# RISK MANAGEMENT OF PUBLIC-PRIVATE PARTNERSHIP (PPP) INFRASTRUCTURE PROJECTS IN LAOS

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การบริหารความเสี่ยงของโครงการ โครงสร้างพื้นฐานความร่วมมือภาครัฐและเอกชน (PPP) ใน
ประเทศลาว

น.ส.สีอำพร มะนีวง

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| Field of Study | Civil Engineering |
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สีอำพร มะนีวง : การบริหารความเสี่ยงของโครงการโครงสร้างพื้นฐานความร่วมมือภาครัฐและเอกชน (PPP) ในประเทศลาว. ( RISK MANAGEMENT OF PUBLIC-PRIVATE PARTNERSHIP (PPP) INFRASTRUCTURE PROJECTS IN LAOS) อ.ที่ปรึกษาหลัก : รศ. ดร.วีระศักดิ์ ลิขิตเรืองศิลป์

ความร่วมมือในการลงทุนระหว่างภาครัฐกับภาคเอกชน (Public-private partnership หรือ PPP) เป็นทางเลือกในการส่งมอบโครงการและรูปแบบสัญญาระหว่างภาครัฐและเอกชนซึ่งใช้กันอย่างแพร่หลายในโครงการโครงสร้างพื้นฐาน มีหลายปัจจัยที่ส่งผลกระทบต่อความสำเร็จของโครงการ PPP โดยส่วนใหญ่เป็นปัจจัยเฉพาะประเทศ เนื่องจากเมื่อไม่นานมานี้สาธารณรัฐประชาธิปไตยประชาชนลาวได้นำ PPP มาใช้ในโครงการโครงสร้างพื้นฐานหลายโครงการผู้มีส่วนได้เสียทุกคนจึงต้องเข้าใจความเสี่ยงวิกฤตที่มีผลต่อสมรรถนะของโครงการ ในงานวิจัยนี้เราระบุ ประเมิน และจัดอันดับปัจจัยเสี่ยง รวมถึงกลุ่มความเสี่ยงวิกฤตที่มีผลต่อการพัฒนาโครงการ PPP ในประเทศลาว เราใช้แบบสอบถามและการสัมภาษณ์เชิงลึกถูกใช้เพื่อรวบรวมข้อมูลจากผู้ตอบจำนวน 9 ท่าน ซึ่งเป็นตัวแทนของภาครัฐและเอกชนมีประสบการณ์ในโครงการ PPP การสัมภาษณ์ดำเนินการภายใต้วิธี Delphi แบบสองรอบ โอกาสการเกิดและความรุนแรงของความเสี่ยง PPP ได้ถูกปะเมินโดยใช้วิธี impact method กลุ่มความเสี่ยงถูกจัดอันดับโดยเทคนิค TOPSIS ปัจจัยเสี่ยงในโครงการ PPP จำนวน 33 ตัวได้ถูกระบุและแบ่งออกเป็น 8 กลุ่ม ผลการวิจัยพบว่า 15 ปัจจัยเสี่ยงวิกฤตจาก 7 กลุ่มมีผลกระทบต่อโครงการ PPP ในประเทศลาวเป็นอย่างมาก สิ่งที่งานวิจัยค้นพบเป็นประโยชน์ต่อรัฐบาลและภาคเอกชนสำหรับเข้าใจปัจจัยเสี่ยงซึ่งมีผลกระทบต่อโครงการ PPP รัฐบาลจะต้องจัดการปัจจัยเสี่ยงเหล่านี้อย่างเหมาะสม เพื่อให้โครงการ PPP ได้รับผลกำไรและดึงดูดนักลงทุนภาคเอกชน ผลลัพธ์เหล่านี้ให้ข้อมูลที่เป็นประโยชน์และเป็นแนวทางสำหรับทุกฝ่ายที่ต้องการเข้าร่วมโครงการ PPP ในลาว

| สาขาวิชา | วิศวกรรมโยธา | ลายมือชื่อนิสิต | ................................................... |
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Siamphone Maneevong : RISK MANAGEMENT OF PUBLIC-PRIVATE PARTNERSHIP (PPP) INFRASTRUCTURE PROJECTS IN LAOS. Advisor: Assoc. Prof. VEERASAK LIKHITRUANGSILP, Ph.D.

Public-private partnership (PPP) is a popular option of project delivery and contractual scheme between the public and private sectors public infrastructure projects. Many factors contribute to the success of PPP projects, most of which are country-specific. Since Laos has recently adopted PPP for several infrastructure projects, all stakeholders must understand the critical risks that influence the performance of PPP projects. In this research, we identify, evaluate and rank the critical risk factors and risk categories that affect the PPP project development of in Laos. The questionnaire survey and In-depth interviews were used to gather information from nine respondents, who represent the public and private sectors and have extensive experience in PPP projects. The interviews were carried out using a two-round Delphi. The likelihood of occurrence and the severity of risks were assessed by using the impact method and the technique for the order of preference by similarity to ideal solution (TOPSIS) method. Thirty-three risk factors in PPP projects were identified and grouped into eight categories. The results show that 15 critical risk factors from seven categories have a major impact on PPP projects in Laos. The findings benefit the Lao government and the private sector for understanding the risk factors affecting PPP projects. The government must appropriately address these factors, so that PPP projects will be more profitable and attractive to the private investor. These results provide valuable information and a guideline for all parties who want to participate in the PPP projects in Laos.

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| Academic Year: | 2018 | Advisor's Signature |
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# ACKNOWLEDGEMENTS

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# CHAPTER 1
# INTRODUCTION

## 1.1    Background

At present, Laos is a nation that achieve her economic growth and development objective, However, the government of Laos acknowledges the poor state of public infrastructure and service in the country, which is a main impediment. The provision of public infrastructures and services has mostly relied on the government budget and foreign development aid. Such basic infrastructures and public services include transportation, electricity, housing, health care and education, The National Socio-Economic Development has a plan to embrace the private sector as the main instrument of growth. To implement this approach, the government has emphasized the role of public-private partnership (PPP) as a tool for bridging the infrastructure gap and improving the performance of public services in the country such as improving transport and communication across the country as well as upgrading energy production, transmission and distribution facilities (The Asian Development Bank, 2015) Between 1993 and 2011, Laos had gained experience in implementing PPP in the energy sector for a total of 16 projects (Ministry of Public Works and Transport, 2014). Meanwhile, the positive experience with PPP has convinced the government that this investment model may succeed in other sectors such as transport sector and health as well.

For the construction industry, the Gross Domestic Product (GDP) of Laos increased from 81 billion dollar in 2016 to about 95 billion dollar in 2017, as shown in Figure 1.1, As can be seen, the average GDP of the construction industry in Laos was about 70 billion dollar between 2012 and 2017 (Gross domestic product, 2018). To achieve this, Laos needed a significant amount of investment from non-government sectors. To attract the private sector, PPP has been arranged to fund such infrastructure needs (Ministry of Public Works and Transport, 2014). PPP has become an important tool for the government to achieve the growth rate above 8% per annum and Laos can graduate from the least-developed country status by 2024.
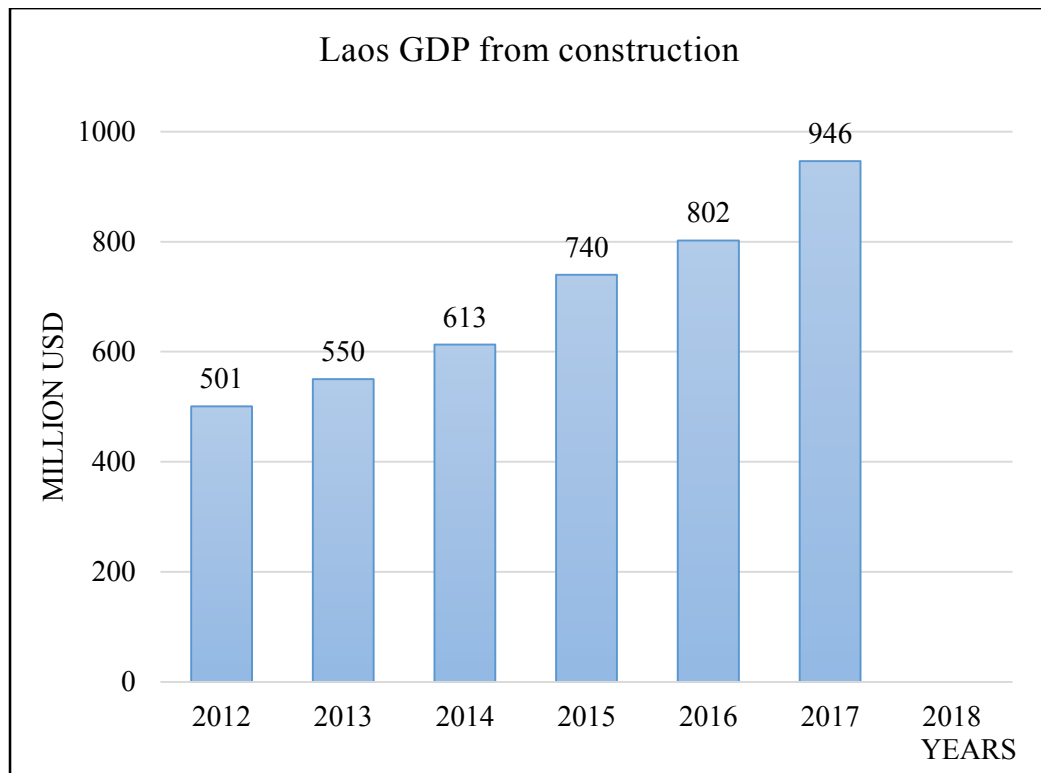
Figure 1.1 Gross Domestic Product (GDP) of construction in Laos (Gross domestic product, 2018)

Between 1993 and 2011, Laos had developed 16 PPP projects in the energy sector. The nation also needs an improved road network to achieve its land-linked vision for the highway sector. Due to its limited resource, the government must prioritize all potential   projects to allocate public investment and encourage greater private investment. Table 1.1 shows the total of infrastructure investment needs in different Asian countries (Bhattacharyay, 2010).

PPP encompasses a long-term relation, which engages various phases of infrastructure projects (i.e., planning and design, construction, and operation). Nevertheless, risks in PPP projects are challenging to control and analyze due to the scale of PPP projects, long concession period and complexity. Appropriate risk transfer and optimal risk allocation between the public and private sections significantly contribute to the success and effectiveness of PPP projects (Bing et al., 2005; Ke et al., 2010; Zou et al.,2008).

Table 1.1 Infrastructure investment needs as a percentage of estimated GDP between 2010 and 2020 (Bhattacharyay, 2010)

| Country | Investment as percentage of Estimated GDP | | | | |
|---------|-------------------|-----------------|---------|------------------------|-----------|
| | Transport (%) | Electricity (%) | ITC (%) | Water & sanitation (%) | Total (%) |
| Cambodia | 4.43 | 0.95 | 2.97 | 0.36 | 8.71 |
| PRC | 1.39 | 3.42 | 0.44 | 0.13 | 5.39 |
| Indonesia | 3.88 | 0.98 | 0.97 | 0.35 | 6.18 |
| Lao PDR | **10.62** | **0.00** | **2.40** | **0.60** | **13.61** |
| Mongolia | 1.94 | 4.42 | 0.27 | 0.04 | 6.68 |
| Myanmar | 12.04 | 0.00 | 1.21 | 0.21 | 13.45 |
| Malaysia | 2.70 | 0.00 | 1.46 | 1.88 | 6.04 |
| Philippines | 2.30 | 1.87 | 1.22 | 0.65 | 6.04 |
| Thailand | 0.58 | 3.69 | 0.45 | 0.19 | 4.91 |
| Vietnam | 2.07 | 3.12 | 2.38 | 0.54 | 8.12 |
| Total | 1.61 | 3.22 | 0.53 | 0.17 | 5.54 |

## 1.2 Problem statement

Risk management is extremely important for construction project management, especially infrastructure projects. Large infrastructure projects are characterized by complexity and uncertainties (Guo et al., 2014), For PPP projects, the similar trend can be observed. PPP projects are usually challenged by both project management problems, which require approaches with short-term solutions and partnership problems, which require strategic long-term approaches. The project success usually needs three main components: (1) achieving time, cost, and quality objectives; (2) quality project management process; and (3) satisfying project stakeholders' needs with respect to the project management process (Baccarini, 1999).

PPP has been increasingly adopted to procure large-scale infrastructure projects. Yet, there have been both successful and unsuccessful projects. Efficient risk management significantly contributes to the success of PPP infrastructure projects (

Zou et al., 2008). It is important for PPP partners to manage risk from the project life cycle perspective. Risk must be identified, assessed, and allocated appropriately before the project begins. The risk management process significantly benefits PPP project development. For Laos, there has been no specific study on PPP risk management, especially identifying the risk factors of the PPP projects in Laos. This is primarily due to lack of PPP experience in the nation. Zhuang (2005) pointed out that the critical problems related to the public in PPP projects were inexperienced government bodies; lack of proper understanding of PPP, government commitment, support, and full cooperation of the private sector; counter party risks related to poor credit quality of local administrative bodies; as well as inappropriate risk sharing and lack of appropriate financial risk guarantees from the public sector. Laos is also facing the problematic issues with the private sector representatives, which are dissatisfied with lack of transparency, policy uncertainty, and inconsistent application of the law (OECD, 2017). Figure 1.2 displays the results from the survey undertaken for the global competitiveness index 2016-2017 about the problematic factors for doing business in Laos. The sixteen factors are: (1) inefficient government bureaucracy, (2) tax rate, (3) tax regulations, (4) corruption, (5) inadequate educated workforce, (6) policy instability, (7) access to financing, (8) poor work ethic in national labor force, (9) restrictive labor regulations, (10) government instability/coups, (11) insufficient capacity to innovate, (12) inadequate supply of infrastructure, (13) poor public health, (14) crime and theft, (15) inflation, and (16) foreign currency regulations.

Ke et al. (2012) pointed out that the existing research studies on risk management of PPP projects have focused on the planning, conceptual or termination stage. In addition, the interviewees were unfamiliar with the risk identification and assessment methods.
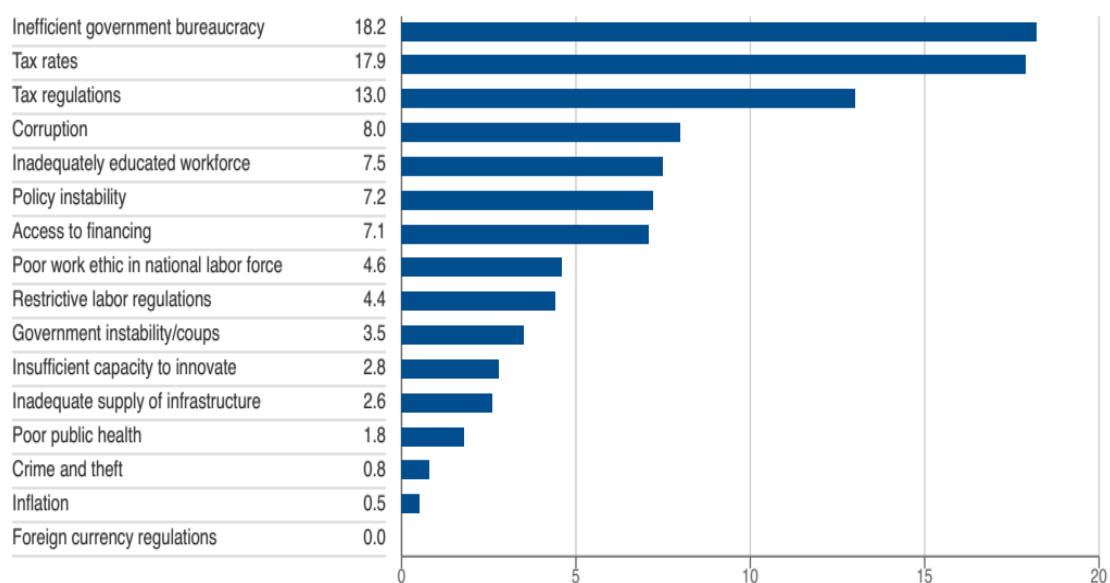
Figure 1.2 Most problematic factors for doing business in Lao PDR from the World Economic Forum 2017 (Ali, 2017).

## 1.3 Research objective

The two main objectives of this research are:

1) To identify and evaluate the critical risk factors that affect the development of public–private partnership (PPP) projects in Laos

2) To rank significant risks factor by risk categories

## 1.4 Scope of this research

This research investigates the PPP projects in Laos from the viewpoints of both public and private sectors. The necessary data were collect through questionnaire surveys and in-depth interviews with a group of experts who have extensive experience in the construction industry and have been involved in PPP project management in Laos.

The prospect respondents are divided into two group.

The public sector includes:

- Department of Promotion of Investment, Ministry of Planning and Investment.

- Department of Electric Energy Policy, Ministry of Energy and Mine and Investment.

- Department of Roads, Ministry of Public Work and Transport.

- Department of Planning and Corporation, Ministry of Public Work and Transport.
- Lao Economic Research Institute

The private sector, which includes:

- Duangdy Construction Co.,Ltd. (Vat Phou Road, Champasack Province)
- Maliny Construction Co.,Ltd. (Pakkayung Bridge, Vientiane Province)

## 1.5  Steps of Research

This research consists of seven steps, as shown in Figure 1.3.

**Step 1:** Do literature review on relevant topics

The first step is to review relevant knowledge collected from academic journals, textbooks, report, and websites. This review focuses on the fundamentals concepts of risk, risk management process, and the basic concepts of Delphi technique applied in construction

**Step 2:** Prepare a preliminary PPP risk list by compiling the results from the literature review

This step is to compile the risk factors in PPP projects compiled from the findings in the previous step

**Step 3:** Verify the preliminary risk list

In this step, we first chose the respondents who had extensive experience in PPP project management in Laos. They were requested to examine the preliminary risk factors that are considered potential risks in implementing PPP projects in Laos. The questionnaire survey was adopted for this verification process.

**Step 4:** Collect data concerning the level of the likelihood of occurrence and the severity of risks

This step is to collect data concerning the level of the likelihood of occurrence risks and the severity of risks, by conducting in-depth interviews with the respondents. Each interview lasted 90-120 minutes.

**Step 5:** Assess the level of the likelihood of occurrence and the severity of risks

This step is to analyze the data collected from the interviews in the previous step. The data were then analyzed, as will be discussed in Chapter 3.

**Step 6:** Rank the risk categories for PPP projects in Laos by using TOPSIS method

In this step, we used the TOPSIS (Technical for Order Preference by Similarity to Ideal Solution) method to rank the risk categories in the PPP projects in Laos.

**Step 7:** Conclude the research

After analyzing the results, we discussed the results, drew conclusions, and discussed the limitation and recommendation of this research.

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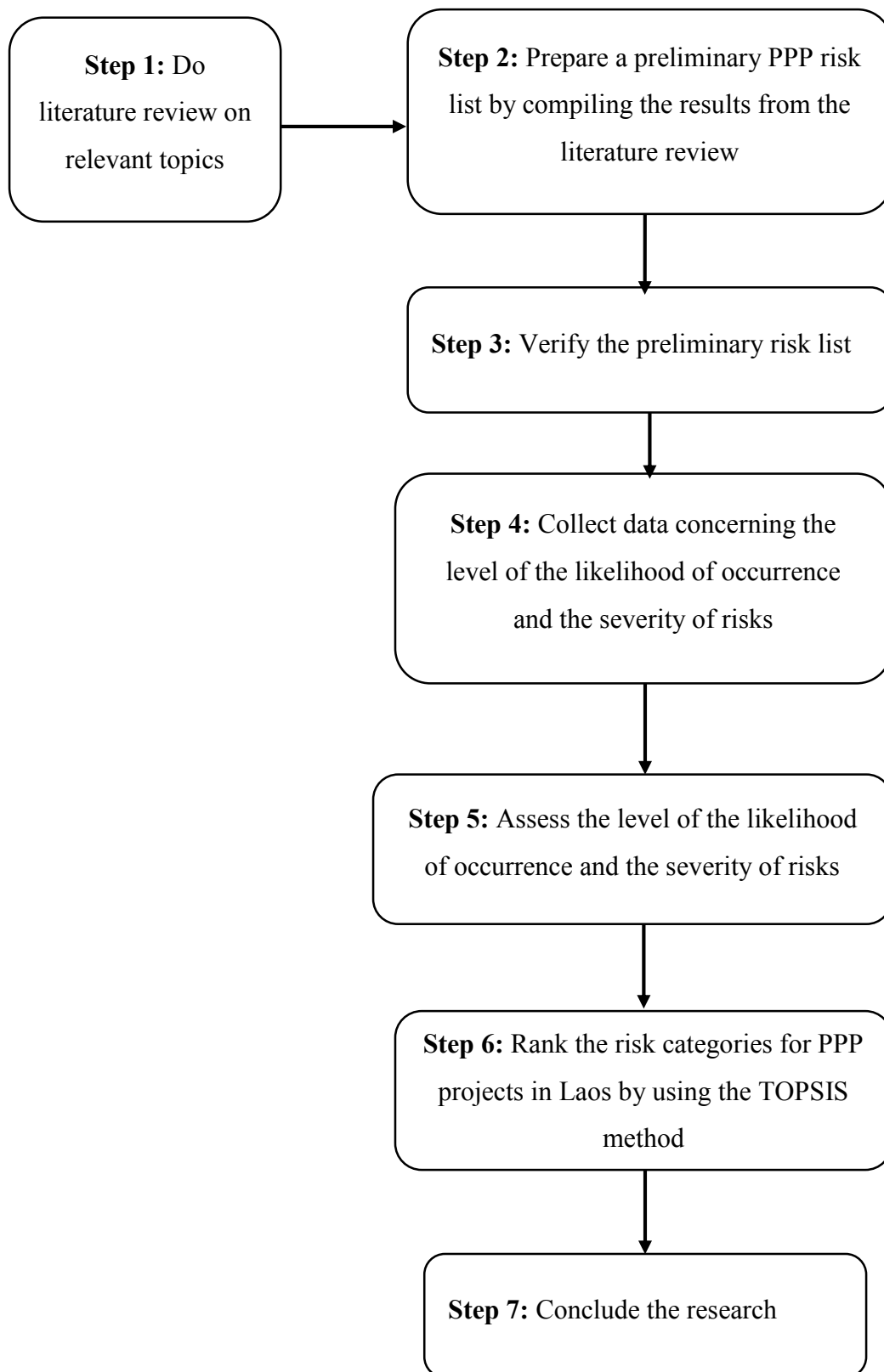
Figure 1.3 Steps of research

**CHAPTER 2**

**LITERATURE REVIEW**

This chapter reviews basic knowledge of risk management in the construction context of projects, which is divided into three sections. The first section focuses on the discussion of previous research on risk management in construction projects. The second section reviews PPP projects. Then, the final section discusses on Delphi and TOSIS method.

## 2.1 Risk and risk management in construction projects

### 2.1.1 Risk in construction projects

Risk is the chance of an adverse event which depends on the circumstances. Mills (2001) stated that risk needs to be identified and managed early in the procurement process. According to Hayes et al. (1987), risk and uncertainty are part of all construction work. They might have positive or negative outcomes. Risk is presented everywhere in every aspect of our lives, in which can be defined as threats that have impacts on the success of projects (Barber, 2005). There are two main categories of risk: (1) unique risk and (2) general risk, which could be faced during designing and constructing stages (Ling & Hoi, 2006).

Edwards & Bowen (1998) categorized risk into two types: the natural and risk which includes weather and geological systems and the human risks consisting of social, political, economic, financial, legal, health, managerial, technical and cultural uncertainty. Risk in construction projects is known as a risky business due to its complexity and strategic nature. There are two sources: predictable engineering risks are and unpredictable non-engineering risks are non-predictable (Renuka et al., 2014), as shown in Figure 2.1.

is risk management. So, that risk of PPP is borne by the party that is best able to manage or to absorb it.

To obtain the objective of a project, risk management is necessary for managing the risk. Therefore, risk management refers to a coordinated set of activities and methods used to direct an organization and to control other potential risks that can affect the ability to achieve such objectives. This is why risk management and risk identification become complicated and crucial in a PPP project (Ke, 2011). In doing this, the identification, allocation, and management have become essential parts of the PPP process. The amount and type of risk depend on each project character.

For PPP transportation projects in Vietnam, Likhitruangsilp et al. (2017) found that some of the most risk factors are land acquisition and compensation, which delay project approvals and permits. With it is also found that eight critical risk factors such as corruption, change of the project scope, lack of transparency in bidding, inflation, payment issues, inadequate feasibility study, inappropriate allocation of responsibility and risk, and fluctuation of interest rate represent the different in China. According to Ke et al. (2011), Ten risk factors were identified in China: These include: government's intervention, poor political decision making, financial risk, government's reliability, market demand change, corruption, subjective evaluation, interest rate change, immature juristic system, and inflation.

### 2.1.3   Risk management in construction project.

Risk management is an regular process of systematically identifying, analyzing, and responding to risk throughout the life cycle of any project, which helps to gain the risk response measures, monitoring and managing risk (Mills, 2001; Wang et al., 2004). Moreover, the risk management process can be applied to any situation where an underside or unexpected outcome could be significant or where opportunities are identified. Risk management is important for the decision-making process in construction project and management (Lu et al., 2007), especially regarding the project's integration, scope, time, cost, quality, human resources, communication and procurement.

Since it allows anticipating the occurrence of events that could adversely affect a construction project and to define actions that could minimize their impact, so that it might represent risk management is an important area of project management then(Serpell et al., 2015). In Figure 2.2, it show the sequence for dealing with risk, including risk identification, risk classification, risk analysis, risk attitude, and risk response (Norman, 1993).
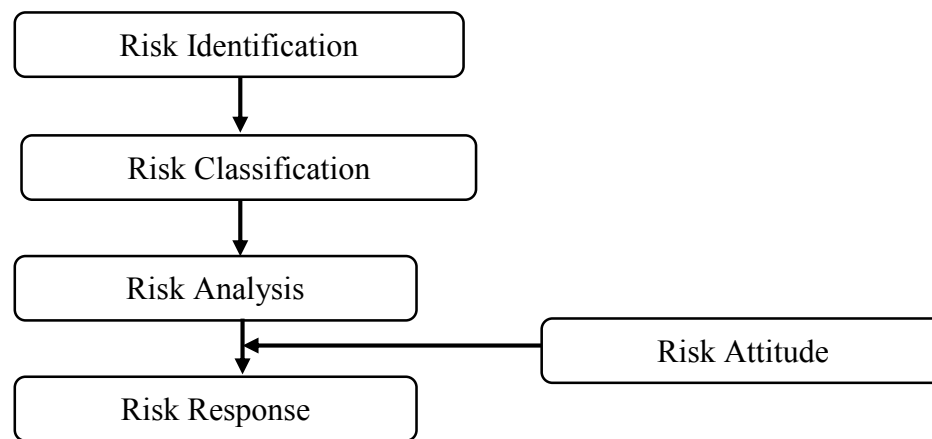


Figure 2.2 The risk management framework (Norman, 1993)

## 2.2 Overview of Public-private partnership projects

Previous studies on PPP shows that an objective, reliable and practical risk assessment model for the PPP project is necessary for the success of the PPP project (Bing et al., 2005). "Public" refers to the government and "Private" refers to enterprise, including both private enterprises and state-owned enterprises. Many researchers have explored the application of PPP to improve the efficiency of infrastructure delivery.

Public-private partnerships (PPP) are widely used to deliver a series of infrastructure projects in the world (Cui et al., 2018). The ADB states that PPP is a contractual arrangement, which is commonly characterized as a long-term arrangement between the public and the private sector, to provide a public service. with risks allocation to the party best able to bear them and often supported throng private financing. In other words, the private sector commits via contract to deliver an economic or social infrastructure project to the government. Therefore, during the PPP contract, the government becomes the buyer rather than the provider of services.

Public-private partnerships (PPP) implementation has an increase in popularity. The basis of PPP format is that the state government departments have transformed from being owners and operators of infrastructure and public assets into the purchasers of service from the private sector. At the same time, those private sector become the long-term service providers by taking the responsibility of the finance, feasibility study, design, construction, and the operation of the infrastructure and facilities.

## 2.3    The key guiding principle of a PPP Programmed

The key guiding principle of a PPP Programmed may include:

**Value for Money:** which is the combination of the cost, price, quality, quantity, timeline, and risk of the PPP project as compared to public delivery. PPP projects should better VFM than conditional delivery.

**Affordability:** PPP projects should only be awarded in the case that the government can meet the payment or liabilities required for the duration of the contract, and/or only if users are able to pay the required tariffs or users fees. If cannot the project should not be implemented as a PPP.
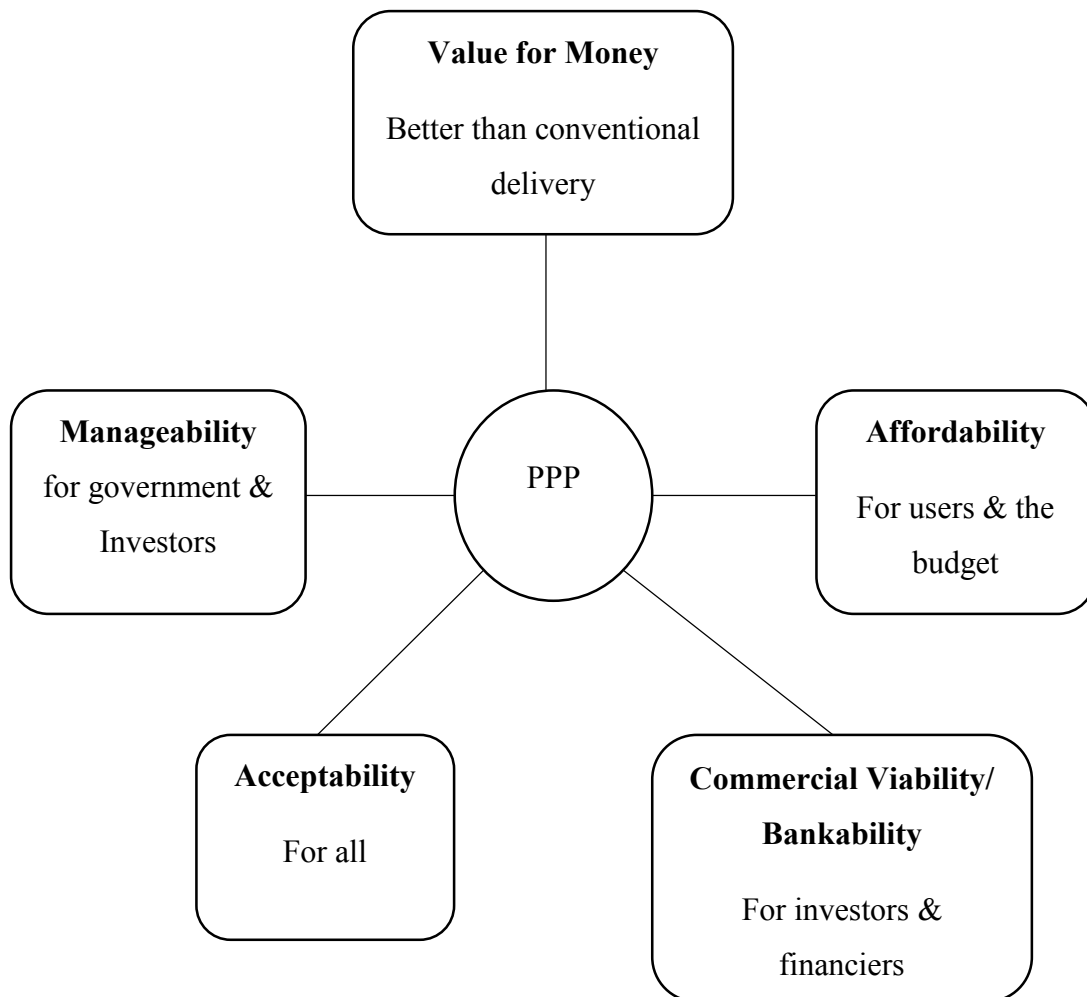
Figure 2.3 Key PPP Guiding Principle (The World Bank, 2017)

**Commercial Viability:** PPP projects should not be implemented if they are not commercially viable or financial for the private sector. The concessionaires in PPPs need to remain profitable if the project is to succeed and deliver value.

**Manageability:** A PPP project must be manageable for both the contracting authority and the concessionaire. It should make sure that the contractual agreement and relates monitoring and management procedures are clear and workable. The contracting authority must also ensure that capacity is in place to manage the contract and to meet its obligations under the contract.

**Acceptability:** One of the government's central responsibilities is to ensure fairness and protection of the public interest.

### 2.3.1 The benefit of Public-private partnership

According to Ke et al. (2010), PPP is a form of procurement recognized as an effective way of delivering the value for money in public infrastructure or service. VFM is defined as the effective use of public funds on a capital project which might be a private sector innovation in asset design, construction techniques and operational practices in transferring key risk in design, construction delays, cost overruns and finance the private sector entities that they have to manage. PPP is it seeks to combine the advantage of competitive tendering and flexible negotiation. another hand. The benefit of PPP is the risk-sharing by the allocation of the risk on an agreed basis between the public and private sectors. Furthermore, PPP has encouraged technology transferring or introducing new technology (Bing et al., 2005).

However, there are some limitations associated with PPP. Esther and Stephen (2010) said that the PPP form of procurement is complex, which involves many parties in conflicting objectives and interests. When the number of parties involved become large, with long-term relationships, it usually cased complicated contract and complex negotiations. The next limitation of PPP is the political risk. It can happen when the local government and stakeholders have no experience with the PPP. This will occur if the local government induce different stakeholders on the PPP policy.

### 2.3.2 Public-private partnership in Laos

In the Lao PDR, PPP is motivated to make an impact on the country economic. which is supported by the facilitation fund. A fund will be established to facilitate private sector investment with the activities regarding as infrastructure investment such as transportation parts (Toll road, railway, bridges, and tunnels), energy part (Power generation and supply), and Social infrastructure (Hospital, schools, and government accommodation). Building infrastructure under a PPP structure is often associated with a form of project financing is known as Build Operated to the government, Some of the project examples, the project in Laos, Thuen-Hinboun Hydropower dam project and National Road No.14A project (Vorasing & Phommasone, 2015). For this agreement, a private-sector which receives a concession agreement usually of between 20 to 50 years from a public sector agency to build and operate infrastructure in such concession

period. This presented in Figure 2.4, contracting partners including the government, the general contractor, leaders and shareholders.
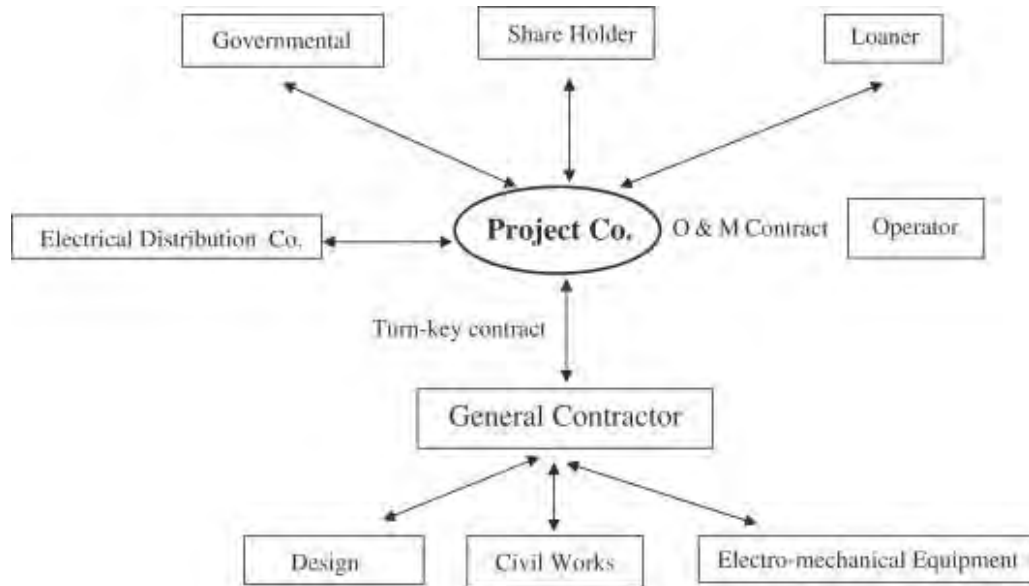


Figure 2.4 Structure of a BOT contact (Forouzbakhsh et al., 2007).

### 2.3.3 The projects under Public-Private Partnership projects

Energy and mining sectors:

Table 2.1 The Energy project under PPP projects

| Year | Name of projects | Investor | Capacity (MW) | Mode | Value ( million US dollar) |
|------|------------------|----------|---------------|------|----------------------------|
| 1998 | Thuen-Hinboun | EDL (Laos) Nordic Group (Norway) GSM ( Thailand) | 210 | BOT, 25 years concession | 240.2 |
| 1999 | Houay Ho | EDL (Laos) HemarajLand & Development (Thailand) Glow Co.,Ltd (Thailand) | 150 | BOT, 25 years concession | 243 |
| 2006 | Xakaman | EDL (Laos) VLPC (Vietnam) | 250 | BOT,29 years concession | 273 |
| 2009 | Nam Thuen 2 | LHSE (Laos) EDL (France) EGCO (Thailand) | 1075 | BOT, 25 years concession | 1300 |
| 2010 | Nam Lik 2 ( Nam lik1-2) | EDL (Laos) CWE (China) | 100 | BOT, 25 years concession | - |
| 2012 | Nam Ngum 2 | EDL (Laos) Shlapak Group (USA) Ch. Kanchang (Thailand) PT Construction & Irrigation Co., (Laos) Ratchaburi (Thailand) | 615 | BOT, 25 years concession | 1300 |

| Year | Name | Developers | Capacity (MW) | Type | Cost |
|------|------|-----------|---------------|------|------|
| | | Bangkok Expressway PCL (Thailand) TEAM Consulting Engineering (Thailand) | | | |
| 2012 | Nam Ngum 5 | EDL (Laos) Sinohydro (China) | 120 | BOT,25 years concession | 200 |
| 2015 | Nam Ou 2 | EDL (Laos) Sinohydro (China) | 120 | BOT, 25 year concession | 300.17 |
| 2015 | Nam Ou 5 | EDL (Laos) Sinohydro (China) | 240 | | 770 |
| 2015 | Nam Ou 6 | EDL (Laos) Sinohydro (China) | 180 | | |
| 2015 | Hongsa | Thailand Lao government | 1878 | BOT, 25 years concession | 3700 |
| 2019 | Xayabuly | EDL (Laos) Ch.kanchang (Thailand) EGCO (Thailand) Natee Synergy (Thailand) Bang kik Expreeway (Thailand) PT (Thailand) | 1260 | - | - |

Transport and Road sector:

Table 2.2 The transports projects under PPP projects

| Year | Name of project | Company | Mode | Value (million US dollar) |
|------|-----------------|---------|------|---------------------------|
| Opened to 1995 | Tha Ngone Bridge | Australian | Join venture, 15-years concession | 50/50 4.2 |
| 2008-2011 | The Road No.14A | Duangdy Construction Sole Company | BOT, 45-years concession | 22,605,080 |
| 2014 | National Road No.13 (13N and 13S) | - | BOT, 25- years concession | - |
| 2017 | Laos-china Railway projects | Laos and China | - | 5986 |
| Project in Planning | Vientiane-Pakxe Expressway | - | - | - |
| Project in Planning | Road 13 South from Vientiane to Pakxan district | - | - | - |

For the legal and financial facilitation, Laos also provided in decree on PPP projects in Laos. The government also establishes a project preparation facility to cover the cost of advisory and support services related to the preparation, structuring, tendering, award, and financial close stages of public-private partnership projects.

The government promotes public-private partnerships through setting up a legal and regulatory framework that are conducive for private sector participation while taking public interests into account. Respecting vested rights and obligations of public and private sectors, and ensuring public interests, the government, through the investment committee, is entitled to amend and supplement the legal and regulatory framework of the Lao PDR to accommodate future public-private partnerships.

Table 2.3 Regulatory restrictions on foreign investment in Lao PDR (OECD, 2017).

| Sector | Description of the restriction | Legal authority/source of information |
|---|---|---|
| Electricity: generation and distribution | Article 10. Investment in Operations Relating to Electricity: The State promotes investment in operations relating to electricity, with an emphasis upon hydropower in order to utilize the [electricity generating] potential of water sources that are natural resources. Investment in operations relating to electricity may be undertaken by different types of enterprises as follows: The State invests by itself; The State invests with other domestic or foreign parties; Domestic cooperative or private investment.[...] Enterprises engaged in operations relating to electricity may undertake their operations in the | Law on Electricity No. 02/97/NA, Art. 10, 12, Dated: 12 April 1997. Law on Electricity No 03/NA, dated 20 December 2011 |

| | | |
|---|---|---|
| | *following forms: Build, operate and transfer (BOT); Build, operate, own and transfer (BOOT); Build, transfer and finance (BTF); The State engages in the undertaking by assigning the State electricity company to be its representative; Investment in some other form.*<br><br>*Article 12. Concession Procedures: An electricity enterprise shall request a concession [...] The government of the Lao People's Democratic Republic will participate in the shareholding when there is a concession for an electricity enterprise.* | |
| *Construction* | *A foreign private sector party may invest up to 100% in a concession investment if the registered capital is more than USD30 million. Where the registered capital is less than USD30 million, the foreign private sector party may only invest up to 49%; the Prime Minister via a decree may exempt this limitation.* | *"Lao Roads Public Private Partnership: A pilot PPP in Lao PDR : National Road No. 13" ,UNESCAP Event on "Public Private Partnerships (PPPs) for Infrastructure Development in Lao PDR" September, Vientiane; Law on Construction No. 05/NA 26 November 2009* |

## 2.4    Delphi method

The Delphi method has been more widely adopted in many complex areas. The idea was originated from the American defense industry which requires unanimous approved (Chan et al., 2001). The Delphi method has been proved as a popular tool in information system research, and it is applied by experts to solve problems in various situation. This method is an iterative process to collect and distill the judgments of experts using a series of questionnaires interspersed with feedback (Rowe & Wright, 1999).
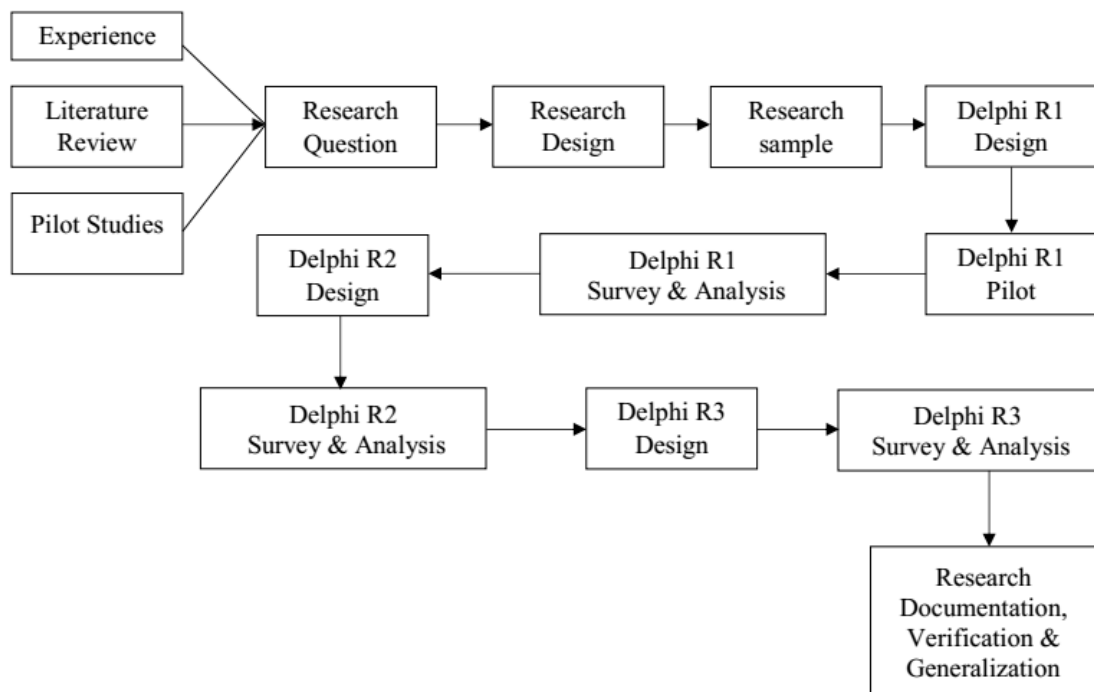


Figure 2.5 Three round Delphi Process (Skulmoski et al., 2007)

The objective of method was to develop a technique that obtains the most reliable consensus of a group of experts. Rowe and Wright (1999) stated that the classical Delphi method by key features: the participants for Delphi are allowed to express their opinion anonymously, the participants are allowed to modify their opinion based previous round, the participants are represented with the feedback from the other participant's view and provides the opportunity for Delphi participant to change their views, and it allows a quantitative analysis and interpretation of data.

According to Manoliadis (2006), the key issues in preparing a Delphi study which are: (1) the definition of experts and their selection, (2) the number of rounds, and (3) the questionnaire structure in each study round. This method could be applied to a qualitative, quantitative or mixed approach, initial question degree of focus whether it is broad or narrow-focused, data collection using the mode of interaction through email, online survey or groupware (Rowe & Wright, 1999; Skulmoski et al., 2007).

## 2.5 TOPSIS (technique for order preference by similarity to the ideal solution)

This method selects the alternative that is the closest to the ideal solution and the farthest from some negative ones. The TOPSIS method is one of Multiple-Criteria Decision Making (MCDM). Rao and Davim (2008) used TOPSIS to evaluate and materials for a given engineering design and There was applied TOPSIS to rank flexible manufacturing system (Rao & Davim, 2008; Venkata Rao, 2008). Such as represents the rationale of human choice, a scale value that both the best and the worst alternative and a simple computation process that can be easily programmed into a spreadsheet (Dursun & Karsak, 2010; Yue, 2011). It also provides several advantages which compare other techniques in risk evaluation of infrastructure PPP projects as well. The steps  shown in Figure 2.6 (Dandage et al., 2018):
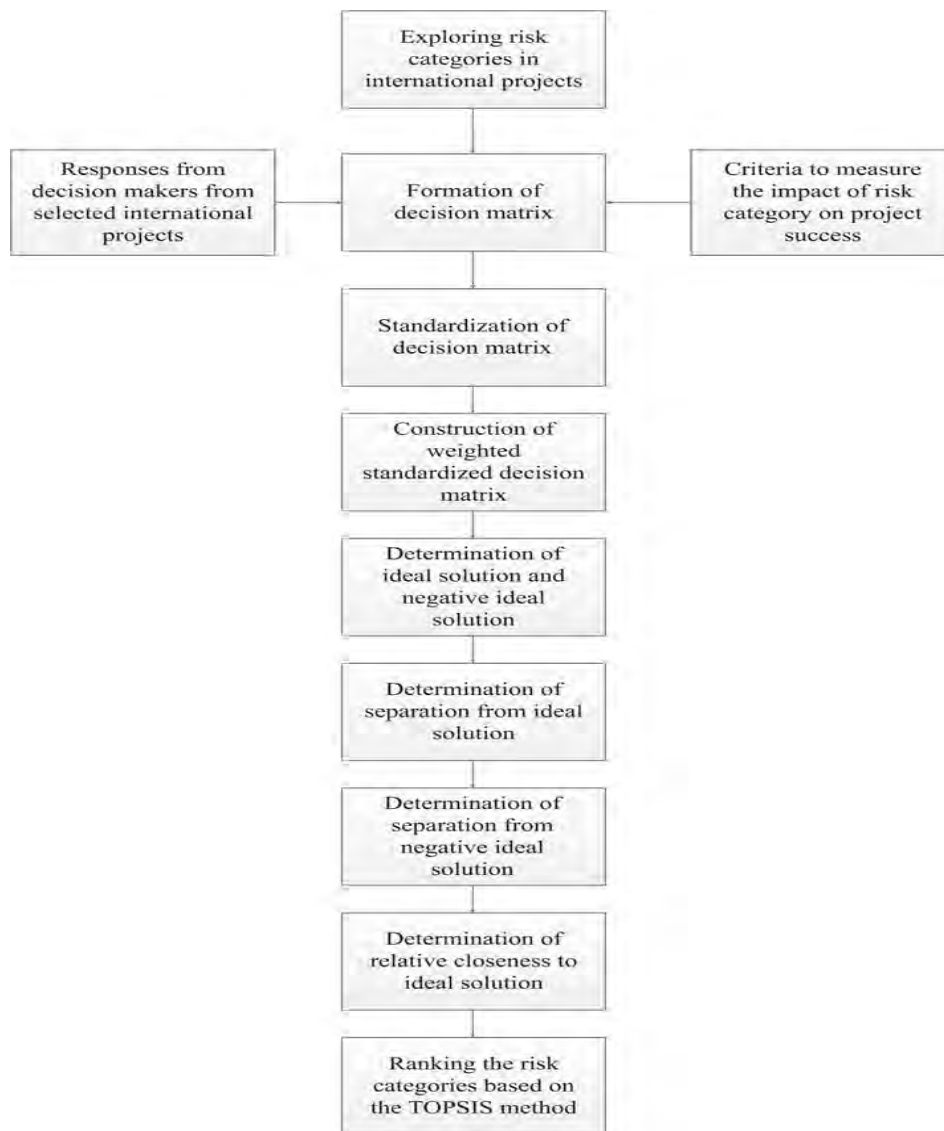
Figure 2.6 Steps of ranking risk categories in international projects using TOPSIS

## CHAPTER 3
## RESEARCH METHODOLOGY

This chapter presents the research methodology use in this. The contents encompass risk identification, risk assessment, risk allocation, data collection, and conclusion, as shown in Table 3.1.Steps of the research

### 3.1 Research methodology

In this research, we adopted the Delphi questionnaire survey of a group of expert via several rounds of intensive questionnaires, which were interspersed with controlled opinion feedback, and with the consolidated result of each round being was fed into the next round.

Table 3.1 Steps of the research

| Step | Description | Method | Source of data |
|------|-------------|--------|----------------|
| 1 | Do literature review on relevant topics | Literature review | Journal, books and report |
| 2 | Prepare the preliminary PPP risk list by compiling the results from the previous literature review | Literature review | Journal, books and report |
| 3 | Verify the preliminary risk list | Questionnaire survey and interview | The first round of the Delphi process |
| 4 | Collect data concerning the level of the likelihood of occurrence risks and the severity of risks | Questionnaire survey and interview | The second round Delphi process |
| 5 | Analyze the result from the interviews in Step 4 | Impact method | The data collection from step 4 |
| 6 | Rank the most significance risk categories for PPP project in Laos | TOPSIS method | The data collection from step 4 |
| 7 | Conclude the research | | The result from each step |

## 3.2 Risk identification

Risk identification is the first step of the risk management, whereby the potential risk factors associated with the construction project are identified and classified (Zou et al., 2007). Risk identification is the first step in risk management. A total of 33 risk factors were identified from the literature, as shown in Table 3.2.

Table 3.2 Risk factors in PPP projects from previous studied.

| No | Risk factors | Ke et al. (2010) | Cheung and Chan (2011) | Hwang et al. (2013) | Ameyaw and Chan (2015) | Likhitruangsilp et al. (2017) | Yu et al. (20180) |
|---|---|---|---|---|---|---|---|
| 1 | Lack of support from government | * | * | * | | * | * |
| 2 | Government corruption | * | * | * | * | * | * |
| 3 | Nationalization | * | | * | * | | * |
| 4 | Public credit | * | | | | | * |
| 5 | Public opposition | * | | * | * | | |
| 6 | Inadequate law and supervision system | * | * | | | * | |
| 7 | Legislation change | * | | | | * | |
| 8 | Interest rate fluctuation | * | * | * | * | * | * |
| 9 | Foreign exchange fluctuation | * | * | | * | * | |
| 10 | Environment risk | * | | * | | * | * |
| 11 | Inflation | * | * | * | * | * | |
| 12 | Change in tax regulation | * | | * | | * | * |
| 13 | Organization and communication risk | * | | * | | | * |
| 14 | Inability of concessionaire | * | * | | | * | |
| 15 | Land acquisition | * | | | * | * | |

Table 3.2 (cont.)

| No | Risk | | | | | | |
|---|---|---|---|---|---|---|---|
| 16 | Delay in project approvals and permits | * | * | * |  | * |  |
| 17 | Conflicting or imperfect contract | * | * |  | * | * |  |
| 18 | Financing risk | * | * |  | * | * | * |
| 19 | Difference in working method |  | * | * |  |  |  |
| 20 | Completion risk | * | * |  |  | * |  |
| 21 | Unavailability material or labor | * |  | * |  |  |  |
| 22 | Poor public decision-making process | * | * | * |  | * |  |
| 23 | Third party delay or violation | * |  | * | * | * |  |
| 24 | Unproven engineering techniques | * |  | * | * |  |  |
| 25 | Unforeseen weather/geotechnical | * |  |  |  |  |  |
| 26 | Operation cost overrun | * | * | * | * |  |  |
| 27 | Market competition (Uniqueness) | * |  |  |  |  |  |
| 28 | Change in market demand | * | * | * |  | * |  |
| 29 | Price change | * | * |  |  |  |  |
| 30 | Inadequate experience in PPP |  |  | * | * |  |  |
| 31 | Lack of supporting infrastructure |  |  | * |  | * |  |
| 32 | Residual risk | * |  | * | * |  |  |
| 33 | Force majeure | * |  | * | * | * | * |

**(1) Political risks**

**Lack of support from the government:** the public sector is unreasonably interfered in their in privatized facilities /services

**Nationalization:** with the political, social or economic pressure, the local government takes over the facility run by a private sector without giving reasonable compensation

**Government corruption:** bribery of bureaucrats resulting in inappropriate privileges and benefits being offered to the private sector

**Public credit:** the rejection by the government or the private sector to implement the responsibilities agreed in the contract that brings direct or indirect damage

**Inadequate experience in PPP:** lack of knowledge or skill acquired with PPP projects or public institution's lack of technical expertise and academic experience related to PPP projects

**(2) Contractual and legal risks**

**Conflicting or imperfect contract:** improper contractual arrangements, including inappropriate risk allocation among stakeholders

**Legislation change:** change of regulations and law and other government macroscopic economic policies will cause the increase in project costs and decrease in revenues

**Change in tax regulation:** central or local government's inconsistent application of the tax regulation

**(3) Social and Cultural risks**

**Public opposition:** political and public opposition to project construction

**Inadequate law and supervision system:** lack of specific laws for PPP projects

**(4) Financial and economic risks**

**Interest rate fluctuation:** unanticipated fluctuation in interest rate

**Inflation:** unanticipated local inflation rate due to immature local economic and banking system

**Market competition (Uniqueness):** an actual market competition of the existing project caused by the new project or rebuild project of government or other investors.

**Financial risk:** poor financial market or unavailable financial instrument

**Foreign exchange fluctuation:** fluctuation in currency exchange rate

**Change in market demand:** dement change from the other factors

**Operation cast overrun:** operation cost overrun resulting from improper measurement, overpriced operation and slow operation

**Price change:** Improper tariff design or inflexible adjustment framework leading to insufficient income and revenue of the project company lower than expected

**(5) Relationship risks**

**Difference in working method:** it is referred to different theories or techniques systems, or planned ways of work

**Organization and communication risk:** an increase of transaction cost or a dispute may occur because of the improper organization and communication

**(6) Technical risks**

**Unavailable of material or labor:** due to delay in acquiring materials, resources, machines and equipment, or energy

**Third party delay or violation:** apart from the government or private investors, other project participants do not implement the responsibilities agreed in the contract or project delay

**Inability of concessionaire:** the incapacity of the concessionaire leading to low productivity of project construction and operation

**Completion risk:** project delay and cost overrun

**Lack of supporting infrastructure:** the risks generated by the unavailability of the supporting facilities of the project

**Land acquisition:** the increase in project cost and extension of the project duration caused by the difficulty of acquiring the right of the land

**(7) Design-related risks**

**Delay in project approvals and permits:** delay or refusal of project approval or permit by the government or the local government

**Unproven engineering techniques:** the techniques cannot fulfill the standards and requirement as expected

**Poor public decision making process:** government makes a wrong or poor decision owing to lack of knowledge or interest.

**(8) Natural risks**

**Environment risk:** according to water pollution, air pollution, and noise and vibration (e.g., the burning of waste, etc.)

**Unforeseen weather/geotechnical:** the project site's bad natural condition (e.g., special geographical, poor site condition, etc.)

**Force majeure:** the circumstance that are out of the control of the both partners

**Residual risk:** assets transferred to the government at the end of the concession period would not be normally running

## 3.3 Risk assessment

In this study, we adopted the risk impact indexes on the project performance to assess risk. the index of a risk is calculated by the following equation (Chan et al., 2014; Xu et al., 2010):

$$\text{Impact} = \sqrt{\text{Likelihood} \times \text{Severity}} \qquad (3.1)$$

where:

Likelihood is the likelihood of occurrence risks is the likelihood of a risk event ranging from 0 to 1, the meaning of which are as follows:

| Scale | Scenario |
|:-----:|:--------:|
| 1 | Not expected to happen |
| 2 | Small likelihood |
| 3 | Quite often occurs |
| 4 | Usually occurs |
| 5 | Very frequent occurrence |

Severity is the severity of risk consequence, ranking from 0 to 1, the meaning of which are as follows:

| Scale | Scenario |
|-------|----------|
| 1 | Very low |
| 2 | Low |
| 3 | Medium |
| 4 | high |
| 5 | Very high |

**(1). Cronbach's Alpha**

Cronbach's Alpha is the method to measure of the internal consistency and reliability (Cronbach, 1951). It commonly used to when they have several Likert-type items that averaged from a score.

$$\alpha = \frac{n}{n-1}\left(1 - \frac{\sum_{i=1}^{n} S_i^2}{S_t^2}\right) \qquad (3.2)$$

where

$n$ = number of items;

$\sum_{i=1}^{n} S_i^2$ = sum of the variances of each item; and

$S_t^2$ = Variance of the total scores.

**Ranking the risk categories by TOPSIS method**

In this method, fuzzy set theory is used to the step rank of risk categories (Ameyaw & Chan, 2015; Xu et al., 2010). Figure 3.1 displays:
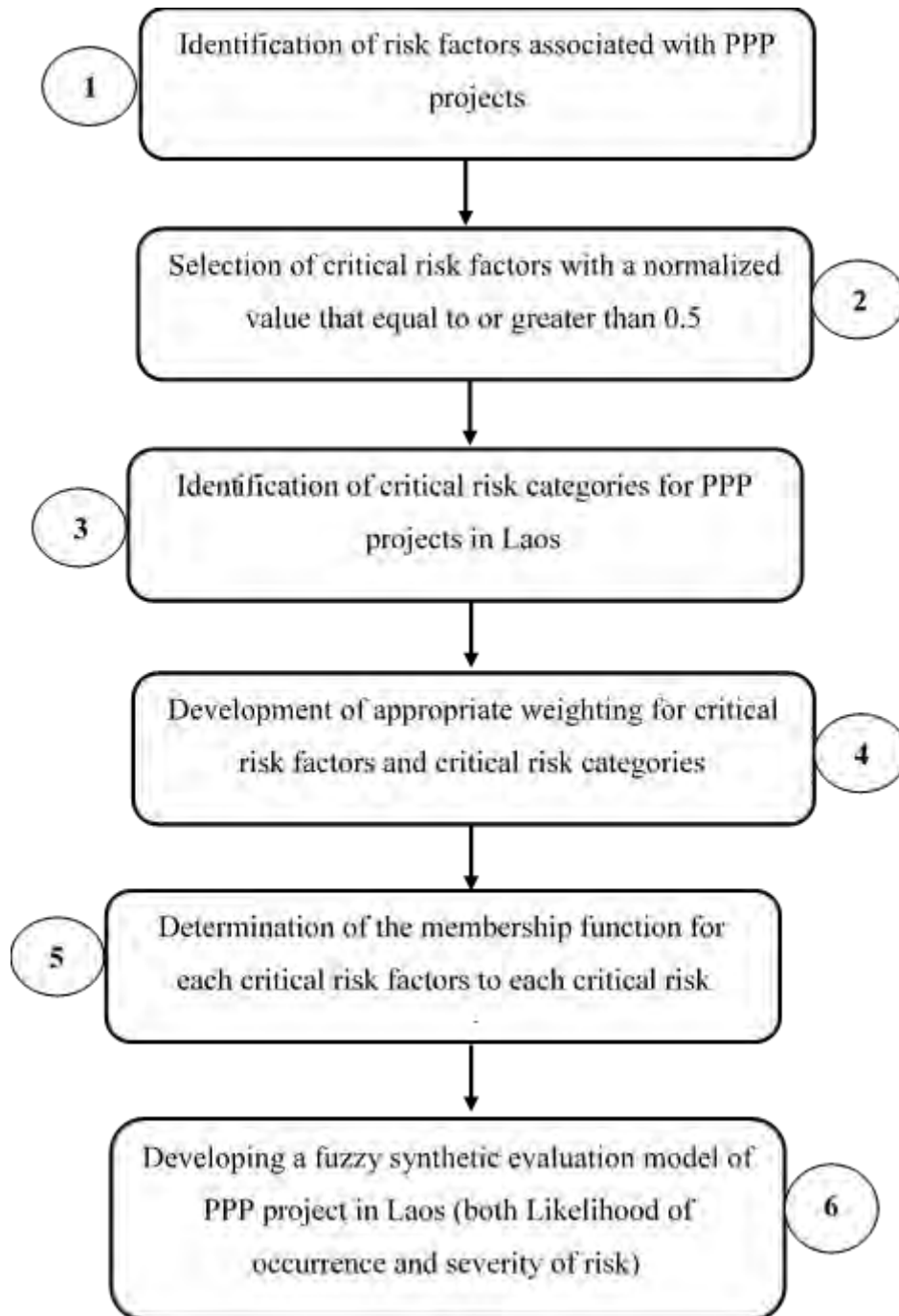
Figure 3.1 Flow chat for ranking risk categories by TOPSIS method

### 3.4 Risk allocation

The rule of thumb for balancing in PPP contracts has traditionally been to allocate risk to the party that can better manage it. Environmental reevaluation is a risk that requires committed involvement from both the public and the private sectors, while both the public and private sectors are vested, by sharing the benefits and risks.
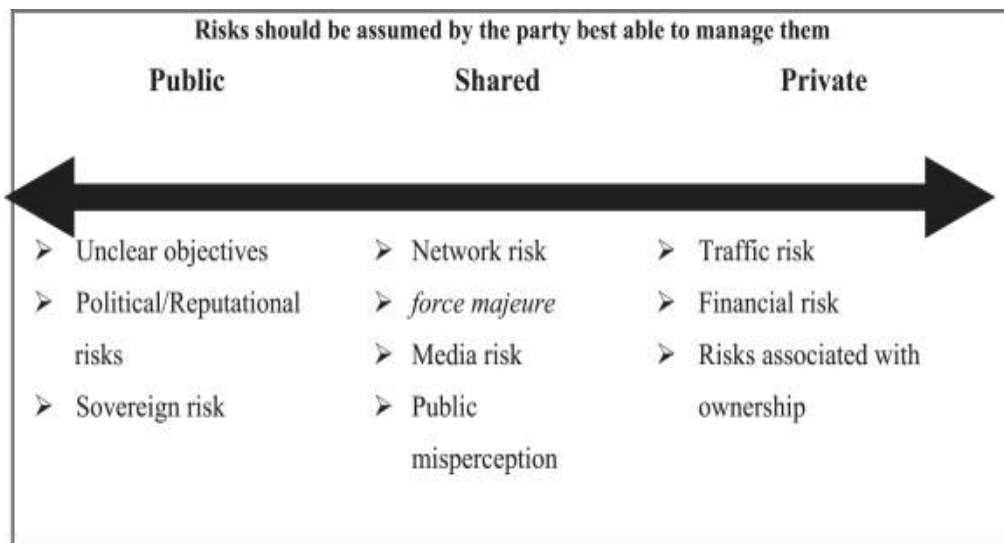


Figure 3.2 Base line of principles on risk allocation (Hwang et al., 2013).

Hwang et al. (2013) proposed that there are risk allocation categories: risks to be allocated to the public sector, risks to be allocated to the private sector, risks to be shared between the public and the private sectors, and risks to be negotiated based on project circumstances.

Figure 3.3 shows a process of negotiation for risk allocation. It is important to understand how the public and private sectors perceive risk allocation, and what allocation they prefer.
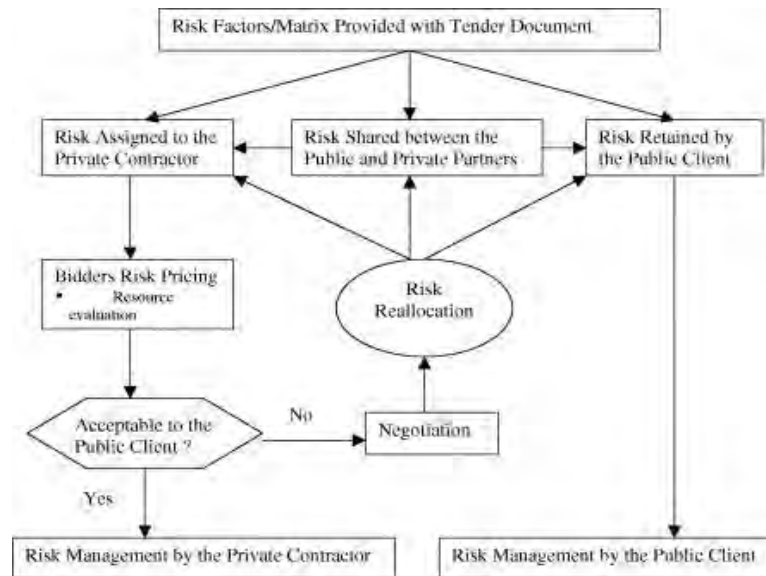
Figure 3.3 Risk allocation process in PPP contract procurement (Bing et al., 2005)

## 3.5 Data collection

In this research, the necessary data were collected by in-depth interviews and questionnaire surveys. The questionnaires were designed to collect qualitative data. The data collection process consists of two round, including the first round is to collect data with interview and questionnaire survey. The second round is to verify the risk factors from the analysis of data collected from the first round as shown in Figure 3.4:
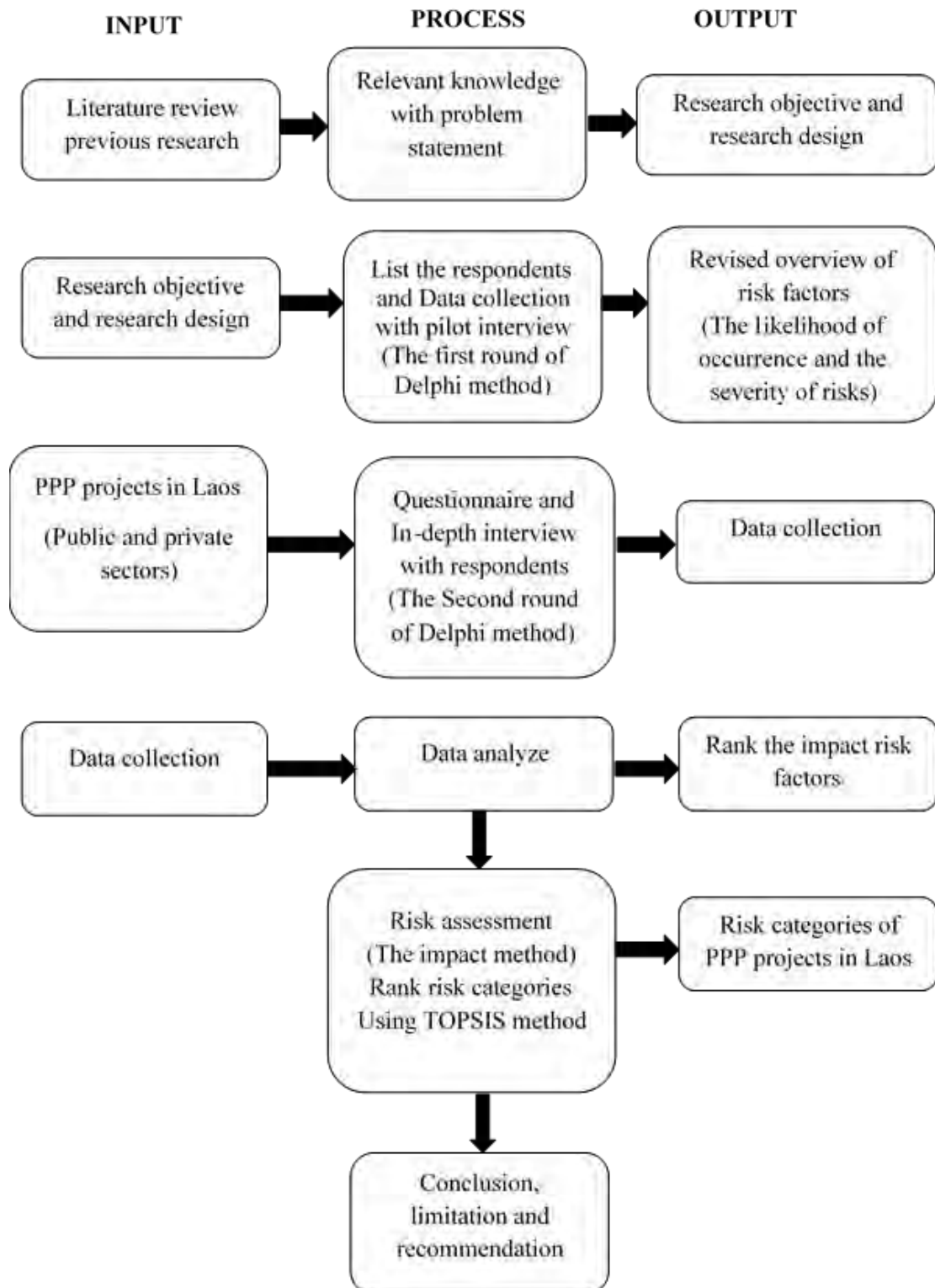
Figure 3.4 Research methodology

The respondents in this study are the professional's companies and organizations working in infrastructure projects. The required information needs the person's experience and knowledge in PPP projects.

The design of questionnaire is based on the findings from our literature review. The respondents were asked to indicate their perception on 33 risk factors using a five-level scale. The risk factors were then divided into eight categories in accordance with the research.

The in-depth interview was used to gather the viewpoints of the respondents and keep them enhance commendation in this study. Furthermore, there are much more opportunities to ask to follow the question, additional information and make more understanding.

## 3.6   Summary

This chapter describes the guidelines such as how to build the questionnaire surveys and collect the data, and analyze method, the relevant data were gathered by various tools and methods included the impact and TOPSIS methods. The results of the data collection and data analysis are presented in the following chapters.

**CHAPTER 4**

**RISK IDENTIFICATION FOR PPP PROJECTS IN LAOS**

This chapter presents and identify risk factors affecting public-private partnership projects in Laos. it was identifying risk factors that face with the construction of PPPs in Laos. which include qualification of respondent. This chapter also conclude with critical risk factors that affect in PPP projects in Laos.

## 4.1    The preliminary risk checklist

This research collected 33 risk factors found in the six journal papers used for identifying the preliminary risk checklist for this study as shown in Table 6. The six journal papers chosen were:

Preferred risk allocation in china's public-private partnership (PPP) projects, by Ke et al. (2010).

Understanding the risks in china's PPP project: ranking of their probability and consequence, by Cheung and Chan (2011).

Public private partnership projects in Singapore: Factors, critical risks and preferred risk allocation from the perspective of contractors, by Hwang et al. (2013).

Risk allocation in public-private partnership water supply projects in Ghana, by Ameyaw and Chan (2015).

A comparative study on the risk perceptions of the public and private sectors in public-private partnership (PPP) transportation projects in Vietnam, by Likhitruangsilp et al. (2017).

Evaluation and ranking of risk factors in transnational Public-private partnerships projects: Case study Based on the Intuitionistic Fuzzy Analytic Hierarchy process, by Yu et al. (2018).

## 4.2    Qualification of respondents

To gather the data that accurately represent the PPP projects in Laos, the respondents must meet the following qualifications. First, they must have at least five years of experience in construction projects, and must have worked or must be working for the PPP projects in Laos.

As the information solicited requires in-depth knowledge. To comply with problem and policies in Laos. Therefore, the data collection is necessary to emphasize respondents both public and private sectors from Laos.

The in-depth interviews were conducted with nine participants. Five experts were from the public sector and the other four were from the private sector, as shown in Table 4.1.

Among the nine respondents, five respondents (55.56%) had more than ten years of work experience in PPP projects, two respondents (22.22%) have 5 to 10 years of work experience in PPP projects, and two respondents (22.22%) have 3 to 5 years of work experience in PPP projects.

Table 4.1 Respondent's profile

| Category | Respondents | |
| --- | --- | --- |
| | Number of respondents | % |
| 1. Years of experiences | 9 | |
| 3-5 years | 2 | 22.22 |
| 5-10 years | 2 | 22.22 |
| > 10 years | 5 | 55.56 |
| 2. Position | | |
| Head of department | 2 | 22.22 |
| Deputy head of department | 3 | 33.34 |
| Project manager | 2 | 22.22 |
| Site engineer | 2 | 22.22 |
| Public sector | 5 | 55.56 |
| Private sector | 4 | 44.44 |

As it can be seen, in Table 4.2 the perspective of respondent's risk management is necessary and very necessary. The percentages are 44.44 % and 55.56 %, respectively.

Table 4.2 Perspective of risk management.

| Category | Respondents | |
|---|---|---|
| | Number of respondents | % |
| 1. Perception of risk management | | |
| Unknown | 1 | 11.11 |
| Know | 6 | 66.67 |
| know very well | 2 | 22.22 |
| 2. Necessary of risk management | | |
| Necessary | 4 | 44.44 |
| Very necessary | 5 | 55.56 |

## 4.3   Risk factors in Public-private partnership projects in Laos

Though the interview, it would be to investigate the likelihood of occurrence, severity of risks and impact risk in PPP projects as shown in Table 4.4. A risk coding system as shown in Figure 4.1, it was help to manage all of the risk factors. In Table 4.3, these risk factors can be groups into eight categories based on the meaning each factors:
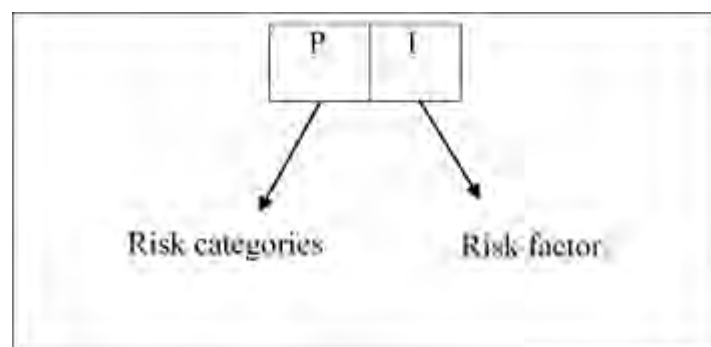


Figure 4.1 Risk code system

**Political risks (P)** concern risk factors with political, such as lack of support from government (P1), nationalization (P2), government corruption (P3), public credit (P4), inadequate experience in PPP (P5).

**Contractual and legal risks (C)** are the risk factors participant with contract and legal of PPP. The problem consists of conflicting or imperfect contract (C1), legislation change (C2), change in taw regulation (C3).

**Social and cultural risk (S)** includes public opposition (S1), inadequate law and supervision (S2)

**Financial and economic risks (F)** interest rate fluctuation (F1), inflation (F2), make competition (F3), financial risk (F4), foreign exchange fluctuation (F5), change in market demand (F6), operation coat overrun (F7), and price change (F8).

**Relationship risks (R)** refer to the risk factors related to relationship, which in two risk factors: difference in working method (R1), and organization and communication (R2)

**Technical risks (T)** are the risk factors that related to technical of PPP projects. Unavailability material or labor (T1), third party delay or violation (T2), inability of concessionaire (T3), completion risk (T4), lack of supporting infrastructure (T5), and land acquisition. These are common technical problem in PPP projects.

**Design-related risks (D)** are the design problems usually face in this categories as delay in project approvals and permits (D1), unproven engineering techniques (D2), and poor public decision-making process (D3).

**Natural risks (N)** are the natural problems such as environment risk (N1), unforeseen weather/geotechnical (N2), Fore majeure (N3), and residual risk (N4).

Table 4.3 List of risk for each categories

| Risk categories | CODE | Risk factor |
|---|---|---|
| P. Political risks | P1 | Lack of support from government |
| | P2 | Nationalization |
| | P3 | Government corruption |
| | P4 | Public credit |
| | P5 | Inadequate experience in PPP |
| C. Contractual and legal risks | C1 | Conflicting or imperfect contract |
| | C2 | Legislation change |
| | C3 | Change in tax regulation |
| S. Social and cultural risks | S1 | Public opposition |
| | S2 | Inadequate law and supervision |
| F. Financial and economic risks | F1 | Interest rate fluctuation |
| | F2 | Inflation |
| | F3 | Market competition (Uniqueness) |
| | F4 | Financial risk |
| | F5 | Foreign exchange fluctuation |
| | F6 | Change in market demand |
| | F7 | Operation cost overrun |
| | F8 | Price change |
| R. Relationship risks | R1 | Difference in working method |
| | R2 | Organization and communication risk |
| T. Technical risks | T1 | Unavailability material or labor |
| | T2 | Third party delay or violation |
| | T3 | Inability of concessionaire |
| | T4 | Completion risk |
| | T5 | Lack of supporting infrastructure |
| | T6 | Land acquisition |
| D. Design-related risk | D1 | Delay in project approvals and permits |
| | D2 | Unproven engineering techniques |
| | D3 | Poor public decision-making process |
| N. Natural risks | N1 | Environment risk |
| | N2 | Unforeseen weather/geotechnical |
| | N3 | Force majeure |
| | N4 | Residual risk |

Table 4.4 Risk impact and ranking risk factors of PPP projects in Laos

| Code | Risk Factors | Impact = $\sqrt{\text{Likelihood} \times \text{Severity}}$ | | | Rank | Normalized values |
|---|---|---|---|---|---|---|
| | | Likelihood of occurrence | Severity of risk | Impact of risk | | |
| F4 | Financial risk | 3.55 | 3.55 | 3.55 | 1 | 1.000 |
| N1 | Environment risk | 3.44 | 3.55 | 3.50 | 2 | 0.958 |
| P5 | Inadequate experience in PPP | 3.55 | 3.33 | 3.44 | 3 | 0.915 |
| F2 | Inflation | 3.55 | 3.33 | 3.44 | 4 | 0.915 |
| F5 | Foreign exchange fluctuation | 3.55 | 3.33 | 3.44 | 5 | 0.915 |
| C3 | Change in tax regulation | 3.66 | 3.22 | 3.43 | 6 | 0.911 |
| P3 | Government corruption | 3.22 | 3.55 | 3.38 | 7 | 0.872 |
| F1 | Interest rate fluctuation | 3.33 | 3.33 | 3.33 | 8 | 0.834 |
| C2 | Legislation change | 3.22 | 3.33 | 3.27 | 9 | 0.792 |
| N2 | Unforeseen weather/ geotechnical | 3.22 | 3.33 | 3.27 | 10 | 0.792 |
| P1 | Lack of support from government | 3.33 | 3.11 | 3.22 | 11 | 0.749 |
| D2 | Unproven engineering techniques | 2.88 | 3.11 | 2.99 | 12 | 0.583 |
| R2 | Organization and communication risk | 3.22 | 2.66 | 2.93 | 13 | 0.533 |
| T1 | Unavailability material or labor | 3.22 | 2.66 | 2.93 | 14 | 0.533 |
| F6 | Change in market demand | 2.88 | 2.88 | 2.88 | 15 | 0.501 |
| R1 | Difference in working method | 3.00 | 2.77 | 2.88 | 16 | 0.499 |
| S2 | Inadequate law and supervision | 3.22 | 2.55 | 2.87 | 17 | 0.487 |
| P4 | Public credit | 2.88 | 2.77 | 2.83 | 18 | 0.459 |
| C1 | Conflicting or imperfect contract | 2.77 | 2.88 | 2.83 | 19 | 0.459 |

Table 4.4 (cont.)

| | | | | | | |
|---|---|---|---|---|---|---|
| F8 | Price change | 2.77 | 2.88 | 2.83 | 20 | 0.459 |
| F7 | Operation cost overrun | 2.77 | 2.77 | 2.77 | 21 | 0.418 |
| T5 | Lack of supporting infrastructure | 2.77 | 2.77 | 2.77 | 22 | 0.418 |
| T6 | Land acquisition | 2.77 | 2.66 | 2.72 | 23 | 0.376 |
| D1 | Delay in project approvals and permits | 2.66 | 2.77 | 2.72 | 24 | 0.376 |
| P2 | Nationalization | 2.66 | 2.66 | 2.66 | 25 | 0.335 |
| D3 | Poor public decision-making process | 2.88 | 2.44 | 2.65 | 26 | 0.328 |
| N3 | Force majeure | 2.66 | 2.55 | 2.61 | 27 | 0.293 |
| F3 | Market competition (Uniqueness) | 2.44 | 2.66 | 2.55 | 28 | 0.25 |
| N4 | Residual risk | 2.55 | 2.44 | 2.49 | 29 | 0.21 |
| S1 | Public opposition | 2.33 | 2.66 | 2.49 | 30 | 0.206 |
| T3 | Inability of concessionaire | 2.33 | 2.55 | 2.44 | 31 | 0.167 |
| T4 | Completion risk | 2.44 | 2.33 | 2.38 | 32 | 0.126 |
| T2 | Third party delay/violation | 2.11 | 2.33 | 2.21 | 33 | 0 |

Normalization value: (average actual value – average minimum value)/ (average maximum value – average minimum value)

## 4.4 Summary

A 33 risk factors affecting public-private partnership projects. These factors were grouped into eight categories. According to the identification by impact risk factor with scale of likelihood of occurrence and severity of risk. The ranking risk factors of PPP projects, it was found that the top five of risk impact were: (1) financial risk, (2) environment risk, (3) inadequate experience in PPP, (4) inflation, and (5) foreign exchange fluctuation.

**CHAPTER 5**

**RISK ASSESSMENT IN PPP PROJECTS IN LAOS**

This chapter presents the assessment by TOPSIS method for the Public-private partnership projects includes all sectors, public sector, and private sector. The last part presents the results and conclusion of risk assessment.


**5.1    Public-private partnerships (all sectors)**

A Public-private partnership including the public and private sectors. There are 9 respondents, five respondents from the public and four respondents from the private sector. It's shown that different perspective. For this research, there was separated for each sector as follow step of assessment:

Step 1: Identification of risk factors associated with PPP projects. A 33 risk factors that literature review as shown in Table 4.4.

Step 2: Selection of critical risk factors associated with PPP projects in Laos.

A total of 33 risk factors were evaluated. Only the risk factors with a normalized values equal to or greater than 0.5. It should be noted that for risk assessment, the rating of risk impact of particular risk factors is calculated by the product of the rating of its associated likelihood of risk and the rating of associated risk severity as shown in Table 5.1. Such selection compiles with the prerequisite of the factor analysis technique, which requires a ratio of 1:5 for variables to sample size. The reason selection mechanism is in line with many previous research studies that adopted the same procedure to meet the basic requirements of factor analysis.

Table 5.1 Ranking of risk factors for running PPP projects in Laos (all sectors).

| Code | Risk Factors | Impact = $\sqrt{\text{Likelihood} \times \text{Severity}}$ | | | Rank | Normalized values |
|---|---|---|---|---|---|---|
| | | Likelihood of occurrence | Severity of risk | Impact of risk | | |
| F4 | Financial risk | 3.55 | 3.55 | 3.55 | 1 | 1.000 |
| N1 | Environment risk | 3.44 | 3.55 | 3.50 | 2 | 0.958 |
| P5 | Inadequate experience in PPP | 3.55 | 3.33 | 3.44 | 3 | 0.915 |
| F2 | Inflation | 3.55 | 3.33 | 3.44 | 4 | 0.915 |
| F5 | Foreign exchange fluctuation | 3.55 | 3.33 | 3.44 | 5 | 0.915 |
| C3 | Change in tax regulation | 3.66 | 3.22 | 3.43 | 6 | 0.911 |
| P3 | Government corruption | 3.22 | 3.55 | 3.38 | 7 | 0.872 |
| F1 | Interest rate fluctuation | 3.33 | 3.33 | 3.33 | 8 | 0.834 |
| C2 | Legislation change | 3.22 | 3.33 | 3.27 | 9 | 0.792 |
| N2 | Unforeseen weather/ geotechnical | 3.22 | 3.33 | 3.27 | 10 | 0.792 |
| P1 | Lack of support from government | 3.33 | 3.11 | 3.22 | 11 | 0.749 |
| D2 | Unproven engineering techniques | 2.88 | 3.11 | 2.99 | 12 | 0.583 |
| R2 | Organization and communication risk | 3.22 | 2.66 | 2.93 | 13 | 0.533 |
| T1 | Unavailability Material or labor | 3.22 | 2.66 | 2.93 | 14 | 0.533 |
| F6 | Change in market demand | 2.88 | 2.88 | 2.88 | 15 | 0.501 |

Figure 5.1 Top 10 critical risk factors in PPP projects in Laos (all sectors)

Step 3: Identification of critical risk categories (CRCs) for PPP projects in Laos.

Before adopting factors analysis for the calculated impact which is measured by the product of the likelihood of occurrence and severity of risk. the 15 most critical risk factors associated with PPP projects, the reliability analysis presented the values of Cronbach coefficient of the likelihood of occurrence and severity were calculated to be 0934 and 0.937 respectively. Factor groupings resulting from factor analysis are given. Three were 7 categories identified as shown in Table 5.2 consists of political risks, contractual and legal risks; financial and economic risks, relationship risks, technical risks, design-related risks, natural risks.

Table 5.2 Risk categories in PPP projects in Laos.

| Risk Categories | Code | Risk factors |
|---|---|---|
| P. Political risks | | |
| | P1 | Lack of support from government |
| | P3 | Government corruption |
| | P5 | Inadequate experience in PPP |
| C. Contractual and legal risks | | |
| | C2 | Legislation change |
| | C3 | Change in tax regulation |
| F. Financial and economic risks | | |
| | F1 | Interest rate fluctuation |
| | F2 | Inflation |
| | F4 | Financial risk |
| | F5 | Foreign exchange fluctuation |
| | F6 | Change in market demand |
| R. Relationship risks | | |
| | R2 | Organization and communication risk |
| T. Technical risks | | |
| | T1 | Unavailability Material or labor |
| D. Design-related risk | | |
| | D2 | Unproven engineering techniques |
| N. Natural risks | | |
| | N1 | Environment risk |
| | N2 | Unforeseen weather/geotechnical |

Step 4: Development of appropriate weighting for the critical risk factors and critical risk categories for PPP projects in Laos.

The weighting for each of the 15 critical risks and 7 critical risk categories as follow equation 5.1 (Xu et al., 2010):

$$W_i = \frac{M_i}{\sum_{i=1}^{5} M_i} \qquad\qquad (5.1)$$

where:

$W_i$      represents the weighting of a particular CRF/CRC

$M_i$      represents the mean ratings of a particular CRF/CRC

$\sum M_i$      represents the summation of mean rating of all CRF/CRC

Note that the mean rating of a particular CRF/CRC are calculated by the summation of individual ratings of a particular CRF/CRC divided by number of expert who provide the ratings as shown in Table 5.3.

Table 5.3 Weighting for the 15 critical risk factor and 7 critical risk categories for PPP projects in Laos (likelihood of occurrence)

| | Critical risk factors (CRFs) | Likelihood of occurrence | | |
|---|---|---|---|---|
| | | Mean vale | Weighting | Weighting for each Categories |
| P | Political risks | **10.11** | | **0.20** |
| P1 | Lack of support from government | 3.33 | 0.33 | |
| P3 | Government corruption | 3.22 | 0.32 | |
| P5 | Inadequate experience in PPP | 3.56 | 0.35 | |
| C | Contractual and legal risks | **6.89** | | **0.14** |
| C2 | Legislation change | 3.22 | 0.47 | |
| C3 | Change in tax regulation | 3.67 | 0.53 | |
| F | Financial and economic risks | **16.89** | | **0.34** |
| F1 | Interest rate fluctuation | 3.33 | 0.20 | |
| F2 | Inflation | 3.56 | 0.21 | |
| F4 | Financial risk | 3.56 | 0.21 | |
| F5 | Foreign exchange fluctuation | 3.56 | 0.21 | |
| F6 | Change in market demand | 2.89 | 0.17 | |
| R | Relationship risks | **3.22** | | **0.06** |
| R2 | Organization and communication risk | 3.22 | 1.00 | |
| T | Technical risks | **3.22** | | **0.06** |
| T1 | Unavailability material or labor | 3.22 | 1.00 | |
| D | Design-related risk | **2.89** | | **0.06** |
| D2 | Unproven engineering techniques | 2.89 | 1.00 | |
| N | Natural risks | **6.67** | | **0.13** |
| N1 | Environment risk | 3.44 | 0.52 | |
| N2 | Unforeseen weather/geotechnical | 3.22 | 0.48 | |

Table 5.4 Weighting for the 15 critical risk factor and 7 critical risk categories for PPP projects in Laos (severity of risks)

| Critical risk factors (CRFs) | | Severity of risks | | |
|---|---|---|---|---|
| | | Mean vale | Weighting | Weighting for each Categories |
| P | Political risks | **10.00** | | **0.21** |
| P1 | Lack of support from government | 3.11 | 0.31 | |
| P3 | Government corruption | 3.56 | 0.36 | |
| P5 | Inadequate experience in PPP | 3.33 | 0.33 | |
| C | Contractual and legal risks | **6.56** | | **0.14** |
| C2 | Legislation change | 3.33 | 0.51 | |
| C3 | Change in tax regulation | 3.22 | 0.49 | |
| F | Financial and economic risks | **16.44** | | **0.34** |
| F1 | Interest rate fluctuation | 3.33 | 0.20 | |
| F2 | Inflation | 3.33 | 0.20 | |
| F4 | Financial risk | 3.56 | 0.22 | |
| F5 | Foreign exchange fluctuation | 3.33 | 0.20 | |
| F6 | Change in market demand | 2.89 | 0.18 | |
| R | Relationship risks | **2.67** | | **0.06** |
| R2 | Organization and communication risk | 2.67 | 1.00 | |
| T | Technical risks | **2.67** | | **0.06** |
| T1 | Unavailability material or labor | 2.67 | 1.00 | |
| D | Design-related risk | **3.11** | | **0.06** |
| D2 | Unproven engineering techniques | 3.11 | 1.00 | |
| N | Natural risks | **6.89** | | **0.14** |
| N1 | Environment risk | 3.56 | 0.52 | |
| N2 | Unforeseen weather/geotechnical | 3.33 | 0.48 | |

Step 5: Determination of the membership function for each critical risk factors of each critical risk categories (CRFs/CRC).

As know, a total of 15 CRFs were identified for assessing the overall risk level of PPP projects in Laos. Assume that the set of basic critical in fuzzy risk assessment model to be $\pi = \{f_1, f_2, \ldots, f_{15}\}$; and the grades for selection are defined as E = $\{1,2,3,4,5\}$. For example, the survey result on the lack of support from government indicated that 0% of the respondents scaled the likelihood of occurrence of this risk as expected to happen; 11% as small likelihood; 56% as quite often occurrence; 22% as usually occurrence; and 11% very frequent occurrence, so that the function membership function of lack support from government (likelihood of occurrence) is given by equation (5.2):

$$P1 = \frac{0.00}{\text{expected to happen}} + \frac{0.11}{\text{Small likelihood}} + \frac{0.56}{\text{quite often occurrence}} + \frac{0.22}{\text{usually occurrence}}$$

$$+ \frac{0.11}{\text{very frequent occurrence}} = \frac{0.00}{1} + \frac{0.11}{2} + \frac{0.56}{3} + \frac{0.22}{4} + \frac{0.11}{5} \qquad (5.2)$$

It can also be written as (0.00,0.11,0.56,0.22,0.11). Likewise, the survey result on the lack of support from government indicated that 0% of the respondents pointed the severity of this risk as very low; 33% as low; 33% as medium; 22% as high; and 11% as very high. Therefore, the membership function of lack support from government (severity of risk) is given:

$$P1 = \frac{0.00}{\text{very low}} + \frac{0.33}{\text{low}} + \frac{0.33}{\text{medium}} + \frac{0.22}{\text{high}} + \frac{0.11}{\text{very high}}$$

$$= \frac{0.00}{1} + \frac{0.33}{2} + \frac{0.33}{3} + \frac{0.22}{4} + \frac{0.11}{5}$$

It can also be written as (0.00,0.33,0.33,0.22,0.11). Similarly, the membership function of all the other critical risk factors for the PPP projects can be derived in the same way shown Table 5.5 in for the likelihood of occurrence and Table 5.6 or the severity of risk, respectively.

Table 5.5 The membership function of all critical risk factors for PPP projects in Laos
(likelihood of occurrence)

| Code | Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|---|
| **P** | **Political risks** | | | (0.00,0.15,0.44,0.30,0.11) |
| P1 | Lack of support from government | 0.33 | (0.00,0.11,0.56,0.22,0.11) | |
| P3 | Government corruption | 0.32 | (0.00,0.22,0.44,0.22,0.11) | |
| P5 | Inadequate experience in PPP | 0.35 | (0.00,0.11,0.33,0.44,0.11) | |
| **C** | **Contractual and legal risks** | | | (0.00,0.06,0.54,0.28,0.12) |
| C2 | Legislation change | 0.47 | (0.00,0.00,0.78,0.22,0.00) | |
| C3 | Change in tax regulation | 0.53 | (0.00,0.11,0.33,0.33,0.22) | |
| **F** | **Financial and economic risks** | | | (0.02,0.13,0.35,0.44,0.06) |
| F1 | Interest rate fluctuation | 0.20 | (0.00,0.22,0.33,0.33,0.11) | |
| F2 | Inflation | 0.21 | (0.00,0.00,0.44,0.56,0.00) | |
| F4 | Financial risk | 0.21 | (0.00,0.00,0.44,0.56,0.00) | |
| F5 | Foreign exchange fluctuation | 0.21 | (0.00,0.22,0.11,0.56,0.11) | |

Table 5.5 (Cont.)

| Code | Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|------|--------------|-----------|-------------------------------|-------------------------------|
| F6 | Change in market demand | 0.17 | (0.11,0.22,0.44,0.11,0.11) | |
| **R** | **Relationship risks** | | | (0.11,0.00,0.56,0.22,0.11) |
| R2 | Organization and communication risk | 1.00 | (0.11,0.00,0.56,0.22,0.11) | |
| **T** | **Technical risks** | | | (0.00,0.22,0.33,0.44,0.00) |
| T1 | Unavailability material or labor | 1.00 | (0.00,0.22,0.33,0.44,0.00) | |
| **D** | **Design-related risk** | | | (0.00,0.44,0.33,0.11,0.11) |
| D2 | Unproven engineering techniques | 1.00 | (0.00,0.44,0.33,0.11,0.11) | |
| **N** | **Natural risks** | | | (0.00,0.16,0.50,0.16.0.17) |
| N1 | Environment risk | 0.52 | (0.00,0.11,0.56,0.11,0.22) | |
| N2 | Unforeseen weather/ geotechnical | 0.48 | (0.00,0.22,0.44,0.220.11) | |

Table 5.6 The membership function of all critical risk factors for PPP projects in Laos
(severity of risk)

| Code | Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|---|
| **P** | **Political risks** | | | (0.00,0.26,0.33,0.22,0.19) |
| P1 | Lack of support from government | 0.31 | (0.00,0.33,0.33,0.22,0.11) | |
| P3 | Government corruption | 0.36 | (0.00,0.22,0.22,0.33,0.22) | |
| P5 | Inadequate experience in PPP | 0.33 | (0.00,0.22,0.44,0.11,0.22) | |
| **C** | **Contractual and legal risks** | | | (0.00,0.17,0.39,0.44,0.00) |
| C2 | Legislation change | 0.51 | (0.00,0.11,0.44,0.44,0.00) | |
| C3 | Change in tax regulation | 0.49 | (0.00,0.22,0.33,0.44,0.00) | |
| **F** | **Financial and economic risks** | | | (0.04,0.13,0.38,0.39,0.07) |
| F1 | Interest rate fluctuation | 0.20 | (0.00,0.22,0.33,0.33,0.11) | |
| F2 | Inflation | 0.20 | (0.00,0.11,0.44,0.44,0.00) | |
| F4 | Financial risk | 0.22 | (0.00,0.11,0.33,0.44,0.11) | |
| F5 | Foreign exchange fluctuation | 0.20 | (0.11,0.00,0.33,0.56,0.00) | |
| F6 | Change in market demand | 0.18 | (0.11,0.22,0.44,0.11,0.11) | |
| **R** | **Relationship risks** | | | (0.11,0.33,0.33,0.22,0.00) |
| R2 | Organization and communication risk | 1.00 | (0.11,0.33,0.33,0.22,0.00) | |

Table 5.6 (Cont.)

| Code | Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|---|
| T | **Technical risks** | | | (0.11,0.22,0.56,0.11,0.00) |
| T1 | Unavailability material or labor | 1.00 | (0.11,0.22,0.56,0.11,0.00) | |
| D | **Design-related risk** | | | (0.00,0.22,0.56,0.11,0.11) |
| D2 | Unproven engineering techniques | 1.00 | (0.00,0.22,0.56,0.11,0.11) | |
| N | **Natural risks** | | | (0.05,0.06,0.33,0.50,0.06) |
| N1 | Environment risk | 0.52 | (0.00,0.11,0.33,0.11,0.11) | |
| N2 | Unforeseen weather /geotechnical | 0.48 | (0.11,0.00,0.33,0.56,0.00) | |

Take the political risks that including lack of support from the government, and inadequate experience in PPP as an example; its membership function (likelihood of occurrence) is as follow equation (5.3):

$$D = W_i \times R_i \qquad\qquad (5.3)$$

where:

$W_i$      represents the weighting of a particular CRF/CRC

$R_i$      represents the fuzzy evaluation matrix.

The membership function of political risk for likelihood of occurrence is:

$(0.33 \times 0.00 + 0.32 \times 0.00 + 0.35 \times 0.00,$

$0.33 \times 0.33 + 0.32 \times 0.22 + 0.35 \times 0.22,$

$0.33 \times 0.33 + 0.32 \times 0.22 + 0.35 \times 0.44,$

$0.33 \times 0.22 + 0.32 \times 0.33 + 0.35 \times 0.22,$

$0.33 \times 0.11 + 0.32 \times 0.22 + 0.35 \times 0.22) = (0.00, 0.15, 0.44, 0.30, 0.11).$

Similarly, the membership function of political risk for severity of risk is:

$(0.31 \times 0.00 + 0.36 \times 0.00 + 0.33 \times 0.00,$

$0.31 \times 0.33 + 0.36 \times 0.22 + 0.33 \times 0.22,$

$0.31 \times 0.33 + 0.36 \times 0.22 + 0.33 \times 0.44,$

$0.31 \times 0.22 + 0.36 \times 0.33 + 0.35 \times 0.11,$

$0.31 \times 0.11 + 0.36 \times 0.22 + 0.33 \times 0.22) = (0.00, 0.26, 0.33, 0.22, 0.19).$

Step 6: Developing a fuzzy synthetic evaluation model for PPP projects in Laos.

After developing appropriate weightings for the 15 CRFs and 7 CRCs for PPP projects, and the following the establishment of fuzzy membership function for each CRF and each CRC (both likelihood of occurrence and severity of risk) as follow:

Table 5.7 The results of fuzzy synthetic evaluation for all CRCs for PPP projects in Laos.

| Code | Risk Categories | Weighting | Membership function of level 2 | Membership function of level 1 |
|---|---|---|---|---|
| Likelihood of occurrence (from level 2 to level 1) |||||
| P | Political risks | 0.20 | (0.00,0.15,0.44,0.30,0.11) | (0.01,0.14,0.42,0.32,0.10) |
| C | Contractual and legal risks | 0.14 | (0.00,0.06,0.54,0.28,0.12) | |
| F | Financial and economic risks | 0.34 | (0.02,0.13,0.35,0.44,0.06) | |
| R | Relationship risks | 0.06 | (0.11,0.00,0.56,0.22,0.11) | |
| T | Technical risks | 0.06 | (0.00,0.22,0.33,0.44,0.00) | |
| D | Design-related risk | 0.06 | (0.00,0.44,0.33,0.11,0.11) | |
| N | Natural risks | 0.13 | (0.00,0.16,0.50,0.16.0.17) | |

Table 5.7 (cont.)

| Code | Risk Categories | Weighting | Membership function of level 2 | Membership function of level 1 |
|---|---|---|---|---|
| colspan | Severity of risks (from level 2 to level 1) | | | |
| P | Political risks | 0.21 | (0.00,0.26,0.33,0.22,0.19) | (0.04,0.18,0.39,0.34,0.08) |
| C | Contractual and legal risks | 0.14 | (0.00,0.17,0.39,0.44,0.00) | |
| F | Financial and economic risks | 0.34 | (0.04,0.13,0.38,0.39,0.07) | |
| R | Relationship risks | 0.06 | (0.11,0.33,0.33,0.22,0.00) | |
| T | Technical risks | 0.06 | (0.11,0.22,0.56,0.11,0.00) | |
| D | Design-related risk | 0.06 | (0.00,0.22,0.56,0.11,0.11) | |
| N | Natural risks | 0.14 | (0.05,0.06,0.33,0.50,0.06) | |

It should be noted that there are three levels of membership function.

    a) Level 3 refers to each of 15 critical risk factors

    b) Level 2 refers to each of the 7 critical risk categories

    c) And level 1 refers to the overall risk index (ORI)

The membership function of overall risk level including political risk, contractual and legal risks, financial and economic risk, relationship risk, technical risk, design-related risk, and natural risk. Likelihood of occurrence is as follows:

(0.20×0.00+0.14×0.00+0.34×0.02+0.06×0.11+0.06×0.00+0.06×0.00+0.13×0.00,

0.20×0.15+0.14×0.06+0.34×0.13+0.06×0.00+0.06×0.22+0.06×0.44+0.13×0.16,

0.20×0.44+0.14×0.54+0.34×0.35+0.06×0.56+0.06×0.33+0.06×0.33+0.13×0.50,

0.20×0.30+0.14×0.28+0.34×0.44+0.06×0.22+0.06×0.44+0.06×0.11+0.13×0.16,

0.20×0.11+0.14×0.12+0.34×0.06+0.06×0.11+0.06×0.00+0.06×0.11+0.13×0.17)

= (0.01,0.14,0.42,0.32,0.10)

Similarly, the membership function of overall risk level including political risk, contractual and legal risks, financial and economic risk, relationship risk, technical risk, design-related risk, and natural risk. The severity of risk is as follows:

(0.21×0.00+0.14×0.00+0.34×0.04+0.06×0.11+0.06×0.11+0.06×0.00+0.14×0.05,

0.21×0.26+0.14×0.17+0.34×0.13+0.06×0.33+0.06×0.22+0.06×0.22+0.14×0.06,

0.21×0.33+0.14×0.39+0.34×0.38+0.06×0.33+0.06×0.56+0.06×0.56+0.14×0.33,

0.21×0.22+0.14×0.44+0.34×0.39+0.06×0.22+0.06×0.11+0.06×0.11+0.14×0.56,

0.21×0.19+0.14×0.00+0.34×0.07+0.06×0.00+0.06×0.00+0.06×0.11+0.14×0.06)

= (0.04,0.18,0.39,0.34,0.08).

The Overall risk index (ORI) as shown in Table 5.8 they can be calculated using equation (5.4). After deriving the membership function of level 1:

$$\text{ORI} = \sum_{k=1}^{5} (\ W \times R_k) \times L \qquad (5.4)$$

where,

ORI    is the overall risk index;

W    is the weighting for each critical risk factor;

R    is the degree of membership function of each critical risk factor (for both likelihoods of occurrence and severity of risk)

L    is the linguistic variable

Therefore, the Overall Risk Index is:

$$ORI = \sqrt{(0.01\times1+0.14\times2+042\times3+0.32\times4+0.10\times5)\times(0.04\times1+0.18\times2+0.39\times3+0.34\times4+0.08\times5)}$$

$$= 3.29$$

Table 5.8 Risk index of a particular CRC and overall risk index (ORI) of PPP projects in Laos.

| No. | Risk categories | Likelihood of occurrence | Risk severity | Risk index |
|---|---|---|---|---|
| C1 | Political risks | 3.38 | 3.34 | 3.36 |
| C2 | Contractual and legal risks | 3.46 | 3.28 | 3.37 |
| C3 | Financial and economic risks | 3.40 | 3.30 | 3.35 |
| C4 | Relationship risks | 3.22 | 2.67 | 2.93 |
| C5 | Technical risks | 3.22 | 2.67 | 2.93 |
| C6 | Design-related risk | 2.89 | 3.11 | 3.00 |
| C7 | Natural risks | 3.34 | 3.45 | 3.39 |
| A | Overall risk | 3.31 | 3.27 | 3.29 |
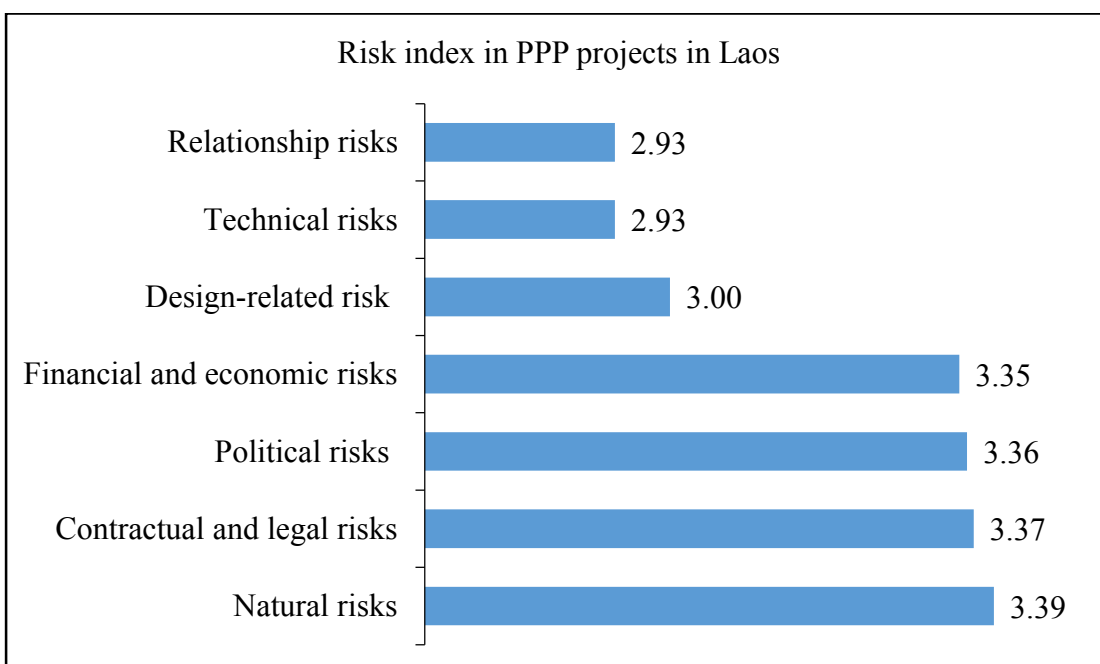


Figure 5.2 Risk index in PPP projects in Laos ( all sector)

## 5.2 Public sector

There are five respondents from four departments such as Department of Public private partnership, Department of roads, Department of planning and corporation, and Department of promotion and investment. The data analysis result shown that 15 critical risk factors greater or equal 0.5. Five-point scale was to used compute score for each factor. Top 10 critical risk factor that affecting for PPP projects in Laos given by public sector. There was inflation risk, financial risk, environment risk, government corruption, Inadequate experience in PPP, change in tax regulation, interest rate fluctuation, price change, unproven engineering techniques, and legislation change, respectively.

Table 5.9 Ranking of risk factors for Public sector in PPP projects in Laos.

| Code | Risk Factors | Likelihood of occurrence | Severity of risk | Impact Factors | Rank | Normalized values |
|------|-------------|--------------------------|------------------|----------------|------|-------------------|
| F2 | Inflation | 3.60 | 3.20 | 3.40 | 1 | 1.000 |
| F4 | Financial risk | 3.20 | 3.40 | 3.30 | 2 | 0.905 |
| N1 | Environment risk | 3.20 | 3.40 | 3.30 | 3 | 0.905 |
| P3 | Government corruption | 3.20 | 3.20 | 3.20 | 4 | 0.806 |
| P5 | Inadequate experience in PPP | 3.20 | 3.20 | 3.20 | 5 | 0.806 |
| C3 | Change in tax regulation | 3.20 | 3.20 | 3.20 | 6 | 0.806 |
| F1 | Interest rate fluctuation | 3.20 | 3.20 | 3.20 | 7 | 0.806 |
| F8 | Price change | 3.00 | 3.40 | 3.20 | 8 | 0.800 |
| D2 | Unproven engineering techniques | 3.00 | 3.40 | 3.20 | 9 | 0.800 |
| C2 | Legislation change | 3.20 | 3.00 | 3.10 | 10 | 0.705 |
| F7 | Operation cost overrun | 3.00 | 3.20 | 3.10 | 11 | 0.705 |
| F5 | Foreign exchange fluctuation | 3.00 | 3.00 | 3.00 | 12 | 0.607 |
| T6 | Land acquisition | 3.00 | 3.00 | 3.00 | 13 | 0.607 |
| P4 | Public credit | 2.80 | 3.00 | 2.89 | 14 | 0.505 |
| N2 | Unforeseen weather/geotechnical | 2.80 | 3.00 | 2.89 | 15 | 0.505 |
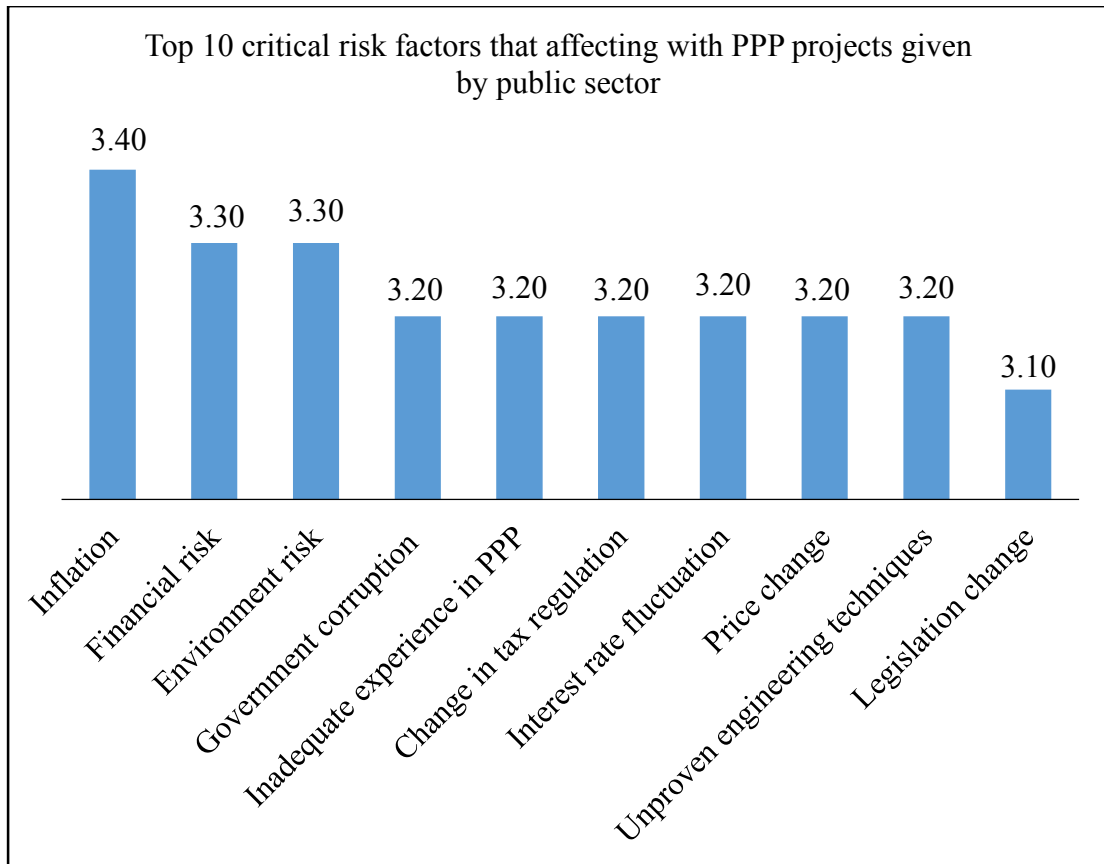
Figure 5.3 Top 10 critical risk factors affecting with PPP projects for public sector

Identification of critical risk categories (CFCs) for PPP projects in Laos on public sector.

Table 5.10 Critical risk and risk categories in public sector

| Critical risk factors and risk categories |
|---|
| P. Political risks |
| P3 Government corruption |
| P4 Public credit |
| P5 Inadequate experience in PPP |
| C. Contractual and legal risks |
| C2 Legislation change |
| C3 Change in tax regulation |
| F. Financial and economic risks |
| F1 Interest rate fluctuation |
| F2 Inflation |
| F4 Financial risk |
| F5 Foreign exchange fluctuation |
| F7 Operation cost overrun |
| F8 Price change |
| T. Technical risks |
| T6 Land acquisition |
| D. Design-related risk |
| D2 Unproven engineering techniques |
| N. Natural risks |
| N1 Environment risk |
| N2 Unforeseen weather/geotechnical |

The development of appropriate weighting for the critical risk factors and critical risk groups for PPP projects in Laos on public sector as shown in Table 5.11:

Table 5.11 Weighting for the 15 critical risk factors and 6 critical risk groups for PPP projects in Laos on public sector (likelihood of occurrence)

| Critical risk factors and risk categories | Likelihood of occurrence | | |
|---|---|---|---|
| | Mean value | Weighting | Weighting for each categories |
| **P. Political risks** | **9.20** | | **0.20** |
| P3 Government corruption | 3.20 | 0.35 | |
| P4 Public credit | 2.80 | 0.30 | |
| P5 Inadequate experience in PPP | 3.20 | 0.35 | |
| **C. Contractual and legal risks** | **6.40** | | **0.14** |
| C2 Legislation change | 3.20 | 0.50 | |
| C3 Change in tax regulation | 3.20 | 0.50 | |
| **F. Financial and economic risks** | **19.00** | | **0.41** |
| F1 Interest rate fluctuation | 3.20 | 0.17 | |
| F2 Inflation | 3.60 | 0.19 | |
| F4 Financial risk | 3.20 | 0.17 | |
| F5 Foreign exchange fluctuation | 3.00 | 0.16 | |
| F7 Operation cost overrun | 3.00 | 0.16 | |
| F8 Price change | 3.00 | 0.16 | |
| **T. Technical risks** | **3.00** | | **0.06** |
| T6 Land acquisition | 3.00 | 1.00 | |
| **D. Design-related risk** | **3.00** | | **0.06** |
| D2 Unproven engineering techniques | 3.00 | 1.00 | |
| **N. Natural risks** | **6.00** | | **0.13** |
| N1 Environment risk | 3.20 | 0.53 | |
| N2 Unforeseen weather/geotechnical | 2.80 | 0.47 | |
| Sum = | **46.60** | | |

Table 5.12 Weighting for the 15 critical risk factors and 6 critical risk groups for PPP

projects in Laos on public sector (severity of risks)

| Critical risk factors and risk categories | Severity of risks | | |
|---|---|---|---|
| | Mean value | Weighting | Weighting for each categories |
| P. Political risks | **9.40** | | **0.20** |
| P3 Government corruption | 3.20 | 0.34 | |
| P4 Public credit | 3.00 | 0.32 | |
| P5 Inadequate experience in PPP | 3.20 | 0.34 | |
| C. Contractual and legal risks | **6.20** | | **0.13** |
| C2 Legislation change | 3.00 | 0.48 | |
| C3 Change in tax regulation | 3.20 | 0.52 | |
| F. Financial and economic risks | **19.40** | | **0.41** |
| F1 Interest rate fluctuation | 3.20 | 0.16 | |
| F2 Inflation | 3.20 | 0.16 | |
| F4 Financial risk | 3.40 | 0.18 | |
| F5 Foreign exchange fluctuation | 3.00 | 0.15 | |
| F7 Operation cost overrun | 3.20 | 0.16 | |
| F8 Price change | 3.40 | 0.18 | |
| T. Technical risks | **3.00** | | **0.06** |
| T6 Land acquisition | 3.00 | 1.00 | |
| D. Design-related risk | **3.40** | | **0.07** |
| D2 Unproven engineering techniques | 3.40 | 1.00 | |
| N. Natural risks | **6.40** | | **0.13** |
| N1 Environment risk | 3.40 | 0.55 | |
| N2 Unforeseen weather/geotechnical | 3.00 | 0.48 | |
| Sum = | **47.80** | | |

Determination of the membership function for each critical risk factors of each

critical risk categories (CRFs/CRC) as represent in Table 5.13:

Table 5.13 The membership function of all critical risk factors for public sector

(likelihood of occurrence)

| Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|
| **P. Political risks** | | | (0.00,0.26,0.40,0.20,0.07) |
| P3 Government corruption | 0.35 | (0.00,0.20,0.60,0.00,0.20) | |
| P4 Public credit | 0.30 | (0.00,0.40,0.40,0.20,0.00) | |
| P5 Inadequate experience in PPP | 0.35 | (0.00,0.20,0.40,0.40,0.00) | |
| **C. Contractual and legal risks** | | | (0.00,0.10,0.60,0.30,0.00) |
| C2 Legislation change | 0.50 | (0.00,0.00,0.80,0.20,0.00) | |
| C3 Change in tax regulation | 0.50 | (0.00,0.20,0.40,0.40,0.00) | |
| **F. Financial and economic risks** | | | (0.00,0.26,0.34,0.37,0.00) |
| F1 Interest rate fluctuation | 0.17 | (0.00,0.40,0.20,0.20,0.00) | |
| F2 Inflation | 0.19 | (0.00,0.00,0.40,0.60,0.00) | |
| F4 Financial risk | 0.17 | (0.00,0.00,0.80,0.20,0.00) | |
| F5 Foreign exchange fluctuation | 0.16 | (0.00,0.40,0.20,0.40,0.00) | |
| F7 Operation cost overrun | 0.16 | (0.00,0.40,0.20,0.40,0.00) | |
| F8 Price change | 0.16 | (0.00,0.40,0.20,0.40,0.00) | |
| **T. Technical risks** | | | (0.00,0.60,0.00,0.20,0.20) |
| T6 Land acquisition | 1.00 | (0.00,0.60,0.00,0.20,0.20) | |
| **D. Design-related risk** | | | (0.00,0.60,0.00,0.20,0.20) |
| D2 Unproven engineering techniques | 1.00 | (0.00,0.60,0.00,0.20,0.20) | |
| **N. Natural risks** | | | (0.00,0.29,0.51,0.09,0.11) |
| N1 Environment risk | 0.53 | (0.00,0.20,0.60,0.00,0.20) | |
| N2 Unforeseen weather/geotechnical | 0.47 | (0.00,0.40,0.40,0.20,0.00) | |

Table 5.14 The membership function of all critical risk factors for PPP projects in
Laos on public sector (severity of risks)

| Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|
| **P. Political risks** | | | (0.00,0.27,0.46,0.13,0.14) |
| P3 Government corruption | 0.34 | (0.00,0.40,0.20,0.20,0.20) | |
| P4 Public credit | 0.32 | (0.00,0.20,0.60,0.20,0.00) | |
| P5 Inadequate experience in PPP | 0.34 | (0.00,0.20,0.60,0.00,0.20) | |
| **C. Contractual and legal risks** | | | (0.00,0.20,0.50,0.30,0.00) |
| C2 Legislation change | 0.48 | (0.00,0.20,0.60,0.20,0.00) | |
| C3 Change in tax regulation | 0.52 | (0.00,0.20,0.40,0.40,0.00) | |
| **F. Financial and economic risks** | | | (0.03,0.24,0.30,0.33,0.07) |
| F1 Interest rate fluctuation | 0.16 | (0.00,0.40,0.20,0.20,0.00) | |
| F2 Inflation | 0.16 | (0.00,0.20,0.40,0.40,0.00) | |
| F4 Financial risk | 0.18 | (0.00,0.20,0.40,0.20,0.20) | |
| F5 Foreign exchange fluctuation | 0.15 | (0.20,0.00,0.40,0.40,0.00) | |
| F7 Operation cost overrun | 0.16 | (0.00,0.20,0.40,0.40,0.00) | |
| F8 Price change | 0.18 | (0.00,0.40,0.00,0.40,0.20) | |
| **T. Technical risks** | | | (0.00,0.40,0.20,0.40,0.00) |
| T6 Land acquisition | 1.00 | (0.00,0.20,0.40,0.20,0.20) | |

Table 5.14 (cont.)

| Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|
| **D. Design-related risk** | | | (0.00,0.20,0.40,0.20,0.20) |
| D2 Unproven engineering techniques | 1.00 | (0.00,0.20,0.40,0.20,0.20) | |
| **N. Natural risks** | | | (0.09,0.11,0.29,0.51,0.00) |
| N1 Environment risk | 0.53 | (0.00,0.20,0.20,0.60,0.00) | |
| N2 Unforeseen weather/geotechnical | 0.47 | (0.20,0.00,0.40,0.40,0.00) | |

The developing a fuzzy synthetic evaluation model for public sector as shown in Table 5.15:

Table 5.15 The result of fuzzy synthetic evaluation for all CRCs for public sector

| Risk Categories | Weighting | Membership function of level 2 | Membership function of level 1 |
|---|---|---|---|
| Likelihood of occurrence (from level 2 to level 1) | | | |
| P. Political risks | 0.20 | (0.00,0.26,0.47,0.06,0.07) | (0.00,0.28,0.38,0.27,0.05) |
| C. Contractual and legal risks | 0.14 | (0.00,0.10,0.60,0.30,0.00) | |
| F. Financial and economic risks | 0.41 | (0.00,0.26,0.34,0.37,0.00) | |
| T. Technical risks | 0.06 | (0.00,0.60,0.00,0.20,0.20) | |
| D. Design-related risk | 0.06 | (0.00,0.60,0.00,0.20,0.20) | |
| N. Natural risks | 0.13 | (0.00,0.29,0.51,0.09,0.11) | |
| Severity of risks (from level 2 to level 1) | | | |
| P. Political risks | 0.20 | (0.00,0.27,0.46,0.13,0.14) | (0.03,0.23,0.36,0.31,0.07) |
| C. Contractual and legal risks | 0.13 | (0.00,0.20,0.50,0.30,0.00) | |
| F. Financial and economic risks | 0.41 | (0.03,0.24,0.30,0.33,0.07) | |
| T. Technical risks | 0.06 | (0.00,0.40,0.20,0.40,0.00) | |
| D. Design-related risk | 0.07 | (0.00,0.20,0.40,0.20,0.20) | |
| N. Natural risks | 0.13 | (0.09,0.11,0.29,0.51,0.00) | |

Table 5.16 Risk index of a particular CRC and overall risk index (ORI) of PPP
projects in public sector

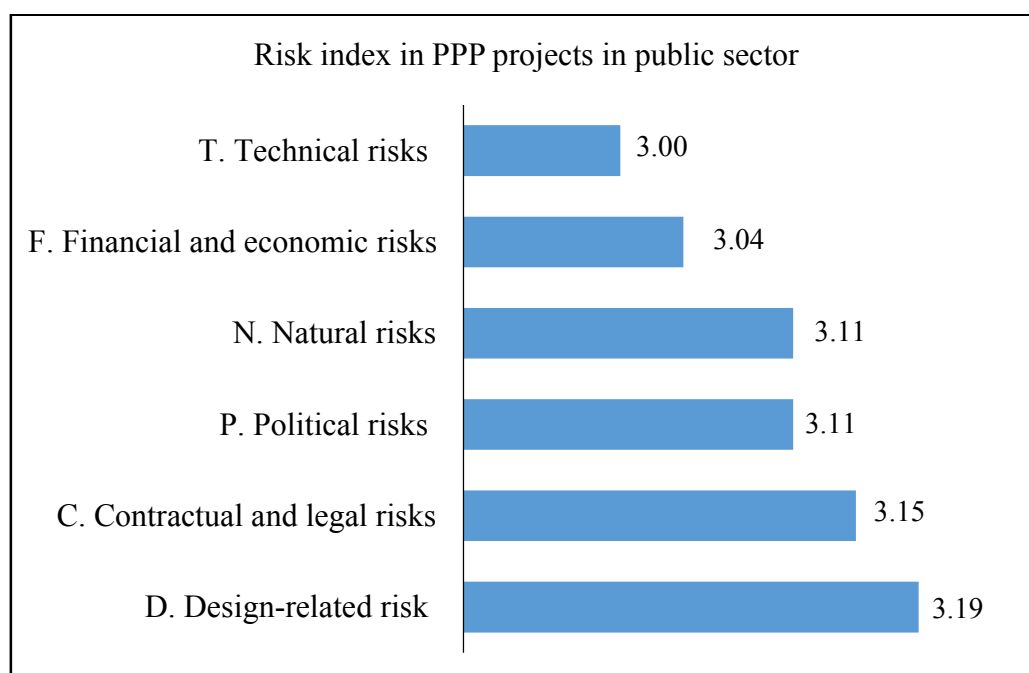| Risk categories | Likelihood of occurrence | Risk severity | Risk index |
|---|---|---|---|
| P. Political risks | 3.08 | 3.14 | 3.11 |
| C. Contractual and legal risks | 3.20 | 3.10 | 3.15 |
| F. Financial and economic risks | 3.01 | 3.07 | 3.04 |
| T. Technical risks | 3.00 | 3.00 | 3.00 |
| D. Design-related risk | 3.00 | 3.40 | 3.19 |
| N. Natural risks | 3.01 | 3.21 | 3.11 |
| Risk overall | 3.03 | 3.16 | 3.09 |



Figure 5.4 Risk index in PPP projects in Laos (Public sector)

## 5.3 Private sector

Table 5.17 demonstrated 15 critical risk factor larger than or equal 0.5 and top 10 critical risk factors rating by a private sector that affecting in PPP projects in Laos. There was foreign exchange fluctuation, financial risk, environment risk, unforeseen weather/geotechnical risk, inadequate experience in PPP, change in tax regulation, lack of support from the government, government corruption, interest rate fluctuation, and inflation, respectively.

Table 5.17 Ranking risk factors for private sector PPP projects in Laos.

| Code | Risk Factors | Likelihood of occurrence | Severity of risk | Impact Factors | Rank | Normalized values |
|------|--------------|--------------------------|------------------|----------------|------|-------------------|
| F5 | Foreign exchange fluctuation | 4.25 | 3.75 | 3.99 | 1 | 1.000 |
| F4 | Financial risk | 4.00 | 3.75 | 3.87 | 2 | 0.940 |
| N1 | Environment risk | 3.75 | 3.75 | 3.75 | 3 | 0.878 |
| N2 | Unforeseen weather/geotechnical | 3.75 | 3.75 | 3.75 | 4 | 0.878 |
| P5 | Inadequate experience in PPP | 4.00 | 3.50 | 3.74 | 5 | 0.874 |
| C3 | Change in tax regulation | 4.25 | 3.25 | 3.71 | 6 | 0.862 |
| P1 | Lack of support from government | 3.50 | 3.75 | 3.62 | 7 | 0.815 |
| P3 | Government corruption | 3.25 | 4.00 | 3.60 | 8 | 0.806 |
| F1 | Interest rate fluctuation | 3.50 | 3.50 | 3.50 | 9 | 0.753 |
| F2 | Inflation | 3.50 | 3.50 | 3.50 | 10 | 0.753 |
| C2 | Legislation change | 3.25 | 3.75 | 3.49 | 11 | 0.748 |
| T1 | Unavailability material or labor | 3.50 | 3.25 | 3.37 | 12 | 0.689 |
| C1 | Conflicting or imperfect contract | 3.25 | 3.25 | 3.25 | 13 | 0.627 |
| S2 | Inadequate law and supervision | 3.50 | 3.00 | 3.24 | 14 | 0.623 |
| R1 | Difference in working method | 3.00 | 3.00 | 3.00 | 15 | 0.502 |
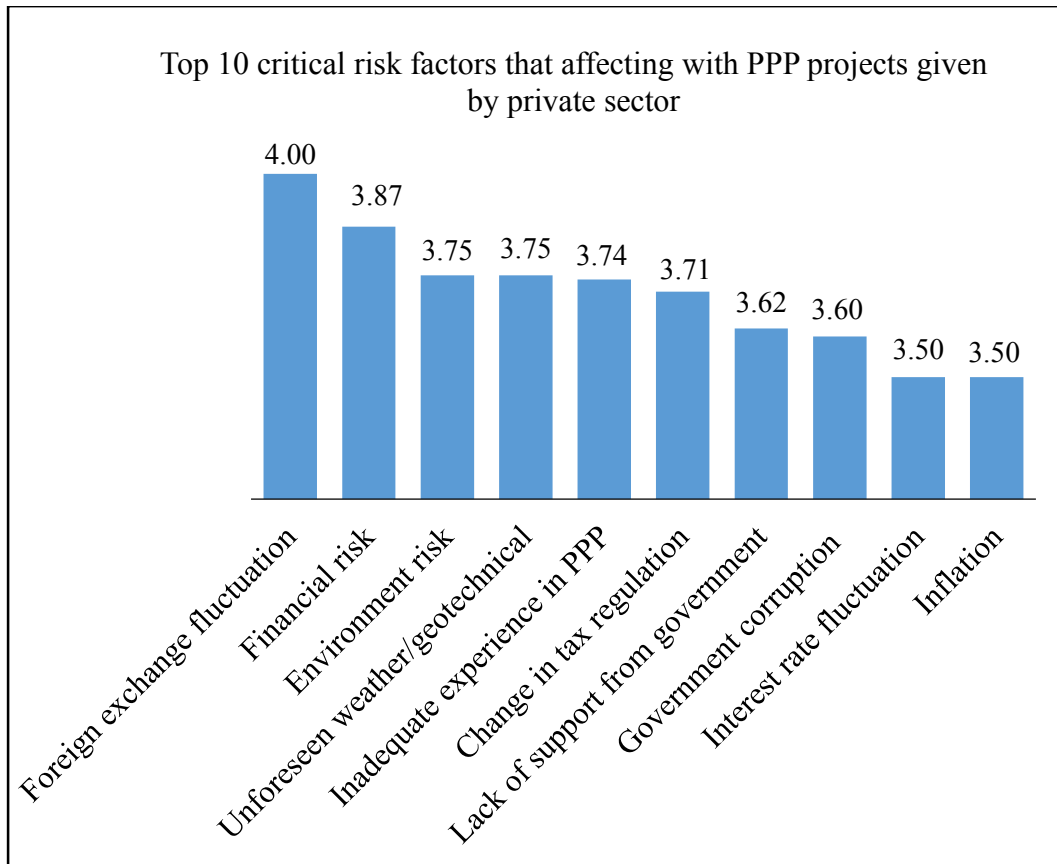
Figure 5.5 Top 10 critical risk factors with PPP projects in private sector

Identification of critical risk categories (CFCs) for PPP projects in Laos on private sector.

Table 5.18 Critical risk factor and risk categories of private sector

| Critical risk factors and risk categories |
|---|
| P. Political risks |
| P1 Lack of support from government |
| P3 Government corruption |
| P5 Inadequate experience in PPP |
| C. Contractual and legal risks |
| C1 Conflicting or imperfect contract |
| C2 Legislation change |
| C3 Change in tax regulation |
| S. Social and Cultural risks |
| S2  Inadequate law and supervision |
| F. Financial and economic risks |
| F1 Interest rate fluctuation |
| F2 Inflation |
| F4 Financial risk |
| F5 Foreign exchange fluctuation |
| R. Relationship risks |
| R1 Difference in working method |
| T. Technical risks |
| T1 Unavailability material or labor |
| N. Natural risks |
| N1  Environment risk |
| N2 Unforeseen weather/geotechnical |

The development of appropriate weighting for the critical risk factors and critical risk groups for PPP projects in Laos on private sector. The weighting for each 15 critical factors and 7 critical categories as follow Table 5.19:

Table 5.19 Weighting for the 15 critical risk factors and 7 critical risk categories for PPP projects in private sector (likelihood of occurrence)

| Critical risk factors and risk categories | Likelihood of occurrence | | |
|---|---|---|---|
| | Mean value | Weighting | Weighting for each categories |
| P. Political risks | **10.75** | | **0.21** |
| P1 Lack of support from government | 3.50 | 0.33 | |
| P3 Government corruption | 3.25 | 0.30 | |
| P5 Inadequate experience in PPP | 4.00 | 0.37 | |
| C. Contractual and legal risks | **10.75** | | **0.21** |
| C1 Conflicting or imperfect contract | 3.25 | 0.30 | |
| C2 Legislation change | 3.25 | 0.30 | |
| C3 Change in tax regulation | 4.25 | 0.40 | |
| S. Social and Cultural risks | **3.50** | | **0.07** |
| S2 Inadequate law and supervision | 3.50 | 1.00 | |
| F. Financial and economic risks | **15.25** | | **0.29** |
| F1 Interest rate fluctuation | 3.50 | 0.23 | |
| F2 Inflation | 3.50 | 0.23 | |
| F4 Financial risk | 4.00 | 0.26 | |
| F5 Foreign exchange fluctuation | 4.25 | 0.28 | |

Table 5.19 (cont.)

| Critical risk factors and risk categories | Likelihood of occurrence | | |
|---|---|---|---|
| | Mean value | Weighting | Weighting for each categories |
| **R. Relationship risks** | **3.00** | | **0.06** |
| R1 Difference in working method | 3.00 | 1.00 | |
| **T. Technical risks** | **3.50** | | **0.07** |
| T1 Unavailability material or labor non- | 3.50 | 1.00 | |
| **N. Natural risks** | **5.00** | | **0.10** |
| N1  Environment risk | 2.75 | 0.55 | |
| N2 Unforeseen weather/geotechnical | 2.25 | 0.45 | |
| Sum = | **51.75** | | |

Table 5.20 Weighting for the 15 critical risk factors and 7 critical risk categories for

PPP projects in private sector (severity of risks)

| Critical risk factors and risk categories | Severity of risks | | |
|---|---|---|---|
| | Mean value | Weighting | Weighting for each categories |
| **P. Political risks** | **11.25** | | **0.23** |
| P1 Lack of support from government | 3.75 | 0.33 | |
| P3 Government corruption | 4.00 | 0.36 | |
| P5 Inadequate experience in PPP | 3.50 | 0.31 | |
| C2 Legislation change | 3.75 | 0.37 | |
| C3 Change in tax regulation | 3.25 | 0.32 | |
| **S. Social and Cultural risks** | **3.00** | | **0.06** |
| S2  Inadequate law and supervision | 3.00 | 1.00 | |

Table 5.20 (cont.)

| Critical risk factors and risk categories | Severity of risks | | |
|---|---|---|---|
| | Mean value | Weighting | Weighting for each categories |
| F. Financial and economic risks | **14.50** | | **0.29** |
| F1 Interest rate fluctuation | 3.50 | 0.24 | |
| F2 Inflation | 3.50 | 0.24 | |
| F4 Financial risk | 3.75 | 0.26 | |
| F5 Foreign exchange fluctuation | 3.75 | 0.26 | |
| R. Relationship risks | **3.00** | | **0.06** |
| R1 Difference in working method | 3.00 | 1.00 | |
| T. Technical risks | **3.25** | | **0.07** |
| T1 Unavailability material or labor | 3.25 | 1.00 | |
| N. Natural risks | **4.50** | | **0.09** |
| N1  Environment risk | 2.50 | 0.56 | |
| N2 Unforeseen weather/geotechnical | 2.00 | 0.44 | |
| Sum = | 49.75 | | |

The determination of the membership function for each critical risk factors of each critical risk categories (CRFs/CRC) in private sector as shown in Table 5.21:

Table 5.21 The membership function of all critical risk factors for PPP projects in
Laos on private sector (likelihood of occurrence)

| Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|
| **P. Political risks** | | | (0.00,0.08,0.33,0.50,0.09) |
| P1 Lack of support from government | 0.33 | (0.00,0.00,0.50,0.50,0.00) | |
| P3 Government corruption | 0.30 | (0.00,0.25,0.25,0.50,0.00) | |
| P5 Inadequate experience in PPP | 0.37 | (0.00,0.00,0.25,0.50,0.25) | |
| **C. Contractual and legal risks** | | | (0.00,0.00,0.55,0.15,0.20) |
| C1 Conflicting or imperfect contract | 0.30 | (0.00,0.00,0.75,0.25,0.00) | |
| C2 Legislation change | 0.30 | (0.00,0.00,0.75,0.25,0.00) | |
| C3 Change in tax regulation | 0.40 | (0.00,0.00,0.25,0.00,0.50) | |
| **S. Social and Cultural risks** | | | (0.00,0.25,0.00,0.75,0.00) |
| S2  Inadequate law and supervision | 1.00 | (0.00,0.25,0.00,0.75,0.00) | |
| **F. Financial and economic risks** | | | (0.00,0.00,0.23,0.70,0.07) |
| F1 Interest rate fluctuation | 0.23 | (0.00,0.00,0.50,0.50,0.00) | |
| F2 Inflation | 0.23 | (0.00,0.00,0.50,0.50,0.00) | |
| F4 Financial risk | 0.26 | (0.00,0.00,0.00,1.00,0.00) | |

Table 5.21 (cont.)

| Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|
| F5 Foreign exchange fluctuation | 0.28 | 0.00,0.00,0.00,0.75,0.25) | |
| **R. Relationship risks** | | | (0.00,0.00,1.00,0.00,0.00) |
| R1 Difference in working method | 1.00 | (0.00,0.00,1.00,0.00,0.00) | |
| **T. Technical risks** | | | (0.00,0.00,0.50,0.50,0.00) |
| T1 Unavailability material or labor | 1.00 | (0.00,0.00,0.50,0.50,0.00) | |
| **N. Natural risks** | | | (0.00,0.61,0.25,0.14,0.00) |
| N1 Environment risk | 0.55 | (0.00,0.50,0.25,0.25,0.00) | |
| N2 Unforeseen weather/geotechnical | 0.45 | (0.00,0.75,0.25,0.00,0.00) | |

Table 5.22 The membership function of all critical risk factors for PPP projects in
Laos on private sector (severity of risks)

| Risk factors | Weighting | Membership Function of level 3 | Membership Function of level 2 |
|---|---|---|---|
| **P. Political risks** | | | (0.00,0.08,0.33,0.34,0.25) |
| P1 Lack of support from government | 0.33 | (0.00,0.00,0.50,0.25,0.25) | |
| P3 Government corruption | 0.36 | (0.00,0.00,0.25,0.50,0.25) | |
| P5 Inadequate experience in PPP | 0.31 | (0.00,0.25,0.25,0.25,0.25) | |
| **C. Contractual and legal risks** | | | (0.00,0.16,0.25,0.43,0.00) |
| C1 Conflicting or imperfect contract | 0.32 | (0.00,0.25,0.25,0.50,0.00) | |
| C2 Legislation change | 0.37 | (0.00,0.00,0.25,0.75,0.00) | |
| C3 Change in tax regulation | 0.32 | (0.00,0.25,0.25,0.00,0.00) | |
| **S. Social and Cultural risks** | | | (0.00,0.25,0.50,0.25,0.00) |
| S2 Inadequate law and supervision | 1.00 | (0.00,0.25,0.50,0.25,0.00) | |
| **F. Financial and economic risks** | | | (0.00,0.00,0.37,0.63,0.00) |
| F1 Interest rate fluctuation | 0.24 | (0.00,0.00,0.50,0.50,0.00) | |
| F2 Inflation | 0.24 | (0.00,0.00,0.50,0.50,0.00) | |
| F4 Financial risk | 0.26 | (0.00,0.00,0.25,0.75,0.00) | |
| F5 Foreign exchange fluctuation | 0.26 | (0.00,0.00,0.25,0.75,0.00) | |
| **R. Relationship risks** | | | (0.00,0.25,0.50,0.25,0.00) |
| R1 Difference in working method | 1.00 | (0.00,0.25,0.50,0.25,0.00) | |

Table 5.22 (cont.)

| | | | |
|---|---|---|---|
| **T. Technical risks** | | | (000,0.00,0.75,0.25,0.00) |
| T1 Unavailability material or labor | 1.00 | (000,0.00,0.75,0.25,0.00) | |
| **N. Natural risks** | | | (0.00,0.72,0.28,0.00,0.00) |
| N1 Environment risk | 0.56 | (0.00,0.50,0.50,0.00,0.00) | |
| N2 Unforeseen weather/geotechnical | 0.44 | (0.00,1.00,0.00,0.00,0.00) | |

The developing a fuzzy synthetic evaluation model for PPP projects in Laos on private sector.

Table 5.23 The result of fuzzy synthetic evaluation for all CRCs for PPP projects in Laos on private sector

| Risk Categories | Weighting | Membership function of level 2 | Membership function of level 1 |
|---|---|---|---|
| Likelihood of occurrence (from level 2 to level 1) | | | |
| P. Political risks | 0.21 | (0.00,0.08,0.33,0.50,0.09) | (0.00,0.09,0.37,0.44,0.08) |
| C. Contractual and legal risks | 0.21 | (0.00,0.00,0.55,0.15,0.20) | |
| S. Social and Cultural risks | 0.07 | (0.00,0.25,0.00,0.75,0.00) | |
| F. Financial and economic risks | 0.29 | (0.00,0.00,0.23,0.70,0.07) | |
| R. Relationship risks | 0.06 | (0.00,0.00,1.00,0.00,0.00) | |
| T. Technical risks | 0.07 | (0.00,0.00,0.50,0.50,0.00) | |
| N. Natural risks | 0.10 | (0.00,0.61,0.25,0.14,0.00) | |

Table 5.23 (cont.)

| Severity of risks (from level 2 to level 1) | | | |
|---|---|---|---|
| P. Political risks | 0.23 | (0.00,0.08,0.33,0.34,0.25) | (0.00,0.15,0.37,0.40,0.06) |
| C. Contractual and legal risks | 0.21 | (0.00,0.16,0.25,0.43,0.00) | |
| S. Social and Cultural risks | 0.06 | (0.00,0.25,0.50,0.25,0.00) | |
| F. Financial and economic risks | 0.29 | (0.00,0.00,0.37,0.63,0.00) | |
| R. Relationship risks | 0.06 | (0.00,0.25,0.50,0.25,0.00) | |
| T. Technical risks | 0.07 | (000,0.00,0.75,0.25,0.00) | |
| N. Natural risks | 0.09 | (0.00,0.72,0.28,0.00,0.00) | |

Table 5.24 Risk index of a particular CRC and overall risk index (ORI) of PPP
projects on private sector

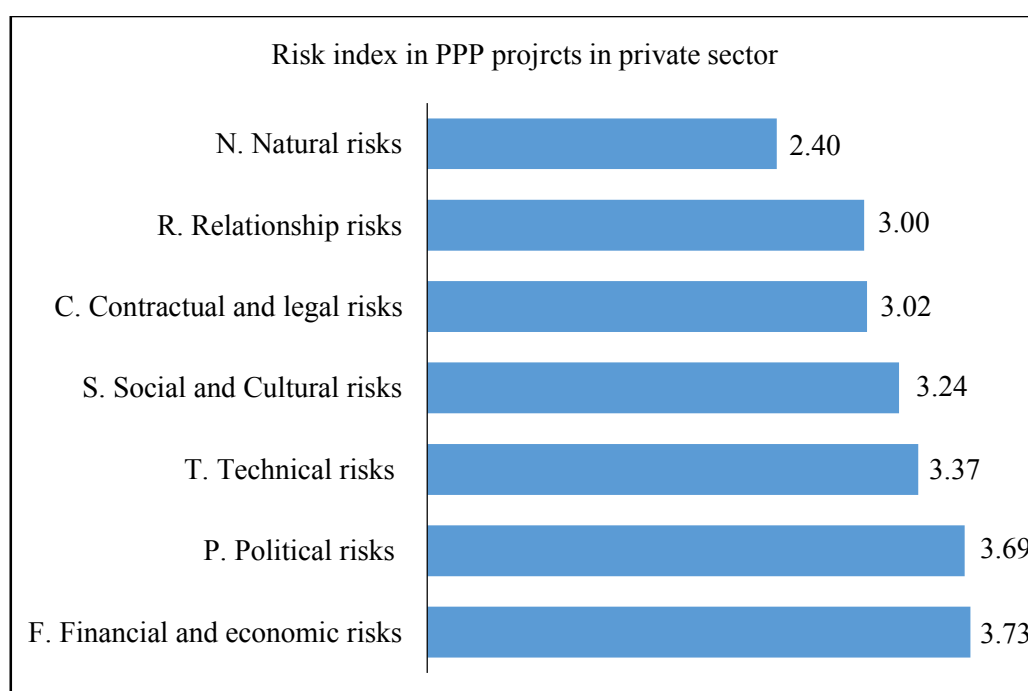| Risk categories | Likelihood of occurrence | Risk severity | Risk index |
|---|---|---|---|
| P. Political risks | 3.61 | 3.76 | 3.69 |
| C. Contractual and legal risks | 3.25 | 2.80 | 3.02 |
| S. Social and Cultural risks | 3.50 | 3.00 | 3.24 |
| F. Financial and economic risks | 3.84 | 3.63 | 3.73 |
| R. Relationship risks | 3.00 | 3.00 | 3.00 |
| T. Technical risks | 3.50 | 3.25 | 3.37 |
| N. Natural risks | 2.53 | 2.28 | 2.40 |
| Overall risk | 3.45 | 3.31 | 3.38 |



Figure 5.6 Risk index in PPP projects (private sector)

## 5.4 Interpretation of Public-private partnership

The PPP project can be initiated by a national government, local government, state-Owned enterprise, local authorities, government agencies or any other government units. The PPPs could be initiated by a private company that submits an unsolicited to the government. The main stages in establishing a PPP project are a preliminary study, feasibility study, tender process, and contract management. It is often that there are PPPs included in specific sectors such as roads, rails, power, and communication; public housing, rural road and bus stating including industrial infrastructure.

One of the reasons why Lao PDR consider doing PPPs projects that it is because PPPs can deliver better value for money when delivering service of Lao PDR. This is given by the examples of, better service at a better price. It also can use private financing to spread the cost of projects.

For many years, the government of the Lao P.D.R lacks the budget to do the projects. In the same way, Lao PDR is a rapid growth thus it requires infrastructure and services to support its economy and people. On the contrary, the government of the Lao P.D.R does not have sufficient the human and financial capacity alone to deliver and manage all the infrastructure and services as required.

The benefit of using PPPs could lead to the construction of projects on time and budget, overall more efficient and effective management of the entire project corresponding to develop of more innovative ways of delivering service and better use of appropriate technologies, exploitation of direct and secondary projects assets and delivery capacity as well. Similar to lifecycle optimization is a better relationship between design and construction, operation and maintenance over time, likewise private financing.

The criteria that could be used to determine project as a PPP project includes project size, project duration, complex projects, public alternative, potential market interest, legacy, potential lifecycle integration, and potential commercial exploitation. The main things to consider is that PPPs are better than government or public provision such as output specification which focuses on the desired outputs, risk allocation, competitive procurement, and post-contract management.

In addition, one of the respondents has given the comment that the main risk of PPP projects that could fact in real problem in Laos. the first risk was financial issues resulted from the economic instability, a social and cultural problems primary form the compensation to the people around prices offset the initial price, but in fact, did not have to set it as a result of a price increase. Therefore, discussing with people is difficult although it was important with a project. In this case, it results in excessive delays that risk caution (they recommence rules that price compensation of the people is the boundaries of the state). Another one, market fluctuation is also a risk of PPP projects. In PPP projects must have a bank guarantee and clear plan to do the project without any unclear project, which should have completed as planned. To monitor transparency according to construction standards, there must be regular audiences. The concept that defines PPP project must be a new project and a project that is not the same as an existing public project, to make sure that what is being created is good and useful for people to get people to use, which is a better option.

## 5.5    Discussion on the results

Based on the summary result of rank risk categories by technique for order preference by similarity to the ideal solution method. There information from respondents both public and private sectors. The result found that most significant risk factors in PPP projects in Laos, for the public sector is inflation (F2) and for the private sector is foreign exchange fluctuation (F5). Moreover, the financial risk also concerns as important risk. Cheng and Chan (2011) indicted that government intervention and poor political decision making usually faced in China. Likewise, other researcher found that the lack of support from government was assigned with the highest criticality and the unavailability of financial instrument is also ranked high in PPP projects in Singapore (Hwang et al., 2013).

### Foreign exchange fluctuation (F5)

For the private sector, Table 5.17 shows that the foreign exchange fluctuation was the critical risk factor that was ranked first of ranking risk impact with the score of 4.00 (high impact). the respondents usually more factor related to financial and economic such foreign exchange fluctuation. It refers to currency fluctuations that direct impact

on the monetary policy of a country. As know that construction projects are a high-risk business activity. There were affected by these fluctuations. They might affect progress and cause delays, which in turn create problems for namely cost overruns. It also causes the price of raw materials to increase, leading the cost overruns.

### Financial risk (F4)

Although the rankings of the combined the risk level of the likelihood of occurrence and the severity of risks between public and private sectors, they agreed that the financial risk was ranked first that impact with PPP projects in Laos.

Ke et a. (2011) found that the impact with financial market the syndicated loan market is not prevalent as a source of debt finance, the corporate bond market is not sufficiently mature compared with sovereign bonds, the arrangement of floating charge on the project assets as a guarantee needed for innovative projects financing is not well established legally.

### Inflation (F2)

Inflation is another factor that has become a chronic problem effects permeate the entire construction industry. For the public sector also concern about this factor. In the implementation of a PPP project, the impact of inflation is the increase in the costs of raw materials, equipment and labor for the project operation, resulting in increased costs and expenses for project construction and operation.

## 5.6   Summary

For partnership: The value of risk index shown that risk categories affecting in PPP projects in Laos are: (1) natural risk consists of risks, (2) contractual and legal risks, (3) political risks, (4) financial and economic risks, (5) design-related risks, (6) relationship risks, (7) technical risks. The value number of the overall risk of this study is 3.29 (high level).   These findings can benefit both public and private sectors for the development of future PPP projects in Laos. They can use these results to prepare an appropriate project plan that appropriately responds to the degree of criticality of each risk category.

For the public sector: due to a literature review, 33 risk factors that affect construction in PPP projects in Laos. These have been identified and divided into 8 risk categories: political risk (5 factors), contractual and legal risks (3 factors), social and cultural risks (2 factors), financial and economic risks (8 factors), relationship risks (2 risk factors), technical risks (6 risk factors), design-relation risks (3 factors), and natural risks (4 factors). According to the assessment of critical risk factors, it was found that the critical risk factors and each risk category having medium to high-risk level. The overall risk level is 3.09. The highest value of risk index for the public sector is a design-related risk and contractual and legal risk. It should be a concern for the next PPP projects in Laos.

For private sector: seven critical risk categories and 15 critical risk factors concerned in this sector. It comprises of political risks (3 factors), contractual and legal risks (3 factors), social and cultural risks (1 factor), financial and economic risks (4 factors), relationship risks (1 factor), technical risks (1 factor), and natural risks (2 factors). The result shown that highest risk index was financial and economic risk is 3.73 and the value of political risk is 3.69. the respondents also indicated natural risks had low affected in PPP projects in Laos for the private sector as shown in Table 5.25.

Table 5.25 Summarize risk index of risk categories

| Risk index | | | | | |
|---|---|---|---|---|---|
| Public | | Private | | All | |
| D. Design-related risk | 3.19 | F. Financial and economic risks | 3.73 | N. Natural risks | 3.39 |
| C. Contractual and legal risks | 3.15 | P. Political risks | 3.69 | C. Contractual and legal risks | 3.37 |
| N. Natural risks | 3.11 | T. Technical risks | 3.37 | P. Political risks | 3.36 |
| P. Political risks | 3.11 | S. Social and Cultural risks | 3.24 | F. Financial and economic risks | 3.35 |
| F. Financial and economic risks | 3.04 | C. Contractual and legal risks | 3.02 | D. Design-related risk | 3.00 |
| T. Technical risks | 3.00 | R. Relationship risks | 3.00 | R. Relationship risks | 2.93 |
| | | N. Natural risks | 2.40 | T. Technical risks | 2.93 |

Due to the in-depth interview, the overview of the PPP project in Laos was based on information from the respondents to all parties. It was found that risk management also affecting the display in the PPP project. They concern about financial as a bank guarantee and a clear plan for operating the project. The main objective of use PPP as help developing countries rapidly. They believed and hope that the PPP is a better way to respond to a require infrastructure and service to support its economic growth and people as government needs.

Based on the opinions of nine respondents, the information given were discussed as follow:

**Contractual and legal risk**

These risk categories were ranked second in all sector, the likelihood of occurrence and severity of risk are 3.46 and 3.28 respectively. Due to the change in tax regulation of government and change of law that will cause an increase in project costs

and decrease in revenue. There was a respond with PPP projects and should be caring for these risk categories before displays the project.

**C. Contractual and legal risks**

Public, 3.15

All , 3.37

Private, 3.02
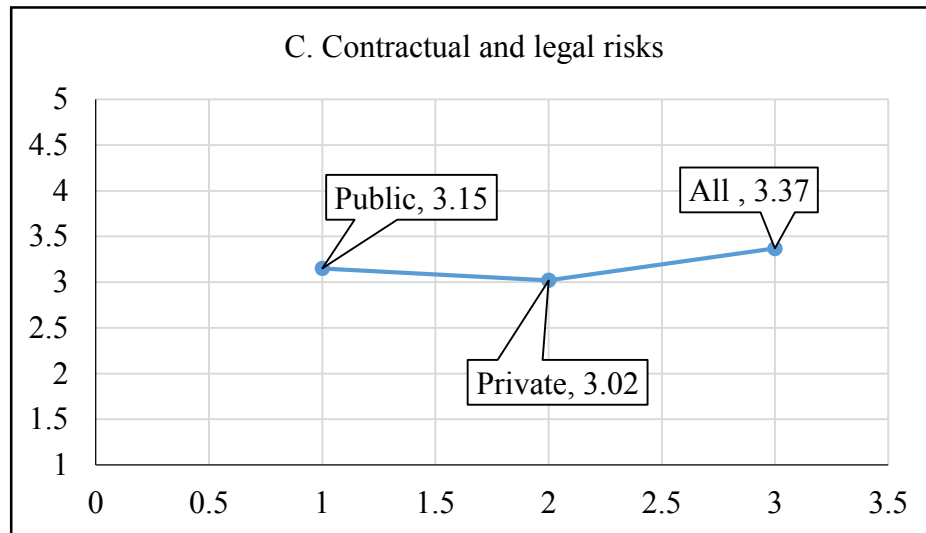
**Design-related risk**

According to the standards and requirement, some investor refers to the private sector cannot fulfill or the techniques are of poor applicability. That way the public sector discusses these risk categories as quite often occur (3.00 is a score of likelihood of occurrence and the value of this risk index represent the public sector is 3.19.

**D. Design-related risk**

All , 3.00

Public, 3.19
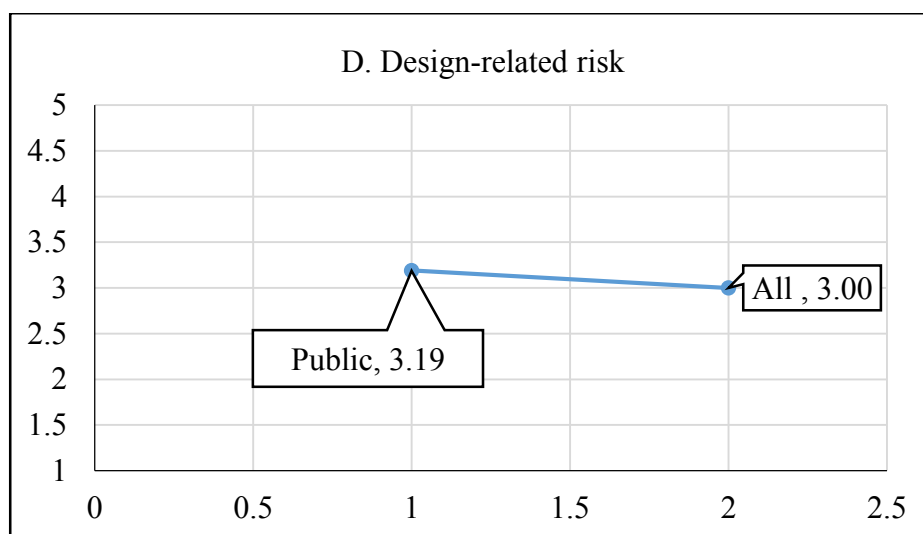
**Financial and economic risk**

In the private sector, many respondents concern about financial and economic risk categories. Especially, foreign exchange fluctuation and financial risk. It was first with a score of 3.73. this risk might occur while the variability of foreign currencies exchange, from the uncertainties of the interest rate volatility. Another, the risk may be arising from the irrational financing structure or finance market.



F. Financial and economic risks
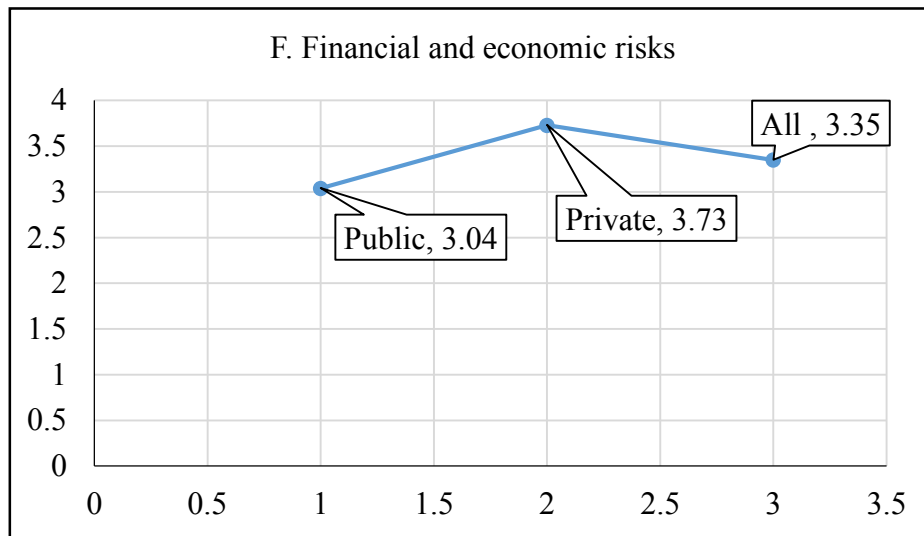
**Natural risk**

The two risk factors are known as environmental risk and unforeseen weather or geotechnical risk. The risk index score is 3.11, 2.40 and 3.39 of the private sector, private sector and all. This risk indicated a nearly high level of severity of risk. Because of the environment risk refers to the increasing requirement of the government or social origination regarding the environment protection. One reason, the construction or project site is and natural condition. Those risks might have originated from the project cost increase, delay in work schedule and others.
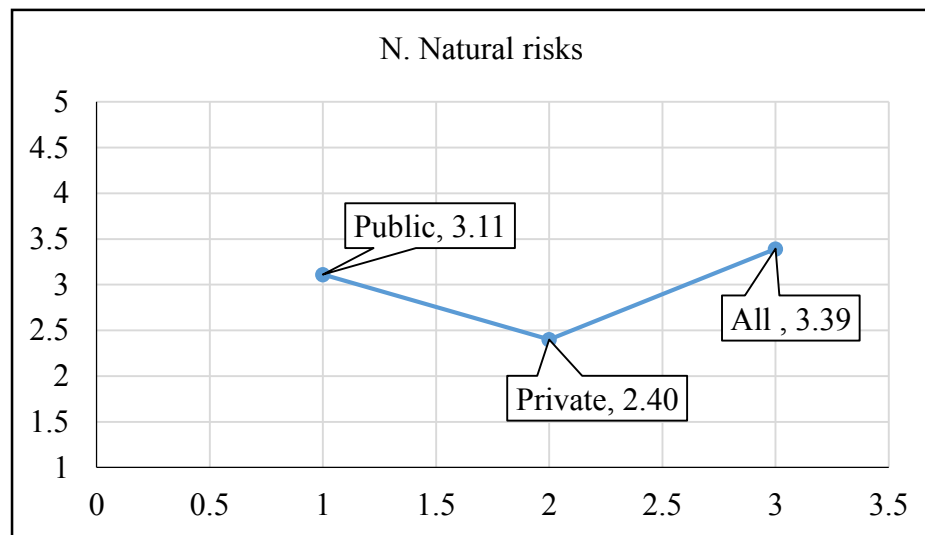


**Political risk**

For these risk categories, the value of the likelihood of occurrence and severity of risk are 3.61 and 3.76 respectively for private sector. Its represent medium to high-risk level in public and all sector. The risk factor that respondents concerning about inadequate experience in PPP due to the government lack of experience and a few of knowledge, they try hard to solve this problem.

**P. Political risks**
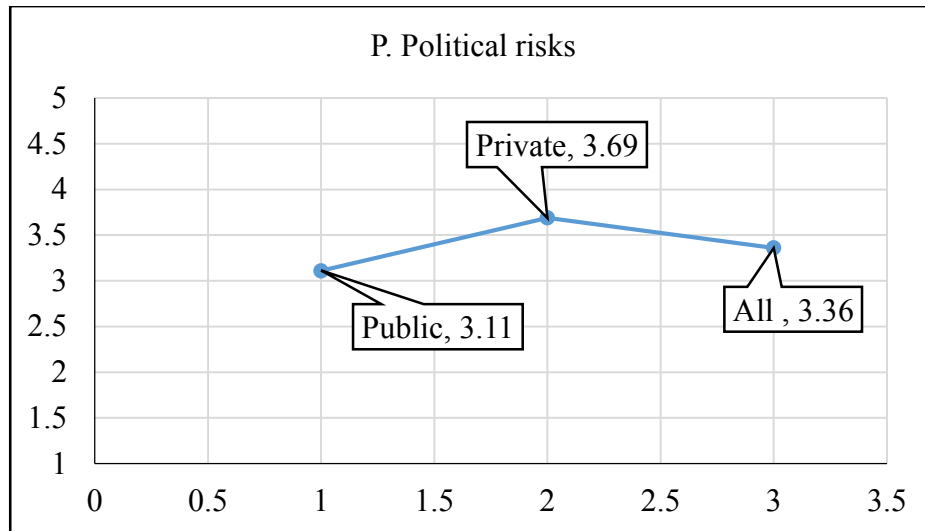


**Relationship risk**

The organization and coordination risk and the difference in a working method are including in this risk categories, there was fifth-ranked and sixth-ranked in private sector and all presents medium level, the reasons of the insufficient coordination ability of project company and the cost of communication among project participants' increase and conflicts occur.
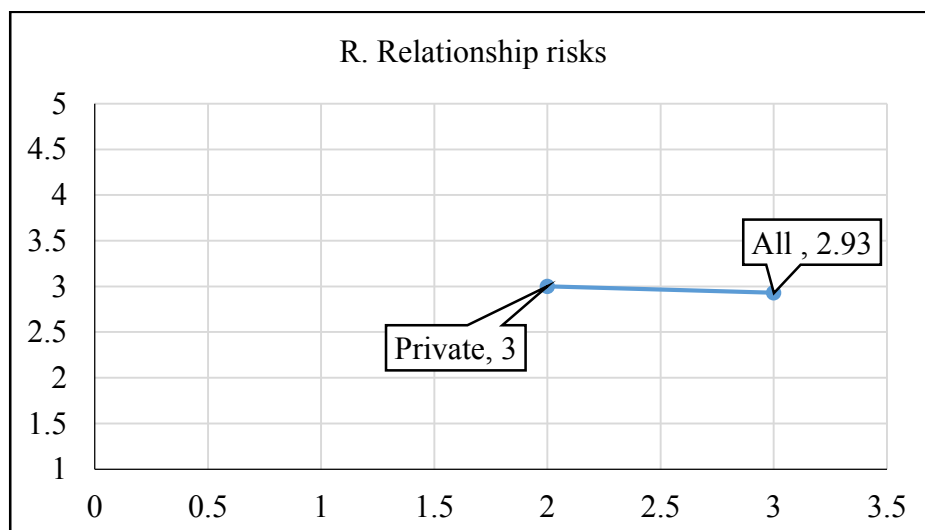
**Technical risk**

Due to the most PPP projects in Laos is a large construction, so that material or labor needs a large amount as well, sometime Laos does not produce as construction needed. It was necessary to export material or labor from another country, for example, Vietnam and China. For this study, the private sector is apprehensive for this risk categories, there was the ranked third and the score indicated the likelihood of occurrence is quite often occurring (3.50) and severity of risk is medium level (3.00)
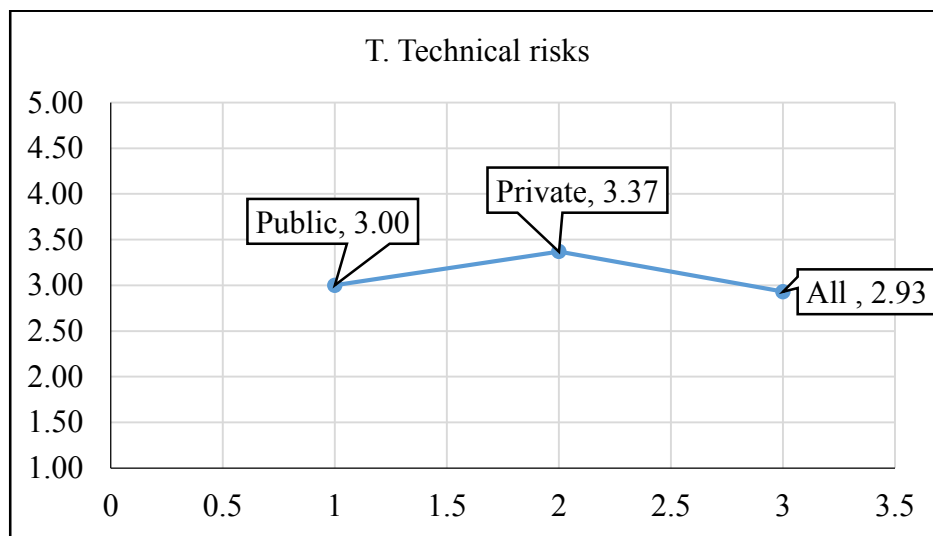
**CHAPTER 6**

**CONCLUSION AND RECOMMENDATION**

This chapter presents conclusions and recommendations for this research. There was based on the information given in the previous chapters. The first part presents the conclusion of this study. The second part indicates the limitation. Finally, the last part represents the contribution of study risk management in public-private partnership projects in Laos.

## 6.1 Conclusions

Public-private partnerships (PPP) is a popular option of project delivery and contractual scheme between the public and private sector enabling public infrastructure. There are many factors affecting the success of PPP projects, most of which are country-specific. PPP risk needs to be identified, assessed and allocated appropriately before the project is carried out. Since Laos has never had a comprehensive study on PPP risk management, it is essential to investigate such an issue. The main objective of this research is to identify and evaluate the critical risk factor that affects development. In addition, to rank significant risk factors by risk categories of the PPP projects in Laos.

This research has studies the likelihood of occurrence and severity of risk factors in Laos's PPP projects. The nine respondents collected were analyzed by the level score. The TOPSIS method used for ranking resulted in the top-ranked risk categories as design-related risks, contractual and legal risks, financial and economic risks, and political risks. It will prove to be very helpful to the projects. The identification of risk factors and risk categories could be help to the private investor to plan for a strategy to respond to their risk.

## 6.2 Limitation of this research

For a few inherent limitations. For the small respondents as sample size that put constraints to generalize the findings of this study. Another limitation is that while 33 risk factors this studies literature review; some bias might exist in the selection of the 33 factors. The data collected in this research, according to Laos have limited experts

who experts for PPP projects that hard to contract and limited time also. Because of they a lot of responsible in their work.

For the result, in this study were identified and evaluated the critical risk factors that affect the development of public-private partnership (PPP) projects in Laos. Another hand, it's also rank significant risks factor by risk categories. The result of this research was based on the perspective or viewpoints of nine respondents who work for both parties as public and private. Furthermore, due to the limited of number respondents, this research might be missing some factors that could occur in construction.

## 6.3    Recommendations for the further research

According to the scope of the respondents carried out only local companies, in the future research should be expended focus on both local and foreign companies. Moreover, the future research will be focus on a larger sample of respondents to increase the efficiency of the information for analyze risk factor in PPP projects.

This research was classified as qualitative research approach. The questionnaire and in-depth interview were used to collect the information from respondents. The future research should collect both qualitative and quantitative method for studied to increase the strengthening reliability of information.

In this research, TOPSIS method were used to rank risk factor. For future research might use other methods for identifying and ranking of risk factors and risk categories to compare the results with using the TOPSIS method.

## 6.4    Research outcome

The main results from this research are the critical risk factors of the PPP project in Lao PDR that are analyzed based on the respondents' experience in previous and current projects. These results reflect the data and opinions, which were provided by both the public and private sectors.

## 6.5 Research contribution

This study can help the private sector to realize the risk factors affecting PPP projects in Laos. The can manage risk factors in the implementation process of PPP projects in Laos and know how to manage risk when working with Laos government projects as problems, political, social, cultural, and relationship.

The result for this result could benefit the Lao government and the private sector for an understanding of the risk factors affecting in PPP projects. It is necessary for the government to revise those factors and PPP projects might become more effective. Moreover, these results present valuable lessons that realize strength with the private sector and they can learn risk factors of the private sector.

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**APPENDIX**

**QUESTIONNAIRE SURVEY**

**RISK MANAGEMENT OF PUBLIC-PRIVATE PARTNERSHIP (PPP)
INFRASTRUCTURE PROJECTS IN LAOS**

The main objective for this questionnaire survey related to identify and evaluate risk factors in public-private partnership projects in Laos and how to manage that potential risk. This study emphasis in Laos and focuses on both public and private sectors.

**SECTION 1: GENERAL INFORMATION**

1. How long have you worked in construction industry?

   ☐ 1-3 years

   ☐ 3-5 years

   ☐ 5-10 years

   ☐ > 10 years

2. What type of project are you participating in?

   ☐ Nothing

   ☐ 1-3 projects

   ☐ > 3 projects

3. How many PPP projects have you participated in?

   ☐ Nothing

   ☐ 1-3 projects

   ☐ > 3 projects

4. What type of project are you participating in?

**5.** Do you know about risk management?

☐ Unknown

☐ Known

☐ Known very well

**6.** In your opinion, Risk management is necessary in Public-private projects in Laos or not?

☐ Unnecessary

☐ Necessary

☐ Very necessary

## SECTION 2: INTERVIEW QUESTIONS

**1.** Risks affect the implementation of Public-private Partnerships project**:**

There are seven risk categories consist of Political risk, contractual and legal risk, social and culture risk, financial and economic risk, technical risk, design-related risk and natural risk.

**a) <u>Political risk:</u>**

What is the strategy of each partner for identifying and allocating risk, and are the partners responsible for each type of risk best able to manage the risk in terms of expertise and resources? (Please give comment)

**b) <u>Contractual and legal risk:</u>**

What contractual risks have you often faced in project implementation?

**c) <u>Social and cultural risk:</u>**

What is the social risks affecting with the implementation of PPP projects? And is there the difference of language and culture barrier?

**d) Financial and economic risk:**

What is the financial risk of projects?

Do economic affecting with the performance of PPP projects?

**e) Relationship risks:**

What is the problem in the relationship in PPP projects in Laos?

**f) Technical risk:**

What is the problems in the technical of PPP projects?

**g) Design-related risk:**

What is the design-related risk in Laos?

**h) Natural risk:**

What are these National risks in the performance of PPP projects?

2. What is the strategy for developing and sustaining open collaboration among the PPP stakeholders?

3. Who is responsible for monitoring and evaluating performance data, and how can the measures be used to demonstrate that the private partners are performing according to government and citizen stakeholder expectations?

## SECTION 3: RISK AFFECTING OF PPP PEOJECTS IN LAOS

Please check on the checklist and (X) in the table based on your own experience and opinion.

**1. Likelihood of occurrence**

| Scale | Scenario |
|-------|----------|
| 1 | Not expected to happen |
| 2 | Small likelihood |
| 3 | Quite often occurrence |
| 4 | Usually occurrence |
| 5 | Very frequent occurrence |

**2. Severity of risks**

| Scale | Scenario |
|-------|----------|
| 1 | Very low |
| 2 | Low |
| 3 | Medium |
| 4 | High |
| 5 | Very high |

| Risk categories | Risk factors | Likelihood of occurrence | | | | | Severity of risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| **P. Political risks** | P1. Lack of support from government | | | | | | | | | | |
| | P2. Nationalization | | | | | | | | | | |
| | P3. Government corruption | | | | | | | | | | |
| | P4. Public credit | | | | | | | | | | |
| | P5. Inadequate experience in PPP | | | | | | | | | | |
| **C. Contractual and legal risks** | C1. Conflicting or imperfect contract | | | | | | | | | | |
| | C2. Legislation change | | | | | | | | | | |
| | C3. Change in tax regulation | | | | | | | | | | |
| **S. Social and Cultural risks** | S1. Public opposition | | | | | | | | | | |
| | S2. Inadequate law and supervision | | | | | | | | | | |
| **F. Financial and economic risks** | F1. Interest rate fluctuation | | | | | | | | | | |
| | F2. Inflation | | | | | | | | | | |
| | F3. Market competition (Uniqueness) | | | | | | | | | | |
| | F4. Financial risk | | | | | | | | | | |
| | F5. Foreign exchange fluctuation | | | | | | | | | | |
| | F6. Change in market demand | | | | | | | | | | |
| | F7. Operation cost overrun | | | | | | | | | | |
| | F8. Price change | | | | | | | | | | |

Cont.

| Risk categories | Risk factors | Likelihood of occurrence | | | | | Severity of risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| **R. Relationship risks** | R1. Difference in working method | | | | | | | | | | |
| | R2. Organization and communication risk | | | | | | | | | | |
| **T. Technical risks** | T1. Unavailability material or labor | | | | | | | | | | |
| | T2. Third party delay or violation | | | | | | | | | | |
| | T3. Inability of concessionaire | | | | | | | | | | |
| | T4. Completion risk | | | | | | | | | | |
| | T5. Lack of supporting infrastructure | | | | | | | | | | |
| | T6. Land acquisition | | | | | | | | | | |
| **D. Design-related risk** | D1. Delay in project approvals and permits | | | | | | | | | | |
| | D2. Unproven engineering techniques | | | | | | | | | | |
| | D3. Poor Public decision-making process | | | | | | | | | | |
| **N. Natural risks** | N1. Environment risk | | | | | | | | | | |
| | N2. Unforeseen weather/geotechnical | | | | | | | | | | |
| | N3. Force majeure | | | | | | | | | | |
| | N4. Residual risk | | | | | | | | | | |

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