FACTORS AFFECTING THE SUCCESS OF RAILWAY DEVELOPMENT PROJECTS
: A CASE OF THAILAND

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งานวิจัยนี้มีจุดประสงค์เพื่อระบุและวัดอิทธิพลในเชิงปริมาณของปัจจัยความสำเร็จต่อโครงการพัฒนาโครงสร้างพื้นฐานทางรางที่เกี่ยวข้องกับฐานโลจิสติกส์ของประเทศไทย ขอบเขตของงานวิจัยประกอบด้วยโครงการก่อสร้างทางรถไฟทางคู่และโครงการก่อสร้างทางรถไฟสายใหม่ที่อยู่ระหว่างการศึกษาและเตรียมการ ในขั้นตอนทบทวนวรรณกรรม ผู้วิจัยพบปัจจัยความสำเร็จต่อการขนส่งสินค้าทางราง รวมทั้งปัจจัยความสำเร็จต่อโครงการด้านขนส่ง รวมจำนวน 24 ปัจจัย โดยสามารถแบ่งปัจจัยได้เป็น 5 มิติ และสร้างแบบจำลองวิธีวิเคราะห์เชิงลำดับขั้น การวัดอิทธิพลในเชิงปริมาณของปัจจัยความสำเร็จดำเนินการด้วยแบบสำรวจซึ่งประกอบด้วยคำถามเปรียบเทียบเชิงคู่ หลังจากใช้การคำนวณด้วยวิธีวิเคราะห์เชิงลำดับขั้นและทฤษฎีฟัสซี ผู้วิจัยสามารถระบุได้ว่า ปัจจัยความสำเร็จที่มีผลต่อโครงการพัฒนาโครงสร้างพื้นฐานทางรางมากที่สุดคือการจัดทำแผนแม่บทโครงสร้างพื้นฐานทางราง และการพัฒนาพื้นที่เชิงพาณิชย์รอบสถานีขนส่งมวลชน จึงสามารถสรุปได้ว่าการพัฒนาโครงสร้างพื้นฐานทางรางที่เกี่ยวข้องกับฐานโลจิสติกส์ของประเทศไทยจะประสบความสำเร็จได้ หากมีแผนระยะยาวที่มีความต่อเนื่องและชัดเจน และต้องพัฒนาการขนส่งสินค้าและผู้โดยสารในคราวเดียวกัน นอกจากนี้ ควรมีการสนับสนุนการพัฒนาตลาดภายในประเทศสำหรับการผลิตและประกอบชิ้นส่วนรถไฟ การสนับสนุนให้มีการร่วมลงทุนระหว่างเอกชนและภาครัฐในโครงการพัฒนาโครงสร้างพื้นฐานทางราง และก่อตั้งหน่วยงานภาครัฐที่จะกำกับดูแลการขนส่งระบบรางของประเทศพร้อมกับการจัดทำแผนแม่บทโครงสร้างพื้นฐานทางรางและการพัฒนาพื้นที่เชิงพาณิชย์รอบสถานีขนส่งมวลชน

สาขาวิชา	การจัดการด้านโลจิสติกส์	ลายมือชื่อนิสิต	....
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KEYWORDS: RAIL INFRASTRUCTURE DEVELOPMENT PROJECTS / LOGISTICS PLATFORM / FUZZY AHP / THAILAND / TRANSPORTATION

WARALEE PEETAWAN: FACTORS AFFECTING THE SUCCESS OF RAILWAY DEVELOPMENT PROJECTS : A CASE OF THAILAND. ADVISOR: PROF. KAMONCHANOK SUTHIWARTNARUEPUT, Ph.D., CO-ADVISOR: ASSOC. PROF. PONGSA PORNCHAIWISESKUL, Ph.D., 113 pp.

This research aims to identify and quantify influence of success factors for rail infrastructure development projects associated with Thai's logistics platform. Projects included in this research are the recent double tracking railways projects and new railways construction projects that are under development. Researcher had extracted 24 factors through literature review associated with rail freight transport and transportation projects. Factors were categorized in five dimensions and analytical hierarchy process model was proposed. Influence of the factors were quantified through a survey containing pairwise comparison questions. By applying analytical hierarchy process and fuzzy theory, leading success factors were identified. The success factor that has the highest influence to rail infrastructure development projects is rail development masterplan, follows by transit oriented development. Therefore, researcher recommends that it is crucial for Thai government to establish a long-term and solid masterplan for rail infrastructure development projects that focus on both freight and passenger transport. Along with the masterplan proposition; encouragement for local market development for rail industry products, rail assembly and public-private partnership scheme; and legislation of new rail regulating agency should also be stimulate altogether.

Field of Study: Logistics Management	Student's Signature ....
Academic Year: 2015	Advisor's Signature ....
	Co-Advisor's Signature ....

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CHAPTER 1

INTRODUCTION

1.1 Background and Problem Review

Railroad had played a significant role in transportation since its first introduction in 1820s. From Britain, construction of railways spread to every continent as it serves long haul transportation for both passenger and freight. As a substitute for inland water transportation, together with the capability of handling large volume of freight as well as passengers railroad has become one of economic development drivers in many countries during 18th and 19th century.

The rapid and aggressive development of highways and motor carrier industry in the last half of 20th century has changed the transportation structure. Although railroad holds its superior over motor carrier in term of cost and capacity, the recession of railroads was inevitable due to changing need in economy. Motor carrier became the major mode of transportation for its flexibility and speed. On the other hand, railroad is unable to compete with water transportation and pipeline on cost and volume (Bardi, Coyle, and Novack, 2006). Struggling in the middle of all five modes, usage of railroads declined continuously in many countries.

Thailand has encountered the similar situation. Rail development was interrupted after the transformation of Department of State Railways which embarked in 1951. The transformation from a government agency to a state enterprise was recommended by the World Bank. Name of the agency was changed to the State Railways of Thailand (SRT). The transformation was not the only reason for rail's depopulation. Another main cause was the government focus which turned to network expansion for highways and rural roads. Negligence in rail investment resulted in insufficient maintenance of infrastructures and relatively low proportion of freight transported by rail, approximately two percent of freight transported domestically. Most railways in the country are still single tracks with 1,000 millimeters width (meter gauge).

Investment in rail infrastructure has not been encouraged before 2000s. Major investments during 1980s – 2000s were mainly infrastructure improvements and maintenance. There were few numbers of new routes, double tracking and triple tracking railroads projects.

The awaken of government concern on country's relatively high logistics cost per gross domestics product (GDP) has pushed the Office of the National Economic and Social Development Board (NESDB) to launch national logistics strategies and masterplan with objective to bring down the cost by at least two percent by 2020. Ministry of Transport (MOT), which played an important part in achieving NESDB's goal, finally turned its focus on rail development after over four decades of highway development concentration.

Over the last ten years, Ministry of Transport has initiated rail infrastructure development projects such as double tracking the existing tracks; construction of new routes, both meter and standard gauge tracks; and construction of high speed railways (HSR). However, shift in government's policies resulted in instable project direction and administration. Public also have bad perception and attitude toward SRT's capability to handle mega projects. Most importantly, impacts on country's logistics system, cost, and performance are still doubtful.

1.2 Research Objectives

Based on previously discussed issues, the research objectives for this dissertation can be described as follows.

1. To identify success factors influencing railway projects contributed to country's logistics platform by using AHP and Fuzzy AHP.
2. To propose a conceptual framework for rail infrastructure development and administration in Thailand.

1.3 Scope of Study

From 2010 to 2015, policy and emphasis on railway development projects were changed from one government to another. This dissertation will not focus on projects from particular government policy but will include all railway development projects contributed to country's logistics platform, as listed in Table 1.1.

Table 1.1: Railway projects included in this research

Projects	Status (As of May 2016)
1.1 Double Tracking Railway Projects (2,482 km.)	
1. Chachoengsao – Kaeng Khoi (106 km.)	Under construction
2. Lopburi – Pak Nam Pho (118 km.)	Approved by MOT
3. Mabkabao – Thanon Jira Junction (132 km.)	Approved by MOT
4. Thanon Jira Junction – Khon Kean (185 km.)	Under construction
5. Nakhon Pathom – Hua Hin (165 km.)	Approved by MOT
6. Prachuabkirikhan – Chumpon (167 km.)	Approved by cabinet
7. Pak Nam Pho – Den Chai (285 km.)	Accepted final report
8. Khon Kean – Nong Khai (174 km.)	Accepted final report
9. Thanon Jira Junction – Ubon Ratchathani (309 km.)	Submitted final report
10. Hua Hin – Prachuabkirikhan (89 km.)	Approved by MOT
11. Chumpon – Surat Thani (167 km.)	Submitted final report
12. Surat Thani – Hat Yai – Songkla (323 km.)	Accepted progress report
13. Hat Yai – Padang Besar (45 km.)	EIA* consideration
14. Den Chai – Chiang Mai (217 km.)**	Accepted final report
1.2 New Railway Projects (973 km.)	
1. Den Chai – Chiang Kong (326 km.) 2. Ban Phai – Nakhon Phanom (347 km.) 3. Surat Thani – Phang-nga – Phuket (300 km.)	Completed feasibility study
1.3 Standard Gauge Railway Projects under Thai – China Cooperation (873 km.)	
1. Bangkok – Kaeng Koi (133 km.) 2. Kaeng Koi – Port of Map Ta Phut (246.5 km.) 3. Kaeng Koi – Nakorn Ratchasima (138.5 km.) 4. Nakorn Ratchasima – Nong Khai (355 km.)	Completed feasibility study
1.4 Meter Gauge Railway Projects under Thai – Japan Cooperation (574 km.)**	
1. Kanchanaburi – Bangkok –Port of Leam Chanbang 2. Bangkok – Chachoengsao – Aranyaprathet	Signed Memorandum of Cooperation

*Environmental Impact Assessment

**Details (route, distance, and stations' location) are still in discussion.

The standard gauge railway projects are administered and regulated by a steering committee under the memorandum of understanding signed between Government of Thailand and Government of People's Republic of China in January 2015. The steering committee comprises of a project management committee led by Thai Minister of Transport and a joint steering committee led by chairman of National Development and Reform Commission of People's Republic of China (NDRC). Under the project management committee, Project Administration Office, the Planning Integration and Implementation Sub-committee, and the Financial and Investment Model Sub-Committee were established to organize the management and implementation framework. The projects' feasibility study was completed in late 2015. According to the project plan, railway in phase I and II (Bangkok – Kaeng Koi – Port of Map Ta Phut) will start operations service in December 2017. Railways in phase III and IV (Kaeng Koi – Nakorn Ratchasima – Nong Khai) are expected to operate in March 2018.

The Government of Thailand has been cooperated with the Government of Japan on rail development issue, especially for high speed railways and relevant technologies, for a period of time. It has been announced in March 2015 that the meter gauge railway projects from Kanchanaburi to Port of Leam Chabang (via Bangkok) and Bangkok to Aranyaprathet will be handle under the Thai – Japanese cooperation. These new meter gauge routes shall promote rail freight transport between two deep sea ports: Dawai in Myanmar and Leam Chabang in Thailand, while act as an East-West transportation corridor, connecting Myanmar, Thailand, and Cambodia. The Ministry of Transport signed the memorandum of understanding with Ministry of Land, Infrastructure, Transport and Tourism in May 2015, making the project plan more solid.

With 14 double tracking railway projects and nine new railway construction projects, Thai railroad network after completing construction works of all projects can be illustrated as in Figure 1.1, making total distance of 6,467 kilometers, or 60 percent longer than the existing network.

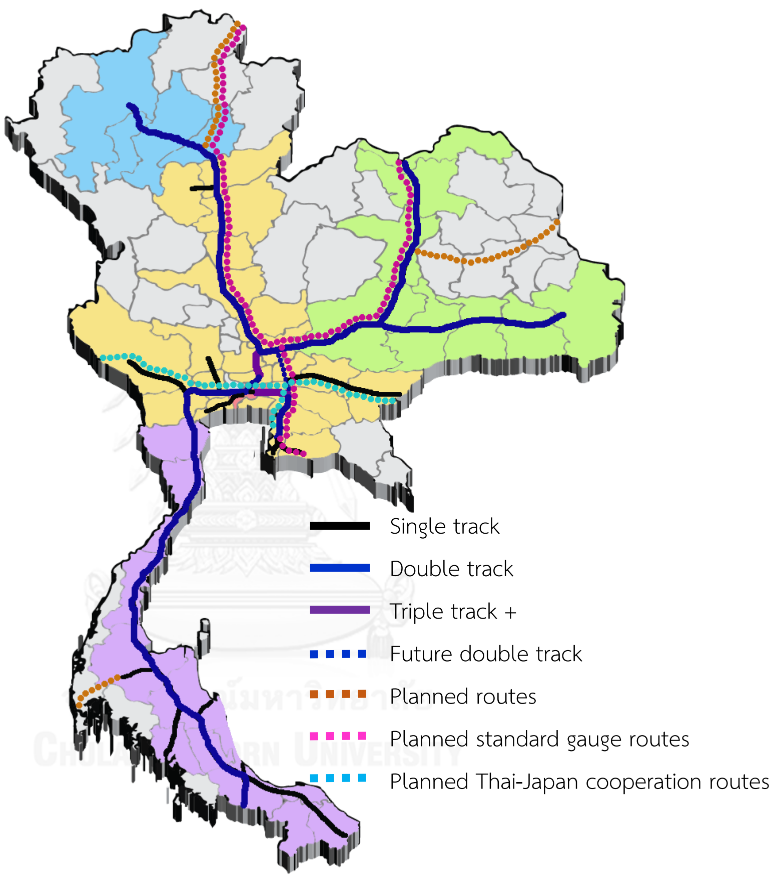


Figure 1.1: Thai railroads network after projects completion

1.4 Contribution

This research identified success factors affecting the railways development project by using AHP and fuzzy AHP. The impacts of particular government's schemes – namely the legislation of new rail regulating agency, transit oriented development, and public-private partnership – towards railways development projects are quantified. Government can also utilized the top priority success factors as drivers, facilitators, enablers or include them as part of primacy railway development planning as well as related railway's issues. Proposed conceptual framework can be used to establish steering committee or working group as well as translated into action plan for railway infrastructure development over the next two decades.

CHAPTER 2

LITERATURE REVIEW

In this chapter, background and development of railways in Thailand are reviewed. Relevant research on context of rail freight transport, factor associated with rail development and transportation projects are discussed. Reviews of AHP and fuzzy AHP are also presented. At the end of this chapter, dimensions used in transportation projects' planning, investment, and evaluation scheme are summarized.

2.1 Development of Thai Railways

The first train operations in Thailand started in 1896 under regulation of Department of State Railways. The construction of approximately 300 kilometers railways – which started in 1890 and linked Bangkok to Nakorn Ratchasima – took six years to complete. Investment in railroads was intensified for the following 50 years. By 1946, Thailand had 3,258 kilometers railroads network, connecting 46 provinces, making railroads the most popular mode of transportation.

However, after the end of World War II and the transformation of railways organization in 1951, the investment on country's infrastructure was shifted from rail to road. Rail investment were mainly for repairing and maintaining the existing infrastructures, with some double tracking and triple tracking railroads projects during 1990s.

Not until the past decade that a very low proportion of domestic freight transported by rail, along with an increasing and relatively high logistics cost per GDP, has triggered the government attention to rail development. Figure 2.1 shows domestic freight transported in 2014. Motor carrier is the dominant mode of transportation, follows by water (coastal and inland waterway). Proportion of domestic freight transported by rail is approximately two percent.

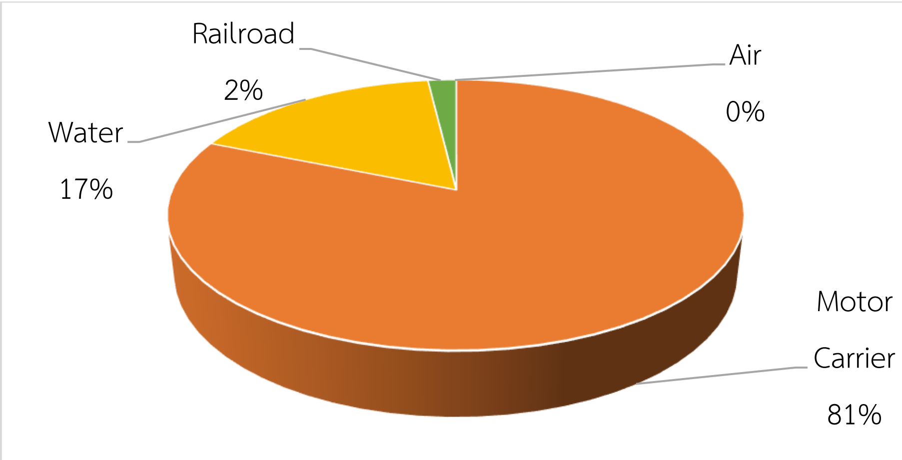


Figure 2.1: Domestic freight transported in 2014

Figure 2.2 shows Thailand's logistics cost per GDP from 2005 – 2014. Despite the fact that the logistics cost per GDP is trending down, the proportion is considered high when compare with logistics cost per GDP of the United States (8.3 percent) in 2014.

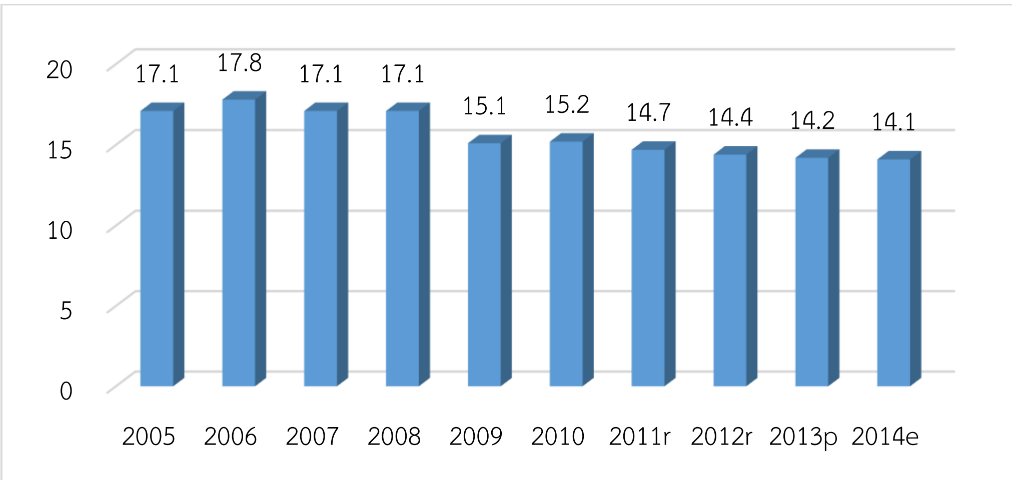


Figure 2.2: Logistics cost per GDP from 2005 – 2014, shown in percentage

An attempt to launch rail infrastructure investment resulted in an establishment of Instantaneous plan for rail infrastructure investment in 2010 as well as a completion of double tracking railway project from Chachoengsao to Port of Laem Chabang in 2012, making total of 4,043 kilometers of railroads network which is owned and operated by SRT. The proportion of tracks are shown in Table 2.1 below. All tracks owned and operated by SRT are meter gauge (rail gauge with 1,000 millimeters width), except the airport rail link network.

Table 2.1: Rail tracks proportion in Thailand

Track	Gauge Width (mm.)	Distance (km.)	Proportion
Single	1,000	3,685	89.29%
Double Track	1,000	251	6.08%
Triple Track	1,000	107	2.59%
Double Track, Electrified*	1,435	84.5	2.05%

*Include Bangkok Transit System, Mass Rapid Transit, and Airport Rail Link

The 2010 instantaneous plan includes not only six double tracking railway projects but also infrastructure investment projects such as track strengthening; track rehabilitation; bridge construction and repair; signaling and telecommunication installation; fence installation; purchasing and refurbishing locomotives; and automatic boom barrier installation. Later on in 2013, Ministry of Finance started drafting the Bill Authorizing Loan for Transportation Infrastructure Investment which includes 12 double tracking railway projects (six projects are drawn from the 2010 instantaneous plan), four high-speed railway projects, and three new railway projects. Along with the bill authorizing loan, SRT has also initiated a new railway project connecting the province of Phang-nga and Phuket to the existing network. Table 2.2 presents all railway projects proposed by SRT and listed the Bill Authorizing Loan.

Table 2.2: Railways projects as of 2014

Double Tracking Railway Projects (2,236 kilometers)	**High-speed Railway Projects (2,556 kilometers)**
1. Chachoengsao – Kaeng Khoi (106 km.)	1. Bangkok – Chiang Mai (745 km.)
2. Lopburi – Pak Nam Pho (118 km.)	2. Bangkok – Nong Khai (256 km.)
3. Mabkabao – Thanon Jira Junction (132 km.)	3. Bangkok – Hua Hin (225 km.)
4. Thanon Jira Junction – Khon Kean (185 km.)	4. Bangkok – Rayong (221 km.)
5. Nakhon Pathom – Hua Hin (165 km.)	**New Railway Projects (988 Kilomenters)**
6. Prachuabkirikhan – Chumpon (167 km.)	
7. Pak Nam Pho – Den Chai (285 km.)	1. Den Chai – Chiang Kong (326 km.)
8. Khon Kean – Nong Khai (174 km.)	2. Ban Phai – Nakhon Phanom (347 km.)
9. Thanon Jira Junction – Ubon Ratchathani (309 km.)	3. Ban Phachi – Nakhon Luang (15 km.)
10. Hua Hin – Prachuabkirikhan (89 km.)	4. Surat Thani – Phang-nga – Phuket (300 km.)
11. Chumpon – Surat Thani (167 km.)	
12. Surat Thani – Padang Besar (339 km.)	

In early 2015, more railway construction projects were initiated – a new railroads network for electrified locomotives that operate on standard gauge track instead of meter gauge track like the existing ones. The expected speed of train is 180 kilometer per hour. The new network includes railway from Bangkok to Kaeng Koi (133 kilometers) and Nong Khai to Port of Map Ta Phut via Kaeng Koi (734 kilometers). The project is operated under the memorandum of understanding for cooperation on the Thailand's railways infrastructure development between Thailand and China. Policy making, regulating, managing, and implementing the project are handled by both governments.

In addition to the new standard gauge project, the government has decided to add another double tracking railway project, from Den Chai to Chiang Mai, completing the Northern network with all double tracked railroads. Figure 2.3 shows all rail construction projects planned between 2010 and 2014.

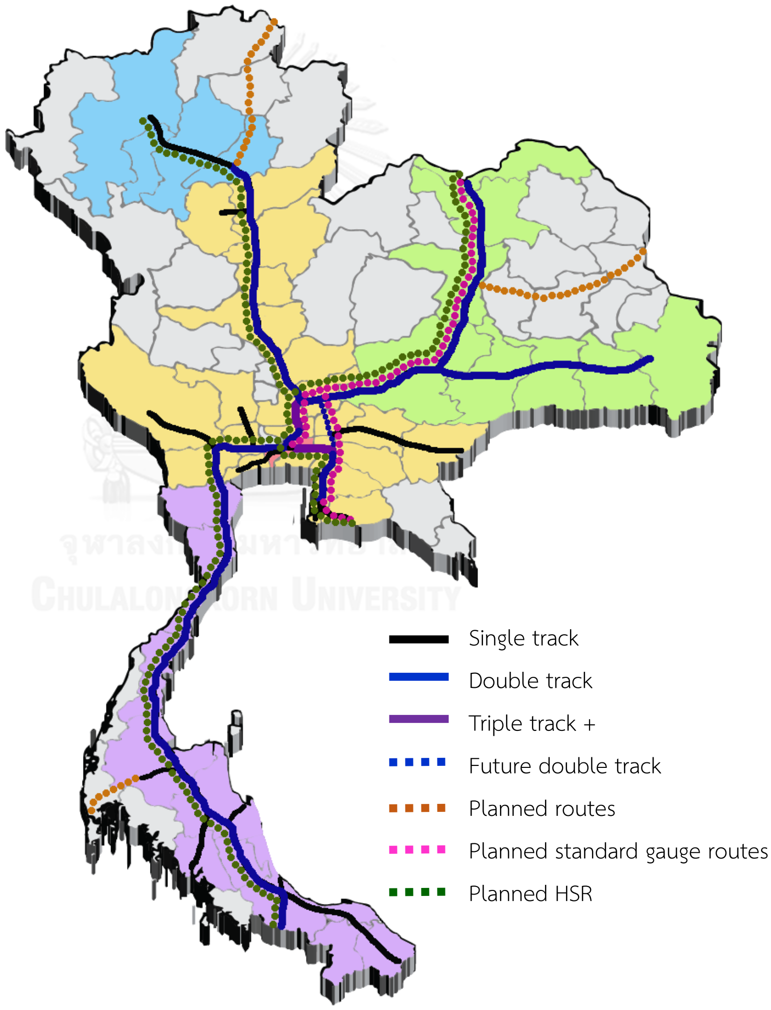


Figure 2.3 – Railroads network after completion of all projects

It is expected that the investment in rail infrastructures will lower national logistics cost per GDP by at least two percent, lower energy consumption by 0.1 trillion Baht per annum, increase speed of freight trains from 39 to 60 kilometers per hour, increase freight transported by rail from two to five percent, and increase border freight volume by five percent. However, one of the largest Thai rail development challenges is politics and government bodies' instability. Each government holds different policies. Frequent change in government also means frequent change in rail development policies. This causes delays in most rail projects at beginning stage and affects project's direction, feasibility study, and approval at cabinet level.

On top of the stated issue, freight operating performance is also one of the major concerns. The freight volume carried by rail decreased from 13,774 thousand tons in 2004 to 11,392 thousand tons in 2014, or 17.29%, as shows in Figure 2.4.

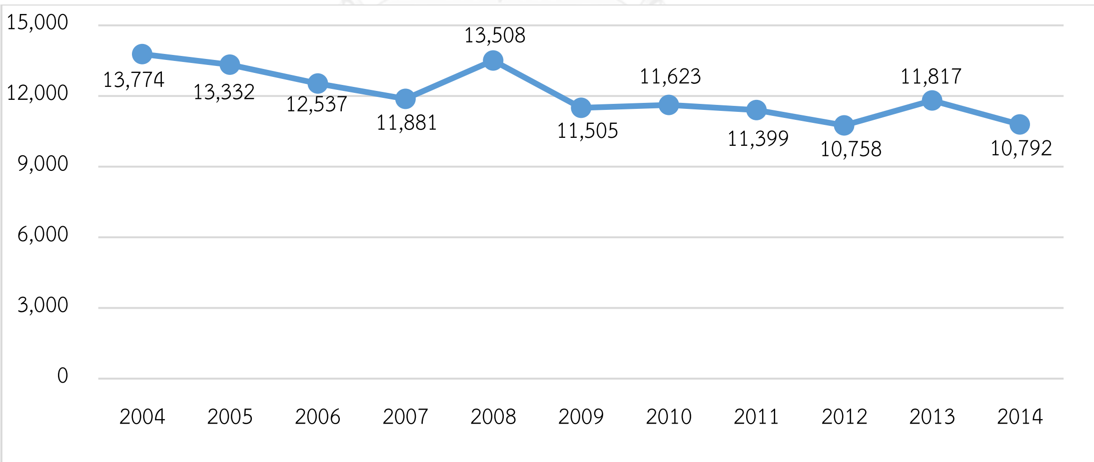


Figure 2.4 – Volume of domestic freight carried by rail from 2004 – 2014 (unit: thousand tons)

Although the railway that links the Inland Container Depot (ICD) at Lad krabang and the Port of Leam Chabang was double tracked since 2012, the container volume's flow by rail into and out of the facility did not increase significantly in 2013 due to lack of locomotives and insufficient flat cars. However, the number of containers flow in the past two years seems promising. Container volume rose from 403,674 TEUs in 2005 to 469,868 TEUs in 2014, or 16.40%, as presents in Figure 2.5.

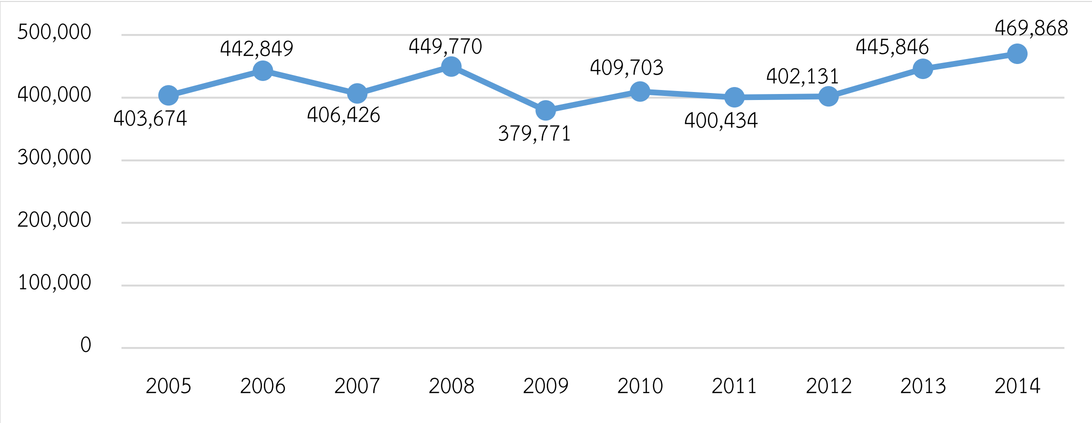
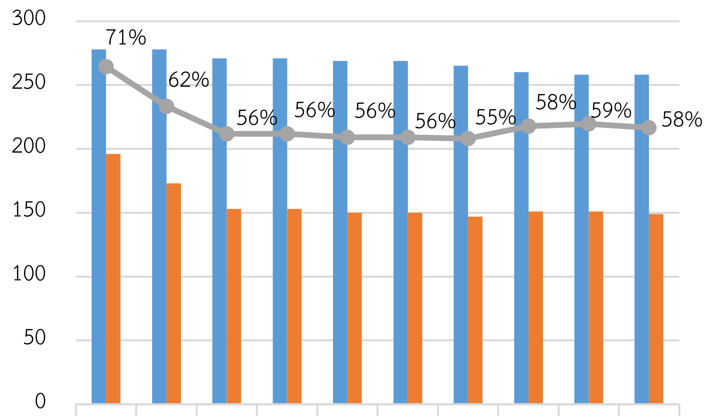


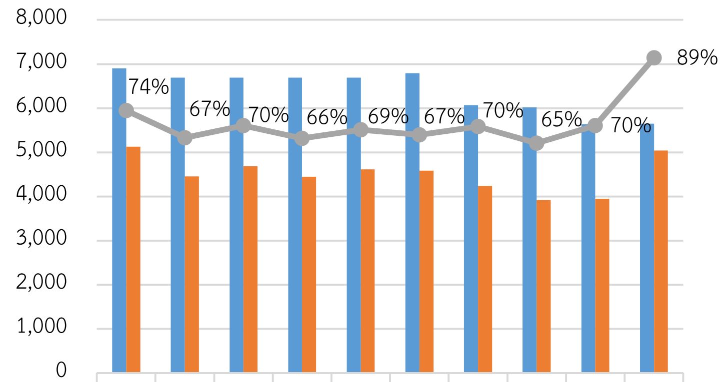
Figure 2.5 – Volume of containers flow by rail through ICD from 2005 – 2014 (unit: TEU)

SRT has operated at loss for decades with total accumulated net loss of 102,021 million Baht (approximately 2,890 million USD) in 2014. Other operating performances, including freight train punctuality, freight volume in ton-kilometer, and train accidents, are all below standard evaluated by TRIS Corporation Limited under regulation of State Enterprise Policy Office (SEPO), Ministry of Finance. Additionally, a number of locomotives available for operations declined instantly. According to record of maintenance center, SRT, the proportion of locomotives availability are illustrated in Figure 2.6, with average locomotive availability of 58 percent in 2013. Figure 2.7 shows proportion of freight rolling stocks, with average freight rolling stock availability of 89 percent in 2013



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Registered Diesel Locomotive	278	278	271	271	269	269	265	260	258	258
Available Diesel Locomotive	196	173	153	153	150	150	147	151	151	149
% Locomotive Availability	71%	62%	56%	56%	56%	56%	55%	58%	59%	58%

Figure 2.6: Locomotive availability from 2004 – 2013



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Registered Freight Rolling Stock	6,900	6,693	6,692	6,692	6,690	6,797	6,069	6,016	5,637	5,647
Available Freight Rolling Stock	5,128	4,457	4,688	4,449	4,612	4,582	4,239	3,917	3,950	5,041
% Freight Rolling Stock Availability	74%	67%	70%	66%	69%	67%	70%	65%	70%	89%

Figure 2.7: Rolling stock availability from 2004 – 2013

As a project initiator, SRT had carried out many feasibility studies on railways projects but most of them were left on shelves untouched. The government has taken these issues very seriously recently. There is an attempt to restructure SRT's debt as well as to sustainably improve SRT's performance. SRT and Ministry of Transport have launched several study projects to seek for a proper business model for the organization. One of them is a "railway sector reform study" carried out by Thailand Development Research Institute (TDRI). TDRI's suggestion was to separate infrastructure asset from operating assets. In December 2009, the cabinet approved the new SRT organizational structure; that is to establish three new business units: rail operations, maintenance, and assets management.

After organization restructuration, Ministry of Transport has continued to legislate a new government agency to regulate rail transport. Some departments in SRT; mainly administration, engineering and construction departments, will be functioned under a government agency so called "Department of Rail Transport" or DRT while the operations related departments remain state enterprise. The transformation should encourage SRT's operations and the rail operations market at the same time. It is expected that the transformation should eliminate approximately three quarters of SRT's debt, especially debt from infrastructure investment since the infrastructures and associated assets will be transferred to the government. The Ministry of Transport is currently drafting the act to establish the Department of Rail Transport. On April 18, 2016, the subcommittee of public sector development has consented the rail transport structure, allowing Department of Rail Transport to establish rail policies and standards, and manage subsidy for public services. Ownership of rail track and infrastructure will remain with SRT. The state enterprise will have to issue action plan for 3 new companies to operate passenger and freight trains, maintain locomotives and rolling stocks, and manage SRT's asset.

2.2 Factors Involving Transportation's Scheme

In researches concerning rail operations, mathematical models with cost and price function and optimization models aiming to solve network or capacity problems are the most popular tools. However, researches associated with rail infrastructure development, investment, and policy are completed by survey, literature review, or combination of both methods.

Lehies (2012) explored the implementation and decision making process of high speed train in France by using semi-structured interview and presented key innovative mechanisms for Mediterranean TGV-line projects. The research showed complexity and difficulty in project management.

Rodemann and Templar (2014) also used a survey, semi-structured interviews, along with case studies from literature to identify enablers and inhibitors associated with Eurasian intermodal rail freight. For *political* dimension, enabler were foreign investment support; cross border trades stimulators; and negative social influence removal, while inhibitors were high control resulted in incompetiveness and government crisis. Enabler for *economic* dimension was the investment location shifts inland caused by economic upswing. Inhibitors for economic dimension were a small landbridge market and government crisis. There was no enabler in *social* dimension while inhibitors included poor security and lacking expertise. Enablers for *technical* dimension were higher reliability and safety. Inhibitor for technical dimension was lack of government support for IT due to poor economic condition. Enabler for *legal* dimension was collaborative and valid waybill while there was no inhibitor in this dimension. For *environmental* dimension, enablers included efficient energy consumption and environmental-friendly system while inhibitor was the extreme weather, geological and geographical conditions.

Through literature review, Ferreira (1997) illustrated linkage between infrastructure needs, specific benefits, and major impacts on Australian freight rail investment, which are service reliability; operating safety; environment; and local and national economy.

Banister and Thurstain-Goodwin (2011) reviewed case studies to define non-transport benefits resulting from rail investment. Benefits were time saving, congestion relief, and rise in employment rate.

Rangarajan, Long, Tobias, and Keiste (2013) suggested the social factors associated with transportation infrastructure projects base on literature review. Social factors indicated in the research were social uncertainty, and sustainability of the transportation.

Amiril, Nawawi, Takim, and Ab Latif (2014) also carried out literature review to explore sustainability factors of transportation infrastructure projects. *Environmental* factors were land use and site selection; water, air, and noise quality; ecology and biodiversity; visual impact; waste management; energy and carbon emission; pollution control; erosion and sediment control; and flora and fauna. *Economic* factors included life cycle cost and project risk. *Social* factors were cultural heritage; public access; health and safety; stakeholder relationships; inter-modality of transport; and site access and development. *Engineering and resource utilization* factors included material type and availability; constructability; quality control and assurance; and functionality performance of physical asset. *Project administration* factors were type of contract; procurement method; and project risk.

2.3 Analytical Hierarchy Process

Apart from survey and interview, there are techniques used in assessing factors or risk associated with transportation scheme – analytical Hierarchy Process (AHP) and analytical network process (ANP). AHP, introduced by Thomas L. Saaty in 1980, is "a multi-criteria decision making tool that use Eigen value approach to pair-wise comparisons" (Vaidya & Kumar, 2004) to assess the relative importance of elements in the same level of hierarchy as well as evaluate options at the end of the hierarchy. Elements in the same level of hierarchy affect one another but there is no connection between elements in different level of hierarchy. While AHP approach provides a "clear-cut" answer (or choice) for the model, ANP approach functions differently. In ANP, all elements are laid in the same level (network). Elements are not only related to each other in the same category or dimension but also across. That is, the relationships between elements in ANP spread throughout the model while in AHP, relationships exist only within the same hierarchy level.

AHP and ANP can be deployed together with analysis tool and statistical tool such as simulation; technique for order of preference by similarity to ideal solution (TOPSIS); geographic information system (GIS); data envelopment analysis (DEA); Delphi method; balanced scorecard; factor analysis; fuzzy logic; genetic algorithm; and strengths, weaknesses, opportunities and threats (SWOT) analysis (Sipahi & Timor, 2010). Usage of AHP and ANP ranges from manufacturing industry, environmental management and agriculture, general decision problem, and transportation industry (Sipahi et al., 2010). In transportation industry, AHP are applied to evaluate fare, logistics performance of intermodal transportation, and impact on transportation measures.

Nassi and de Carvalho de Costa (2012) applied AHP to their work on evaluation of transit fare system. Results from AHP indicated that distance/zone-base fare is the most preferable system comparing to service-base, market-base, time-base, and flat fare. Gradient sensitivity analysis was applied to confirm that the distance/zone-base is the best fare system.

Awasthi and Chauhan (2011) assessed impact of sustainable transport in medium-sized cities using AHP and Dempster-Shafer theory on group of human experts, traffic sensors, questionnaire surveys and model. Results from AHP were used to compute transportation sustainability index (TSI) and plugged into carsharing model for impact evaluation. After 23 experiments through sensitivity analysis, the authors deduced that carsharing yield positive impact on city sustainability.

Tang, Zhang, Ye, and Li (2011) applied ANP to evaluate risks in urban rail transit project. Risks associated in the research included political; economic; legal and contractual; environmental; completion contractual; and operations and maintenance. Results revealed that project overall risks are relatively high due to high risk in legal and contractual; and completion contractual.

Lee, Wu, Hu and Flynn (2013) conducted a research to rank success factors of waterfront redevelopment in four dimensions – economic function, port function, community function, and city branding – by using both AHP and ANP. Results obtained from AHP and ANP are dissimilar. While AHP identified “contribution to regional economy”, “transformation of port/city interface”, and “efficiency/service” as top three success factors in weight, ANP indicated that “connectivity”, “maritime clustering" and "transformation of port/city interface" are the top three success factors. The authors concluded that "transformation of port/city interface" is a prevalent criterion for both approaches.

Lam and Lai (2014) employed ANP-QFD approach to determine "customer requirements and design requirement for environmental sustainability in shipping operations". Results indicated that the most important design requirement is the use of green design ship, engines and machinery while the most important customer requirement is to fulfill regulatory and higher sustainability standards.

2.4 Fuzzy Analytical Hierarchy Process

Application of fuzzy theory with AHP was introduced by Van Laarhoven and Pedrycz (1983). The fuzzy triangular numbers was used in place of priority weights in general AHP. Buckley (1985), Chang (1996), and Cheng et al. (1999) proposed their own steps and fuzzy triangular numbers for priority weight calculations.

Kunadhamraks and Hanaoka (2008) evaluated logistics performance of intermodal transportation in Thailand (network from Laem Chabang Port to inland container depot at Lat Krabang) by using fuzzy AHP and fuzzy-multi-criteria analysis (fuzzy-MCA). The model includes logistics cost, service quality, reliability, and security dimension. Questionnaires were collected in 2 stages: the first stage was carried out to determine weight factors and the second stage was performed to generate data for membership function. Data from second stage were used in regression analysis to model the relationship between survey data and membership function. Results from fuzzy-AHP served as input for logistics performance index calculation in fuzzy-MCA. It was revealed that trucking is the most attractive mode in terms of handling cost and service, which consistent with the fact that motor carrier plays the leader in transportation industry in the area of study.

Nguyen, Nguyen, Le-Hoai, and Dang (2015) used fuzzy AHP to quantify complexity in transportation projects in Vietnam. Factors were identified through literature review. Researchers conducted two surveys. The first survey was performed to determine the relative importance for factors. Factor Analysis was applied to group relevant components together, resulted in 18 out of 50 factors that were classified into six components which cover two third of total amount variance explained. The components are sociopolitical, environmental, organizational, infrastructural, technological, and scope complexity. The second survey was carried out to identify the weight of components through pairwise comparison. Researchers calculated normalized pairwise comparison matrix and local weight by applying fuzzy AHP theory. Fuzzy scale in this research were triangular numbers proposed by Tesfamariam and Sadiq (2006). The calculation of priority vectors was based on Buckley (1985) and Meixner (2009). Defuzzification followed the method of Deng (1999) and Liou and Wang (1992). Researchers indicated that sociopolitical complexity was "the most defining component of complexity in transportation projects" while site compensation and clearance was the most significant parameter of projects' complexity.

From the stated literatures; factors, benefits, enablers and inhibitors can be categorized in nine dimensions as shows in Table 2.3. Obviously, economic, social and community, and environmental dimension are the most prevalent dimensions. The research context and tools do not show much similarity from one research to another, leaving gaps for this research.

Table 2.3: Dimensions used in transportation projects' planning, investment, and evaluation scheme

Authors (Year)	Dimension									Context	Tool
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]		
Ferreira (1997)	✓		✓	✓						Freight rail operations planning	Literature Review
Kunadhamraks et al. (2008)	✓			✓						Logistics performance of intermodal transportation	Fuzzy AHP-MCA
Awasthi et al. (2011)	✓	✓	✓	✓						Sustainable transport solutions	AHP
Banister et al. (2011)	✓	✓	✓							Benefits on rail investment	Case Studies
Tang et al. (2011)	✓		✓	✓	✓	✓	✓			Risk in urban rail transit under PPP	Fuzzy ANP
Lee et al. (2013)	✓	✓		✓					✓	Waterfront redevelopment	AHP, ANP
Rangarajan et al. (2013)		✓								Rail infrastructure development	Survey
Amiril et al. (2014)	✓	✓	✓				✓	✓		Transportation Infrastructure sustainability projects	Literature Review
Lam et al. (2014)				✓						Shipping Operations	ANP-QFD
Rodemann (2014)	✓	✓	✓		✓	✓		✓		Intermodal rail freight factors	Survey
Nguyen et al. (2015)		✓	✓	✓	✓		✓	✓		Complexity of Transportation projects	Factor Analysis, Fuzzy AHP
Dimension frequency	8	7	7	7	3	2	3	3	1	-	-

[1] Economic [2] Social/ Community [3] Environmental/ Energy
[4] Transport/ Infrastructure/ Operations [5] Political [6] Legal [7] Administration
[8] Technical/ Technology/ Engineering [9] City Branding

CHAPTER 3

RESEARCH METHODOLOGY

This chapter first illustrates the research design. The AHP model is proposed along with factors' origin and description. Data collection and questionnaire design are discussed. Calculation principle for data validation, AHP, and fuzzy AHP are thoroughly explained. Finally, partnership model and collaboration assessment method are proposed as method to deliver the conceptual framework.

3.1 Research Design

This research follows the steps illustrated in Figure 3.1 in the next page: step 1 is to identify factors relevant to railways infrastructure development projects through literature review. In the second step, AHP model is constructed. In the third to fifth step, AHP pairwise comparison matrixes are constructed, consistency of responses are checked, and priority weights for AHP are calculated. In the sixth to eighth step, fuzzy AHP processes and defuzzification are applied. Results from AHP and fuzzy AHP are compared in step 9. In the tenth step, semi-structured interviews based results from step 9 is constructed by using collaboration assessment questionnaire. In the eleventh step, conceptual framework for railways infrastructure development projects is established. The last step is the discussion and conclusion of the research.

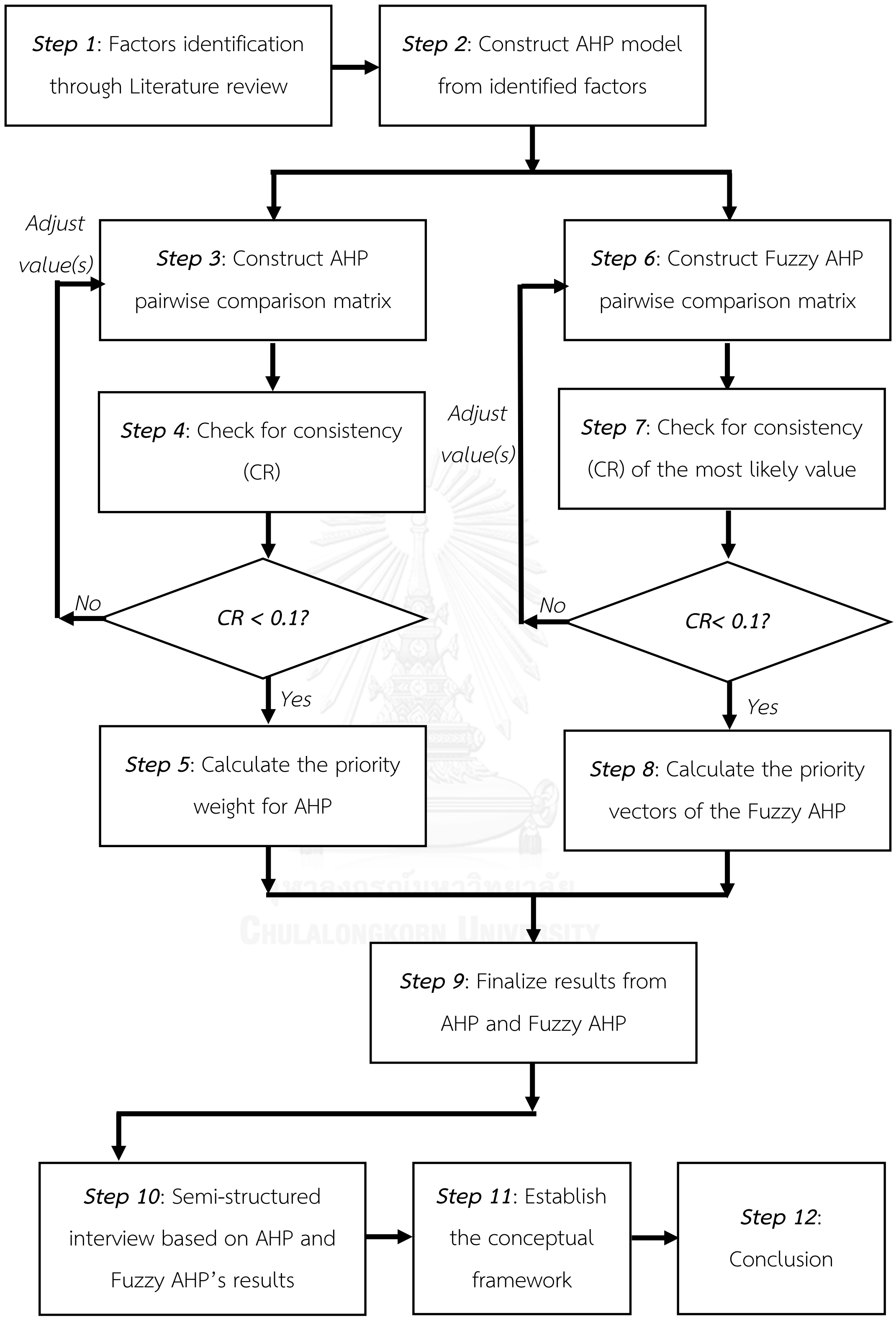


Figure 3.1: Research Design

3.2 AHP Model

Figure 3.2 illustrates the AHP model which comprises of five dimensions – administration, economic, logistics platform, social, and technical.

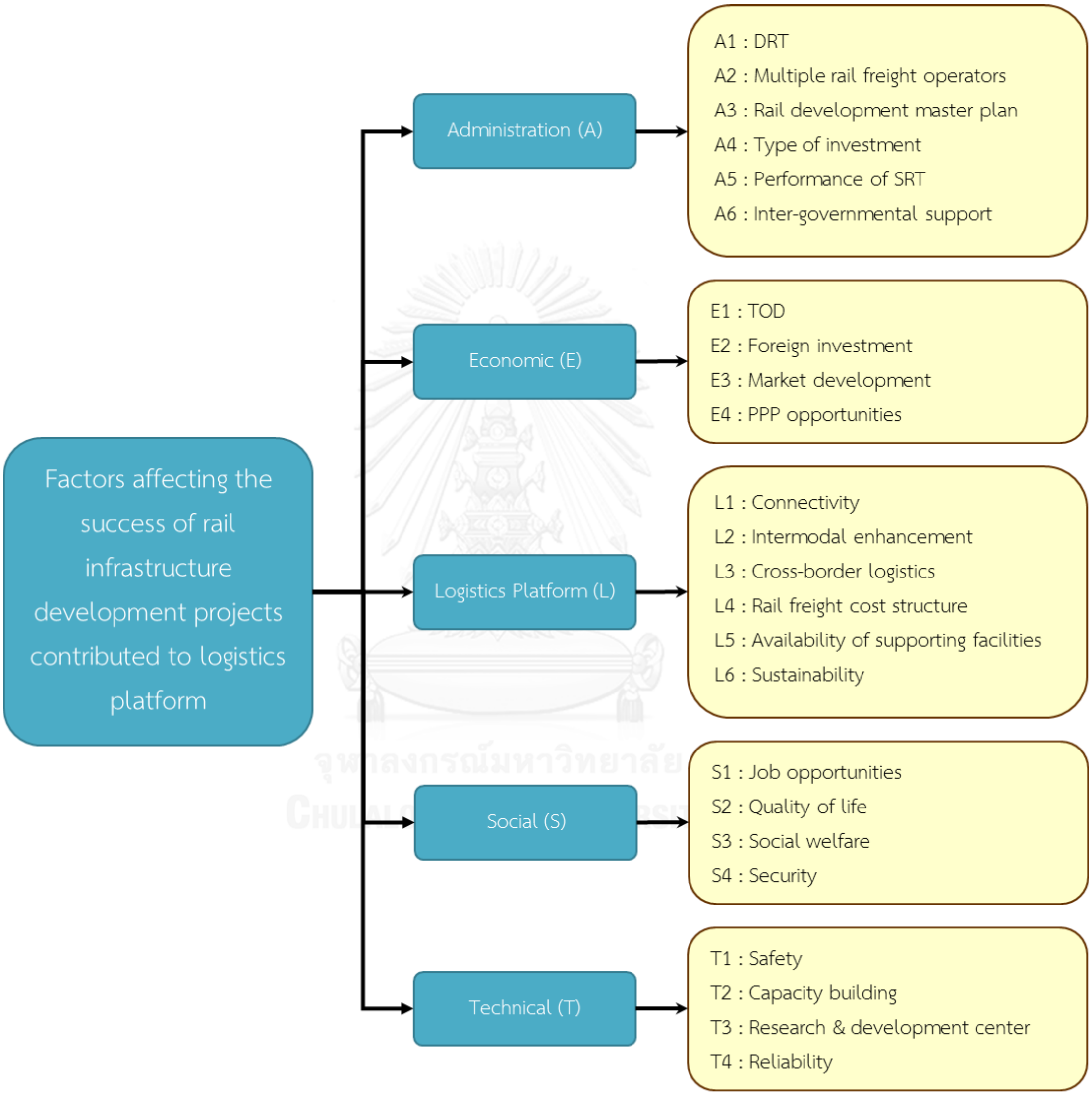


Figure 3.2: AHP model

According to the literature review and dimensions' summary in chapter 2 (Table 2.4), three most common dimensions were selected for assessment – economic; social; and transportation, infrastructure, and operations. Logistics platform dimension includes factors associated with transportation, infrastructure, and operations; and environmental and energy, which is also one of the most popular research dimensions. Administration was included to examine how can government administer and regulate country's future rail infrastructure development and operations after project completion. Researcher included technical dimension to quantify influential factors discussed by Rodemann et al. (2014); and Nguyen et al. (2015).

Total of 24 factors were extracted from nine literatures involved with transportation projects' planning, investment, and evaluation scheme; as listed in Table 3.2. The last column, Count, represents frequency of factor mentioned in literatures. Safety and reliability were mentioned the most (5 times), followed by sustainability (4 times). Some factors, such as cross-border logistics, job opportunities, and security, are directly mentioned in literature as factors, impacts, benefits, risks, enablers or inhibitors. However, there are some factors that were adapted from literature. Department of Rail Transport, for example, is the administrative factor that was adapted from Nguyen et al. (2015)'s parameters in sociopolitical complexity component. Rail development masterplan and performance of SRT also follow the same principle. Sustainability were adapted from environmental-friendly factors in several literatures as well as directly discussed in Amiril et al. (2014)'s literature on sustainability factors and performance.

Table 3.2: Factors extracted from literature review

Factor	Literatures									Count
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	
A1 : Department of Rail Transport									✓	1
A2 : Multiple rail freight operators	✓									1
A3 : Rail development masterplan								✓	✓	2
A4 : Type of investment				✓			✓		✓	3
A5 : Performance of SRT									✓	1
A6: Inter-governmental support								✓		1
E1 : Transit oriented development			✓			✓	✓			3
E2 : Foreign investment								✓		1
E3 : Market development				✓						1
E4: PPP opportunities						✓	✓			2
L1 : Connectivity					✓	✓				2
L2 : Intermodal enhancement						✓	✓			2
L3 : Cross-border logistics								✓		1
L4 : Rail freight cost structure	✓		✓					✓		3
L5 : Availability of supporting facilities					✓					1
L6 : Sustainability	✓					✓	✓	✓		4
S1 : Job opportunities			✓				✓			2
S2 : Quality of life						✓				1
S3 : Social welfare					✓					1
S4: Security		✓	✓					✓		3
T1 : Safety	✓		✓			✓	✓	✓		5
T2 : Capacity building						✓		✓		2
T3 : Research & development center						✓			✓	2
T4 : Reliability	✓	✓	✓			✓		✓		5
Total	5	3	6	2	3	11	6	10	5	

[1] Ferreira (1997) [2] Kunadhamraks et al. (2008) [3] Banister et al. (2011)
[4] Tang et al. (2011) [5] Lee et al. (2013) [6] Rangarajan et al. (2013)
[7] Amiril et al. (2014) [8] Rodemann et al. (2014) [9] Nguyen et al. (2015)

Each factors was classified under a dimension based on their original category in the literatures. Detailed explanation of each factor are described in Table 3.3.

Table 3.3: Factor Description

Factors	Explanation
Dimension 1 : Administration (A)	
A1 : Department of Rail Transport	A new government agency under Ministry of Transport, will initiate rail infrastructure projects, regulate all rail operations including electrified trains in Bangkok. SRT will remain its role as a rail operator.
A2 : Multiple rail freight operators	Private sector is allowed to invest in and operate rail service business on SRT's network by paying access charge.
A3 : Rail development masterplan	The masterplan on rail development policy that focus on country's logistics infrastructure should be established by stakeholders. This long-term planning is supposed to shape country's rail policy for next 2 – 3 decades.
A4 : Type of investment	Options are funded by foreign government, invested by Thai government, turnkey, public-private partnership (which comes in various forms), and invested by private sectors.
A5 : Performance of SRT	As the only rail freight operator, the extended network and new projects should support SRT in bringing up rail freight volume, operating performance and profits.
A6: Inter-governmental support	Support from foreign government such as cooperative planning, funding, and technical assistance.

Factors	Explanation
Dimension 2 : Economic (E)	
E1 : Transit oriented development (TOD)	Route expansion and new station will draw people to move into area surrounding railways stations for business and property development.
E2 : Foreign investment	Route expansion and better infrastructure will draw foreign investment to area with rail connectivity.
E3 : Market development	Opportunities for domestic market expansion and growth in related businesses and industries such as sleepers, spare parts, signaling, telecommunication, electrified systems and final assembly.
E4: PPP opportunities	Opportunities for Public-Private Partnership (PPP) to lessen public debt from investment.
Dimension 3 : Logistics Platform (L)	
L1 : Connectivity	Network expansion increases domestic and international inter-city linkages.
L2 : Intermodal enhancement	With double track railways and extended network, there are opportunities to establish intermodal terminal in certain areas such as Port of Map Ta Phut, Chiang Kong, and Nakorn Panom.
L3 : Cross-border logistics	Facilities for cross-border trading have to be developed and well-maintained to ensure convenience in freight movement activities.
L4 : Rail freight cost structure	Change in rail freight cost structure to be more profitable for SRT and rail operators.
L5 : Availability of supporting facilities	Sufficient and efficient container yards, inland container depots, and container freight stations in appropriate locations for higher freight volumes and movements.

Factors	Explanation
L6 : Sustainability	Higher use of rail leads to greener transportation, less CO_2 and greenhouse gas emission, and higher energy efficiency.
Dimension 4 : Social (S)	
S1 : Job opportunities	Stimulate national and local job opportunities that comes with construction and operations.
S2 : Quality of life	Better railroads network brings about economy of speed and towns urbanization. People can live in suburban areas instead of overcrowded cities.
S3 : Social welfare	People with low income can choose to travel by rail at low cost with extended network.
S4: Security	Precaution protocols against act of crime and terrorist in station buildings, track sides, and on boards.
Dimension 5 : Technical (T)	
T1 : Safety	Higher operating safety (derailment and other accidents) from advanced rail technology.
T2 : Capacity building	Technical training and educational programs to create experts in rail planning, construction and operations.
T3 : Research & development center	Encourage regional and local research and development activities so that Thailand can less rely on technology from other countries.
T4 : Reliability	Minimized trains' delays and unexpected incidents from well-planned operations and better technology.

3.3 Data Collection

Data collection was performed in two ways: a focus group and individual interviews. Target participants are engineers, technicians, researchers and government officers whose work associated with railway.

Participants can be categorized into three groups: government, academia, and private sector, as follows.

- *Government participants* are representatives from Office of the National Economic and Social Development Board (as a macro-policy maker), Office of Permanent Secretary, Ministry of Transport (as a project controller), Office of Transport and Traffic Policy and Planning (as a transport project initiator), SRT (as a project manager and rail operator), and National Science and Technology Development Agency (as a rail technology integrator).
- *Academia participants* are representatives from public and private universities, research institutes, and independent researchers.
- *Private sectors participants* are representatives from rail associated business such as construction company, transportation service provider, rail equipment distributor, rolling stock manufacturer, commercial bank, and project consultant.

3.4 Questionnaire Design

Questionnaire was developed in English and translated to Thai to ensure that participants would have full understanding of the research (See Appendix A). The translated questionnaire was proofread to make sure that lost in translation has not occurred.

In the questionnaire, participants were asked to compare two elements (dimension or factor) by using the scale of relative influence level of two elements with respect to another given elements, as follows.

9 – Extreme Influence:	One element will influence 9 times more on a given element than the other does.
8 – Substantial Extreme Influence:	One element will influence 8 times more on a given element than the other does.
7 – Substantial Influence:	One element will influence 7 times more on a given element than the other does.
6 – Strong to Substantial Influence:	One element will influence 6 times more on a given element than the other does.
5 – Essential or Strong Influence:	One element will influence 5 times more on a given element than the other does.
4 – Moderate to Strong Influence:	One element will influence 4 times more on a given element than the other does.
3 – Moderate Influence:	One element will influence 3 times more on a given element than the other does.
2 – Equal to Moderate Influence:	One element will influence 2 times more on a given element than the other does.
1 – Equal Influence:	One element will influence 1 times more on a given element than the other does.

To complete one pairwise comparison question, participant has to determine which element will influence more on a given element than the other. Once the more influential element has be selected, participant has to determine the scale of relative influence.

The questionnaire contains three sections. The first section is concerned with the relative important between five dimensions and 24 factors with respect to evaluation of the success to railway development projects. The second section is concerned with the relative important among all dimensions by assuming existence of dependency relationship with respect to evaluation of the success to railway development projects. The third section is concerned with the relative important among all factors with respect to their dimensions. There are total of 59 pairwise comparison questions in the questionnaire. Participants also have to specify their demographic information such as job sector, job level, and working experiences.

3.5 Data Validation

Since the data are collected from pairwise comparison questions with at least four elements lay within the same category, it is possible that inconsistency will occur. Therefore, data must be validated before computing the final weights and vectors. If inconsistency exist, that data set has to be rejected. The measurement used to proof inconsistency is consistency ratio (CR).

(1) Construct the normalized pairwise comparison matrix.

Let *n* be the number of component in a matrix and *A* be the AHP pairwise comparison matrix and a_{ij} be the comparison weights where *i = 1, 2, ... , n* and *j = 1, 2, ... , m*

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} \\ \vdots & \ddots & \vdots \\ a_{i1} & \cdots & a_{ij} \end{bmatrix}$$

The normalized pairwise comparison weight, $\tilde{a}_{ij}$ is

$$\tilde{a}_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

(2) Calculate the consistency index (CI) and consistency ratio (CR)

<u>Step 1:</u> Start with normalized pairwise comparison matrix, computed row averages.

<u>Step 2:</u> Divide each element of the matrix by its row average i.e. divide elements in column A by average of A.

<u>Step 3:</u> Compute row summation and divide the summation results by the average in Step 1.

<u>Step 4:</u> Compute the average of values from Step 3, denote this value as λ_{max}

<u>Step 5:</u> Compute CI and CR by using the following formulas.

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

And

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

RI are the random indexes proposed by Saaty (1980) and vary by *n*. Values of RI are shown in Table 3.4.

Table 3.4: Random Indexes

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

The comparison is considered consistent if CR is less than 0.1.

3.6 Computation for AHP

(1) Construct AHP pairwise comparison matrix.

Let *n* be the number of component in a matrix and *A* be the AHP pairwise comparison matrix and a_{ij} be the comparison weights where *i = 1, 2, ... , n* and *j = 1, 2, ... , m*

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} \\ \vdots & \ddots & \vdots \\ a_{i1} & \cdots & a_{ij} \end{bmatrix}$$

The normalized pairwise comparison weight, $\tilde{a}_{ij}$ is

$$\tilde{a}_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

(2) Calculate the priority weight.

The priority weight or the arithmetic mean of the normalized pairwise comparison weight can be computed by taking the row average.

3.7 Computation for Fuzzy AHP

(1) Construct fuzzy AHP pairwise comparison matrix.

Fuzzy AHP scales used in this research follows fuzzy scales used by Deng (1999); Tesfamariam et al. (2006); and Nguyen et al. (2015) (see Table 3.5). Noted that the fuzzy scales of 1 is set as (1, 1, 3) for lower, middle, and upper scale; making the difference of upper scale and middle equals to two. For scale 9, the fuzzy scales is set as (7, 9, 11). Both fuzzy scales of 1 and 9 are the same as membership functions used by Deng (1999). For other fuzzy scales, the difference of upper scale and middle (or fuzzification factor) is one, the same as fuzzy scales used by Tesfamariam et al. (2006); and Nguyen et al. (2015).

Table 3.5: Fuzzy AHP Scales

AHP Scale	Fuzzy AHP Scale	Definition
1	(1,1,3)	Equal importance
3	(3-Δ,3,3+Δ)	Weak importance
5	(5-Δ,5,5+Δ)	Essential or strong importance
7	(7-Δ,7,7+Δ)	Demonstrated importance
9	(7,9,11)	Extreme importance
2,4,6,8 (x)	(x-Δ, x, x+Δ)	Intermediate values between two adjacent judgements
1/x	(1/(x+Δ), 1/x, 1/(x-Δ))	

Where Δ is a fuzzification factor and in this case, equals to 1

(2) Calculate the priority vectors.

Apply the extent analysis method proposed by Chang (1992) and Chang (1996).

Let $X = \{x_1, x_2, \dots, x_n\}$ be an object set

$U = \{u_1, u_2, \dots, u_n\}$ be a goal set

Each object is taken and extent analysis for each goal, g_i, is performed, respectively. The M extent analysis values for each object can be obtained by using the following signs:

$$M_{gi}^1, M_{gi}^2, \dots, M_{gi}^m \quad \text{where } i = 1,2,\dots,n$$

Where all the M_{gi}^j $(j = 1,2,\dots,m)$ are triangular fuzzy numbers.

<u>Step 1:</u> Compute the value of fuzzy synthetic extent with respect to *i*th object:

Given the formula

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$$

Where

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_i, \sum_{j=1}^{m} m_i, \sum_{j=1}^{m} u_i\right)$$

And

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(\frac{1}{\sum_{j=1}^{m} u_i}, \frac{1}{\sum_{j=1}^{m} m_i}, \frac{1}{\sum_{j=1}^{m} l_i}\right)$$

<u>Step 2:</u> Apply the degree of possibility to calculate local weight.

For the degree of possibility

$M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is defined as

$$(M_2 \geq M_1) = \sup_{y \geq x}\left[\min\left(\mu_{M1}(x), \mu_{M1}(y)\right)\right]$$

And can be equivalently expressed as follows:

$$V(M_2 \geq M_1) = hgt(M_2 \cap M_1) =$$

$$\mu_{M2}(d) = \begin{cases} 1, & if\ m_2 \geq m_1 \\ 0, & if\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases}$$

Where *d* is the coordinate of the highest intersection point between μ_{M1} and μ_{M2}.

Step 3: Determine the weight vector.

In this step, *d* is located between the intersection of M_1 and M_2 and can be determined by identify the minimum values of S_i.

Assume that $d'(A_i) = \min V(S_i \geq S_k)$

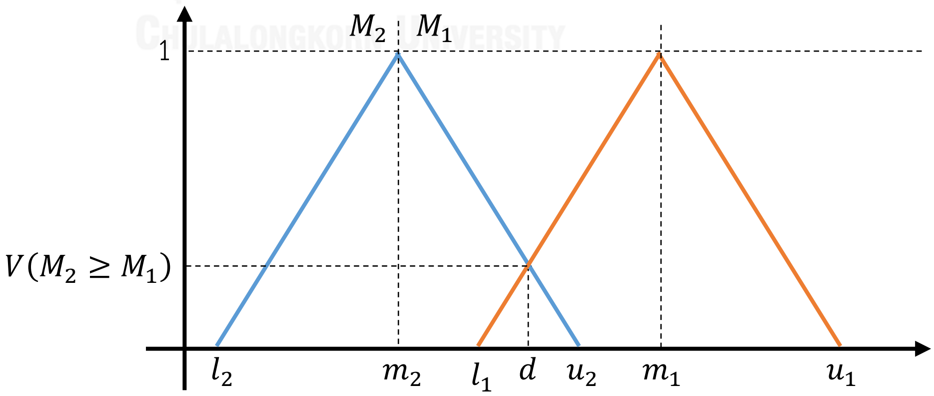


Figure 3.3: The intersection between M_1 and M_2

For *k = 1, 2, ... , n* and *k ≠i*. The weight vector can be written as follows.

$$W' = (d'(A_1), d'(A_2), \ldots, d'(A_n))^T$$

Where A_i (i = 1, 2, … , n) are *n* elements.

Step 4: Normalize the weight vector.

The normalized weight vector can be written as follows.

$$W = (d(A_1), d(A_2), \ldots, d(A_n))^T$$

Where W is a non-fuzzy number.

3.8 The Partnership Model

The partnership model was introduced by Lambert, Emmelhainz, and Gardner (1996) by using detailed case studies. Researchers have identified firms' relationships into six types. Arm's Length means "single exchanges or multiple transactions" which implies that between parties, the relationship involves with business transactions but there is no joint commitment or operations. However, if partnership should occur, it can be categorized as Type I, Type II, and Type III. Additionally, if relationships between parties went beyond partnership level, the parties might be related as joint venture or vertically integrated.

Type I partnership indicates partnership with limited basis. Coordination and joint planning are low and rare, or with short-term focus. Most of the time, this type of partnership involves with single department or function in each party.

In Type II partnership, relationships between parties involve more than just coordination. The relationships are rather long-term. Multiple departments, divisions, or functions in each party are engaged in the partnership.

Parties in Type III partnership share “substantial level of operational integration” and whole organization were included in the partnership. Typically, there is no end date for this type of partnership.

Lambert et al. (1996) proposed the partnership model as illustrated in Figure 3.4. The model consists of four parts: partnership’s drivers, partnership’s facilitators, partnership’s components, and partnership’s outcomes.

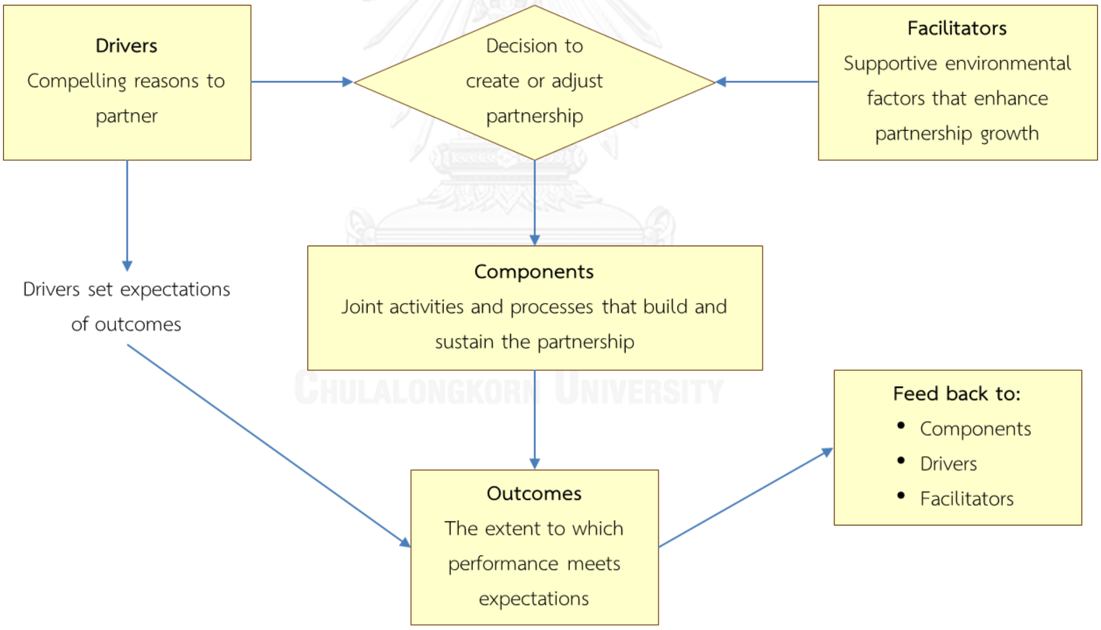


Figure 3.4: The partnership model

Drivers are “compelling reasons to partner” and influence outcome. Drivers include asset and cost efficiency, customer service, marketing advantage, and profit stability and growth. Facilitators are “supporting environmental factors that enhance partnership growth". There are several facilitators in partnership model, including corporate compatibility, managerial philosophy and techniques, mutuality, and symmetry. Those four elements are called primary facilitators. Absences of them may resulted in partnership's failure. The additional facilitators normally support the chance of success of partnership. However, absence of these facilitators does not mean failure. The additional facilitators are exclusivity, shared competitors, close proximity, prior history, and shared end user.

To determine type of partnership needed to meet expected outcomes, drivers and primary facilitators are assessed by using five-scale rating semi-structured interview questions. Drivers and facilitators have to be assessed separately. The question in the assessment form will ask respondents to give probability of success, improvement, or substantially encourage by specific drivers and facilitators. The additional facilitators are assessed by using yes/no semi-structured interview questions.

After completion of assessment, probabilities and yes/no answers will be converted to points and mapped into propensity to partner matrix, as in Table 3.6 below.

Table 3.6 – Propensity to partner matrix

		Driver Points		
		8 – 11 Points	12 – 15 Points	16 – 24 Points
Facilitator Points	8 – 11 Points	Arm's Length	Type I	Type II
	12 – 15 Points	Type I	Type II	Type III
	16 – 24 Points	Type II	Type III	Type III

The type of partnership will determine components required for partnership's success. Partnership's components include planning, joint operating controls, communications, risk/reward sharing, trust and commitment, contract style, scope, and investment. Each type of partnership require different component implementation. Normally, the more integrative partnership level require higher level component implementations. However, it is not necessary that the most integrative type of partnership, Type III, will require all components to be implemented in high level. Partnership component levels depend on each party's mutual agreement and decision in utilizing resources, personnel, investment, and commitment.

CHAPTER 4

RESULTS ANALYSIS AND DISCUSSION

This chapter presents summary of respondents' characteristics. Results of consistency ratio computation as well as computation of AHP's priority weights, fuzzy AHP's priority vectors, local and global weights are presented and discussed. The semi-structured interview's results are summarized and used for proposing conceptual framework.

4.1 Respondents

Data was collected during September – December 2015 through focus group and individual interviews. The focus group was held in September 2015. Participants of the focus group are trainees from class of 2015's Rail Engineer Personnel Development Program which is an intensive training program held by Thailand Railway Technology Development Institute Project, National Science and Technology Development Agency. Total of 37 questionnaires were collected, 26 from focus group and 11 from individual interviews. Table 4.1 presents the participants' job sector, job level and working experiences. Noted that job level for participants in academia group is classified different from the other group. Independent researchers and lecturers without academic title are classified in operations level. Lecturers with academic title are classified in management level. Lecturers with academic title who hold administrative position are classified in executive level.

Table 4.1: Characteristics of participants

Participants (n=37)	Mean	Frequency	Percentage
Working Experience (years)	15.73		
Job Sector	-		
- Government		14	37.84%
- Academia		12	32.43%
- Private		11	29.73%
Job level	-		
- Operations		8	21.62%
- Management		17	45.95%
- Executive		12	32.43%

4.2 Consistency Ratio

According to Saaty (1980), a response is considered consistent when the consistency ratio is less than 0.1. Out of 37 responses, 30 responses are qualified. Table 4.2 shows the consistency ratio of all eligible responses. Total average consistency ratio of 30 responses is 0.05528. Notably, average consistency ratios of economic, social and technical are less than average consistency ratios of administration and logistics platform because the latter two dimensions contain more elements (or *n*) within dimension. This is coherent with the fact that RI values differ by *n*. The higher the value of *n*, the higher value of RI.

Table 4.2: Consistency ratio

Response	Dimension level	Factor level				
		Administration	Economic	Logistics Platform	Social	Technical
G01	0.02440	0.05453	0.04414	0.07262	0.05372	0.00772
G02	0.04316	0.05492	0.07761	0.09899	0.08159	0.04071
G03	0.09584	0.09605	0.08112	0.08741	0.08246	0.00292
G04	0.08320	0.08972	0.04453	0.08034	0.09273	0.07023
G05	0.00833	0.07520	0.05645	0.07544	0.03855	0.03187
G06	0.03385	0.08105	0.08167	0.05983	0.06692	0.06424
G07	0.04022	0.01430	0.03063	0.00000	0.00000	0.00388
G08	0.04042	0.07559	0.06220	0.04033	0.09791	0.02274
G09	0.08486	0.04696	0.01717	0.08007	0.00233	0.06939
G10	0.06097	0.08865	0.03750	0.06195	0.03750	0.07261
R01	0.09329	0.08961	0.05473	0.08087	0.08520	0.05549
R02	0.08713	0.07426	0.02668	0.03765	0.03312	0.01722
R03	0.06308	0.08929	0.06995	0.07817	0.05439	0.05413
R04	0.09707	0.06216	0.07179	0.08303	0.09074	0.05695
R05	0.08307	0.07480	0.07704	0.09941	0.09177	0.05692
R06	0.09695	0.05198	0.08641	0.09834	0.08258	0.07080
R07	0.01539	0.00731	0.00000	0.01301	0.00156	0.00000
R08	0.07971	0.09306	0.07238	0.09610	0.08196	0.08143
R09	0.00890	0.04953	0.01716	0.01710	0.00388	0.00389
R10	0.02306	0.01297	0.00156	0.00977	0.01829	0.00000
P01	0.05800	0.01724	0.00000	0.08240	0.00000	0.00000
P02	0.07204	0.07752	0.05819	0.07569	0.03050	0.08141
P03	0.07185	0.08064	0.07722	0.08531	0.06381	0.04053
P04	0.04771	0.03108	0.02681	0.03521	0.03067	0.06164
P05	0.06906	0.09451	0.04978	0.04697	0.05016	0.04495
P06	0.06700	0.06157	0.02266	0.08790	0.02681	0.05379
P07	0.09085	0.08528	0.02667	0.09089	0.02656	0.09775
P08	0.08139	0.08043	0.05923	0.05289	0.06291	0.00000
P09	0.08461	0.08132	0.01233	0.08195	0.00000	0.05752
P10	0.08521	0.07652	0.06996	0.08050	0.04467	0.03348
Average	0.06302	0.06560	0.04712	0.06634	0.04778	0.04181
					Total Average	**0.05528**

G: Government representatives

R: Academia representatives

P: Private sector representatives

With 30 responses, average working experience is 15.067 years. Most respondents work in management and executive level, with proportion of 50 percent and 33.33 percent, respectively. Table 4.3 summarizes the characteristics of qualified respondents.

Table 4.3: Characteristics of qualified respondents

Respondents (n=30)	Mean	Frequency	Percentage
Working Experience (years)	15.067		
Job Sector	-		
- Government		10	33.33%
- Academia		10	33.33%
- Private		10	33.33%
Job level	-		
- Operations		5	16.67%
- Management		15	50.00%
- Executive		10	33.33%

Government group consists of respondents from the National Economic and Social Development Board; the Office of Permanent Secretary, Ministry of transport; the Office of Transport and Traffic Policy and Planning, the State Railways of Thailand; the National Science and Technology Development Agency, and the World Bank. Sixty percent of respondents work in management level and 30 percent of them work in executive level, as illustrated in Figure 4.1.

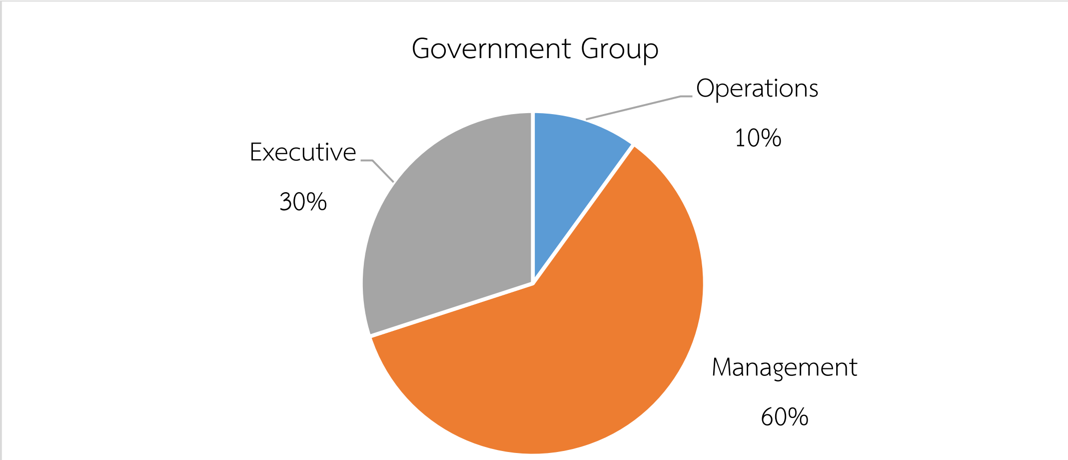


Figure 4.1: Job level proportion in government group

In academia group, respondents are railway and transport researchers from Asian Institute of Technology; Chiang Mai Rajabhat University; King Mongkut's Institute of Technology at Ladkrabang; Khon Kean University; Thammasat University; and Transport Institute, Chulalongkorn University. Independent researchers are also included in this group. Figure 4.2 shows that 90 percent of respondents hold doctor of philosophy degree, and 55 percent of respondents with doctor of philosophy degree hold academic title.

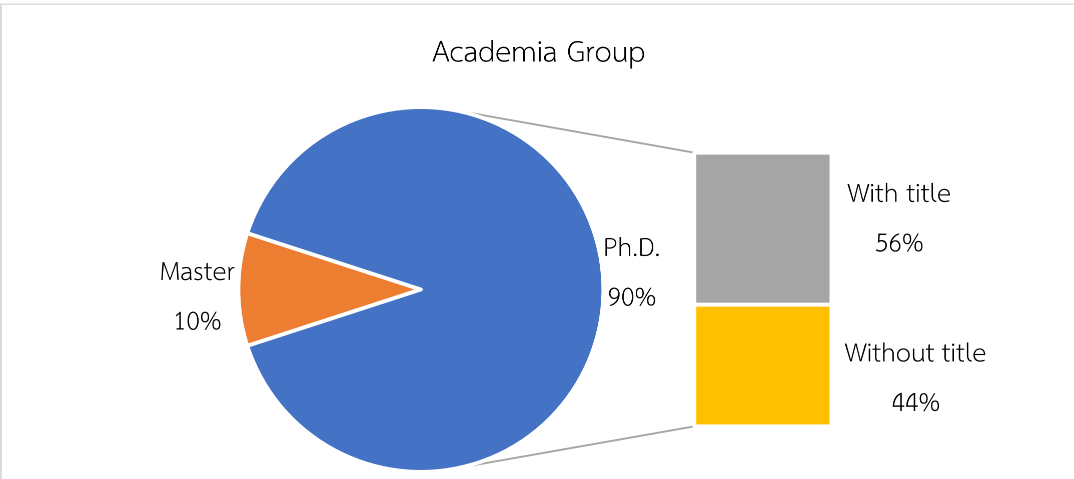


Figure 4.2: Education and academic title in academia group

As presented in Figure 4.3, Private sector's respondents are drawn from three cluster: construction companies; rail equipment distributors, suppliers & intermediaries; and project consultants, with proportion of 20, 60, and 20 percent, respectively. The first cluster includes respondents from Italian-Thai Development Public Company Limited, and Sino-Thai Engineering and Construction Public Company Limited. The second cluster comprises respondents from SCP Electric Company Limited, Bombadier Transportation Thailand, Charoong Thai Wire and Cable Public Company Limited, Loxley (Thailand) Public Company Limited, Siemens Thailand, and The Krungthep Thanakom Company Limited. The project consultant cluster includes respondents from TEAM consulting company limited, and Siam Commercial Bank.

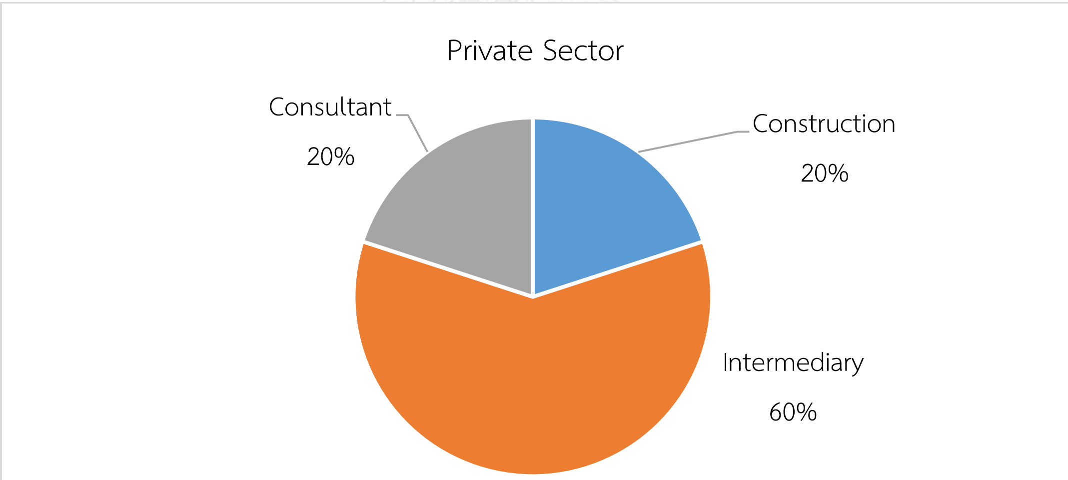


Figure 4.3: Business cluster in private sector group

4.3 AHP and Fuzzy AHP Results

In this research, AHP evaluated the pairwise comparisons in two levels: dimension and factor. Relative importance of dimension was also evaluated against factor. It has been founded that dimension will influence 2.49 times more than factor, indicating macro-level of importance to country's railway development projects. In dimension level, the administration dimension is the dimension that has the highest effect to railway projects contributed to country's logistics platform, follows by economic, logistics platform, social, and technology dimension, respectively. Local weights of both Fuzzy AHP and AHP are presented in Table 4.4.

Table 4.4: Results in dimension level

	Fuzzy AHP				AHP
	Upper	Middle	Lower	Local Weight	
Administration	0.56432	0.29687	0.14345	0.30549	0.30554
Economic	0.50172	0.24879	0.12315	0.26842	0.24500
Logistics platform	0.43196	0.20816	0.10037	0.21520	0.20817
Social	0.31290	0.12923	0.06279	0.11669	0.12832
Technical	0.29264	0.11696	0.05629	0.09419	0.11297

In factor level, pairwise comparisons were conducted only within dimension. For administration dimension, the rail development masterplan (A3) is determined as the most success factor affecting railway projects contributed to country's logistics platform, followed by the Department of Rail Transport (A1) and multiple rail fright operators (A2). As for economic dimension, transit oriented development (E1) is weighted the highest, followed closely by PPP opportunities (E4) and market development (E3). Rail freight cost structure (L4) is identified as the most success factor in logistics platform dimension, followed by connectivity (L1) and intermodal enhancement (L2). Quality of life (S2) is clearly holding the top rank in social dimension, followed by job opportunities (S1). In technical dimension, it is safety (T1) that is defined with substantial weight as the most success factor, followed by reliability (T4). The local weights of fuzzy AHP and AHP are presented in Table 4.5.

Table 4.5: Results in factor level

	Fuzzy AHP				AHP
Administration	Upper	Middle	Lower	Local Weight	
A1 Department of Rail Transport	0.40591	0.19533	0.09086	0.18953	0.19313
A2 Multiple rail freight operators	0.37055	0.17077	0.08291	0.18094	0.16952
A3 Rail development masterplan	0.52305	0.27014	0.12687	0.28324	0.28124
A4 Type of investment	0.36427	0.16296	0.07524	0.16063	0.15608
A5 Performance of SRT	0.28712	0.12115	0.05822	0.12354	0.11918
A6 Inter-governmental support	0.22684	0.07964	0.03747	0.06213	0.08085
Economic					
E1 Transit oriented development	0.64998	0.30504	0.13817	0.30352	0.31023
E2 Foreign investment	0.39031	0.14345	0.06646	0.14419	0.14277
E3 Market development	0.57592	0.25972	0.12013	0.25913	0.25287
E4 PPP opportunities	0.64051	0.29179	0.12967	0.29317	0.29414
Logistics platform					
L1 Connectivity	0.42730	0.20194	0.09373	0.19779	0.19898
L2 Intermodal enhancement	0.40377	0.18643	0.08773	0.18448	0.18482
L3 Cross-border logistics	0.22285	0.08128	0.03674	0.06221	0.07897
L4 Rail freight cost structure	0.49061	0.24845	0.11598	0.26257	0.25630
L5 Availability of supporting facility	0.31068	0.13125	0.06143	0.12999	0.12715
L6 Sustainability	0.32245	0.15065	0.07537	0.16296	0.15379
Social					
S1 Job opportunities	0.62054	0.28638	0.12425	0.27409	0.29636
S2 Quality of life	0.74270	0.35261	0.16124	0.37304	0.35998
S3 Social welfare	0.46381	0.18061	0.07906	0.18011	0.17252
S4 Security	0.47189	0.18040	0.07853	0.17276	0.17113
Technical					
T1 Safety	0.77414	0.39415	0.18048	0.39386	0.39665
T2 Capacity building	0.51425	0.20985	0.09516	0.20374	0.20439
T3 Research & development center	0.37776	0.13601	0.06147	0.13281	0.13924
T4 Reliability	0.59141	0.25998	0.11942	0.26959	0.25972

Although both fuzzy AHP and AHP yield similar ranking in dimension and factor level. Global weights of both AHPs generate slightly different ranking, as show in Table 4.6 in the next page.

Table 4.6: Global weights and ranking of fuzzy AHP and AHP

Factor	Fuzzy AHP		AHP	
	Weights	Rank	Weights	Rank
A1 Department of Rail Transport	0.06266	5	0.06095	5
A2 Multiple rail freight operators	0.04645	7	0.04766	8
A3 Rail development masterplan	0.09078	1	0.08688	1
A4 Type of investment	0.04448	9	0.04574	9
A5 Performance of SRT	0.04338	10	0.04074	12
A6 Inter-governmental support	0.01774	22	0.02357	21
E1 Transit oriented development	0.08156	2	0.07600	2
E2 Foreign investment	0.03949	13	0.03658	14
E3 Market development	0.07410	3	0.06330	4
E4 PPP opportunities	0.07327	4	0.06911	3
L1 Connectivity	0.04467	8	0.04316	11
L2 Intermodal enhancement	0.04302	11	0.03935	13
L3 Cross-border logistics	0.01169	24	0.01638	23
L4 Rail freight cost structure	0.05665	6	0.05261	6
L5 Availability of supporting facility	0.02471	20	0.02457	19
L6 Sustainability	0.03447	15	0.03210	16
S1 Job opportunities	0.02545	16	0.03345	15
S2 Quality of life	0.04085	12	0.04784	7
S3 Social welfare	0.02524	17	0.02383	20
S4 Security	0.02516	19	0.02319	22
T1 Safety	0.03495	14	0.04431	10
T2 Capacity building	0.02159	21	0.02532	18
T3 Research & development center	0.01243	23	0.01601	24
T4 Reliability	0.02522	18	0.02732	17

The variations in result were caused by fuzzy triangular numbers. By setting fuzzy scales of (1, 1, 3) for lower, middle, and upper scale, the difference of upper scale and middle equals to two, while for other fuzzy scales, the difference of upper scale and middle (or fuzzification factor) is one. However, this logic did not apply for scale 9. By setting fuzzy scales of 1 as (1, 1, 3), local weights of fuzzy AHP tended to higher values but it solve the problem of having a lot of zeros for triangular weights after defuzzification (most values of $V(M_2 \geq M_1)$ with fuzzy scales of (1, 1, 1) were zero, resulted in numerous final local weight values equal to zero).

4.4 Discussions

(1) Dimensional level

Among five dimensions, administration is weighted the highest. This can be related to the past and current organization's performance. SRT's constant operating loss for both passenger and freight originated from extremely high proportion of operating expenses. The organization also owns high proportion of long-term debt. This issue has been acknowledged by the Ministry of Transport and Ministry of Finance for years. Although SRT was trying to solve the problem by changing some critical business operations from departments to business units, the issue remains unfixed.

Figure 4.4 presents fuzzy AHP results in dimension level. The results are categorized by respondents' group. It can be noticed that the priority weights among three participant groups do not show significant difference except the social dimension, in which academia group weighted this dimension higher than other group.

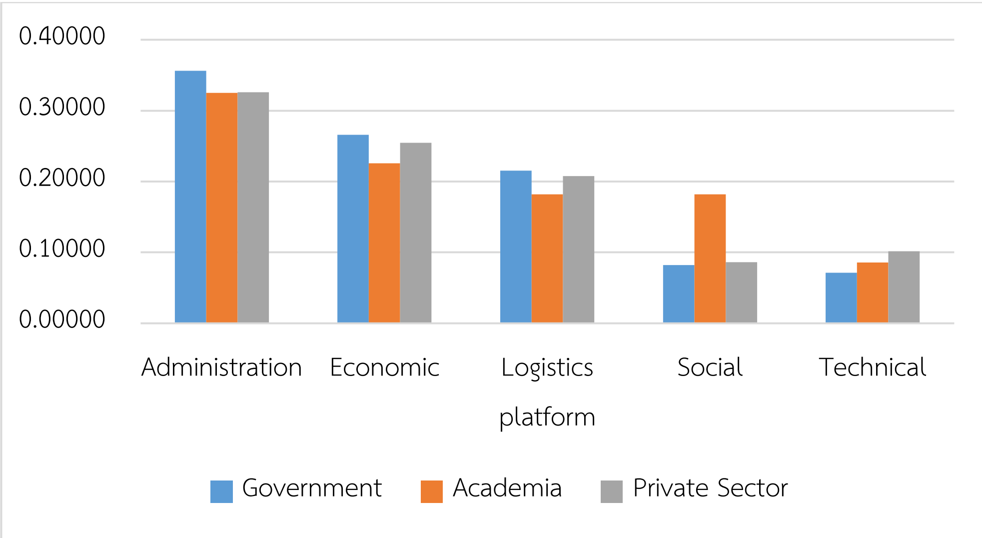


Figure 4.4: Fuzzy AHP result in dimension level

By taking closer look into academia responses for social dimension as presented in Figure 4.5, it can be seen that the average priority weight is dominated by two respondents who work considerably far from Bangkok. Both respondents (denoted as R01 and R03) rate the relative importance of social dimension considerably high, 0.51651 and 0.40151, respectively, when compare with the average priority weight of 0.18194. The respondents stated that low income citizens who live up country depend on free public transport, in which SRT is the only inter-city public transportation service provider that offer free train rides regularly. Therefore, by investing in rail infrastructure projects, those citizens will definitely receive social benefits.

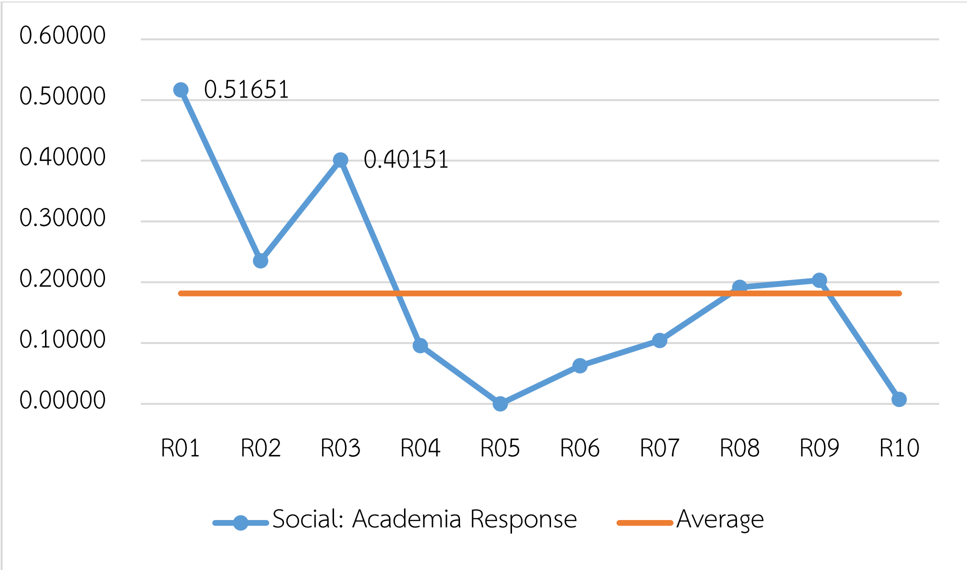


Figure 4.5: Academia responses for social dimension

(2) Factor Level

(2.1) Administration

Figure 4.6 shows AHP and fuzzy AHP results in administration dimension. Among six factors, rail development master plan (A3) is clearly the factor with highest priority weight in this dimension, follows by Department of Rail Transport (A1), which can be asserted that a large-scale, long-term rail planning together with projects' stability and solid government regulator is required for rail infrastructure development projects' success.

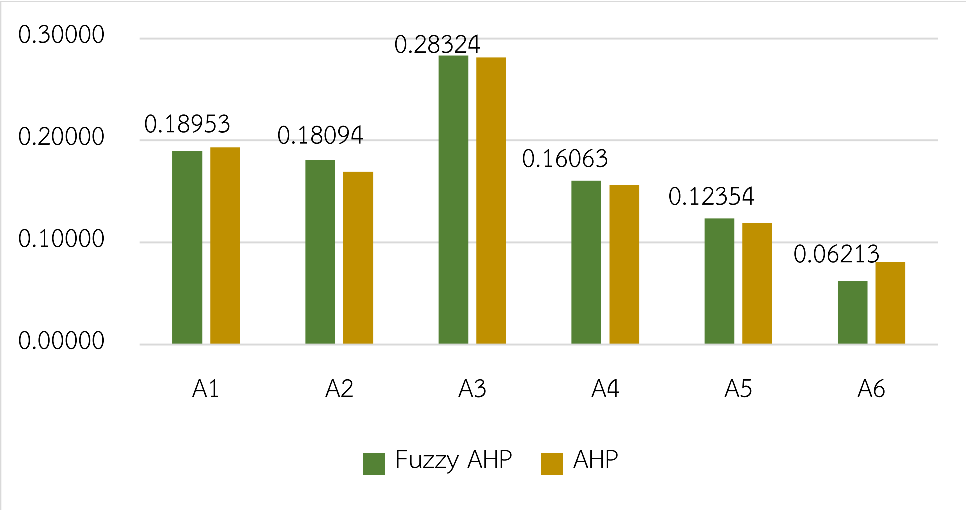


Figure 4.6: AHP and fuzzy AHP results in administration dimension

Notably, there are outliers in some factors; one from performance of SRT (A5) and another from multiple rail freight operators (A2). As illustrated in Figure 4.7, the outlier for performance of SRT in government group is actually the response from SRT's employee and thus can be considered as bias within government group. After removing this response, the average weight for performance of SRT (A5) drop from 0.12354 to 0.10265.

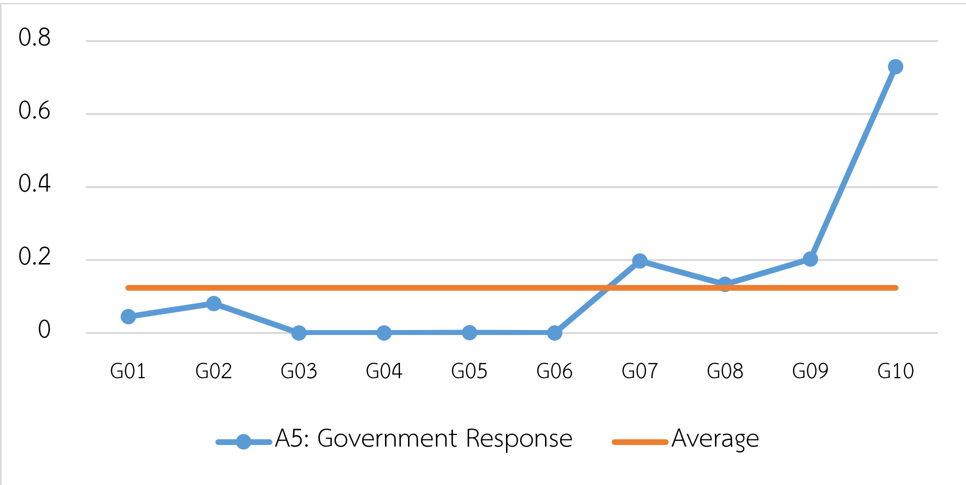


Figure 4.7: Outlier in performance of SRT (A5)

As can be seen from Figure 4.8 and 4.9, the outliers of multiple rail freight operators and rail development masterplan come from the same responder who represented international organization in government group. The responder addressed that having multiple rail freight operators should arouse the competition in the rail service business and eventually lead to projects' success, which can be concluded that pushing forward such policy into practices would be more effective than establishing a large-scale plan.

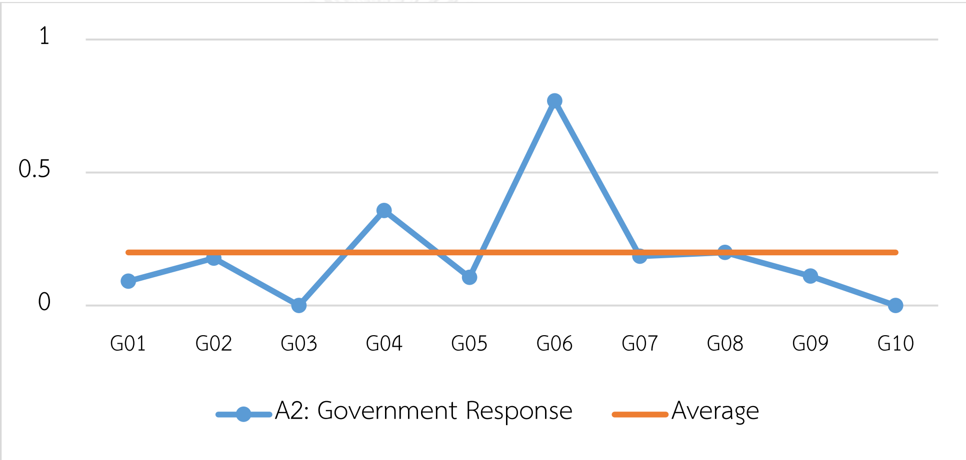


Figure 4.8: Outlier in multiple rail freight operator (A2)

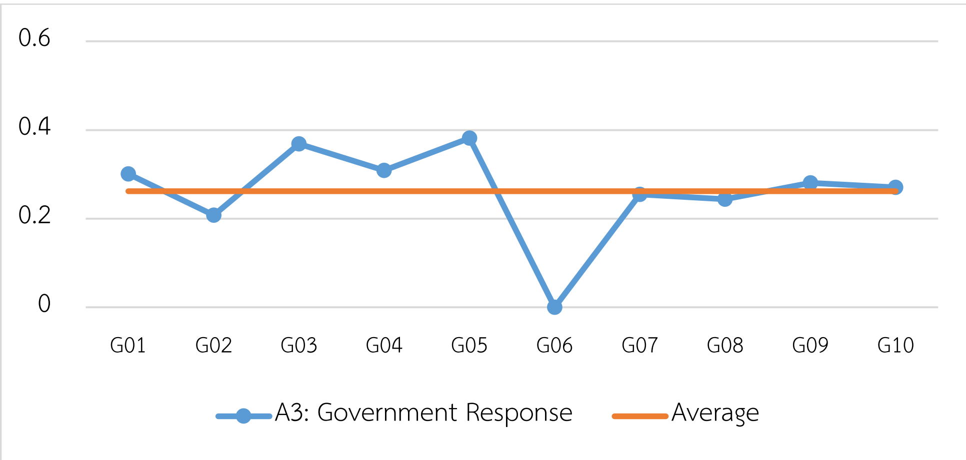


Figure 4.9: Outlier in rail development masterplan (A3)

On average, government group gives moderately lower weight to type of investment (A4) when compare with academia and private sector group, as shown in Figure 4.10. It can be implied that government does not take the financial acquisition options seriously because they realized that only certain types of investment can be successfully employed. This is strongly supported by the weight given by government group to PPP opportunities (E4) in economic dimension. Additionally, academia, especially a group of researchers whose research interest is transit oriented development or TOD (E1), weights Department of Rail Transport lower than average priority weight. The TOD researchers explained that Department of Rail Transport will be definitely instituted soon at any cost, this factor should not have much effect to rail projects' success.

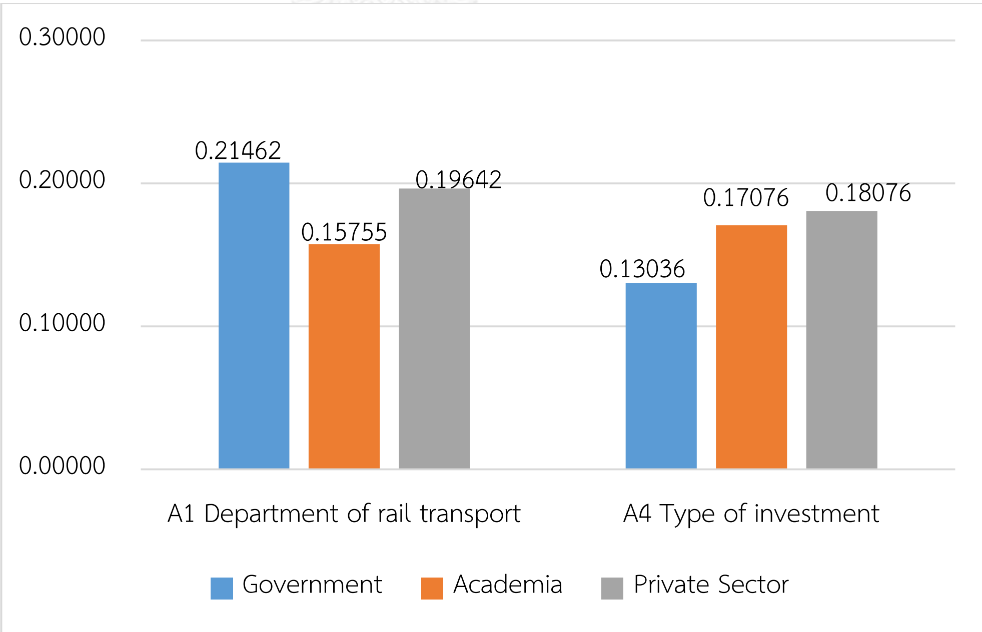


Figure 4.10: Result variation for Department of Rail Transport (A1) and type of investment (A4)

(2.2) Economic

TOD (E1) is identified as the factor with highest priority weight in this dimension, follows closely by PPP opportunities (E4) and Market Development (E3), as illustrated in Figure 4.11. The results for fuzzy AHP and AHP does not show significant difference.

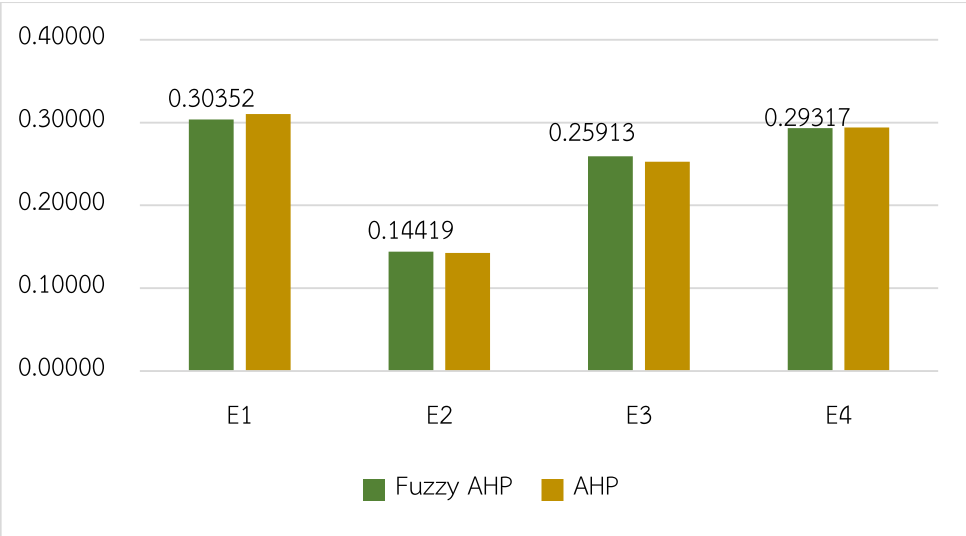


Figure 4.11: AHP and fuzzy AHP results in economic dimension

Figure 4.12 presents result variation in market development (E3) and PPP opportunities (E4). On average, academia and private sector rate market development for rail product industry higher than government, which reflect less concern on encouraging domestic industry capability in manufacturing rail part and car assembly.

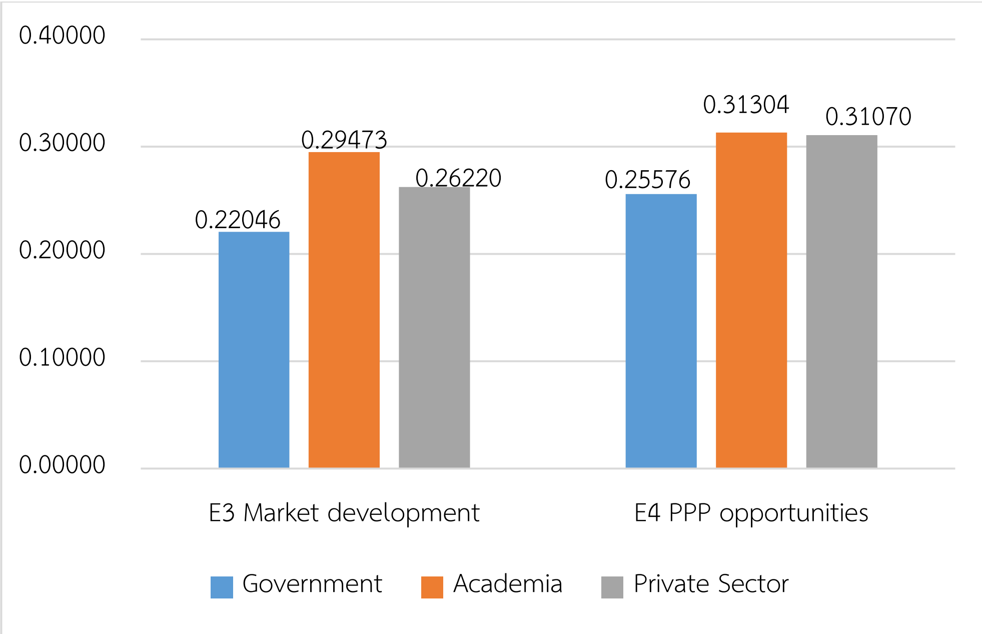


Figure 4.12: Result variation for market development (E3) and PPP opportunities (E4)

As discussed earlier that respondents in government group rate type of investment quite low in compare with other groups because they intend for particular investment options to happen. This implication is supported by PPP opportunities weight of government group which has the lowest average weight among three groups. In the past, the successfully implemented PPP's scheme took place only with mass transit projects. Additionally, investment type for half of rail development projects in this research has been determined. SRT intended to self-administer the projects by using either international and domestic loan or government's annual budget. This financial option was proposed by SRT and other relevant government agencies had acknowledged for years. Hence, opportunities for PPP is less likely to happen when compare with academia and private sector group.

(2.3) Logistics Platform

In this dimension, rail freight cost structure (L4) has the highest priority weight, follows by connectivity (L1) and intermodal enhancement (L2), as illustrated in Figure 4.13. The results for fuzzy AHP and AHP in this dimension are also resemble.

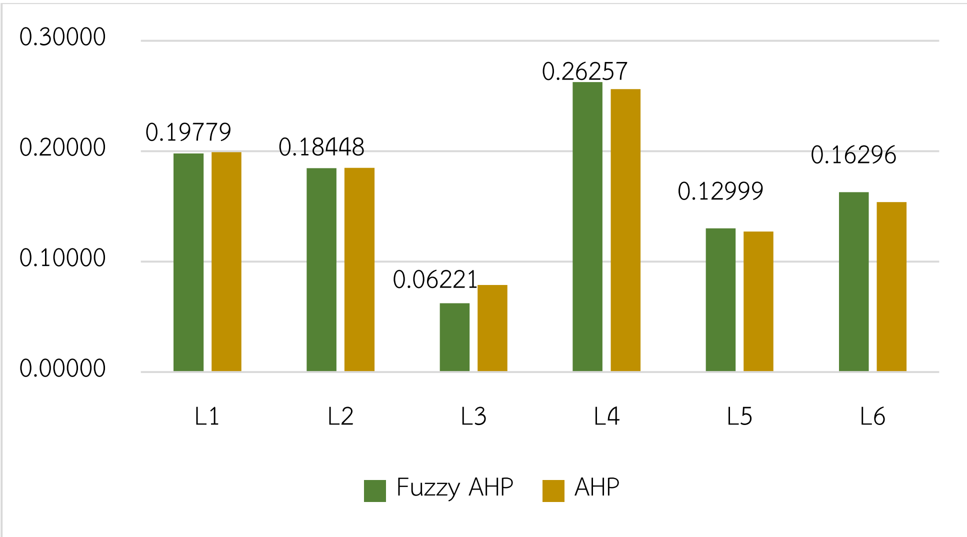


Figure 4.13: AHP and fuzzy AHP results in logistics platform dimension

For intermodal enhancement, it is the academia group that gives low priority weight and conversely weights the influence of sustainability (L6) to project's success the highest of all factors in this dimension, as shown in Figure 4.14. Responders explained that rising green logistics trend will definitely draw industry to transport freight by rail if SRT can solve transportation bottleneck issue caused by single track. The rail infrastructure development projects in this research is certainly the solution to the bottleneck issue and thus can stimulate the use of rail freight transport once the construction of the new network is completed.

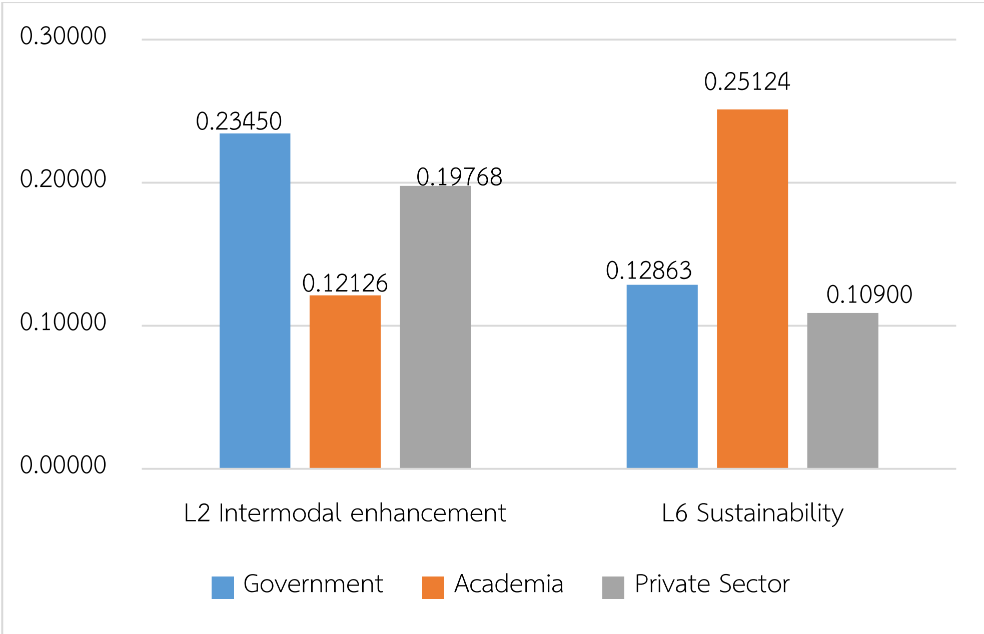


Figure 4.14: Result variation for intermodal enhancement (L2) and sustainability (L6)

(2.4) Social

Figure 4.15 presents the leading success factor in social dimension, quality of life (S2), which pinpoint that freight oriented development is inseparable from passenger oriented development since the focus of social dimension and quality of life is on citizens. This coincide with the result in economic dimension which the priority weight of transit oriented development is the highest.

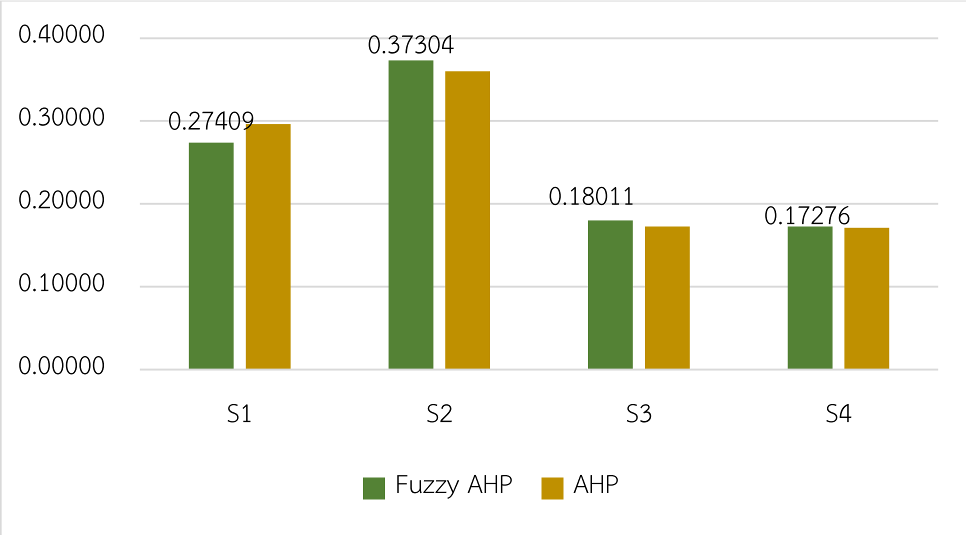


Figure 4.15: AHP and fuzzy AHP results in social dimension

Figure 4.16 shows result variation for job opportunities and social welfare. For job opportunities, academia rate this factor much lower than government and private sector. This coincide with priority weight pattern of capacity building (T2) in technical dimension. On the other hand, people will receive more benefits on social welfare from free inter-city and long distance train rides offered by SRT, which resemble the priority weight pattern of social dimension as discussed earlier.

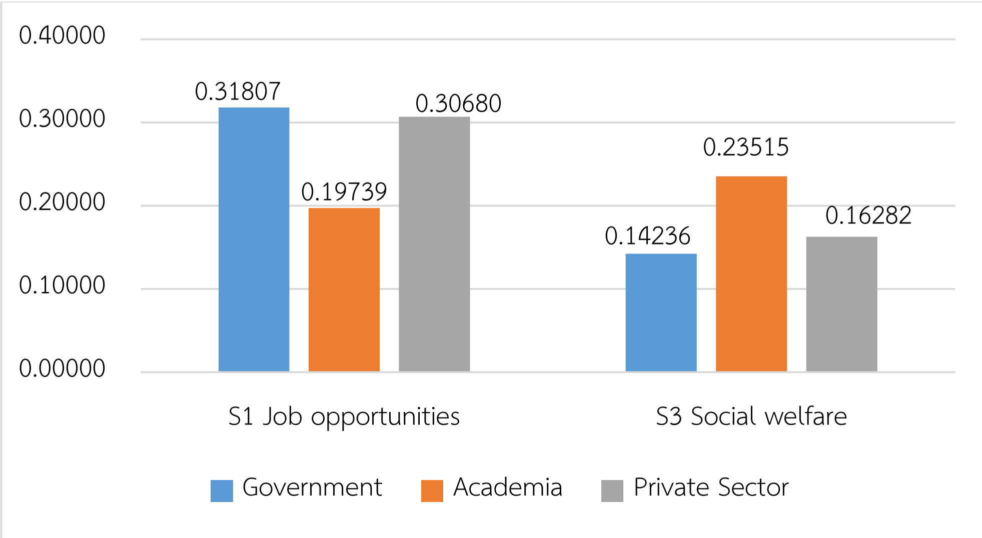


Figure 4.16: Result variation for job opportunities (S1) and social welfare (S3)

(2.5) Technical

Safety (T1) is identified as the leading factor in technical dimension, follows by reliability (T4), as presented in Figure 4.17. Similar to the other dimension, results for fuzzy AHP and AHP does not show significant difference.

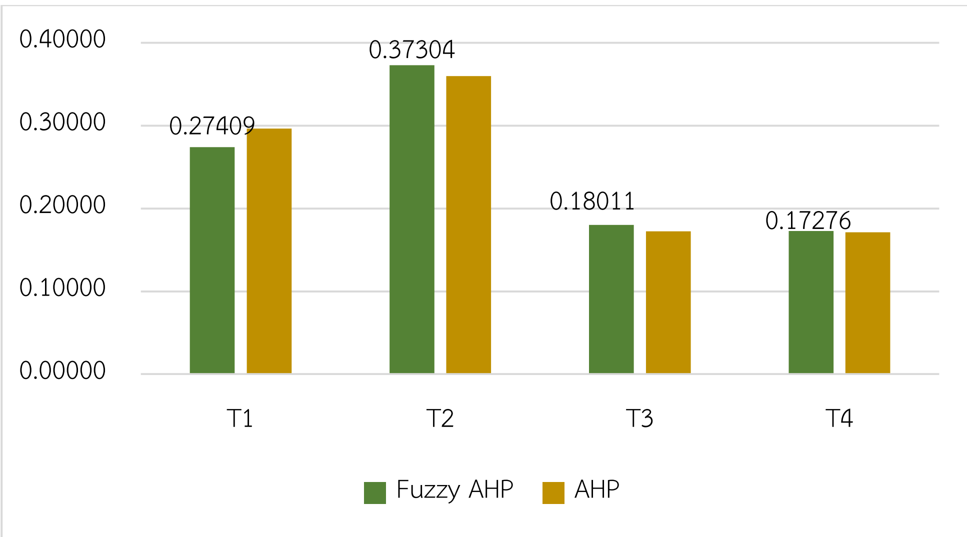


Figure 4.17: AHP and fuzzy AHP results in social dimension

Notably, the respondents in government group give weight to safety (T1) moderately lower than academia and private sector group. They also view reliability and capacity building (T2) more significant than the other two groups, as shown in Figure 4.18. Academia views capacity building less important than the other group. Responders addressed that capacity building should be influenced by the rail infrastructure projects instead of influencer and, currently, there are numerous railway engineering programs offered by Thai universities, vocational colleges, and technical schools. In their opinion, capacity building is considered much less significant than safety, which is the heart of rail operations.

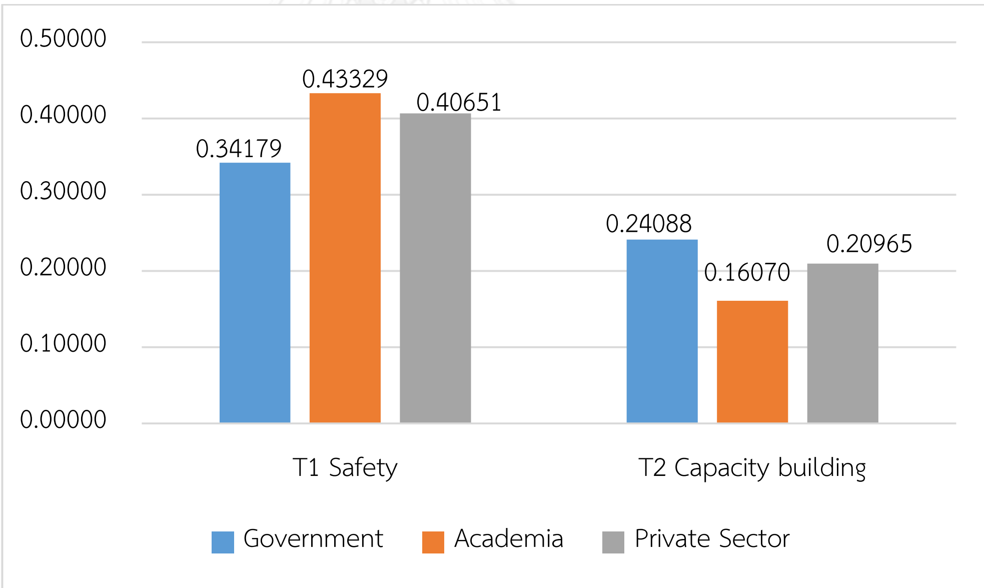


Figure 4.18: Result variation for safety (T1) and capacity building (T2)

(3) Overall

As stated earlier, the global weights for both fuzzy AHP and AHP show dissimilarity in ranking. Discussion in this section will be based on fuzzy AHP's results. Because railway development projects has to be operated under uncertainty circumstance, using fuzzy AHP's results would be more suitable than AHP's results.

By considering normalized weight of each factor, the rail development masterplan (A3) is clearly identified the leading success factor, which can be asserted that a large-scale, long-term rail planning together with projects' stability is required for rail construction project's success. As previously discussed in Chapter 2, there were discontinuity and instability in railway projects in the recent years due to cabinet change, causing alteration in railway projects' policy. Having the masterplan as the top factor can be implied that the projects require clear roadmap, well-defined investment options, and appropriate administration and operations to become success. Drafting and generating a masterplan is not a simple process and it necessitates high collaboration between government agencies. Although most of rail masterplan were created for rail passenger transport, like Japanese's metro plan or Bangkok mass transit development masterplan, there were countries that established rail development master plan for both passenger and freight. One example is the Saudi Railway Master Plan (SRMP), a rail passenger and freight development plan from 2010 to 2040 for the Kingdom of Saudi Arabia. Several policies were applied to the masterplan, namely public-private partnership, the share responsibilities among associated rail transport sectors, multimodal transportation system, regional and global market development, and transport infrastructure. This SRMP is expected to develop and construct approximately 9,900 kilometers of railway in the Kingdom of Saudi Arabia for 30 years. European is another example. European Rail Infrastructure Masterplan (ERIM) project was established to upgrade the existing rail infrastructure as well as installing new infrastructure in major international rail corridors need by 2020 due to traffic growth. This project mainly supports freight transport throughout 32 countries in Europe, covered about 50,000 kilometers of railways. One key results of this project is to "improve market performance of rail mode".

TOD (E1), being rank the second, suggests that the rail freight transport could not be solely developed, but it has to be implemented together with passenger transport. Enhancing passengers' convenience in transit, for example, providing access to rail stations and creating commercial and property development's opportunities, will draw more passengers into rail transport systems. Interestingly, respondents addressed that TOD will contribute to rail logistics in the sense that it will stimulate the passenger concurring freight such as baggage, small package and parcel shipping service on passenger train. This logic can be supported by a study that the Office of Transport and Traffic Policy and Planning carried out in 2013. The study, which is an addition to the feasibility study of Bangkok – Nongkai (Thai – Lao PDR border city) high speed train project, indicated four types of freight that can be transported with passenger train: parcel transported with inter-city bus; air freight; parcel transported with premium carriers such as DHL and FedEx; and express mail service. It was estimated that daily volume of parcel transported with inter-city bus in that route alone can be up to 25.7 tons. The Office of Transport and Traffic Policy and Planning also proposed that after three years operations in Bangkok – Nongkai route, parcel transported with passenger train can be as high as 70 tons per day. The Office of Transport and Traffic Policy and Planning concluded that rail passenger operator may generate revenue from parcel service under two conditions: the rail parcel rate should be similar to road and air freight rate; and total transportation time for passenger train has to be 50 percent shorter than current total transportation time. Although grossing from the parcel service is not currently significant, SRT should promote the service to capture revenue that come with better station accessibility and transit convenience after projects are completed.

Based on fuzzy AHP's result, market development (E3) is ranked the third success factor. This indicates the need for rail industrial growth. Although Thai companies can currently manufacture concrete sleepers and some rail spare parts, but the variation of rail associated products that can be produced domestically is considerably small. In 2009, a research funded by Office of Industrial Economics, Ministry of Industry and conducted by Transportation Institute of Chulalongkorn University revealed possible electrified rail product categories for local manufacturing and assembly. There are 443 items or 78.55 percent of rail product categories that can be manufactured and assembled by using local capability. The rail associated products involve with 13 industries, for example, glass and mirror industry, chemical industry, metallurgy and mechanical industry, and electronic industry. This research report also propose manufacturing options, framework, and electrified rail product development plan in 6 phases. Financial feasibility study and investment options was also proposed. However, major obstacles was lack of continuity in government's policy and attention. Hence, without strong and stable government's support, private sector was not encourage to invest in rail industry, making the market development for rail industry very challenging.

PPP opportunities (E4) is ranked the fourth success factor, according to fuzzy AHP approach, suggesting that investment in rail development projects should not only be handle by the government but also the private sector. Despite the fact that financial option of most rail projects listed in this research has been finalized, responders still support for public-private partnership. In the past, railway projects that can successfully implement public-private partnership scheme was mass rapid transit projects in Bangkok and concession of inland container depot at Ladkrabang, which supervised by SRT. Therefore, the organization is familiar with the past and current public-private partnership Act as well as public-private partnership's procedure. The remaining concern is the undetermined host agency on government side for future rail projects since the rail regulator agency has not been legislated.

Having the Department of Rail Transport (A1) ranked as the fifth success factor also reflects need for projects durability. By transferring ownership and debt of rail infrastructure to government should not only lessen SRT's debt obligation but also stimulate better operating performance. However, there is one interesting issue on performance of SRT. Some responders did not take SRT's performance as part of railway projects' success. They stated that it does not matter how well SRT would perform in the future because its role would be limited to a rail operator after a formal institution of the agency.

Rail freight cost structure (L4) is ranked as the sixth success factor. Decreasing use of rail freight transport in Thailand and number of freight transport in ton-kilometer are ones of the greatest logistics challenges. One of the causes is the rail monopolization. While SRT is the only rail freight operator in Thailand, the number of locomotives and rolling stocks was insufficient. On average, approximately 70 percent of locomotives and 80 percent of rolling stocks are available for operations as of March 2016. Consigners had to switch from rail to truck when locomotives were not available. Additionally, the freight rate set by SRT is not enough to cover high operating expenses, with more than half of the expenses are spent on labor and depreciation costs. Another constraint is the length of siding track at most stations can support up to only 25 freight cars, limiting number freight carried per trip and consequently limiting the revenue generated per trip while fuel and other operating costs continue to increase. Hence, from responders' point of view, double tracking the existing network and adding new double track railways can help improve rail freight cost structure.

4.5 The Collaboration Model

As discussed previously, both fuzzy AHP and AHP revealed that rail development masterplan is the most success factor affecting railway projects contributed to country's logistics platform, followed by transit oriented development, market development, public-private partnership opportunities, the Department of Rail Transport and rail freight cost structure. These factors can be considered as interrelated drivers to push forward the rail collaboration. In this section, analysis for possible collaboration were held and adapted based on partnership model proposed by Lambert et al. (1996) and SRMP's policies to provide conceptual framework for rail infrastructure development and administration. Despite the fact that the partnership model was intended for business organizations to evaluate themselves and their partners and the model could assess drivers and facilitators that influence decisions to establish or modify partnership. It can be applied to evaluate the collaborative attempts to create the rail development masterplan because such macro-scale, long term plan requires numerous participations from associated government agencies.

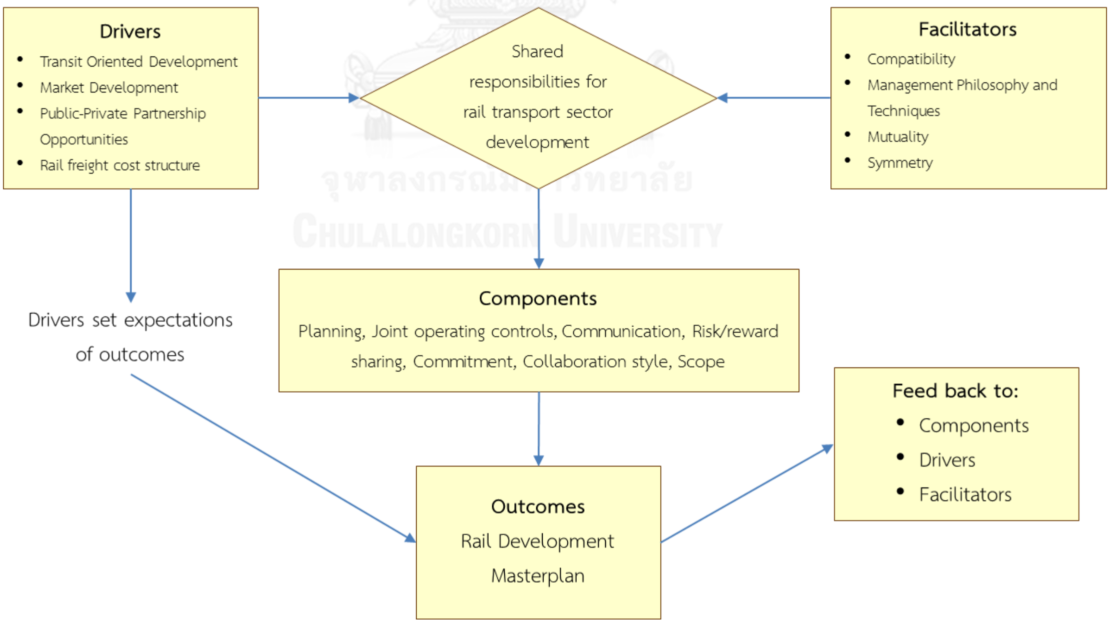


Figure 4.19: The collaboration model between government agencies to establish the rail development masterplan

The collaboration model, as shown in Figure 4.19, comprises four drivers adapted from the success factors calculated by fuzzy AHP. Out of six top factors from Fuzzy AHP analysis, four of them were deployed as drivers for collaboration. Some items in the component were adjusted and excluded to suit the collaboration style.

The rail development masterplan factor was indicated as the model's outcome, thus, excluded from drivers. The Department of Rail Transport factor was not identified as drivers because it serves the model as one of associated parties.

In this model, participants (or partners in model of Lambert et al., 1996) can be classified into two groups. The Department of Rail Transport, the Office of Transport and Traffic Plan and Policy, and SRT, all operate under Ministry of Transport's supervision, are the hosts for drafting rail development masterplan. Relevant agencies, namely Office of the National Economic and Social Development Board, the Bureau of Budget and ministry of finance are the facilitators and commentators of the masterplan.

The collaboration assessment questions were developed in English and translated to Thai with proofreading, to ensure that lost in translation does not exist. The assessment consists of eight five-scale probability rating questions and four yes/no questions. Each probability ratings is assigned with particular score, for instance, probability of 75 percent will equal to score of 4, as presented in Table 4.7. For yes/no questions, score for answering yes equals to one, while score for answering no equals to zero.

Table 4.7: Score assignment to probability ratings

Probability				
No chance				Certain
0%	25%	50%	75%	100%
1	2	3	4	5

Five representatives from host and facilitator agencies and transport researchers completed the assessment form (See Appendix B). Table 4.8 displays characteristics of respondents in this assessment.

Table 4.8: Characteristics of respondents in collaboration assessment

Organization	Job level/ Academic Title	Working Experiences (years)
Office of the National Economic and Social Development Board	Management	15
Ministry of Transport	Management	15
State Railways of Thailand	Executive	22
King Mongkut's Institute of Technology at Ladkrabang	Professor	13
Chulalongkorn University	Assistance Professor	19
	Average	16.8

Result of assessment reveals that this collaboration fall into Type II category, having average driver score of 13.4 and average facilitator score of 14.4, as presented in Table 4.9. The last column shows the average score of five respondents (C01 – C05).

Table 4.9: Collaboration Assessment Results

Items	Response					Ave.
	C01	C02	C03	C04	C05	
Drivers						
1. Transit oriented development	3.0	4.0	3.0	3.0	4.0	3.4
2. Market development	3.0	3.0	3.0	4.0	2.0	3.0
3. Rail freight cost structure	4.0	4.0	3.0	4.0	3.0	3.6
4. Public-private partnership	3.0	4.0	3.0	3.0	4.0	3.4
Sum	**13.0**	**15.0**	**12.0**	**14.0**	**13.0**	**13.4**
Facilitators						
5. Compatibility	3.0	3.0	3.0	3.0	4.0	3.2
6. Management philosophy & technique	4.0	2.0	3.0	4.0	2.0	3.0
7. Mutuality	4.0	3.0	3.0	3.0	1.0	2.8
8. Symmetry	4.0	4.0	3.0	3.0	2.0	3.2
9. Experience in success collaboration	1	0	0	0	0	0.2
10. Close physical proximity	1	1	1	1	1	1.0
11. Willingness for exclusive deal	1	0	0	0	0	0.2
12. Share high value end user	1	1	1	1	0	0.8
Sum	**19.0**	**14.0**	**14.0**	**15.0**	**10.0**	**14.4**

The average scores can be converted into floor probability. According to the score assignment to probability rating mentioned previously, score of 3 means probability of 50 percent while score of 4 means probability of 75 percent. Therefore, it is prudent to conclude that the average score between 3.1 and 3.9 will have floor probability of 50 percent, or have at least 50 percent probability of occurrence. The same principle applies to the other score range. However, the average score of supporting facilitators (Item 9 – 12) can be directly converted into probability. The probabilistic results are summarized in Table 4.10.

Table 4.10: Collaboration's floor probability

Items	Average Score	Floor probability
Drivers	-	-
1. Transit oriented development	3.4	50%
2. Market development	3.0	50%
3. Rail freight cost structure	3.6	50%
4. Public-private partnership	3.4	50%
Facilitators	-	-
1. Compatibility	3.2	50%
2. Management philosophy and technique	3.0	25%
3. Mutuality	2.8	50%
4. Symmetry	3.2	50%
5. Experience in success collaboration	0.2	-
6. Close physical proximity	1.0	-
7. Willingness for exclusive deal	0.2	-
8. Share high value end user	0.8	-

Most responses consent that there are at least 50 percent probability that this collaboration will lead to successful TOD's scheme and public-private partnership's scheme. For market development, there are at least 50 percent probability that this collaboration will substantially encourage the market development for rail industry. The probability that this collaboration will substantially adjust country's rail freight cost structure is also at least 50 percent. On average, all facilitators are scored at least three or at least 50 percent probability except for mutuality which achieves average score of 2.8. Responders assess that the probability all parties have the skills and predisposition need for mutual relationship – which include two-sided thinking and action, taking perspective of other parties, taking a longer term view, having mutual respect, willing to share information and having integrated system – is at least 25 percent. All responders agree that the key players in the associated parties are in close physical proximity to each other. Twenty percent, or one respondent believes that there is willingness to deal exclusively with other parties. The same respondent is also the only respondent who stated that all parties have prior experience with successful collaboration.

From the collaboration assessment results, it can be concluded that facilitator that would hinder this collaboration the most is the mutuality. Therefore, all parties have to put themselves in the associates' shoes and think beyond their own organization's goals and aspirations to achieve success in this collaboration. Sensitive information sharing and integration are strongly encourage along with sustainable growth in management skills.

With the specified collaboration level and based upon Lambert et al. (1996)'s partnership component levels, the components of this collaboration should be the medium level and can be described as follows.

- *Planning:* The style of planning should be regularly scheduled, with focus on process rather than individual projects or tasks. The content of plan should be created and performed jointly while eliminating conflicts in strategies.
- *Joint operating controls:* Operating measures should be jointly developed and shared. The focus should be on individual party's

performance. Parties may apply changes to other system after getting approval.

- *Communications:* Non-routine communication should be conducted more regularly and completed at multiple levels. Officers should also be open and honest. In day-to-day communication, there should be limited number of scheduled communications with some routinization. Communication should also be two-way but not necessary to be balanced. Electronic communication should be jointly modified in individual systems.
- *Risk/reward sharing:* Each party should have willingness to help other gain.
- *Commitment:* The commitment should be a longer-term relationship.
- *Collaboration style:* Collaboration should cover a longer timeframe and the coverage should be more general in nature.
- *Scope:* The activities should represent a modest share of workload for at least one partner. There should be multiple functions and departments associated in the collaboration to create value-added activities. Critical activities considerably important for each party's success should be included.
- *Investment:* There should be an extensive and exchangeable use of personnel and technology from each party. Joint design for research and development is recommended. Financial investment can be applied on low value assets of each party.

Despite the fact that the collaboration requires Type II partnership, the current collaboration among government agencies was rather Type I, or fall in low level of partnership component level. Planning style was partially regularly scheduled but the focus was on projects and tasks instead of process. There are limited willingness to help the other gain. Commitment of each agency is to specific project. Collaboration style tended to be in short time frame. Therefore, pushing government agency to strengthen partnership component from low to medium and high level can be very challenging, especially when some of the projects' details are not settled and government's policy is still changeable.

4.6 Conceptual framework

From the fuzzy AHP's results and the collaboration model, rail development masterplan should be established inclusively with transit oriented development, market development for local rail industry, and public-private partnership policy. The component concept of masterplan can be drafted as presented in Figure 4.20 below.

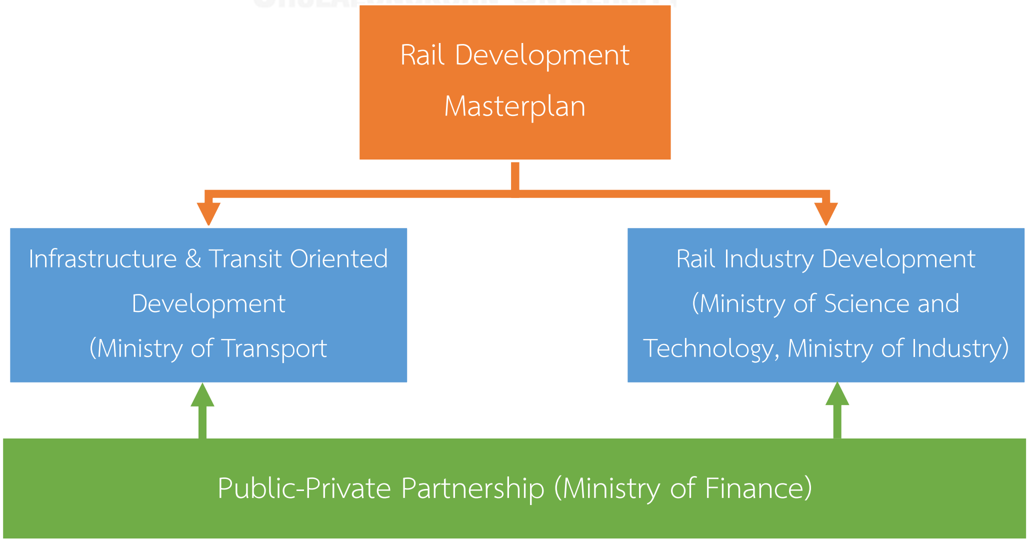


Figure 4.20: Rail development masterplan's component concept

At ministry level, there are at least four ministries involving with the masterplan: Ministry of Finance, Ministry of Transport, Ministry of Science and Technology, and Ministry of Industry. When such high level of cooperation is needed, one of the most common practices to successfully collaborate is through a steering committee or working group. Government agencies responsible for the national railways development masterplan should be one of the following Ministry of Transport's agencies: the Office of Transport and Traffic Policy and Planning, the Department of Rail Transport, and SRT; The agencies in this ministry should be responsible for the content of rail infrastructure development as well as transit oriented development.

Implementation of public-private partnership should take part in both rail infrastructure development and rail industry development. Although most of railways development projects in this research will not be implementing public-private partnership, it can still be applied with transit oriented development projects such as property, real estate, commercial, and retail business development at potential railway stations. Within this masterplan, role and responsibility of State Enterprise Policy Office would be the facilitator and regulator for public-private partnership implementation in future railway development and transit oriented development projects.

The focus on rail industry development should be on train manufacturing and assembly. Currently, Thai companies can manufacture parts for civil and track works. According to Office of Industrial Economics (2009), one of the rail industry development options is to establish national design for electrified trains in all networks. Should this option be implemented, government and train manufacturer can jointly design the industrial standard for not only electrified train but also inter-city train for both passenger and freight. Major benefits in this option are the economy of scale for rail product manufacturing, technology transfer for local content, and increasing in government's negotiation power. The rail manufacturing facility can be jointly cooperated by rail operators, local train manufacturers and international train manufacturers, with government support. Although one of the drawbacks of this option is the design will be too specific and consequently will limit the component choice. On the other hand, rail operations and maintenance can be unified, which will create large enough volume for rail industry growth while maintenance cost can be saved from having fewer variation in locomotives and rolling stocks' spare parts. The national design option will require high collaboration between host for rail industry development (relevant government agencies) and facilitator (train manufacturers). Government agencies associated with rail industry development are Ministry of Industry (Office of Industrial Economics, Thai Industrial Standards Institute), and Ministry of Science and Technology (National Science and Technology Development Agency, National Science Technology and Innovation Policy Office, and Thailand Institute of Scientific and Technological Research).

In general, timeframe for transportation masterplan ranges from 20 to 30 years. SRMP is set for 30 years development while Indonesian National Railway Masterplan covers 20 years. The mass rapid transit masterplan in Bangkok was also set for 20 years. According to the Office of Industry Economics (2009), the electrified rail industry development plan should take 14 years to reach the last phase. When using the mentioned plan as a baseline, the rail industry development in this research should take the same period of time. Therefore, draft of rail development masterplan's timeframe can be exhibited as in Figure 4.21.

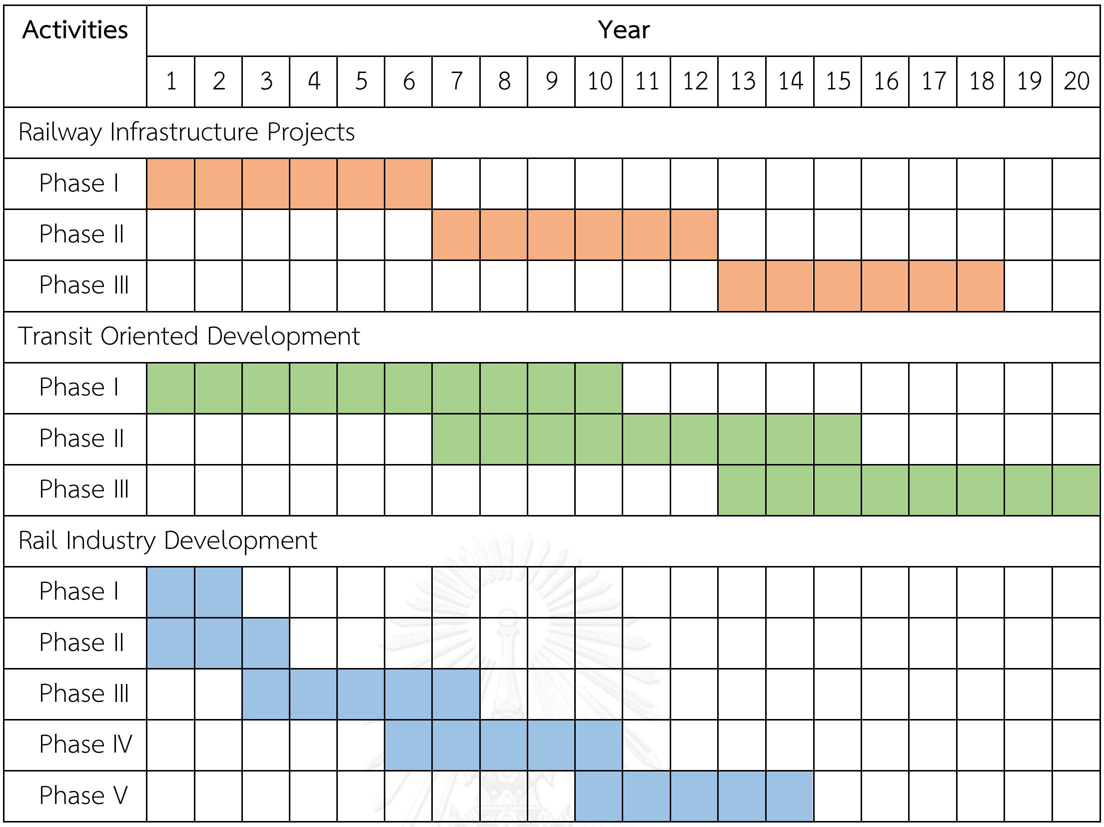


Figure 4.21: Timeframe for rail development masterplan

From Figure 4.21, railway infrastructure projects phase I (year 1 to year 6) includes all railways development projects in this research. Phase II (year 7 to year 12) includes high-speed railways that are studied under cooperation between Thai and Japanese government (Bangkok – Chiang Mai) and East-West corridor railways (Mae Sod – Mukdahan). Phase III (year 13 to year 18) includes double tracking railway projects for the remaining single track railways.

Each phase of TOD will concur with infrastructure development. Phase I and II take 10 years for development while Phase III take 8 years. Phase I and II require more development time because projects in both phase consists of new railways and stations while projects in Phase III are double tracking the existing network. Noted that the transit oriented development projects will be succeeded only when employ "concurrently" with the railway infrastructure projects, not after.

By adapting the electrified rail industry development plan from the Office of Industry Economics (2009), the rail industry development phase I (year 1 to year 2) is the initial phase for rail manufacturing facility. Major activity in this phase is final assembly where most rail components have to be imported from international suppliers. National design should be crafted in this phase. During phase II (year 1 to year 3), government has to push forward the local manufacturing for rail components. Phase III (year 3 to year 7) is the phase that local rail manufacturer may start producing rail bogie as well as rail compartment, which requires technology transfer from world-class rail manufacturer. Phase IV (year 6 to year 10) is the advance stage for local rail manufacturer. Rail technicians and engineers will have sufficient skills to design rail system while local manufacturer is able to produce more complex rail components. In the last phase (year 10 to year 14), rail technicians and engineers will be able to design and build entire locomotive and rolling stocks, while majorly rely on rail components manufactured domestically. This phase requires rail technology innovation which can be developed from technology transferred during phase IV. National design can be modified to better suit the operations and maintenance requirements.

From the mentioned timeframe, the conceptual structure of rail development masterplan can be written under two scenarios.

Scenario 1: the rail development masterplan is conducted "before" the legislation of the Department of Rail Transport. Therefore, SRT still owns all right of way and existing rail infrastructures. The conceptual structure, role and responsibilities of relevant agencies can be illustrated as in Figure 4.22.

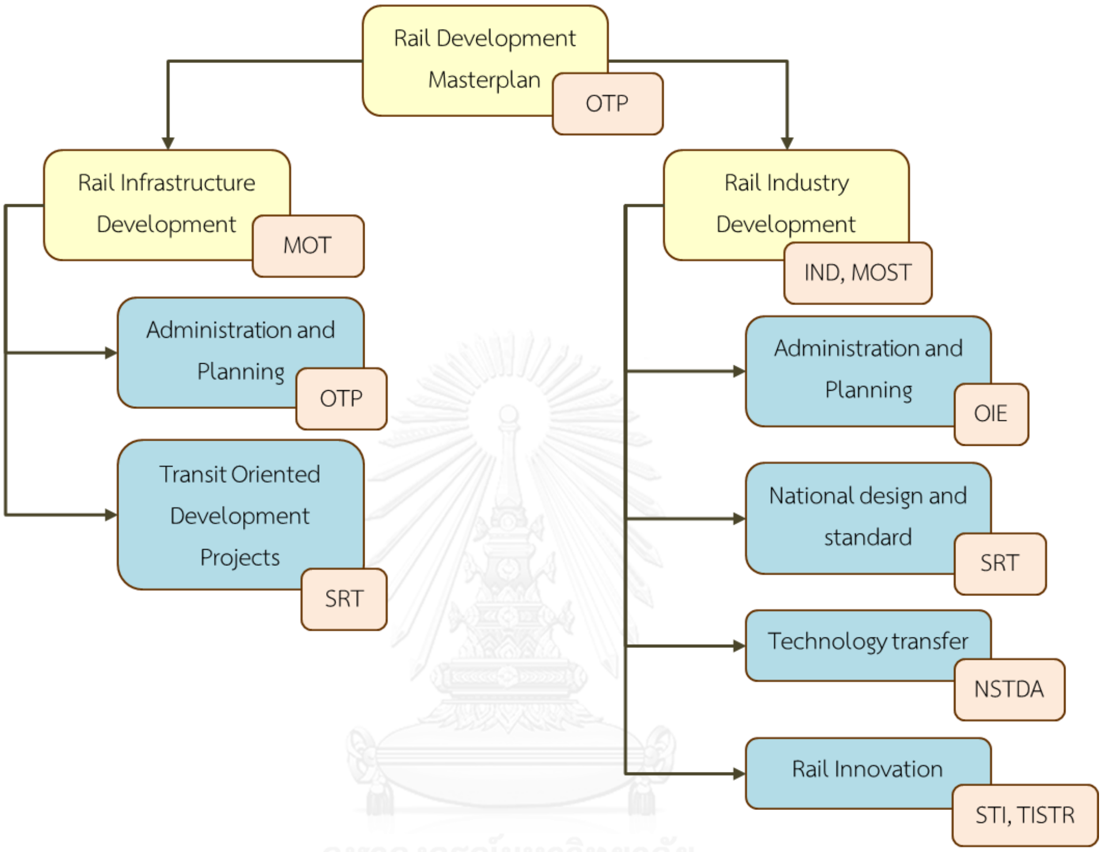


Figure 4.22 – Conceptual structure of railways development in Scenario 1

Scope and organization of rail development masterplan in this scenario can be written as follows.

1. Rail infrastructure and transit oriented development

The responsibility of overall administration and planning for current and future rail infrastructure development should be assigned to the Office of Transport and Traffic Policy and Planning since there is no mode regulator. For transit oriented development projects, the project owner, SRT, will have to determine projects' scope, plan, budget, as well as implementation.

2. Rail industry development

Collaboration in this section includes crafting national design, setting industrial standard for rail components, transferring technology from rail manufacturer. Office of Industrial Economics (OIE) should be responsible for drafting rail industry development plan. The Office of Transport and Traffic Policy and Planning and SRT have to jointly determine safety and material standard for rail components while Thai Industrial Standards Institute (TISI) can certify the industrial standard for rail components. Responsibility of National Science and Technology Development Agency (NSTDA) would be ensuring rail technology transfer from world-class rail manufacturers to the joint ventures that establish the rail manufacturing facility. Lastly, National Science Technology and Innovation Policy Office (STI) and Thailand Institute of Scientific and Technological Research (TISTR) should be in charge of innovation research and development for rail industry.

Scenario 2: the rail development masterplan is conducted "after" the legislation of the Department of Rail Transport. Therefore, the Department of Rail Transport will act as a national rail regulator. The conceptual structure, role and responsibilities of relevant agencies can be illustrated as in Figure 4.23.

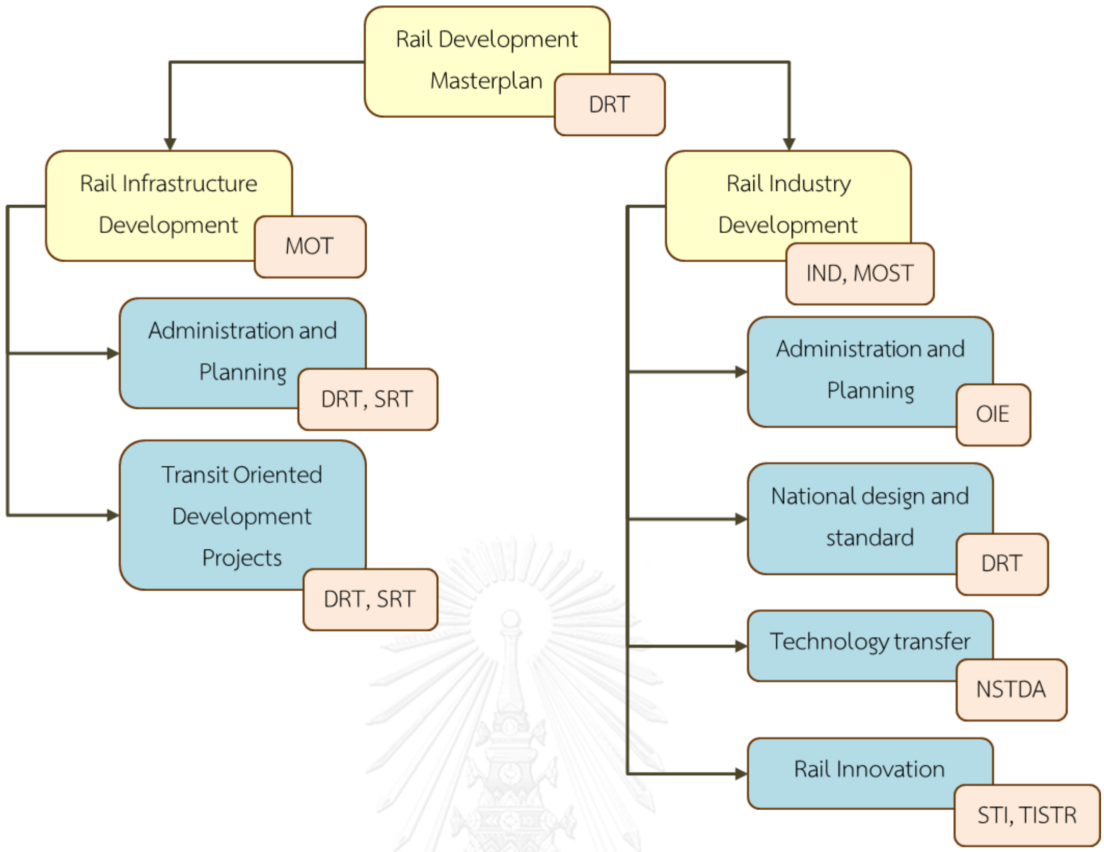


Figure 4.23 – Conceptual structure of railways development in Scenario 2

Scope and organization of rail development masterplan in this scenario can be written as follows.

1. Rail infrastructure and transit oriented development

The responsibility of overall administration and planning for current and future rail infrastructure development should be assigned to the Department of Rail Transport. For individual projects, SRT can manage railway projects in its right of way while the Department of Rail Transport regulates the non-SRT railway projects.

For transit oriented development projects, the project owner will have to determine project’s scope, plan, and budget. Should public-private partnership be implemented in any railway infrastructure project, the project owner will have to be responsible for transit oriented development.

2. Rail industry development

Collaboration in this section includes crafting national design, setting industrial standard for rail components, and transferring technology from rail manufacturer. Office of Industrial Economics should be responsible for drafting rail industry development plan. Department of Rail Transport has to determine safety and material standard for rail components while Thai Industrial Standards Institute can certify the industrial standard for rail components. Responsibility of National Science and Technology Development Agency would be ensuring rail technology transfer from world-class rail manufacturers to the joint ventures that establish the rail manufacturing facility. Lastly, National Science Technology and Innovation Policy Office and Thailand Institute of Scientific and Technological Research should be in charge of innovation research and development for rail industry.

Both scenarios were considered by five experts, who are respondents of collaboration assessment in the previous section. All respondents agreed that "Scenario 2" is more appropriate. The Department of Rail Transport will be the key success factor for the railway infrastructure development projects. The agency will act as a planner for rail development masterplan; an implementer for railway infrastructure development projects and transit oriented development projects; a safety and economic regulator for rail safety standards and rail transport business; and a promoter for rail transport investment.

CHAPTER 5

CONCLUSION

5.1 Conclusion

By using AHP and fuzzy AHP, leading dimensions and success factors affecting railway projects contributed to country's logistics platform were identified. The top five leading factors consist of factors in administration and economic dimension, namely rail development masterplan, transit oriented development, market development, public-private partnership opportunities, and Department of Rail Transport. Hence, it can be concluded that in order for the railway projects to become success, it is critical to establish large-scale, long-term and integrative plan. The masterplan should be based on both passenger and freight transport since the result, weight of transit oriented development, confirms that they cannot be developed independently. Market development for rail related products should be encourage. Public-private partnership should be the one of the prevalent investment option. Additionally, it is crucial to formally institute Department of Rail Transport as a regulator.

Researcher developed a collaboration model based on supply chain partnership model proposed by Lambert et al. (1996). Rail development masterplan was defined as collaboration outcome while Department of Rail Transport was defined as one of parties associated in the collaboration. Transit oriented development, market development, public-private partnership opportunities, and rail freight cost structure, which is the sixth leading success factors, were mapped into the collaboration model as drivers. By having representatives from associated government agencies and academia assessed the drivers and facilitators of the collaboration model, the level of collaboration and collaboration components were identified. To summarize, it is essential for all parties to jointly develop operating measures, plan, and eliminate conflicts. Each party should have willingness to help other gain. The commitment should be a longer-term relationship rather than specific project. Therefore, when establishing the rail development masterplan, each government agency should strengthen their relationships, make sure that communication among parties are sufficient, as well as review and redesign the standard operations approach to be more integrative to best support the collaboration.

5.2 Limitations and Further Research

There are several controlling circumstances applied to this research. First, in order for rail development projects to become success, the infrastructures (tracks, crossing signals, and telecommunication systems) have to be well maintained. Rolling stocks and spare parts must be sufficient, stocked, spared, and available for operations and usage at all time. Illegal crossings, which is the major cause of rail crashing accident, must be well taken care off and there should be sustainable solution to the issue. Second, this model excludes the discussion of political and transparency issues, which are the most sensitive areas and have always been one of the largest obstacles in rail development.

Since the quantitative methods used in this research are AHP and its extension, ANP can also be applied, like in the research of Lee et al. (2013). Some of cross-dimensional factors, for example, rail development masterplan (administration dimension) and transit oriented development (economic dimension); or transit oriented development and quality of life (social dimension), are unquestionably related. ANP would have identified such cross-dimensional relationships and yield substantially interesting results. Furthermore, this research focuses on rail development projects only in Thailand. However, the ASEAN Economic Corridor that started in January 2016 would link rail transportation between Thailand and countries in Indochina, and research scope can be further extended to cover all possible international connectivity.

The concept of transit oriented development can be transfigured to freight oriented development or cargo oriented development, as proposed by Center for Neighborhood Technology in United States. The cluster of warehouses, distribution centers, and freight yards nearby the train stations would both support and promote the use of rail freight transport. Research on how associated organizations should adopt and adapt the concept of cargo oriented development into rail transport as well as the possibility of such application to success are considered a blue ocean for Thai rail systems.

5.3 Recommendation

It is recommended that rail development masterplan should comprise infrastructure and industry development planning, with public-private partnership as an implementation option. The masterplan should be hosted by the Department of Rail Transport. Administration and planning for railway infrastructure development should be hosted by both Department of Rail Transport for the future projects, and SRT for existing projects. Owner of railway infrastructure development project will be responsible for concurrent transit oriented development's implementation. Combining the masterplan with the national design and the rail industry development plan in five phases would provide a clear steering direction for rail development for the next two decades. Since the Department of Rail Transport is the key to success factor in the masterplan, legislation of the agency is very crucial and should be completed at earliest to formally initiate the masterplan.

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APPENDICES

APPENDIX A

แบบสอบถาม เรื่อง ปัจจัยความสำเร็จที่มีผลกระทบต่อโครงการก่อสร้างรถไฟทางคู่และทางรถไฟสายใหม่เพื่อสนับสนุนฐานโลจิสติกส์ของประเทศ

แบบสอบถามชุดนี้มีจุดประสงค์เพื่อสำรวจความคิดเห็นของท่านที่มีต่อปัจจัยความสำเร็จที่มีผลกระทบต่อโครงการก่อสร้างรถไฟทางคู่และทางรถไฟสายใหม่เพื่อสนับสนุนฐานโลจิสติกส์ของประเทศไทย ผู้วิจัยได้กำหนดมิติ (Dimension) ของแบบจำลองจำนวน 5 ด้าน ซึ่งประกอบด้วยเกณฑ์การตัดสินใจ (Criteria) ของปัจจัยความสำเร็จที่มีผลกระทบต่อโครงการฯ จำนวน 24 ข้อ โดยในแบบสอบถามจะเป็นการให้คะแนนความสำคัญเปรียบเทียบ (Relative importance) ของแต่ละมิติและเกณฑ์การตัดสินใจ การประเมินผลจะดำเนินการด้วยกระบวนการลำดับชั้นเชิงวิเคราะห์ (Analytical Hierarchy Process: AHP)

ขอขอบคุณเป็นอย่างสูงสำหรับความร่วมมือ

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ข้อมูลทั่วไป

วันที่ตอบแบบสอบถาม (วว/ดด/ปปปป): ....

ลักษณะงาน:
( ) หน่วยงานราชการ
( ) อาจารย์มหาวิทยาลัย/ นักวิชาการ/ นักวิจัย
( ) หน่วยงานเอกชน
    ( ) ที่ปรึกษาโครงการ
    ( ) ธุรกิจก่อสร้าง
    ( ) ผู้ให้บริการขนส่ง
    ( ) ผู้ผลิตรถไฟและระบบรถไฟ
    ( ) ผู้ผลิต/ผู้แทนจำหน่ายสินค้าระบบราง
    ( ) อื่นๆ โปรดระบุ:..

ประสบการณ์ทำงาน (ปี): ....

ตำแหน่งงาน:
( ) ระดับบริหาร (ระดับเชี่ยวชาญ/ทรงคุณวุฒิ หรือตำแหน่งด้านอำนวยการ หรือบริหารสำหรับข้าราชการ)
( ) ระดับผู้จัดการ (ระดับชำนาญการและชำนาญการพิเศษ สำหรับข้าราชการ)
( ) ระดับปฏิบัติการ (ระดับปฏิบัติการ สำหรับข้าราชการ)
( ) อื่นๆ (เช่น ตำแหน่งวิชาการ) โปรดระบุ: ....

ระดับความสำคัญเปรียบเทียบ

ปัจจัยใน AHP จะมีระดับความสำคัญเปรียบเทียบ 9 ระดับ โดยค่าตัวเลขจะแสดงว่าปัจจัยใดที่มีอิทธิพลเหนือกว่า และมีอิทธิพลเหนือกว่าคิดเป็นกี่เท่า โดยเปรียบเทียบจากเกณฑ์ที่ทั้งสองปัจจัยมีร่วมกัน โดยมีรายละเอียดดังนี้

9 – มีอิทธิพลขั้นสูงสุด	ปัจจัยหนึ่งมีอิทธิพลเหนือปัจจัยคู่เปรียบเทียบคิดเป็น 9 เท่า เมื่อเทียบกับปัจจัยอื่น
8 – มีอิทธิพลขั้นสูงมากถึงสูงสุด	ปัจจัยหนึ่งมีอิทธิพลเหนือปัจจัยคู่เปรียบเทียบคิดเป็น 8 เท่า เมื่อเทียบกับปัจจัยอื่น
7 – มีอิทธิพลขั้นสูงมาก	ปัจจัยหนึ่งมีอิทธิพลเหนือปัจจัยคู่เปรียบเทียบคิดเป็น 7 เท่า เมื่อเทียบกับปัจจัยอื่น
6 – มีอิทธิพลขั้นสูงถึงสูงมาก	ปัจจัยหนึ่งมีอิทธิพลเหนือปัจจัยคู่เปรียบเทียบคิดเป็น 6 เท่า เมื่อเทียบกับปัจจัยอื่น
5 – มีอิทธิพลขั้นสูง	ปัจจัยหนึ่งมีอิทธิพลเหนือปัจจัยคู่เปรียบเทียบคิดเป็น 5 เท่า เมื่อเทียบกับปัจจัยอื่น
4 – มีอิทธิพลปานกลางถึงสูง	ปัจจัยหนึ่งมีอิทธิพลเหนือปัจจัยคู่เปรียบเทียบคิดเป็น 4 เท่า เมื่อเทียบกับปัจจัยอื่น
3 – มีอิทธิพลปานกลาง	ปัจจัยหนึ่งมีอิทธิพลเหนือปัจจัยคู่เปรียบเทียบคิดเป็น 3 เท่า เมื่อเทียบกับปัจจัยอื่น
2 – ค่อนข้างมีอิทธิพล	ปัจจัยหนึ่งมีอิทธิพลเหนือปัจจัยคู่เปรียบเทียบคิดเป็น 2 เท่า เมื่อเทียบกับปัจจัยอื่น
1 – มีอิทธิพลเท่าเทียมกัน	ปัจจัยหนึ่งมีอิทธิพลเท่ากับปัจจัยคู่เปรียบเทียบ

ผู้วิจัยได้ดำเนินการทบทวนวรรณกรรมและค้นพบปัจจัยที่มีผลกระทบต่อการดำเนินโครงการประเภทขนส่งโครงการก่อสร้างและพัฒนาโครงสร้างพื้นฐาน ตลอดจนปัจจัยที่มีผลกระทบต่อการขนส่งด้วยระบบราง รวมจำนวน 24 ปัจจัย โดยสามารถแบ่งปัจจัยออกเป็น 5 มิติ ได้แก่ ฐานโลจิสติกส์ สังคม การบริหารจัดการ (ซึ่งครอบคลุมปัจจัยด้านการเมืองและนโยบาย) และเทคนิค ซึ่งขอบเขตของงานวิจัย ครอบคลุมโครงการก่อสร้างรถไฟทางคู่ 14 โครงการ โครงการก่อสร้างทางรถไฟสายใหม่ของ รฟท. 3 โครงการ โครงการก่อสร้างทางรถไฟขนาดมาตรฐานภายใต้ความร่วมมือของรัฐบาลไทย – จีน และ โครงการก่อสร้างทางรถไฟ รางขนาด 1 เมตร ภายใต้ความร่วมมือของรัฐบาลไทย – ญี่ปุ่น ทั้งนี้ ปัจจัยทั้งหมดอยู่ภายใต้สมมติฐานว่าโครงสร้างพื้นฐานของระบบราง (ราง ระบบอาณัติสัญญาณ สื่อสาร โทรคมนาคม) ต้องอยู่ในสภาพสมบูรณ์ รถจักรและล้อเลื่อนต้องมีการบำรุงรักษาให้อยู่ในสภาพพร้อมใช้งาน อะไหล่ต้องมีการสำรองและวางแผนสำรองไว้ล่วงหน้าอย่างรัดกุม รวมถึงต้องมีการแก้ไขปัญหาจุดตัดและทางลักผ่านอย่างมีประสิทธิภาพและยั่งยืน

วิธีตอบแบบสอบถาม

ตัวอย่างที่ 1:

แบบสอบถามในแต่ละแถวจะมีปัจจัย 2 ข้อ อยู่ในช่องซ้ายสุดและขวาสุด (“เชื่อมโยงโครงข่าย” และ “ขนส่งยั่งยืน” ตามลำดับ ซึ่งเป็นส่วนหนึ่งของมิติ “ฐานโลจิสติกส์”

“มิติฐานโลจิสติกส์”

เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน

<u>ขั้นที่ 1:</u> ระบุว่าระหว่างปัจจัย “เชื่อมโยงโครงข่าย” กับ “ขนส่งยั่งยืน” ข้อใดมีอิทธิพลต่อฐานโลจิสติกส์มากกว่า ในกรณีนี้ สมมติให้ “ขนส่งยั่งยืน” มีอิทธิพลต่อ “ฐานโลจิสติกส์”มากกว่า “เชื่อมโยงโครงข่าย” ให้เลือก (วงกลมหรือ Highlight) “ขนส่งยั่งยืน”

“มิติฐานโลจิสติกส์”

เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน

<u>ขั้นที่ 2:</u> ประเมินว่า “ขนส่งยั่งยืน” มีอิทธิพลต่อฐานโลจิสติกส์มากกว่า “เชื่อมโยงโครงข่าย” คิดเป็นกี่เท่า โดยใช้ระดับตัวเลขระหว่าง 2 ถึง 9 ในกรณีนี้ สมมติให้ “ขนส่งยั่งยืน” มีอิทธิพลต่อ“ฐานโลจิสติกส์” มากกว่า “เชื่อมโยงโครงข่าย” ในระดับ 5 ให้เลือก (วงกลมหรือ Highlight) หมายเลข 5 ในด้านขวา

“มิติฐานโลจิสติกส์”

เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน

ตัวอย่างที่ 2:

ในกรณีที่ปัจจัยทั้งสองมีอิทธิพลต่อมิติ “ฐานโลจิสติกส์” เท่าเทียมกัน ให้เลือกระดับ 1

“มิติฐานโลจิสติกส์”

เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน

ส่วนที่ 1 : ความสำคัญเปรียบเทียบระหว่างมิติและปัจจัย

แบบสอบถามส่วนนี้เกี่ยวข้องกับความสำคัญเชิงเปรียบเทียบระหว่างมิติ 5 ด้าน (ฐานโลจิสติกส์ เศรษฐกิจ สังคม การบริหารจัดการ และเทคนิค) และปัจจัย 24 ข้อ โดยเป็นการประเมินความสำเร็จที่มีผลกระทบต่อโครงการก่อสร้างรถไฟทางคู่และทางรถไฟสายใหม่เพื่อสนับสนุนฐานโลจิสติกส์ของประเทศไทย

ให้ระบุว่าระหว่าง มิติ หรือ ปัจจัย ข้อใดมีความสำคัญในการตัดสินใจในโครงการก่อสร้างรถไฟทางคู่และทางรถไฟสายใหม่เพื่อสนับสนุนฐานโลจิสติกส์ของประเทศ โดยเลือกระดับตัวเลขของความสำคัญเปรียบเทียบระหว่าง 1 – 9

a1	มิติ	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ปัจจัย

ส่วนที่ 2 : ความสำคัญเปรียบเทียบระหว่างมิติทั้งหมดโดยสมมติว่ามีความสัมพันธ์ระหว่างกัน

แบบสอบถามส่วนนี้เกี่ยวข้องกับความสำคัญเชิงเปรียบเทียบระหว่างมิติทั้งหมดโดยสมมติว่ามีความสัมพันธ์ระหว่างกัน โดยเป็นการประเมินความสำเร็จที่มีผลกระทบต่อโครงการก่อสร้างรถไฟทางคู่และทางรถไฟสายใหม่เพื่อสนับสนุนฐานโลจิสติกส์ของประเทศไทย

คำถามที่ (1): เกี่ยวกับการประเมินการประเมินความสำเร็จที่มีผลกระทบต่อโครงการก่อสร้างรถไฟทางคู่และทางรถไฟสายใหม่เพื่อสนับสนุนฐานโลจิสติกส์ของประเทศไทย ให้เลือกมิติที่มีอิทธิพลเหนือกว่า โดยใช้ระดับตัวเลขของความสำคัญเปรียบเทียบระหว่าง 1 – 9

a2	ฐานโลจิสติกส์	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	เศรษฐกิจ
a3	ฐานโลจิสติกส์	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สังคม
a4	ฐานโลจิสติกส์	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	การบริหารจัดการ
a5	ฐานโลจิสติกส์	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	เทคนิค
a6	เศรษฐกิจ	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สังคม
a7	เศรษฐกิจ	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	การบริหารจัดการ
a8	เศรษฐกิจ	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	เทคนิค
a9	สังคม	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	การบริหารจัดการ
a10	สังคม	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	เทคนิค
a11	การบริหารจัดการ	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	เทคนิค

ส่วนที่ 3: ความสำคัญเปรียบเทียบระหว่างปัจจัยทั้งหมดตามมิติของปัจจัยนั้นๆ

แบบสอบถามส่วนนี้เกี่ยวข้องกับความสำคัญเปรียบเทียบระหว่างปัจจัยทั้งหมดตามมิติของปัจจัยนั้นๆ

คำถามที่ (2): เกี่ยวกับการประเมินความสำคัญเปรียบเทียบของปัจจัยทั้งหมดภายในมิติ “ฐานโลจิสติกส์”

(ฐานโลจิสติกส์)

a12	เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งต่อเนื่อง
a13	เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	โลจิสติกส์ข้ามแดน
a14	เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	โครงสร้างต้นทุน
a15	เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สิ่งอำนวยความสะดวก
a16	เชื่อมโยงโครงข่าย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน
a17	ขนส่งต่อเนื่อง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	โลจิสติกส์ข้ามแดน
a18	ขนส่งต่อเนื่อง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	โครงสร้างต้นทุน
a19	ขนส่งต่อเนื่อง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สิ่งอำนวยความสะดวก
a20	ขนส่งต่อเนื่อง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน
a21	โลจิสติกส์ข้ามแดน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	โครงสร้างต้นทุน
a22	โลจิสติกส์ข้ามแดน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สิ่งอำนวยความสะดวก
a23	โลจิสติกส์ข้ามแดน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน
a24	โครงสร้างต้นทุน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สิ่งอำนวยความสะดวก
a25	โครงสร้างต้นทุน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน
a26	สิ่งอำนวยความสะดวก	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ขนส่งยั่งยืน

คำถามที่ (3): เกี่ยวกับการประเมินความสำคัญเปรียบเทียบของปัจจัยทั้งหมดภายในมิติ “เศรษฐกิจ”

(เศรษฐกิจ)

a27	TOD	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	การลงทุนของต่างชาติ
a28	TOD	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	การพัฒนาตลาด
a29	TOD	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	PPP
a30	การลงทุนของต่างชาติ	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	การพัฒนาตลาด
a31	การลงทุนของต่างชาติ	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	PPP
a32	การพัฒนาตลาด	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	PPP

คำถามที่ (4): เกี่ยวกับการประเมินความสำคัญเปรียบเทียบของปัจจัยทั้งหมดภายในมิติ “สังคม”

(สังคม)

a33	โอกาสจ้างงาน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	คุณภาพชีวิต
a34	โอกาสจ้างงาน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สวัสดิการสังคม
a35	โอกาสจ้างงาน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สวัสดิภาพ
a36	คุณภาพชีวิต	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สวัสดิการสังคม
a37	คุณภาพชีวิต	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สวัสดิภาพ
a38	สวัสดิการสังคม	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	สวัสดิภาพ

คำถามที่ (5): เกี่ยวกับการประเมินความสำคัญเปรียบเทียบของปัจจัยทั้งหมดภายในมิติ “การบริหารจัดการ”

(การบริหารจัดการ)

a39	กรมการขนส่งทางราง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ผู้ให้บริการหลายราย
a40	กรมการขนส่งทางราง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	แผนแม่บท
a41	กรมการขนส่งทางราง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ประเภทการลงทุน
a42	กรมการขนส่งทางราง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รฟท.
a43	กรมการขนส่งทางราง	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รัฐบาลอื่น
a44	ผู้ให้บริการหลายราย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	แผนแม่บท
a45	ผู้ให้บริการหลายราย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ประเภทการลงทุน
a46	ผู้ให้บริการหลายราย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รฟท.
a47	ผู้ให้บริการหลายราย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รัฐบาลอื่น
a48	แผนแม่บท	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ประเภทการลงทุน
a49	แผนแม่บท	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รฟท.
a50	แผนแม่บท	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รัฐบาลอื่น
a51	ประเภทการลงทุน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รฟท.
a52	ประเภทการลงทุน	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รัฐบาลอื่น
a53	รฟท.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	รัฐบาลอื่น

คำถามที่ (6): เกี่ยวกับการประเมินความสำคัญเปรียบเทียบของปัจจัยทั้งหมดภายในมิติ “เทคนิค”

(เทคนิค)

a54	ความปลอดภัย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	พัฒนาบุคลากร
a55	ความปลอดภัย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ศูนย์กลาง R&D
a56	ความปลอดภัย	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	เชื่อถือได้
a57	พัฒนาบุคลากร	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	ศูนย์กลาง R&D
a58	พัฒนาบุคลากร	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	เชื่อถือได้
a59	ศูนย์กลาง R&D	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	เชื่อถือได้

APPENDIX B

การประเมินระดับความร่วมมือสำหรับแผนแม่บทเพื่อพัฒนาการขนส่งระบบราง

จากการประเมินปัจจัยความสำเร็จที่มีผลกระทบต่อโครงการก่อสร้างรถไฟทางคู่และทางรถไฟสายใหม่เพื่อสนับสนุนฐานโลจิสติกส์ของประเทศไทย จำนวน 24 ปัจจัย ด้วยกระบวนการลำดับชั้นเชิงวิเคราะห์ความคลุมเครือ ผู้วิจัยพบว่าปัจจัยที่มีความสำคัญ 6 ลำดับแรก ประกอบด้วย

ลำดับความสำคัญ	ปัจจัย	ค่าน้ำหนัก
1	แผนแม่บทเพื่อพัฒนาการขนส่งระบบราง	0.090776
2	Transit oriented development (TOD)	0.081562
3	การพัฒนาตลาดที่เกี่ยวกับระบบราง	0.074097
4	โอกาสของ Public-Private Partnership	0.073269
5	กรมการขนส่งทางราง	0.062664
6	โครงสร้างต้นทุนขนส่งสินค้าทางราง	0.056647

ผู้วิจัยจึงมีความสนใจประเมินระดับความร่วมมือเพื่อจัดทำแผนแม่บทเพื่อพัฒนาการขนส่งระบบราง จากภาคส่วนที่เกี่ยวข้อง โดยพัฒนาแบบจำลองความร่วมมือซึ่งมีรากฐานมาจากแบบจำลองความเป็นหุ้นส่วนของ Douglas E. Lambert และให้สมมติฐานว่าปัจจัยลำดับที่ 2, 3, 4, 6, และ 7 จะเป็นแรงผลักภายใต้ความร่วมมือฯ โดยมีภาคส่วนที่เกี่ยวข้องกับการจัดทำแผนแม่บทฯ ดังนี้

~ กระทรวงคมนาคม
- กรมการขนส่งทางราง
- การรถไฟแห่งประเทศไทย
- สำนักงานนโยบายและแผนการขนส่งและจราจร

} หน่วยงานเจ้าภาพ

~ สำนักงานคณะกรรมการพัฒนาการเศรษฐกิจและสังคมแห่งชาติ
~ สำนักงบประมาณ
~ กระทรวงการคลัง

} ผู้ให้การสนับสนุนและให้ความเห็นกับแผนแม่บทฯ

ทั้งนี้ การประเมินแรงผลักและแรงสนับสนุนในแบบจำลอง จะสามารถระบุระดับความร่วมมือที่เป็นไปได้ รวมถึงรายละเอียดต่างๆ ขององค์ประกอบ สำหรับกำหนดหลักเกณฑ์และวิธีปฏิบัติเพื่อนำไปสู่ผลลัพธ์ที่ต้องการต่อไป

ผู้วิจัยขอขอบคุณสำหรับความร่วมมือของท่านมา ณ โอกาสนี้

ส่วนที่ 1 การประเมินแรงผลัก

ให้เลือกระดับความน่าจะเป็นที่ตรงตามความเห็นของท่านมากที่สุดเพียงข้อเดียว

	ความน่าจะเป็น				
	ไม่มีโอกาส				แน่นอน
Transit Oriented Development (TOD)	0%	25%	50%	75%	100%
1. ความน่าจะเป็นที่ความร่วมมือตามแบบจำลองนี้จะทำให้แผนงานและการดำเนินการที่เกี่ยวข้องกับ TOD ประสบความสำเร็จ เท่ากับเท่าใด? - การวางแผน พัฒนาและดำเนินโครงการ - การสนับสนุนจากระดับบริหาร - กฎและระเบียบที่เกี่ยวข้อง	1	2	3	4	5

	ความน่าจะเป็น				
	ไม่มีโอกาส				แน่นอน
การพัฒนาตลาดที่เกี่ยวกับระบบราง	0%	25%	50%	75%	100%
2. ความน่าจะเป็นที่ความร่วมมือตามแบบจำลองนี้จะส่งเสริมและสนับสนุนให้มีการพัฒนาตลาดที่เกี่ยวกับระบบรางอย่างกว้างขวาง เท่ากับเท่าใด? - ประเภทของอุตสาหกรรมและผลิตภัณฑ์ - ความสามารถและวิสัยสามารถของการผลิต - อุปสงค์ของตลาด - แรงงานที่มีทักษะ	1	2	3	4	5

	ความน่าจะเป็น				
	ไม่มีโอกาส				แน่นอน
โครงสร้างต้นทุนขนส่งสินค้าทางราง	0%	25%	50%	75%	100%
3. ความน่าจะเป็นที่ความร่วมมือตามแบบจำลองนี้จะทำให้เกิดการเปลี่ยนแปลงโครงสร้างต้นทุนขนส่งสินค้าทางรางในระดับสูง เท่ากับเท่าใด? - ความต้องการขนส่งสินค้าทางราง - สภาพของล้อเลื่อนที่พร้อมและเพียงพอใช้งาน - การนำให้สินทรัพย์ด้านรางไปใช้ประโยชน์	1	2	3	4	5

	ความน่าจะเป็น				
	ไม่มีโอกาส				แน่นอน
โอกาสของ Public-Private Partnership (PPP)	0%	25%	50%	75%	100%
4. ความน่าจะเป็นที่ความร่วมมือตามแบบจำลองนี้จะทำให้แผนงานและการดำเนินการที่เกี่ยวข้องกับ PPP ประสบความสำเร็จ เท่ากับเท่าใด ? - การตั้งต้น นำเสนอและประเมินโครงการ - องค์ประกอบและบทบาทของคณะกรรมการ PPP - เกณฑ์วิธีที่เกี่ยวข้อง	1	2	3	4	5

คะแนนรวม

ส่วนที่ 2 การประเมินแรงสนับสนุน

แรงสนับสนุนหลัก: ให้เลือกระดับความน่าจะเป็นที่ตรงตามความเห็นของท่านมากที่สุดเพียงข้อเดียว

	ความน่าจะเป็น				
	ไม่มีโอกาส				แน่นอน
ความเข้ากันได้	0%	25%	50%	75%	100%
1. ความน่าจะเป็นที่ทุกภาคส่วนในแบบจำลองความร่วมมือนี้ จะทำงานร่วมกันอย่างราบรื่น เท่ากับเท่าใด? - จุดประสงค์มีความสอดคล้องต้องกัน - ผู้มีส่วนเกี่ยวข้องภายนอกมีความสำคัญ - แผนกลยุทธ์และวัตถุประสงค์มีความสอดคล้องต้องกัน - มีพันธสัญญาในความร่วมมือ - มีความต้องการที่จะเปลี่ยนแปลง	1	2	3	4	5

	ความน่าจะเป็น				
	ไม่มีโอกาส				แน่นอน
ปรัชญาและเทคนิคการจัดการ	0%	25%	50%	75%	100%
2. ความน่าจะเป็นที่ปรัชญาและเทคนิคการจัดการของทุกภาคส่วนในแบบจำลองความร่วมมือนี้ จะเข้ากันได้อย่างราบรื่น เท่ากับเท่าใด? - โครงสร้างองค์กร - พันธสัญญาที่จะปรับปรุงให้ก้าวหน้าอย่างต่อเนื่อง - ระดับการสนับสนุนจากผู้บริหาร - ความสำคัญของการทำงานเป็นกลุ่ม - ระดับของการกระจายอำนาจให้เจ้าหน้าที่	1	2	3	4	5

	ความน่าจะเป็น				
	ไม่มีโอกาส				แน่นอน
ความสัมพันธ์ร่วมกัน	0%	25%	50%	75%	100%
3. ความน่าจะเป็นที่ทุกภาคส่วนในแบบจำลองความร่วมมือนี้ จะมีทักษะและความทุ่มเทที่จำเป็นต่อการสร้างความสัมพันธ์ร่วมกัน เท่ากับเท่าใด? - การแบ่งปันข้อมูลและสาร - ระบบแบบบูรณาการ - เข้าใจและใช้มุมมองของภาคส่วนอื่นในการทำงาน - ใช้มุมมองการทำงานแบบระยะยาว	1	2	3	4	5

	ความน่าจะเป็น				
	ไม่มีโอกาส				แน่นอน
ความสมมาตร	0%	25%	50%	75%	100%
4. ความน่าจะเป็นที่ทุกภาคส่วนในแบบจำลองความร่วมมือนี้ มีปัจจัยสำคัญซึ่งส่งผลต่อความสำเร็จของความร่วมมือที่คล้ายคลึงกัน เท่ากับเท่าใด? - ผลิตภาพ / ความสามารถในการทำงานให้ประสบผลสำเร็จ - ความซับซ้อนของเทคโนโลยี	1	2	3	4	5

แรงสนับสนุนรอง: ให้เลือกคำตอบว่าใช่ หรือ ไม่ใช่ เพียงข้อใดข้อหนึ่งเท่านั้น

	ใช่	**ไม่ใช่**
5. ทุกภาคส่วนที่เกี่ยวข้องเคยมีประสบการณ์ดำเนินความร่วมมือในลักษณะเดียวกันกับความร่วมมือในแบบจำลองนี้ จนได้รับผลสำเร็จ	1	0
	ใช่	**ไม่ใช่**
6. ผู้มีบทบาทหลักในทุกภาคส่วนที่เกี่ยวข้องมีความใกล้ชิดกันในเชิงกายภาพ	1	0
	ใช่	**ไม่ใช่**
7. แต่ละภาคส่วนมีความสนใจที่จะร่วมมือระหว่างกันเป็นพิเศษ	1	0
	ใช่	**ไม่ใช่**
8. ทุกภาคส่วนที่เกี่ยวข้องมีผู้ใช้ขั้นปลายที่มีมูลค่าสูง (high value end user) ร่วมกัน	1	0

คะแนนรวม [ ]

VITA

Waralee Peetawan received Bachelor of Science in Management Technology from Sirindhorn International Institute of Technology with first class honor and Bhumibol scholarship award fund in 2007. She was granted a Royal Thai Scholarship and received Master of Business of Logistics Engineering from the Ohio State University, United States in 2010. Her professional experiences includes plan and policy analyst on rail transport at Office of Permanent Secretary, Ministry of Transport. She is interested in transport and logistics research. Her past publications are sugar logistics mathematical model analysis and the electrified light metro used in Winter Olympic 2014.