossroad (No 48 highway and North – South railway)	Cienco 4	4	480	420	60	480	57.6	422.4			Jun-14	Jan-16	Jan-16	Hoang Mai
23	Phu Ly city bypass road	FACON-CIENCO1	20	2000	1750	250	2000	240	1760			Oct-14	Oct-16	Nov-16	Dong Van
24	New No 3 highway Thai Nguyen – Cho Moi	Not decided yet	40	4800	4500	300	4800	576	4224			Sep-14	Oct-16	Nov-16	Km65
25	Crossroad No 1 highway and No 8B highway	Not decided yet		300			300								
IV.2	Domestic waterway			1,598	-	-	-	-	-	-	-				
1	Upgrade Cho Gao Canel	Not decided yet		1,407											
2	Waterway Ham Luong River	Not decided yet		191											
IV.3	Marine Project			473	228	2	-	-	91	230	230				
1	Upgrade Cai Trap Cannel	Not decided yet	5.1	107	105	2	-	-	91	107	107	2014	2014		
2	Vessel Traffic Service System Hai Phong	Not decided yet	0	123	123	-	-	-	-	123	123	2014	2014	0	

3	Derogation of Bo De canal for Nam Can port	Not decided yet		243											
IV.4	Railway			61,882	-	-	-	-	-	-	-				
1	Bien Hoa – Vung Tau Railway	Not decided yet		33,882											
2	Railway to Hai Phong Port	Not decided yet		28,000											
IV.5	Air Transportation			171,287	124,678	15,130	60,819	845	4,555	64,289	-				
1	Long Thanh Airport	Not decided yet		164,157	117,978	14,700	55,419			62,559		2,019	2,025		
2	Cam Ranh Airport	Not decided yet		2,000	2,000		700	140	560	1,300		2,014	2,017		
3	Quang Ninh Airport	Not decided yet		5,130	4,700	430	4,700	705	3,995	430		2,017	2,020		