Freight transport in least developed landlocked countries: a case study of Laos PDR

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Abstract

Least developed landlocked countries' freight transport has been a step slower than other countries in the world trading market. While many research studies and international organisations report on landlocked countries' situation and issues but few explain the causes of the problem and the relationships between the factors. Moreover, there have been few comprehensive studies in which several solutions and policy implementations have been investigated to determine the best result. This research was aimed at identifying general problems by structuring a traditional causal loop diagram to present the key problems and relationships based on the previous studies' resources. The research used qualitative data collection to increase understanding of stakeholders' experiences and transport policy solutions. Thus, Laos was chosen as a typical case study, where its trade was obstructed by it being landlocked. The primary factors found through qualitative data collection were represented on a model that identifies the key dynamic factors within specific groups. The most concerning policy was chosen to formalise a dynamic hypothesis and set up a new hypothesis for an alternative solution. The research's results show the causal loop diagram has presented a better view of the structure and overall connection among themes. The fieldwork information represents complex real-world factors and causes that have effectively suggested small details that might be more important than seeing factors. Where the stock and flow model gave a better understanding of how dynamic freight transport system behaviours changed through the policy, it confirmed that cooperation among internal sectors and cooperation between landlocked countries and their transit neighbours is a primary approach to developing least developed landlocked countries' freight operations.

Contents

List of Tables

List of Figures

List of Abbreviations

ADB	Asian development bank
ASEAN	Association of Southeast Asian nations
BC	Border charge
BOD	Border opening day
BCT	Border crossing time
BCTL	Border crossing time limitation
BOH	Border opening hour
BPT	Border processing time
BTU	Border technological upgrade
BPR	Border processing rate
BPDP	Border technological upgrade (Policy)
BPP	Border processing procedure
BTUC	Border technological upgrade construction time
CLD	Causal loop diagram
DPC	Dry port charge
DPPT	Dry port processing time
DPCT	Dry port construction time
DPO	Dry port operation
DPOP	Dry port operation (Policy)
EE	Estimates of elasticity
FC (t)	Freight transport generalized cost in year time
FC (t-1)	Freight transport generalized cost in year time-1
GL_CLD	General least developed landlocked countries causal loop diagram
IBOP	Increase Border
IBOC	Increase Border opening time construction time
IBO	Increase Border opening time

JICA	Japan international cooperation agency
LLDC	Landlocked developing country
LDC	Less developed country
LDLC	Least developed landlocked country
LOPI	Laos' official port input
LOA	Laos' official available
LOPI	Official time rate
LOIQ	Laos' official input quota
LOVAP	Laos' official in the Vung Ang port
LOVP	Laos official agent at Vung Ang port (Policy)
LOVC	Laos official agent at Vung Ang port construction time
LOV	Laos official agent at Vung Ang port
NOB	Number of officials at the border
P	Percentage
PD	Port delay
PLC	Port lane capacity
PWTR	Port waiting time reduction
PWTL	Port waiting time limitation
PWT	Port waiting time
PPT	Port processing time
PT	Port time
PC	Port charge
PSC	Port storage cost
PCC	Percent cost change
PTC	Percent truck change
MPWT	Ministry of Public Works and Transport
NBPT	Neighbour border processing time
NBWT	Neighbour border waiting time

NBCT	Neighbour border crossing time
OI	Official input
OIQ	Official input quota
OO	Official out
OOQ	Official out quota
SD	System dynamics
SDM	System dynamics model
SFD	Stock and flow diagram
SFM	Stock and flow model
ST	Smooth time
TBD	Daily truck crossing Na Khao border per day
TTCB	Travel time from central Vientiane (warehouse) to border
TTBP	Travel time from border to port
TNC	Truck number change
TC	Time cost
TTC	Travel time cost
TT	Travel time
TI	Truck increasing
TV	Truck volume
TTT	Total travel time
TR	Truck rate
UN	United Nation
VAP_CLD	Vung Ang port causal loop diagram
WTDP	Waiting time for border processing
WHRC	Warehouse rate cost
Y	Year

Chapter 1 Introduction

1.1 Introduction

Over the past period, despite an increase of transport and trade through international markets, a research that observed the landlocked countries experience transport disadvantages when compared to their maritime neighbours in terms of freight and timely deliveries was studied (Faye et al.). As these landlocked countries do not have territorial access to the sea, not having their own port affects their income, especially in Asia and Africa, as export and import are significant factors in developing their economy.

Each landlocked country has its own issues it faces with each neighbour negotiation, including different transport policies and many overlapping agreements. So far, no research has been done to find stronger evidence on how each issue relates to another (Forrester, 1995) , what the effects are regarding generic landlocked countries' transport issues, or solutions that can be applied to any landlocked countries with the aim of reducing transport costs, providing on time delivery despite complicated documentation in each transit pass, and gaining more power over neighbour ports.

Up until now, landlocked countries have tried to improve negotiations with their transit countries. In addition, some landlocked countries have tried to solve their problems and change their strategies by becoming land linking countries and providing important transit services to their transit neighbours. Lao PDR is a landlocked country that introduced a new policy strategy to change from a landlocked country to a land linking country in Southeast Asia. Moreover, this strategy can benefit all Southeast Asia regions in increasing the efficiency of transit transport. Thus, research has tended to focus on transport in Laos as one of the case studies to apply the new system dynamic model and analyse the best transport policy solution.

With the advances of system dynamics, it is possible to find the critical issues in transport that relate to other factors, and it is possible to find the main problems and improve the policy by reducing transport costs, maintaining on time delivery, and improving the complicated documentation in each transport process. Additionally, this would aid landlocked countries to gain power and

control over neighbouring ports and produce specific solutions that can be applied to any country in the same situation.

Continued from above, system dynamics is the method that has been selected to solve the research problems. Previously, to create the best solution for the case study, the system dynamic models are faster and require less data. These models have the additional advantage of incorporating connections and feedback among transport and land use with same view supported by De Jong et al. (2004). In practice, however, a method that directly forecasts the policy analysis needs knowledge to develop the complex analysis; thus, the research has followed the systems thinking and modeling technique by Sterman (2000) and applied in the Laos transport case study model by Vensim software.

There is a need to indicate common transport problems from different landlocked countries and study their individual solutions. This research will guide the reader to understand the landlocked countries' disadvantages in terms of transport with particular situations in individual regions. It will also identify reasons that affect generic landlocked countries' transport and help develop new methods from a system dynamic model for analysing landlocked countries' transport. Additionally, the research will select transport policies while giving the general policy recommendation for the particular case, especially for freight transport policies.

To accomplish those aims, this research describes the existing knowledge in several chapters by reviewing the theoretical and historical data of landlocked countries' transport, which is important information that will help readers understand the landlocked country's situation and background. Following that, the paper will illustrate a causal loop diagram with the intention of representing the causes from the data collection and literature review, which is the first step to setting up the system dynamic model.

1.2 Research objectives

The goal of this research is to generate a systematic understanding of least developed landlocked countries' freight transport problems. The following objectives are pursued:

- **Create a high-level causal loop diagram to identify factors that influence freight transport for least developed landlocked countries**

The freight transport problem in a less developed landlocked country (LDLC) is conceptualised as a complex system behaviour covering policy, geographical problems, economy, regional agreement, and more. The aim is to understand the behaviour and the connection between them.

As suggested by Sterman and John (2000), to identify the system behaviour, the research used a traditional causal loop diagram to present key problematic causal relationships and used document review as the main data to develop the complex system into a causal loop diagram (CLD).

- **Determine the factors that influence Lao transport and their relationship with one another using a case study of Vung Ang port.**

To understand more about least developed landlocked countries, this research adopts a qualitative study, following the suggestions of Musselwhite et al. (2012) and Tetali et al. (2013) and uses comprehensive literature in a particular area (Laos).

- **Develop a causal loop diagram to determine the effectiveness of Vung Ang port**

Continuing from second objective, by develop model to represent the data from qualitative study in a traditional model diagram. The CLD represents the slim down GL_CLD structure from the first objective combined with new factors from objective two, which represents the interaction with each other and generates system behaviour in VAP_CLD.

- **Implement a policy on system dynamic model to improve the Vung Ang Port corridor system**

It is concerning to see how new port investments contribute to landlocked countries' transport. Thus, the research chooses to focus on the corridor investment of an optional policy that could reduce freight transport cost that will lead to increase opportunities for landlocked countries to have negotiation power with neighbouring countries or have more chances to go into international markets. A quantitative model, or stock and flow model, of corridor investment is consequently developed by adopting the CLD from objective two

and supporting it with the qualitative data collected and data from other secondary data sources, particularly literature.

1.3 Scope of the research

While freight transport problems, transiting, bordering, and other factors are related, the current research focuses on landlocked countries for a number of reasons. First, according to Faye et al (2004) landlocked countries often lag behind their maritime neighbours in overall development and external trade, even with technological improvement in transport. Developing countries especially continue to face structural challenges in accessing the world market.

This study focuses on new port investment behaviour after the port started operation in 2011 and how the port project contributed to Laos' transport system behaviours. As indicated by Carruthers et al. (2003), the importance of efficient ports can lead to logistics and trade growth in developing countries (Carruthers et al., 2003). Thus, the concentration is on the Vietnam Laos new port investment, while the research findings clearly demonstrate that the "sea road" combination via own port is competitive in terms of cost and distance (Ruth and K.C., 2004).

The study covered the quantitative model developed, where statistical data was after the port invested in Vietnam prior to the data collection exercise. Moreover, the quantitative model tests are further extended to show the simulated behaviour of the system for an additional eleven years into the future (i.e., up to the year 2025), a period of time covering about twice the longest time period in the model.

1.4 Thesis chapter description

This thesis is divided into 12 chapters. The first chapter provides a literature review relevant to the different topic areas by starting with the background of landlocked countries in Chapter 2 before moving to a method review of system dynamics in Chapter 3. The full research methodology is explained in Chapter 4. The last part contains Chapters 5 to 12, which present the data analysis and model development. Specifically, Chapter 5 introduces GL_CLD chapter development continue with background case study information Chapter 6. Lastly, Chapter 12 concludes the thesis, which, like the introductory chapter, is separated into three parts. More detail chapter is described below:

Chapter 2 introduces a review of the literature on general least developed landlocked countries' inland freight transport modes. It discusses the issues of transport challenges that landlocked countries face. It reinforces this by including individual policy and strategy literature from these particular countries.

Chapter 3 introduces the description of what system dynamic approaches with the concept. It contains a causal loop diagram and stock and flow method sections. It then provides an explanation of the process system dynamics model development. Moreover, it provides the challenge of developing system dynamics models for both qualitative and quantitative data used. And presents the qualitative methods that this research can approach with different opinions about qualitative research methods. The chapter shows that flexible, reliable, and valid results can be accomplished using qualitative methods.

Chapter 4 discusses the research methodology with the process approaches taken step by step with four objectives. The chapter includes a key methodological justification for each object. It also contains a methodology limitation.

Chapter 5 shows the development of the first causal loop diagram, which highlights the general least landlocked countries in identifying feedback paths that produce either balancing or reinforcing feedback loops. The model can be used in a learning process where the data is collected from secondary data sources and analysed by document review to create CLDs.

Chapter 6 introduces the case study area. It begins with the background information about the geography of Laos PDR and focuses on transport systems; it then presents a corridor that relates to the port case study. Lastly, it concludes with information about the port, which is related to the case study.

Chapter 7 gives a complete description of the data collection process. This chapter includes of how each respondent was determined for each data collection methods used. It concludes with the steps taken and a reflection from the researcher on the data collection process. And verifies how the qualitative data collected was analysed through an inductive approach by starting with the analysis guideline to create and transform data, from finding data and readying it, to analysing it and coding it. In addition, it describes the processes that led to the development of the causal loop diagram and includes the researcher's reflection at the end before the chapter's conclusion.

Chapter 8 presents the development of diagram from the key findings by using a causal loop diagram and the data summaries from Chapter 2 and Chapter 7.

Chapter 9 develops a quantitative system dynamics model subsystem to develop a corridor system dynamic model by using data from Laos' freight transport, resulting in a system behaviour model.

Chapter 10 Model validation

Chapter 11 Policies test

Chapter 12 This is the final chapter; it discusses the final results and themes drawn from research's main findings. It also gives an overview of the research limitations and further research suggestions.

Chapter 2 Literature review

2.1 Introduction

Previous studies which have aimed to study the disadvantages of landlocked countries and solutions have presented various findings. Although this chapter aims to cover a wide range of topics relating to the least developed landlocked countries (LDLCs), it will address key issues that are repeated throughout the review of general landlocked literature, reviewing research that refers to LDLC systems, as well as the challenges and policies that apply. It will summarise the issues and factors that will be used in the next chapter and, finally, review the research related to the approach that focuses on these issues.

There are 48 landlocked countries in the world, as shown in **Figure 2-1**, in which the red countries represent the LDLCs, the main focus of this research, and the blue indicates developing and developed landlocked countries, which are taken into account by some of the related literature. The United Nations (UN) currently designates 30 countries as landlocked developing countries (LDCs), including 15 in Africa, 13 in Asia and two in Latin America. Within this group, there are 17 countries that the UN classifies as 'least developed countries. These countries were defined as such on the basis of their low income, human resource weakness and economic vulnerability.

Section 2.2 shows the general classifications situation and issues literature review. Then, Section 2.3 presents system dynamic and freight transport modeling research related to the LDLCs area or within the same field in the case of the model simulations of system dynamics and freight modeling in which this research is interested. The conclusion is in section 2.4.

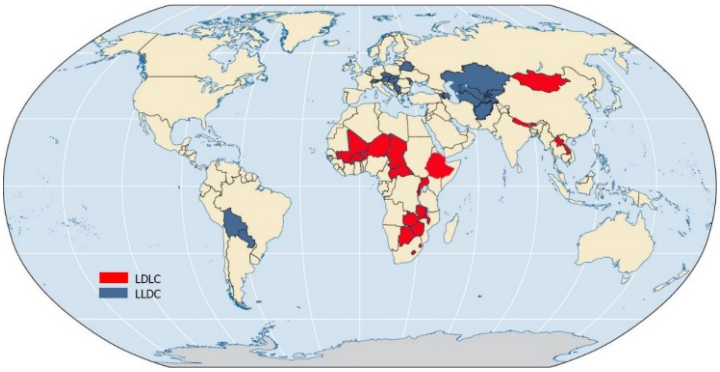


Figure 2-1: Map of 43 landlocked countries. Source: Edited by author, from WDR, (2009).

2.2 Least developed landlocked countries (LDLC) general freight transport system

To understand the overall fundamental mechanisms of landlocked countries, the specific challenges they face and their effects, research by (Snow et al.) analysed the political, transit and social environment problems from a systematic assessment of 30 case studies of landlocked countries. These can define the background to the overall major issues facing individual landlocked countries, but cannot give detailed explanations of the relationships among them; what can be learn from, are some effective strategies/policies that have been working to alleviate the challenges of being landlocked without terms of process or a detailed structure. However, they provide a good overview of the level of relationships between landlocked countries and their transit neighbours, distilling each of the primary challenges of each individual case country into three sections: *infrastructure, trade and international relationships*.

A study conducted by (Faye et al.) focuses particularly on the challenges of being a LDC, showing the important role of certain aspects of the transit neighbour on which the landlocked country's trade depends. The paper described various types of factors from transit neighbour like: infrastructure, political relationship, stability and administrative being external ones. It also named specific factors, but did not give a detailed description of their relationship with different regions/landlocked countries, and did not described which area have most and least affected. When LDLC were first mentioned, they represented landlocked countries with a low Human Development Index - less than 0.76 - considered as the least developed countries by the UN (Faye, McArthur, Sachs, & Snow, 2004. p.40).

A significant report by UNESCAP (2003), which presents the economic situation, trade performance and policy directions of individual LDCs and regions, analyses their past, present and effective future integration from the viewpoint of different international organisations. It is thus able to address typical LLDC constraints and effectiveness factors, together with insights as to how specific landlocked countries may overcome unfavourable geographical conditions with different strategies that can be learned from typical LLDC limits.

Another major study on the impact of landlocked countries on trade, by Raballand (2003), found that being landlocked can reduce trade by more than 80%. His sample of 46 countries over a five-year period with 10,000 observations measured the impact of being landlocked from estimates of geographical distance to port, borders crossed and port facilities. His results consider which factors can be considered linked to effects on transport costs. Although his research focused on an economic solution, it may demonstrate the relationship between the specific variables that have an impact on trade in his calculation.

Arvis et al. (2007) propose a microeconomic quantitative description of the logistic costs and supply chain reliability of being landlocked. Their real-world data calculation gives significant detail of the factors link and relationship support among landlocked countries logistic issues. Arvis *et al.* (2011) later published research introducing the strategies to connect LLDC to their market of trade corridors in the 21st century by means of policies and cross-border improvement. His views differ from those of the traditional government vision that focuses on physical infrastructure.

Nonetheless, there have been numerous research studies investigating particular LDCs as specific case studies that can be taken into account to understand the overall general least developed freight transport. The first of particular interest was the case of Nepal's trade problem: thirty years ago, Jayaraman and Shrestha (1976) presented an analysis of a trade solution for Nepal based on geographical disadvantage, whereby total exports were confined by India. Thirty-four years later, research by Pohit (2010) analysed the new trends of Nepal's trade in logistical partnership with India and showed various strategies had brought about significant change over time, with some policies bringing about improvement: the present border crossing situation has been improved by the political relationship and trade

agreement with India, and the development of inland container depots that connect with other Nepal's transport services.

Not far from Nepal, other landlocked countries have a similar geographical disadvantage and satisfy the criteria of being LDLCs. Laos, or Lao PDR, has also been a country of interest for many researchers concerned with the study of trade and export issues. Ruth Banomyong, who is among the most prolific researchers of landlocked countries in Asia, has concentrated on the case of Laos since the 20th century. An observation analysis by Banomyong and Beresford (2001) included a detailed freight cost analysis on Laos garment exports with various alternative route choices available. An analytical model of each route choice shows individual factors that have affected real transport costs, which is not only helpful in the selection of routes but for transport decision makers, who can specify issues directly related to transit time and cost. Three years later, Banomyong (2004), published an assessment of import channels for a landlocked country in the case of Lao PDR, where he analysed the generalised cost of transport by alternative routes and modes following the cost, time, distance, transport mode and intermodal transfer elements to find the fastest transit time. The model assumptions gave clear point factors on each transiting area and satisfied different issues that could be developed with transiting neighbours. Lewis (2008) undertook a number of research studies on the special challenges to Laos's trade based on the Laos WTO accession process and domestic reform; he gave three types of policy recommendation in terms of the improvement of domestic, regional and international aspects.

However, there is a consensus that geographical disadvantage and weak physical infrastructure are the main challenges of being landlocked, and many policymakers and researchers call for urgent improvement. Borchert *et al.* (2012) introduce research studies that set out to determine whether LDC challenges come from the lower levels of political accountability and limited services. His measurement shows that policy reform and international cooperation lead to an increase in transport performance, and are more sustainable than various physical investments that are likely to earn a low return.

2.2.1 Availability and quality of infrastructure

The main disadvantages of LLDC arise from weaknesses in their fundamental physical infrastructure. Thus, in order to develop modern logistic

capabilities, it is of great importance for these countries to improve their domestic transport infrastructure, such as highways, stations, airports and dry ports. Many studies have pointed out that the main factor influencing LDLCs' transport systems is the poor quality of internal domestic infrastructure itself, where missing links lead to a smaller choice of routes.

(Hesse and Rodrigue) studied the relationship between goods movement and freight distribution with transport costs and trade areas. Their detailed investigations show up the logistical friction concept, with the possible impedance factors on assessments measures displayed that can be used as detailed factors in the relationship of internal infrastructure model factors. Where it gave the reader to able to understand the factors that lead to transport delays and failures of bottlenecks from weak infrastructure or poor road performance that blockages the efficiency of any countries' trade businesses. The study would have been more relevant if it had included case studies, especially of the worst affected, like landlocked countries.

A study that is more relevant to the transport challenges of landlocked countries on the impact of internal infrastructure was a survey carried out by (Snow, 2003). His section researching infrastructure described each individual challenge in three categories: road, rail and waterway together with some policies applied from 30 landlocked cases. From these data, the researcher was able to specify overall LDLC transport challenge variables and better understand the connection between factors. However, the research made no attempt to give detail on each specific country's policies, so its effectiveness may be limited.

Additionally, several studies which have mentioned the cause and effectiveness of transport infrastructure can be taken into account; (UNCTAD, 2007, p. 13) highlighted that when external investors select a host country for investment they consider its physical infrastructure. A number of international studies have reported similar findings. Minten and Kyle (1999) analysed the causes of food price variation in Zaire using survey data collected from itinerant traders. They found that transport costs were on average twice as high on dirt roads as on paved roads. A study by Levy (1996) on the impacts of converting dry-season access to all-season access roads in Morocco found that travel times were typically cut by around 50%. One study reported research findings for a country that has a well-developed rail infrastructure, Zambia, but found that it was congested as a result of price and service difficulties, which had a resulting impact on transit time (Raballand et al.). Also,

along with alternatives for transport, it is essential to consider their connection to policy options, as a working research paper by Ingo et al found that air transport policies and telecommunications are significantly more restrictive in landlocked counties than elsewhere (Borchert et al.).

In conclusion, landlocked countries can use their disadvantage to create a geographical advantage. A key articulation of this theory was offered by geographers Debrie and Steck (2001), who pointed out that landlocked countries could use the advantage of being centrally located among surrounded countries to provide direct and cheaper transit routes between them. While a country's geographic characteristics cannot change, it is possible to find a solution that could change its position as a disadvantaged landlocked economy through improvements in the shipping industry (Debrie, 2001). Studies report that this strategy has been used in many landlocked countries, such as Lao PDR, which developed a strategy to change from landlocked to land link (Andersson, M. and Banomyong, R, 2010); Afghanistan, which links Asia with Europe (Lin, 2011); and lastly Nepal (Rana, P. and Karmacharya, B.K, 2014), where the authors depicted its role in facilitating the land connectivity in Asia as a revival of the silk roads (Rana, P.B. and Chia, W.M, 2014).

2.2.2 Internal infrastructure

Many previous studies have debated the ability of LDLCs to take control of their trade, because, as noted by Hesse (2004), no matter what the demand for trade might be, it may not be possible for a landlocked country to reach its maximum level of opportunity because of problems caused by infrastructure bottlenecks or road quality as described in Section 2.2.1. All these issues ultimately trace back to a lack of funding for financial development, where MacKellar et al. (2000) have observed that landlocked developing countries have a lower economic growth rate, which consequently prevents them from developing alternative transport routes and other facility improvements.

Additionally, not only does this weak internal infrastructure obstruct the growth of exportation, it may also diminish investors' interest. This has been researched by Snow (2003), who showed that countries with the worst transport infrastructure also had low levels of foreign direct investment (FDI). It was also found by UNCTAD (2007) that physical infrastructure was among the main economic determinants that external investors considered first, as was shown in Section 2.2.1. Nonetheless, there is a chance that growing

amounts of FDI and development in exportation can ultimately lead to economic growth and improvement (United Nation, 2003, p. 30).

2.2.3 Accessing global market

Research by Uprety (2006) reported that landlocked developing countries are situated far from the international market and at the extremities of transport networks, which has a profound impact on their exportation, as described in Section 2.2.7. The choice of corridors may also be influenced by the political situation, which may impose controls of the country's share of trade. A good example of this is found in a study by Jayaraman and Shrestha (1976), which points out that the trade in Nepal is fully dependent on India, which lessens the country's bargaining power and subjects their export/import system to outside controls, such as mentioned in Section 2.2.7. It can thus be concluded that the chance to access global markets plays an important role in GDP growth. Less power in negotiation with transit countries is likely to result in concessions that are disadvantageous to the country's export activities.

2.2.4 Border crossing

For international freight movement, border crossings or customs control is possibly the place where bottlenecks happen the most: a place where two countries connected to each other through a small checkpoint plays an important role in the freight transport and transit process. A report from Anyango (1997) on comparative transport cost analysis in East Africa discusses border crossing issues, describing most of East Africa's customs system, facilities and organisation that can be used as a model representative of other developing or LLDCs' borders, as they have very similar conditions and systems. Moreover, as the research focuses on the cost analysis, all the detail on border crossing procession costs, individual charges and external costs that have an impact on the border crossing were sufficiently covered. Nevertheless, the report only discusses African countries, whereas other landlocked counties could have different conditions. Thus, to fill this gap, a research study by Faye *et al.* (2004) took a case study of a landlocked country's cross-border in Asia as part of their research analysis, giving an additional view of border impact. Even if this does not take into account the details of operations, it can be seen that each region can have a different policy solution.

One major research by Uprety (2006) that he also gave detailed on the important role of border crossing and its system comprise numerous elements, including border infrastructure, facilities, border traffic, inspections, documentation, and regulation, that have impact to border crossing quality and border crossing time. But what interesting is the impact from international law, which he argues that is always have less attention but in terms of border development this should the special attention rather than focusing on physical development that have huge investment.

A major study by Uprety (2006) also gave detail on the important role of a border crossing and its system, comprising numerous elements including border infrastructure, facilities, border traffic, inspections, documentation and regulation, that have an impact on border crossing performance and border crossing time. Additionally, there are numerous studies that determine the effects of border crossings. Kharel (2009) provided an overview of the major reasons that border crossings in South Asia are cumbersome and complex, including transhipment at the border and lack of harmonisation of technical standards. His study found that a 10% reduction in transaction costs at the border would have the effect of increasing a country's intraregional exports by about 3%. This was also pointed out by a study published one year later by Kharel and Belbase (2010), which demonstrated that reducing border delays on exports by one day would have the effect of increasing exports by about 1% and that this same reduction would increase imports by 0.5%. Similarly, research studies by Dion (2000) argued that border crossing and customs charge issues can be solved by cooperation between two countries, thus reducing customs charges, or could be increased by poor or worsening relations between countries in a region. The benefits of regional cooperation were also supported in research presented by Mayhew (2002).

It can be seen that border crossings are an issue that influences many other factors and requires consideration of both sides of the crossing, as both sides have an impact on freight time and cost. A study by Faye et al. (2004) determined that border delays occurred more on the landlocked country's side because of overall border quality issues such as low technology, high number of inspections, low telecommunication capabilities, and weak border facilities. Similarly, on the transit side, Uprety (2006) showed that border delays happened among transit neighbours because of inspection, documentation, and regulation complexities, as described in Section 2.2.1. Additionally, previous research by InfraAfrica (2001) found that freight costs increase as a

direct effect of border delays because of border point administration requirements. Among all factors that influence freight cost, one statistic has indicated that an increase of 20% in direct freight costs can be attributed to the border crossing time (Anyango, 1997).

2.2.5 Transit network

Considering the fundamentals of distribution management and companies' operational efficiencies, goods from LDLCs suffer from higher costs than necessary because of the additional costs imposed by transport mode problems. LDLCs commonly have fewer available transport mode options because of their weak internal infrastructure, as shown by Ogwude (1990), who found that many developing countries suffer from complex transport modes, where the difficulty in travel makes them less capable of connecting with the various transit networks of their neighbouring countries (ESCAP, 2003). Additionally, only air transport in landlocked countries can only be of benefit in cases of goods having a high value/weight or value/volume ratio (Snow et al., 2003, p. 9).

Geographically, landlocked countries are surrounded by other countries, which means every corridor to an end route or port must include factors from internal and external considerations (UNDP., 2007). The infrastructure of an LDLC's transit neighbours could have many aspects that may change the LDLC's situation or hinder its quality. An example of this is given by Faye et al., (2004), who studied individual situations where quality problems in a neighbouring transit country arose because of natural disasters, misgovernance, or internal conflict; these situations have a direct impact on trade passing through the transit country and, thus, limit the entire network's ability to access international markets.

2.2.6 Transit neighbours' impact

It is important to accept that, when considering a landlocked country's freight transport, not all problems come from the side of the landlocked country: it has been reported in many studies that the general issues that influence freight transport may come from both landlocked countries and their transit countries. A cooperation report study from four international organisations (UN-OHRLLS et al.) has reported the different LDCs' trade issues, in which transit neighbour factors have been taken into account, showing the differential trade process impact. Nevertheless, it has been

acknowledged that the transit neighbour situation is out of the control of the landlocked country, and all recommendations point out relationships with them should be improved or internal improvements should be made to gain some bargaining power. This has been considered by (Lahiri, B. and Masjidi, F.K, 2012), who modelled the unique asymmetries in a game setting, the outcome showing that bilateral cooperation between a landlocked country and its coastal neighbour have improved the economic welfare of both parties.

To emphasise the important role of the political relationship between a landlocked country and its transit neighbour (Kharel P., 2009) has focused, in his research case study involving transit arrangements in South Asia, on where regional cooperation leads to regional investment where it is evident that the landlocked country and the region would gain equally by improving their trade quality and transport services

Landlocked economies suffer from constraints due to lack of alternative transit neighbour routes for ocean access to international markets. A study by Grigoriou (2007) highlighted that the problems of choosing a route through neighbours have a huge impact on landlocked economies and that these are uncontrollable. He recommended the option of improving the domestic route to connect to and have alternative transit neighbours and improving individual policies to gain bargaining power. (Limão and Venables) conducted a study on transport costs, and how these depend on both a country's geography and its level of infrastructure and concluded that landlocked countries could overcome a large part of their disadvantages by improving their infrastructure to a standard as high as that of their transit countries.

In examining the challenges that landlocked countries have with transit neighbours, research by *Faye et al*. (2004) showed the share of these problems according to the different characteristics of the LDLC's transit neighbour. They concluded that there are four main aspects of a transit neighbour that could serve to obstruct the landlocked country's freight transport: the neighbour's infrastructure; the existence of sound cross-border political relations; the neighbour's peace and stability; and the neighbour's administrative practices. All of these are important aspects that are impossible for the landlocked country to control.

Several studies emphasised the impact of transit infrastructure on landlocked countries' trade, (see, for example, Carrere, C. and Grigoriou, C, 2011), noting that the weak infrastructure of their neighbours has a particularly

negative impact on value cost, return of investment and market opportunity. Research by Limao and Venables (2001) estimated that improving the transit infrastructure would reduce both landlocked country and coastal country transport cost by 46 percent to 43 percent and lead to an increase in the trade volume of 2 percent.

The essential aspect, a neighbour's peace and stability, is an important issue everywhere, and many studies have been published on this subject. However, for a landlocked developing country, this is a vital theme, as an unstable neighbour could cut off its transit corridor or completely block it from trading, as effectively happened in Africa and some parts of central Asia (Saghafi-Ameri, 2012).

Neighbour's administrative practices have been discussed as an issue that requires a strong commitment at the highest political level to complete reforms in administrative practices and behaviours (World Bank, 2008). With respect to regional transit agreements, in the case of ASEAN it has been suggested as a necessary requirement that a single administrative document or declaration be used to cover the whole transit transport system (Kharel, P. and Belbase, A, 2010).

2.2.7 Regional cooperation

There are plenty of justifications for regional cooperation, but among the most important factors for LDLCs is cooperation, where their transit neighbours or other countries provide trade corridors for the passage of goods. In Section 2.2.2, it has been noted that crossing-border documentation and customs charges between countries in a particular region have been decreased because of regional cooperation agreements (World Bank, 2008); (Kharel, P. and Belbase, A, 2010). Moreover, excellent regional cooperation can decrease border delays, because countries can share telecommunication information and cooperate in high-technology inspections (Faye et al., 2004, V.5.P.48). However, just as regional cooperation can reduce transit neighbours customs charges, those same charges could immediately increase in the event of poor or worsening relations between countries in the region (Dion, 2000; Mayhew, 2002), as mentioned in Section 2.2.1.

2.2.8 Port

For some landlocked country freight movement to the markets of different international continents, a port is the end of the inland route before turning to a different mode transport, across the sea, and going to another port which is beyond its control. Several reports and studies have described issues or challenges in the port that could have a huge impact on the freight cost. Research by (Snow et al.) has shown different kinds of port situations and issues; individual factors such as weak infrastructure, small capacity, complicated formalities and delays that happened in different regions constitute a brief overview, as the research was not intended to focus in detail on port systems or policy solutions.

There are many processes in the port, which could be related to different situations based on the performance or rules of each port. Research by (Anyango) studies the comparative transport cost analysis in East Africa, where all detailed processes were taken into account. One of the important sections covered the procedures at the ports of Dar-es-Salaam and Mombasa and included a "sensitivity analysis on port transit times'', which shows detailed information on all the tariff costs, procedures, various charges, etc. This one report gave so much detailed information that the whole system behaviour could be seen, and it represented most of the challenges that landlocked countries face when using a transit neighbour's port. The research made recommendations about the port which related directly to the issues and could be applied to reduce the delay and cost.

Research by (Banomyong and Beresford), studies the alternative routes of Lao PDR exports to the European Union through three different transit countries and ports. In this research, real-life information about the use of each route was presented with a focus on two main impacts: cost and time. All were different in terms of the effect on infrastructure, policy and regulation. Moreover, research by (JDI) studied the new project gateway for landlocked countries in which a port was part of the project. This study gave an understanding of the port's fundamental construction, development plan and port system, with several factors and conditions described. Moreover, the report gave a great deal of detail on each process system that related to the port agreement between the transit country which owned the port and the landlocked country.

Ports seem to have some of strongest impact on travel time and cost, as they are at the end of inland routes that are difficult to navigate and mostly out of landlocked countries' control. One of the issues that have always been mentioned is the port infrastructure or quality itself, which lead to huge delays or waiting times at the port.

Neighbour border crossing times seem to be more standard compared to LDLCs, where most of the time taken is because of delays at the landlocked country's side owing to many LDLC neighbour's border quality being possibly at a high level of standardization.

2.3 Summary list of issues

From a review of the literature cited here, this section has summarised the key issues and made the following basic observations:

1.) LDLCs can increase exportation by improving their internal transport infrastructure as a top priority. The development of the country's transport infrastructure has the ability to attract external investors, and this increase in foreign investment will lead to a growth in exportation over the long term. However, this cannot happen without a development fund for such countries to support this development in transport infrastructure at the outset.

2.) As market opportunities and demand are growing rapidly, LDLCs would greatly benefit from taking part in the global market, but their ability to do so is obstructed by their having fewer access routes and greater hurdles than other competitors. The major factor that influences a country's status as an LDLC is the poor quality of internal and transit infrastructure in the region itself, while some missing links in the available modes of transport result in fewer choices and limited transport capabilities. This has a more concerning effect on the export volume of LDLCs when their route is controlled by a single transit neighbour.

3.) Multimodal transport has been proved by many research studies to be one of the best possible outcomes for LDLCs. Unfortunately, because of the lack of financial resources, LDLCs may not be able to develop alternative transport modes to what they currently have. A possible solution would be to seek external funding from investors who might see a possible benefit from their intended use in the long term.

4.) LDLCs engaging in trade cannot avoid using transit neighbour routes as a means to access overseas destinations. It must be accepted that this is an uncontrollable situation, and the LDLC's choice of corridors

will depend on four aspects that are described in a research study by Faye et al. (2004).

5.) At the point where two different countries' routes connect, border crossings contribute significantly to transit time and cost. Although all transit (export and import) faces differential difficulties, such processes may involve higher than expected costs because of non-standardisation or a lack of cooperation between the countries connected.

6.) It can be seen that LDLCs suffer from various problems which are difficult for them to overcome alone. Thus, it is necessary to look to international and regional developed neighbours for support that could create greater transit efficiencies at the regional level and, as a consequence, improve the LDLC's economy.

2.4 General issues

Section 2.3 summarizes the key issues found in the literature and document review concerning freight transport in LDLCs. In this section provide a grouping of these key issues and factors, as provided in a summary form in table below. The groups have been separated into two lists: internal and external issues.

Table 2-1: Summary of internal issues for LDLCs

Internal issues	
LDLCs' transport infrastructure	Most LDLCs suffer from a poor internal transport infrastructure, which causes them to be less attractive to investors, as it creates a disadvantage in exportation.
Accessing the global markets	Many LDLCs have few opportunities to engage in trade with overseas countries, as they have a small network/choice of corridors for transit outside their region.
Transport mode choice	Some LDLCs have little opportunity to access the global market, as they do not have many options among transport modes for trade.

Table 2-2: Summary of LDLCs' external issues

External issues	
Transit neighbours infrastructure	Inevitably, all trade from an LDLC must pass through their transit neighbours. However, some LDLCs face a situation in which their neighbours have many issues, causing the neighbour's transport infrastructure to have decreased quality or to be completely unusable. This limits the LDLCs' choice of corridors or may even completely cut them out of the market.
Border crossing	The combination of internal and external border conditions is represented in this group as the border crossing situation. An inefficient border crossing process creates delays in the time spent at the border, where transit regulation and documentation are still complex. This point has often been discussed in the literature.
Regional cooperation	Many LDLCs find it hard to develop their countries without help from other countries, as the LDLCs themselves have limited funding. Thus, regional cooperation seems to be the most effective and progressive move for an LDLC seeking to overcome internal and external trade issues.
Regional investment	Among all projects that occur in or are related to LDLCs, the most beneficial have come from regional cooperation; thus, regional investment is a positive factor that can benefit LDLCs.

2.5 Freight modelling

It has been a while that many countries and regions have tried to do something to deal with their freight transport (import/export or transit), in order to help them deal with future transport, and have decided on policies to give them advantages or to solve their issues. Thus, various modelling for freight transport had been used in different countries to assist their governments to control national freight transport issues. However, as various models have been developed to be more comparable, a model has been created with special requirements, challenges and issues that need to be solved to make the model run perfectly. Thus, this section will describe the freight model development literature and pick the model that suits this research by focussing on freight at a national level and picking a suitable model to get into more

detail on how that particular model has been used in comparison to other models.

Each type of freight model has been developed since the 1990s to have different purposes, like a study by (De Jong, G.; Gunn, H.F.; Walker, 2007), which clearly described a number of national model systems that have all been developed to focus on policy simulation, forecasting future demand, or project evaluation at the national and international level. In order to find the right model suited for use on a typical landlocked country, this research used the literature from research by De Jong, Tavasszy, and Bates (2016) as a guideline, as it gives perfect discussion of the issues concerning each model of freight transport at the national level that the researcher will face seeking a model that has conditions that fit with this research, focussing on four keys: institutional, requirements, specification and data.

2.5.1 Traditional freight modeling

With the first discussion on models for production and attraction a trend and time series models, where De Jong et al., has shortly described as is meant for short-term forecasting with using less data and shown not outfit in national level that intended to look for long-term policy test and its limited possibility for policy causality and effects. However, it has advantages, as its limited data requirements are good for explanatory variables, such as gross domestic product etc. such as in research by Adhikari and Agrawal (2013), where they defined the time series models as a dynamic research area that is important to many practical fields, such as finance, science, business, engineering, and economics, which can be true by the act of guessing the future by understanding the past. Consequently, it good for research that has realistic quantitative data even though it does not require much data but still needs it, which does not suit research that wants to decide a new policy that a case study never happened in that area. Moreover, as it not possible to find causality and effects of the policies produced, in the long term, this model does not suit research at the national level as the time scope for the national level would look for long-term investment and could link to other areas for which data might be impossible to retrieve.

A next model, an input-output model, which seems to have many advantages and disadvantages, has been called a basic model of macroeconomics, where tables was the main method that data was input

in one sector and go to output on another table sector or some between regions, which was used in many countries to look into economic trade flow where the tables are described in monetary units. It can be seen that it is able to predict sectoral growth on future trade flows, such as in (Beuthe et al.) research, where they produced a demand of region freight model by using 17 sectors. This shows this model is good for specific use and it can provide perfect outcome predictions but, as it requires a complex method and data with fixed coefficients, it might not suit research that wants to test new policies at the national level, where data is limited and restrictive assumptions are fixed and one can't see the causal effect of that new policy.

A zonal trip rate model has been concluded by De Jong et al., with few advantages that are suitable for research with limited data requirements, where work is best on zone types that are able to classify cross-sectional data on transport volumes to/from zone to zone. Sample literature they mentioned was Cambridge Systematics et al. (1997), where they gave information on the model of policy analysts' freight demand forecasting and policy analysts effectively integrating freight planning. However, this model has limited scope for policy effects, where it also has little insight into causality and the model is typically for road transport only. Thus, at the national level, where policy causation would be important, it can be classified that this model is good with freight demand prediction but it would much more suit the trip rated of zone to zone in the urban region.

Several studies on freight focus on landlocked countries using different traditional models. The main disadvantage of landlocked countries is the long distance to ports, which causes them to have high transportation costs, where their own transport infrastructures are a big barrier. Thus, a model that can help policymakers was used to discover the key concerns for improving market access and overcoming infrastructural challenges (Parida, 2014). Where the research studied on Rail infrastructure and regional infrastructural development were questioned in South-African countries.

A model looking for long-term outcomes seems to be very popular in this area as most landlocked countries have limited budgets. Therefore, policymakers would need to carefully decide on their investment plans. A focus sector of border investment 40 year (Yang and McCarthy, 2013),

where a multi-model network analysis model was used, was able to assess the impacts of the proposed investment, specify transport journal cost, and further to the whole country, which can find what should be emphasised for the country to invest in for their future trade planning.

Some landlocked studies were developing a freight and trade model from an environmental perspective that combined the development of intermodals: highways, railways, and seaports, where inland dry ports remain at an early stage of development (Hanaoka and Regmi, 2011), where other earlier models of transport development might have implemented a unimodal method in which road and rail projects were planned and constructed without much reflection for their probable future incorporation.

Being a landlocked country badly affects bilateral trade. This is mainly because landlocked countries face higher logistic costs to access ports, which makes their competitiveness and their level of exports lower than other neighbouring countries that have their own sea port. One study in Africa looked at the potential for internal trade and regional integration (Geda and Seid, 2015) by developing a model to analyse and model simulation results to reveal the existence of significant potential for intra-Africa trade with the aim to address the challenge of export supply constraints, export competitiveness, and diversification and the need of policy improvement of liberalisation to the actual realisation of the potential for trade through the provision of regional (multi-country) and domestic infrastructures etc.

One study used a landlocked developing country as a case study to find out the effectiveness of the policy packages by developing a model that can forecast sector-wise transport demand in order to analyse energy efficiency and bio-energy on land transportation in Laos P.D.R (Phoualavanh and Limmeechokchai, 2015).

A typical policy study used the gravity model of trade (GMT) for landlocked countries and neighbours of the former Soviet Central Asian countries to boost their trade by measuring contributions of country-specific properties and networking factors from bilateral agreements (Mazhikeyev, Edwards and Rizov, 2015). The model was modified from Newton's gravity equation (Zwinkels and Beugelsdijk, 2010) in order to predict bilateral trade flows based on economic sizes and geographic

distance of two trading countries, where a game tree of openness and trade: actors and interactions show the outcome of the interaction of decisions of a number of actors in response to their environment and to each other.

Numerous different types of models have tried to overcome the barriers of trade. One model was built to understand how administrative costs affect trade volumes, shipping decisions, and welfare (Hornok and Koren, 2015). The model is able to help explain why policymakers emphasise on trade facilitation and why trade within customs unions is larger than trade within free trade areas.

Table 2-3 List of sample traditional freight model

Study	Model	Scope area, location	Model Objective(s)
(Adhikari and Agrawal)	Trend and time series models	Finance, science, business, engineering, and economics	Guessing the future by understanding the past.
(Beuthe et al.)	Input output model	Trade flow between sector, countries or regions	Predict sectoral growth on future trade flows.
(Cambridge Systematics)	A zonal trip rate model	zone types of transport volumes to/from zone to zone	Freight demand forecasting and policy analysts effectively integrating freight planning
(Yang and McCarthy)	Network analysis models	Border, network origin- destination, city and whole country	To assess the impacts of the proposed investment
(Hanaoka and Regmi)	Activity-based emission modeling	Dry ports, country and regional	Highlighting factors that have influenced the development and operation of dry ports and intermodal transport.

(Geda and Seid)	Gravity model	Intra-Africa, country and regional.	Simulate the potential for intra-Africa trade seeking for export factors challenges.
(Phoualavanh and Limmeechokchai)	Long-rang Energy Alternative Planning (LEAP) model	Transport sector	Forecast sector-wise transport demand, estimate and analyse the future energy consumption in the transport sector of Laos which will be expressed under the assumption where no new policies or new actions.
(Mazhikeyev et al.)	Gravity model of trade (GMT)	Country to country, regional. country-specific properties and networking factors (Central Asian countries)	Predicts bilateral trade flows, capture time varying bilateral effects on trade volumes.
(Hornok and Koren)	Heterogeneous-firm trade model with standard gravity equation.	Transport sector, policy.	Administrative barriers to trade to understand how they affect trade volumes, shipping decisions and welfare.

2.5.2 System dynamic freight modeling

A model on freight reviewed is the system dynamics model, which able to find the relations between land use, using less data requirements and is perfect for research that wants external and looks for policy effects with variables included, which can forecast short to long-term freight transport demand and transport cost. However, with a disadvantage that it is not able to do statistical tests on parameter values owing to it obtaining the parameters from literature by checking the resulting dynamic behaviour of the system, it seems to not be suited for 3-D and network detail to yield zone-to-zone flows and link loadings. This would not answer judge that that system dynamics

model not suit for the national level event it not been popularly used. Because if a researcher wants to analyse a new policy from a particular country that needs to improve the freight transportation situation that goes through its neighbouring countries where data might not be fully supported, a system dynamics model would seem to work well.

Therefore, to be clear, it needs to look in more detail in research by Shepherd (2014), as over 50 system dynamics journal papers were peer-reviewed by him since 1994 when Abbas and Bell (1994) evaluated the strengths and weaknesses of the system dynamics approach and recommended it as well-suited to strategic issues and suitable for policy maker that aims to make decision-making for their policy analysis. In research by Shepherd (2014), it can be seen the kinds of categories in which a system dynamic was applied, where the use of high-level studies at a national level look at implications transportation seem to be had plenty using system dynamics to modelling future prediction to find the change of transport demand and cost under the transport policy respond.

There was some more literature where the system dynamics model was used in freight transport, such as a research from Piattelli et al. (2002). Their research was not mainly about freight forecasting or policy on freight issues but this research also used the system dynamics model to analyse freight movements' effect that will cause reduced road sharing, where it aims to find the carbon use. Another research by Randers et al. (2007) created a small system dynamics model to forecast the freight rates, where stock and flow was used to predict the rate growth to find out the right time to invest or leave the market from a loop of roughly a 20-year wave.

Many studies have reviewed the problems and provided suggestions for system dynamics. However, to confirm, suggest, and recommend that this model would suitable for freight on the national level or a landlocked country, this research will summarise using a table just like De Jong, Tavasszy, and Bates (2016) did but give more justification following the issues in modelling freight transport at the national level four keys from De Jong et al. to give an understanding in simple justification on this research as national level with limited data to create a policy to solve freight problem.

A detailed examination of the effectiveness of transport infrastructures in terms of microeconomic impacts was performed in research by (T. R. Lakshmanan and William P. Anderson). This study provides important insights

into transport infrastructure improvement modelled as a diagram impaction model from cost-benefit analysis in different forms that have an impact on transport cost and production. However, even the research has giving awareness data of freight transports challenges in term of infrastructure impacts model that can be used on any worldwide convoluted model. It seems not to be completely relevant as the paper focused on information related to developed countries, whose solutions might not be suitable for the least developed countries.

Key research relates to a solution for LLCs in which models can be adapted to improve understanding of individualised landlocked challenges, and justify the adoption of policy with the ability to monitor behavioural changes. (Warren) studies the difficulties and constraints of the trading system with analysis of the general structure of a trade zone in Nigeria. Research is seeking new ways to use dynamic modeling software to analyse and understand possible problems in the portfolio of commercially viable trade efforts that are compatible with all types of borders and through or with the same systems. Many studies have reviewed the problems and provided suggestions, but unconfirmed data suggest that those recommended policies are beneficial. This research by Warren is capable of understanding the interactions and impact of a sample policy, and the benefits of system dynamic mapping that can be monitored and evaluated for future frameworks. Despite their simplistic design, data collection and modeling of what they learn and aim to improve the system and impact that affects more than one transport mode when more information can be provided. In the event that many literature studies have reviewed the problems and provided many suggestions. But unconfirmed data suggests that those recommended policies are beneficial. This research from Warren is capable to understand the interactions and impact of sample policy, and the benefits of system dynamic mapping and that can be monitored and evaluated for future frameworks. Despite their simplistic design, data collection, and modeling of what they learn, they still have aim to improve the system and impact that affects more than one transport mode when more information can be provided.

Previously published studies by (Thaller et al.) related to Warren's research provide detailed information on how the System Dynamic (SD) is modelled. The research intends to analyse urban transportation for medium- and long-term forecasts by using a causal loop diagram model, which is the

first step before the SD format. The research provides a basic understanding of urban transport systems as a tool to explain the impact of different decision making and stakeholder behaviours on urban transportation. However, what is useful and learned from this research is that the concept of SD is a model that can also be modified by the same landlocked country model with different elements, as well as the feedback loops.

Table 2-4 List of system dynamic freight model sample

Study	Area	Study Objective(s)
(De Jong, GC, Tavasszy, L, Bates)	National level	The issues in modelling freight transport.
(T. R. Lakshmanan and William P. Anderson)	Transport sector	The effectiveness of transport infrastructures in terms of microeconomic impacts
(Warren)	Country trade zone	Improve understanding of individualised landlocked challenges, and justify the adoption of policy with the ability to monitor behavioural changes
(Thaller et al.)	Urban transportation	Analyse urban transportation for medium- and long-term forecasts to understanding of urban transport systems as a tool to explain the impact of different decision making and stakeholder behaviours on urban transportation
(Shepherd)	High-level studies at a national level	Peer-review system dynamic
(Piattelli et al.)	Freight movements	Freight forecasting

(Randers and Göluke)	Freight movements	Forecast the freight rates growth

2.5.3 Summarize key modeling

By using ‘’the key question overview of the issues in modelling freight transport at the national level’’ (De Jong, GC, Tavasszy, L, Bates, 2016) show in Figure 2-2 tranforming to Table 2-5, which summaries literature from section 2.5.1 and 2.5.2 for the key of model sample that can be applies for freight modelling for this thesis area.

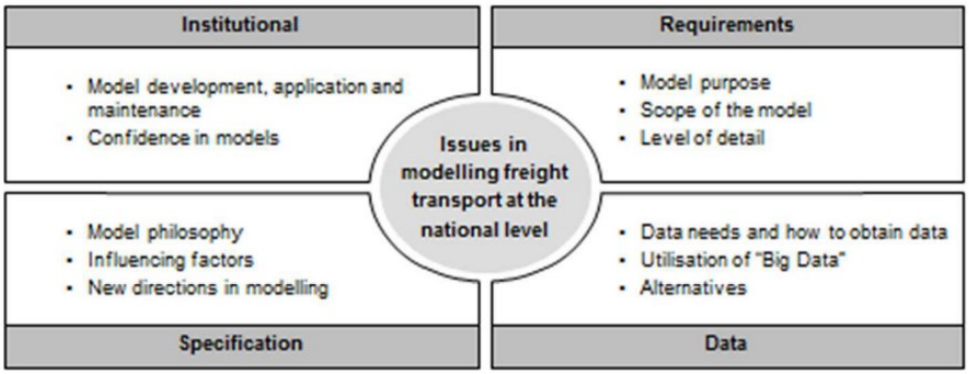


Figure 2-2 Issues in modeling freight transport at the national level (De Jong, GC, Tavasszy, L, Bates, 2016)

Table 2-5 Model key summarize using modified table from Figure 2-2

	Institutional (Model development)	**Requirement** (Level of detail Scope of the model)	**Specification** (Influencing factors)	**Data** (Data needs)
System dynamic model	- Future freight demand prediction - Understand dynamic behaviour of the system	- land use interactions - Not contain sufficient spatial and network detail to yield zone-to-zone flows	- External and policy effects variables can be included	- Less data requirements - Not obtained from statistical estimation, but from existing literature
Trend and time series models	- Extrapolated into the future - Truck flows and is meant for	- Limited scope for policy effects	- Little insight into causality - Simple growth factor models	- Limited data requirements for many years

	short-term forecasting		- Complex auto-regressive moving average models	
Input output model	- Macro-economic models - Final demand by consumers - Not focussing on transport - Not handled in transport model.	- land use interactions - Preferably multi-regional - A feedback to land use	- Policy effects if elastic coefficients - the choices in the transport model	- Need input-output table - Model complexity and run times.
Gravity model	- Measure of the (generalised) transport cost, trade flows, generalised - Policy effects through transport cost function	- zone to zone	- Limited scope for including explanatory factors and policy effects - Limited number of calibration parameters	- Based on aggregate data - Limited data requirements
A zonal trip rate model	- Cross-sectional data on transport volumes - Freight Forecasting	- Zone to zone - Limited scope for policy effects	- Little insight into causality	- Limited data requirements (zonal data) - Investigation from another similar area
Network analysis models	- Explain a particular real-world network - Gurther hypothesis testing	- Groups of groups	- World Wide Web and the Internet to social, biochemical, and ecological systems.	- Interpretation of network data

2.6 Conclusion

From the research reported in this chapter, the situation for landlocked countries, both collectively and individually, has been discussed. It has been shown that landlocked countries can be classified differently based on their level of economy, as is true for other countries in the world. However, not

every landlocked country can easily overcome the geographical disadvantages of being landlocked; their degree of ability to do so results in the different classifications as identified in Section 2.2. The research further shows that, among those classified as landlocked countries, the countries that are defined as least developed countries have greater problems than others. A number of research papers have classified LDLCs separately from LDCs, which is clearly a valid distinction. However, the research also shows that freight transport problems are the main barriers for most landlocked countries, regardless of classification. Section 2.3 identifies a number of freight transport issues that have not been solved as might be expected. It further shows that each of these problematic factors are linked, but many studies have failed to identify each link clearly. This might be the reason that many policy actions have not proved to be as successful as planned. Moreover, there has been a lack of studies that can facilitate a better understanding of all these problematic conditions and thus verify the appropriateness of recommended policies.

With a long travel time to port, LDLC freight transport regularly suffers high transport costs over other countries because they take longer on the road. Further, some LDLCs suffer from bad road quality, which makes the vehicles run slowly. Moreover, the time taken for border crossing and the port waiting time could take more than a day. All of these would affect the time cost together with other regulation charges, such as border charges and port fees. The freight transport generalized cost seems to be the main aspect attracting foreign direct investment to the country if the cost is low, as they can see the profit if the product cost is cheap owing to the transport cost not being high. If the product cost reduced, this will lead to having more production in the future and mean it will increase trade.

Consequently, to extend the current understanding of the challenges faced by LDLCs, this chapter will next provide a description of the methods to be used in enhancing the understanding of how all these problems relate to each other, to achieve the objectives of this research.

Chapter 3 System dynamic

3.1 Introduction

Chapter 2 identified the use of system dynamic on this research as a tools options for improving the understanding about landlocked countries freight transport system and issues. It principally showed the advantage of being able to approximately detention and clarify social behaviour based on the different sights of different stockholders.

In section 3.2 gives a detailed description of the system dynamic concepts. What follows is the explanation of the lists process of model development on section 3.3. Then, in Section 3.4 review the data collection methods. The last section, Section 3.5, provides the review of the data analysis.

3.2 System dynamics concept

Simply put, system dynamics (SD) is a method that allows an expert to decompose a complex social or behavioural system into its basic mechanisms and then mix these mechanisms into a whole that can be easily seen and simulated. As a representation of a systems approach, many elements of a system e.g., cause and effect, stock and flow, feedback and delays are incorporated to provide insight into the dynamic behaviour of the system over time. A study of the theory of nonlinear dynamics by Sterman (2000) determined that SD is a feedback control that also employs psychology, economics, and other social sciences. Within an SD method that captures behaviours of a system over time, it is also necessary to consider the dynamic behaviour that results because of delays and feedback in the system.

The SD methodology was first developed in 1961 by Jay W. Forrester, who noted that system dynamics could demonstrate how businesses and, in some manner, municipal systems could act in ways that run against most of what humans would do to correct their ills. This same obtuse behaviour can be assigned to the largest social issues that confront nations and even the world. Since then, system dynamics have been used in many different cases, like the challenges of dynamic complexity in public health (Homer, J.B. and Hirsch, G.B, 2006), policy management (Roese, J.J. and Graham, R.W, 2009), and many other complex issues and problems. As those problems are too difficult for humans to process, the SD model is able to merge situations into a system that is easy to understand (Kirkwood, 1998)

Numerous SD studies have presented the distinction between two main types of system dynamic model (SDM): the qualitative system dynamic model and the quantitative system dynamic model [(Coyle, 1996); (Wolstenholme, 1999)]. Harris & Williams (2005) observed that SD involves two basic types of approaches. The first seeks to understand the possible consequences of dynamic relationships by *mapping* them through a variety of methods, such as causal loop diagrams and qualitative models. The second is the model that was developed and used by Jay Forrester in the 1950s and John Sterman in the 2000s, a model that *simulates* the consequences of dynamic relationships by using different quantities of intervention, delay, and feedback through timing. Among these types of models, Coyle (2000) has argued that quantitative models are more restrictive than qualitative ones, as the data demands for developing some quantitative models cannot be met. However, quantitative SD models are more commonly used, where they are usually referred to as stock and flow models (SFMs) (Sterman, 2000).

Many basic guides have followed the same structure for developing an SFM. The process starts by stating with modeling the problem, issues, or evaluation questions as some part of the problem, not trying to cover the entire real-world situation, which assumes most problems have endogenous causes (Harris, B. and Williams, B, 2005). Thus, to develop a dynamic hypothesis explaining the cause of the problem and to identify the model problem, a non-system dynamics causal loop diagram is constructed in this part.

3.3 Causal loop diagram (CLDs)

This section introduces causal loop diagrams and reviews issues identified in the literature surrounding their use. It then describes the history of how causal loop diagrams were developed. This part of the literature will assist in understanding alignment as a complex dynamic system, and several notions from different techniques will be used. Additionally, from the resulting diagram, the developer will make comments and present hypotheses developed from the model. Finally, the limitations and usefulness of the technique will be discussed.

Causal loop diagrams (CLDs) are tools that use of nodes and arrows to construct directed graph models of causes and effects; this technique was invented in the path analyses conducted by Sewall Wright in 1918, long before system dynamics was developed (Greenland et al., 1999). CLD techniques

continued to be developed and used by system thinkers after that (Capra, 1996). However, because of the considerable debate about their usefulness within system dynamics, their use did not become popular until the 1960s, when CLDs were first introduced to a much wider audience (Senge, 1990). One of the most important developers of system dynamics since the 1960s, Jay Forrester, maintain that CLDs should not be used in system dynamics (Campbell and Avison, 2004). The developments in system dynamics were hotly contested in the twentieth century by a number of researchers, one of whom applied a quantitative system dynamics model to non-participants from an initial hypotheses and uncovered the mental model of participants (Sterman, 2000a). Nevertheless, some studies still argue that this method of analysis has too many limitations in seeking to understand and then act upon a complex world (Vennix, 1996; Wolstenholme, 1990). More literature will be reviewed on this point.

The first object here is to represent a GLDLC system structure with a CLD based on a dynamic hypothesis of the characteristic problem.

The literature on causal loop diagrams offers several papers that provide a comprehensive review of causal modeling [(Wolstenholme, 1990); (Sterman, 2000a)]. The processes of grounded theory provide a means for grounding systems modeling, especially structural modeling approaches such as CLDs, which represents an interesting textual technique through which modellers [(Luna-Reyes and Andersen, 2003), (Sterman, 2000a), (Yearworth and White, 2013)] can observe its direct link with grounded theory, where all factors are connected to each other, though it may still not be able to explain which variable is more important or why it is.

This research used causal loop diagrams as its main fundamental methodology to describe the background problem. The CLD models used two styles, a quantitative model and a qualitative model, for different purposes (Coyle, 2000). The qualitative model, or a model that uses causal loop diagrams only, can be used for general landlocked countries to emphasise the identification of feedback paths that produce either balancing or reinforcing feedback, which can then be used in a learning process with data collected from secondary data (Daas and Arends Tóth, 2009) and an analysis from the document review to code and create CLDs. The quantitative model, as the normal way of using system dynamics as per the method described, will be applied to a case study that presents the behaviour tests from the system dynamic model and the stock and flow of the policy tested.

The quantitative model is the normal way of using system dynamics, as per method described in chapter 4.5. As the first CLDs were used to answer the question of general landlocked countries, one limitation of the information provided is that it was not possible to do primary data collection (document review). On the other hand, the conditions of the second set of CLDs were feasible for gathering the data source. The case study required a system dynamic test plus a stock and flow outcome, which will continue to be used for the policy tested. Hence, the second CLDs were created by means of a quantitative model with data collected by doing a semi structured interview and focus group, and appended with a document review.

3.3.1 CLD development sample

For a better understanding of model development, it may be helpful to consider the case sample of ‘’Mental Model of the Traffic Problem’’ by Sterman (2000, p, 178) for positive and negative loops using traffic volume depends on congestion which similar to this research model.

The loops show some part of the traditional solution to traffic jams and congestion. The concept of the model is building new road to reduce congestion and traffic jams. Such like in LDLC where the delay or congestion happen what data shown which solution that these countries have been done or what made this congestion happen? And ‘’what happens if the roads are built?’’ or ‘’what feedback effects of road construction?’’ where this been ask by Sterman (2000, p, 179) to begin capturing the physical structure of the system and what been followed by this research.

The model shown in Figure 3-1 below start with the ‘’average travel time’’, which is use a name of ‘’Travel time’’ in the model, where is ta a best for the model that able to measured and has operational meaning.

The first question is ‘’what determines travel time?’’, where in here it depends on the two things: the road condition or ‘’Highway Capacity’’ and the amount of vehicle in road, where the model name ‘’Traffic volume’’. However, two variables have different effect conditions. Whereas if the traffic volume increases, the travel time will take longer that, which in the model used a (+) signs at arrow heads indicate that the effect is positive related to the cause.

But if the Highway Capacity or quality increase, the average travel time will fall as the vehicle can run faster, which use a negative sign (-) at arrow heads that the effect is negative related to the cause.

Importantly the capacity of highway is can be improved by the ‘’Road construction’’ that can be both meaning of building new road or upgrading the available one. However, no matter the cases is always take time to be done which in the model represent as a ‘’Delay’’ where the increase of the road construction will be delay until the highway capacity changed or responded.

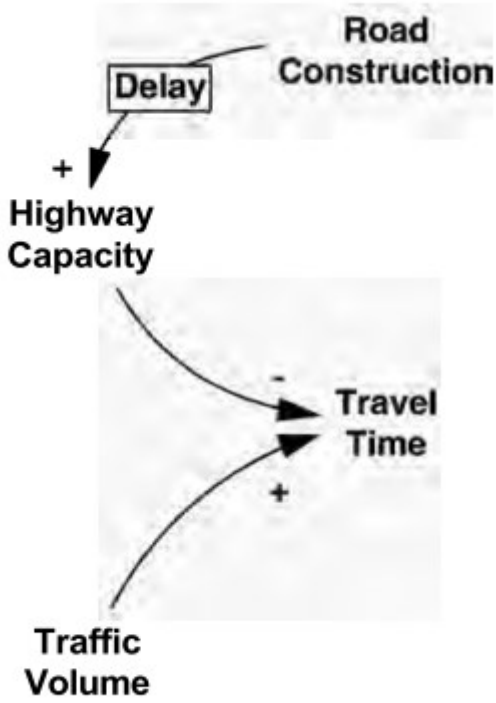


Figure 3-1: Determinants of travel time by Sterman (2000, p, 179)

Secondly, the model continuing to input political pressure to do something when the travel time rises and the traffic jams become the norm. Figure 3-2 show that the ‘’Pressure to Reduce Congestion’’ was came from the travel time together with the ‘’Desired Travel Time’’. Where at the end the government or whom responded would not resist the pressure and building new road.

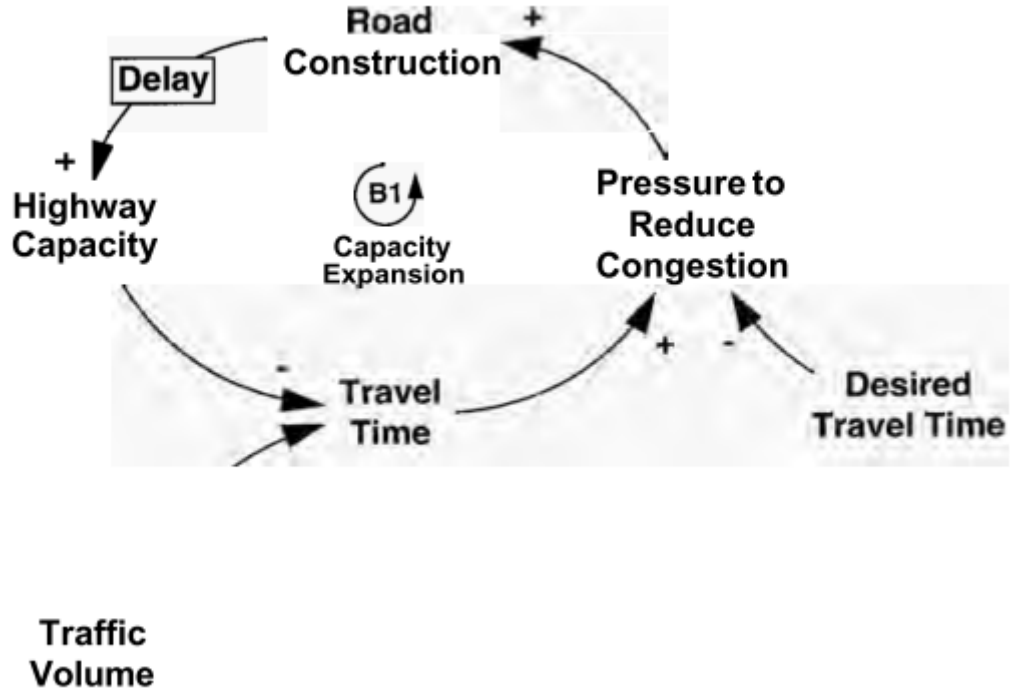


Figure 3-2 The Capacity Expansion model by Sterman (2000, p, 180)

In conclude the model aims is to show the loop of Capacity Expansion (B1) with purpose to reduce travel time to acceptable levels. This was followed by this research respectively where all the analysed data from the literature were coded, where all the relationship, behaviour, feedback an effective had transformed to a causal model. Moreover, as this model development follow the suggestion by Sterman (2000) that to construct the diagram the variables must be able to measure or consider the unit and a clear definition of and relationship among the variables, which been analysed purely conceptual from the secondary data to develop a general LDLC freight transport model.

3.3.2 Feedback (balancing and reinforcing loop)

After the model causal loop diagram were created along with the time delays and stock and flow structure, which determine behaviours of the dynamics of system. Thus, in order to understand the dynamic of complex system Sterman (2000, p, 12-13) descript this interaction as ‘’feedbacks’’ where it has two types of feedback loops, positive (or self-reinforcing) and negative (or self-correcting) loops.

Balancing loop or negative loops that self-correcting counteract change, the change where the feedback of causation balancing the number of the system not to increase or decrease. Too much as it has causal link with other variables to keep the total number stay in balance. For example, Figure 1 show as the number vehicle crossing in a border grows, various negative loops will act to balance the vehicle number with its carry capacity. The more vehicle crossing border, the more the more border traffic congestion will be. If there is any more traffic congestion it will be less attractive to that border, which will decrease the number of vehicles that interested and will change or move to other border or it mean the vehicle crossing number in this border will decrease. The B in the centre of a loop in Figure 1 represents a balancing feedback. If the vehicle crossing border loop was the only one operating (say because all driver not intend to use this border), the number of Border traffic congestion would gradually decline until none remained.

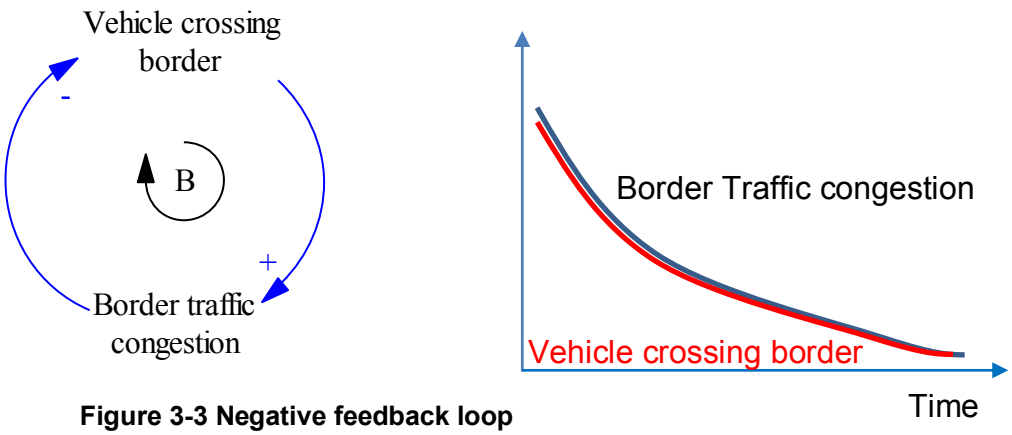


Figure 3-3 Negative feedback loop

Reinforcing loop or positive loops as tend to reinforce or increase whatever is happening in the system. The feedback that caused the loop will keep increasing the number of those variable. For example, in this case of population growth, more births per year which add to the number of populations, leading to still more births per year on the future, and so on. A Causal Loop Diagram or CLD captures the feedback dependency of population and birth. The arrows indicate the causal relationships. The + signs at the arrowheads indicate that the effect is positively related to the cause: an increase in the population causes the number of births to rise above what it would have been. The loop is self-reinforcing, hence the loop polarity identifier R. If this loop were the only one operating, the population and births would both grow exponentially. Of course, no real quantity can grow forever. There must be limits to growth. These limits are created by negative feedback.

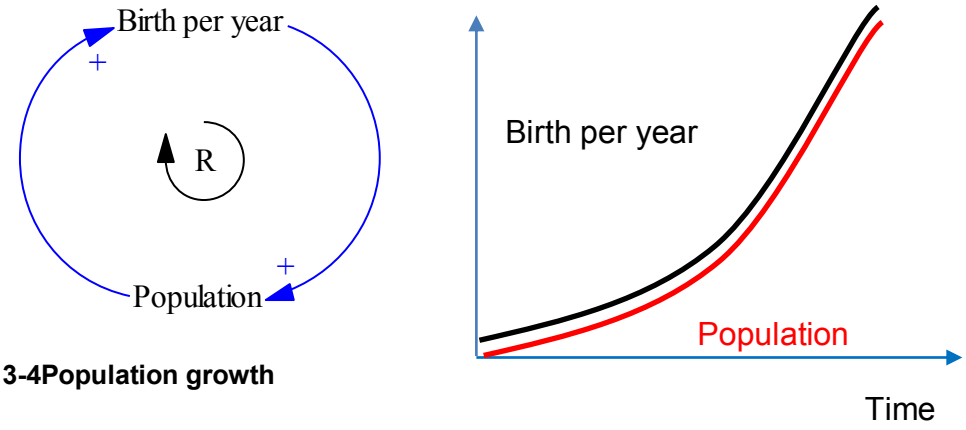


Figure 3-4Population growth

3.3.3 Data collection for system dynamic model

There are several basic categories of qualitative data collection used in the social sciences. In particular, it is common to look at interviews, oral histories, focus groups, Delphi groups, observations, participant observations, and experimental approaches that lead to qualitative data (Luna-Reyes L. a., 2003). In order to find and collect data sources to answer the research question and supply the CLDs and system dynamic model, three main methods were used in this study: document review, semi structured interviews, and a focus group.

The goal of a focus group is to gather fundamental information, experiences, ideas, and perspectives on a particular topic of interest. A focus group is a qualitative research method that can be utilized in the search for answers to research questions, and it allows the researcher to collect data with many common features by less structured interviews with several participants at once. More specifically, a focus group is a group discussion on a particular topic organised for research purposes. This discussion is guided, monitored, and recorded by a researcher. While many other researchers might conduct interviews or oral histories before using a focus group, the focus group is a group of people usually between 6 and 12 who meet in an informal setting to talk about a particular topic that has been set by the researcher (for other definitions, see Krueger, 1988; Morgan, 1997; Merton and Kendall, 1990; Swenson et all., 1992; Greenbaum, 1993; Stewart et al., 2006; Gregory et al., 2009).

One of the common techniques to handling building complex system dynamic models is directly with group's work model building. This kind of technique model building require just a small group of clients that has become

increasingly common in the field of system dynamics since Jac Vennix used health care as practitioners to construct and refinement of system dynamic model of health care, which has described on their research procedure (Vennix et al.) Together, many consultants have practice of developing causal loop diagram to sketches, model development, refinement and present as a client group such as Barry Richmond described on his model building and analysis strategic (Richmond). Where one of article new modeller can use as a specific guide is a paper from (Andersen and Richardson), which had discussed process scripts technique that been used to implement for small group system dynamic modelling approach from others literature since 1973.

In general, the data collection method of semi structured interviews was selected for a variety of purposes, but as a means of gathering primary data it serves two important considerations. First, it allows for an exploration of the perceptions and opinions of respondents regarding complex and sometimes sensitive issues and enables the researcher to probe for more information and clarification of answers. Second, the varying types of professional and educational background and personal histories for the individuals within the sample group precluded the use of a standardized interview schedule (Louise Barriball and While, 1994). Interviews guides or techniques can be described as existing on a continuum of structure starting, from ‘unstructured’ to ‘semi structured’ and highly ‘structured’. Each range is determined by how much ‘control’ the interviewer will have over the interaction, which is set by the researcher (Fontana and Frey, 2005) with guidance from similarly studies (Harrell and Bradley, 2009) and other proponents of a similar perspective (Charmaz and Belgrave, 2002, Knox and Burkard, 2009).

questionnaires,

surveys

3.3.4 Analysing data for system dynamic model

As the literatures review represents the most important step of the research process in qualitative research studies (Boote and Beile, 2005; Combs, Bustamante and Onwuegbuzie, 2010). This focus on the literature analysis that the data will be used for finding data results, as it been noted my Onwuegbuzie et al. (2010) about the benefits that can be derived from conducting a quality review of the literature that would be useful for the research to identify variables that are relevant to the topic, identify

relationships between theory/concepts and practice etc. According to Fraenkel and Wallen (2006) has they described that a literature review not only help researchers to collect the ideas of others interested in particular research question but it also let them deliver about the outcomes of the other similar or related studies. As purpose to collecting and summarizing literature ‘’the six steps involved in a literature search’’ is Fraenkel and Wallen (2006, p.68).

The possible qualitative analyses for this research synthase was theme analysis, where other optional techniques like constant comparison analysis, domain analysis, taxonomic analysis, componential analysis can also be used to analysed literature in a structured, and rigorous manner (Onwuegbuzie, A.J., Leech, N.L. and Collins, K.M., 2012). Theme analysis has been mentioned by Onwuegbuzie, (2012), where original defined by (Spradeley, 1979) that is conducted to discover the conceptual themes relationship among the record. Additionally, a specific advantage of theme analysis that contains an exploration for relationships among fields or factors, it also able to search for how these relationships are linked to the overall social situation (Onwuegbuzie et al., 2012). As this analysis can been used from souces like talk, documents and observations informations that can use qualitative techinque as theme analysis to inform research syntheses.

3.4 Stock and flow

Stock and flows signify the accumulation and dispersal of resources central to the dynamics of complex systems; a good example is that a population is increased by births and decreased by deaths (Sterman, 2000a). With natural meanings in many contexts outside of business and its related fields, stock and flows are the basic building blocks of system dynamic models. Jay Forrester defined them as ‘levels’ (for stock) and ‘rates’ (for flow) (Sterman, 1992). Swanson and Tay explained a stock and flow as follows: ‘A stock (or "level variable") in this broader sense is some entity that is accumulated over time by inflows and/or depleted by outflows. Stocks can only be changed via flows. Mathematically a stock can be seen as an accumulation or integration of flows over time with outflows subtracting from the stock. Stocks typically have a certain value at each moment of time e.g., the number of populations at a certain moment. A flow (or "rate") changes a stock over time. Usually can clearly distinguish inflows (adding to the stock) and outflows (subtracting from the stock). Flows typically are measured over a certain interval of time e.g.,

the number of births over a day or month.' (Swanson and Tayman, 2012). More literature will be discussed in the review.

Numerous definitions exist of the system dynamics methodology, but this research consider the main research provided by Wolstenholme (1990), Sterman (2000a), and Cavana and Maani (2000). These definitions are undertaken to answer the research question and help thinking in a rigorous way, visualising the overall problem and its main cause, and identifying the future development of complex, dynamic world issues over time. The purpose of system dynamic thinking as used herein is to solve the problems uncovered by the literature review in chapter 2 and to create a more robust design for solutions. To do this, the research begins by creating operational maps (document reviews), then using these to develop simulation models (CLDs) that externalise mental models and capture the interrelationships among physical and behavioural processes (system dynamics, stock and flow) whose sources stem from organisational boundaries, policies, information feedback, and time delays, and finally using this architecture to test the holistic outcomes of alternative plans and ideas for policy recommendations.

3.4.1 Developing a stock and flow model

Table 3-1: Comparison of different authors' steps for building an SDM

(Radzicki, M.J. and Taylor , R.A, 1997)	**(Albin, 1997)**	**(Hwang, L. and Hu, G, 1999)**	**(Sterman, 2000)**	**(Luna-Reyes L. a., 2003)**
Problem identification	Conceptualisation	Conceptualisation	Problem articulation	Conceptualisation
Develop hypotheses	Formulation	Formalisation	Dynamic hypothesis formulation	Formulation
			Formulation of simulation model	
Test hypotheses	Testing		Testing	Testing

Test policy alternatives	Implementation	Building a micro world	Policy design and evaluation	Implementation

Sources: Edited from (Luna-Reyes L. a., 2003)

Table 3-1 presents a sample of steps for system dynamic model development from different authors. It can be seen that some of these authors used different processes, but the concepts still follow the same general path; they all formulate the problem, then develop or formulate a model hypothesis [though Sterman (2000) adds the extra step of 'Formulation of simulation model'], before moving to the step of testing the model [with only Hwang, L. and Hu, G (1999) omitting this part]. For the final step, each of these authors presents their own objectives, which reflects how different model results have different implementations within an individual field. In conclusion, no matter how many steps or processes authors use and combine with their own techniques in developing an SDM, they still follow the same general concept as invented by Jay W. Forester. Additionally, there are still many SDM building techniques offered by other authors that are not shown here, such as that of Harris and Williams (2005) but theirs includes many more steps than those mentioned here and thus their process seems to be too complex. A process that seems both simple and suitable for the present research is the process used by Luna Reyes and Andersen (2003) and by Albin (1997), which follows the same steps as used in a very early work by Randers (1980). This process consists of four steps, starting with conceptualisation and then formulation, followed by model testing and finally implementation, as shown in Table 3-1 on the right side of the table.

3.4.2 The conceptualisation stage (problem definition)

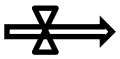
In the first stage of modeling, the real-world situation that needs to be tackled must be identified clearly. This process begins by focusing specifically on what issues the clients are most concerned with. Luna Reyes and Andersen (2003) point out that the modeling process at this stage would be high level in a more qualitative way, as it has been described as a 'mental model', including 'a verbal description of the feedback loops that are assumed to have caused the reference mode' (Randers 1980, p.199). Sterman (2000) also demonstrated that there are many methods by which the modeller can characterise the problem, including data collection, interviews, and direct observation or

participation with the client team. Sterman (2000) defined this first step as problem articulation or boundary selection, where he identifies the theme selection by asking: 'What is the problem? Why is it a problem?'

3.4.3 Stock and flow model sample

As qualitative model shown in section 3.3.1, this section will show basic sample of quantitative model stock and flow. The model was created using Vensim software, which used the symbols that described in Table 3-2 for SFD. The model used a basic examples of stocks and flow with the unit of measure from (Sterman, 2000. p, 200).

Table 3-2: Description of Vensim model symbols

Symbol	Name	Description
	Stock or levels	Levels (also called accumulations, stocks, and states). Stocks can be imagined as containers or boxes. Their value indicates the capacity or volume in the box at a certain point in time. They can have any kind of units.
	Auxiliary or constant	Auxiliary can be constant variables, data, or temporary variables used in calculations. Auxiliary does not have memory, and their current values are independent of their values at previous times.
	Shadow variable	A shadow variable serves as a reference to another variable, which has been previously named before, and allows it to be placed close to where it is needed for viewing.
	Flow	Flows can be imagined as valves. They determine the change in a stock per time step. Each flow describes an inflow (or an outflow) from a stock. Their units are determined by their associated stock (e.g., $/year, births/year…).
	Information link	The arrow is a connector that provides information from one variety to the other relationships. This can include any kind of flow between the entities, as well as material flows.

	Delay link	This connector indicates that there is a delay between when one variable affects the other.
	Cloud	The icon that resembles a cloud represents the boundary of the model, where a flow can lead to or come from a source that is outside the model's boundary.

(Source: Vensim documentation, (Ventana Systems, 2007)

The 'Population' represented a Stock shown in rectangle in Figure 3-5 as a box to hold the content of population amount in particular year. A left side flow represents an inflow to a stock of 'Birth Rate' as a pipe with valves controlling the rate of flow into a stock, which in here rate amount of people per year. Then on a right side represented an outflow out a stock 'Death Rate' as a pipe with valves controlling the rate of flow out a stock, which in here rate amount of people per year.

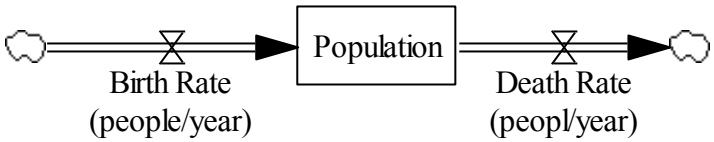


Figure 3-5 Basic stock and flow Population flow

The simulation time period units for the model's time boundaries were set to year (Units for Time = Year). The time step for the accuracy of the model simulation was set to 1 (TIME STEP = 1). The integration type used was Euler integration. The time horizon of the research model was chosen to start at 0 (INITIAL TIME = 0). Then the model would finish in 10 (FINAL TIME = 10). This research intends on simulating 10 years further. The birth rate set as 10 people per year and the death rate set as 4 people per year with the initial value of people of 0. The outcome shown in Figure 3-6 as the population will increase 6 people per year because the equation below:

$$Stock\ (t) = \int_{t_0}^{t} [inflow\ (s) - outflow\ (s)]ds + Stock\ (t_0)$$

Stock (1) = $\int_0^1 [inflow\ (10) - outflow\ (4)]ds + Stock\ (0)$

Stock (1) = 6

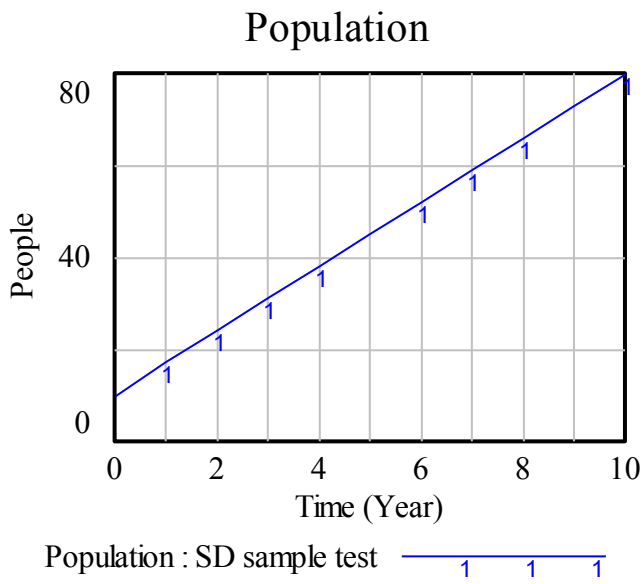


Figure 3-6 Basic stock and flow Population flow graph outcome

3.4.4 Formulating the model

Once the initial dynamic hypothesis, the model boundaries, and the conceptual model from the previous section have been developed, Sterman (2000) suggests that the next stage is to test them. No model is perfect; however, some are more valuable than others (Sterman, 2000). Even the dynamic hypothesis can be tested by experiments, but as always, conceptual models or real-world experiments are more difficult for human systems to deal with. Luna Reyes (2003) notes that this stage can be covered in part by qualitative data by hypothesising a detailed structure and selecting the limit values. Meanwhile, Albin (1997) states that this is the stage where feedback diagrams are converted to level and rate equations. Where the symbols that used in to formulate the stock and flow model shown in Table 3-2 below.

3.4.5 Testing

After the model is formulated, every equation must be checked for dimensional consistency to avoid errors in the measurement system. Diker et al. (2005) have described this step as the process of developing confidence in the model relative to its intended use. Sterman (2000) has suggested that

the model must use extreme hypothesis conditions that may never have existed before or are far from replication in the historical behaviour.

Once the initial dynamic hypothesis, the model boundaries, and the conceptual model from the previous section have been developed, Sterman (2000) suggests that the next stage is to test them. No model is perfect; however, some are more valuable than others (Sterman, 2000). Even the dynamic hypothesis can be tested by experiments, but as always, conceptual models or real-world experiments are more difficult for human systems to deal with. Luna Reyes (2003) notes that this stage can be covered in part by qualitative data by hypothesising a detailed structure and selecting the limit values. Meanwhile, Albin (1997) states that this is the stage where feedback diagrams are converted to level and rate equations.

3.4.6 Model implementation

Implementation is the final step of the modeling process. Luna Reyes (2003) suggests that at this stage the modeller needs to transfer study insights to the users of the model. Alternatively, Sterman (2000) defined this stage as a process of improvement to design and evaluate policies, once confidence in the model has been developed. At this stage, the system dynamics outcome offers the opportunity to reflect on possible outcomes, as Spectora (2001) determined that SD is useful in helping stakeholders to gain practice and experience in real life situations. The process implementation stage involves the use of 'what if' hypothesis conditions, which does not normally happen in checking the model's behaviour under various scenarios set by the modeller. In determining the model outcome, Ülengin et al. (2007) suggested that different scenarios can produce different alternative futures; thus, rather than focusing on predicting outcomes, the modeller should focus on understanding the causes that drive an outcome.

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Chapter 4 Methodology

4.1 Introduction

This chapter provides an overview of the methods used to achieve the research objectives described in Section 1.2. Various available methods were described with supporting literature in Chapter 3. This chapter focuses on the methods that were selected for this study with a strategic approach adopted to address the objectives. Each objective has different data collection and analysis methods followed by the description and the detailed techniques and processes followed by the use of system dynamics in this research as an option.

First, Section 4.1 introduces an overview of the methodology; Section 4.2 details the research objectives; and the following four sections 4.3-4.6 tackle each of the four objectives in turn. Section 4.7 explains the limitations of the methodology and Section 4.8 summarizes the ways in which ethical issues were handled and data was protected. Finally, Section 4.9 provides a summary of the methodology.

4.2 Research objective

This section explains the research objectives and expected results, as shown in Table 4-1 below. The table also gives the data collection method and information source for each objective. The objectives are as follows:

Research object lists

- Create a high-level causal loop diagram to identify factors that influence freight transport for general least-developed landlocked countries.
- Determine the factors that influence Laos transport and their relationship with one another referring to a case study of the Vung Ang port corridor.
- Develop a causal loop diagram to determine the effectiveness of Vung Ang Port corridor (VAP_CLD).
- Implement a policy on system dynamic model to improve the Vung Ang Port corridor system.

Table 4-1: Overview of research objectives

Objective	Method Used	Expected Result	Information Source
# 1	Causal loop diagram	A high-level causal loop diagram that can show factors related to freight transport in a least-developed landlocked country.	Published data and existing models from international individual organizations, reports, papers, and articles that are related.
# 2	Empirical method: • Focus group • Interview • Comprehensive review	Local perspectives on structures and behaviors within Laos' freight transport and Vung Ang Port corridor information.	Transport and logistic academics from the University of Laos. Laos' private-sector transport officials and policymakers.
# 3	Causal loop diagram	Factors that influence the effectiveness of Vung Ang Port and the Laos transport system.	Resources from objective 1 (model GL_CLD) and objective 2 (analysis outcome)
# 4	System dynamic model (stock and flow diagram)	Understanding of system behavior and the feedback structure of the Vung Ang Port corridor in various possible future conditions.	Data from objectives 2 and 3. Quantitative data: published data and empirical data from international individual organizations.

4.3 Objective 1

- Create a high-level causal loop diagram to identify factors that influence freight transport for general least-developed landlocked countries.

This first objective requires identifying the factors that influence least-developed landlocked countries (LDLCs) with respect to the inland freight transport problem. These countries have more problems than most other landlocked countries and even the geographical challenges are similar. Moreover, the data sources from this particular area were difficult to access. Many international organizations conduct research in these areas and many

relevant studies have been published, as described in Section 2.2. The process of this objective is to start by reviewing the data from published international organization sources then analyze and summarize all the factors to create an LDLC causal loop diagram (GL_CLD), which can provide visualization to better understand complex problems.

4.3.1 Collecting general LDLC freight transport data

To serve as a data source, the research followed Sterman's (2000) techniques that used available up-to-date and reliable historical data to capture process means, variance, and structures. The data were collected from other researchers and international organizations that were gathered and maintained by others (secondary data), such as done in studies by Daas and Arends Tóth (2009).

The data sources focused on secondary data literature as early as 1990 up to 2016 by hand searching from the international organization studies literature in national-level databases, in-depth reports, research studies, journals, articles, and web pages if the following journals*: United Nations, the Asian Development Bank, the Japan International Cooperation Agency*, etc. Moreover. these data were found by used multiple search methods including electronic search from the public domain (internet) using the keywords below, which were input in the search function like google scholar and Web of Science.

The keywords included:

- Landlocked country
- Landlocked countries freight transport problem
- Least developed landlocked countries transport situation
- Landlocked countries transport factors
- Landlocked countries transport policy
- Landlocked countries import/export
- Landlocked countries border crossing
- Landlocked countries port
- Landlocked countries dry port
- Landlocked countries and transit neighbours

4.3.2 Reviewing general LDLC documents

Document review was the first method this research used to gather overall knowledge fundamentals about general LDLCs. This method can cover a wide geographic and temporal range to gain a broad understanding of the research questions, as described in section 3.3.3. Researcher decided that this method was the best option such as described that the method can saving time, eliminating cost, and obtaining direct data sources from published reports and international research, where the secondary data were also helpful in designing later primary research and could provide a comparison for the primary data-collection solutions. Hence, it benefited this study to begin with a review of the secondary data for this research objective. As this method of data collection is relatively inexpensive and requires limited research time, it was a good option for finding background information quickly. Moreover, online data collection provides numerous possibilities and significant challenges, but the benefits of reducing cost, ease of data entry, format flexibility, and ability to access different populations make this type of data collection extremely appealing.

Other primary data collection methods described in section 3.3.3, were not suitable for this objective. Surveys and questionnaires have characteristic weaknesses and have little value for examining complex social relationships or intricate patterns of interaction. While personal interviews and focus groups may be useful for further work. However, the document review was also used to gather certain types of data for the case study and model building. The document review is a necessary step in implementing a fundamentals data, as the development of such a data collection tool for evaluation that can support the selection of key factors for creating any model diagrams when other data collection methods cannot be used because of limitations in time and resources. Also, reviewing existing documents allows for a better understanding of the issues, which can assist in formulating questions for other collection methods, such as interviews and focus groups.

4.3.3 Analyzing general LDLC data

The result of the data collection, even after verification, was a large amount of qualitative data. Thus, a logical form of document analysis was needed. Therefore, the content analysis followed the guidelines adapted from Bernard (1991) and Zhang (2009), such as described in Section 3.3.4. These were

chosen because they give a detailed step-by-step guide for analyzing data. Zhang (2009) also provided an example research content analysis that was similar to the research by Foster (2004). The process is described in Table 4-2.

The data from the document review had already been transcribed, as needed. All of the selected data was in English, so no translation was necessary. The sources of data were based on the literature review in Section 2.2, where the summarization was done in Section 2.2.7.

Table 4-2: Burnard (1991) stages of data analysis

Stage	Burnard (1991) stages of data analysis	Adapted
1.	Note taking	As all data came from secondary data, which has a large amount of words and information, marking words or sentences was used to scrimp the data. A personal decision was made relating to the aim of the model and noted in different categories (theme).
2.	Reading transcripts and noting the general theme	All the data were organized in seven themes, which were intended to be a group of factors, areas, or variables that were frequently mentioned as being related to general LLDC freight transport, as can be seen in sections 5.3 to 5.9.
3.	Open coding: identifying a heading that described all aspects of the content	The coding was done manually on the word count without uploading into any software tools, as the researcher wanted to focus on particular areas and did not want the model to be too broadly.
4.	Clustering: collapsing similar	As the advantage of coding manually without any software was parallel with the model drawing, the causation codes or

	themes into categories	factors that seemed to be collapsed were not to be considered.
5.	Reviewing the categories obtained in the previous stage	All factors and causation were used as a general viewpoint rather than whom or which paper responded specifically. Thus, the review of categories was based on the researcher grouping the data they were interested in or the area they wanted to focus on or represent in the model.
6.	Using other people to code data and compare coding	The data were always compared to other research data that had been noted from the first stage. However, without any other people coding data, the model could truly use an intern in the researcher's focus area.
7.	Rereading the transcript alongside categories and sub-headings to ensure all aspects of the data are fully covered	As mentioned before, the data were not using any software help. Thus, all the transcriptions were imported as sentences and converted into causation while being analyzed at the same time by the researcher to specify the links and relationships among them and categorizing headings.
8.	Coding categories and sub-headings by working through the transcript	
9.	While coding, similar sections of transcripts are cut out and grounded together in a manner that the context of the coded sections was maintained	Normally, these steps can be automatically cut out by the software tools. However, as the researcher did not use the software tools but still wanted the coding to be clear and representative.

10.	The cut out sections are arranged together under appropriateness, or otherwise, of the category system	Thus, the similar sections are cut out and grounded together by personal decision.
11.	Some respondents are asked to check the appropriateness, or otherwise, of the category system	The process uses all the secondary data to code the model. Thus, it not necessary to recheck or confirm. However, the whole model would be rechecked in specific countries' case, where all the data would be rechecked and a new specific model created based on this model structure.
12.	All sections are brought together for writing-up purposes	All the data were summarized in each section and placed in a table for clarity in section 5.2.
13.	Writing up section by section with rich quotations	With a theme determined from all the data from the document review, and the coding that emerges from the data affecting causation related to general LDLC freight transport, write up in sections 5.3 to 5.9.
14.	Linking the write-up with the literature	All the links were purely coded from the literature. Thus, it was more like a conversion stage where the literature was the main aspect coded then, in another chapter, it would be linked with the responses.

4.3.4 Developing a general LDLC causal loop diagram (GL_CLD)

This research used CLD for the first objective as its main fundamental methodology to describe the background problem of LDLCs, and to emphasize the identification of feedback paths that produce both balancing

and reinforcing feedbacks, which can then be used in the next process where the dynamic hypothesis of the characteristic problem is related.

The principal purpose of objective 1 was to produce a definite theory about the structure of the system. This required determining the key factors and how each factor connects to the dynamic characteristic system. The CLD method was chosen to represent the general LDLCs' freight transport dynamic hypothesis because CLDs produce a representation of the dynamic features of the structure in a systematic way (Sterman, 2000). Although there are similar tools that can identify the problem structure, such as a causal network (Goh et al, 2010), they are unable to generate dynamic hypotheses regarding the structure of the system problem.

The process of the model development followed the "Guideline for causal loop diagrams" from Sterman (2000, p, 141-190), specifically following the development of the case similar to the sample in "Mental Model of the Traffic Problem" by Sterman (2000, p, 178) for positive and negative loops using traffic volume dependent on congestion, which is similar to this research model.

4.4 Objective 2:

- Determine the factors that influence Laos transport and their relationship with one another referring to a case study of the Vung Ang port corridor.

The outcome from objective 1 provided a diagram of the system that presented the general structure of freight transport in least-developed landlocked countries. To understand the behavior of the freight transport system in a particular country, as each country has individual issues, as mentioned in Section 2.2, a specific case study was conducted.

Laos People's Democratic Republic (Laos) was chosen as a representative of least-developed landlocked countries from the characteristic countries in objective 1. Within Laos, the study focused on the new corridor connecting to the new port project, which was one of the policies used by Laos to stimulate development. The process included collecting data by using both qualitative and quantitative methods (document review, focus group, and interview) then analyzing and summarizing.

4.4.1 Review document case study

To serve as a data source for the CLD and SD, the data needs to be up to date and reliable. The model requires historical data to capture process means, variance, and destructions. This could include data that collected by the researcher or his organization (primary data) or data that is gathered and maintained by another (secondary data). In this research, the entire process of collecting data sources for creation of a CLD for general landlocked countries can be referred to as secondary data collection or document review, which will be followed by data source collection from semi structure interviews and a focus group.

The secondary data collection method involves collection of data from national level databases, in depth reports, research studies, journals, articles, web pages, etc., which are available on the web or from organizations such as United Nations, Asian Development Bank, Japan International Cooperation Agency, etc. As this method of data collection is relatively inexpensive and requires limited research time, it is a good option for finding background information agilely. Moreover, online data collection provides numerous possibilities and significant challenges, but the benefits of reducing cost, ease of data entry, format flexibility, and ability to access different populations make this type of data collection extremely appealing (Granello and Wheaton, 2004). More literature will be discussed in the review.

This objective required fundamental data from the published data, as described in 3.3.3. The main data collection included qualitative methods. The research technique in this section was similar to that used in objective 1. However, in this case, the review was limited to a particular country, Laos PDR, which was not covered in the literature review in Section 2.2. The review was separated and completed in Chapter 6 to explain the transport system in Laos PDR with a background of the country, corridor information relating to the port case study, and a review of the port itself.

Other possible methods for this objective include questionnaires and observations. However, questionnaires could not examine complex social relationships, and may have missed important aspects as the questions were limited by the information available to the researcher beforehand and their assumptions. Observation is suitable for collecting data about people, processes, and cultures. Lastly, in options such as the Delphi group method, it is not always possible to reach a fair consensus.

4.4.2 Focus group

The focus group method was chosen for extracting qualitative data based on the preparation supported in the literature review, as described in Section 3.3.3. The focus group method was chosen for numerous reasons, such as it is able to synthesize a wide range of views from local experts in the field. The focus group structure shown in section 7.4, where participants came from Laos' academic experts in transport and related areas like logistic, road engineering, transport economic, transport policy etc. It is also a means of gathering people from similar backgrounds and experiences to discuss the subject of interest. Participants may agree or disagree with each other, which itself provides insight into how a group thinks about an issue and the range of opinions and estimates. Lastly, it can be used to explore the meanings of survey findings that cannot be explained statistically, the scope of impressions/opinions on the subject of interest, and a wide assortment of local conditions, where, in this case, is on Laos as a representation of least-developed countries.

This research process intends to illuminate general landlocked countries freight transport causation within the Laos freight transport system by deduction. As based on the literature reviewed, this focus group involved diagrammatically expressing researchers' understanding of the causal structure of the Laos freight transport system. This step generated the fundamental structure of the Laos's freight transport system and connections with the new port case study. This led to developing initial questions for the interview method to extend the emerging causal structure.

To handle the complex modeling and facilitation processes involved in group work, the research followed the guidelines for developing and implementing focus groups shown in section 7.5 and Appendix at the end of thesis, as laid out by Krueger (1994). This study also used the "scripts" by Andersena D (1997) as the first part because this context is similar to his group modeling.

4.4.3 Group modeling

This research's focus group that described above was different from other traditional methods because the researcher combined focus group interviews and group modeling. Thus, at the end of the workshop, the participants had the option to present and answer the researcher's question, either using a causal loop diagram or their own method. The focus group questions were

adopted following the research objectives. The process is described in detail in Section 7.5.

The focus group workshop was chosen for this research because the author wanted to use this workshop for group modeling with the advantage that academic experts would join together, discuss, and present their transport opinions in a model diagram. Moreover, CLD development requires and relies heavily on respondents building on each other's experiences and remarks, as mentioned by Luna Reyes (2003). To conclude, this expectation was to use the opportunity where focus groups can collect information and an advantage to learn from local experts where the CLD is developed by them.

Selecting participants

The participants were selected following Richardson and Rabiee (2001), where through similar social characteristics they would be comfortable talking to each other and to the interviewer. To understand the local issues, information about the Laos PDR transport problem and Vung Ang Port was gathered from academics at the National University of Laos. Their knowledge of transport in Laos and transport policy involves both academic expertise and personal experience, which included academic expertise on their focus group participants with more explanation in Section 7.3.

4.4.4 Interviews

In this research, the interview method was chosen to follow up after a literature review and focus group. Other methods, as described in Section 3.3.3, were not appropriate for this research because they were too expensive and time-consuming. A semi-structured interview method was chosen, beginning with an informal interview and followed by guiding questions. This is the best method when there is only one chance to interview someone. The interviews followed the eight principles of the preparation stage with more explanation in section 7.6.

The other element of the interview preparation was the pilot test, which assists researchers in identifying limitations and weaknesses of the interview design and allows researchers to make necessary revisions prior to the study's implementation. However, there was not enough time to do a pilot test before the real interview. The researcher, therefore, conducted the interviews without a pilot test but upgraded and improved the interview structure after each interview, as needed.

The interview method was guided by information from the focus group and document review, to obtain qualitative data about policies and stakeholders, as described in Section 7.6. In addition, conducting separate interviews after the focus group that allowed the researcher to gather people from similar backgrounds and experiences to discuss the specific subject of interest, which, in this case, was Laos' freight transport and the effect of the Vung Ang Port project.

Interviewee choice

The interviewees included two main groups: the government transport sector and freight transport companies. Owing to the limited time for this research, it was important to select appropriate candidates to interview, followed by Creswell's (2007) suggestion that researchers should use one of a set of sampling strategies to obtain qualified candidates, which will produce the most reliable information. Therefore, a process similar to that of choosing focus group participants was used, with a focus on those with direct knowledge of transport in Laos. In particular, people were chosen whose location, activities, business, or responsibilities involved a certain understanding of the problem. Some interviewees also represented specific state agencies, had administrative responsibilities in transport policy planning, were experts in a particular field, and so forth. Interview 'snowballing', whereby an interviewee recruits another (Valentine, 2005), was also used to gain varied expert perspectives. As interviewing strangers usually involves a high refusal rate (Longhurst, 2003), the researcher prepared and followed a direct visiting approach for preparing and conducting interviews (Dörnyei, 2007), as described in Section 7.6.

4.4.5 Data preparation, analysis, and outcome

In this section, the analysis development followed Burnard's (1991) stage 3 to open coding in Table 4-2, to identify headings that describe all aspects of the content by reading through the transcript and generating headings or categories and writing them down (Burnard, 1991, p.462). The content analysis and the method described in Section 3.5.1 were used. The process started with reading the transcript data "word by word to derive codes" (Hsieh and Shannon 2005, p.1279). The coding was done manually on the transcripts, as described previously in Section 8.2. This coding process involved assigning a word or a short phrase to summarize the meaning of a portion of the qualitative data. As recommended by Miles et al. (2014, p.84),

it's nice to have what he calls "definition of code." This is the apparent operational guide to searching and coding data. Saldana (2013) noted that this handbook can be informed by research paradigm, theoretical approach, an emergent conceptual framework, or methodological needs. In this research, the guide is informed by the research paradigm, which is post-positivist. The "definition of code" used in this analysis has two focuses:

- Respondents' main discussion themes
- The connection between themes

4.5 Objective 3:

- Develop a causal loop diagram to determine the effectiveness of the Vung Ang Port corridor (VAP_CLD)

To understand the characteristics of the transport behavior as a model structure rather than words being explained. Thus, object 3 developed a CLD that adapted from the object 1 (GL_CLD) with the information gathered in object 2. The research used the same analysis technique for creating a CLD as was used for objective 1, as described in section 3.2.1. Thus, without collecting new data, the information from the interviews and focus group were accounted for.

The first GL_CLD was used to answer the question of general landlocked countries. One limitation of the information provided was that it was not possible to do primary data collection (document review). On the other hand, the conditions of the second set of VAP_CLD were feasible for gathering the data source. The case study required a system dynamic test plus a stock and flow outcome, which will continue to be used for the policy tested. Hence, the second VAP_CLD was created using a quantitative model with data collected by doing a semi-structured interview and focus group, and appended with a document review.

However, rather than create the CLD from a new model structure, this VAP_CLD used the model GL_CLD as the main fundamental structure. The GL_CLD was created as a high-level causal loop diagram, which identified factors that influence freight transport for least-developed landlocked countries.

4.5.1 Develop Vung Ang Port corridor causal loop diagram (VAP_CLD)

As GL_CLD was created to identify factors that influence freight transport for a general least-developed landlocked country, to develop a specific case, any supplemental links suggested and mentioned in the interviews and focus groups were added to the new diagram. The variables and relationships never found in the literature or mentioned in any workshop were assumed to be unimportant and were excluded from the new diagram. However, some additional causal links not mentioned in the interview or other data source needed to be added for basic physical relationships that were obvious to everyone.

The process of creating VAP_CLD began with the same variables, fundamentals, and causes, similar to the GL_CLD as described in Section 3.2.1, where each section followed the same theme. Each variable was renamed for an obvious specific meaning in the case study or changed to fit with the data from the respondents. To transform the general CLD to specific CLD, some variables not relevant to Laos's freight transport and the Vung Ang Port corridor were removed and some variables mentioned by the respondents were considered in composing new link relationships.

4.6 Objective 4:

- Implement a policy on system dynamic model to improve the Vung Ang Port corridor system

This objective provided a structure for Laos' freight transport and test policy options to improve the Vung Ang Port corridor. Although the researcher wanted to understand the consequences of investment on this corridor, by reason of the qualitative causal loop diagram from objective 3, it was clear it could not be used reliably to explain the system's behavior. While a CLD would help with understanding the problem structurally, the real system behavior can only be experienced through a simulated quantitative model, as discussed by Homer and Oliva (2001). Thus, a quantitative system dynamic model (a stock and flow model) was required.

The VAP_CLD from objective 3 were used as fundamentals model structure to transform to quantitative system dynamic model by adding stock and flow model in. This objective was aimed at preparing this model system as a

sample for policymakers for further development and to guide implementation for policy evaluation. The range of this research was limited owing to time and resources. However, this research model was to provide a structure for broad development in the future. This section, therefore, includes justification for each method at each development step followed the principal tools, as adapted by Sterman (2000) in the table list of “Steps of the modeling process” Sterman (2000, p, 86) in Table 4-3 below.

4.6.1 Data collection

Several basic categories of qualitative data collection are used in the social sciences. In particular, it is common to look at interviews, oral histories, focus groups, Delphi groups, observations, participant observations, and experimental approaches that lead to qualitative data (Luna-Reyes L. a., 2003). To find and collect data sources to answer the research question and supply the CLDs and system dynamic model, three main methods were used in this study: document review, semi-structured interviews, and a focus group.

This model’s main data came from qualitative data treated under objective 2, where some statistics were noted during the process and supplied by the respondents. Some variables were set using estimates based on the publishing sources, as system dynamics not only require the intense use of qualitative data but also human judgment (Luna Reyes, 2005; Ford and Sterman 1998). As noted by Ford and Sterman (1998, p, 313), the structure generated from numerical data often lacks supporting contextual information. Thus, the use of literature is considered appropriate for the chosen study location because of previous findings from international organizations and other researchers, which were described in data collection for objective 1. All the numerical data related or those that could be used for the system dynamic model were noted for this purpose.

4.6.2 Formulating a stock and flow model

The previous process of generating a dynamic hypothesis was the first phase in developing the stock and flow model, as the research data was analyzed and extended. The system dynamics concept approach is described in Section 3.2. The system dynamics approach was easy to handle, as the transport system is characterized by hidden feedbacks with time lags, as argued by Pfaffenbichler (2011). The process involved mapping the

relationships between system parameters, as well as specifying their initial conditions.

To develop the model, this research used the Vensim model software simulation environment, which is used for developing, exploring, analyzing, and optimizing simulation models (Eberlein and Peterson, 1992). It was chosen because of the ease with which it can address any type of problem. It is also able to build any model and verify it throughout the building process, which is rarely the case with other software (JJ, 2011). Additionally, to improve the model, the equation was validated iteratively by checking the system behavior's expected trend.

This objective start used the support data from objective 2 together with the VAP_CLD fundamental structure that specified the variable and provided an important basis for developing the stock and flow model. The steps for objective 3, with the VAP_CLD already conceptualizing the system dynamics model, were able to identify the relationships between variables and define the parameters with equations from significant factors. However, the model followed the rules in developing the model's equations (Ventana Systems, 2007).

Table 4-3 Steps of the modeling process by Sterman (2000, p, 86)

No.	Main step	List details	Process description
1	Boundary Selection	• Theme selection • Key variables • Time horizon • Dynamic problem definition (reference modes)	As described in objective 2, Section 4.4 and analyzed in Section 7.9. All the themes and key variables were based on this dynamic problem with specific case behavior on Laos' transport case study focusing on the Vung Ang Port corridor data.
2	Formulation of Dynamic Hypothesis	• Initial hypothesis generation • Endogenous • Mapping	This process was from objective 3 in Section 4.5, where the purpose was to create a VAP_CLD, as shown in Chapter 8, to conceptualize the system dynamics model, identify the

			specific problem, and define the significant factors related to the Vung Ang Port corridor. The outcome from objective 3 provided an important basis for the development of the stock and flow model in the next step.
3	Formulation of a simulation model	• Specification • Estimation • Tests	This was the main step done in objective 4, as described in sections 5.3 and 5.9, which show the approach of model development representing the process in which data and equations were used in the Vensim model's tools and in Chapter 9.
4	Testing	• Comparison to reference modes • Robustness under extreme conditions • Sensitivity	This step described in section 4.6.3, where the model was tested by compared the outcome to other reference data with sensitivity tests. Moreover, extreme tests were also used to create an unrealistic model. This is represented in Chapter 10.
5	Policy Design and Evaluation	• Scenario specification • Policy design • ''What if …'' • Interactions of policies	This step is defined in 4.6.4, where four different policies with similar scopes were tested to find a solution in order to recommend the best policy to improve the Vung Ang Port corridor. This is represented in Chapter 11.

4.6.3 Model validation

The model validation first tested the sensitivity of the model. As noted by Forrester (1961), "the behaviour of a model should be carefully checked".

Thus, this model was checked based on the proposed research objective and tests of validity to determine the extent to which the model fulfils that purpose (Forrester and Senge, 1980) and to determine the limitations and practicality of the model, as suggested by Diker et al. (2005).

Additionally, followed by the test that Luna Reyes (2003) highlights, the sample test defined by Forrester and Senge (1980) points out that the model structure testing could include an evaluation of model assumptions by individuals that are highly knowledgeable about consistent parts of the real system.

Finally, the last test following Sterman's (2000) suggestion, used extreme hypothesis conditions, which may never have existed before or are far from replication in the historical behavior of this corridor case.

4.6.4 Model implementation

In the final step of the modeling process, the research followed the suggestion from Luna Reyes (2003) by concluding the insights and use of the model. As Sterman (2000) described, it benefited the process by improving the design and evaluating policies after the model was developed properly, which was described in Section 3.3.4.

The process implementation followed the "12 principles for effective development and implementation of system dynamic models" concluded by Sterman (2000, p, 80-81). Moreover, the model stage involved the use of 'what if' hypothesis conditions, which did not normally occur when checking the model's behavior under various scenarios set by the modeler.

4.7 Methodology limitation

This research has four main objectives, each with their own methods. Thus, this section will describe the limitations of each step.

The first limitation, shown in objective 1, concerns a high-level CLD that intends to cover the general factors that represent the general LDLC freight transport model. The limitation of the model was that it could not present all the related factors realistically, which could lead to a huge and complex diagram that would be hard to read and understand. Nevertheless, the model used obvious factors that were frequently mentioned and formulated a model

diagram that clearly defined the problem, which was the main purpose of the object.

Secondly, in objective 2, which was more specific, the part about qualitative data collection was a limitation. The numerical data was hard to obtain because the Laos freight transport statistics from the government sector are unreliable and hard to access. Obtaining any document or information from the government required a long, complicated, formal process. Data from other sources, such as the private sector, was impossible to obtain. Thus, the only reliable measurements were taken from sources including academic literature, reports by international organizations, and some noted from the interview data. However, as the objective was aimed at understanding the specific area and identifying the data to support the model build, the data received were good enough to fulfill the process.

Lastly, to formulate a quantitative system dynamic model in objective 4, the model required quantitative specification data. However, data collection in Laos is limited, which made the model rely on published data. Moreover, this means the model could not be rechecked or confirmed by any stakeholders. The only possibility was doing the model test, where the outcome shown by the model would be useful. However, it was better to have it calibrated by respondents that experienced or were able to see the behaviors.

4.8 Ethical and data protection

This fieldwork followed the university's rules of conduct. First, an application was approved by the University of Leeds Research Ethics Committee. Interview participants received a formal letter and participant consent form. The letter explained the purpose of the research and that the data would be published in a research study.

All letters were sent to the participants a month before the interview to request their voluntary participation. In addition to giving participants time to manage their schedules, this also gave them time to prepare answers for the interview. These letters also provided a Participant Consent Form, which was translated into the local language (Lao).

As the fieldwork was conducted outside the UK, the data were saved directly on private storage and was password protected. The data was also saved to the M drive of the University of Leeds' secure system. To properly protect all the data, the researcher's laptop and external hard drive have advanced

security password protection from Information IT systems services. In accordance with the University Information Protection Policy, the laptop was also encrypted by Leeds University ISS.

4.9 Conclusion

This chapter details the research method, including the justification of methodological approaches, which was used for each objective. The methods adopted were reviewed supported by literature and some sample processes together with the link to full details in each chapter.

To conclude, the first research objective was accomplished to answer the first research question by developing a causal loop diagram with the data from a comprehensive review. Then, the second objective got into detail especially data with used of a qualitative approach that combined data from a focus group, semi-structured interviews, and a literature review from local experts. Despite this, the third objective used the same method as the first objective but used the results from objective two combined with the literature review to develop a CLD, which resulted in a possibly more specific focus. It can be seen that the last objective adopted a system-dynamic model to involve the development of the case study approach using all the data sources from the previous objectives to develop a stock and flow model, where the methodology's limitations and ethical and data protection were described.

Chapter 5 Least-developed landlocked countries' freight transport causal loop diagram

5.1 Introduction

This chapter present and describe a general CLD of the freight transport structure of least-developed landlocked countries (LDLCs) in terms of the causal feedback structure of the system, in accordance with the technique described in 3.2.1 with the intention of the key dynamic factors within groups. This chapter uses data sources from a literature and document review as secondary data to produce a variable and causal link relationship that shows either balancing or reinforcing feedback (Daas and Arends Tóth, 2009), together with the document review reported in Section 2.2 and the list of key issues in Section 2.2.7, to develop grounded theory for the structural modeling approach technique to observe the direct links between connected factors. This process begins by offering a CLD feedback link, followed by a description of the variables and an explanation of the causal links. In the final sections, the causal loop diagram will be provided and all the mini diagrams will be combined to provide the final CLD for general LDLCs.

The first development of the causal loop diagram model, LDLC_CLD, for this research begins in Section 5.2 by transforming the summarized list of issues from Section 2.2.7 into a dynamic factor within the system and presenting a list of key summary variables. Then a recommendation to the policy maker diagram development was described in sub-sections i to vii respectively such as show below:

i. LDLCs' exportation loop:
ii. Accessing the global markets loop:
iii. Transport mode choices loop:
iv. Transit neighbour's infrastructure loop:
v. Border crossing loop:
vi. Regional cooperation loop:
vii. Regional investment loop:

Section 5.3 describe the recommendation of this CLD to the policy maker. E End with section 5.4, which will have the final the diagram of this chapter.

showing a combination of all mini diagrams as the LDLC_CLD outcome with conclusion.

5.2 LDLC_CLD overview

This section combines all the previous mini diagrams and develops them into the LDLC_CLD, as shown in Figure 5-1. This CLD represents a dynamic hypothesis about the factors that influence freight transport for LDLCs. It shows that growth in LDLC transport infrastructure will cause the number of domestic road networks to increase and will give rise to a similar increase in the number of corridor choices for trade. This, in addition to LDLCs having a better chance to access the global market, will contribute to an increase in exports. However, without regional cooperation, LDLCs will not be able to connect to the network corridors.

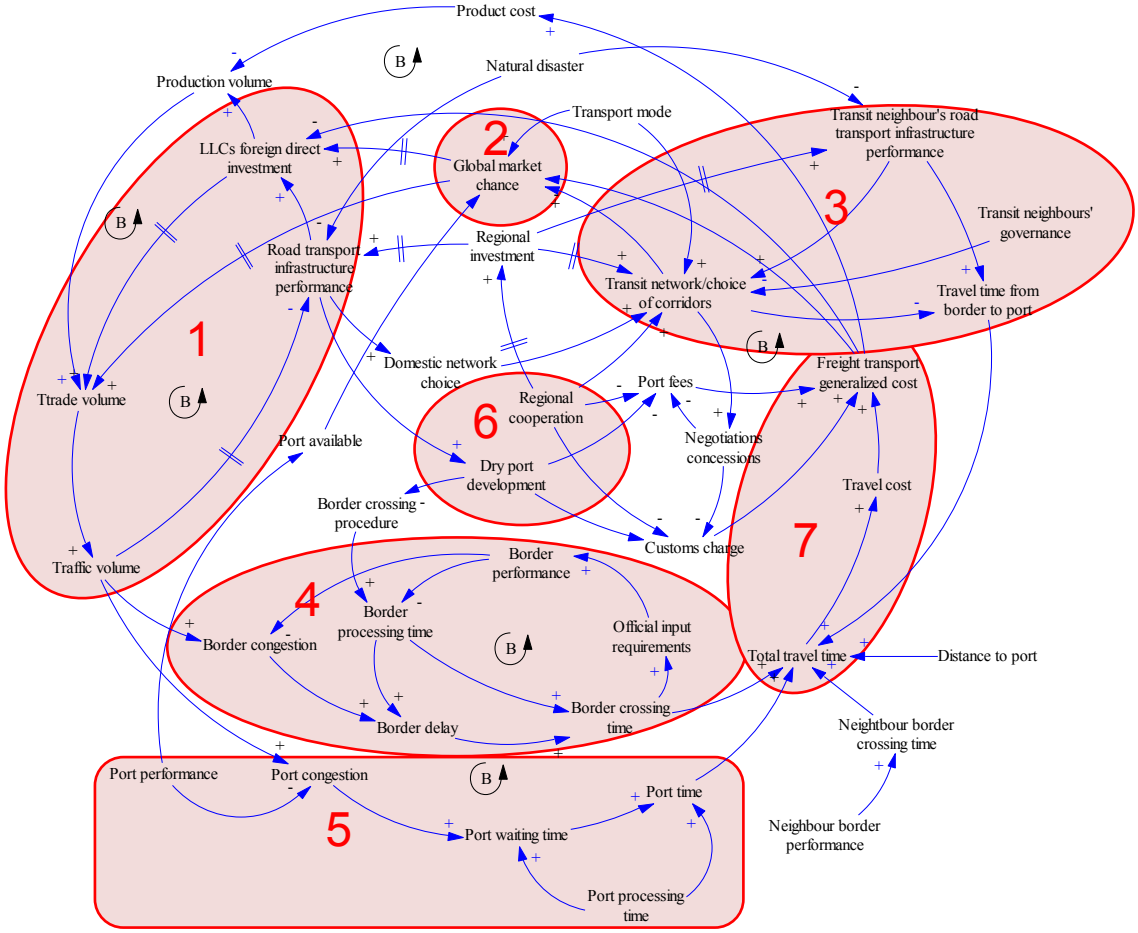


Figure 5-1 LDLC_CLD overview

i. LDLCs' exportation loop

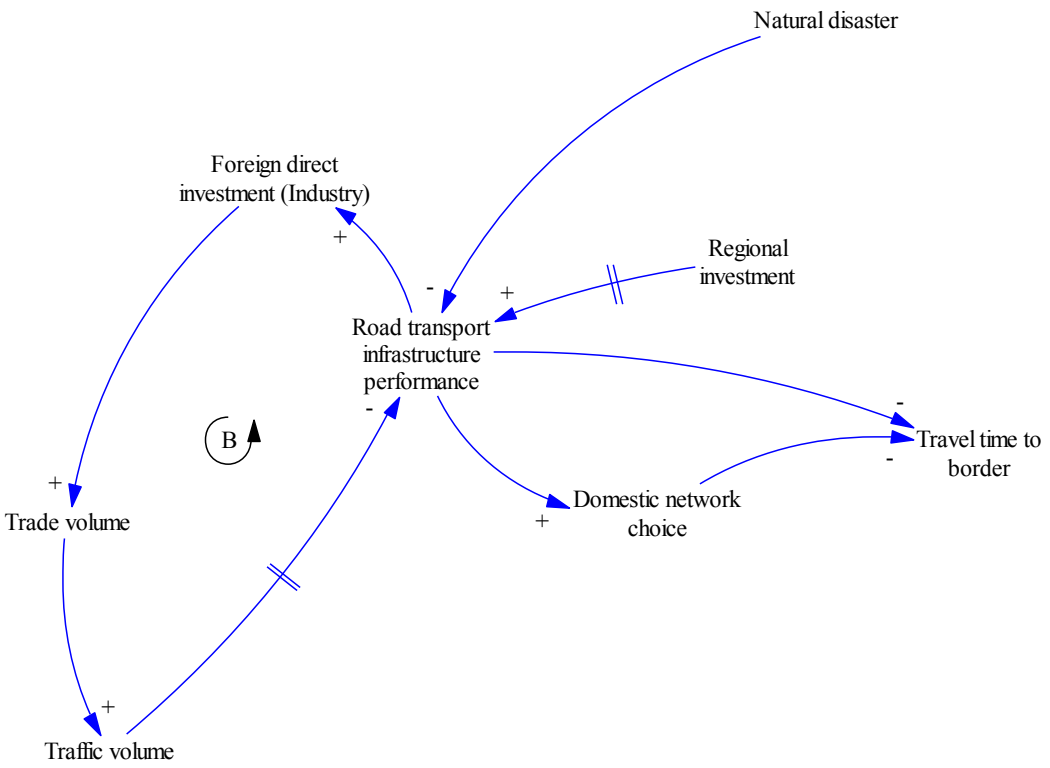


Figure 5-2 LDLCs' exportation loop

It can be seen that the internal transport infrastructure is a significant factor that determines whether and how much an LDLC can engage in trade. It reflects that it is difficult for any type of trade to travel from origin A to destination B without being affected by the physical infrastructure, where in here the mini loop diagram started by represents road transport infrastructure quality as central that links with others factors related. Where focused on the loop impact where if the road quality increase would lead to have attract new foreign investment, which increase the trade volume to import/export as it means the traffic volume will increase. However, as the traffic volume increase, in the long-term effect it will cause some damage to the road quality.

Additional variables and causal links are described in Section 2.2.1 and the tables below. A clarification of Figure 5-2 is given in Table 5-1 and the causal link is explained in Table 5-3, which provides an overview and description of each cause, as well as information about the causal link relationship.

Table 5-1: Description of LDLCs' exportation loop

Variables	Description
1. Road transport infrastructure quality	Road infrastructure quality refers to the overall level of quality of various physical infrastructure, such as road conditions and all import/export facilities that can be specified as worse, normal, good, or high standard, for example.
2. Trade volume	The trade volume of the landlocked countries is the volume of exports/imports being transferred to the foreign market.
3. Foreign direct investment (industry)	Foreign direct investment is defined as the investment made by foreign companies that manufacture goods for export.
4. Traffic volume	This variable is the number of vehicles (trucks) on the road that LDLCs use as a transit corridor through neighbour's.
5. Regional investment	Regional investment refers to regional cooperation projects that may be beneficial to regional countries, where frequently funded by international countries or organizations.
6. Domestic network choice	Amount of internal routes choice, which can connect to the access paths of the neighbour's seaport.
7. Travel time to border	The time that trucks take on the road from warehouse to the border.
8. Natural disaster	An unexpected situation that may affect any infrastructure, especially the road condition.

Table 5-2: LDLCs' exportation loop

Causes	→ (+/-) Effect	Description
1.) Road transport infrastructure quality	(-) Travel time to border	Internal road transport infrastructure affects the speed of trucks. By standard highway, trucks are twice as fast compared to poor road conditions, which can only be lower than 50 km/hour.

Causes	→ (+/-) Effect	Description
2.) Road transport infrastructure quality	(+) Domestic network choice	In many cases, LDLCs cannot take advantage of the corridors of transit neighbours because of their poor road conditions.
3.) Domestic network choice	Travel time to border	Countries with alternative domestic routes that connect with neighbouring countries are always helpful to reduce travel time because they can use or pick the short way.
4.) Road transport infrastructure quality	(+) LDLCs' foreign direct investment	Countries with unfavorable transportation infrastructure do not attract foreign investors.
5.) LDLCs' foreign direct investment	(+) Trade volume	Statistical data show that countries with open doors for foreign direct investment are seeing growth in trade volumes.
6.) Trade volume	(+) Traffic volume	Admittedly, increased international trade will affect the number of vehicles in the corridor.
7.) (+) Traffic volume	Delay (-) Road transport infrastructure quality	When the road is good enough to attract vehicles, there is feedback in the long-term from the increase of traffic volume to have an effect on the road conditions to be decreased and maintenance is required faster. Delay: The delay time could be around 3-5 years, where the traffic volume increase means the more truck or vehicle will run on that road, which might increase more than the construction expectation, which could possible causing the road condition.
8.) Natural disasters	(-) Road transport infrastructure quality	One of the factors that could cause the road conditions is unexpected natural disasters, in which certain LDLCs are always present.

Causes	→ (+/-) Effect	Description
9.) Regional investment	Delay (+) Road transport infrastructure quality	Transport infrastructure issues require investment in projects that involve a lot of expenses. LDLCs with limited development funding would have less gradual improvement without help from others. Delay: The delay could possible happened around 10-15 year including document process and construction.

ii. Accessing the global markets loop:

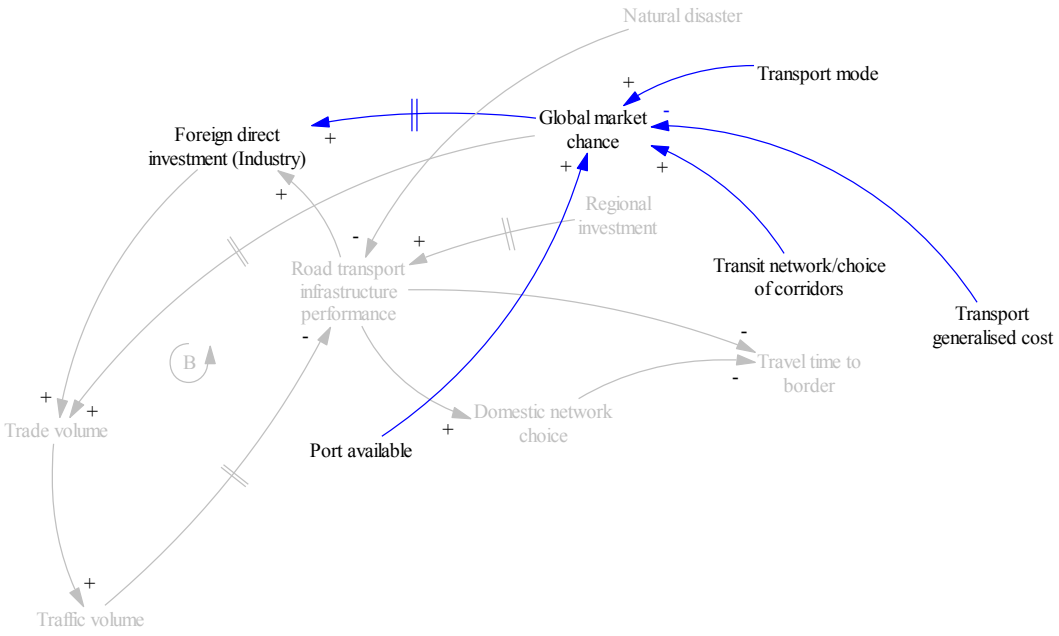


Figure 5-3 Accessing the global markets

Following from the discussion of LDLCs' transport infrastructure in the previous section, it is necessary to understand what are the reason why LDLCs lag behind others countries in term of global market change. Thus, this factor uses a variable of ''Global market change'' as a central diagram to present what are the factors that related. Table 5-3 provides a description of the variables in Figure 5-3 while Table 5-4 gives an overview of the sources' causal relationships.

Table 5-3: Description of the global market access variables

Variables	Description
9. Transit network	A landlocked country's transit network/choice of corridors is defined as the number of neighbour's routes that are connected with the landlocked country's domestic network, both of which must be in sufficient condition to permit delivery the goods to the port.
10. Global markets potential	The potential for landlocked countries to trade their products with global overseas markets through transit neighbours.
11. Transport mode option	LDLC transport mode selection refers to the number of transportation options that may include roads rail, vessel, and air planes.
12. Ports available	The number of possible ports that the LDLC can transport to the global market.
13. Freight transport generalized cost	Represent the sum of the freight costs of LDLCs.

Table 5-4: Accessing the global market causal links

Causes	→ (+/-) Effect	Description
10.) Transit networks/ choice of corridors	(+) Global market chance	The number of corridor options is very important for LDLCs, especially for small countries. LDLCs with little or no alternative choice would be fully controlled by the owner, which is likely to reduce trade opportunities significantly.
11.) Freight transport generalized cost	(-) Global market chance	In terms of economic transport, transportation cost for a product is one of the most important factors. Countries with high

Causes	→ (+/-) Effect	Description
		transportation costs are less likely to be in the global market.
12.) Transport mode	(+) Global market chance	There are many options to travel to foreign markets or overseas destinations. However, with fewer transport modes, choices may be difficult for LDLCs to reach because they may require multiple transitions that increase the price and time significantly, which, in turn, will affect global market opportunities.
13.) Global market chance	Delay (+) Foreign direct investment	In terms of economic transport, investors are looking for areas of advantage while any potential global market may attract new investors into that country. Delay: The delay would take around 3-5 year or more than that based on the the contract or the trent of investment, where foreign investor will decided to move to invest after seeing the opportunity, which in here global market chance.
14.) Global market chance	(+) Trade volume	The data show that most LDLCs trade with their neighbour's. However, growing business with foreign markets will increase the country's export volume to meet the increasing demand and benefits.
15.) Road transport infrastructure quality	(+) Global market chance	To be able to use as a standard corridor, both internal and external structures must have the same quality or similar structure. However, most of the quality of LDLCs domestic transportation was not good enough to link with neighbouring public transport. Thus, upgrading internal transport infrastructure could increase global market opportunities

Causes	→ (+/-) Effect	Description
16.)Port available	(+) Global market chance	Most LDLCs consider that road transport is the primary transport. However, access to the international market must pass through the port. As a landlocked country with many options for providing services close to the ports, there is a greater chance that these LDLCS will gain access to the global market, as opposed to one with a few port options.

iii. Transport mode choices loop

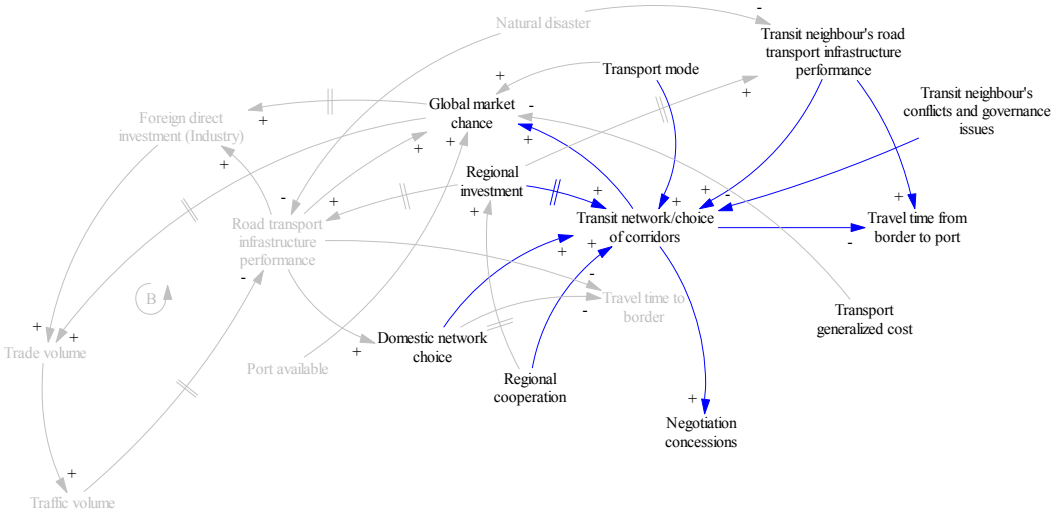


Figure 5-4 Transport mode choices loop

Continue from the previous section, which present the factors that made LDLCs global market change lower than their neighbour's, one of the main issues is because LDLCs have few transit networks to go the port. Thus, this section showing the general factors that causes to ''Transit network'' of LDLCs. A general description of this variable is given in Table 5-7 while Table 5-6 provides an overview of the meaning of Figure 5-3 and its supporting references.

Table 5-5: Transport mode choice variables description

Variables	Description
14. Transit neighbour's road infrastructure quality	Transit neighbour's road transport infrastructure refers to the overall level of quality of various physical infrastructure, such as road conditions and all import/export facilities that can be specified as worse, normal, good or high standard, for example.
15. Travel time from border to port	The time that trucks take on the road from border to the port.
16. Negotiation concessions	The LDLC's concessions in negotiations were defined as the negotiating trade-offs where the landlocked country engages with their transit neighbour's in terms of transport agreements.
17. Regional cooperation	Regional cooperation refers to the scope of the framework, which includes a number of agreements or common goals for inspiring self-development in the LDLC's and around neighbour's in the region.
18. Transit neighbour's conflicts	Conflict and neighbour's governance issues are situations in which two or more scenarios can create specific corridors to prevent LDLCs from accessing ports—an uncontrollable situation.

Table 5-6: Transport mode choice causal links

Causes	(+/-) Effect	Description
17.)Transport mode	(+) Transit network/choice of corridors	LDLC transportation modes may be limited owing to specific circumstances, such as certain types of transportation may not be available in some countries or may not be available as a result of geographic, financial, or technical reasons. Countries with alternative transportation modes will be able to connect to existing ways.

18.) Transit neighbour's road infrastructure quality	(+) Transit network/choice of corridors	Regardless of how much infrastructure is being developed in the country, all their transport systems still rely on neighbour's transportation. Therefore, the infrastructure of the neighbours in their freight corridor is important in choosing the transit route to reach the nearest port.
19.) Transit network/choice of corridors	(-) Travel time from border to port	LDLCs are willing to reach more than one market. However, for different areas, alternative corridors will save them a lot of time as they can choose wisely.
20.) Transit network/choice of corridors	(+) Negotiation concessions	It is difficult for LDLCs to control their freight through neighbouring countries. Further, when there are few LDLC routes, there is less chance of having good conversations with neighbours to come to an agreement.
21.) Regional cooperation	(+) Transit network/choice of corridors	Regional cooperation can strengthen regional corridors by opening different routes for LDLCs that may be involved in investment projects, as these countries need to be improved, especially in infrastructure to connect with neighbour's highways.
22.) Regional cooperation	Delay (+) Regional investment	Regional cooperation can strengthen regional corridors by attrach the investment from investor in the regional or external foreign investor Delay: The delay time would take around 5-10 year to deal with the cooperation and documentation before it start construction on any investment.

23.) Domestic network choice	(+) Transit network/choice of corridors	To be able to use as standard corridors, both internal and external structures must have the same quality or similar structure. However, the quality of domestic transportation of many LDLCs was not good enough to link with neighbouring public transport.
24.) Regional investment	Delay (+) Transit network/choice of corridors	Regional investment would improve regional infrastructure that covers both LDLC and neighbours in transportation together as is part of the investment project. Delay: The delay would take around total 10-15 years after decided to invest, bilateral agreement to connect the corridor and construction time as average 5-10 year.
25.) Regional investment	Delay (+) Transit neighbour's road infrastructure quality	Regional investment would also improve neighbour's infrastructure that covers both LDLC and neighbours in transportation together as is part of the regional investment project. Delay: The delay would take around total 10-15 years after decided to invest, bilateral agreement to connect the corridor and construction time as average 5-10 year.
26.) Transit neighbour's conflicts and governance issues	(-) Transit network/choice of corridors	When neighbouring countries are involved in civil war or other conflicts, they may cause damage to transportation routes. In some cases, the neighbours have their own problems that affect the corridors, where it may also be possible that the country's governance process may

		affect the transport arrangements with LDLCs.
27.)Natural disasters	(-) Transit neighbour's road infrastructure quality	Natural disasters are one factor in many cases. But when these happen, they can affect the infrastructure of neighbouring countries, with some routes that are not available for a long time.
28.)Transit neighbour's road infrastructure quality	(+) Travel time from border to port	Time when trucks are used on the road from the border to the dock, which is a neighbour's transit road. The speed and time travel of the truck depends on the quality of the road.

iv. Border crossing loop:

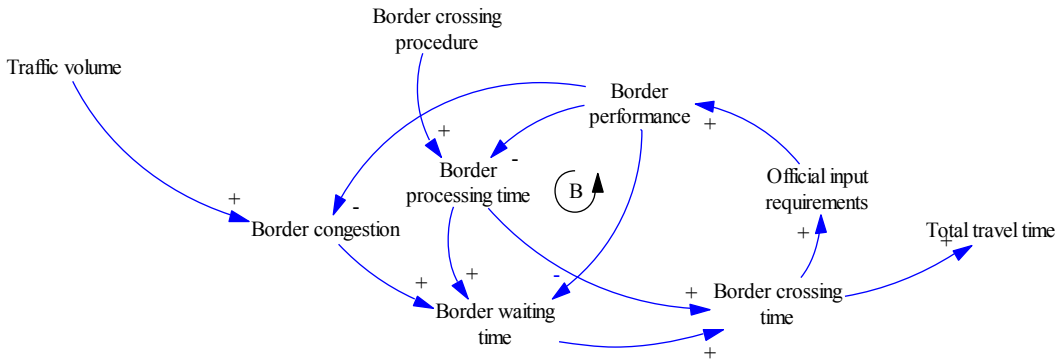


Figure 5-5 Border crossing loop

From the review section 2.2.4, LDLCs border crossing seem to be one of the most significant problem, which every LDLCs hardly to deal with. Thus, this section presents a diagram showing the border processing system and the balancing loop of the border official input system. A description of this variable is provided in Table 5-11 while Table 5-8 provides an overview of the meaning of Figure 5-5 and its supporting references.

Table 5-7: Border crossing loop variable description

Variable	Description
19. Border congestion	Cross-border congestion is defined as the density of traffic of the vehicle (truck) at the border. The number of vehicles influences the speed or time of the vehicle movement, which can take longer than the average because there are too many vehicles crossing at the same time, which may lead to delays at the border.
20. Border waiting time	The waiting time here is for the time the driver stays in the queue (wait queue).
21. Bureaucratic crossing procedures	The procedures number and official documents required to cross the border.
22. Border processing time	Determine the time of the border process taken when crossing the border.
23. Border quality	Cross-border quality refers to the combination of telecommunications technology, infrastructure, and location efficiency. Each part has its own quality measurement. However, this critical variable is defined as the overall quality level of the border.
24. Official input requirements	By reason of the delay or border processing, the system requires the input staff to speed up the system.
25. Border crossing time	Defined as the total time taken at the LDLC's border before crossing or entering the neighbour's border.
26. Total travel time	Total time for transport is the time taken to deliver the material from the shipping area (landlocked country) to the nearest port before sending to the international market, which may be on other continents over the ocean.

Table 5-8: Border crossing loop causal links

Causes	(+/-) Effect	Description
29.) Traffic volume	(+) Border congestion	The corridor connecting the transit border; the number of vehicles on the road is a factor in border congestion.
30.) Border quality	(-) Border congestion	In the case of border congestion, many of the vehicles on the border are more than the border's capabilities. Optimizing border quality, such as adding more lanes or improving other's capacities can reduce congestion owing to more space or stations.
31.) Border congestion	(+) Border waiting time	Because the congestion affects the speed or movement time of the vehicle, it may take longer than average because there are too many vehicles at the same time, which means that the waiting time will increase if there is high congestion.
32.) Border quality	(-) Border processing time	Crossing the border requires a lot of bureaucracy, but LDLCs have a lack of facilities and technology in place. Therefore, the border with low quality will take longer to process than it should.
33.) Border quality	(-) Border waiting time	The quality of the border also means lanes or other facilities that allow vehicles to move smoothly follow the procedure. So, if the quality is low, the course will be delayed during the waiting period.
34.) Border crossing procedure	(+) Border processing time	The number of crossing procedures, such documentation and inspection, are important to the total processing time, as most LDLCs' processes were slower than average. If more steps are taken, delays will be increased.
35.) Border processing time	(+) Border waiting time	If the processing time is high, this will lead to long waiting at the border.

Causes	(+/-) Effect	Description
36.) Border waiting time	(+) Border crossing time	For export or import time, the total border crossing time considers two facts: the processing time of the border and the waiting time, as both will support the same flow.
37.) Border processing time	(+) Border crossing time	
38.) Border crossing time	(+) Official input requirements	LDLCs have low technological border processing systems. Thus, when the border crosses reach the highest standard, they will need more staff to help with this situation because most systems are manually completed.
39.) Official input requirements	(+) Border quality	Because the efficiency of the border is due to insufficient personnel, incoming employees will increase the efficiency of the border.
40.) Border crossing time	(+) Total travel time	Crossing the border is considered part of overall transport time, which can lead to extended time if the truck is stuck at the border.

v. Port and transit neighbour's infrastructure loop

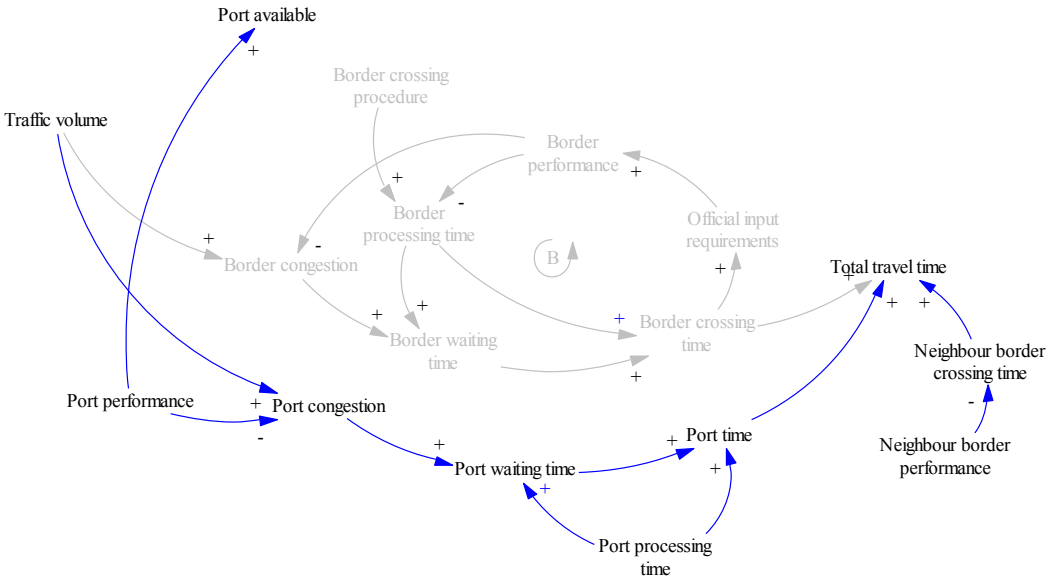


Figure 5-6 Port and transit neighbour's infrastructure loop

Port is where the road transport finish before change to travel by vessel to the third county destination. Thus, mostly a transport travel time would calculate end of this transport process. Moreover, a port system is very complex and the LDLCs not able to control. This section presents a simple diagram factors that show the link between the port qualities that can have impact to the port congestion where all these will be count at the end of total travel time account. A description of this variable is provided in Table 5-9 while Table 5-10 provides an overview of the cause link of Figure 5-6.

Table 5-9 Port and transit neighbour's infrastructure loop variable descriptions

Variable	Description
27. Port quality	Port quality refers to the combination of many parts such as technology, infrastructure, efficiency, capacity, and facility etc. Each part has its own quality measurement. However, this critical variable is defined as the overall quality level of the port.
28. Port congestion	Port congestion is defined as the density of traffic of the vehicle (truck) at the port entrance. The number of vehicles influences the speed or time of vehicle movement, which can take longer

Variable	Description
	than average because there are too many vehicles crossing at the same time, which may lead to delays at the port.
29. Port waiting time	The waiting time here is for the time the driver stays in the queue (wait queue) for port processing and others like loading/unloading containers.
30. Port processing time	The time of the port process takes when crossing the border, which includes document and physical inspection.
31. Port time	The time taken at the port until goods or containers are loaded on the ship or vessel ready for shipping.
32. Neighbour's border quality	The overall quality of the neighbour's border, where the quality refers to the combination of telecommunications technology, infrastructure, and location efficiency. Each part has its own quality measurement. However, this critical variable is defined as the overall quality level of the neighbour's border.
33. Neighbour's border crossing time	Defined as total time taken at the neighbour's border.

Table 5-10 Port and transit neighbour's infrastructure loop variable causes and effects descriptions

Causes	(+/-) Effect	Description
41.)Traffic volume	(+) Port congestion	The more vehicles entering the port makes the border more congested.
42.)Port quality	(+) Port available	Many LDLCs may have multiple ports near them, where some ports are not available or not capable.
43.)Port quality	(-) Port congestion	In the case of port congestion, many of the vehicles at the port are more than the border's capabilities.

Causes	(+/-) Effect	Description
44.) Port congestion	(+) Port waiting time	With congestion at the port, the speed or vehicle movement may take longer than average because there are too many vehicles at the same time, which means the waiting time at the port will increase if there is high congestion.
45.) Port processing time	(+) Port waiting time	If the processing time is high, this will lead to very long waiting times at the port.
46.) Port waiting time	(+) Port time	For the port time for export, the time is determined by the three factors: waiting time, document processing, and physical inspection and loading, which are all included in the processing time.
47.) Port processing time	(+) Port time	
48.) Port time	(+) Total travel time	Using the port is considered part of overall total travel time, which can lead to extensive time if the truck is stuck at the port, where some LDLCs could wait more than a week or a month.
49.) Neighbour's border quality	(-) Neighbour's border crossing time	Time crossing the neighbouring border is considered as the overall time taken, such as processing, waiting time, and physical inspection. Therefore, overall quality will affect the time it takes to cross.
50.) Neighbour's border crossing time	(+) Total travel time	For exporting, LDLCs crossing neighbouring borders often takes time less than internal borders. However, some transiting countries have many procedures, which add to the total travel time as well.

vi. Regional cooperation loop

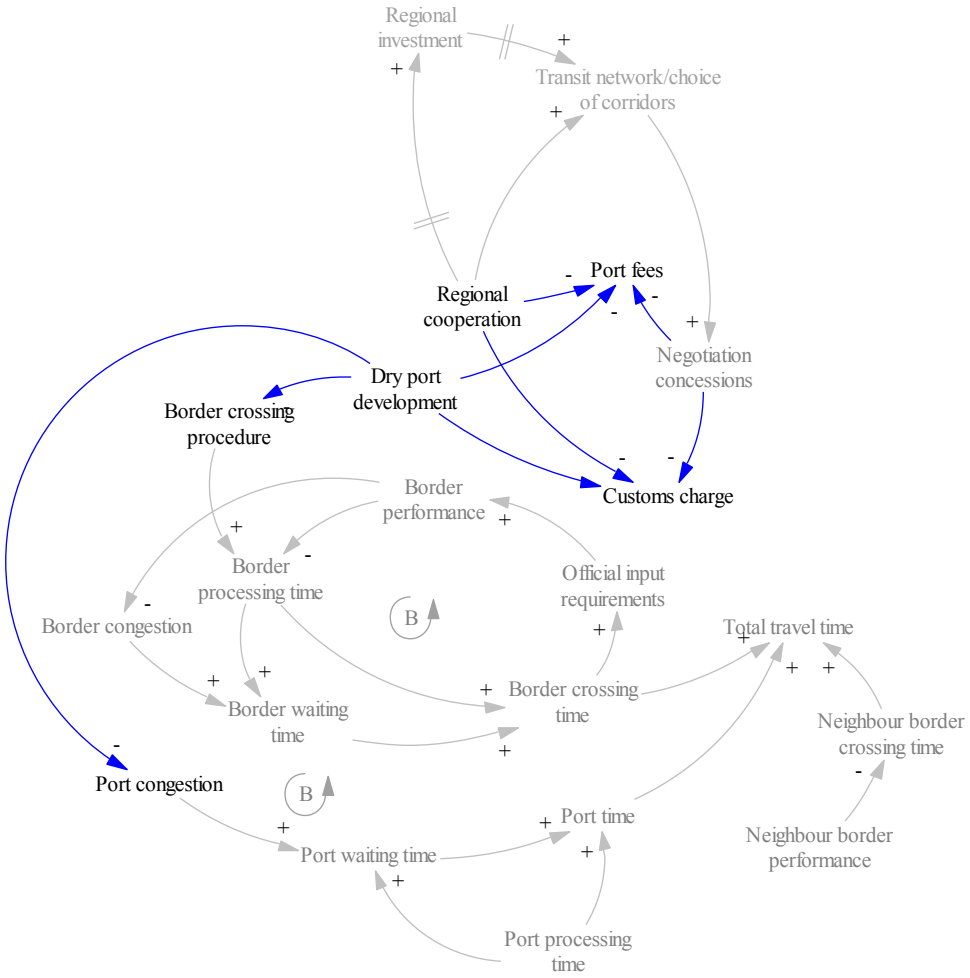


Figure 5-7 Regional cooperation loop

Many LDLCs have able to solve their freight transport problem by operated a dry port. However, the dry port operation will work best together with regional cooperation. This diagram will present a link that can have benefit from both dry port development and regional cooperation together. A description of this variable is provided in Table 5-11 and Table 5-12 provides an overview of the meaning of Figure 5-7 and its supporting references.

Table 5-11: Description of the regional cooperation variable

Variable	Description
34. Dry port development	With common investments to challenge border and port delays in many countries, especially for landlocked countries, the dry port development here tend to represent the number of dry docks in the corridor or in the country.
35. Port fees	Fees that are considered payments at the port, which represent all payments, such as inspection documents and other systems, such as handling charges.
36. Customs charge	Fees that are considered payments at the border, which represents all payments, such as inspection documents and other system procedures.

Table 5-12: Regional cooperation loop causal links

Causes	(+/-) Effect	Description
51.) Dry port development	(-) Border crossing procedure	Transportation with the use of dry ports. Some regulations required at the border or port process can be done or have to be done at the dry port first, especially for physical inspections, which means decreasing the required process at the border. In addition, all payments are charged at the dry dock, which may have some discounts.
52.) Dry port development	(-) Port fees	
53.) Dry port development	(-) Customs charge	
54.) Dry port development	(-) Port congestion	With transport operations at dry ports, bottleneck traffic at port entries can be reduced, as having a greater number of dry ports will reduce port congestion because many products can be loaded together if they are going to the same port. Moreover, the documentation and inspection can be done at the dry port, which can then cut out the waiting time and congestion.
55.) Regional cooperation	(-) Port fees	Good regional cooperation can be negotiated to reduce costs at the port, as they benefit from the

		cooperation of landlocked countries and transit neighbour's trading.
56.) Regional cooperation	(-) Customs charge	Excellent regional cooperation leads to beneficial bilateral agreements between landlocked countries and their transit neighbour's, where landlocked countries could ask transit neighbour's to reduce customs charges. Conversely, situations involving worsening relations between countries in the region can cause neighbour's to increase customs charges.
57.) Negotiation concessions	(-) Port fees	With a number of negotiated deals being discussed, there is the opportunity to build a deal that will lead to negotiation to reduce transportation costs, where the two main points are the border and the port.
58.) Negotiation concessions	(-) Customs charge	

vii. Regional investment loop:

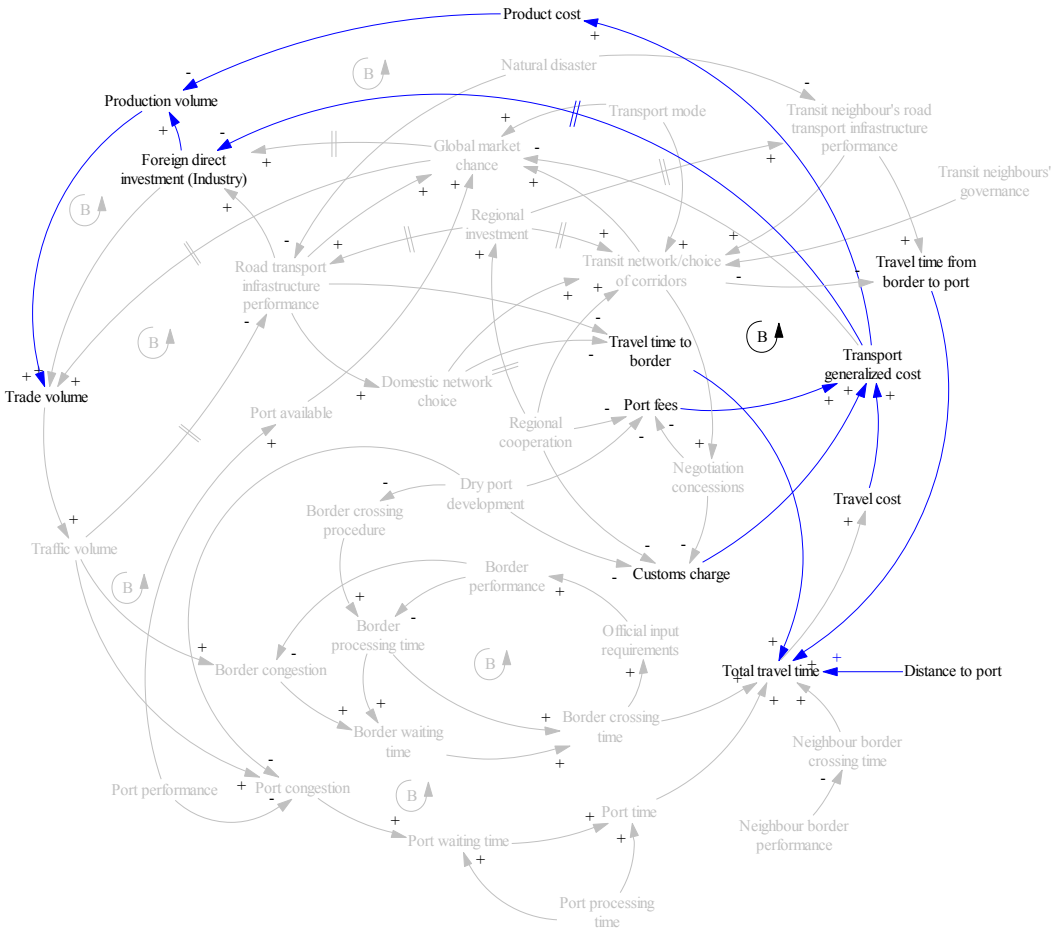


Figure 5-8 Regional investment loop:

As rely that LDLCs have high freight transport cost and take longer time than others countries to export/import goods, which made they product higher price in the market. Thus, this section wants to present the factors that causes the travel time and freight transport cost of LDLCs freight transport system. A description of this variable is provided in Table 5-13 and Table 5-14 provides an overview of the meaning of Figure 5-8

Table 5-13 Regional investment loop causes description

Variable	Description
37. Distance to port	The measure of corridor distance or the road distance from the factory or warehouse to port destination in kilometers.

38. Travel cost	The shipping cost calculated based on total travel time at no additional cost.
39. Product cost	The cost of the average product produced for export.
40. Production volume	The number of products that a landlocked country can produce for export to the international market.

Table 5-14 Regional investment loop causes and effect description

Causes	(+/-) Effect	Description
59.) Distance to port	(+) Total travel time	One of the main influences on travel time comes from the road time taken where landlocked countries have high freight transport owing to having a long distance from the factory or warehouse to the port, which causes their trucks to travel longer than other countries' trucks.
60.) Total travel time	(+) Travel cost	All travel time, from the trucker at the warehouse through the dry port to the port and the stopping time, such as waiting for the time owing to queues or procedures, is measured as travel cost. Increasing the time will increase the cost.
61.) Travel time to border	(+) Total travel time	Travel time on the road is divided into two parts. The first part is from the time taken to the border and the second is the time taken from the border to the port.
62.) Travel time border to port	(+) Total travel time	
63.) Travel cost	(+) Freight transport generalized cost	Freight cost is calculated from the total cost of travel, plus the total cost of the process, all of

64.) Port feeds	(+) Freight transport generalized cost	which are backed up to increase the cost of general transportation.
65.) Customs charge	(+) Freight transport generalized cost	
66.) Freight transport generalized cost	Delay (-) Foreign direct investment (Industry)	Investors who are looking for areas with low payments and low shipping costs are one of the main considerations for attracting investors. Countries with low average transportation costs will benefit by attracting many foreign investors. Delay: The delay would take around 3-5 year or more than that based on the the contract or the trent of investment, where foreign investor will decided to move to invest after seeing the opportunity of transport cost changed.
67.) Freight transport generalized cost	(+) Product cost	Freight transportation is an asset included in the cost of goods, with any costs necessary to procure the asset in place and ready to use. Therefore, if the goods from the location have high transportation costs for delivery to the customer, the price will also be high.
68.) Product cost	(-) Production volume	If the cost of the product is cheap, it will be possible to produce more. On the other hand, if the cost of goods is high, it will have a negative impact on production.
69.) Foreign direct investment (Industry)	(+) Production volume	Increasing the number of industries in many countries will lead to more goods.
70.) Production volume	(+) Trade volume	A lot of goods mean a lot of trade or transportation takes place in that area or country

		to deliver products to customers inside or outside the country.

5.3 Recommendation to the policymakers

For the policymakers in general, this landlocked freight transportation CLD would be useful for them to see the view of the weirdest ranges, where the model created would be practical to understand the link between each variable area and factor of freight transportation while being a tool that can help policymakers that intend to solve the national freight problem. This model diagram would be able to summarise various information combined from various data sources from different case LLDCs together, which would possibly be many pages but organised into one picture. So, when policymakers want to create a new policy that will solve some issues that show up in this CLD, they will be able to see what situation they will face and what that policy can be affecting or what can be influenced to fix that area they are interested in, so they can be prepared and find more information on that area.

5.4 Conclusion

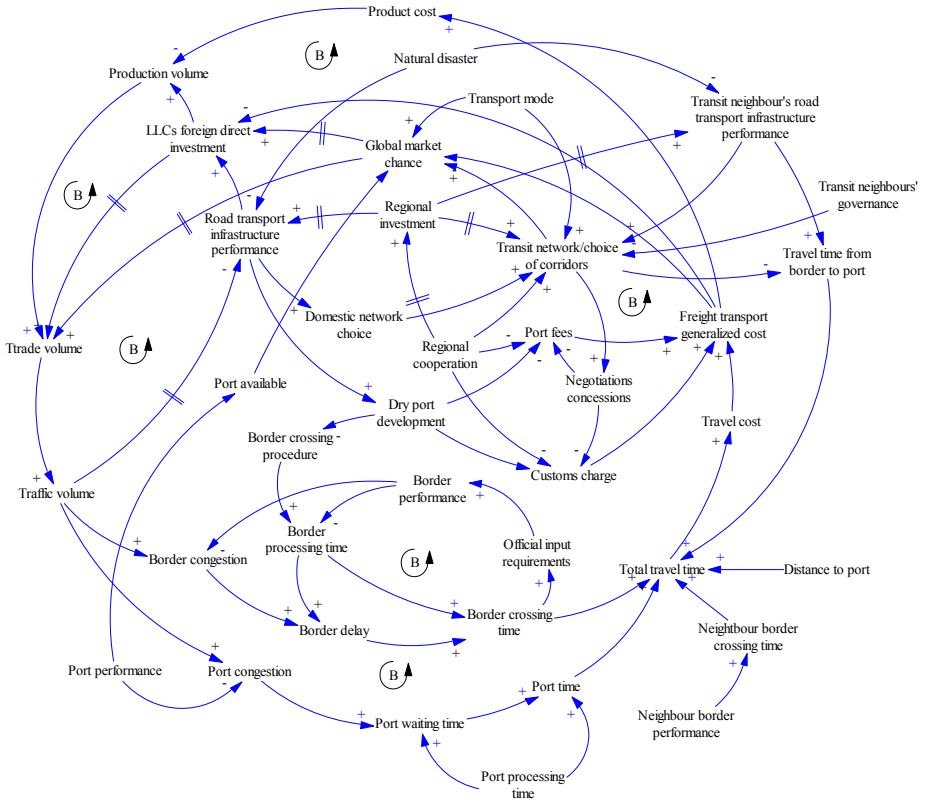


Figure 5-9 LDLC_CLD

This chapter identifies and describes key causal summaries of internal and external factors that are important for an LDLC's freight transport behavior. The outcome of these key causal summaries is presented in Figure 5-8 as a diagram of seven feedback loops, where it has been developed as the LDLC_CLD model. The outcome shows that LDLCs are still lacking in development, which results in trade delays and contributes to increases in freight cost, which, in turn, reduces their chances of accessing the global market. Given this result, regional cooperation can be seen as one of the best outcomes for LDLCs with limited funds, as it would help them negotiate with their transit neighbours to reduce transit regulations and encourage collaboration on projects, which could improve the regional infrastructure and increase the LDLCs' access to the global market. This illustrates the need for long-term investment, which is represented in the CLD. In conclusion, the LDLC_CLD is presented as a system that serves as a useful sample guide for others that want to develop a more efficient classification of this problem. The next chapter introduces a background case study that focuses on one specific country.

Chapter 6 Background case study

6.1 Introduction

This chapter provides an overview of the case study country background and location characteristics, which involves a justification of the selection of the case study and why it is relevant. In chapter 2, it was shown that least developed landlocked countries suffer from various factors, which make them slower in developing their country and make them fall behind their neighbours. This chapter will focus on particular LDLC country, which this chapter pick Laos to represent the challenges that caused their freight transport system. This chapter will start with the section 6.2 introducing the background country profile and geographical of Laos as a case study. Then describe the Laos' freight transport situation in section 6.3. Followed by section 6.4 introduce a corridor that Lao used for import/export. Then present the border system in section 6.5. Dry port situation in Laos in section 6.6 and the new port development section 6.7 that could possible improving Laos's freight transport situation.

6.2 Laos country background

Laos, or Laos People's Democratic Republic (PDR), is a least-developed landlocked nation in Southeast Asia. As can be seen in Figure 6-1: Laos' geographic map, Laos shares borders with five countries: Thailand, Vietnam, China, Burma, and Cambodia. With the lack of access to the sea, Laos has one of the highest transport costs among Southeast Asian countries. The reason behind this is attributable to the many difficulties and impediments for the international transport of goods, which made this country remote and isolated from world markets. Moreover, this situation causes high prices for export and import in Laos, which reduces competitiveness and profitability with other countries in the same region. Thailand and Vietnam are neighbouring countries, which Laos's main corridor dependence on to access to the sea.

Figure 6-1: Laos' geographic map

Source: *National Geographic* map (2016)

6.2.1 Transport infrastructure

The findings of literature review indicate that Laos' freight transport truly suffers from bad infrastructure, where the road system is mostly below the national road standard. Moreover, the data show that Laos' government has improved this situation by building a national highway that links major towns and provincial capitals, which also connect to transit neighbours. However, it is estimated that more than 60 percent of Laos' road network is in either poor or bad condition (World Bank, 2001), and will hardly be developed without external funding. ADB (2010) noted that despite large investments to develop Laos' national roads and highways, the road network remains less developed owing to funding constraints. PPIAF (2013) noted that the Laos road development project depended on the level of government responsible for the contract and how the project was financed, which created noticeable differences in the procurement of construction services for road projects, where many projects were below the project's estimated cost owing to the limited budget paid by the government.

The rudimentary road system issues do not only come from the poor infrastructure but Laos' underdeveloped border also makes it hard for smooth freight transitioning. Moreover, the agreement between Laos and other transit neighbours seems to be unpredictable with the limited number of permits available; permits free of charge are also granted under agreements to give preferential access to one country's road network for truck operators over another.

In most of the findings, a lack of funds mainly caused the underdevelopment of Laos' transport infrastructure. However, Warr (2007) reported that even with significant improvements in road quality, only about half of the best segments of Laos' road network could be relied on to provide all-weather connectivity. According to Warr (2007), there was less explanation from any document, report, or literature on why, since the significant improvement of Laos' road in the 2000s, Laos still suffers from road maintenance. The data show that the lack of control in fundamental infrastructure construction makes Laos road quality not qualify for the international road standard. In Laos, unprepared project operation and the indistinct process still exist, which causes the maintenance lifecycle and lack of a maintenance fund.

6.2.2 Transport mode choices

6.2.2.1 Road

Laos' road system is mostly in disrepair and suffering from bad maintenance. As 60 percent of the Lao rural road network are in either a low-level condition with estimated about 60 percent from The World Bank (2001). However, since the 2000s, the Laos's government and foreign donors have paved and graveled surfaces to improve up to half of the national roads (highway), which included linking the major towns and provincial capitals while providing connections to neighbouring countries as well. Nevertheless, even with significant improvements in road quality, previous research has reported that only about half of the best segment of the overall road network of the national roads can be relied on to provide all-weather connectivity (Warr, 2007).

The clearly understand that the badly maintained road makes it hard for businesses to export/import goods to/from the international market. Moreover, the data from The World Bank (2001) show that as a result of Laos' lack of transport choices, there is a reduction in choices to connect internal networks with modern transit neighbour's corridors. This is supported by Ruth (2004), who noted that if Laos PDR wants to achieve growing accessibility to the global market, all modes and all possible transfers to international logistic channels between modes must be improved to be same as the region's modal and multimodal infrastructure.

6.2.2.2 Waterway

Rivers and mountains dominate much of the landscape. In addition, the Mekong River runs through the country from north to south. However, owing to the unpredictable level of water and small islands, it is not possible for vessels to gain access from the sea. Most of the waterway is used for domestic services.

However, a short distance in the north of Mekong River, a small vessel less than 200 DWT can travel. Here, most vessels are used to carry agricultural and industrial products and are popularly used for tourists.

6.2.2.3 Air

Air transport is still an option in situations where fast delivery and good service is needed. There are three national airports since 2016 but only a few airline companies mainly from neighbouring countries. There is only one direct flight that is well-known and used by tourists direct to Incheon, Korea; others only fly domestic.

6.2.2.4 Rail

While other countries use rail as one of their main transport roles, Laos lacks the required infrastructure, causing rail transport to be insignificant. However, the rail link project between Laos and Thailand, which is about 3.5 km to connect to the Thai railway network, has been constructed and opened for traffic since March 2009. A further development is pending.

Ongoing railway project

There is a project railway named One Belt One Road project under the Trans-Asian rail link. One part of the line connects the south of China to Vientiane, Laos next to the Thailand border (Figure 6-2). The construction started in 2010 and is expected to open in late 2021, with 70% funded by the Chinese government.

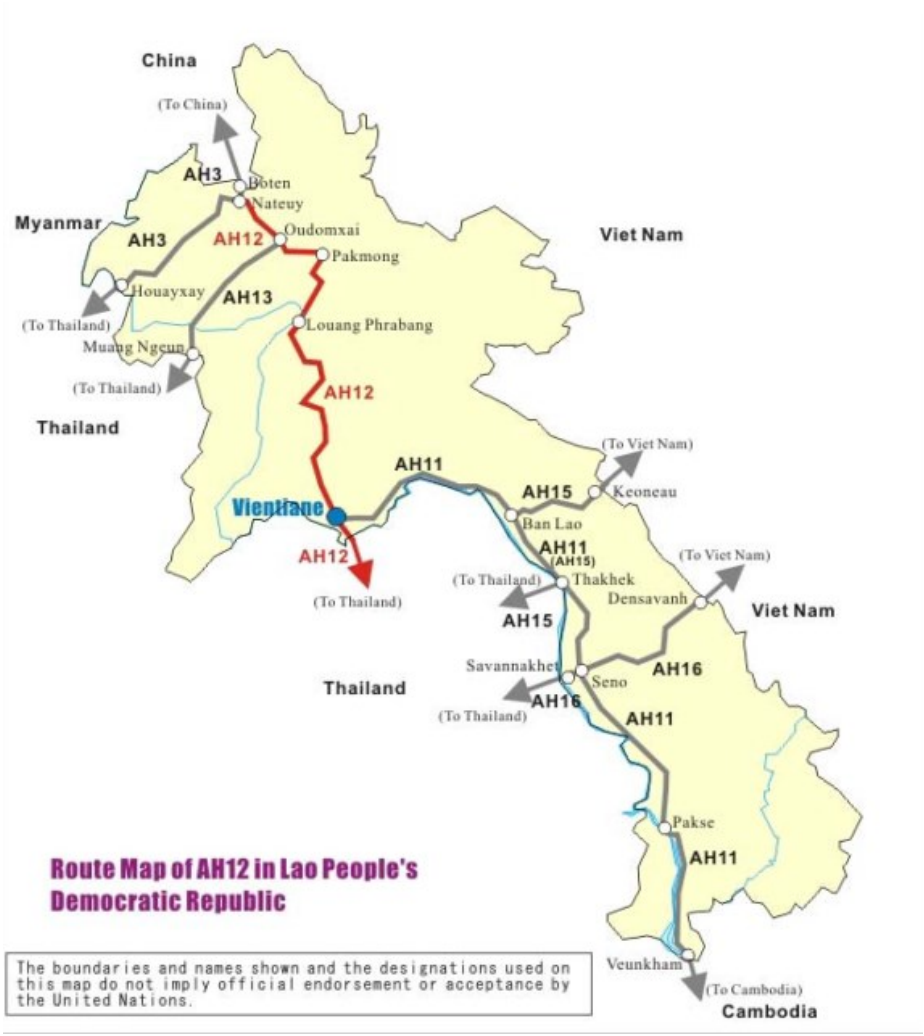


Figure 6-2 Laos' railway development project plan
Source: UNESCAP presentation by (Wang and Officer)

Future plan project

From Figure 6-2, Laos' government has six railway project plans for a railway to extend the rail connecting with the neighbour's line in the future:

1. The first project was described above as connecting the capital city with China, which will link Kunming, China and Singapore together. This railway will have medium speed trains averaging 160km/hour for passengers and 100-120 km/hour for freight with an estimate to finish and open in early 2022.

2. JDI (2010) reported that since 2003, Laos and the Vietnamese government have planned to cooperate to build a railway connecting Vung Ang Port and Thakek province, Laos. The development is estimated to cost about US$ 247 million after Singapore's Kunming Rail Link is completed. This railway will connect with Singapore's Kunming Rail Link. The Vietnamese government predicted this project will attract private companies from Laos and

the region to transport goods through Vung Ang Port with aims to cover about 15-20% of the share of transport in the region. These railways will enable trade to be safe, effective, and economical.

3. The third project was to extend the previous rail by 3.5km to connect with Thailand on the west by building 7.5 km to the city, which will be connected with the Lao-China Railway as an interchange loading yard, as the new Thai-China railway will only carry passengers. The freight will still keep using the metre gauge.

4. Next is the internal railway line to extend the rail line from the capital city that will go through Vietnam and will have a station in Thakhek the south of Laos that will be connected with Cambodia.

5. The last two projects are optional depending on the main railways mentioned above, especially number 4. Where this project will be an option for connecting between the number 4 project with Vietnam in the mid of Laos as second route choices, which will also be the main transiting from Thailand to Vietnam pass through this line.

6. The last project is the extend railway line from number 4 to the west connecting with the east of Thailand.

In conclusion, all the projects will satisfy the demands of facilitating the social and economic development and resources development along the line, building the modern integrated transportation network of Laos, and accelerating construction of the large-capacity railway network between neighbouring ASEAN countries. In terms of freight, using rail will be the best option to cut freight cost because it can carry much more than other choices and, with cheap and fast transportation, this will be perfect if Laos can build rail. However, as there are many barriers that would not be easy to overcome, the first thing is the railway project requiring a huge amount of investment, which Laos' government cannot handle. Thus, this country has to wait for international investment or help from neighbouring countries, just like the case of the Laos-China railway. Other difficulties would be that Laos is very new to rail; there still no railway law or framework agreement with neighbours, and there is a lack of expertise and budget to cover all the requirements to build the railway compared to other investments, such as road transportation. Therefore, it is a good option but has large requirements, for which the government has already set up a plan and is just waiting for investors to come.

6.2.3 Transit neighbours

From the study, the data show that Laos PDR still has some aspects of dependence on transit neighbours according to the four types of dependence landlocked developing countries have on transit neighbours (Michael, John, Jeffrey, & Snow, 2004). The data show that Laos does not have any negative effect on its neighbour's infrastructure. On another hand, the country is surrounded by high-quality transport network infrastructure from both Thailand and Vietnam. Michael et al. (2004) reported that as Laos still has weak domestic networks and a limited internal transport network, it has often to not been unable to take advantage of the neighbour's transit systems. Moreover, the data show that Laos has a good political relationship with all transit countries and, luckily, the two main corridors through Thailand and Vietnam do not have any situations stemming from vulnerability to civil conflict.

However, with the report by Michael et al. (2004), Laos has an effect on high administrative burden by reason of transit and border crossings that cause long delays in transit traffic.

The data show that Laos' export/import used to suffer from the transit neighbour's tax but since the regional cooperation, the tax has been reduced. However, the cost of border crossing still has not gone down as the transit neighbour's customs charges still continue to rise because of the lack of a standard agreement. Fortunately, the customs charges and tax on imports and exports will be reduced when Laos becomes part of the AEC.

Ruth Banomyong (2004) has also calculated that the cost of transit and other charges on his sample cargo import from Marseilles to Vientiane via Bangkok can represent up to 22% of the total transport cost. This combined three different modes of transport (road, rail, and sea), where all transit and other charges happened in border charge, port charge, and sea charges such as the sample shown in Section 6.3.6, Table 6-5 (the sea charges are not present). More information on this can be seen in Banomyong's (2004, p, 73) research.

6.2.4 Policy

The data show that to address the challenges that limit Laos' potential gains from trade and, hence, limit the resource base for country development, several suggestions have been produced with key policy priorities that can be stressed.

The data show that the low road quality does not satisfy the international standard. Laos' transport infrastructure investment must pay more attention, especially from the start of construction. However, the data indicate that each development policy operation required a considerable amount of funding. This was supported by M. L. Faye et al. (2004), who reported that Laos PDR needs to place particular emphasis on developing its internal transport infrastructure, investments in railways and roads, and both construction and maintenance to keep transport costs down.

Secondly, the data show that regional infrastructure integration strategies are needed to develop active trade routes and to expand market access for Laos. This support by Ruth (2004), where he noted that importers/exporters and local logistics service providers must be able to re-evaluate their strategies related to international logistics neighbours channels, as all modes and all possible transfers between modes must be considered with the development of new modal and multimodal infrastructure in the region. In following this, Laos PDR would be able to achieve a growing accessibility to the global market.

The data show that Laos, in requiring regional integration strategies, needs to focus on administrative coordination. As noted in the Greater Mekong Sub region East-West Corridor Project (PPER, 2009) and (ADB, 2010), ADB should work closely with the government to enable full ratification and implementation of the Cross-Border Transport Agreement to achieve the main project impact of enabling cross-border traffic along the East-West Corridor.

There was some data showing that Laos' product cost is affected by the imbalance of manufacturing, which the government needs to consider for local industry development. This is supported by M. L. Faye et al. (2004), who noted that to be less affected by transport cost for export, a service or development of the manufacturing sector must be developed, which includes shifting away from primary commodities that are subject to major price fluctuations and low value-to-weight ratios toward those with higher value or lower transport costs relative to the value of goods.

Nevertheless, many policy recommendations now argue that the Laos government should find another choice or improve transport routes via Vietnam. These two options can make Laos more resilient when disagreements occur between the two countries. Laos needs to reduce its

dependence on transit countries, as it has truly affected their transport costs and bargaining power.

6.3 Freight transport

6.3.1 Import/Export Value

Laos' total trade value of exports and imports has grown steadily since the 1990s. The major factor contributing to growth in exports is the export of electricity to neighbouring countries while the largest export by value has been wood products (logs and timber). Other industries, such as the copper and garment industries, have also increased as foreigner investment has increased.

However, even though the value of exports in Laos has increased, the largest destination, which covers 75% of the accounted total export, is the Greater Mekong Sub region (GMS). The remaining 25% comprises exports to overseas destinations, as shown in Table 6-2. For Laos, Thailand is the largest overseas trading partner because of the similar culture and language, which make it easy to communicate and become business partners. On the other hand, the opposite side via Vietnam's corridor seems to be less attractive.

Table 6-1 Laos export value

Export				
Year	2013			
Total Value	$ 3,030,000,000			
Non-overseas	China	32%	75%	$ 2,272,500,000
	Thailand	25%		
	Vietnam	16%		
	Others	2%		
Overseas		25%		$ 757,500,000

Source: author, with data from (Simoes, 2014)

Table 6-2 Laos import value

Import	
Year	2013
Total Value	$ 6,430,000,000

Non-overseas	China	56%		
	Thailand	26%		
	Vietnam	6.2%	88.20%	$ 5,671,260,000
Overseas		11.80%		$ 1,607,500,000

Source: author, with data from (Simoes, 2014)

From the trading economics website, the historical data of Laos' export value has increased since 2014, as shown in Figure 6-3. On the other hand, the import values are dropping, as shown in Figure 6-4. This proves the economy is improving.

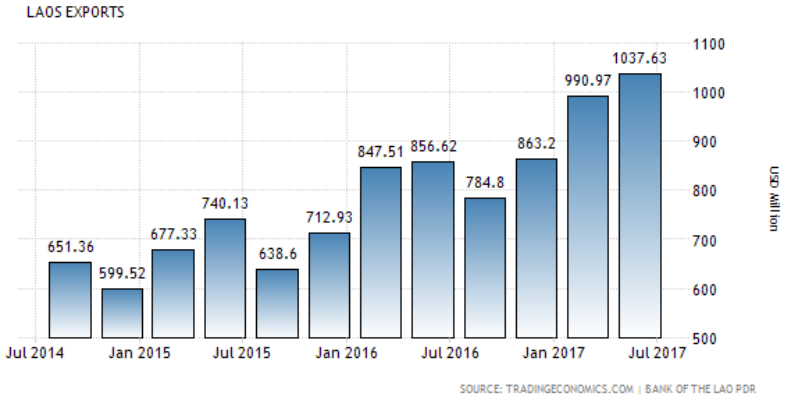


Figure 6-3: Laos exports value 2014-2016

Figure 6-4 Laos imports value 2014-2017

6.3.2 Import/export balance

The previous section introduces trade value, where it can be seen that Laos has imports more than exports from Figure 6-3 and Figure 6-4. Thus, to have a clear vision, this research has brought a graph from (OEC, 2016) showing

Laos' import/export in Figure 6-5 since 1995 to 2016, where the red line represents the imports and the blue line represents the exports.

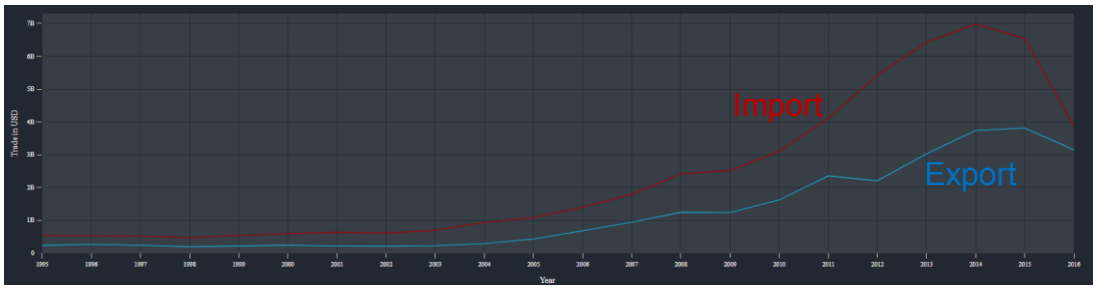


Figure 6-5: Laos' import/export balance
Source: (OEC, 2016), The Observatory of Economic Complexity – Laos import trade balance

The import volume is high compared to the export volume. In other countries, especially Laos' transit neighbours Thailand and Vietnam, the import/export balance is in good condition. Figure 6-6 shows Thailand's trade balance, where their exports rose higher than imports since 1997 till now. The economy and GDP are high compared to other countries in Southeast Asia.

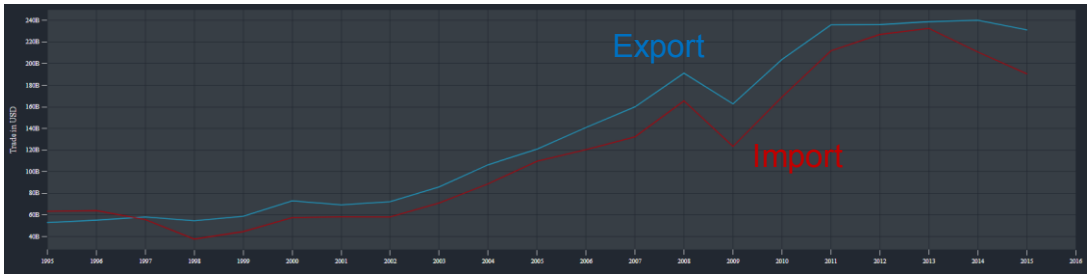


Figure 6-6: Thailand's import/export balance
Source: (OEC, 2016), The Observatory of Economic Complexity – Laos import trade balance

On the other side, Vietnam's economy is growing quickly and a significant improvement to solving their trade balance can be seen in Figure 6-7, where their exports have risen over imports after 2011 and have kept increasing.

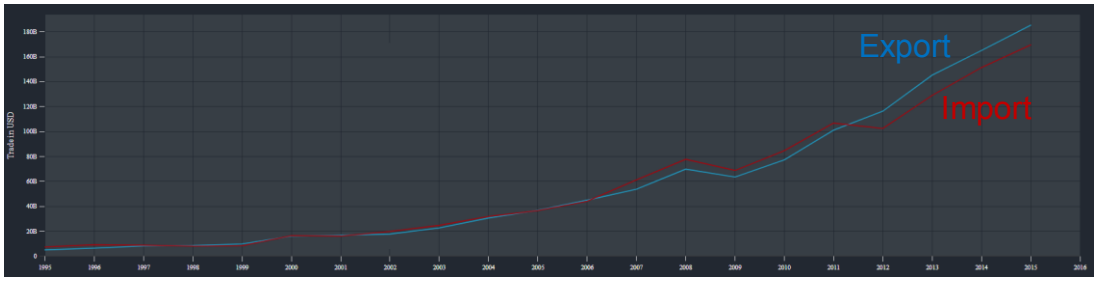


Figure 6-7: Vietnam's import/export balance
Source: (OEC, 2016), The Observatory of Economic Complexity – Laos import trade balance

Lastly, to compare with other least-developed landlocked countries, Mongolia is a good case. The graph on Figure 6-8, shows their trade balance also has a similar case like that of Laos, where the imports are higher than exports. However, after 2013, the imports fell and have been kept stable.

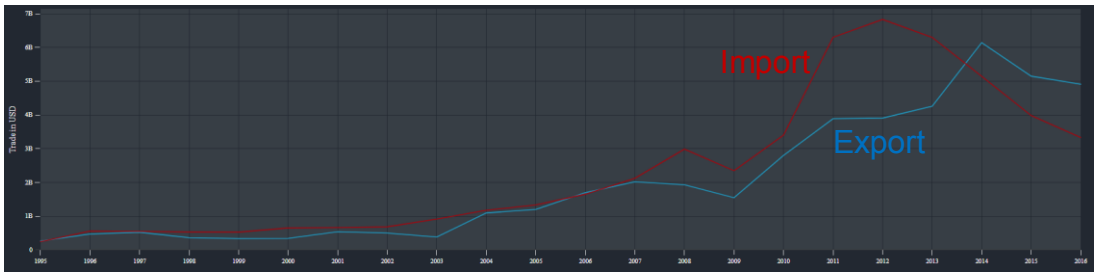


Figure 6-8: Mongolia's import/export balance
Source: (OEC, 2016), The Observatory of Economic Complexity – Laos import trade balance

As Laos' imports decreased in 2016, it will be good to keep the trade balance like that. Thus, this research also wants to pick up one of the new corridors and improve the system to make it help to increase the export volume in the future.

6.3.3 Import/export origin/destination

It can be seen from Figure 6-9 that 85% of Laos' export goes to neighbouring countries while the import is 90% from neighbours: 61% from Thailand, 19% from China, and 10% from Vietnam based on OEC (2016) statistics. This might be because of being a landlocked country. The best possible way is to import/export goods with low transport cost, which means the shortest destination/origin is the only market that Laos could reach. However, it is a small percentage but Laos' has exported some goods through transit neighbours crossing the sea to international markets like Japan, India, European countries, United States, and Canada, as shown in Figure 6-10.

Figure 6-9 Laos' export destination
Source: Author edited from (OEC, 2016), The Observatory of Economic Complexity – Laos

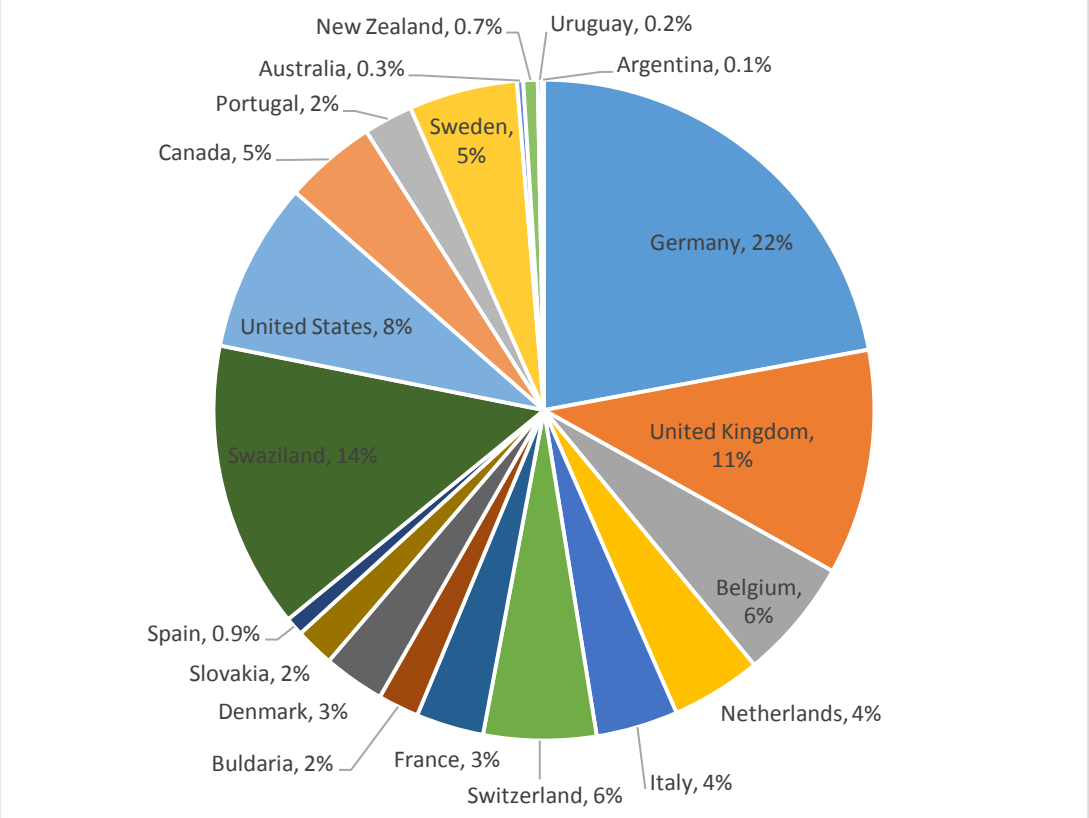


Figure 6-10 Laos' oversea export destination (Not include India and Japan)
Source: Author edited from (OEC, 2016), The Observatory of Economic Complexity – Laos

6.3.4 Import/export oversea route

For Laos' import/export to international overseas market, there are quite a few data references showing the route they use. The only data from Ruth and K.C.

(2004) described the garment export to Marseilles (Europe), which gave three route choices though Thailand with two route choices (Bangkok port and Laem Chabang port) and Da Nang Port (Vietnam). Both must pass the Singapore port before going to Europe (Figure 6-11).

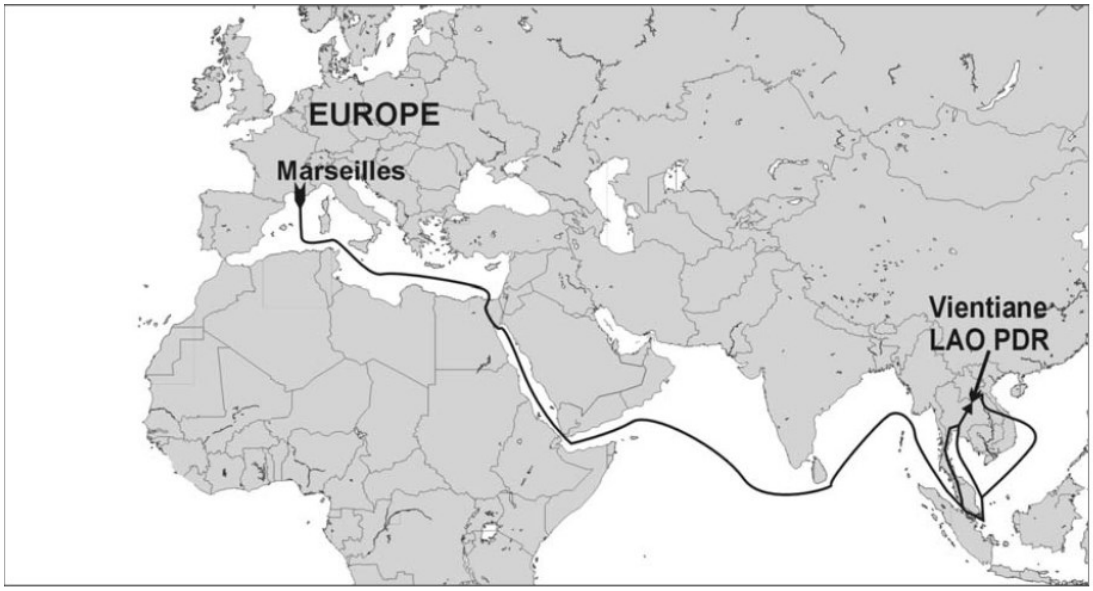


Figure 6-11 Laos' garment export to Europe map
Source: Laos' garment export to Europe map by (Banomyong and Beresford)

However, a vessel sea map (RickMers-Line GmbH & Co. KG) showing the vessel route from Laem Chabang (Thailand port) and Haiphong (Vietnam Port) that passes Da Nang Port could be a possible route that Laos' trade used.

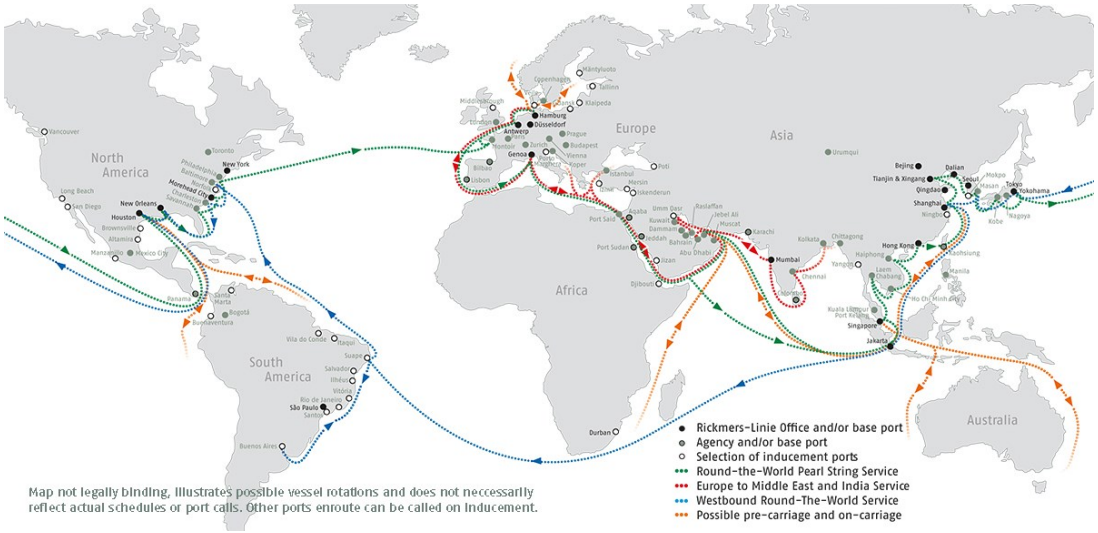


Figure 6-12 World vessel route map
Source: World vessel route map (RickMers-Line GmbH & Co. KG)

6.3.5 Import/export types

From an import/export trade section, it can be seen that Laos' exports are less than imports because Laos has very few factories. Thus, most exported goods are raw materials like copper ore and refined copper, as can be seen in Figure 6-13 for Laos export and Figure 6-14 for Laos' import products (OEC).

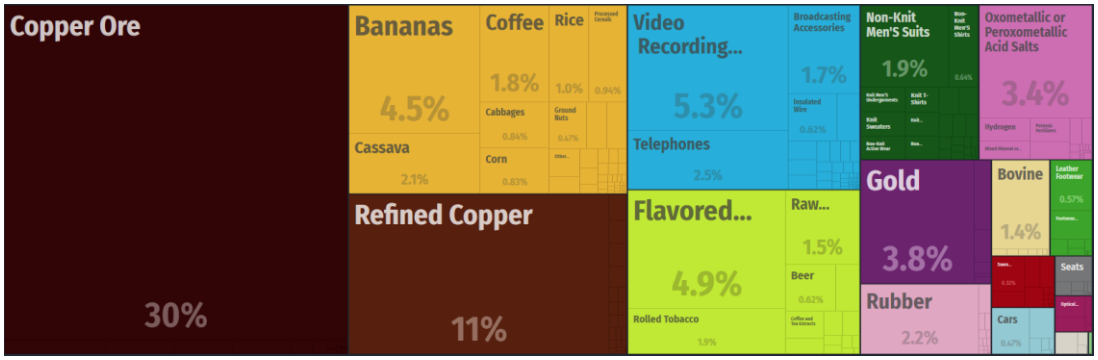


Figure 6-13 Laos' export types

Source: (OEC, 2016), The Observatory of Economic Complexity – Laos

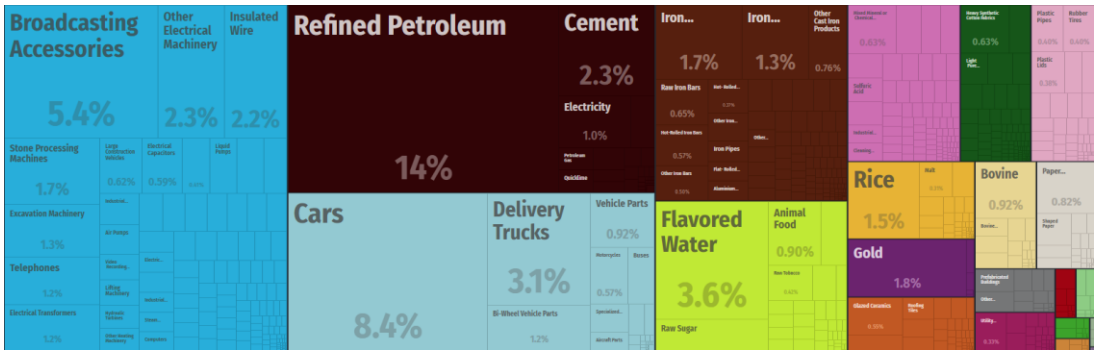


Figure 6-14 Laos' import

Source: (OEC, 2016), The Observatory of Economic Complexity – Laos

6.3.6 Import/export shipping cost

Laos has one the most expensive and complex procedures for transport compared to other countries in the same region. According to the World Bank (2012), Laos has the highest cost to export per container, where it doubles the price, time, and procedures (documents) compared to Thailand (Table 6-3).

Table 6-3 Southeast Asia: average shipping cost, time, and documents

	Documents to export (number)	Time to export (days)	Cost to export (US$ per container)	Documents to import (number)	Time to import (days)	Cost to import (US$ per container)
Malaysia	5	11	435	6	8	420
Singapore	4	5	456	4	4	439
Thailand	5	14	585	5	13	750
Vietnam	6	21	610	8	21	600
Cambodia	9	22	755	10	26	900
Laos PDR	10	26	2,140	10	26	2,125
East Asia & Pacific	6	21	923	7	22	958

Source: Edited from Doing Business World Bank, (2012).

For a specific route to Japan, comparing Laos' transport to other countries in Asia, the chart below (IDE-JETRO) shows the price of transport in 2014-2015 where Japan imported goods from 12 different countries in Asia (Figure 6-15). The line chart shows that Laos has the highest transport cost, which is disadvantageous in terms of market opportunities.

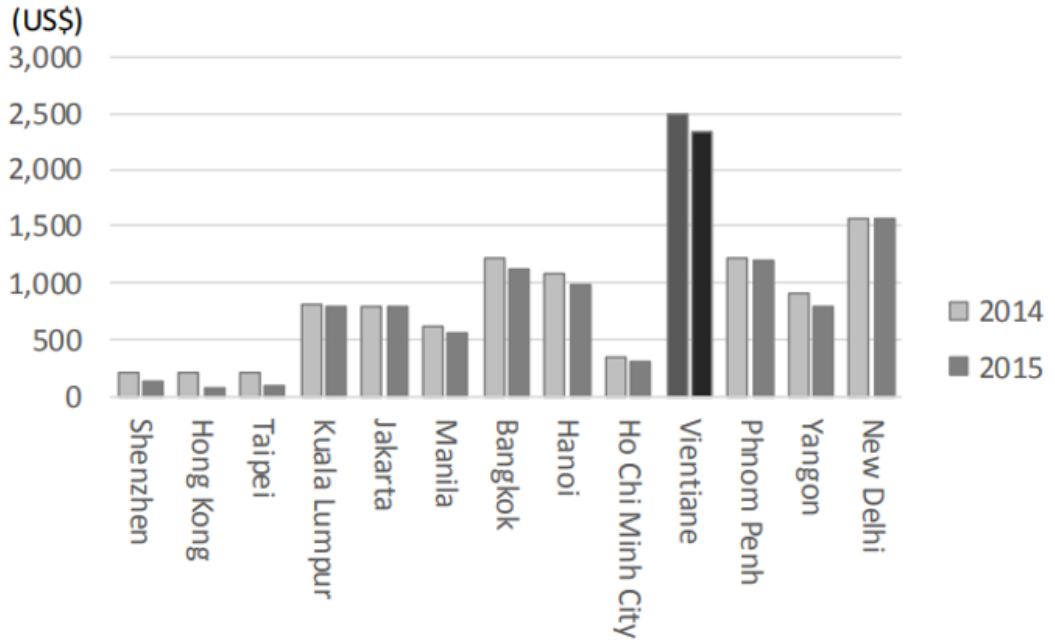


Figure 6-15: Japan import transport cost from 12 Asia countries

Source: JETRO Censor, 2016.

In the case sample of shipping cost from Vientiane to Europe, Laos has various corridors but only two country options. Ruth Banomyon points out that "The most frequently utilised routes via Bangkok (Thailand) [are] not

necessarily the most competitive in terms of time and cost for Laos garment exporters" (Asia et al.), where others routes also have high cost and time, as shown in Table 6-4.

Table 6-4: Total transport cost, transit time from Vientiane to Europe

Route	Total transport cost (USD) per TEU	Total transit time (days)
Da Nang (Vietnam)	2,797 - 3,420	31 - 32
Bangkok (Thailand)	2,476 – 2,927	31 - 33
Laem ChaBang (Thailand)	2,503	30 - 31
Lard Krabang (Thailand)	2,518	30 - 31
Port Klang (Malaysia)	2,467 - 2900	28 - 30

Source: Author edited and combined from Laos garment export (Banomyong and Beresford) and (Asia et al.).

Table 6-5 shows the sum of costs along the corridor with three route choices (Asia et al.); (Banomyong) and (Banomyong and Beresford): Laem Chabang Port in Thailand, Da Nang Port in Vietnam, and Vung Ang Port (Vietnam). Vung Ang Port is a new gateway developed as the shortest way for Laos to access the sea. This gateway shares investment between Laos as a landlocked country with Vietnam, who is a transit neighbour, as described in sections 6.4.3 and in 6.6.

Table 6-5 Summary different route choices cost

	Thai (Laem Chabang port)			Vietnam (Da Nang port)			Vietnam (Vung Ang port)		
	Cost (USD) per TEU	Time (hour)	Distance (Km)	Cost (USD) per TEU	Time (hour)	Distance (Km)	Cost (USD) per TEU	Time (hour)	Distance (Km)
Vientiane to Thanaleng dry port	47	1	13	47	1	13	47	1	13
Thanaleng to border	8	1	4	750	48	733	335	10	478
Laos side	13	4		10	5		10	5	
Border Processing	20			40			40		
Document	10			50			50		
Transit side	13	6		20	6		20	5	
Border processing	15			30			30		
Document	10			50			50		
Transit entry document	5			10			10		
Border to Port	1500	36	633	220	12	326	100	3	145
Handling charge	13			32			32		
Gate charge	15			12			12		
Container stevedorage	21			45			45		
Container wharfage	22			17			17		
Life on/off charges	17			15			15		
Terminal handling charges	68			50			50		
Bill of lading charge	13			30			30		
Total	1810	48	650	1438	72	1072	863	24	623

Sources: Data from (Asia et al.); (Banomyong), (Banomyong and Beresford); (JDI).

6.4 Laos' import/export corridor

As mentioned above, most of Laos' import/export is done with neighbouring countries. However, as Laos also imports/exports to international overseas markets, there are three main routes that Laos uses, where the (1) and (2) are the two main route choices and (3) is the newly upgraded corridor operating since 2009.

6.4.1 Route (1): Vientiane – Lao-Thai Friendship Bridge - Nong Khai, Thailand (Laem Chabang and Bangkok port Thailand)

This route is the shortest route to access a transit neighbours country, where the distance from the central dry port warehouse in Vientiane to the border is less than one kilometer and take less than one hour and the road condition is good. This is because the capital city of Laos (Vientiane) is located next to the one of the Thai province (Nong Khai), as shown in Figure 6-16. However, from the border to the port is far (more than 650 Km with a 24-hour ride) but the road condition and facilities on the Thai side are in good, standard condition compared to other routes.

Figure 6-16 Route (1) Vientiane to Thai's ports

6.4.2 Route (2): Vientiane – Road No.13 – Road No.16 – Laos Bao, Vietnam (Da Nang port corridor)

Vietnam's gateway was always a second choice. This route is the oldest gateway from Laos to Vietnam's Da Nang port, where the distance is about

1070km from Vientiane to the port as can be seen in Figure 6-17. The route starts from Vientiane along Road No. 13 till Savannakhet province south of Laos and changes to Road No. 16 to the Laos Bao Vietnam border and takes around 326 km to reach Da Nang Port. With the development of the Department of Road, Ministry of Public Works and Transportation of Laos, this road is in good condition with a lot of improvements since 2010. However, it is not a high-standard highway, as some parts enter into a mountain area with sharp curves and many through villages. This makes trucks slowly but there is no problem with traffic congestion.

Figure 6-17: Route (2) Vientiane – Da Nang port

6.5 Border

Laos' border has a different system compared to other countries in the same region. The biggest situation is the clearance time, where the document processing could be more than 2-3 days at the border (Banomyong) and for the waiting, the charge was around 10 USD/TEU per day for storage.

A case is the Laos Bao border, as reported by Ruth Banomyong (2004), where Laos' export through that border has had significant delays in the past. Thus, most of the transit formalities will be done in the Da Nang port for the transit cargo.

The data shows that border crossing separate to two sections, one is Lao's border and the second are transit neighbour. The data finding shows that Lao

still have weakness on border quality and facility, which unable to handle the high traffic demand. These borders require infrastructure improvement and adding high technological equipment to be the same level as transit neighbour's border. Moreover, that data shows that with the lack of standard equipment, often causing long queue for the regulation process, inspection and paperwork.

Secondly, transit neighbour's border mostly has higher quality and technology. However, a long queue often happens due to paperwork. Moreover, with the bilateral agreement between Lao and transit country, the data show that Lao's truck would not allow passing through neighbour's border. Thus, the additional time would be on loading process, which causes border delay.

- The Thailand and Vietnam border sides seem to be better able to handle large trucks with a good, efficient, computerized customs process (JDI).
- The average time that one official spent on one procedure which about 15 minutes (GMS, ART Net, 2011)
- If the new hardware input it could take only 8 minute per procedure (JDI)
- From Lao's export law and bilateral agreement with Vietnam, exporting through Vietnam corridor require 5 procedure (3 process for document checking and 2 for physical inspection) (MPWT).
- If the dry port were operated two of the process will be done at the dry port. Thus only 3 process will be requiring on border (Nations), (Ikebe et al.).

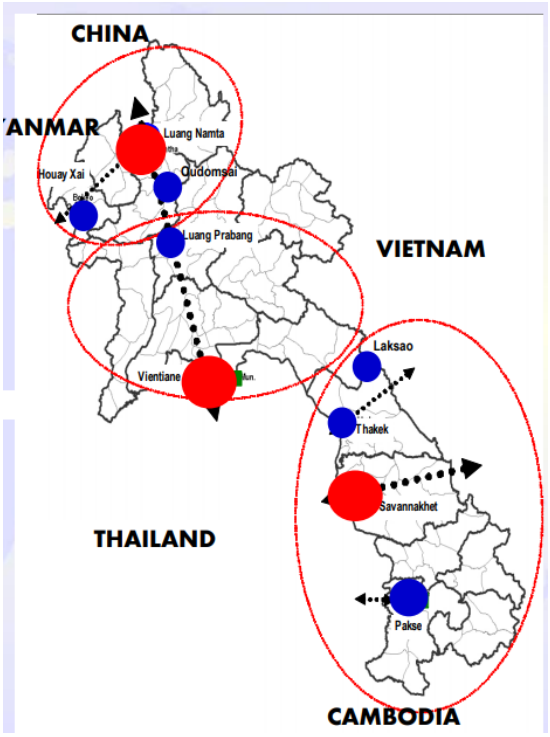
6.6 Dry port

There is only one dry port in Laos right now, Thanaleng, which is less than one km to the Lao-Thai border on the Laem Chabang port corridor. The data show that most of the import and export through the Thai corridor must be cleared in Thanaleng, where the process is not efficient. Some take more than 2-3 days waiting at the storage yard, as reported by Banomyong & Beresford (2001). However, the advantage is this dry port can reduce delays at the Lao-Thai border, where most of the documents can be done at this dry port. A report by IDE-JETRO (2017) described the benefit of this dry port that the freight forwarder can rent an empty container from this dry port and transport their goods to the Thai port (Laem Chabang Port) and leave it there rather than returning empty. However, others ports like Da Nang Port and Vung Ang Port still do not cooperate as Laem Chabang does with Thanaleng. Thus, it is

hoped that this strategy can be learned from the new dry port that will be constructed near the Vietnam corridor side. Moreover, the benefit of the dry port operation can also be seen, as many processes can be done in the dry port rather than stuck at the border or port. In a report by JDI (2000), if the dry port operated at the Vung Ang Port corridor, it would reduce 75% of port waiting time as can be seen in Figure 6-19 with symbol explanations in Figure 6-20.

There was a dry port nominated under the intergovernmental agreement on dry ports will be 9 dry ports in future plan such as shown in Figure 6-18. Where Number 1-3 are priority for detailed Feasibility study and construction of Thanaleng dry ports under 5 years development plan (2016-2020) and Status on Ratification: in the process of approval by the Minister of Public Works and Transport for approval before submitting proposal to the government (Phounsavath).

1. Thanaleng, Vientiane
2. Nateuy, Luangnamtha
3. Seno, Savanakhet
4. Houyxai, Bokeo
5. Laksao, Borikhamsai
6. Luangprabang, Luangprabang
7. Oudomsai, Muangxai
8. Pakse, Champasack
9. Thakhek, Khammouane



Source: Lao MPWT Presentation at Bangkok, 2015 on Status on Dry ports development in Lao PDR

Figure 6-18 Dry port development in Laos

6.7 Port

The first well-known port that Laos uses is the Thai port Laem Chabang, which is about 700 km, as described in Section 6.4.1 on Route (1) Vientiane to Thai Port. This port would likely be used as Thailand and Laos have been trading for a long time and the language is similar, so it is easy to communicate and deal contracts. This journey through Laem Chabang port is the import/export from/to a third destination, such as Europe. But the problems occur if the container is owned by shipping firms. In agreement with the contract between a shipping firm and a freight forwarder, for instance, when a manufacturing firm in Vientiane exports products to a third country via Laem Chabang port, the freight forwarder must transport an empty container to Vientiane (Banomyong, 2001).

Second, is Vietnam port, where there are many seaports, one of the most in Southeast Asia, with a total of 114 seaports; however, only 14 of these ports exist as keys to economic development (Runckel, 2006). As time has passed, several port facilities and support services have become out of date, as most are relatively too small to handle big vessels. Besides, there were three large ports, which were integral to the economic development of Vietnam and the transit gateway from Laos and Thailand: Haiphong port (north), Da Nang port (central), and Saigon port (south).

6.8 Case study Vung-Ang port corridor

This section will provide an overview of the specific case study background on the corridor from Vientiane though Thakek province to the Laos-Vietnam border at Na Phao border, which gives access to Vung Ang port in Vietnam, such as shown in Figure 6-19, where the symbols are explained in Figure 6-20. The data continue from the information from the country's background above but in more detail where some areas are still in planning.

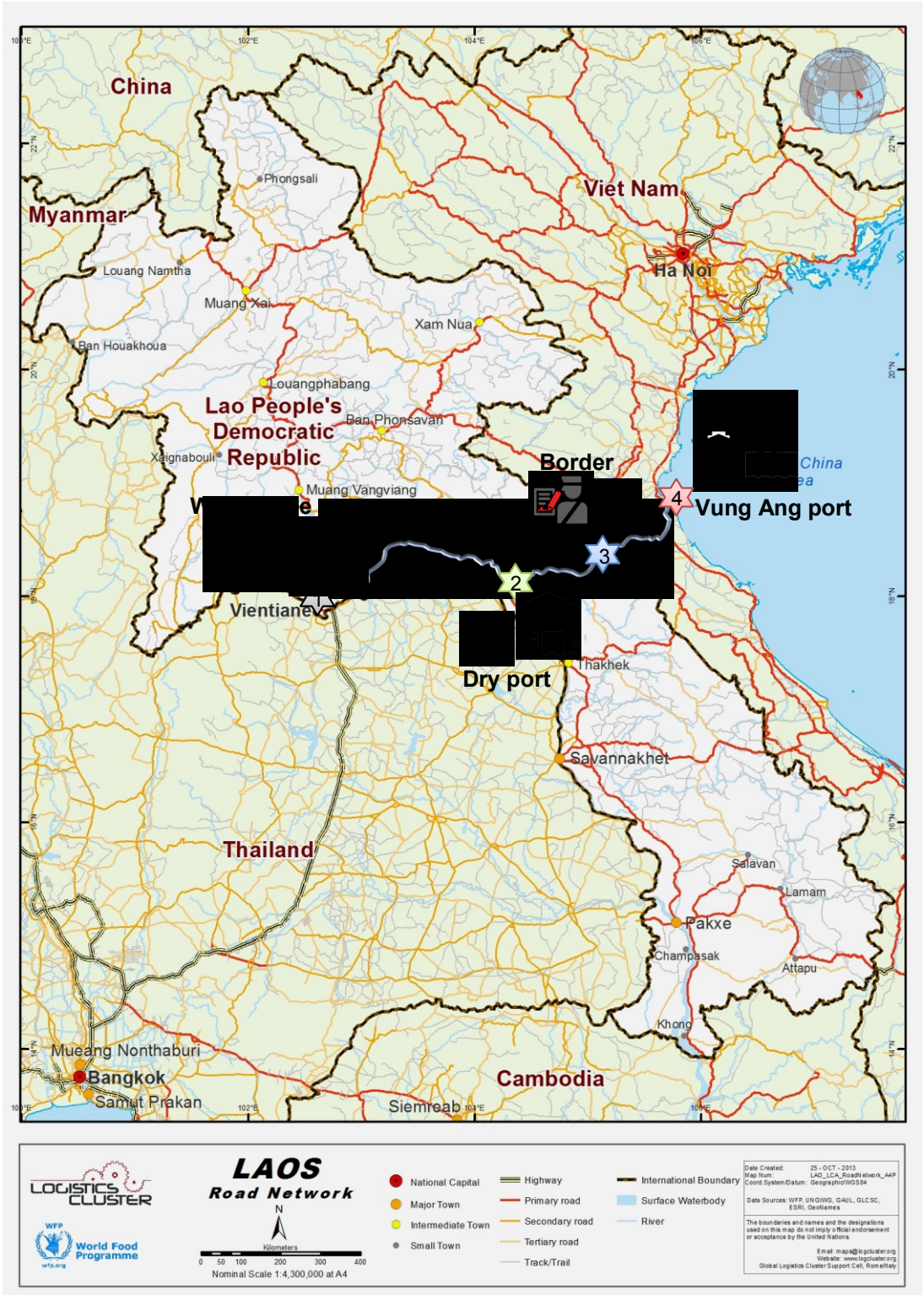


Figure 6-19 Total case study map
Source: Author edited from (*The Logistics Capacity Assessment (LCA)*)

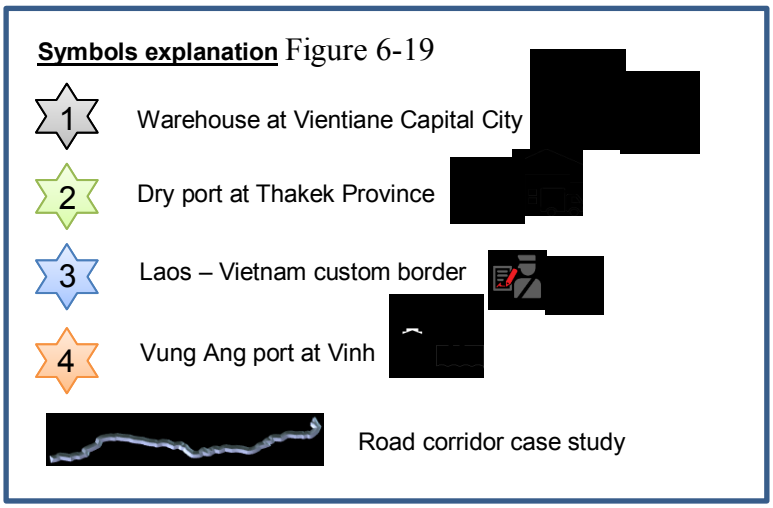


Figure 6-20 Symbols explanation

6.8.1 Transport infrastructure

Since 2000, there have been many regional investment projects that Laos invested and has benefitted from. First, the highway road investment of the GMS Economic Corridor was developed under the route funded by ADB (ADB, 2016) and route upgrading, which connects the north of Thailand through Laos (Thakhek) and ends at the Vietnam border, which is the final destination to Vung Ang port.

6.8.1.1 Route (3): Vientiane – Road No.13 – Road No.12 – Na Phao, Vietnam (Vung Ang port corridor)

This new corridor upgraded as a part of the Vung Ang Port project supplies wood chips to the Japanese market. When considering the export of wood chips from central Laos, distance is the main important transport route factor. This makes Vietnam's gateway the best option based on the direct route rather than the Thai gateway, where the distance is longer.

Thus, the project of building a new port involves improving the gateway (Road No. 12), as shown in Figure 6-18. This route was covered in a new port project between Vietnam and Laos in 1996 and was intended to help Laos (a landlocked country) to promote trade business and gain a route to access international markets. Even though the port facility completed its construction in 2001, it took eight years to finish the connection between Thakhek (Laos) and Vung Ang Port in June 2009. Moreover, transport of agroforestry products from central Laos is set to increase, which will cause an increase in the traffic volume. Therefore, a Road No.12 improvement plan has been prepared so

that wood chips can be exported without major traffic. The first part takes the same route as the Da Nang corridor as it using Road No.13, which is in good condition, before changing to Road No.12.

Figure 6-21 Route (3) Vientiane – Vung Ang port

From the report (JDI, 2010), the traffic count from the Department of Road, Ministry of Public Works and Transportation of Laos, reported that the traffic volume in this corridor, especially Road No.12, has significantly increased from 1,500 vehicles/day to 4,000 vehicles/day after the road was improved in 2008. The report also calculated the increased rate expectation of trade, especially for a truck with 20 TEU, where the outcome showed that it will increase to 1,000 trucks/day after 2016.

6.8.2 Transport mode choices Vientiane to Vung Ang port, Vietnam

The only available mode that can be used right now on this corridor is road. As mentioned above in Section 6.8.1 about the road condition, it has significantly improved. However, as the traffic volume will increase, this corridor might experience traffic congestion in the future and maintenance will needed.

There was a plan from the Laos government that this corridor would be able to build the railway line connected with Vung-Ang port, as mentioned in

Section 6.2.2.4. As they already finished the feasibility study, this railway project is just only waiting for investment from an international or joint-avenger, as Laos did with China on building the Lao-China railway. Moreover, as this corridor seems to be of interest to many private companies, as the railway line passes through many industry zones, private companies would like to share the investment so they can also benefit from this railway to export their goods through Vietnam.

6.8.3 Transit (Thailand-Laos-Vietnam)

Since the Third Friendship Bridge at the border of Thailand and Laos in Thakek in 2011, the traffic volume from North-eastern Thailand has increased rapidly year by year. Thailand has transits via this corridor though Thakek to Vung Ang port and imports from Vietnam, such as carrying oil transiting Thakek to Thailand, has likely increased as well. In a report shown by JDI (2010), calculated by the Department of Highway (DOH), Thailand has shown the estimate of traffic volume prediction crossing this corridor from Thailand, such as shown in Figure 6-22 below.

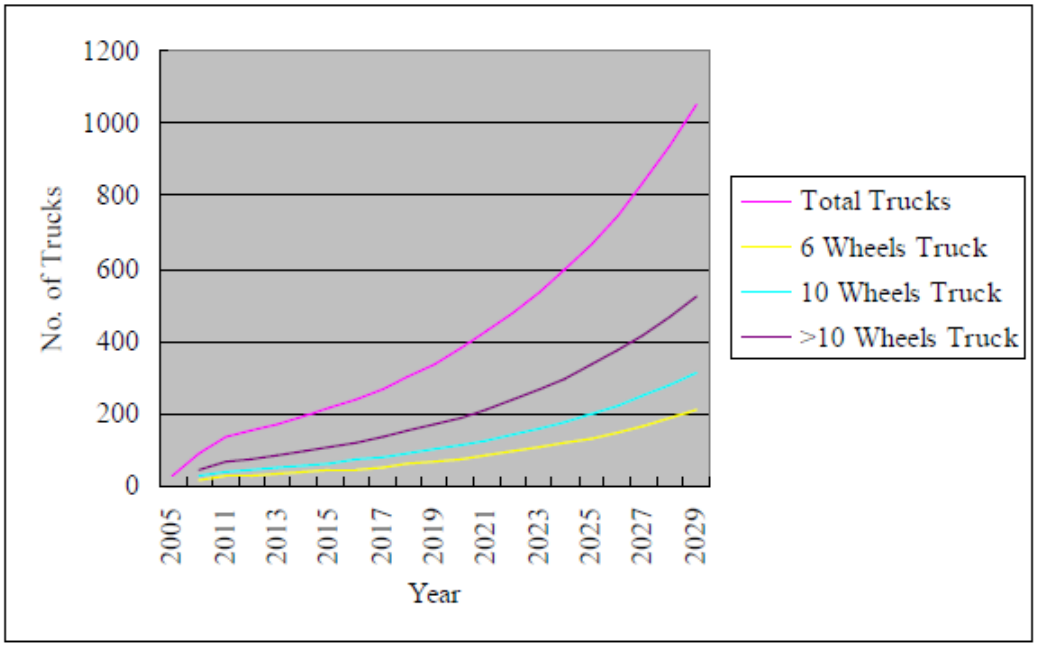


Figure 6-22 Estimated Average Daily Truck Transportation on the Third Friendship Bridge Thailand – Lao (Source: DOH)

6.8.4 Policy and bilateral agreement between Lao-Viet

Vung Ang Port (JDI, 2010). Fortunately, the project was on a bilateral agreement made between the governments of Vietnam and Laos to launch

an agreement project called “Vung Ang Port Joint Stock Company” to develop a new port at the Vung Ang economic zone in Ha Tinh Province, Vietnam for a common cargo port for both countries (JDI, 2010). It was also promoted for Laos to facilitate the transit of goods to and from Laos (Minh, 2011). There was some information that did not match with the report. The data show the Vung Ang Port project is still not convenient for any local trade provider. However, owing to the government’s inability to support them, it makes this choice of corridor still an optional route where, in the future, someone will invest, as it could be cheaper with less travel time compared to primary routes.

6.8.5 Freight import/export via Route No.12 (Vung-Ang port corridor)

Recently, many products have been imported/exported from/to central Laos through this corridor, such as cattle and limestone, especially woodchips, timber, rubber, cassava, coal, and other agro-forestry and minerals from along the corridor line. For example, the woodchips started exporting in 2012 with approximately 180,000-400,000 tons of woodchips the first and second year and will increase to 900,000 tons/year after 2019 (JDI, 2010).

This will be followed by the number of trucks (trailers and long bodies) with an average 10-20 ton carrying capacity. By 2012, the trucks required per day just for woodchips from central Laos was 25 truck per day for 20 tonner and will increase to 123 trucks or trips/day traffic, such as shown in Table 6-6 from JDI (2010). Moreover, this only shows the number of woodchips, where other numbers will also increase as the economic efficiency of the Thakek-Vung Ang Gateway is verified, such as shown in Table 6-7 (JDI, 2010).

Table 6-6 Require trucks per day to transport woodchip from central Laos

Year (s)	Production (based on MT per year)	Required trucks per day based on truck capacity		
		10 –tonner	15- tonner	20-tonner
2012	180,000	50	38	25
2013	400,000	110	83	55
2014 -18	800,000	220	165	110
2019 onwards	900,000	246	185	123

(Source: JDI Study Team)

Table 6-7 Require trucks per day to transport other Agro-Forestry from central Laos

Year (s)	Production (based on MT per year)	Required trucks per day based on truck capacity		
		10 –tonner	15- tonner	20-tonner
2012	340,000	100	76	50
2013	800,000	220	166	110
2014 -18	1,600,000	440	330	220
2019 onwards	1,800,000	492	370	246

(Source: JDI Study Team)

Moreover, as this corridor connects with Thailand, with the advantage of the strategic location of this corridor, the exchange of commodities and materials between Thailand, Laos, and Vietnam is expected to increase in the future, where this corridor will be used and the traffic volume of trucks will increase. If all is added up, based on the assumption that all transportation and other vehicles on the road will increase to 1,000 vehicles per day every year for the future traffic demand on the Vung-Ang port corridor (JDI, 2010).

6.8.6 Border (Na Phao)

Another case is at the Na Phao border of the Vung Ang Port corridor, as can be seen in Figure 6-20 with symbol explanations in Figure 6-19. A report from JDI (2010) stated that the Laos custom process at the border was inefficient. There was a software system upgrade in 2010, but still, many documents were done manually. With the case sample of wood chip exporters, they required five pieces of documentation. However, the problem often reported was that office hours at the customs border was the problem, as the opening time was not suitable for the traffic flow and the charge for unofficial working time was $100 to the duty officer.

6.8.7 Thakek Dry port

As described in Section 6.5, the dry port located in the Vung Ang port corridor, as shown in Figure 6 18, is still just a project plan, and is still not yet approved by the government. However, this dry port project will be reconsidered when the railway project is approved (Phounsavath, 2015). Moreover, the plan was to build the dry port with the same layout as the Vientiane capital city dry port, which was already approved, as shown in Figure 6-22.

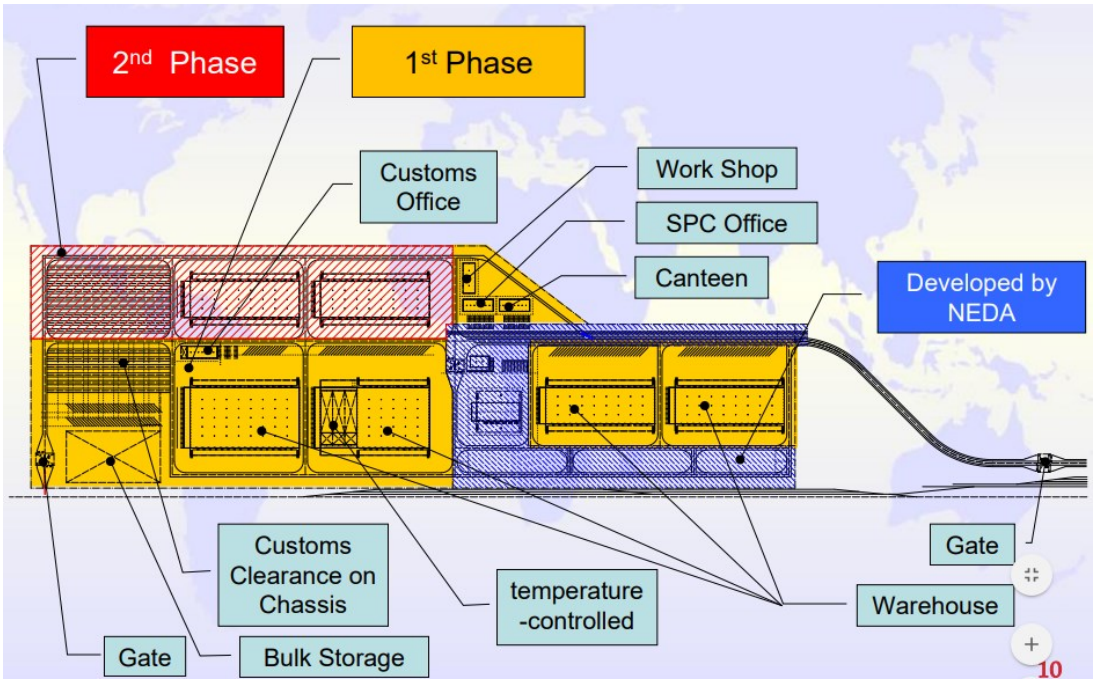


Figure 6-23 Layout of Dry port

6.8.8 Vung Ang port

In 1996, Laos and Vietnam launched an agreement project called “Vung Ang Port Joint Stock Company” to develop a new port in the Vung Ang economic zone in Ha Tinh Province, Vietnam, as can be seen in Figure 6 20 with symbol explanations in Figure 6 19. The study report explained that the agreement was based on a 2001 bilateral agreement made between the governments of Vietnam and Laos to use the Vung Ang seaport in Ha Tinh province, Vietnam, as a common cargo port for both countries (JDI, 2010). The first section of the project, Vung Ang Port Berth No.1, began operating in 2001. Berth No.2 was opened in 2010 (SAIGON GPDAILY, 2015). Besides a report on the development of the “East-West Economic Corridor”, a contract to set up the joint venture was signed in April 2010 between Vietnam and Laos to facilitate the transit of goods to and from Laos (Minh, 2011). Finally, the project cooperation between the Vietnam-Laos Vung Ang Port Joint Stock Company began its operation at the Vung Ang economic zone in the central province of Ha Tinh on the 16th of June 2014 (Minh, 2011).

Based on a report, Vung Ang Port, strategically located on the east-west economic corridor linking Laos and north-eastern Thailand, is a deep-water port with an average depth of between 10-15 meters (JDI, 2010). The port can accommodate 50,000 DWT class vessels. At the end of the gateway, there are two seaports in the Vung Ang area. The first is called the Vung Ang Port,

which currently has two operating berths. Berth No.1, which can handle up to 45,000 DWT vessels, was completed in 2001 and was already operated by the Ha Tinh Port Joint Stock Company. Berth No.2, which is able to accommodate as large as 50,000DWT vessels, started operations in March 2010 by a joint company called Vung Ang Port Viet-Lao Joint Stock Company, which has been invested in by 10 different entities from Vietnam and Laos. The second port is called the Son Duong Port. Vung Ang and Son Duong are situated next to each other but are geographically divided by the Ron Cape Peninsula. Funded by a Taiwanese Formosa Group, Son Duong Port was completed by 2012. The area has a potential of accommodating ships as large as 200,000-400,000 DWT, potentially making it the largest port in Asia.

Area

- Total Area: 17,740 ㎡
- Storage: 3,200 ㎡
- Yard: 7,040 ㎡ (DFS 8,200 ㎡)
- Roads Inside Port: 5,168 ㎡
- Road Width: 10m

Handling Rate

- Bagged Cargo: 1,500tons per day
- Bulk Cargo: 2,000-7,500 tons per day
- General Cargo: 2,500 tons per day

Chapter 7 Data collection analysis

7.1 Introduction

The approaches adopted in this research involved qualitative data for develop causal loop diagrams and system dynamics, as described in section 3.4. The approaches seek data from multiple sources, which included focus groups, interviews, and document reviews. Interviews constituted the main qualitative data source, while focus groups provided fundamental information. Data collection through the focus groups and interviews followed a structured process, while the document reviews were a less structured process. The focus groups and interviews were conducted between July 2014 and September 2014. And followed by the process of data analysis and the outcome is described followed by the process of data collection from the previous chapter. The analytical steps taken to examine the data and generate the findings reported are also described in this chapter

The first start with describes the data organisation in section 7.2. This section is followed by the sequence Section 7.3, which describes the process of identifying respondents. Then, in Section 7.4, the focus group process is described. Section 7.5 introduces the group modeling. Section 7.6 describes the interview structure, while Section 7.7 gives a reflection on the fieldwork experience and the limitations of the secondary data sources obtained. Then section 7.8 present the outcome from the data collection. Where section 7.9 gives a detailed description from respondents' main discussion themes in seven sub-sections.

7.2 Data organisation

The data collected from focus group and interview, all the participants using the local language (Lao), where it needed to be converted to English.

The primary data collected for this research was separated into two parts: a focus group and interviews. The focus group was transcribed from note taking during workshop discussion combining with video from participant presentation. For interview, the audio recorded were transcribed normally, where only some were already in written format as some interviews were all note taken because the participant would not allow the recording.

The second stage, researcher read the transcripts and noted a general theme by highlighting key words to capture the concepts theme, same as Burnard's method (1991).

After the focus group and interview data were transcribed, the process of coding was initiated. The research coding encourages finding the meaning in the data based on the ten steps of coding guidelines (Gelfand et al., 2010).

The process started by grouping together focus groups and interview responses that have similar concepts and themes of interest. This is beneficial as it is easier to discover differences, distinctions, and connections within and between themes (Gelfand & Godefroy, 2010). It helps in understanding the coding process by creating, cutting, and pasting Word documents and creating worksheets in Excel.

7.3 Respondents' identification

The data collection for this research identified respondents by using the principle of purposeful sampling. It's important to remember that this research uses two data collection methods: focus groups and interviews. Thus, respondents consisted of stakeholders in Lao trade and transport system operations where the focus group/group modeling was for academic and interview were for companies and government.

To select potential academic participants, each transport divisions of freight transport planning, transport engineer and logistic academic of University of Laos of each institutions were contacted. This contact was made in person with their head divisions to deliver the "invitation letter" by hand. However, it is not possible to reach all the participants. Thus, the recruitment process for relevant academics used the snowball method (Atkinson and Flint, 2001; Coyne, 1997).

In the case of private company group, the process was similar to that of academics, where visits were made to their company office. The researcher met with participants listed to deliver the "invitation letter" by hand. Similarly, some big companies also required a good connection in order to make an appointment with the participants listed. However, two companies that the researcher did not have any connection with allowed the researcher to walk in to explain the purpose. It appeared that one company allowed an interview, while another did not make contact.

The government sector had more procedures as they required formal government document approval for each sector. All these sectors were contacted through their offices with the help of internal staff that the researcher knew in order to speed up the process. Nevertheless, the documents were approved after the researcher was allowed to discuss and deliver the "invitation letter" by hand.

7.4 Focus group structure

The purpose of the focus group was to collect information about opinions and beliefs while encouraging discussions about Lao transport and policy. Moreover, this focus group would provide opportunities for the participants to learn about system dynamics and causal loop diagrams. The method relies on group interaction whereby people are encouraged to discuss with each other, ask questions, and comment on each other's point of view. This focus group was run by one person, the researcher.

This research focus group is different from other traditional methods, because the researcher combined focus group interviews and group modeling. Thus, at the end of the workshop the participants had the option to present and answer the researcher's question, either using a causal loop diagram or with their own method.

The focus group was conducted on 3rd September, 2014 in the university conference room in Vientiane, Laos. The formal invitation letters were sent in early August, 2014. The letters were divided and delivered to three divisions (Transport engineering, logistic and transport economic). The researcher's intent was to meet all the respondents before the workshop to introduce the purpose of the research and the workshop, and together determine a suitable date. However, some respondents could not be reached for personal discussion; however, phone calls solved some challenges.

This research recruited academics. These academics were expert lecturers of transport studies, freight, logistics, and policy and transport engineering from the University of Laos.

The invitation letters included an invitation to join the focus group, a participant consent form, and the letter of research explaining the aim of the research, the nature of the focus group, the focus group schedule, questions that could be asked, and some exercises for preparation that would be used in the workshop. All documents were translated into the local language (Lao). The

challenge was to find the suitable date for the 17 participants invited. It was postponed three times due to participants' schedule. One week before the workshop, materials were prepared and phone calls were made to participants to remind them of the focus group. As the focus group's target focuses on academic expertise, the time was set up on a school holiday so most could participate. Moreover, to make it simple for participants, the location for the focus group was the university's conference room, as this was a place they were used to. Still, three respondents were unable to participate in the workshop.

The focus group time had to be decreased from six hours (full day) to three hours in the morning (8:30am – 11:30am) as shown in Table 7-1. This was requested by many participants, as their schedules were full in the afternoon. Moreover, the senior participants also suggested decreasing the focus group time to make it as short as possible. Initially, fourteen academics from three departments participated in the workshop: six from the transport department, five from the logistic department, and three from the transport economics department. One respondent's unable to be there due to his schedule was full, while two respondents did not contact back. This might be due to the researcher not having the opportunity to personally invite and explain the objective of the focus group thoroughly.

Table 7-1: Focus group schedule

8:30 am to 8:45 am	Registration and reception
8:45 am to 9:00 am	Opening focus group workshop
9:00 am to 10:00 am	Introduce the research Introduce system thinking Set up groups (4 5 people/group) for three groups. Mini exercise (Identify Lao transport main factor)
10:00 am to 10:15 am	Break
10:15 am to 11:30 am	Presentation: Causal loop diagram Build CLD Participants present CLD Discuss conclusion

The focus group structure was started by separating participants into three groups, mixing individual expertise of 4 5 people per group. The focus group consisted of two parts, where the first section was compressed in substance with a brief introduction of the research object, then a description of the data collection and focus group purpose, and an introduction to system dynamic thinking and the causal loop diagram (CLD). The audience was intrigued by CLD and SD, because it was new to them. Most of them were able to understand, while some of them already had experience with similar tools like fishbone diagram and tree diagram. The second part was to let participants create their own CLD, answer the focus group questions, and share their ideas by presenting their group summarisation for a maximum of 15 minutes.

The focus group was not fully recorded; only presentations were recorded as a video recording, together with note taking during the workshop by the researcher and presentation posters from the three groups. Importantly, data from the workshop focused on qualitative information; thus, quantitative data was not found in this part.

7.5 Group modeling

This section describes the situation and limitations of the group modeling in detail. The workshop was intended for two purposes: the first was to collect local information on Laos' freight transport situation by letting the group's participants work together to present their own knowledge from different academic fields; the second was to introduce a causal loop diagram, as this research seeks a model presentation from participants to use as references and to adapt to this research model.

The first limitation was time management, where the participants had limited time. The focus group workshop was scheduled to run for a full day but, unfortunately, owing to participant availability, it was cut to half a day. This affected the program, as the presenter realized that most of the participants were not well-prepared, even though some information was already in the invitation form. However, this was predicted and prepared for but, as the time was cut, it was difficult to manage the program, especially the time for model building.

Secondly, with an inexperienced presenter who organized the group modeling, it was noticed that it was difficult to control every participant and

have them follow the researcher's idea. Some senior participants would lead through their own idea, which led other participants to follow. The result came out in the presentations, where 70% of the participant's used their own techniques (not CLD) in the presentation and the 30% who used the CLD did not understand the concept.

The outcome shows that group modeling has limitations as participants do not have enough time to understand the concept of model building. However, it still able to correct the information from the presentation, where participant used they own methods.

7.6 Interview structure

The interviews were conducted in Laos between August and September, 2014 by the researcher. The formal invitation letters were sent on August, 2014, where the researcher informally discussed the interview aim and set the meeting date with respondents. The invitation letters included the invitation for the interview, participant consent forms, and the letter of research explanation, which was designed to instruct respondents about the aim of the research, the nature of the interview, the questions to be asked, and other information about the research. In addition, the respondent group that was in the government sector required specific governmental documentation approval for interview. All documents were translated into the local language (Lao). Ultimately, two respondents did not respond to the invite, and one respondent decided not to participate, as he claimed that he might give the same information as his colleague.

The interview was started by the private companies (IP), which responded immediately after they could find the suitable date. The other respondent's group that was in the government sector (IG) required an approval document as mentioned above (extra documentation) to be signed by the head of their division, which took some weeks before respondents received the invitation letters.

A second appointment for the formal interview followed the same process structure for both groups. All the respondents wanted to use their personal offices, and only one respondent had other colleagues in the room during the interview. All respondents signed the consent form, and the researcher repeated the right to participate or withdraw at any time without notice before

the interview started. However, two respondents chose not to be recorded, but taking notes was allowed.

The process structure used the semi structured interview for both IP and IG meetings. The concept and structure of the semi interview was adopted for the purpose of obtaining stakeholders' mental perception and knowledge of Lao trade transport system characteristics and transport policies. All the respondent groups' demonstrated interest in Lao trade issues as their activities, business, or responsibilities involved a certain understanding of the system and problem. As a result, though the interview question structure was similar for both groups, it can be seen that they have different answering styles. IP respondents came up well with the Lao trade situation and issues, which was mostly unpredictable and different from the literature and document reports. Moreover, IP respondents mostly did not have a negative perception of the transport policies, but seemed to accept and agree with the government. Nevertheless, they all ended up leaving a question and a recommendation as a request to the government sector for individual policy improvements. In the other group, IG respondents came up with explanations of the Lao transport system, trade situation, and transport policies. However, as a result, the personal view from IG focused on the details of the overall system structure rather than the overall situation. Moreover, IG respondents eventually described government transport strategies and future plans that related to the private company in Laos.

For quantitative data collection, on the first informal meeting, the researcher requested that respondents prepare their quantitative data for the second appointment, where the data could be based on their responsibility and capability for this research. In this case, IP respondents intended to show only their companies' brochures and suggested that the researcher find information on their respective websites. The IP respondents explained that there could not allow externals to see their numerical data, except for government staff. In the other group, two IG respondents gave useful documents: one being the Lao new transport law books and the other being the Lao new logistic plan project, with quantitative data included in the documents.

7.7 Reflection

The fieldwork exercise for both the focus group and interview was completed according to the research design. Experience with qualitative data collection

was not that smooth from the start. The schedule time designed for the focus group changed, as it was cut by half. The script designed for the focus group ran according to the plan, but the outcome was unpredictable. Issues showed up in the second part of the workshop, where some participants intended to use their own tools to answer the research questions. The fact is these persons led other participants to follow. One of the three groups intended to use their own method to describe their idea, although the researcher wanted them to use CLD in this section. They argued that the method was similar to the tools that they were using, and it was better to use methods that he/she was familiar with to provide better information for the researcher. In that situation, the researcher was unable to obstruct.

The tool they used is called the fishbone diagram technique. This technique is similar to the causal loop diagram, where they both are problem diagnosis analysis tools. Fishbone diagrams are used identify the problem by providing formats that can easily show cause and effect relationships. The fishbone diagram process starts by giving a quality problem and is analysed by initially defining the problem, then channelling possible causal relations into predetermined categories (Ilie, G. and Ciocoiu, C.N, 2010)

It is vital to note that the only group that intended to use CLD are the youth academics. This group intended to use CLD because they were interested and excited to try it. It is not surprising that they focused too much on the causes, which is similar to the fishbone diagram method. At the end, they found it hard to finish their loops. For the other two groups using their own method to present their idea, it was faster compared to the group using CLD. However, an important point is that all three groups were able to supply the data, which was the focus group's purpose.

What matters here is some respondents did not read or study the invitation letter, which had information and sample exercises on CLD, before the event as the researcher had requested. Secondly, this might have happened because of the focus group's duration; if the event ran all day and gave more time for the participants to study and create the CLD, the outcome might have been different. Lastly, the issues that come up and should be mentioned are seniority issues. This seems to be a hard aspect to control, as it may not be possible to lead senior participants to follow the plan. Notwithstanding, these senior participants are important, and the focus group would not have been successful without them, as they offer experience and an academic point of view that are rare. In addition, this might be an issue due to the organiser's

lack of experience in running the event and not being able to control the situation.

The fieldwork exercise for the interview data collection was successful in terms of its qualitative purpose. Only two respondents listed refused to participate, where others showed interest in participating in the exercise and wanted to share their experience and express their opinion about the Lao transport system. Of a total of six interviews, four of these gave permission to audio record, and note taking was taken to complement two of them. The interview ran according to the script designed for a semi structured interview.

7.8 Data analysis outcome for Lao's general freight transport

This process was on step 8 and step 9 by Gelfand et al. (2010) and relates to the Burnard (1991) guideline steps addressed in stages 12 and 13 as described in section 4.4.5. The outcome of the analysis was written out, which included the description supported by quotations from the data, where powerful quotes that speak to the themes were pulled out. In addition, some respondents' comments and speech are included to support the causation codes, and to attribute coding (Saldana, 2013). Names were changed to ensure anonymity. The respondents' code names are divided into two main groups as the data collection collected from the focus group and interviews. The names start with "FG," which indicates "focus group," where academic respondents were divided into three group with the names ending with FG1 to indicate group one in the workshop. The second names starting with "I" mean "interview." The interview had seven respondents and is divided into two categories. The code name starting with "IP" indicates respondents in "interview private company," which had four respondents. The last code name starting with "IG" represents "interview government sector," which had three respondents.

7.9 Respondents' main discussion themes

This section provides an explanation of the codes that developed from the data as factors that cause the Lao freight transport operation and the effect of policy solution simply by respondents. The theme code is grounded on two

thematic statements. A table is also attached to each group of codes as presented by “descriptive codes” involved with meaning.

7.9.1 Lao freight transport

The first theme represents the aim of the research to find out what is the factor that influences Laos’ freight transport. Respondents FG1, FG2, IP3, IP4, and IG3 indicated that the main thing about Lao freight transport is transport infrastructure, especially the road quality. Respondents FG1, FG2, IP3 reported that not only the road quality but also the border quality were the country’s transport weakness, which is included in the country’s infrastructure disadvantage. Moreover, if compared to other landlocked countries, Laos is the one that has less alternative transport mode choices, such as rail or water transport, while an aeroplane is not in the case for standard trade value, as stated by FG3, IP3. Respondents IP2 and IG2 indicated that the fact that makes it hard for Laos’ businesses to access the international market is the goods’ prices, which are higher compared the competition. This price increase is based on two parts: first, the volume of manufacturing is small; second, the total freight cost is very high compared to other competitive countries in the same region, as stated by IP1, IP2, and IG2.

The data shows that, when determining the factors of disadvantage, the external causes seem to be as difficult as internal ones. Respondents IP2, IP3, and IP4 noted that due to many unclear bilateral agreements between Lao and transit neighbours, it is easy for Lao and foreign businesses to become confused and suffer from too complicate and too much paperwork. Thus, many foreign companies prefer to hide the third-party logistics from transit neighbours to do the delivery job, as this is a less complicated with cheaper process, as stated by IP2. However, without support from any respondents, many private companies have to find their own international partners to deliver their goods, which creates a lot of risk and causes them to suffer from higher payment, as stated by IP2, IP4.

Finally, respondent IG2 indicated that the government has planned many projects to improve the transport system to increase the chance for Laos businesses to access the global market. The Vung Ang port is one of the projects, wherein the government wants the port to become the first choice as it is the shortest route to port.

Table 7-2 : Descriptive related codes under the Lao's freight transport system

Theme	Descriptive codes	Meaning	Respondent
Laos' freight transport factor	Road quality	Road quality refers to the level of road quality and road availability. Road investment will increase road quality, in that the travel time taken is reduced.	FG1, FG2, IP3, IP4, IG3
	Border quality	Border quality refer to the standard quality, which include infrastructure, telecommunication and border crossing facilities. Where many border delay happened due to these factors.	FG1, FG2, IP3
	Alternative transport mode choice	This indicates whether the trade provider has optional choice to deliver their goods or the ability to pick the appropriate transport mode for their product.	FG3, IP3
	Laos' volume manufacturing	This means that the less quantity of Lao manufacturing causing the production price to be higher than the mass manufacturing from other developing countries.	IP1, IP2, IG2
	Neighbour's agreement	This refers to regulation contracts, which are made by landlocked countries and transiting neighbours. The data shows that an increase in agreements could neither cause nor affect trade situations.	IP2, IP3, IP4
	Laos' trade partnership	This describes business connections and trade partnerships between Laos and other countries, especially transit neighbours.	IP2, IP4

Freight cost	This refers to the price of transport per trade (import or export)	IP2, IG2
Available port for Laos	This indicates the port Laos' businesses can use.	IG2

7.9.2 Laos' freight transport policy related

In this section, Laos' transport policy theme is considered. The data shows that infrastructure investment was influencing transport systems whether there was an increase in time, freight, or cost (FG1, FG2, and IP3). Respondent FG1 stated that Laos' transport infrastructure must pay more attention, especially from the start of construction. However, the data indicates that each development policy operation required a considerable amount of funding (IG1, IG2).

Another investment required is the border development, which is mostly undeveloped and unable to handle the high traffic demand, while there are still parts of the border that use small board taxis to cross the river, as stated by IG1. However, even with the well-built quality and facility, it still does not qualify to be used as internal border trade or transit (FG2, FG3).

In addition, parallel to the infrastructure improvement, respondent FG3, IP2, and IP3 indicated that transport systems require additional tools, which some countries lack, such as high technology equipment or even international standard requirements. This investment in technology has been necessary from all parts such as road traffic monitoring, border inspection, and telecommunication control. While the country has used human beings to do the work, it still is not enough to cover the need, as stated by IP2, IP3.

The data shows that the other indirect cause that influences the transport system is economics itself. Respondents IP1, IP2 and IG1 indicated that the imbalance of trade and the small internal volume manufacturing of Laos industry needed some recovery from every responder, especially the help or support by the government. Moreover, related to domestic support, business providers require the government to solve the problem in transit operation, particularly the unreliable agreements, as stated by IP1, IP2, and IP3.

Table 7-3: Descriptive related codes under the Lao's freight transport policy related

Theme	Descriptive codes	Meaning	Respondent
Lao's freight transport policy related	Infrastructure	This is described as the particular transport infrastructure policy investment of highway or trade route quality and facility development, which suffers from bad maintenance and disrepair, disqualifying the international road standardisation. This is used to describe the need of improving border quality and facilities.	FG1, FG2, IP3, IG2
	Technological	The unbalancing between demand and supply, where Lao's industry manufacturing volume not covered the need of domestic demand. This causes the balance of the country trade and state GDP to import more than export.	FG3, IP2, IP3
	Human resource	This indicates the workers in an expert field are not enough or lacks demand to supply the need of companies and government sectors.	IP2, IP3
	Economy	This refers to the inspection tools, monitoring technology, and the sharing of high telecommunication relate to the trade.	IP1, IP2, IG1
	Transit operation	This indicates the process of goods passing through the border, which involves internal and transit border procedures.	IP1, IP2, IP3

7.9.3 Lao freight travel time and cost

One must understand that the total travel time from landlocked country to an oversea destination country involves the time the truck spends on domestic roads and the time in a transiting neighbour country, plus the time on port and sea. These times were already assumed to be calculated by any provider or carrier. However, there was an extra time that stakeholders from Laos and other landlocked countries would include for any situation. Respondents IP1, IP2 and IP3 indicated that companies are always wasting time at border crossings, especially at the Laos border for both export/imports. The queue can be very long on some days and it can take many hours, as stated by IP1. Even though the regulation process is reduced, thanks to the new agreement, but the queue is still long, where it need to wait for an officer to sign a crossing border documents, which is not an improvement, as stated by IP1. Moreover, respondent IP2 also said that the border inspection could sometimes be complicated, where there are random checks by officers. All respondent stakeholders who run trade businesses always require the government to improve border quality and technology, especially inspection technology, and increase the number of border officers to fulfil the need for shorter transit times, as stated by IP1 and IP2.

Respondent IP1, IP2 and IP4, who always uses the corridor through the Thai side, stated that even the transit time is much longer, which sometime could take a day to arrive due to the distance to the port is longer compare to Vietnam corridor's, but they still prefer to use Thai corridors. In another side corridor through the Vietnam port, the distance from Laos' border to the port is short and it is less than a six hour to arrive the port, as IP3stated. However, respondents indicated that the Thai highway is much better than Vietnam's road; however, respondent IP1, IP2 and IP3 indicated that the Thai port is much more internationally and reliable. When considering using the Thai corridor, the only extra time would be in the inspection, even is straighter than Vietnam side said by IP1. However, the Vietnam side takes longer and costs more because the goods always have to wait at the port, which means the company has to pay for the warehouse as they expect the vessel to be full or ready to be shipped, said IP3.

The data shows that the freight cost was not decreasing even though many related parts were improving. The reason behind why the freight cost did not

decrease was given by the stakeholders who experienced it. Respondent IP3 and IP4 indicated that their company's freight cost was calculated based on the distance where it could not change as they were hiring neighbour carriers to do the job. As soon as they could not find a shorter route, the price would not be decreased, said IP4. The data also shows that most of the carriers in Laos were using neighbour trucks to perform international trade, as they wanted to avoid the empty return haulage, said IP1 and IP2. There were many situations where the stakeholder had to pay for the empty return haulage back to the port; this increases the freight cost by much if the company responds, said IP2. In the past, when Laos' export/import suffered from the transit neighbour's tax but was seen by the regional cooperation, the tax was reduced. However, the cost of border crossing still has not gone down as the transit neighbour's customs charges still continue to rise because of the lack of a standard agreement, said IP2. Besides the time where the goods were on Laos' border itself was also included due to the longer queue, said IP2.

The alternative cost was coming from the port, which includes port tariffs, loading/unloading, and warehouse prices, when they have to wait for the ship, said IP2 and IP3. However, the price increases due to the waiting time there, but this mostly happened at the Vietnam port, while the Thai port's schedule is fixed and able to control the available time for the truck, said by IP1 and IP2. Thus, the travel time and transit time were always mentioned by respondents, where the customer always considered the shortest corridor time as a priority, as stated by IP1, IP2, IP3 and IP4. As one customer said to IP2, "the more time they are waiting for their goods, the more they will be losing their money".

Table 7-4: Cause and effect of Time freight and freight cost

	Causes and effect codes		
	Cause	**Effect**	**Respondent**
1	Border regulation	Time Border crossing	IP1, IP2, IP3
2	Internal border quality		IP1, IP2, IP3, IP4
3	Traffic congestion		IP1, IP2
4	Time Border crossing	Time freight	IP1, IP2, IP3, IP4
5	Time on vehicle		IP1, IP2, IP3

6	Road quality		
7	Port operation		IP1, IP3
8	Time freight		
9	Distance to port		IP1, IP2, IP3, IP4
10	Empty return haulage		IP2
11	Transit neighbour's customs charge	Freight cost	IP1, IP2, IP3
12	Port tariff		IP2, IP3
13	Port operation		IP2, IP3

Table 7-5: Code description

No	Causation code	Description and quotes
1	Border regulation effects border crossing time	The more border regulation requirement, the more time waiting at the border increases, which causes border delays. ''Our truck has to wait in a long queue to crossing the border, just because it needs customs officer to check and sign many paperwork one by one,'' said IP1.
2	Internal border quality affects time spent border crossing	Laos has very few border crossings can handle the standard trade value, while the available one struggles with the high traffic demand, which leads to longer queues because border quality is not good enough.
3	Traffic congestion affects time spent border crossing	"Border passing for either export or import, not problem if document prepared, but the problem is there is not enough border crossing, so everyone is when to the same border, which increases the longer queue on border," said IP2.
4	Border crossing time affects	

	freight transit times	
5	Road quality affect freight transit times	In many instances, freight travel time rapidly increases because of bad roads, mainly during the rainy season. "On raining season, we could not guarantee delivery our goods via some road, so we have to use another route even the distance is double," said IP.
6	Port capacity affects freight transit times	Port capacity is more reliable and the operation is faster, but the time spent on each port individually depends on the port size. "Thai port traffic is dependable with much movement, so the container does not have to wait for a long time compare to Vietnam port, where sometimes the container has to wait until the vessel ready or till maximum," said IP3.
7	Freight transit times affect freight costs	Freight costs are calculated by the time delivery taken plus operations cost (Customs charge, loading, loading, etc.) "The customer prefers to pick the fastest route, where
8	Distance to port affects freight costs	delivery time causes to the freight," said IP2. "'The corridor distance from Lao to port via Vietnam route is cheaper if considering only travel time and," said IP4.
9	Empty return haulage affects freight costs	The empty return is one of the main causes of cost for any trade because the export/import needs to pay an extra price for empty containers returning to starting point. "They do not benefit for Lao business to use their truck due to the problem with the empty backlog, which company in Laos not intend to do," said IP3.
10	Transit neighbour's customs charges	The cost measures the fees related with completing the procedures to export/import the goods through transit neighbours from/to Laos are included. These include administrative fees, customs clearance, and technical

	affect freight costs	control, documents, terminal handling charges, and inland transport fees. With costs measured, official values are recorded, but this does not include tariffs or trade taxes. "The border fees via Vietnam is cheaper than Thai border, but this price is not," said IP2.
11	Port tariff affects freight costs	"The problem is not only with the port, but is the staff of port, where they asking too many documents, and high," said IP1.
12	Port quality affects customer decision	"Customer dominate to choose the destination or corridor which they want to the past. The reason they wanted for example via Thai, because Thai port cheaper due to port traffic more dependable and much movement,'' said IP3.

7.9.4 Accessing the global market

This section represents the data connection under a theme of accessing the global market and includes the causation code and effect description table with supporting quote tables.

The data shows that road quality is one of the main reasons Laos' businesses have fewer opportunities to access the global market. This view is supported by academic groups (FG1, FG2), where they noted that, because of the dishonesty in the road construction, Laos' transport suffers from the badly maintained road, which makes it hard for all business to export/import goods to/from the international market. Respondent Laos's business trade providers (IP3, IP4) indicated that the road quality is one reason Laos' businesses are not competitive in global markets. Road quality affects the availability of the road network and the travel time taken during transport, which ultimately increases the freight cost. The government sector respondent IG3 indicated that, in the past, it was difficult to transport items during the bad season (rain); thus, the government has always planned and focused on the road investment to improve the quality to make it available to use for any season, so that it could be beneficial to any transport or Laos business trade to supply their goods efficiently. Moreover, as the freight transport cost of that particular road reduce, it possible that the amount of trade (truck or others vehicle) will happen in that IG3.

Table 7-6 : Cause and effect of accessing the global market

	Causes and effect codes		Respondent
	Cause	Effect	
1.	Road quality	Corridor choice	FG1, FG2, IP4, IG
2.	Border quality	Corridor choice	FG1, FG2, IP3
3.	Corridor choice	Global market chance	IP3
4.	Time freight	Global market chance	IP3
5.	Freight cost	Global market chance	IP2, IG2
6.	Volume manufacturing	Global market chance	IP1, IP2, IG2
7.	Transit Agreement	Global market chance	IP2, IP3, IP4
8.	Trade partnership	Global market chance	IP2, IP4
9.	Port available	Global market chance	IG2
10	Transport cost	Truck number	IG3

Table 7-7: Code description

No	Causation code	Description and quotes
1.	Road quality affects corridor choice	In many instances, some main roads were completely closed due to the rainy season. ” On raining season, we could not guarantee delivery our goods via some road, so we have to

		use other routes even the distance is double,'' said IP1.
2.	Border quality affects corridor choice	Laos has very few border crossings able to handle the standard trade value, while the available one struggles with the high traffic demand, which leads to longer queues because border quality is not good enough. "The problem is due to there is not enough border crossing, so everyone is when to the same border, which increases the longer queue on border,'' said IP2.
3.	Freight times affect global market chances	The less time it takes from industry to destination, the more interest by the customer, who is concerned with delivery time as the first priority. "''Logistic, service, production cost, help them to competitive in global market, where goods have to be just in time,'' said IG2.
4.	Freight cost affects global market chance	Freight cost usually influences customer's decisions, where goods can have individual choices with the similar price in the global market, but the difference was competition on the cost of freight. "This rate increased based on two parts, first is the volume manufacturing is small, and the other is total the freight cost is very high when to compare to other competitive in the same region,'' said IP2.
5.	Volume manufacturing affects global market chance	It comes as no surprise that the goods with mass production were able to sell cheaper than those of competitors with less volume manufacturing. "This price increased based on two parts: first is the volume manufacturing is small, and the other is total the freight cost is very high when to compare to other competitive in the same region,'' said IP2.

6.	Transit agreements affects global market chance	Every bilateral or trilateral transit agreement has the purpose of helping the trade flow from landlocked countries thorough any transit countries to be at the port as fast as possible. However, if the trade was obstructed by inspection or is having problems with transit due to regulations, it would be hard for any trade to be delivered from/to the market. "It's very difficult sometime when import or export product through some area which having overlapping agreements or not clear who should we deal with, when the problem exist,'' said IP2.
7.	Trade partnership affects global market chance	To access the international market, small businesses or trade companies require help or cooperation with other foreign companies to be trade partners. "Previously, Thai Lao, is very hard to do the trade, but after 1999 have been significantly improve, but the price of product still high, so what the problem, is because the operation, and we need to be a partner with another countries, need government to control, need distribution, need mid person to control information, to share information. So, we can be fight with others if we export our goods to the market,'' said IP2.
8.	The number of Port available affects global market chance	The number of ports that available for Laos to do trade increase chance for to accessing the global market as there are many optional corridors. "Right now, we only use 2 ports for our trade, where other not suitable or too far to delivery, but if Laos and Vietnam building new port that the distance is shorter than existing one, this will absolutely help many businesses to reduce their freight cost and other issues where we always lag behind other international competitors,'' said G2.

7.9.5 Border crossing

IG4 has briefed about the policy on new input on Laos' border: the number of official inputs is dependent on each border requirement on how much officials need from the headquarters for each year. The system works, as when the border crossing time reaches the border crossing time limitation, the headquarters will decide how many officials they require for that year. However, the input would have to depend on the official input quota set by the government, which is normally less than 3 people per year.

- The policy on new official input in the Lao's border: the number input was depended on each border requirement on how much official needed from the headquarters for each year when the border crossing time reach the border crossing time limitation. And the input would depend on the official input quota set by the government (IG4)
- Each border has different time set, were the limitation time that small border would ask for more official is when the border crossing time have spent more than half a day or 6-8hour (IG4)
- The border law, were the limitation time that small border would consider transfer official out is when there is no waiting time at the border (IG4)
- The maximum official that can be transfer to other sector or remove is 2 people/year. However, it must have at least 2 officials available (IG4)
- Total number of officials working on processing part (document checking and inspection respondent)

7.9.6 The regional cooperation and the Vung Ang port project

This section addresses the theme of regional cooperation, where respondents IP1 and IP2 noted that a number of their trade partners increased since the government joined the regional association. Moreover, many respondents agreed that regional cooperation has attracted foreign investors (IP, IP2, IP3, IG1, IG3, FG1, and FG3.) As a matter of fact, the purpose of regional agreement was to solve the regional problem. Respondents (IG1 and IG3) said that, at the end of regional meetings, the group would always produce a new agreement or improve the existing agreement, especially on transit regulations. It is no great surprise that regional cooperation has had an effect on customs charges, where landlocked countries always ask transit neighbours to reduce their tax or customs charges (IG1, IG3).

Regarding the theme of the Vung Ang port's effectiveness, academic and government respondents have positive perspectives on the Vung Ang port project in which they are told it is the best move from the government to invest in an optional port for Laos, as stated by FG1, FG2, FG3, IG1 and IG2. Respondent IG2 also indicated that the government has a long-term plan for Vung Ang port to become optional for the country where it used to depend on the Thai port, where the price is high, and a longer distance to the South of Vietnam, where the travel time is double. Respondents IG2 and IG1 noted that the port project will increase the relationship between two countries, and if the project is successful, it would lead to another project. As the Vung Ang port has the advantage of the shortest distance to port compared to the primary port, this would be seen by foreign investors, as stated by FG1 and FG2. Moreover, the Vung Ang port project also included the local economic zone where the country opens for foreign investors to join and share the investment, as stated by IG2.

IG5 has explained that Vung Ang Port had a specific lane for Laos' trade, which was smaller than other lanes owing to Laos' small trade volume compared to other countries. IG5 also described that right now the port waiting time for Laos export was more than 24 hours in 2016-2017. Thus, the transport headquarters have set a new strategy to deal with port delay to reduce the port waiting time to less than 12 hours by sending a Laos official to work at the Vung Ang Port to deal with all the port processes, as has been done at Da Nang Port. However, this is still a plan and needs more discussion with the Vietnam government and port operation (IG5).

Table 7-8: Descriptive theme of Lao regional cooperation and Vung Ang port project effectiveness

Theme Policy	Policy effect	Respondent
Regional cooperation	1. Trade partnership	IP1, IP2
	2. Foreign investment	IP, IP2, IP3, IG1, IG3, FG1 and FG3.
	3. Regional agreements	IG1, IG3
	4. Transit customs charge	IG1, IG3
Vung Ang port investment	5. Port available	FG1, FG2, FG3, IG1, IG2

6. Political relationship with neighbours	IG1, IG2
7. Freight time	FG1, FG2, IG2
8. Foreign investment	IG2

Table 7-9: Lao government strategy codes meaning

No	Code	Description and quotes
1	Regional cooperation affects trade partnerships	Many regional cooperation meetings invite local trading companies to share their issues, which ultimately makes them cooperate and become trade partners. " We have many trade partnerships with neighbours, especially with Thai companies and keep increasing since Laos corporates with other Asian countries,'' said IP1.
2	Regional cooperation affects the number of foreign investments	Investment results in Southeast Asia increased rapidly after these countries cooperated. "The number of foreign investors increasing since 1990s, as many of them told me that it was an advance of the improving our bilateral and trilateral agreements with Thailand and Vietnam,'' said IG3.
3	Regional cooperation affects agreements	As a matter of fact, the purpose of the regional agreement was to solve the regional problem, which often results in producing new agreements or improving existing agreements, especially the transit regulations. "We always discuss and negotiate with neighbours, especially with Thailand, where we want to change some agreements or want them to reduce some particular regulation,'' said IG3.
4	Regional cooperation affects neighbour's'	It is no great surprise that regional cooperation has an effect on the customs charge, where landlocked countries always ask transit neighbours to reduce their tax or customs charges.

	customs charges	"In the past, we do not have much power to negotiate with neighbours to change the transit regulation and transits charge. But right now, since we work together, we can ask them to reduce the price and it work,'' said IG1.
5	Vung Ang port investment affects the number of ports available	The more port investment built around Laos, it serves as a port choice for Laos' trade. "Where ever right now is might not been interested by the private Lao companies to whatever reason, it so far as we know it will be one of the good choices for Lao trade through international as is one of the shortest corridors,'' said FG1.
6	Vung Ang port investment affects political relationship with Vietnam	The probability that a political relationship would increase with an increase in the number of shared projects. "It's important for you to remember that this port project was the share corporation between our country and Vietnam, thus it also means we have improved our relationship further and if this project work, why it would not be another project,'' said IG2.
7	Vung Ang port investment affects freight times	The freight time is regarded as the distance. The Vung Ang port is the shortest corridor to port and takes less time compared to other corridors. "The less distance or time from warehouses to port mean less cost, so it has to accept that this new port was the cheapness when consider about the trade distance.'' IG2

7.9.7 The government policies

The data indicates that each government development policy to improve the transport operation required a considerable amount of funding, which is based on Lao's development (GDP). The transport infrastructure investment is one of the primary strategies that Laos' government focused on, as the road quality is the central issue where Laos's trade suffered. This was the main priority, but Laos' government lacked the ability and funds to make the investment.

Respondents FG1 and FG2 agree that road quality is lower compared to neighbouring countries because of lack of investment, which affects these countries as there is a lack of reliable and optional routes for freight to access the international market. Respondents FG3, IG1, and IG2 indicated that many available domestic networks, which have been used for rural transport and domestic travel, could be upgraded to qualify the standard, but this is only possible if the government has enough funds. In addition, the best option is to invest in the rail network to connect with neighbour's rail, as stated by FG2 and IP2.

Another investment required is the border, which many are used only for small transport crossings. Some borders do not connect by the bridge, and small board taxis are used to cross the river, as said by IG1. However, there are still many borders that connect by well-built roads that could be used by medium to heavy trucks. However, these borders' quality are weak and lack quality facilities to be used for international trade. This causes an increase of high demand on available borders and longer queues due to the high traffic, as stated by FG3 and IG2. One of the respondents from FG3 argued that the cause for the border delay not only comes from the cause of high demand, but it is also due to the border quality, which needs to be improved.

In addition, to the cause of border delays, IG2 and IP1 indicated that the Lao border still lacks technology and telecommunication, which causes more work for the customs officer to do inspections and paperwork. Even more, there is still the lack of human sources for this job, which is due to a small salary supply by the government, as stated by IG2.

Fortunately, the customs charges and tax for imports and exports were reduced and will continue to be cut when Laos becomes part of the AEC. This involves the documentation also getting reduced thanks to the new agreement with transit neighbours, as stated by IP1 and IP3. However, the freight cost will not be reduced if the transit time is still not improved, as stated by IP1.

To clarify why the freight cost is still not reduced, respondents IP1, IP2, and IG1 all agreed that it is due to the balancing of trade, where Laos imports more than it exports. Laos has a small economy compared to its neighbours, especially China, Thailand and Vietnam. Respondent IG2 said that the imbalance of trade responded by the Laos' volume manufacturing is low, and even the internal goods need to be supplied by neighbours. IG2 said that for long term investments, the government needs to focus on industry

investments for expanding to international export, where it will benefit to increase Laos' GDP in the future. However, all respondents from private companies (IP1, IP2, IP3, and IP4) mentioned that they lack well educated human resources to work for them, so the country does not have direct experts in the field and is not producing enough in this kind of field to supply the need for an increase in transport and logistic companies.

Table 7-10 : Descriptive theme under the country policies internal development

Theme Policy	Policy effect	Respondent
Laos' transport infrastructure investment	1. Rail network	FG2, IP2
	2. Laos' road quality	FG1, FG2
	3. Laos' development (GDP)	IG2
Laos' industry and business investment	4. Laos' manufacturing	IP1, IP2, IG2
	5. Laos' domestic distributor and logistic provider	IP1. IP2
	6. Laos' domestic distributor and logistic provider	IP1, IP2, IP3 and IP4
Laos' human resources management	7. Laos' border delay	IG3
	8. Crossing Laos' border procession	IG2
Laos' border investment	9. Laos' border quality	FG3, IG2
	10. Crossing Laos' border procession	IG2
Laos' technology and telecommunication investment	11. Laos' border quality	FG3, IG1, IG2
	12. Crossing Laos' border procession	IG2
	13. Laos' border delay	IG2, IP1

Table 7-11: Code description

No	Causation code	Description and quotes

1)	Laos' transport infrastructure investment affects Laos' road quality	The road quality is regarded as low standardisation, where it requires high investment to upgrade the road/highway. ''Road investment and road maintenance between a corridor, when to compare to international, Laos still lag behind the neighbour standard. The example they can get a 12 13 tonne, Lao can only 9.1 tonne maximum. But we can't upgrade yet; we still lag of fund,'' said IG3
2)	Laos' industry and business investment affects Laos' manufacturing	To reduce the imbalance of trade, where Laos imports more than it exports, industry and internal businesses must invest to increase the export.
3)	Laos' human resources management affects Laos' distributor and logistic providers	This indicates the workers in expert fields are not enough or lack of demand to supply the need of society and government sector. ''It hard for new business to run the transport business in Lao due to they were few workers that have direct expert field that has skill of carriage or logistic if they are not hiding the operator or driver from neighbour,'' said IP1.
4)	Laos' border investment affects Laos' border quality	The border wishes to handle international trade, which requires standard construction and facilities. Many of Laos' borders were not invested in qualifying standardisations, which causes Laos to lack available trade borders and increases the queue at its current border, where they are unable to handle high traffic congestion. ''The border delay happened due to it, not enough border crossing, which increases the long queue,'' said IG2.

5)	Laos' human resources management affects Laos' border delay	When goods cross the border, they go through many regulation processes, such as paperwork and inspection. Depending on the amount of paperwork, the time at the border can increase. International border inspection processes always depend on technological tools, which means that inferior technology does the job or it is being done by a human, increasing the time to finish. Thus, if any border uses a human worker to do all of the processing, it requires many sectors and wastes time, as it all can be done online and by inspection tools.
6)	Laos' technology and telecommunication investment affects Laos' border quality	
7)	Laos' technology and telecommunication investment affects Laos' border delay	

Chapter 8 Vung Ang Port corridor causal loop diagram

8.1 Introduction

This chapter seeks to improve the understanding of the freight system in Laos focusing on the Vung Ang Port corridor, characterising the problem in terms of the underlying feedback structure of the system. The analysed data in Chapter 7 is extended to obtain a causal loop diagram (CLD). In addition, the causal loop diagram created in Chapter 5, which is a causal loop diagram for general landlocked least developed countries (LDLC_CLD), will be adapted as a fundamental variable and link to obtain the Vung Ang port corridor causal loop diagram (VAP_CLD) used in this chapter. However, this thesis has interest in a particular corridor, which is the Vung Ang Port corridor Road No.12. Thus, the model will not look at all the factors from Chapter 6 but will pick only those relevant to this route. This section combines all the previous mini diagrams and develops them into the VAP_CLD, as shown in Figure 8-1 below.

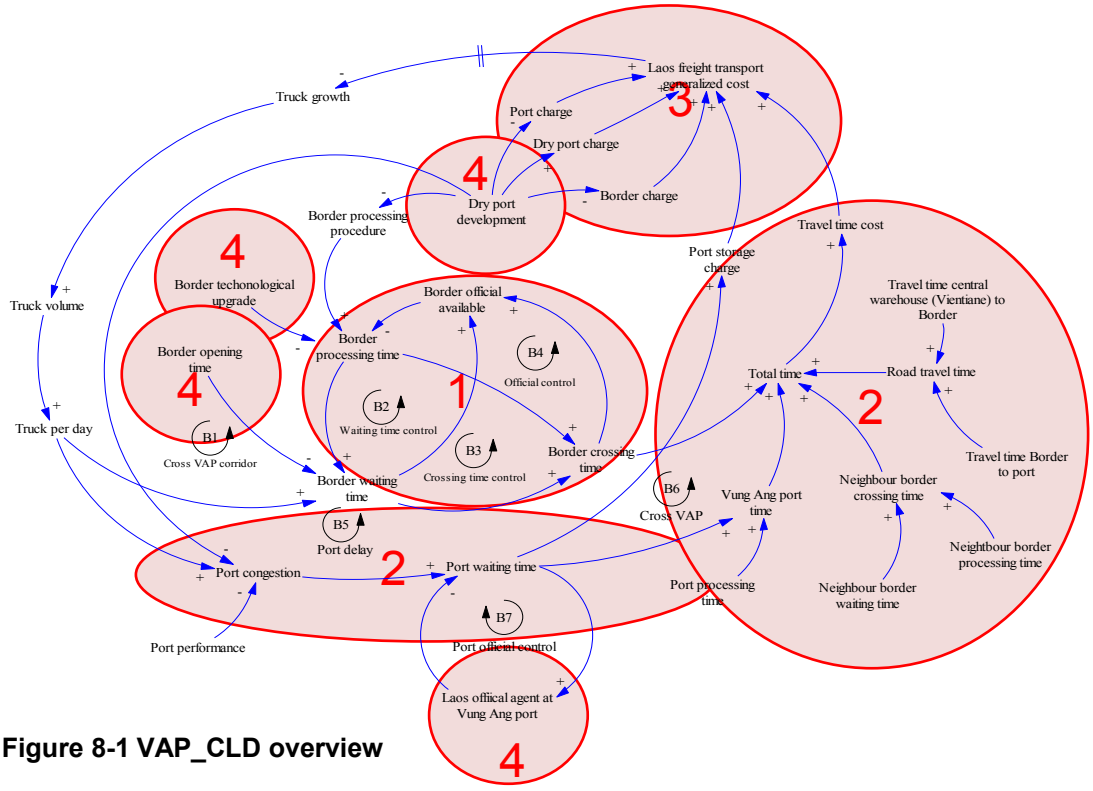


Figure 8-1 VAP_CLD overview

This chapter show the development of the Vung Ang port causal loop diagram (VAP_CLD) begins with the sub-section i to iv respectively. And then with section 8.2 compares the different between previous LDLC_CLD with this specific VAP_CLD. End with section 8.3 of chapter conclusion.

i. Border loop
ii. Port and time loop
iii. Freight transport generalised cost loop
iv. Policies loop

i. Border loop

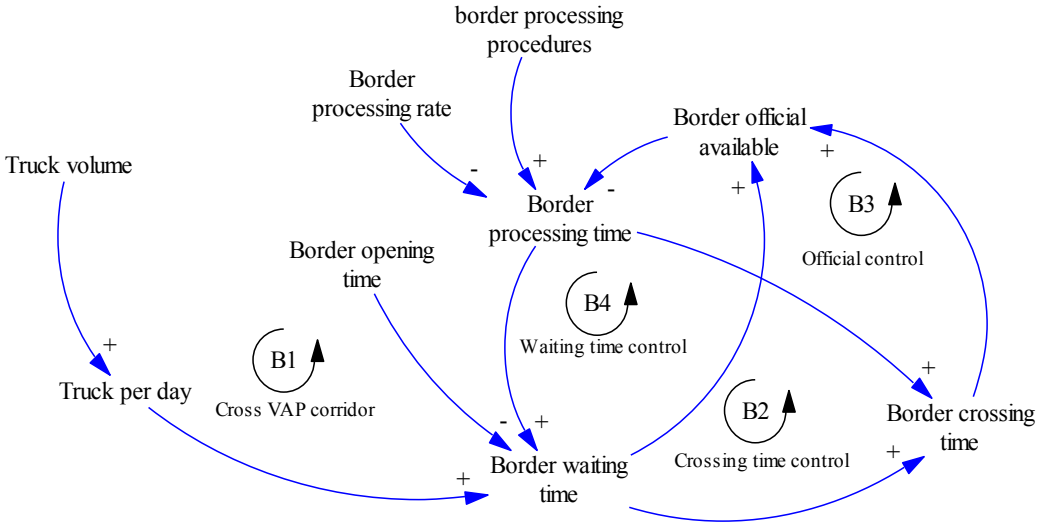


Figure 8-2 Border loop

Along with road-quality issues, border crossing is the most complex part of Laos' freight transport and transit operation. Laos' border infrastructure and facilities are lacking in improvements compared to the borders of its neighbours. This is due to a lack of financial planning in Laos' development. Figure 8-2 present a Na Khao border system as developed based on background information from section 6.5 together with the interview from section 7.9.5 Table 8-1 gives a border variable description, followed in Table 8-2 describe a causal link details that explain the relationships.

The amount of truck volume leads to increases in the number of trucks per day as customers decide to export by crossing the Vung Ang Port corridor, represented as the loop Cross VAP corridor (B1). As the number of trucks entering the border grows, loop (B1) has an effect through (B2), (B3), and (B4), where the effect from (B1) is an increase in the border waiting time and border crossing time together, which lead to pressure for official input in loop (B2). When the border crossing time reaches the limit maximum allowed, official input is required as a process of official control (B3) from the Laos

border's official system. However, in the case of no waiting time at the border, where too many officials are available without any work, a waiting time control loop (B4) acts to reduce some officials or move them to other departments.

Table 8-1 Border loop variable description

No	Variable	Description
1.	Truck volume	This variable is transformed from *trade volume* from section i chapter 5, Table 5-1_No.2, which determines the number of trucks using the Vung Ang Port corridor from the central warehouse in Vientiane, the capital city of Laos, to the border Na Khao, before crossing the Vietnam border.
2.	Border opening day	Defined as a number of days of border opening, which is set to be one of the themes of the border quality, as discussed in section 7.9.1, Table 7-2.
3.	Border waiting time	This variable represents the same facts from section iv, Table 5-7_No.20. However, it does not represent the overall border but focuses on the Vung Ang Port border and is defined as the time where the driver has to wait until the official is available to serve or the time starting from entering the queue till the driver handles the documents and starts the border processing system.
4.	Border opening hours	Defined as the time the Vung Ang Port border official opens till closing, where it is related to border quality and Laos' transport policy together, as discussed in section 7.9.1, Table 7-2.
5.	Border processing rate	This variable was part of the border quality from section iv, Table 5-7_No.23 and is defined as the time for border system processing, which refers to the official document checking speed.
6.	Border processing time	This variable was converted from section iv, Table 5-7_No.22, defined as the time border procedures take when crossing this border but represents time at the Na Khao border in particular.

No	Variable	Description
7.	Number of officials at the border	This variable was part of the border quality from section iv, Table 5-7_No.23. However, this variable is defined as the number of trucks who responded on the part about truck-crossing procedures (document checking, inspection).
8.	Number of procedures	This variable was converted from *bureaucratic crossing procedures* in section iv, Table 5-7_No.21, where this is defined as the number of steps or procedures required as a border crossing rule.
9.	Border crossing time	This variable used the same facts from the border crossing time from section iv, Table 5-7_No. 25, and counts as the total time taken for crossing this border.

Table 8-2 Border loop causes and effect description

No	Causes	Effect	Description
1)	Truck volume	(+) Truck per day	The link was transformed from the LDLC_CLD where *trade volume* impacts the *traffic volume,* as described in section i Table 5-2_No.6 mixed together with the link where *traffic volume* affects the *border congestion* from section iv, Table 5-8_No.27. Here, the link represents the number of trucks using the VAP corridor, which have influenced the number of trucks crossing the Na Khao border per day because Road No.12 is only connected to one border, as mentioned in Section 6.3.3.
2)	Border opening day	(-) Truck per day	The link was transformed from the LDLC_CLD where *border quality* impacts the *border congestion* described in section iv, Table 5-8_No.28, together with the data supported in 8.8 that the border opening could have an impact on the number of trucks crossing the border as, if it has a few days open, all the trucks would come on the same day.
3)	Truck per day	(+) Border waiting time	The link was transformed from the LDLC_CLD where *border congestion* influenced the *border waiting time* showed in section iv, Table 5-8_No.29. This was supported with the data from 8.8, where the amount of trucks entering the border has an impact to the border waiting time as the more trucks lead to more people in the queue and the waiting time increases.
4)	Border opening hours	(-) Border waiting time	The link was transformed from the LDLC_CLD where *border quality* impacts the *border waiting time,* as can be seen in section iv, Table 5-8_No.31, together with

			the interview data from 8.8, where the official time the border opens has an impact to the border waiting time, owing to everyone not wanting to cross the border on the extra time as they have to pay an overtime charge. Thus, the less time the border opens would increase the number of people in the queue as the rate of trucks arriving would be more than in times where the border is opened longer.
5)	Border processing time	(+) Border waiting time	The link was transformed from LDLC_CLD where *border processing* impacts the *border waiting time* from section iv, Table 5-8_No.31 and data from section 6.5 and section 7.9.5 that border processing has the most impact on the queue time or waiting time. If the rate capacity is less than the arrival rate, it will significantly push the waiting time rapidly high.
6)	Border processing rate	(+) Border processing time	This link was added based on the interview data from section 7.9.5, where the rate of processing impacts the border time, as the more time per process increases the total time taken.
7)	Border processing procedures	(+) Border processing time	The link was transformed from LDLC_CLD as shown in section iv, Table 5-8_No.32 and supported by interview data from section 7.9.5, where the number of steps or procedures impact the border processing time taken, as the number increase would also mean time has to be added.
8)	Border processing rate	(+) Border processing time	The link was created from the data in section 7.9.5, where each border has a processing rate per document/procedure. Thus, if the rate of time taken increases,

			this means it will increase the total border processing time.
9)	Border waiting time	(+) Border crossing time	The link used the same causes from LDLC_CLD, as shown in section iv, Table 5-8_No.34, and is supported by data from section 7.9.3 and 7.9.5, where border crossing time is always combined with two parts, which are the combination of border waiting time and processing time, where mostly the waiting time is the one that takes longer than the processing time.
10)	Border processing time	(+) Border crossing time	The link used the same connection where *border processing time* impacts the *border crossing time* shown in section iv, Table 5-8_No.35 and is supported by data from section 7.9.3, where border processing time is the main time that is always calculated in the border crossing time. When the processing time increases, the crossing time increases at the same time.
11)	Border crossing time	(+) Number of officials at the border	The link was transformed from section iv, Table 5-8_No.36, where LDLC_CLD showed the causes of *border crossing time* impact the *official input requirements*. This was supported by data from section 7.9.5 on Laos' policies on new officials put at the Laos border, where the input was dependent on each border's requirement on how much officials are needed from the headquarters each year. However, the number of requirements depends on the border crossing time limitation, where each border head would decide the maximum time limit for them.

12)	Number of officials at the border	(-) Border processing time	The link was transformed from LDLC_CLD where the increase in *border quality* reduces the *border processing time* shown, as in section iv, Table 5-8_No.30, together with the link from section iv, Table 5-8_No.37, where increases in the *official input requirements* increase the *border quality.* This link supports data from 8.8 as on Laos' border technology still cannot cover all the processing. Thus, the document checking and physical inspection at the border is always handled by the official at the border, where the more officials available would reduce the amount of time taken for processing.

ii. Port and time loop

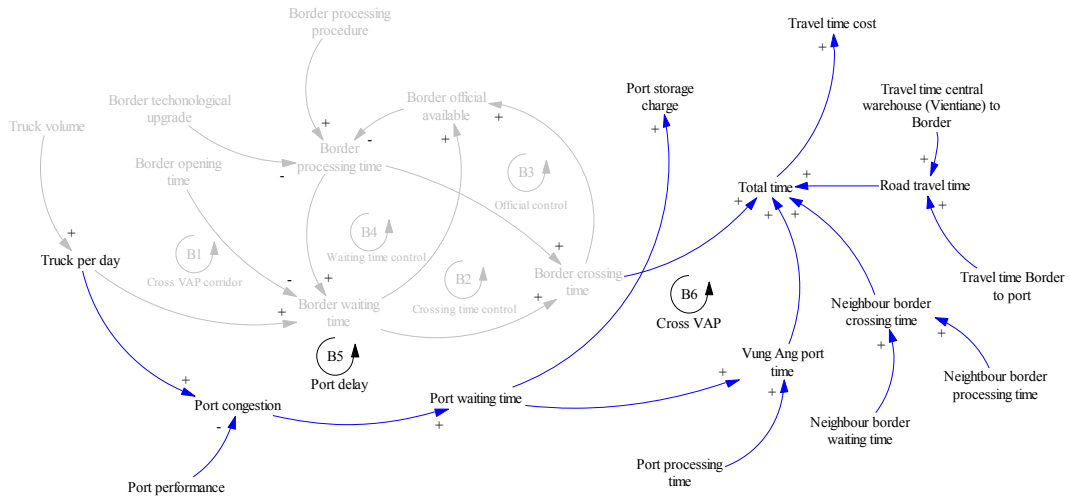


Figure 8-3: Port and time loop

Port loops discussion:

After the VAP corridor opens, the truck volume increases and the VAP port congestion increases, especially for Laos' export where the port delay always happens owing to low port quality. The port delay loop (B5) increases as the number of trucks increases. This affects the containers or trucks that have to wait at the port, which, in some cases, is more than a week, which affects the port storage charge. Moreover, with the extra time increase from the delay (B5), the total travel time combined with the port processing time affect the total travel time cost, causing it to increase rapidly as customers have to face the cross VAP loop (B6).

Table 8-3 Port and time loop variables and related descriptions

No	Variable	Description
10.	Port lane	This variable represents the capacity level of Vung Ang Port on the particular lane in which Laos' truck enter transformed from the *port quality* shown in section v, Table 5-9_No.27 and the interview data supported in section 7.9.6.
11.	Port delay	This variable represents delays in the lane in which Laos' truck enter mentioned in the interview data supported from section 7.9.6, where this is transformed from the *port congestion* variable from section v, Table 5-9_No.28.

No	Variable	Description
12.	Port waiting time	This variable is the same variable from LDLC_CLD section v, Table 5-9_No.29 but represents the port waiting time at Vung Ang Port and is similar to the waiting time at the border as defined as the time where the driver has to wait until the port official is available to serve, or the time starting from entering the queue till the driver handles the document and starts the port processing system.
13.	Port processing time	Port processing time is counted as the time for document handling till the time the goods or containers are ready to be loaded on the vessel, such as shown in section v, Table 5-9_No.30.
14.	Vung Ang Port time	This is defined as the time taken especially for Laos' trade via Vung Ang Port, as it has a special bilateral agreement different to other Asian countries, where it was transformed from the *port time* variable from LDLC_CLD, as described in section v, Table 5-9_No.31.
15.	Neighbour border processing time	This variable was transformed from the *neighbour border quality* from LDLC_CLD, as shown in Table section v, 5-9_No.32, which focuses on the processing time, which is the main time taken on border crossing similar to Laos' border operation. However, this border represents a border on the Vietnam side, which has a system different from other borders.
16.	Neighbour border waiting time	This variable came from the interview data mentioned in section 7.9.4 and 7.9.5, where it is defined as the time the driver has to wait after they arrive at the Vietnamese border till in the first queue for the border crossing procedure.
17.	Neighbour border crossing time	The variable represents the same variable as used in the LDLC_CLD of *neighbour border crossing time,* as shown in section v, Table 5-9_No.33, which is defined as the total time taken in transit to the Vietnamese border.
18.	Total time	The variable represents the same variable as used in the LDLC_CLD of *total travel time* shown in section iv, Table 5-7_No.26, where this is defined as the total time taken from the

No	Variable	Description
		start, where here it represents from the central warehouse in the middle of Laos to Vung Ang Port.
19.	Road travel time	This variable was transformed from the *distance to port* on the LDLC_CLD, as shown in section vii Table 5-13_No.37, which, here, is defined as the time the truck spends on the road not including the border or port time.
20.	Travel time central warehouse (Vientiane) to Border	This variable was transformed from the *distance to port* on the LDLC_CLD shown in section vii,Table 5-13_No.36, where it represents the total distance but, here, is defined as a time the truck spends on the road from the start not including the border or port time.
21.	Travel time Border to port	This variable was transformed from the *distance to port* on the LDLC_CLD, as shown in section vii,Table 5-13_No.36, where it represents the total distance but is, here, defined as the time the truck spends on the road from the border after crossing the Vietnam side till arriving at Vung Ang Port.
22.	Port storage charge	Defined as the cost depending on how much time the container or goods have to wait at the port, as mentioned in section 7.9.6.
23.	Laos official in the Vung Ang Port	Defined as the Laos agent working at the Vietnam port who deals with the Laos trade document process, as mentioned in section 7.9.6.

Table 8-4 Port and time loop varaibles causes and effect descriptions

No	Causes	Effect	Description
13)	Truck per day	(+) Port delay	The rate of trucks per day that arrive at the port would have an impact on increasing the delay time, which was transformed from the link of *traffic volume* that affects port congestion, such as discussed in section v, Table 5-10_(No.39.) and is supported by data, where the more trucks arriving make the port delayed.

No	Causes	Effect	Description
14)	Port lane capacity	(-) Port delay	The port delay time would be high if the amount of trucks reaches more than the limit capacity. Thus, the lane that Laos' trucks use has control over the delay time, such as discussed in section 7.9.6. However, the link was transformed from the cause's link in the LDLC_CLD, where the good *port quality would* reduce the *port congestion,* such as discussed in section v, Table 5-10 (No.41.)
15)	Port delay	(+) Port waiting time	The link was transformed from the LDLC_CLD where the high p*ort congestion* would lead to high *port waiting time.* Thus, this link represents the time delay after arriving at the port but still have to wait for port official allowing to entering the port processing queue.
16)	Port processing time	(+) Vung Ang Port time	The link was transformed from the LDLC_CLD, where the *port time* depended on the *port processing time* and *port waiting time* together and if any of them increased, it would also make the port time increase such as shown in section v, Table 5-10_No.44 and No45, where the Vung Ang Port time is influenced by two main parts, where port processing is the standardisation and port waiting time is extra time and both support the Vung Ang Port time.
17)	Port waiting time		
18)	Neighbour border waiting time	(+) Neighbour border crossing time	Both links were separated from the link of *neighbour border quality,* which impacts the *Neighbour border crossing time* from LDLC_CLD section v, Table 5-10_No.47. This link focuses on the neighbour border waiting time and border processing time, which is the main support combined with the neighbour-border crossing time.
19)	Neighbour border processing time		

No	Causes	Effect	Description
20)	Travel time Border to port	(+) Road travel time	Both travel times were transformed from the *distance to port* on the LDLC_CLD on section v, Table 5-14_No.57, where road travel time via the Vung Ang Port corridor is influenced by time from the warehouse to the border and the time from that border to Vung Ang Port, such as discussed in section 7.9.4.
21)	Travel time central warehouse (Vientiane) to Border		
22)	Border crossing time	(+) Total time	The *total time* here was transformed from the *total travel time* on the LDLC_CLD. All the links are similar such as: - *Border crossing* time: section iv, Table 5-8_No.38. - *Port time:* section v, Table *5-10_No.46* - *Neighbour border crossing time:* section v, Table 5-10_No.47 - *Distance to* port: section vii, Table 5-14_No.57 where this link represents the Laos export time to port (Vung Ang Port) computed by four different time parts, where Laos' border, port, and the neighbour's border are timed on processing and the road travel time is the time of trucks' moving distance, such as discussed in section 7.9.4. If any of these variables increase, it would have an effect on increasing the time as well.
23)	Vung Ang Port time		
24)	Neighbour border crossing time		
25)	Road travel time		
26)	Port waiting time	(+) Port storage charge	The link is implemented from the interview data from section 7.9.6. When the truck arrives at the port, goods must be unloaded and there is document processing and inspection before loading on the vessel. Thus, the more time spent at the warehouse, the more the fees that have to be paid at the port.

No	Causes	Effect	Description
27)	Port waiting time	(+) Laos official in the Vung Ang Port	The link was implemented based on the interview data from section 7.9.6, where they are still in the process of negotiating the deal with this cause link. However, the data show that it could follow the same system as it works in another port (Da Nang port) and it uses the same policy as the border's official system, where new official input would depend on each sector's requirement on how many officials are needed from the headquarters each year. However, the number of requirements would depend on the average time and each border head would decide what the maximum time limit is for them.
28)	Laos official in the Vung Ang Port	(-) Port waiting time	

iii. Freight transport generalised cost loop

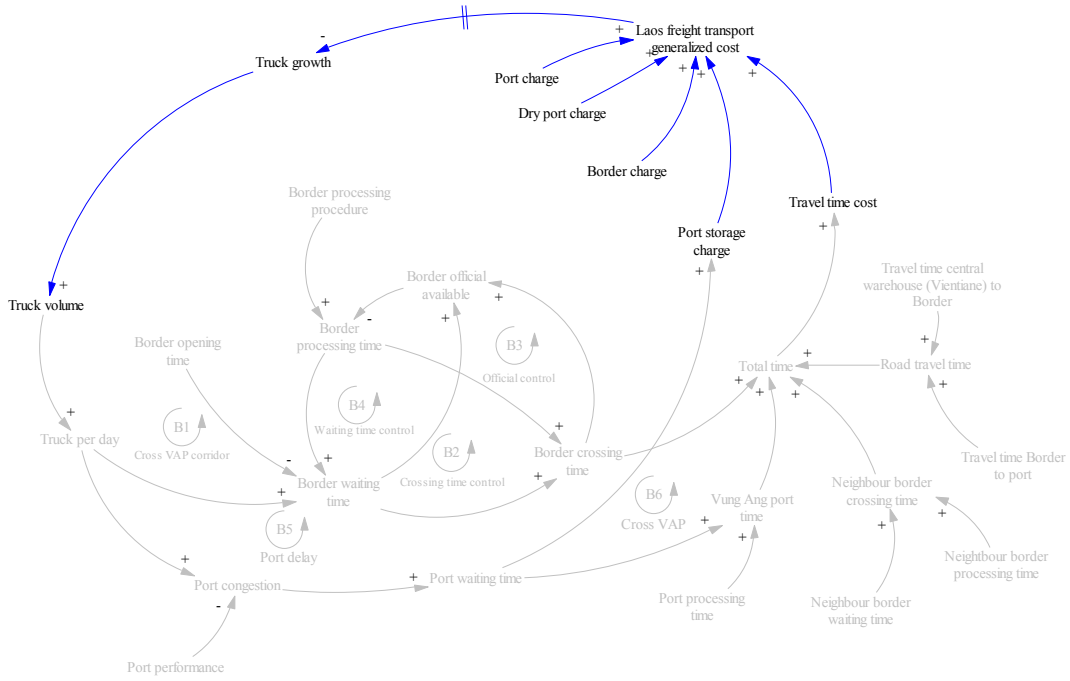


Figure 8-4: Laos' freight transport generalised cost loop

Laos' freight transport generalised cost and truck growth loops discussion:

All three loops, B1, B4, and B5, affect the transport cost. The cross VAP corridor (B1) acts on the travel time depending on the border crossing time, where the cross VAP (B6) is desired as the total time trucks use at the port, where these two are relevant to travel time. Moreover, the port delay loop (B5) is the cost that most Laos's trucks face because of the delay where trucks wait at the border for many days, which causes them to pay high storage charges.

The link of transport costs has a long-term feedback effect on the number of trucks, where the truck increase rate could have dropped if the transport cost increased rapidly. However, in the opposite, the truck volume could rise and cause more problems to the border loop (B2, B3, B4, B5 and B6) if the truck number increases in the future.

Table 8-5 : Laos' freight transport generalised cost loop variable related descriptions

No	Variable	Description
24.	Travel time cost	The variable was transformed from the *travel cost* from the LDLC_CLD described in vii, Table 5-13_No.37. This variable is defined as the cost of time taken, which counts the time payment for the driver, truck cost, and fuel for Laos' trucks on average on the Vietnam corridor for 20 TEU standard trucks.
25.	Port charge	The variable was transformed from the *port* fees in section vi, Table 5-11_No.35. This is defined as the cost required for the Vung Ang Port using cost.
26.	Border charge	The variable was transformed from the *Customs charges* in section vi, Table 5-11_No.36. This is defined as cost required for the Na Khao border crossing cost, which includes the document and physical checking fees.
27.	Dry port charge	This was defined as a charge, which is set as the same amount as the charge at the dry port at the capital city, based on the data from section 6.6.
28.	Laos freight transport generalised cost	This variable was transformed from the *transport generalised cost* from the LDLC_CLD shown in section ii, Table 5-3_No.13, where this variable represents the total transport cost of goods via the Vung Ang Port corridor till the goods or containers are loaded on the vessel.
29.	Truck growth	This represents the number of trucks changing rate, which can be increase or decrease depending on the change of freight cost on this corridor, where the drivers decide which corridor they are willing to use based on the interview data from section 7.9.4.
30.	Truck change	This variable was transformed from two variables of *global market chance* section ii, Table 5-3_No.10 and *foreign direct investment* section i, Table 5-1_No3 to represent the number of trucks that reflect the change in transport generalised cost in this corridor, where customer reflection (number of trucks) decides the route of choice to access the international market.

Table 8-6: Laos' freight transport generalised cost loop causes and effect link descriptions

No	Causes	Effect	Description
29)	Travel time cost	(+) Laos freight transport generalised cost	There were two mains factors that influence the corridor's generalised cost: the time cost, where trucks travel from the central warehouse to the port, such as discussed in section 7.9.4; and the charge from each process along the corridor, such as at the border in section 7.9.5, port, and dry port in section 7.9.6, where each cost contributes the freight transport generalised cost increasing as the time increases from the same link that was transformed from the LDLC_CLD, as described in section vii,Table 5-14_No.60-61-62-63.
30)	Border charge		
31)	Port storage charge		
32)	Port charge		
33)	Dry port charge		
34)	Laos freight transport generalised cost	(-) Truck growth	The cost of freight transport on the Vung Ang Port corridor road impacts the customer's decision of route choice, which can change the rate increase/decrease expectation, where, if the cost increases, it is likely that the customer will use other corridors with expect to change in a couple year delay time, such as mentioned in section 7.9.4.
35)	Truck growth	(-) Truck volume	Truck volume could increase/decrease regularly based on the increasing rate prediction. However, this would also impact the transport generalised cost changing on this corridor, which causes some customers to leave or enter the corridor based on researcher knowledge.

iv. Policies loop

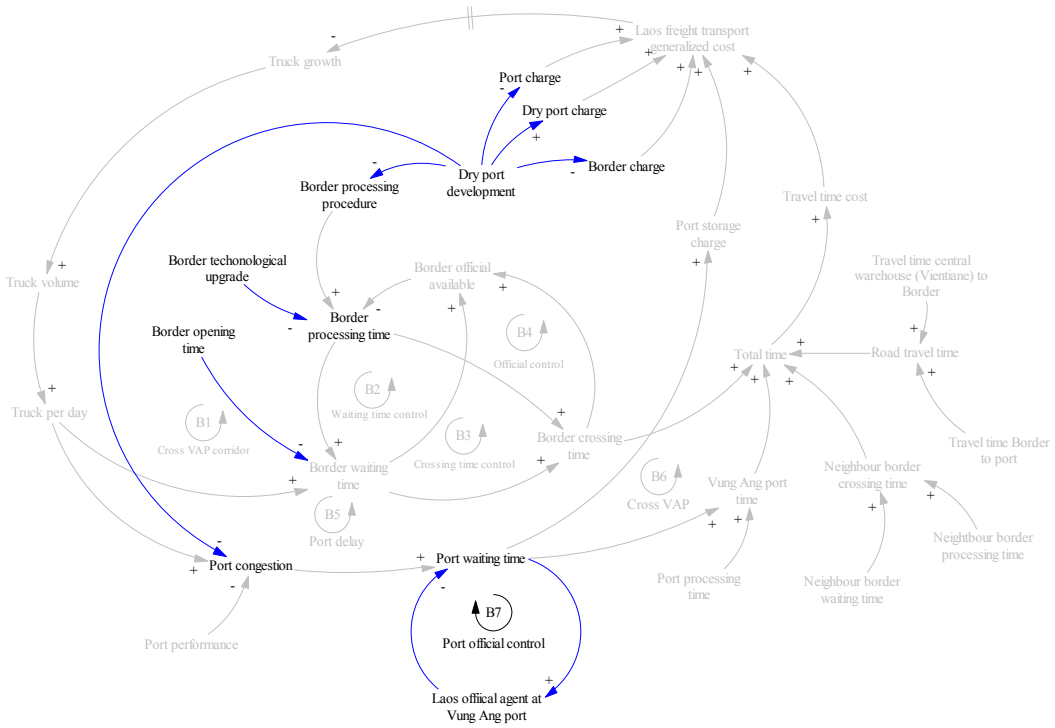


Figure 8-5: Policies loop

Port official control loop discussion

Similar to the border official control where three loops, B1, B2 and B3, affect each other, the port official control loop (B6) has the same system from Laos' law, where the port sends an official agent to work with the Vung Ang Port operation to deal with the port waiting time with the aim to reduce the waiting time there. The process would be simple as, if the port waiting time rose to more than the limit time set, more officials would be required.

Table 8-7 Policies loop variable descriptions

No	**Variable**	**Description**
31.	Dry port development	This variable uses the same variable as shown in the LDLC_CLD from section vi,Table 5-11_No13 together with the support information on section 6.6. This represents a policy where Laos' government invests in a dry port in the Vung Ang Port corridor.

No	Variable	Description
32.	Laos official agent at Vung Ang Port	This policy variable did not show up in the LDLC_CLD but came from the interview data such as mentioned in section 7.9.6. This represents a policy where Laos' government sends an agent to work at Vung Ang Port, which has been required since the port's operations, as it requires some Laos officials to help and respond for goods from Laos and mostly deal with all the document processing.
33.	Border opening time development	As of now, this border still has less opening time compared to other big borders, as mentioned in section 7.9.5. Thus, this variable represents a policy, which is to increase the opening hours to be the same as that of the capital's border.
34.	Border processing development	As the border upgrade was part of Vung Ang Port project, this border's technology can still be developed, especially the technological processing system, which still uses a manual system such as mentioned in section 7.9.5. Thus, this variable represents the policy, which suggests upgrading by adding a highly technological system just like being used at the capital border and other neighbour's borders.

Table 8-8 Policies loop causes and effect descriptions

No	Causes	Effect	Description
36)	Border processing system development	(-) Border processing time	By using this policy, it will upgrade the system to reduce the border processing time, as it will be changed from manual to a software system, which is faster and more reliable, as mentioned in section 7.9.5.
37)	Border opening hour development	(+) Border opening hour	By applying this policy, the border opening hours will increase from 8 to 12 hours, which will be a more flexible time, as mentioned in section 7.9.5.
38)	Laos official agent at	(-) Port waiting time	By using this policy, the aim is to reduce the port waiting time, as there was no Laos's agent working at Vung Ang Port. Thus,

No	Causes	Effect	Description
	Vung Ang Port		sending an official there would reduce port waiting times, as mentioned in section 7.9.6.
39)	Port waiting time	(+) Laos official agent at Vung Ang Port	If Laos's government sends an official to work at Vung Ang Port, it has still not considered how many are required. But with the port waiting time increase more officials are required, as mentioned in section 7.9.6.
40)	Dry port development	(-) Border processing time	By using the dry port, some documentation that is required to be checked before crossing the border have already been checked, which means it will cut the border processing time, as mentioned in and section 6.6.
41)	Dry port development	(-) Border processing procedure	By using the dry port, most of the main work there is inspection. When a truck arrives at the border, it is not necessary to reopen the container or re-inspect again. This count is able to cut off some procedures at the border, as mentioned in section 7.9.6.
42)	Dry port development	(-) Port charge	The dry port must be operated by the Laos government but also cooperate with the particular port in that corridor. Vung Ang Port will already be concerned about the dry port system, where the cost of using the dry port will already be charged at the dry port, as mentioned in section 7.9.6.
43)	Dry port development	(-) Border charge	By developing a dry port, some procedures at the border will have already been done at the dry port, which means the cost or charge at the border will be charged at the dry port, as mentioned in section 6.6.
44)	Dry port development	(+) Dry port charge	As the dry port is used, it will have to include the charge of using the dry port, such as mentioned in section 6.6.

No	Causes	Effect	Description
45)	Dry port development	(-) Port delay	By developing a dry port, which also has a port agent, this policy of developing a dry port will also reduce port congestion, such as mentioned in section 6.6.

8.2 Specific VAP_CLD comparison to the general GL_CLD

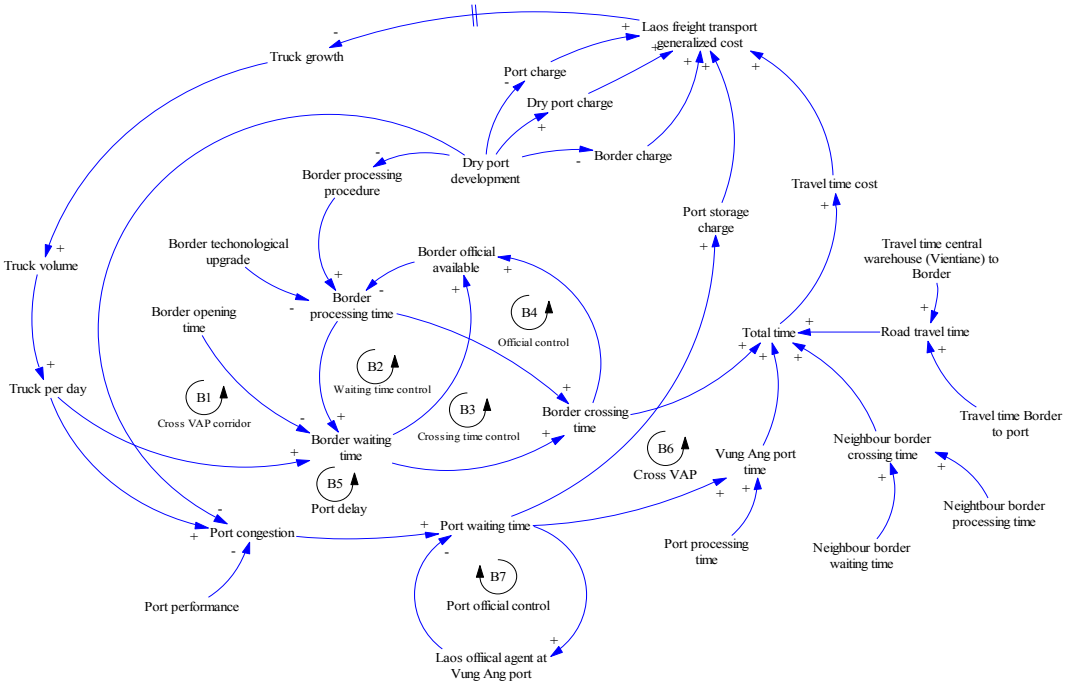


Figure 8-6 VAP_CLD

To compare this specific VAP_CLD in Figure 8-6 with the previous general GL_CLD in Figure 5-9, the main focus is the link of truck volume and the border system and port operation connected with the travel time, with all having an effect to the transport cost, with feedback on the vehicle volume change.

The first to not be included in the specific VAP_CLD are the elements that are not in the part or theme of the Vung Ang Port corridor directly, such as the freight direct investment, production cost, production volume, and neighbour factors. Because of the GL_CDL, many landlocked countries might have to

face this situation where both countries' relationship could have a huge impact on the corridor situation, but in Laos' case, does not. All the neighbour relations are good. Moreover, as the general GL_CLD uses the global market chance to represent the loop that acts from the transport cost, it could possibly increase the vehicle volume in the long-term. However, the specific VAP_CLD does not intend to justify where the vehicle will come from or how much this corridor will be attractive or how much chance that will create if any development is applied. Thus, the global market change is not considered to be specific on this VAP_CLD.

The second element considered to not be included in the VAP_CLD is the policy or development that requires too much budget or huge funds, such as road infrastructure development. This is because the project would not be applied easily compared to other policies used in the VAP_CLD, such as the border's technological upgrade, border opening time expanding, or sending official agents to work at the Vung Ang Port. However, there is still a policy where dry port development is included in the VAP_CLD but, as the development was already part of the government's project in the future, the investment would not be much compared to the road's infrastructural development.

Third, the other transit corridor choice/network of corridors not included or represented in the VAP_CLD through is related. However, as mentioned above, the VAP_CLD has not specified where the vehicle will come from because the truck rate is already calculated. Thus, other corridor choices are not important, as they would not have much effect, but rather the transport cost of the corridor itself to be able to make changes on the vehicle volume or not.

Lastly, regional cooperation and negotiation concessions from the landlocked country and neighbour are not included in the VAP_CLD because this corridor already passes the government agreement and other agreements not considered related, as it wants to focus on the corridor system, where other projects still do not exist and the fees have already been set, as the negotiation would make any change to this corridor regulation or process or charge.

8.3 Study learn from the CLD to Lao and other policy maker

For policymakers in general but especially for Lao, this specific CLD for the Vung Ang port corridor CLD would be very useful, as it is not just created to

be practical and does not require much time to understand. But this specific case study shows more detail on areas where freight transportation happened in the capital city of Laos to Vung Ang port in Vietnam, for which there is a lack of information. Moreover, as to what factors of this model was created from the sources that cannot be possibly be found in published sources, as some were collected from local information, academic experts, and persons who responded. Thus, this CLD may help policymakers or might also useful for external investors that intend to invest in this corridor, so they can see what sectors exist along this corridor line. Additionally, as Lao PDR has many ministries that respond to different sectors, if any problem needs to be solved by new policy, it would need various responses to come and discuss, where the policy maker would find it difficult of which sector that related to this particular area. Consequently, it is not easy for policymakers to know if the policy they create will possibly solve the right point or not and what could be the effects without spending time finding information what should be focused, in order to not have bad impacts and not benefit the public.

8.4 Conclusion

To conclude, this chapter has identified and described the specific key causal summaries of Road No.12, which is the Vung Ang Port corridor, which represents Laos' freight export process and system alongside the corridor and behaviour. Figure 9-5 shows the outcome of these key summaries from the four themes and six loops feedback discussion from the data from local information to develop a Laos CLD model (VAP_CLD). However, small details not able to be specified are other vehicle types and neighbour factors. However, all the elements included in this chapter are the main ones that influence the transport cost of this corridor. The outcome can be seen as two main problems or the delay happening at the border and the port. Thus, a policy hypothesis set in this model was from the references and is expected to reduce the time and cost of this corridor. All policies that apply to this model do not require much time development and the scope of the budget is not different. In conclusion, this VAP_CLD is presented as a simple structure that serves as a valuable model for others that might be in a similar situation and want to develop a more efficient classification of this problem, where this model would be profitable when applied as the fundamental model structure of the system dynamics model to calculate the behaviours and the policies' benefits.

Chapter 9 System dynamic stock and flow model development

9.1 Introduction

Continuing on from chapter 8, the VAP_CLD was developed to represent a qualitative dynamic hypothesis for Laos' freight transport policies on Road No.12, which the main corridor is connecting to Vung Ang Port on the Laos side. This chapter takes part of the model to describe the trade behavior relating to the new port project, in order to develop a simulation dynamic hypothesis model. This research uses quantitative data to develop a system dynamic model of stock and flow (SFD), which can identify how loops operate and improve how the model communicates actual causal processes. The main focus of the SFD is to represent the behavior describing the freight situation and procedure on Road No.12 that impact the freight cost after the Vung Ang Port project is operated and tested with specific policies.

The process for developing the SFD model development is presented in Section 9.2; then some model descriptions are discussed in Section 9.3. Sections 9.4 to 9.9 describe the development of the model structure and the functional definition of the model equations.

9.2 Approach to model development

The new port and corridor project development offers the chance to increase Laos' trade volume by giving an alternative route choice that has a short distance to port with low freight cost. However, since the corridor opened, the freight volume has impacted the border crossing, which is not ready to handle a large number of vehicles (trucks) crossing. Moreover, the port operation is still unsatisfactory thanks to long waiting times.

Therefore, this research wanted to identify the level of freight volume that has influenced the border system and port procedure to reduce the freight transport generalized cost on this corridor by adding three different policies to the model system, where each hypothesis of policy options would be justified for suitable solutions that should be applied.

9.3 Model description

The model was created using Vensim software, which will describe all the symbols used in the SFD. The model equations and the variable descriptions for all parameters used in the SFD are discussed in Section 3.3. The simulation time period units for the model's time boundaries were set to one year (Units for Time = Year). The time step for the accuracy of the model simulation was set to 0.125 (TIME STEP = 0.125). The integration type used was Euler integration. The time horizon of the research model was chosen to start at 2018 (INITIAL TIME = 2018), where historical data would be available. Then the model would finish in 2048 (FINAL TIME = 2048). This research intends on simulating 30 years further. Moreover, model had also test with the time step test set to 1 year, but prefer to use the TIME STEP = 0.125 as it more accuracy for the model.

9.4 Truck volume via Vung Ang Port corridor Road No.12

Since the Vung Ang Port project contracted from 2004 and the corridor upgraded and opened in the year 2008, there is little information available about traffic on this route. However, a single report (JDI 2010) has used data from the Department of Highways, Ministry of Public Works and Transport of Laos PDR to calculate the sources and forecast that the annual number of vehicles on Road No.12 would increase by 1,000 vehicles per year after 2019. This is a combination of wood chips trucks and other agro-forest products, in which 20 tons of trucks are used mainly in this corridor.

However, as no data has been verified by any government agency, there is no way to verify that the data is accurate. Thus, this section will create a stock and flow model that will serve as a new measure of the growth of trucks on Road No.12, which may affect transportation costs, and combine a fixed-rate estimate from the reference calculation.

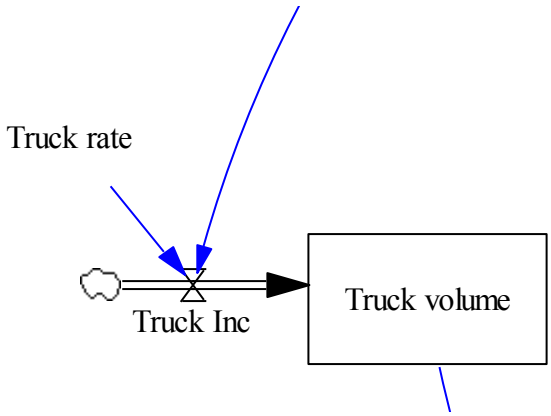


Figure 9-1 Truck volume yearly exportation via Vung Ang Port corridor Road No.12

Table 9-1: Truck volume via Vung Ang Port corridor Road No.12 variable descriptions

No	Variable	Code	Description	Value or equation	Unit
1	Yearly Truck rate expectation	TRE	From the Vung Ang Port project report, the vehicles on Road No.12 will increase to 1,000 vehicles every year (JDI, 2000).	1000	Truck/year
2	Truck Inc	TI	This rate increase follows on the rate increase from the Yearly Laos Truck rate expectation plus the truck volume that has an impact on the transport cost change based on the causal loop diagram.	Equation 1	Truck/year
Equation 1 $TI = TRE + TC$					
This equation shows the feedback where the number of trucks on this corridor will change based on the calculation from literature of the vehicles on Road No.12 will increase constant growth of 1,000 truck every year after 2019 till 2040 (JDI, 2000). However, as the reference calculated based on the average amount of truck and considered from the demand growth in this area without considered the impact from others factors. Thus, this model set up and dynamic hypothesis where the constant growth has impact from the generalized cost changed.					
3	Truck Volume	TV	The number of trucks on Road No.12 enter the Na Khao border	Equation 2	Truck

			on Vung Ang port corridor per year in 2018 = 1000		

Equation 2

$$TV_t = Stock \int_{2018}^{2048} TYVR_t = TYVR_{(t-1)} + TR_t; TYVR_{t(2018)} = 1000$$

The quation show the amount of truck on each year increasing by the number changed from truck increase from year 2018 to 2048.

9.5 Border crossing

Na Khao border has been used a border crossing from Thakek (Laos) to Vietnam for a long time. Before the Vung Ang Port project operated, the border was officially used only for small vehicle crossings as trucks would mostly go to another border owing to the road condition and the border itself not being able to perform official container inspection. Since the corridor project opened and the border also been upgraded in 2008, the border has been impacted by a large number of vehicles (trucks), as the border processing system is slow. However, the border system is set by the Ministry of Public Works and Transport of Laos PDR to handle the increased number of border crossings by supplying more officials to work and help at the border as with other borders in Laos. But the waiting time still high and requires a new strategy to improve.

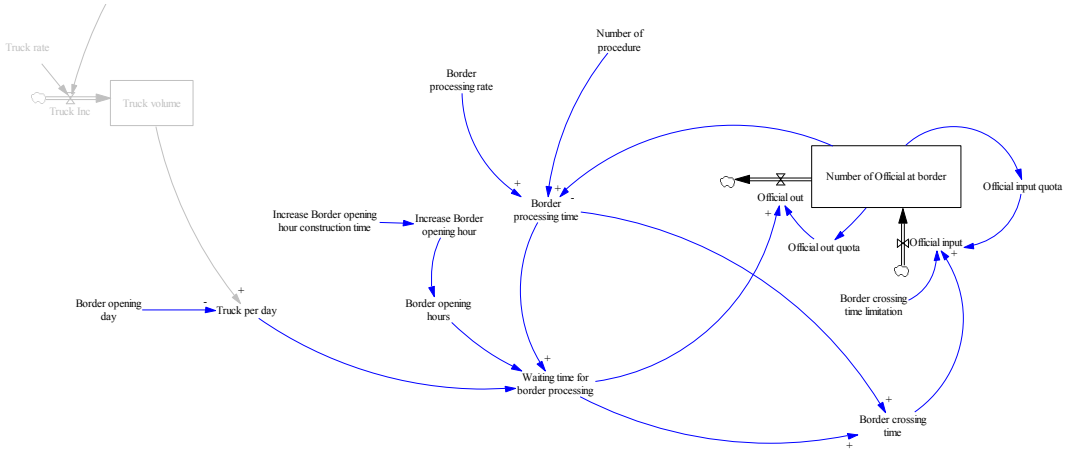
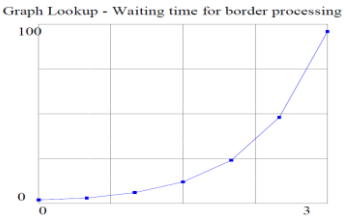


Figure 9-2 Na Khao Border system

Table 9-2 Na Khao border system variables description

No	Variable	Code	Description	Value or equation	Unit
4	Border opening day	BOD	Laos' border is daily opening from Laos' government law set the public holiday (MPWT). With more variable explanation in section i, Table 8-1_No.2.	365	Day
5	Truck per day	TPD	An average amount of trucks passing Na Khao border per day based on the total volume of trucks on Vung Ang Port corridor in that particular year that has been divided equally by the border opening day without considering different peak times. With more variable explanation in section i, Table 8-1_No.1-2.	Equation 3	Truck/day
Equation 3 $\frac{TV}{BOD}$					
As the Na Khao border officially open every day, which is 365 day/year. Without satatisticcal data on what average number of truck per day. Thus, this equation set as basic assumption where the total amount of truck though this border devided by day opening.					
6	Border opening hour	BOH	Na Khao border opens daily from 08:00 am to 4:00 pm, which is eight hours/day (JDI). With more variable explanation in section i, Table 8-1_No.3. If the new policy increases the border opening hour (BOHI), the border will open from 7:00 am to 7:00 pm, which will create a 12 hour/day as the border at the capital city. With more variable explanation in section i, Table 8-1_No.3	Equation 4	Hour/day

<table>
<tr><td colspan="6">Equation 4
$IF\ THEN\ ELSE\ (IBOH > 0\ ,12\ ,8\ )$</td></tr>
<tr><td>7</td><td>Waiting time for border processing</td><td>WTDP</td><td>The time where the driver is waiting in the queue for processing. The time calculated from the qualitative data based on the border data history recorded and expectations. With cause link description from section i, Table 8-1_No.3_No.3-4-5</td><td>Equation 5</td><td>hour/truck</td></tr>
<tr><td colspan="6">Equation 5
$WTDP = LOOKUP\ (\frac{(\mathrm{TPD/BOH})}{(1/\mathrm{BPT})}\ )$
Initial Value ([(0,0) -(8,200)], (0,2), (0.5,3), (1,6), (1.5,12), (2,24), (2.5,48), (3,96))
 
</td></tr>
<tr><td colspan="6">Due to no numerical data on what is the waiting time for border processing on this border. Thus, this equation hypothesis created from only available data, which a recorded expectation from the official at the border showing in graph as the waiting time increase as the more truck coming.</td></tr>
<tr><td>8</td><td>Border processing time</td><td>BPT</td><td>The border processing time per one truck, related by three factors. The first depended on the speed processing rate per process (DPR) that officials can do section i Table 8-1_No.3_No.4, which is multiplied by the total number of processes that require (BPP) section i, Table 8-1_No.3_No.7. Where the overall will be divided by the number of officials who responded (NOB) section i, Table 8-1_No.3_No.8. With cause link description from section i, Table 8-1_No.3_No.6-7 & 11.</td><td>Equation 6</td><td>hour/truck</td></tr>
</table>

Equation 6 $$BPT = \frac{(\text{BPR} * \text{NP})}{\text{NOB}}$$					
9	Border processing rate	DPR	The average time that one official spent on one procedure, which was about 15 minutes (GMS, ART Net, 2011). Section i, Table 8-1_No.3_No.4 If the new hardware is implemented, it could take only eight minutes per procedure (JDI). Section i, Table 8-1_No.3_No.4	Equation 7	hour/procedure*official
Equation 7 $$DPR = \text{IF THEN ELSE}\ (\ \text{BTU} > 0, 0.1, 0.25)$$					
The equation based on the data from the interview of the average that one official spent on one procedure. However, this included a fact that if the border processing got upgraded then the time will changed (as the equation show that BTU is 0, if it change to 1 that mean policy run it will reduce time to 0.25) 0.1 mean 0.1 mean 0.1 hour = 8 minute and 0.25 = 15 minute.					
10	Number of procedures	NP	From Laos' export law and bilateral agreement with Vietnam, exporting through Vietnam corridor require five procedures (three processes for document checking and two for physical inspection) (MPWT). Section i, Table 8-1_No.3_No.7 If the dry port were operated, two of the processes would be done at the dry port. Thus, only three processes would be required at the border (Nations); (Ikebe et al.), as described in section i, Table 8-1_No.3_No.1 with causes linked from section i, Table 8-2_No.6.	Equation 8	Procedure /Truck

Equation 8 $NP = \text{IF THEN ELSE}\,(\text{DPO} > 0, 3, 5)$					
The equation based on the data from the interview and literature of the average number procedure in Lao. However, this included a fact that if the dry port operated then the number will changed (as the equation show that DPU is 0, if it change to 1 that mean policy run it will change from 5 to 3)					
11	Border crossing time	BCT	The time where all processes have been taken combined with the waiting time, which counts as total time on Laos' border side described in section i, Table 8-1_No.9 with causes linked from section i, Table 8-2_No.8-9	Equation 9	Hour/truck
Equation 9 $BCT = \text{WTDP} + \text{DPR}$					
The equation set from two time that happen in the border the first is the waiting time at the border and the number of border processing time togethers.					
12	Official input	OI	The policy on new official input in Laos' border: the number of inputs was dependent on each border requirement on how many officials were needed from the headquarters each year when the border crossing time reached the border crossing time limitation. The input would depend on the official input quota set by the government (IG4) with cause link from section i, Table 8-2_No.10	Equation 10	Official/year
Equation 10 $OI = \text{IF THEN ELSE}(\text{BCT} > \text{BCTL}, \text{OIQ}, 0)$					
13	Border crossing time limitation	BCTL	Each border has different time sets, where the limitation time that small border would ask for more officials is when the border crossing time has passed more than half a day or 6-8 hours (IG4), such as described in section 7.9.5	6	hour/truck

14	Official input quota	OIQ	The maximum number of officials that can be transferred to other sector or removed is two people/year. However, it must have at least two officials available (IG4), such as described in section 7.9.5.	Equation 11	Official/year
Equation 11 $OIQ = \text{IF THEN ELSE}(\text{NOB} >= 10, 0, 1)$					
15	Official out	OO	The border law, where the limitation time that small border would consider transferring an official out is when there is no waiting time at the border (IG4), such as described in section 7.9.5.	Equation 12	Official/year
Equation 12 $\text{OO} = \text{IF THEN ELSE}(\text{WTBP} <= 0, \text{OOQ}, 0)$					
16	Official out quota	OOQ	The maximum number of officials that can be transferred to other sectors or removed is two people/year. However, it must have at least two officials available (IG4), such as described in section 7.9.5.	Equation 13	Official/year
Equation 13 $OOQ = \text{IF THEN ELSE}(\text{NOB} <= 2, 0, 2)$					
17	Number of officials at the border (NOB)	NOB	Total number of officials working on processing (document checking and inspection respondent) with variable descriptions from the causal loop diagram from section i, Table 8-2_No.6.	Equation 14	Official

Equation 14

$$NOB_t = \text{Stock} \int_{2018}^{2048} NOB_t = NOB_{(t-1)} + \text{OI}_t - OO_t \; ; \; NOB_{2017} = 4$$

9.6 Vung Ang Port

After the Vung Ang Port began operations and other goods were exported from Laos through this port, the data show that it had long delays thanks to the waiting time at the port being high. From the interview, it was found that owing to the lane that the port organization set for Laos's exports, the processing was slow as there was lack of officials to handle this part.

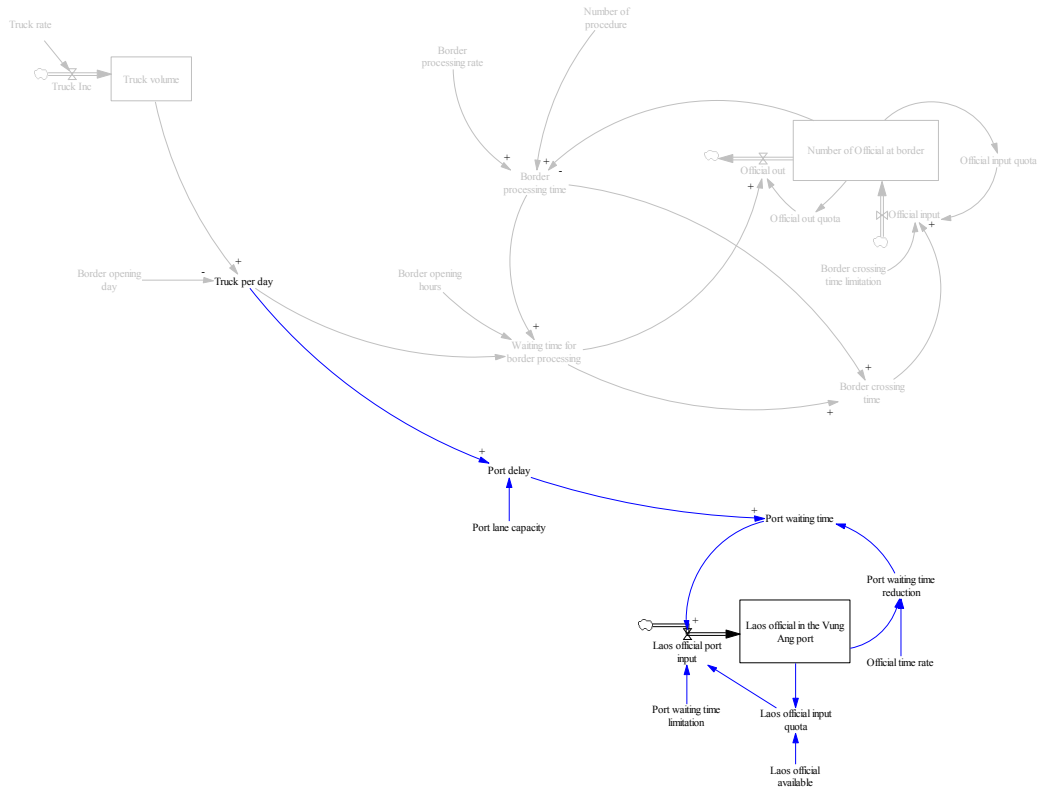
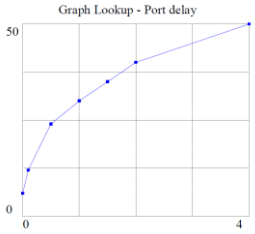


Figure 9-3 Vung Ang Port system model

Table 9-3 Vung Ang Port system variables description

No	Variable	Code	Description	Value or equation	Unit
1	Port lane capacity	PLC	Vung Ang Port had specific lanes for Laos' trade, which was smaller than other lanes owing to Laos having a small trade volume compared to other countries, which can handle 50 truck/day (JDI) with more explanation in section ii, Table 8-3_No.1	50	Truck/day
2	Port delay	PD	The port delay depended on the number of Laos' trucks compared to the port capacity, which normally averaged 8-15 hour/trucks (JDI). However, with the dry port operation, it hopefully will be reduced by 75%. With causes linked from section ii, Table 8-4_No.13-14.	Equation 15	hour/truck
Equation 15 $PD_{\text{Equations with LOOKUP}} = \text{IF THEN ELSE}\left(\text{DPO} > 0, \left(\frac{\text{TPD}}{\text{PLC}}\right) * 0.25, \left(\frac{\text{TPD}}{\text{PLC}}\right)\right)$ $\text{Initial Value} = ([(0,0) - (15,50)], (0,6), (0.1,12), (0.5,24), (1,30), (1.5,35), (2,40), (4,50))$  					
3	Port waiting time	PWT	The time where Laos' exports have to wait before being able to get in the port process from the causes linked in section ii, Table 8-4_No.15. However, the time can be reduced if it has a Laos' official agent there.	Equation 16	hour/truck

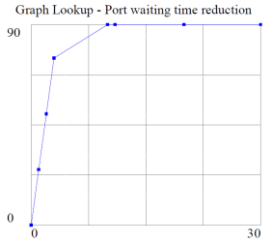
Equation 16 $PWT = \mathrm{PD} - (\mathrm{PD} * \mathrm{PWR}/100)$					
4	Laos' official port input	LOPI	The number of official inflow when the port waiting time reaches the maximum limit from the causes linked in section ii, Table 8-4_No.16	Equation 17	official/Year
Equation 17 $LOPI = \mathrm{IF\ THEN\ ELSE}\ (\mathrm{PWT} > \mathrm{PWTL}, \mathrm{LOIQ}, 0)$					
5	Port waiting time limitation	PWTL	Like now, the port waiting time for Laos export is more than 24 hours. Thus, the transport headquarters have set the new strategy to deal with port delay to reduce the port waiting time to less than 12 hours (Policymaker, interview, 2017) from the causes linked in section ii, Table 8-4_No.16.	12	hour/Truck
6	Laos' official available	LOA	This was dependent on the policy where Laos' government would agree to send officials to work at Vung Ang Port or not. Where the quota was set to one official per year. (Policymaker, interview, 2017) from the cause's link on section ii, Table 8-4_No.16.	Equation 18	official/Year
Equation 18 $LOA = \mathrm{IF\ THEN\ ELSE}(\mathrm{LOVAP}\ > 0, 1, 0)$					
7	Laos' official input quota	LOIQ	There was an unofficial agreement where the maximum number of officials that can be there was less than 10 people from the causes linked in section ii, Table 8-4_No.16.	Equation 19	official/Year
Equation 19 $LOIQ = \mathrm{IF\ THEN\ ELSE}(\mathrm{LOVAP}\ >= 10, 0, \mathrm{LOA})$					
8	Laos' official in	LOVAP	The number of officials working at Vung Ang Port. However, since	Laos official port input	official

	the Vung Ang port		2016, there is still no official available there and the government is still considering this policy (Policymaker, interview, 2017) from the causes linked on section ii, Table 8-4_No.16.		
9	Official time rate	OTR	The number of Laos's officials working at Vung Ang Port from the causes linked on section ii, Table 8-4_No.17	2	Official
10	Port waiting time reduction	PWTR	The time expectation that can be reduced in terms of officials available at the port from the causes linked in section ii, Table 8-4_No.17.	Equation 20	Dmnl

Equation 20

$$PWTR_{Lookup\ Equations} = \frac{\text{LOVAP}}{\text{OTR}}$$

$$\text{LOVAP Initial Value} = \big([(0,0)-(30,90)],(0,0),(1,25),(2,50),(3,75),(10,90),(11,90),(20,90),(30,90)$$



9.7 Transport time

The transport time calculated from the total freight transport process from Laos' border crossing time together with neighbour's border crossing time which in here is Vietnam's border, port time and road travel time from both Laos and Vietnam route from central warehouse in Vientiane capital to Na Khao border and from border to Vung Ang port. Moreover, if the dry port were operated the dry port processing time would be also included.

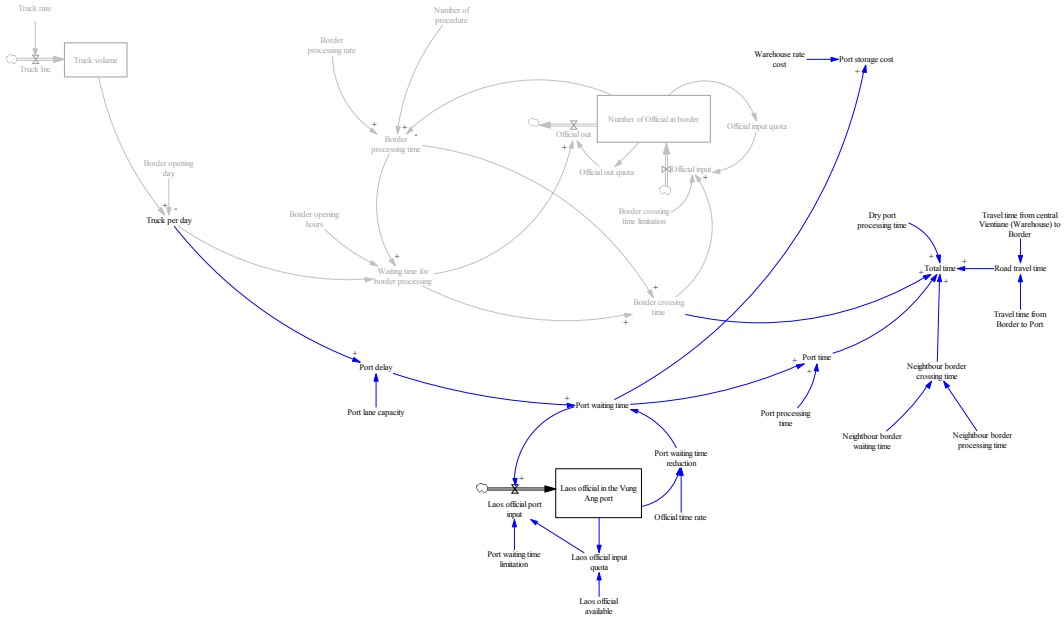


Figure 9-4 Total freight transport time

Table 9-4 Transport time description

No	Variable	Code	Description	Value or equation	Unit
1	Port processing time	PPT	Vung Ang Port processing time as an average (JDI) from section ii, Table 8-3_No.13	1	hour/truck
2	Port time	PT	The total port time for Laos' exportation from Table 9-3_No.14	Equation 21	hour/truck
Equation 21 $PT = \mathrm{PWT} + \mathrm{PPT}$					
3	Travel time from central Vientiane (warehouse) to border	TTCB	The time of a truck traveling on road from (warehouse) to border (average speed from historical data). This is not considered road quality (JDI). Section ii, Table 8-3_No.20	12	hour/Truck
4	Travel time from border to port	TTBP	The time of a truck traveling on the road from border to port (average speed from historical data) (JDI), such as mentioned in section ii , Table 8-3_No.21	12	hour/Truck

5	Road Travel time	RTT	The time of a truck traveling on the road from causes linked in section ii, Table 8-4_No.20,21	Equation 22	hour/Truck
Equation 22 $RTT = \text{TTCB} + \text{TTBP}$					
6	Neighbour's border processing time	NBPT	The neighbour's (Vietnam's border) processing time from historical data of garment and wood export (JDI) from Table 9-3_No.15	0.5	hour/Truck
7	Neighbour's border waiting time	NBWT	The neighbour's (Vietnam's border) waiting time from historical data of garment and wood export (JDI) from section ii, Table 8-3_No.16	0.5	hour/Truck
8	Neighbour's border crossing time	NBCT	The neighbour's (Vietnam's border) border crossing time from historical data of garment and wood export from section 0, Table 8-5_No.18-19	Equation 23	hour/Truck
Equation 23 $NBCT = \text{NBPT} + \text{NBWT}$					
9	Dry port processing time	DPPT	The time that will be considered only if the dry port was operated, such as mentioned in section ii, Table 8-3__No.13	Equation 24	hour/Truck
Equation 24 $DPPT = \text{IF THEN ELSE}(\text{DPO} > 0, 2, 0)$					
10	Total travel time	TTT	The total time of Laos' export till the goods or container was ready for loading on the vessel from causes link on section ii, Table 8-4_No.22-23-24-25	Equation 25	hour/truck
Equation 25 $TTT = R\text{TT} + \text{BCT} + \text{NBCT} + \text{PT} + \text{DPPT}$					

9.8 Freight transport generalized cost

From the whole impacts that have on this corridor for export having impact to the freight transport generalized cost, which changing overview time based on various change and flow from other factors. Thus, the model would like to see the behavior of the cost change that has an impact on changing the number trucks on this corridor on the cost change yearly.

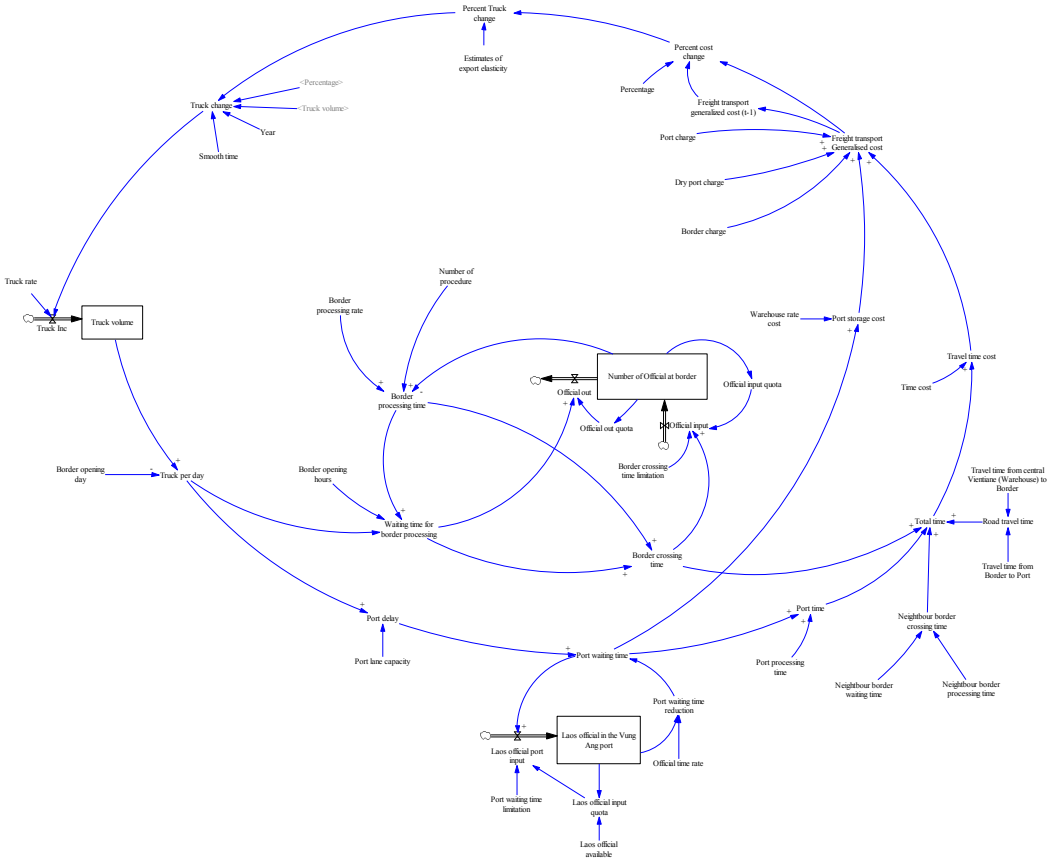


Figure 9-5 Vung Ang Port corridor Road No.12 Freight transport generalized cost

Table 9-5 Vung Ang Port corridor Road No.12 Freight transport generalized cost variables description

No	Variable	Code	Description	Value or equation	Unit
1	Time cost	TC	The time cost for Laos' truck per hour (Banomyong and	11	$/Hour

			Beresford) from section 0, Table 8-5_No.24		
2	Travel time cost	TTC	The total time cost from section 0, Table 8-5_No.24	Equation 26	$/Truck
Equation 26 $TTC = \mathrm{TC} * \mathrm{TTT}$					
3	Border charge	BC	Na Khao border standard charge (JDI) from section 0, Table 8-5_No.26 If the dry port was operated, the cost would be reduced by 50%.	Equation 27	$/Truck
Equation 27 $BC = \mathrm{IF\ THEN\ ELSE}(\mathrm{DPO} > 0, 20, 40)$					
4	Dry port charge	CPC	The dry port charge will only be considered only if the dry port was operated from section 0, Table 8-5_No.27	Equation 28	$/Truck
Equation 28 $CPC = \mathrm{IF\ THEN\ ELSE}(\mathrm{DPO} > 0, 50, 0)$					
5	Port charge	PC	Dry port processing charge from Table 9-5_No.25. If the dry port was operated, the cost would be reduced by 30% from section iv, Table 8-8_ No.7	Equation 29	$/Truck
Equation 29 $PC = \mathrm{IF\ THEN\ ELSE}(\mathrm{DPO} > 0, 105, 150)$					
6	Port storage rate cost	PSC	The cost of parking or container storage cost at Vung Ang Port from section ii, Table 8-3_No.22	10	$/hour
7	Port storage cost	PSC	Storage charge from section ii, Table 8-3_No 26	Equation 30	$/Truck

Equation 30 $PSC = \text{PWT} * \text{WRC}$					
8	Freight transport Generalized cost	$FC_{(t)}$	Total Laos' freight transport generalized cost via Vung Ang Port corridor charge from section 0, Table 8-5_No.28 with causes linked to section 0, Table 8-6_No.29-30-31-32-33	Equation 31	$/Truck
Equation 31 $\text{FC}_{(t)} = \text{BC} + \text{PC} + \text{TTC} + \text{PSC} + \text{PDC}$					
9	Freight transport generalized cost (t-1)	$FC_{(t-1)}$	Laos' freight transport generalized cost via Vung Ang Port corridor of the previous year to calculate the rate change per year	Equation 32	$/Truck
Equation 32 $\text{FC}_{(t-1)} = \text{DELAY FIXED}\ (\text{TGC}, 8 * 0.125, \text{TGC})$					
10	Percent cost change	PCC	The percent change of Laos' freight transport generalized cost	Equation 33	Dmnl
11	Percentage	P	Percentage	100	Percent
Equation 33 $\text{PCC} = ((\text{FC}_{(t)} - \text{FC}_{(t-1)})/\text{FC}_{(t-1)}) * \text{P}$					
12	Estimates of elasticity	EE	The rate estimates change of cost that has an impact on the export (which is here considered as the number of trucks) with causes linked to	-3	fraction
13	Percent truck change	PTC	The percent of truck changes in that particular year that have an impact from the cost change.	Equation 34	Percent

Equation 34 PTC = EE * PCC					
14	Year input	Y	Unit model equation fix	1	Year
15	Smooth time	ST	The SMOOTH function that take time averages of customer decision to change from the effect of cost changing. And in here represent expectations to be affect in 2 year.	2	Year
16	Truck change	TC	The number of truck changes in that particular year that have an impact from the cost change	Equation 35	Truck/Year
Equation 35 $TC = SMOOTH\left(\frac{\left(\frac{TV * PTC}{P}\right)}{Y}, ST\right)$					
The hypothesis created based on the literature where the impact of transport generalised cost had affect to charged the number of transport volume or in here represent as number of truck. Thus, this impact mean to set the customer decision, where the amount of truck changing with smooth impact.					

9.9 Policies

From all the situations happening at Vung Ang Port corridor, the project that makes the rate of truck volume change will create various factors that could make this corridor hard to use or not the worst to use. Thus, three policies' implications have been applied to this model to see the behavior changes that could make this corridor have better situations by aiming to reduce the total freight transport generalized cost and especially reduce the time on specific procedures, such as border crossing and port waiting times.

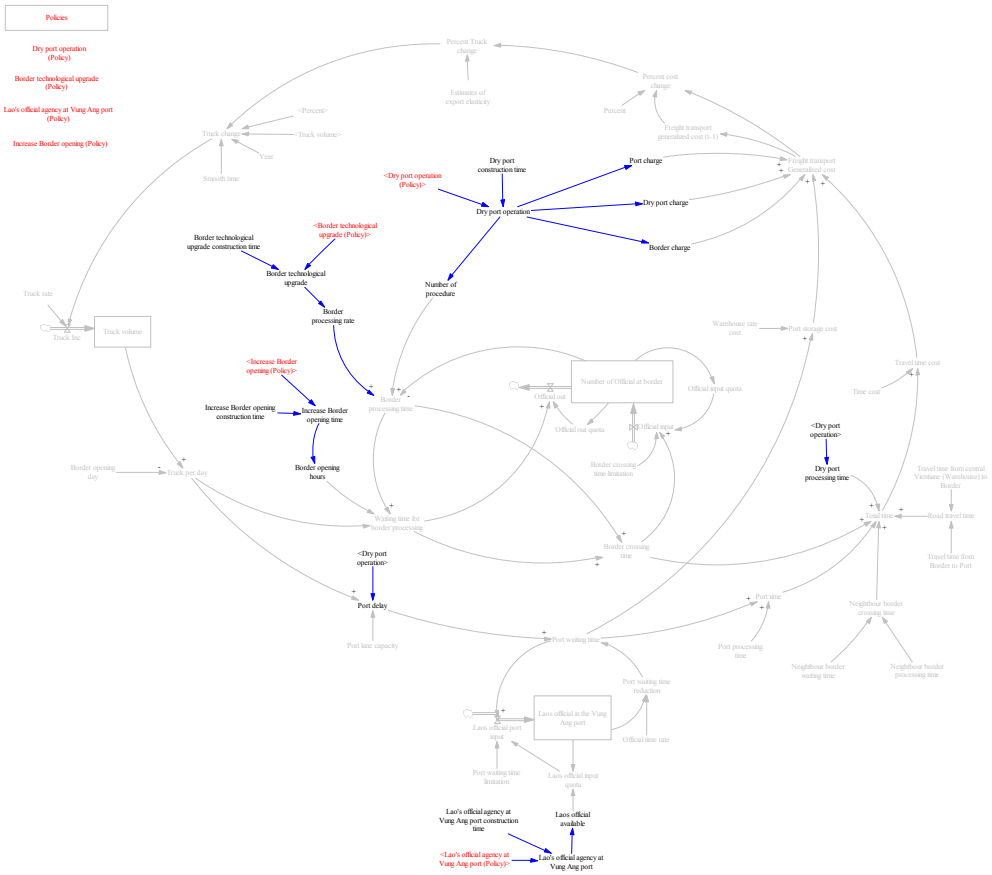


Figure 9-6 Policies apply

Table 9-6 Policy variables description

No	Variable	Code	Description	Value or equation	Unit
52	Dry port operation (Policy)	DPOP	A policy where Laos' government develops a dry port on Vung Ang Port corridor	0 or 1	fraction
53	Dry port construction time	DPCT	An average construction time for a dry port to be ready to use	2	Year
54	Dry port operation	DPO	A dry port was operated	**Equation 36**	(fraction)
Equation 36 DPO = DELAY FIXED (DPOP, DPCT, 0)					

55	Border technological upgrade (Policy)	BPDP	A policy that Laos' government develops a border process, such like inputting a high technology and a border lane to increase the speed of processing.	0 or 1	(fraction)
56	Border technological upgrade construction time	BTUC	An average construction time for Border technological upgrade	0.5	Year
57	Border technological upgrade	BTU	Na Khao Border technological was upgraded with set up time of 6 month	**Equation 37**	(fraction)
Equation 37 BTU = DELAY FIXED (BPDP, BTUC, 0)					
58	Laos official agent at Vung Ang port (Policy)	LOVP	A policy that Laos' government sends agents to work at Vung Ang Port as the Vietnam government and Vung Ang Port requires.	0 or 1	((fraction))
59	Laos official agent at Vung Ang port construction time	LOVC	An average construction time for Laos official agent at Vung Ang port	1	Year
60	Laos official agent at Vung Ang port	LOV	Laos official agent were sent to work at Vung Ang port with the set up time of 1 year	**Equation 38**	(fraction)
Equation 38 LOV = DELAY FIXED (LOVP, LOVC, 0)					
61	Increase Border	IBOP	A policy that Laos' government develops a border opening time and increase the opening time to be same	0 or 1	(fraction)

	opening time (Policy)		as the border at the capital city through the Thailand corridor.		
62	Increase Border opening time construction time	IBOC	An average construction time for Increase Border opening time	0.3	Year
63	Increase Border opening time	IBO	Na Khao border opening time were increase with setup time for 0.3 year or 4 month	**Equation 39**	(fraction)
Equation 39 IBO = DELAY FIXED (IBOP, IBOC, 0)					

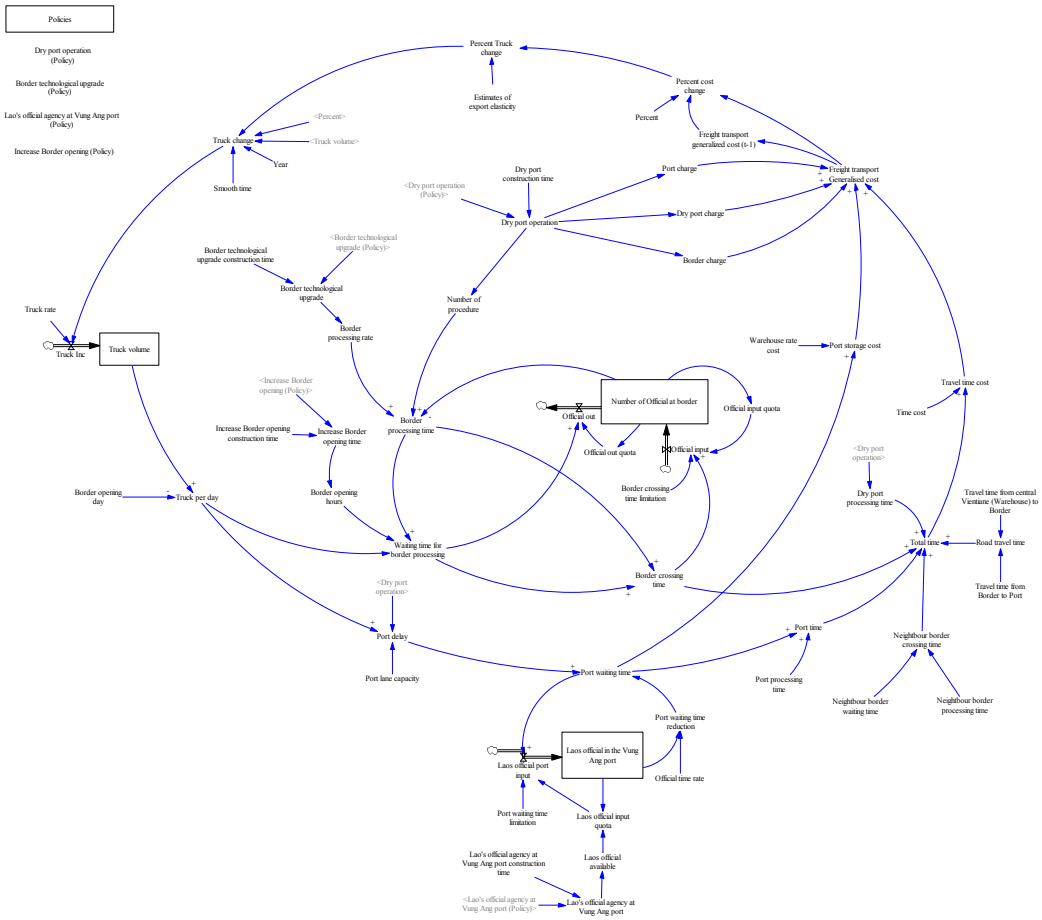


Figure 9-7 Final system dynamic stock and flow model for Vung Ang port corridor

Chapter 10 Model validation

From chapter 9, the model was constructed using the available data. However, it is acknowledged there are still many uncertainties in the model's parameters. Thus, in this section, the extent of the model's validity will be tested using the standard system dynamics test from Sterman (2000) together with empirical tests including structural assessment, parameter assessment, boundary adequacy, sensitivity, behaviour replication, and extreme conditions testing.

10.1 Model behaviour description

Sterman (2000) noted that models should be evaluated for validity using different principles to ensure the behaviour they exhibit represents a reasonable response. Therefore, this section tests some of the behaviours of the variables in the model.

10.1.1 Laos' annual truck yearly traffic on Road No.12 test

Figure 10-1 shows the graph for the number of trucks that carry goods through Road No.12 per year, resulting from the baseline test conducted in this research. The exact number of trucks increasing refers to the data from the Vung Ang Port project report and the minimum traffic volume, based on the assumption that all companies will use 20-tonne trucks for transportation and other vehicles on the road will increase to 1,000 vehicles every year. However, it can be seen that the data does not exactly increase to 1,000 vehicles every year from the model's calculation but it can be accepted that it follows the same trend.

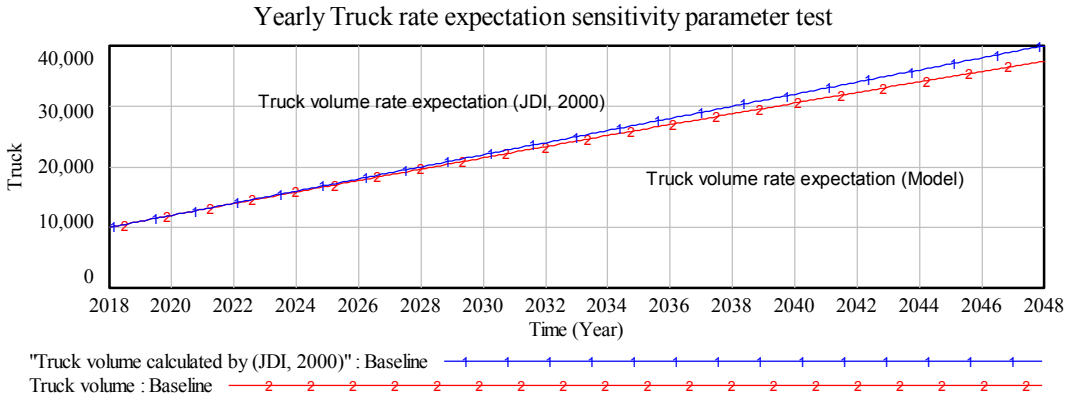


Figure 10-1: Laos' annual truck traffic on Road No.12 (Truck volume stock)

10.1.2 Freight transport generalised cost via Road No.12 test

Figure 10-2 shows that the freight cost via Vung Ang Port slowly increases after the Vung Ang Port's operation and the annual number of trucks increases. As the information about the rate cost on this road. Thus, it has to relate to Banomyong's study (2001). In his study, the transport cost via Danang port shows that the cost increased 1-2% per year, if there was no significant change or new policy that impacted the cost.

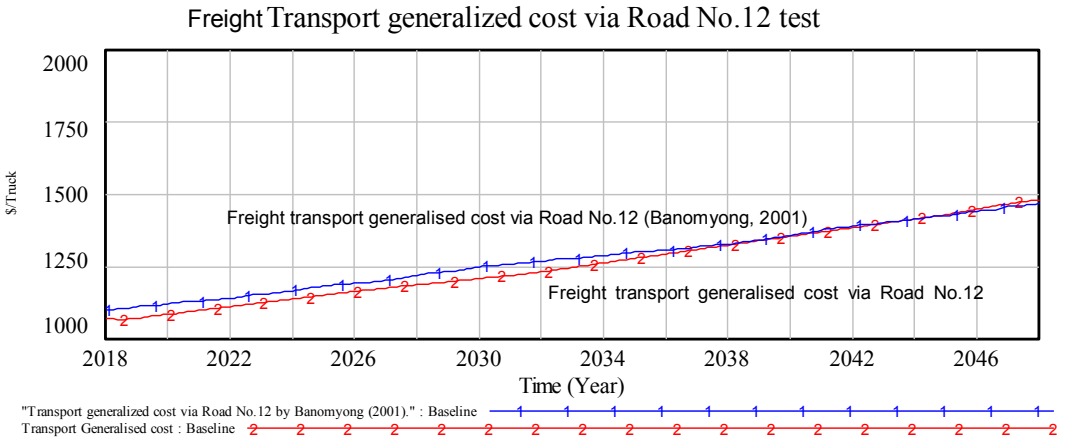


Figure 10-2: Freight Transport generalised cost via Vung Ang Port corridor Road No.12

10.2 Sensitivity test

The sensitivity test conducted for this model was done with some constants. Sensitivity testing is the process of changing the assumptions about the values of certain constants in the model and examining the resulting output.

This type of test is intended to identify the parameters to which the model is highly sensitive and to ask whether this sensitivity would make sense in the real system (Vlachos et al., 2007). This test was conducted to examine broad variations in the values of several of the model's parameters. The outcome shows the sensitivity of these parameters generally makes sense and confirms the model is robust. Some of the test results are discussed below.

10.2.1 Truck yearly rate expectation sensitivity parameter test

Figure 10-3 indicates the sensitivity of the parameter truck yearly rate expectation (**TYR)** or truck rate variable **(TR)** in the model Figure 9-7 to the model's simulation, where this parameter is determined from the truck rate 1000 truck per year calculated by the (JDI, 2000). The result shows that this parameter is an important variable in the model, where it is relevant to the increase of truck rates, which have truly affected the transport generalised cost. Moreover, others, such as total travel time, border waiting time, port waiting time, and especially the number of trucks on Road No.12, will all affect the change of the truck rate.

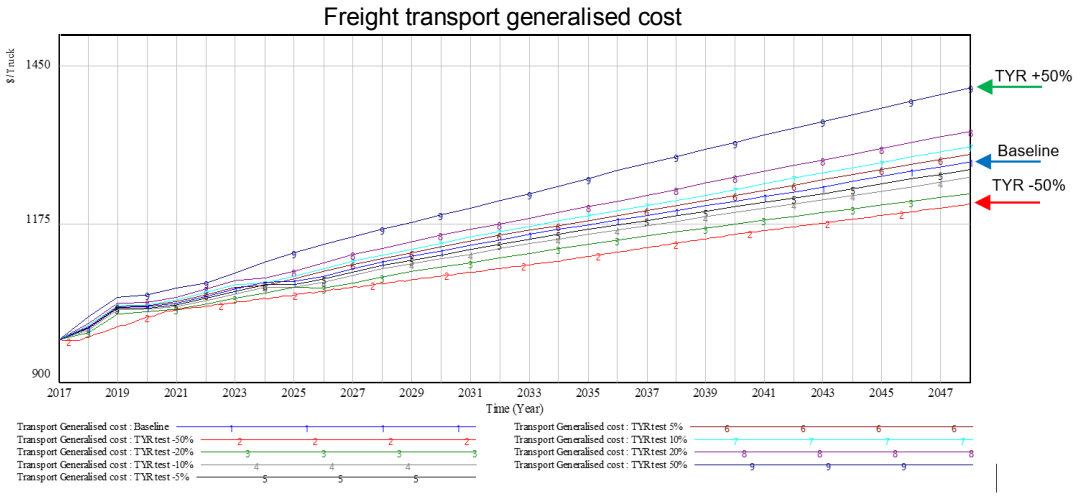


Figure 10-3: Yearly Truck rate expectation sensitivity parameter test at 5%, 10%, 20%, 50% and -5%, -10%, -20%, -50% of 1000 vehicle/year at baseline run.

10.2.2 Border opening time sensitivity parameter test

The sensitivity test of **border opening time (BOT)** is varied in the area from a 50% to 50% change. This is shown in Figure 10-4 where the transport generalised cost graph changes when the BOT increases or decreases. This is because the BOT is the parameter that was important to the model, as it

affects the transport generalised cost, total travel time, the number of trucks, and especially the border waiting time. However, it has less effect on the port's wait time.

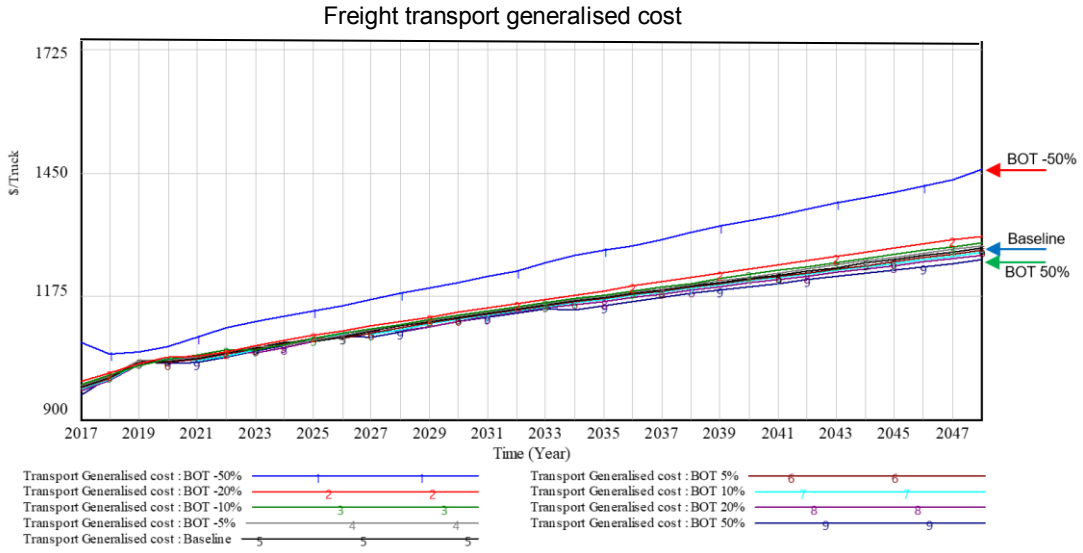


Figure 10-4 Border opening time sensitivity test with rate with increases of 5%, 10%, 20%, 50% and decreases of 5%, 10%, 20%, 50% of 8 hour/day.

10.2.3 Border processing time sensitivity parameter test

Figure 10-5 shows the sensitivity analysis for border processing time (BPT), where the parameter is varied by down and up to 50% of its value. The results show this parameter does have an effect to the model's behaviour because the BOT is the parameter that was important to the model as it affects the total transport time, which is part of border operation time that truly affects the transport generalised cost. However, it has less effect on the port time, as it is not relevant but could have a small effect as it relates to the truck volume change.

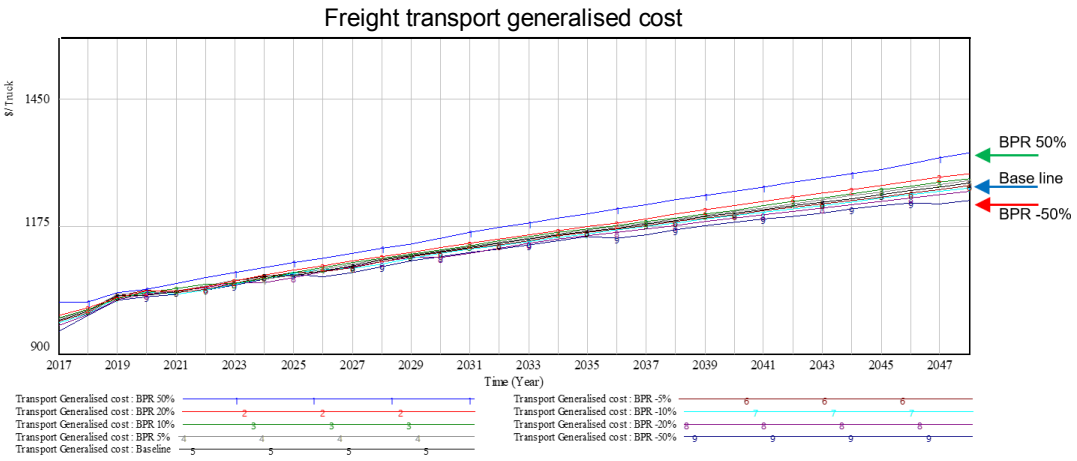


Figure 10-5 Border processing time sensitivity test on transport generalised cost by increases of 0%, 5%, 10%, 20% and decreases 5%, 10%, 20%, 50% of 0.25

10.3 Extreme condition test

The last model validation process was to test the model in extreme conditions to test the model's validity by analysing model behaviour beyond the initial boundary in case surprising conditions occur to determine how the model would respond to those real-life conditions (Forrester and Senge 1980). The model tests by changing the parameters to extreme values, where it will test the equations in the model to be sure they make sense when they take extreme values.

The model picks uncertain calamities of natural disaster (flood) before 2018 that could possibly block the Danang port corridor, which would lead to all trucks having to go to through the Vietnam side to use the Vung Ang Port corridor. Then, it picks the same situation but with the Vung Ang Port corridor, where all the trucks have to use the Danang port corridor and, after 2018, the corridor opens and customers start returning.

- Extreme Max: the model sets the initial value (Section 10.4, Table 10-2, and No_3) in truck volume change from 10,000 trucks to 30,000 trucks in 2018.
- Extreme Minx: the model sets the initial value (Section 10.4, Table 10-2, and No_3) in truck volume change from 10,000 trucks to 0 trucks in 2018.

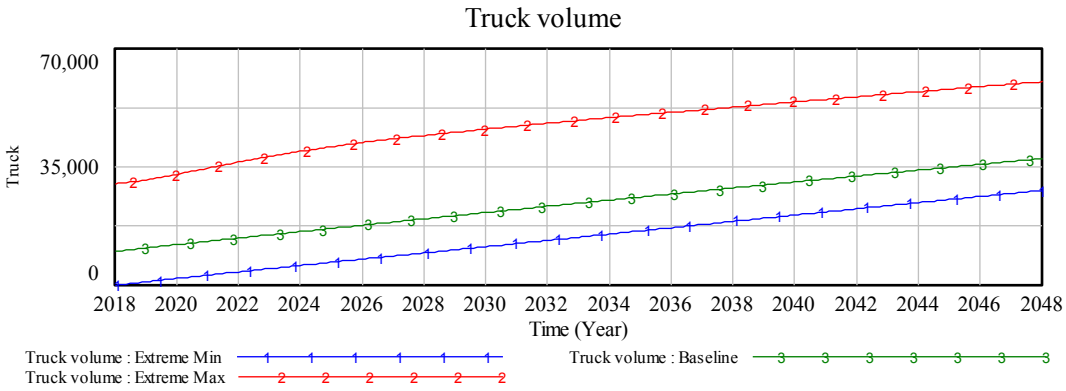


Figure 10-6 Truck volume extreme test

Figure 10-6 shows line 1 under others two lines, which represents a case of no trucks going through the Vung Ang Port corridor in 2018 owing to the natural disaster (flood); the road was blocked and reopened in 2018. The customers came back slowly and increased constantly parallel to the trend of baseline line 3 in the middle. The reason for this behaviour is that if the customer already moved to another corridor, them changing back requires some time for them to be confident.

Line 2 shown in above others lines, represents a case of the current amount of truck change immediate, where the initial amount of truck in 2018 double others cases due to the natural disaster (flood) that happened in the Vietnam corridor leading to all trucks having to go through the Vung Ang Port corridor and the road and border having to handle huge amounts of trucks at the same time. However, the line shows that the volume of trucks keeps increasing but this behaviour is possible as the rate increase will keep increasing.

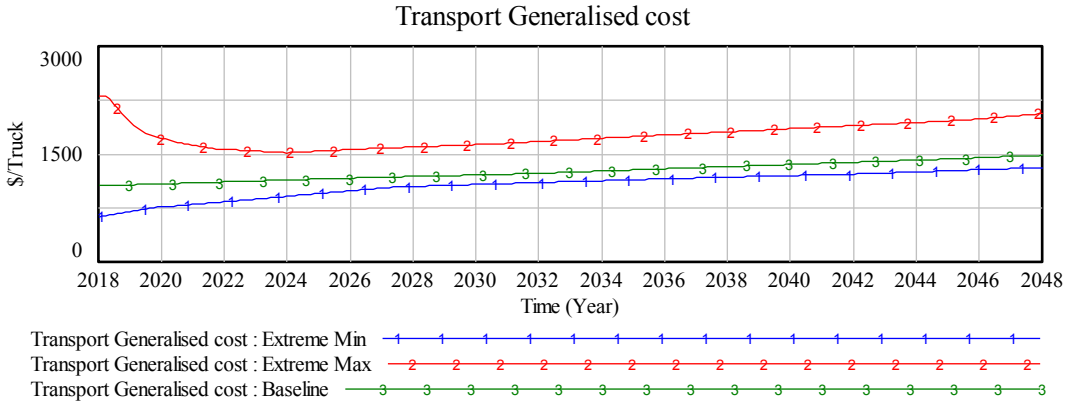


Figure 10-7 Freight transport generalised cost extreme test

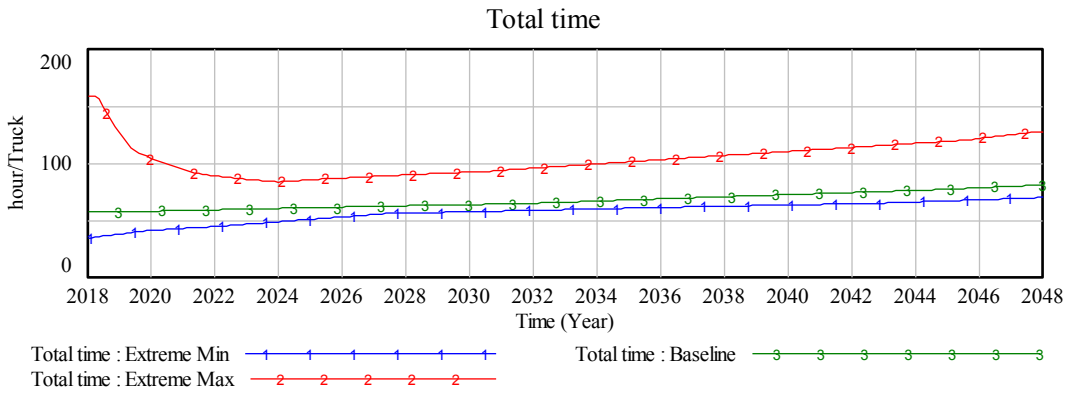


Figure 10-8 Total time extreme test

Figure 10-7 and Figure 10-8 represent the cost and time where both line graphs have a similar trend. For line 1, where no truck goes through the Vung Ang Port in 2018, the total time and cost are lower than normal because fewer trucks lead to low waiting times at the border and port; this behaviour is possible.

For line 2, where the number of trucks changes rapidly, the cost and time are high and it takes many hours to cross this corridor. This rarely happens but is possible as many trucks will come at the same time and become stuck at the border and port. However, the line drops down a bit as it makes sense in a real situation that the number of officials will increase to handle this situation and the government will have to do something. They might move an official from another border to help at this border. However, as the model did not cover that, the official number will increase following the law. The outcome behaviour test shows the number that possibly accepts.

Chapter 11 Policies test

Now that this research has developed confidence in the structure and behaviour of the preceding model, in this section it will use the model to design and evaluate four policies for improving this corridor. This test of policies involves making changes in the value of model parameters, such as increasing border opening hours, improving border processing systems (technological upgrade), investing in a dry port, and sending officials to work as agents at Vung Ang Port. All policies were tested from the initial time, from 2018 to 2048. Moreover, these policies will involve changes to the variables of equations that will cause feedback values for the baseline's outcome behaviour to be changed. The three tests are shown below:

1.) Baseline run
2.) Increase border opening hours
3.) Border technological upgrades
4) Dry port operation
5.) Laos' official agents at Vung Ang Port

11.1 Unit changes

Table 11-1 Policy variable and equation

No	Variable	Code	Description	Value or equation	Unit	Affect
1	Dry port operation	DPO	A policy where Laos' government develops a dry port at the Vung Ang Port corridor. The equation shows in Table 9-6, No.54, Equation 36	0 or 1	fraction	- **Port delay** reduced by 75%. (Table 9-3.No.2) - **Number of border procedure** reduce from 5 to 3 (Table 9-2, No.10) - **Port charge** reduced by 30% (Table 9-5, No.5) - **Dry port charge** will charge 50 USD/truck (Table 9-5, No.4) - **Border charge** reduced by 50% (Table 9-5, No.3)
2	Border processing	BPD	A policy where Laos' government develops a border process, such	0 or 1	fraction	**Border processing rate** and time reduce from

	developme nt		as inputting high technology and a border lane to increase the speed of processing. The equation shows in Table 9-2, No.9, Equation 7.			15min/percedure to 8min/percedure (Table 9-2, No.9)
3	Laos official agent at Vung Ang Port	LOAV AP	A policy where Laos' government sends agents to work at Vung Ang Port as the Vietnam government and Vung Ang Port require. The equation shows in Table 9-6, No.58-60.	0 or 1	fraction	**Laos official input at the Vung Ang port** will be add 2 people (Table 9-6, No.60 – to Table 9-3, No.6)
4	Border opening time developme nt	BOT D	A policy where Laos' government develops a border opening time and increases the opening time to be the same as the border of the capital city through the Thailand corridor. The equation shows in Table 9-2, No.6, Equation 4.	0 or 1	fraction	**Border opening hours** incease from 8 hour/day to 12 hour/day (Table 9-2, No.6)

Table 11-2 Policy expectation and barriers

No	Variable	Expectation	Barriers to implementation
1	Border opening time development	Make the border traffic run smoot Reduce border waiting time	Lack of government official Cultural condition where Lao people do not prefer to work at night.

			Might need to hide higher price for official to work at the night time or private company to handle.
2	Border processing development	Make the border traffic run smoot Reduce border waiting time Reduce document process	Lack of skill, need to train official to use. Need technical support or maintenance or plan B if the hardware when down. Require standard or similar technology with others border
3	Laos official agent at Vung Ang Port	Make the port traffic Lao truck lane smoother Reduce port waiting time for Lao export Reduce document process for Lao export Deal with others issues happen at the port	Bilateral agreement requires Special language official skill requires Office and some investment cost require Need to deal with the port owner.
4	Dry port operation	Make export/import traffic flow smooth Reduce document process Reduce transportation cost Reduce transportation time at the border and port Improve logistic Attach international investor	Require huge investment Government can't invest Have to wait for investor Require construction time.

11.2 Policy comparison of truck volume

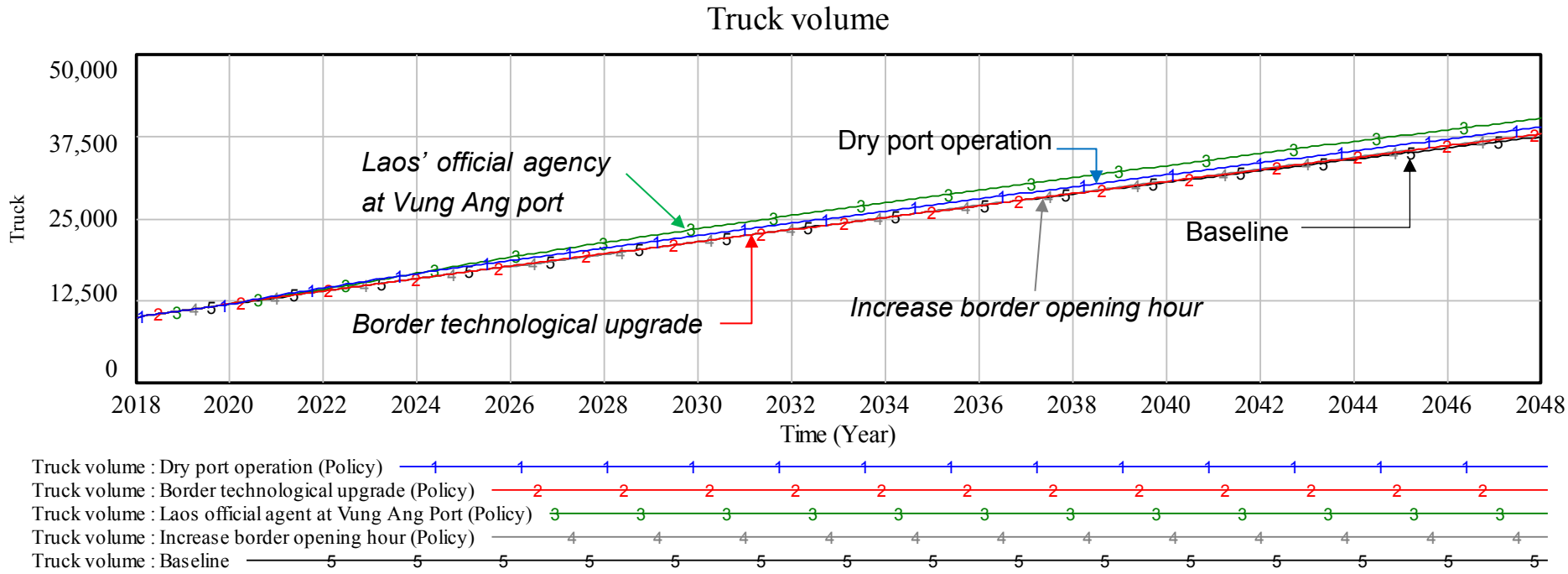


Figure 11-1 Truck volume policy test

Policy implications on truck volume

By applying the *increase border opening hour*, *border technological upgrade*, and *dry port operation*, the policy implication outcomes do not significantly change the behaviour from the baseline or the one that represents the ongoing system. The outcome shows the truck values increase slowly, where the dry port development higher than others two polices, flowing by *increase border opening hour* in the long run but still does not have a huge difference. However, the *border technological upgrade* does not seem to produce any benefit on the truck volume where it has low values in the long run that are smaller than the baseline.

One of the significant changes is the policy where Laos' official agents are applied at Vung Ang Port. The outcome is shown in the graph where the value grows rapidly a couple years after the policy is applied and keeps growing till 2029, which is 10 years later, before it follows the same increasing trend like other policies. This proves the truck volume is the main cause.

In conclusion, in order to increase the truck volume or to increase the amount of export or trade, solving the problem at the border might not produce significant changes.

11.3 Policy comparison of freight transport generalised cost

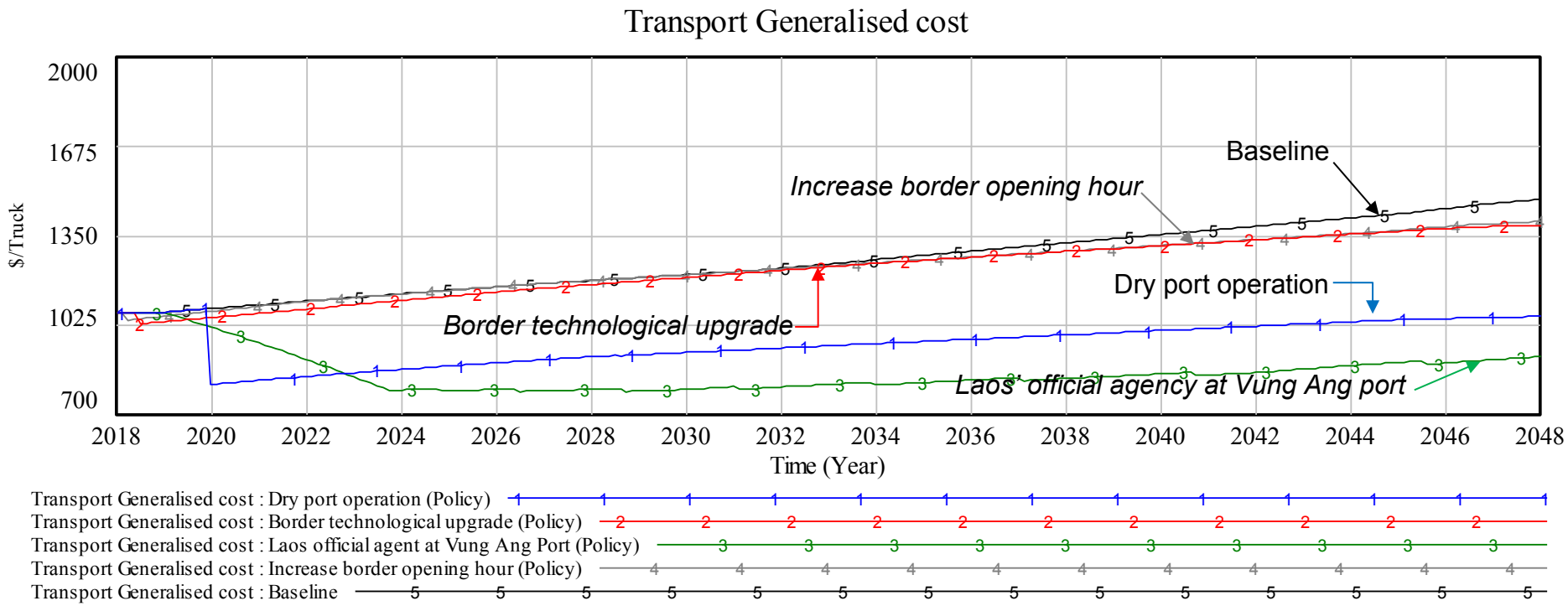


Figure 11-2 Freight transport generalised cost policy test

Policy implications on transport generalised cost

By applying the *increase border opening hour* and *border technological upgrade*, these two policies do not produce significant behaviour changes from the baseline in the case of transport cost. However, both policies show that it is worse to invest where the border processing development can reduce some transport cost in the short and long run and the increasing opening would show that in the long run it will reduce some amount of cost on this transport corridor or border.

By applying the dry port operation, it is shown that the cost immediately changes the average transport cost from 1100 $/truck to 700$/truck just from its operation in 2018 and follows the same trend where the cost increases constantly 1-2% per year just as mentioned by (Asia et al.). This because the dry port operation would have to solve all the processing procedures and re-manage the truck scheduling time, which reduces the border time and port time as well.

Lastly, applying a Laos' official agent at Vung Ang Port shows that the transport generalised cost of the Vung Ang Port corridor dropped less than the dry port operation policy in the five years before 2028 till it kept the container stable following the same trend but still has the lowest value compared to others policies.

In conclusion, to reduce the transport cost of this corridor, in short and long-term investment, the policies of the Laos official agent being placed at Vung Ang Port and dry port operation would be the best to develop. However, for the other two policies, improving the border system might not be the best but will still get the job done if the government want to reduce some transport cost as these two policies would also have some worst to invest.

11.4 Policy comparison waiting time for border processing

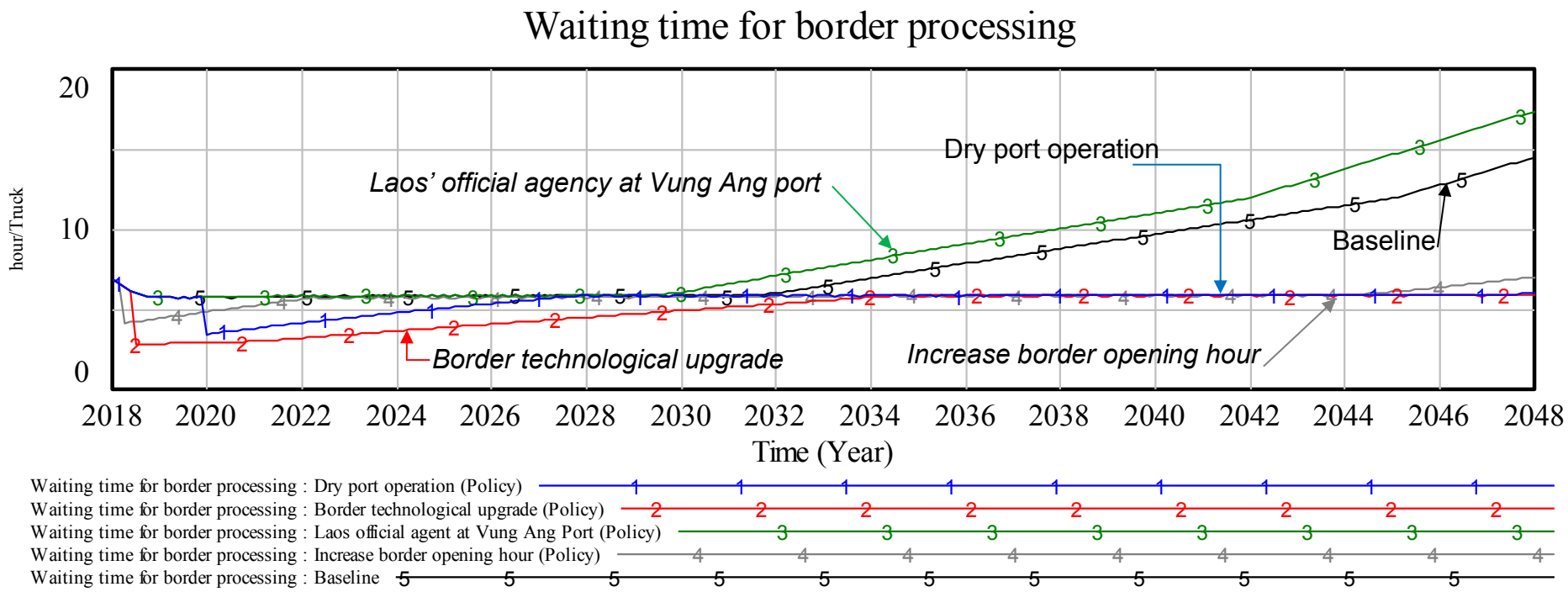


Figure 11-3 Waiting time for border processing policy test

Policy implications on waiting time for border processing

By applying an official Laos's agent at Vung Ang Port, the border waiting time, if considered only for the waiting time beneficial not the overall, this policy seems to be the worst to do as the waiting time will increase more rapidly than with other policies. However, the reason behind this is the truck volume will increase and many trucks will enter the border at the same time or have to wait for longer than normal, where this policy did not improve any border systems.

Dry port operation and increased border opening hours seem to have the same trend in the short term like the baseline run. However, in the long term, those policies have better value as they have less waiting time than the baseline of 2-3 hours.

The border processing development has different trends where the long-term has similar values to the dry port operation and increase in border opening hour policies. However, in the short term, it is shown that it has significant low waiting time if applied for 1-2 hours before. Twenty years later it increases to the same line as the other policies.

In conclusion, to improve this corridor, border processing would be the best to invest in as it immediately shows the outcome of the investment and has good value in the long run as the other policies. However, the Laos official agent at Vung Ang Port might be worse to do as the waiting time increases, but it can explained that the number of trucks increases and it is not because it affects the system. As for other benefits, such as truck volume and transport cost, it is shown that this policy is still the worst in which to invest.

11.5 Policy comparison of port waiting time

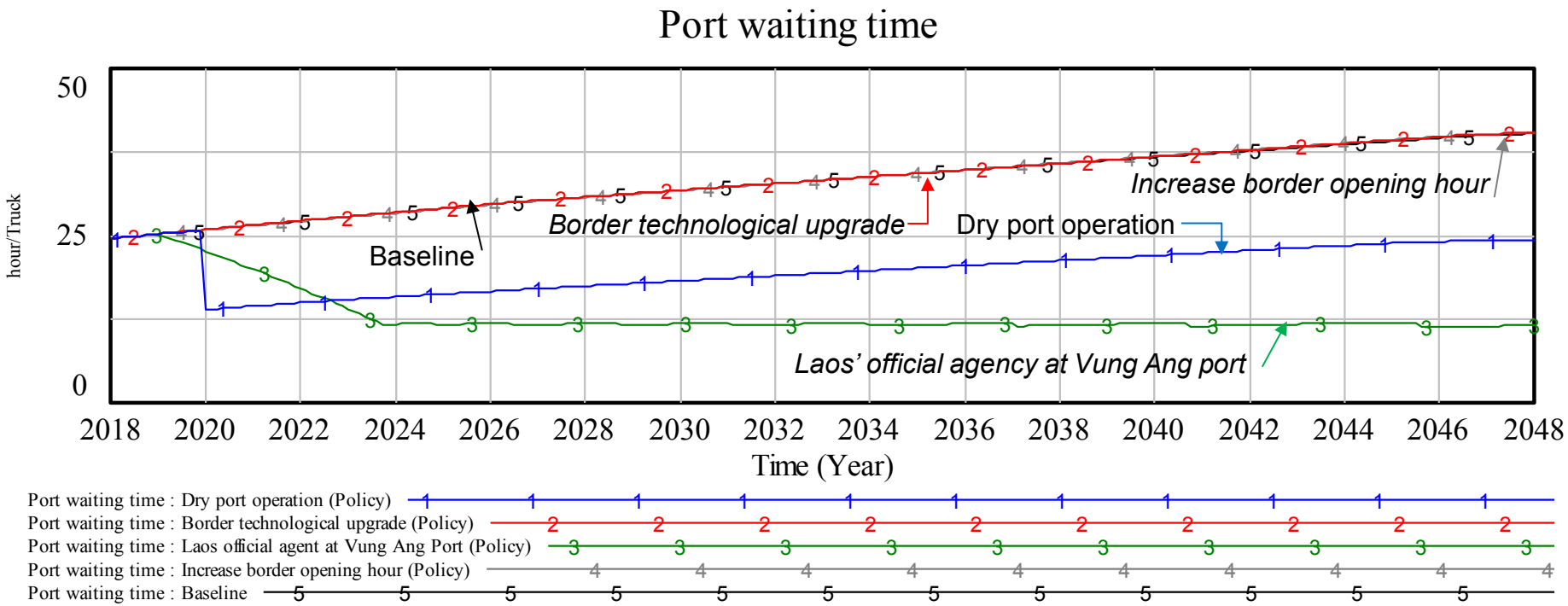


Figure 11-4 Port waiting time policy test

Policy implications on port waiting time

By applying the *increase border opening hour* and *border technological upgrade*, these two policy implications do not significantly change the port waiting time, as they are dynamically not related in terms of directly affecting the system of different areas. The dry port operation policies applied show the clearly change the port waiting time as it reduces the time to more than half the normal baseline. The policy seems to be constant, as it applies and follows the same trend as the baseline slowly increases but is still half value. The Laos official agents at Vung Ang Port was the policy that significantly changed the port waiting time value, as it shows in the graph that the number drops rapidly owing to the policy directly changing or improving the port waiting time.

In conclusion, to reduce the port waiting time, as is clear from the outcome graph, sending a Laos's official agent to Vung Ang Port would be the best way followed by the dry port operation, which also has a good outcome. The others policies would not have much effect on the port waiting time but are important to other factors.

11.6 Policy combines

This section has setup running 3 optional policies that could possible happened, the resource show in Figure 11-5. The new policies option would be combined differently from the 4 policies options. The new 3 policies option discussion and resource are discussed below:

Option 5th: In Figure 11-5, show as line number 1 (colour Blue), where two policies at the border were apply together (Increase border opening hour and border technology upgrade), this representing the policies that would not be too hard to implement and require less investment cost and one advantage is it in the same area (Border).

- The resource show that it a bit better situation outcome to baseline or individual policy of increase border opening hour and border technology upgrade one by one, but could not reach to benefit of dry port or official sent to work at the port. This because these two policies have scope of impact at the border, which can reduce the border waiting time, where the main issues are the port waiting time that caused this corridor transportation cost.

Option 6th: In Figure 11-5, show as line number 2 (colour red), 3 policies combines together (Increase border opening hour + border technology upgrade + Lao official agent at the Vung Ang port), these representing the policy which can be possible happen even the policy of Lao official agent at the Vung Ang port require

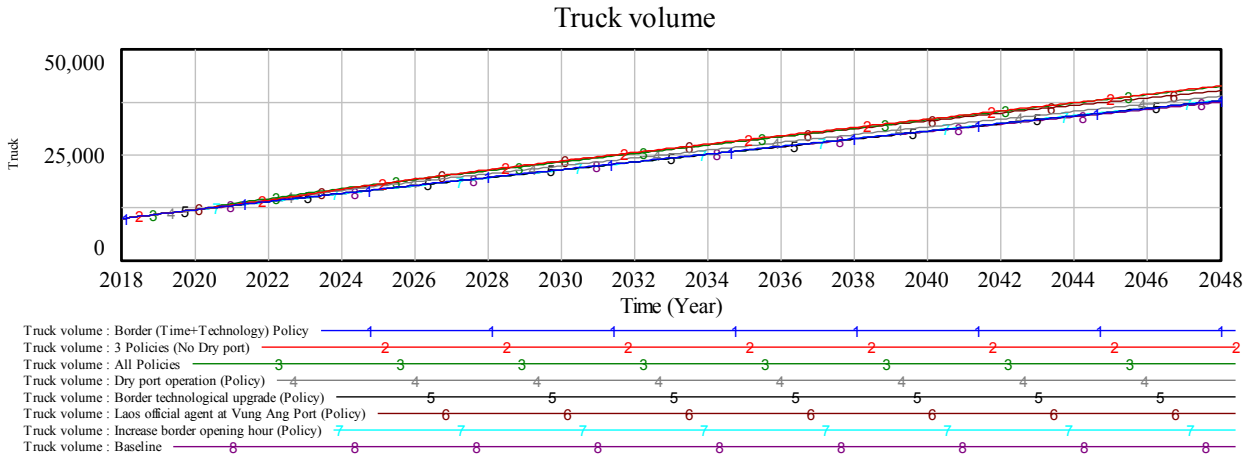
some cost and complication process, but it still possible to happen and Lao government would be able to support from the government fund.

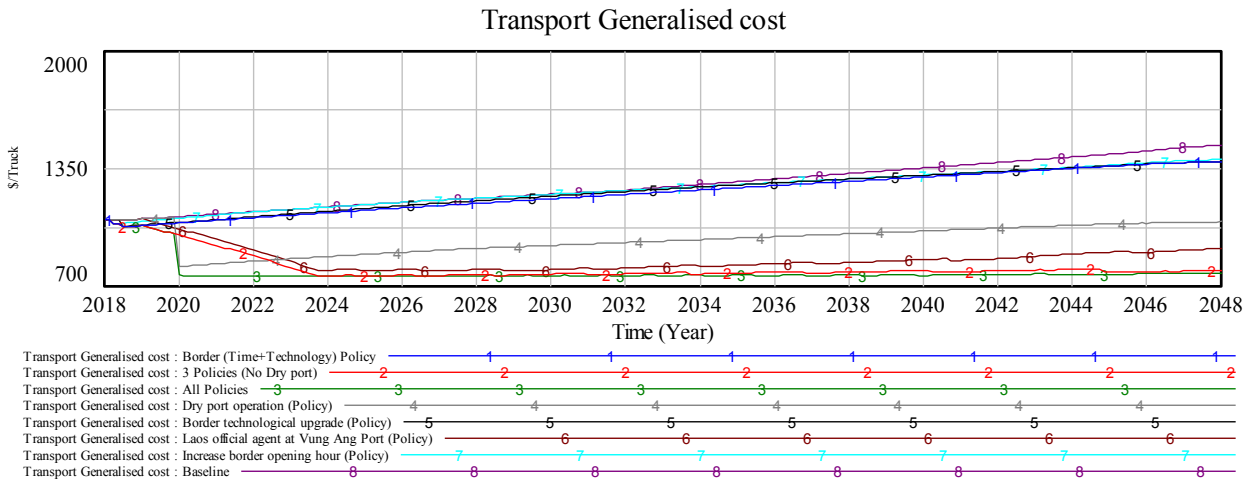
- The outcome show that it has significant effect, the transportation cost and time reduce and have better resource than others 1st - 5th options, which is also better than the dry port development and it have less investment cost. This could be possible happening soon, where it might happen at the same time, but it surely all 3 policies would be applied in the future just like it combined here.

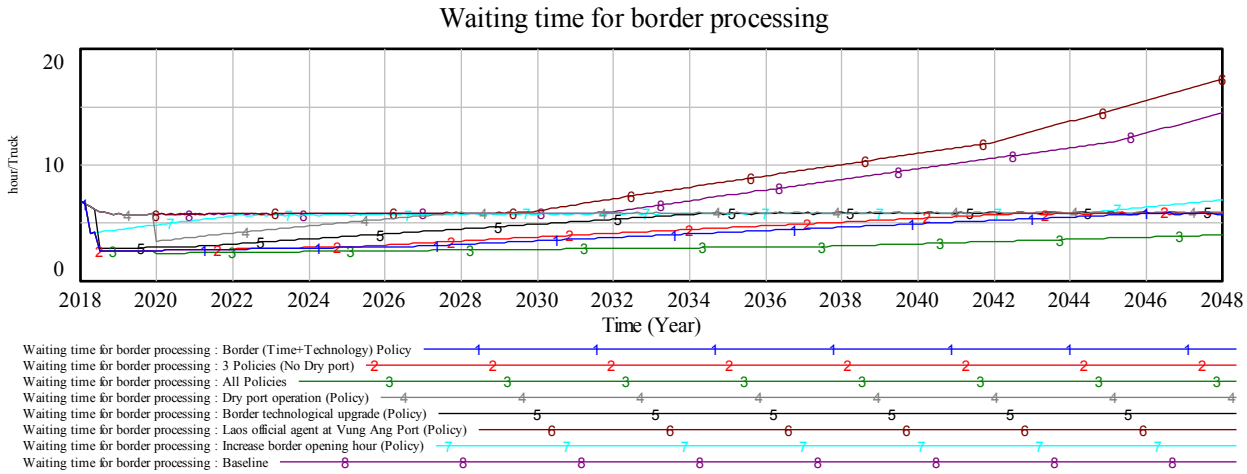
Option 7th: In Figure 11-5, show as line number 3 (colour green), all 4 policies combines together by adding Dry port development policy to Option 6th. This would represent the policy without considering the investment budget. All hypothesis would assume to run or apply at the same time togethers.

- The graph outcome show that all the focus issues solved, where it has most reduced transportation cost, less transportation time and less waiting time at border and port. However, this hypothesis is the best possible option but hardly to happened as to run all apply 4 policy together, which in this case where it might require different ministry to approved and the big barrier to implement is the budget fund especially the dry port development.

Figure 11-5 Outcome graph of all policies options







11.7 Policy comparison

This section shows the rank comparison of all policies options, with the new latest information from the official responded to the similar project in Laos about the average policy investment cost below:

Policy investment cost	
1. Increase border opening hour	500,000 US Dollar
2. Upgrade border technology	1,000,000 US Dollar
3. Official at Vung Ang port	15,000,000 US Dollar
4. Dry port	50,000,000 US Dollar

Sources: Information from the official that responded to the similar investment.

Table 11-3 Policy option comparation

Option	Border time	Border technology	Official at Port	Dry port	Cost (US dollar)	Truck volume	Freight transport generalised cost	Waiting time at the border
0					0	8th	8th	7th
1	✓				500,000	7th	7th	5th
2		✓			1,000,000	6th	6th	2nd
3			✓		15,000,000	5th	5th	8th
4				✓	50,000,000	3rd	3rd	6th
5	✓	✓			1,500,000	4th	4th	4th
6	✓	✓	✓		16,500,000	2nd	2nd	3rd
7	✓	✓	✓	✓	66,500,00	1st	1st	1st

Table 11-3 shows the different ranks of graph outcome from section 11.6, where the resource description of option 1-4 described in section 11.8 and option 5-7 described in section 11.6. For future development the table can be improve by calculate the cost beneficial analysis.

11.8 Policy conclusion

This research has emphasised the importance of improving the Vung Ang Port corridor by implementing policies to find the suitable investment, however, under the condition that the government has a low budget and wants to avoid interfering in other departments and neighbour's transport systems. Thus, the right policy should be the one that is able to reduce the freight transport cost and time.

The 1st option in the case that government have limited budget, the policy that shown to be the good option is to apply the one that have lowest investment cost, which is increasing border opening hour. This policy is a safe move, and require lowest cost compared to others but will work well to solve the right point as it will help to traffic flow and reduce waiting time at the border. However, this would only work in a short-term, where in future the vehicle volume will increase, then the same problem will comeback (border delay) and the transport cost will be high again.

The 2nd option is also good option with the case that the government have limited budget, the policy of upgrading border technological especially the documentation and inspection section. This policy requires few investment costs similar to option 1 with double price. Where the outcome also has similar resource that able traffic congestion and reduce border waiting time. However, as it might be a bit good at outcome but condition is the same, where this would only work in a short-term only and somehow it must be applying again in future.

The 3rd option would be the government sending an agent to work at the Vung Ang Port, this option is one of the best options as it can cut off a lot of transport time, which will reduce the transportation cost in short and long-term. However, it might not be best option just only it might require difficult process to deal with the port and cooperation with neighbour. Moreover, it requires high investment and long-term plan. Thus, this option would be good if the government has budget and have good cooperation with neighbour. However, there are an alternative option where the government could cooperate with private company investor from Laos, so they can work as Lao agent there at the Vung Ang port.

The last policy 4th option is the dry port investment; this policy is one the good option just like the 3rd option but have more barrier conditions. And it the policy that require significant investment fund. The dry port development was one of the policies that every country should have and every developing country already had. Because the dry port development would be able to solve a lot of area situation like reduce traffic congestion, improve logistic system, reduce transport time and transportation cost. But as this policy

option require huge amount of cost, where most least developed country would not able to be done by them self, the only possible is to wait for international support. But if it happens it would be one of the best options in short and long-term situation for the corridor and country transportation.

Chapter 12 Thesis conclusion

12.1 Introduction

The last chapter of this thesis presents the conclusions of this research, and in so doing, this chapter will describe all the research approach results and the problems encountered during the research, along with the researcher's recommendations. The summary begins in Section 12.2 with a summarisation of the research approaches used. Section 12.3 reports the outcome of the research objects identified in Section 1.2. Section 12.4 gives an outline of research's original summarisation. Then, in Section 12.5, research limitations are identified. The chapter ends with Section 12.6, in which the researcher gives recommendations to administrators and others involved in transport for further research and implementation of the conclusions offered by this research.

12.2 Research approach

This research started by identifying the general factors that influence a developing landlocked country's freight transport. It acknowledges that freight transport is facing extinction in many landlocked countries, and especially in developing and least developed landlocked countries, because of poor infrastructure, transit agreements, and limited funding. Section 2.2 shows that, while freight transport barriers operate across several continents, the specific nature of these barriers may differ; e.g., the conditions in Africa are different from those in Asia. However, Asia and especially Laos has many problems that may seem impossible to solve, which means that its circumstances have attracted more attention than other LDLCs. Chapter 6 shows that the challenges faced regarding freight transport in Laos are similar in nature to those in many other LDLCs with similar modes of transport (including places such as Nepal). However, the attention given to the freight transport problem in Laos has not substantially improved its safe operation, despite several policy measures that have aimed to address these problems. In Laos, the literature shows that freight transport now requires the most documentation and the longest time and highest price among all exports or imports in southeast Asia (World Bank, Doing Business Report 2010: East Asia and the Pacific, 2010).

Consequently, the purpose of this research is to understand the main problems that cause the economies of least developed landlocked countries to lag behind other maritime countries. As is observed in the general overview, freight transport is one of the main problems, as it is a complex system that does not suggest a clear strategy on policies that might alleviate the problem. This situation is evident in Laos, which has embarked on a strategy to overcome the barriers. Thus, this research focuses on the particular problem of

freight in Laos to understand the system behaviour of this country and to develop a strategy from this case study that could be implemented in another landlocked country.

12.2.1 Data collection

Literature and report review

From the literature review, it can be seen that there is a lack of pure studies on freight transport in least developed landlocked countries. Many previous studies have tended to combine multiple individual factors of the landlocked countries' problems, with less explanation on any one specific area. Moreover, various studies have provided less detail on the connections between factors or a causal effect approach, which makes it difficult to explore the particular feedback effects of each transport operation. Also, most of the existing research studies were done by an international organisation rather than by the country itself, which means that the statistical data cannot be considered fully reliable, but rather is limited, with unclear collection methods, and is mostly out of date. In conclusion, these previous studies focused mainly on the overall situation of these countries, where the transport system is only part of their study; therefore, they provide only a limited explanation of a complex freight transport system. A better approach to the problem and the effectiveness of policy measures must include fieldwork study and a more qualitative method on a case study of interest, so that results can support an adequate understanding of the problem's causes and the impacts of the proposed policies.

Focus group and interview

As mentioned previously, limited data was the first barrier for this research. As quantitative data were deemed unreliable from the beginning, the use of a qualitative method and system approach was adopted here to research the problem. The research organised a focus group workshop to conduct a fundamental data fieldwork exercise on local area conditions, where academic experts in transport and related field were approached to participate in the process of developing a local transport mental model. Next, interviews were conducted to collect data from specific stakeholders from trade and logistics providers in Vientiane, the capital city of Laos. Lastly, the fieldwork also included interviews of government transport administrators, in which the focus was on policy implementation. From the fieldwork data collected, the content analysis method was used to summarise the causal links and present the analysis for individual use. The results were first characterised as a summary report consisting of a written explanation of the findings. Secondly, the data was transformed to a causal network to permit a better understanding through a loop diagram. Finally, a stock and flow model was used to discover system behaviours, as is explained in more detail in the following section.

12.2.2 General least developed landlocked countries causal loop diagram (GL_CLD)

A CLD was generated to provide a diagram highlighting the general transport characteristics of least developed landlocked countries (LDLCs). The research used a summarisation from the literature review to establish a cause and effect feedback loop. As the model has numerous variables and factors, the research chose to highlight specific variables that have less complexity but are still able to describe the freight transport system in LDLCs. The GL_CLD does not show all variables but instead groups the variables into particular sets, each representing the main factors in the individual country's case, recognising that some countries may or not may not have to face particular factors in their country. Nevertheless, the GL_CLD provides a system to examine the general freight problems that exist in different areas.

12.2.3 Data analysis

To understand the specific problem and policy outcome, it is necessary to conduct a local fieldwork study using a qualitative method in the area of interest. Data collected from a focus group and interview were analysed using content analysis. The outcome from this qualitative method was summarised as a theme, which is beneficial in that it enables an easy discovery of differences, distinctions, and connections within and between each mode of transport operation. The data identify structures and behaviours of various factors that affect Laos' freight transport and how they are representative the challenges for least developed landlocked countries in general. The content analysis method is used for this objective in combination with the literature, expressing the view of the particular freight transport structure as the data source for developing a causal loop diagram.

12.2.4 Vung Ang port causal loop diagram (VAP_CLD)

Continuing from the fieldwork data analysed previously, the fundamental GL_CLD structure used for the general depiction of LDLCs is combined with the specific literature review to develop a causal loop diagram for Laos' freight transport that includes the factors affected by the country's port development. From the previous data analysed, this VAP_CLD provides a better understanding of the dynamic problematic structure within the same specific theme. Moreover, this VAP_CLD was developed from the first GL_CLD structure and feedback loop, whose object was to present a fundamental structure for any LDLCs' freight transport problem.

12.2.5 Stock and flow model

As can be seen from the empirical studies outcome, some policy implemented situations do not work as planned. The development of VAP_CLD reproduced a clear understanding of Laos's freight transport behaviour, which is that some policies are mathematically formalised under the quantitative model (stock and flow). Thus, this research has constructed a model that is based on historical quantitative data with several validation tests and a series of tests that includes a trending and behavioural comparison of the outcome parameters with realities and literature data. Additionally, it includes the port implementation policy theme and internal infrastructure improvement, which demonstrate potential for its flexibility for policy testing and analysis.

12.2.6 Comparison of the outcomes of the research findings

The four main results obtained herein based on the research objectives have been summarised in Table 12.1 below.

Table -12-1: Summary of research results

	Benefits	Limitations
GL_CLD	The outcome provides a simple understanding of the overall freight transport situation for LDLCs, which can be seen as a group of important factors that must be known. Provides a basic fundamental structure of the feedbacks that show what drives the systemic problem at a big picture level and gives an understandable framework for a developer.	CLD 1 should have a bigger and more complex feedback loop, as it represents general freight transport issues for LDLCs, but it was scoped using a specific area. Only the main factors that have a significant effect or have been mentioned the most in other previous studies are taken into account in this CLD.
Data analysis	The outcome of the method used for the data analysis was originally separate from the other method used in this research.	The data were hard to understand without a thorough reading. Even though it shows and explains the factors' cause

	The information from this result could be adapted by any developer to any method, as it is a summarisation of data showing the situation in the specific area from the local point of view.	and effects, the information cannot be easily seen in a picture or diagram.
VAP_CLD	Compared to GL_CLD, VAP_CLD gives more detailed information on the specific area, which also provides more understanding of the system's structure than is provided by data analysis, as it is easier to follow a pictorial explanation. It has advanced by providing a feedback structure that transforms from the first diagram with a clearer framework for policy design and model development.	It is truly hard to find information and literature on specific factors, which for some feedback loops require existing knowledge to generate the outcome. The framework could not cover all possible factors from all stakeholders' sides, as this research depended on local information, which could have a different feedback structure.
Stock and flow model	From the qualitative model, this model simulation offers a better understanding of each variables value and showing the impact of different intervention factors.	The model development requires significant quantitative data to obtain the accuracy results. Where in this case that most of the quantitative data was limited and not up to date as this had been replaced by modeling assumptions that it can lead to incorrect result.

12.3 Objectives summarisation

The overall aim of this research was to identify a general understanding of freight transport challenges for least developed landlocked countries and then to seek information relating

to a specific example, the country of Laos, so as to improve the understanding of the difficulty of its freight transport system and the effectiveness of the country's port implementation. The development of a causal loop diagram in chapter 5 provides a fundamental view that answers this study's first objective. The second research objective was addressed in chapter 7. Chapter 8 answers the third objective, and chapter 9-10-11 addressed the final research objective. A more detailed summary of the contributions made in this study for each research objectives is provided below.

12.3.1 Objective 1

- Create a high level causal loop diagram to identify factors that influence freight transport for general least-developed landlocked countries

The first model was developed for the purpose of providing a general view of this issue; thus, many factors deemed not important or less impactful on freight transport were not considered or not shown in the model. Moreover, the model focused on particular transport mode choices such as road transport, which is the most reliable and popular choice among LDLCs, based on the research findings. From all the data sources summarised in the literature review, it can be seen that there may be different factors that affect an LDLC's freight transport, where different areas have different situations. However, there are some basic factors that exist for all LDLCs. Causal loop diagram for least developed landlocked countries' transport. This first CLD development identified all possible affective factors that exist in LDLCs; thus, this GL_CLD provides the opportunity to gain a fundamental understanding of the general situation and supports the development of the specific CLD identified as the third objective of this research. In conclusion, this GL_CLD shows the basic problem as defined below:

i. LDLCs' exportation loop: A growing volume of exports is considered to be one of the main improvements needed for an LDLC's GDP.

ii. Accessing the global markets loop: Getting into the international market is what most countries want, but it is the biggest challenge for LDLCs that have individual problems, making it less likely that such countries will have the opportunity to achieve this goal.

iii. Transport mode choices loop: The LDLCs' choice of transport mode is limited because of the specifics of the individual case; e.g., in some countries, river transport is either non-existent or cannot be used because of geographic, financial, or technical reasons.

iv. Transit neighbour's infrastructure loop: The infrastructure of the transit neighbour's that the landlocked country trade uses and depends on is an important external factor, but it is impossible for any landlocked country to overcome this situation.

v. Border crossing loop: This is a problem that always occurs to some degree but it has a huge effect on overall time and cost. Improvement in this area requires development on both sides, but especially on the landlocked country side, which has limited funds.

vi. Regional cooperation loop: This process does not require much cost to achieve compared to other strategies but could still be one of the best solutions for any landlocked country with limited funding and good relationships with neighbours, as it offers a high chance of improving or solving the problem.

vii. Regional investment loop: Regional investment could not exist without good relationships or cooperation that brings benefits to both, but this process mostly consisted of huge projects that required external funding.

12.3.2 Objective 2

- Determine the factors that influence Laos' transport modes and their relationships with one another using the case study of Vung Ang port.

Based on the analysis of the qualitative data collected from local fieldwork studies, many of the factors mentioned in other previous studies were more of a high view; meanwhile, the factors identified in this research from local fieldwork studies are different and greater in number. These factors have never before been introduced in a published paper or international organisation report, which makes the information presented herein different from the first objective, which was obtained fully from the literature review. These factors are summarised and grouped into themes in Table 12-2 below. While this research describes the freight transport problem, it also includes a new information factor that influences the research's original aims. Moreover, this research has summarised all the data findings as statements of conclusions and has elected not to use any additional method to represent the outcome of the data analysis.

Table 12-2 Summary of Laos' freight transport situation and related policy

Data finding	Laos' freight transport situation	Related policy

Laos' transport infrastructure	Suffers from poor infrastructure and lack of improvements	Require more development in country and an external fund to develop. Project development needs to be monitored for standard quality
Accessing the global market	Internal business providers have fewer opportunities to access the global market, as their product price is higher than other competitors	Alternative transport modes and all possible transfers to international logistic channels between modes must be improved to the level of region modal and multimodal infrastructure
Transport time and cost	Laos requires the most documentation for trade and takes the most time for export and import	Regional cooperation can reduce some transit document requirements and combine with improvements in telecommunication for faster data transfer and inspection process.
Transit neighbours	Less effect from transit neighbour infrastructure, but high administrative burden on border crossings and long delays because of strict regulation	Negotiation and regional cooperation requirement with neighbours could reduce issues.
Border crossing	Weak quality of internal borders and lack of facilities. Low technological data transfer, which causes a more reliance on paperwork at transit neighbour's border.	Require border investment and technological improvements from the government.

Regional investment	Many regional investment projects pass through Laos and most have benefited.	Laos needs to be more attractive to such projects, which could increase investment and result in project cooperation that benefits investors.
Policy	Some policies could not be implemented or achieved because of a lack of funding.	Policy making requires more research and internal cooperation.

12.3.3 Objective 3

- Develop a causal loop diagram to determine the effectiveness of Vung Ang Port corridor (VAP_CLD).

Following on the outcome of objective 2, the data analysis was used as the source for the development of VAP_CLD, which provided a better understanding of Laos' freight transport system and explained the related of Vung Ang port implementation. Based on the structure of GL_CLD from objective 1, the problem causation has emerged and transformed in VAP_CLD. The key themes that represent the focus of the loop were developed into a GL_CLD, where VAP_CLD fulfils the third objective of the research and summaries below:

i. Laos' exportation loop: The growth of Laos' export industry is presently obstructed by its poor internal transport infrastructure together with the small market share in its internal market.

ii. Laos' access to the global markets loop: Most of Laos' exports and imports were with neighbours, as the oversea trade presents the burdens of high transport cost and time compared to neighbouring countries.

Laos' transport mode choices loop: Road transport is the most dependable mode of transport in Laos, where other modes such as waterways are not accessible, a train system is still in development and not in use, and air transport is very expensive. Thus, these transport mode choices were not considered in VAP_CLD.

iii. Laos' transit neighbour's infrastructure loop: Laos is surrounded by neighbours with high infrastructure quality on both sides of its corridor. Thus,

issues coming from transit neighbours and the resulting loop were not considered in VAP_CLD.

iv. Laos' border crossing loop: Problems and delay at the borders still exist, where Laos' border is still lacking in quality and Laos' transit neighbour still has a great deal of regulation.

v. Laos' regional cooperation loop: Laos has a very good relationship with its neighbours and other countries in the region.

vi. Vung Ang port project investment: In view of the good relationship with Laos' transit neighbour, this project can create many benefits to Laos, as well as to the country where the port is located. However, as the funding for this project does not come from Laos, but rather from an external country combined with the port owner, this made it difficult for Laos to negotiate an agreement that would provide as much benefit to the country as it might otherwise have done.

12.3.4 Objective 4

- Implement a policies on system dynamic model to improve the Vung Ang Port corridor system.

One of the group mini diagrams under part of VAP_CLD that was structured in research objective two was used to develop a quantitative model for objective four. This objective model used the system behaviour of Vung Ang port project investment on Laos's freight transport, with the main focus being on the freight cost and time. The importance of this model is the factor of freight transport generalised cost. The model simulation reflects an individual behavioural change under various parameter tests, the outcomes of which are summarised below:

- Freight transport time is the main impacts of the freight transport cost, while an additional charges were less impactful.
- The most delay or waste time happened in the port due to truck or container have to wait for many hour for document procedure. Moreover, the border waiting time also have an effect to increase the total transport time.
- The truck volume was the main factor that lead to the border waiting time, as the Na Khao border processing time is slow.
- The border delay happened in the Lao's side, where the transit neighbour (Vietnam border) border crossing time mostly stable.
- The Na Khao border opening time was open less hour than the others border, which was one of the factor that lead to increase the border waiting time.
- Port processing time
- Port waiting time

- Lao's freight export waiting at the Vung Ang port
- The cost changes effect to truck volume
- The Vung Ang port is obstructed by the port waiting time, which is high compared to others corridor. This would not be able to attract any user no matter how much other facility or infrastructure improvement was made without fixing this problem.
- Thus, by reducing the port waiting time would be the best option to

12.4 Summary of original contributions

1.) Developed a model that illustrates the system structures of general least developed landlocked countries (LDLCs) that are negatively affected by being landlocked. Though LDLCs' disadvantages were previously studied from individual research and organisation reports, there is no detailed explanation on how the factors influence each other. In this research, a diagram that shows the actual system where there are circular chains of cause and effect was developed. And also included an analysed what causes particular patterns of behaviour. Therefore, this made this research contribution different from other kinds of literature.

2.) Determined deep contextual detail to help in understanding LDLCs' freight transport system, where other previous researchers used secondary data sources as main sources. There are various studies that have used Laos as a case study, where, in terms of freight operation, most of them have been able to access statistics and secondary data, which produced a clear vision of the issues. However, while this research was obstructed by the limited access to statistics and secondary data, this research used direct observation, which has not been used before to express the issues and system of freight transport in Laos. Moreover, the outcome highlighted associations between variables, which were different from the literature reviewed. Thus, this research contributes to literature on the topic by describing, through direct observation, by empirical studies in Laos, where none of the freight transport information was presents as a focus group or in depth interviews from local experience expertise before.

3.) Continued to develop a model diagram from the empirical studies, where individual stakeholders from the local field were discussed based on the freight transport behaviour in export operations and policy implementation. While feedback model behaviour of freight transport has been applied in a basic causal loop diagram, in a high level causal loop diagram, it still not been used to evaluate freight transport behaviour through the regional area and involved policies as this model constructed. Furthermore, this study has, therefore, gone further to test the hypothesis under the suggestion and empirical information collected from local expertise.

4.) In the case of landlocked countries, there were several types of research designed from the statistical data that show route choice comparisons. However, it is difficult to see the dynamic changes, as they only present the issues and real world situation. Many studies have provided suggestions but these suggestions have not been tested or shown in any research where they would work best in landlocked

countries in particular situations. Thus, with this research simulation model, there is the potential of policy learning and hypothesis changes, through providing reliable and sufficient data to policy makers for further development, which makes this model original.

12.5 Limitation of the research

There are two main limitations of this research with respect to both the qualitative and the quantitative methods developed. First, the qualitative data used in creation of the model could not cover the LDLC transit neighbour's point of view, as the research fieldwork was able to collect data only in the local area in Laos. Second, the low amount of quantitative data available could hinder the accuracy of the quantitative model parameters. This limitation owes to the fact that numerical data was hard to find and even impossible to get from Laos' business stakeholders, as information from the government requires official documentation and time to access the database. However, there was still sufficient quantitative data available from international organisation reports when combined with the qualitative data to develop a model.

Furthermore, the model is not able to cover other transport modes that could have an effect on the transport's operation. This is because other modes of transport are still not in popular use or are presently impossible to use; even in cases where project plans have already been introduced, these offer less information that is needed to contribute to the model. Thus, the model can only reflect the present transport system's feedback loop in its calculations, without considering other transport modes that still do not exist.

From the fieldwork data collected in the qualitative analysis, the researcher did not have the opportunity to present the results of the data analysis or model to respondents for testing or confirmation. This could lead to a different model outcome, if the respondents had the chance to be part of the model's development or to add new factors that are presently missing.

12.6 Recommendations for research

12.6.1 Recommendations for policy maker

i. The results of the general view from the causal loop diagram developed under literature reviews shows that most landlocked countries could not overcome the transport disadvantage of being landlocked by themselves. Many of them could not negotiate with transit neighbours because of a lack of resources. Thus, it is recommended that lesser developed countries that have limited funds propose geographical weaknesses as advantages like how being landlocked allows them to

be a central economic corridor that can attract external investors and regional cooperation when seeking to collaborate with neighbours.

ii. The empirical data shows that there is still a lack of collaboration among government sectors, which is shown in the many cases when arbitrary policy regulatory pronouncements do not succeed. This was mentioned by the users and has also been accepted by the policymakers. Therefore, it is recommended that not only collaboration between policymakers be required but also that the opinions of stakeholders, who are experienced under the previous regulations, be considered.

iii. The causal loop diagram development outcome under the qualitative data sources shows that the factors that increase freight transport were caused by individual issues that have all linked together, with the main causes coming from internal factors. However, it also is shown that transport systems are not the only cause of Lao's freight cost; other factors like the lower manufacturing volume of landlocked countries is considered. Thus, focusing on improving infrastructure might have the efficiency to reduce some transport costs and improve the trade operation system, but all investment would be put into a particular project sector that is not even able to guaranty the standard because of a lack of resources and a lack of maintenance responses. Thus, it is recommended that there be collaboration between different policymakers from the different ministries and that the complexity of each ministry be acknowledged so that, in the end, any arbitrary regulatory pronouncement made could solve most of the problem rather than focusing on the improvement of one particular sector.

iv. The current practice of implementing new ports with transit neighbours may look perfect, but because in reality only the government and specific partners can use those routes, the current practice does not satisfy the project, which was introduced to help the landlocked country overcome the disadvantage of being landlocked. It is recommended that each project framework more honestly share the purpose of that project's objectives and, if possible, give more accessibility to avoid some unclear exploitation.

v. Removing the Vung Ang port registration fee is the most efficient measure taken from this research model, and it seems to benefit all of Laos's stakeholders, as it increases the number of optional port choices and could possibly reduce freight costs. However, reviewing the response of the one who wanted to keep the Vung Ang registration fee is recommended. If the registration fee is kept, then an explanation for the fee or a promise that the long term investment of paying the fee would be worthwhile should be given.

12.6.2 Recommendations for model improvement

i. General GL_CLD: As a qualitative model developed, having limited data made it hard to know when the model would stop. However, even if the tools are able to represent all the factors that could possibly happen in the interested area, for the

researcher who has limited time and resources and who would prefer to use literature and documented reviews as a main source for the model data, it is recommend to set a clear scope and determine the kind of theme diagram they intend to present in the early stages. It is not necessary to cover all the small details, as they could be grouped up and represented as a theme, and these small detail factors would otherwise require direct observation. If the developer intendeds to develop a high level CLD that covers all the factors as much as possible, more information may be needed than what could be obtained from the literature without primary data collection.

ii. It has been confirmed that focus groups are one of the best tools for primary data collection for CLD development. This research ran two focus group workshops: Using a focus group for model development in this local area did not seem to work well, but the second aim of collecting fundamental information from local experts succeeded. The reason for this is that to develop a model, participants need to understand the tools they are going to be using before they use them. The hardest thing here is to bring out participants' knowledge with the tools the workshop leader wants them to use. In this situation, it is possible that the leader will achieve only one aim, either developing a good model that might not have good information or obtaining good information that comes from using different tools.

iii. In order to achieve both aims, more preparation on the participants' part is required so that they understand the tools they are going to be using. The workshop leader also has to be sure that he motivates the participants so that they will use the tools. Lastly, as any situation can occur, the workshop leader must decide what he actually wants in terms of results by the end of the workshop. The focus group could possibly work well for the first stage of empirical studies, as gaining fundamental local knowledge could be beneficial to the next stage. For example, local knowledge could be helpful when forming questions that will be used in future interviews.

iv. It is recommended that the interviewer be aware of the uncontrollable nature of a respondent's answers when conducting a semi structured interview. This type of interview is useful for empirical research, but when it is used for developing a model, respondents must remain within the predetermined theme or scope of the interview. Thus, it is recommended that the model developer prepare the question structure carefully and control the situation so that the interviewees do not lead the interview out of the scope that the model will cover. Secondly, as the model requires answers that show a relationship between factors, the researcher must be sure that they will be able to collect enough information from the limited respondents to develop a good model. It is therefore recommended that the developer look back on the first CLD and the other early information, as this could help them manage, which respondent will be able to answer questions on a particular area. Then for the second interview, it will be possible to avoid that question. Or, if the developer

intends to have a confirmation, they must be sure of what it will take to get the same answer rather than finding a new factor that might be more useful. This would be like upgrading the questions from every interview until they fulfil all the model is interested in.

v. VAP_CLD: The qualitative data from the fieldwork has truly proved to be useful in developing a CLD model that is like the first model created from the literature resources. However, as this model was self-developed, it is not quite satisfactory when it comes to accuracy, nor is it accepted by any stakeholder. Different respondents could have different perspectives; thus, to justify who the developer would believe and follow for the model development, it truly depends either on the model developer's justification or on what side the model intends to present. Moreover, it does not mean that one side of the information is right or wrong. Some factors are more complicated and both sides might be reasonable, which another side won't understand. Thus, as a middle person who wants to present a model that can represent reality as well as possible and not be on any one side, it is recommended that the model developer either use a variable hypothesis that could represent both parameters or present a model in different situations.

vi. The model should represent behaviour as realistically as possible, and this stock and flow is able to achieve that. However, before it is introduced to policymakers, more accurate information and more direct observation than what was in this study are needed. Also, some parameters that represent human perspective or decisions need to be studied more carefully, as they are highly sensitive and may change the model behaviour. The structural modification of the model requires communication between the policymakers who control the system and the local stakeholders who use the system, as sometimes those who use the system are able to describe an issue that helps bring the model closer to a real-world situation.

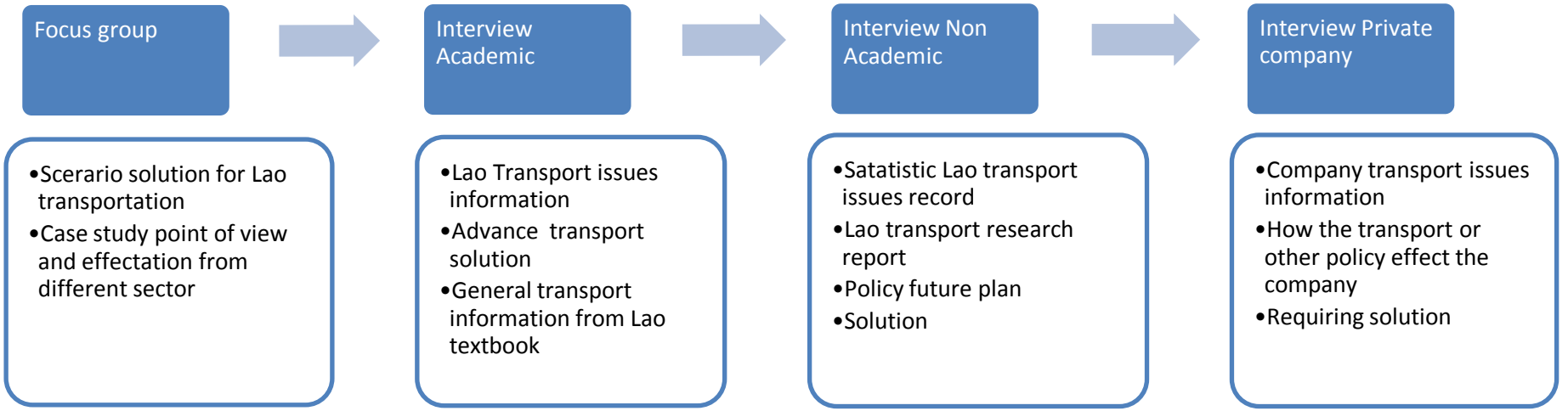
Appendix

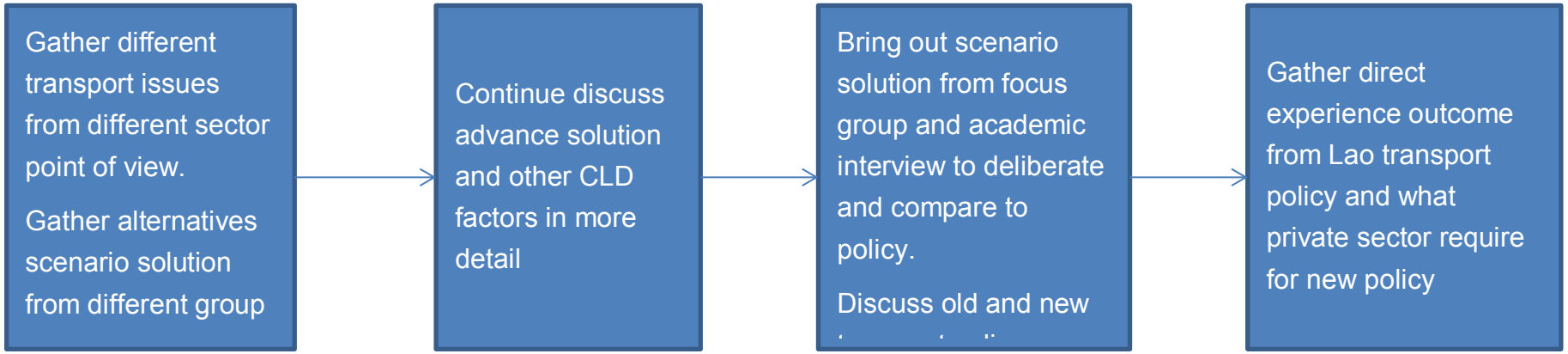
1. Data collection area

Participants	Lists	Method	Amount	Time	Date	Detail	Out come	Option
Academic	University: Logistic expert Policy expert Transport expert Freight expert	Focus group	12-15	6 hours	1st Aug-30th Aug One day workshop	Participant will be learned about system thinking and CLD, carry on by separate in to group and creating their own CLD	CLD information, Case study, another main factor, scenario solution	
Academic	University: Logistic expert Policy expert Transport expert Freight expert	Interview/ participatory model build.	3-5	1-2 hour	15th July- 30th July; 1st Sep-20th Sep Interview after focus group	For whom that interests or want to continue their CLD that provide more information to the research will be arranged to participatory model building one on one.	Lao Transport issues information, advance academic solution	CLD information, participatory discuss model build, commenting research CLD

Non - Academic	Ministry of Transport sector, Department of transport sector, Transport policy planning/make r	Interview	3-5	1-2 hour	15th July- 30th July; 1st Sep- 20th Sep Interview before or after focus group	These interviews will follow Semi-structure question and discuss from their statistic data during the interview.	Lao Transport issues information, Statistic data, Research report Policy future plan, possible or realistic solution	CLD information, commenting research CLD
Private company	Logistic provider Freight company	Interview	3-5	1-2 hour	15th July- 30th July; 1st Sep- 20th Sep Interview before or after focus group	These interviews will follow Semi-structure question and discuss their experience, perspective point of view on topic interest	Lao Transport issues information, how policy effect the company, requiring solution	

2. Methodology approach for data collection in Laos


Focus group
Interview Academic
Interview Non Academic
Interview Private company
•Scerario solution for Lao transportation
•Case study point of view and effectation from different sector
•Lao Transport issues information
•Advance transport solution
•General transport information from Lao textbook
•Satatistic Lao transport issues record
•Lao transport research report
•Policy future plan
•Solution
•Company transport issues information
•How the transport or other policy effect the company
•Requiring solution


Gather different transport issues from different sector point of view.
Gather alternatives scenario solution from different group
Continue discuss advance solution and other CLD factors in more detail
Bring out scenario solution from focus group and academic interview to deliberate and compare to policy.
Discuss old and new
Gather direct experience outcome from Lao transport policy and what private sector require for new policy

3. Planning data collection

a) Identifying respondents

Key informants from participants under knowledge or witnesses of transportation in Laos, people who their position, activities, business or responsibilities, which have involved or a good understanding of the problem must be explore. Moreover, to being participants of specific problems, they may represent specific state agency, have administrative responsibilities in a transport policy planning/maker, be experts in a particular field, and so forth.

b) List of participation:

Lao transport government sector

- Ministry of Transport sector
- Department of transport sector
- Transport policy planning/maker

Lao private freight forward

- Lao-Thai logistic company
- Lao freight forward
- Lao-Viet forward
- International logistic company

Internationals transport sector

- UNDP transport sector
- Asian Development Bank transport sector
- World bank transport sector

Transport, Freight and Logistic expert lecturer

- Logistic lecturer
- Head of the department of transport faculty of Engineering
- Transport lecturer

c) Number of participants

Is still unable to confirming exact numbers of interviews that have to be done for research data collection about Lao transportation. Therefore, several groups have listed above to make sure the qualitative and quantitative data sources will be enough for creating system dynamics. However, several conditions that will consider in deciding on how many interviews to conduct:

- Available time and resources: In some situation that participants not participate or cancel the interview due to any situations. To be considering that the data resources may not always available, other target sector may be consider adding in to account to fulfil the requirement.
- Data saturation: Under optimal conditions, data collections from interview are overlapped or not provide up to date.
- Changing participants: In case of participate list is incompetent to answer the question or not responsiveness to the research interest, i.e. participant may suggest to another person, which he/she have more suitable.

d) What kinds of data need?

1.) Data for general causal loop diagram

Qualitative data:

- Lao transport issues (Logistic, Border, Port and infrastructure)
- General point of view about transport policy
- Opinion and argument for CLD
- Suggestion for new policy, strategy and solution

Quantitative data

- Lao transport issues report or statistic
- Lao freight recorded
- New policy plan
- Transport future plan

2.) Data for the CLD for the case study

Qualitative data:

- Suggestion for new policy, strategy and solution which relate to case study
- Vung-Ang Port project information
- Lao-Viet transport agreement and policy

Quantitative data

- Lao transport issues report or statistic which relate to case study
- Transport research report which relate to case study
- Vung-Ang Port project information
- New policy plan which relate to case study
- Transport future plan which relate to case study

3.) Data for system dynamic model for the case study

Qualitative data:

- Vung-Ang Port project information
- Lao-Viet transport agreement and policy

Quantitative data

- Lao transport issues report or statistic which relate to case study
- Lao freight recorded which relate to case study
- Import and export number recorded via Vietnam (price and statistic)
- Vung-Ang Port project
- New policy plan which relate to case study
- Transport future plan which relate to case study

4. Focus group

e) Research purpose and outcome

The purpose of this is for collecting information about opinions and beliefs, encouraging discussions about Lao transport and policy. Moreover, this focus group wills provide opportunities for the participants to learn about system dynamic and causal loop diagram. The method relies on group interaction whereby people are encouraged to discuss with another, ask questions and comment on each other's point of view.

f) Personnel and staffing resources

As the lone personal working, this focus group will only run by one person, the researcher. However, facilitator/assistance might be asking to help to set up the meeting or supplying materials.

g) Timeline

This focus group will require 6-8 weeks preparation time prior to the focus group meeting, which include:

Paper works:

- Ethical approval
- Risk assessment
- Consent form

Interview plan:

- Interview structure
- Objective
- Research question
- Identify the participants
- Contract information of the participants

Second step for 4-5 weeks before the start of the group:

- Select a facilitator
- Develop the questions
- Create PowerPoint presentation
- Create a script / topic guide
- Book a location.

Third step for 3-4 weeks before the start of the group will send out invitations, or hand in be by visiting participants, and follow up with phone calls one week later for confirmation.

Finally, a couple days before the start of the group gather materials and phone participants to remind them the focus group is coming up.

h) Determine participants

Is still unable to predict how many people interest or available to be participating for this focus group. Therefore, the limitations of participants are 12 and 15 maximums. Due to the plan to separate in to 3 groups that can be group of 4 or 5. These meeting will be set up at the University, thus the target group will be lecturer, which are expert of transport study, freight and logistic, policy and transport engineering.

i) Location, dates, and time for focus groups

The focus group will be place in Faculty of Engineering, National University of Lao. The room will be book and set on meeting room that have capacity to handle more 30 people, which have all facilitate requirement (Chair, table, white board, projector, air conditional, fan, toilet, parking space and restaurant nearby). Moreover, during the break will be providing snacks and beverages for the participants.

The focus group will be start from the morning 8:30am until 11:30am with 15mn break and continue again at afternoon 1:00pm after 1.5-hour lunch break, and 15mn break at the middle time before it ends on 3:30pm.

Date of focus group will be set in the middle or end of August, which is summer/holiday accordingly there are no class for lecturer at the time.

j) Focus Group Schedule

8:30 am to 8:45 am	Registration and Reception
8:45 am to 9:00 am	Opening focus group workshop
9:00 am to 10:00 am	Introduce research Introduce system thinking Set up group Mini exercise
10:00 am to 10:30 am	Break
10:30 am to 11:30 am	Presentation: Causal loop diagram
11:30 am to 13:00 pm	Lunch break
13:00 pm to 14:00 pm	Presentation: Causal loop diagram workshop Create CLD
14:00 pm to 14:30 pm	Break
14:30 pm to 15:30 pm	Continue CLD Participant present their CLD Discuss and summaries outcome

Detail:

1.) Registration:
Participants will require filling **Participant Contract Sheet**
Participants will require handing **Consent form (Focus group)**
2.) Opening focus group workshop:
Introduce researcher and purpose of the focus group
3.) Introduce research:
Abstract, aim and object of the research project

Methodology of research (system thinking, CLD)

4.) Introduce system thinking:
Principle of system thinking
Set up group (4-5 people/group) for 3 groups.

5.) Participant will be divided in to three groups, each group will have member of 4-5 people. In condition, each member has to be from different expert or field e.g. Team (A): Logistic expert, Policy expert, Transport engineering and Transport lecturer.

6.) Mini exercise (Identify Lao transport main factor)
Each group will have 10mn to identify Lao transport main factor
At the end will be select two main factors to create CLD in the CLD workshop (The third CLD will be case study Vung Ang Port)

7.) Presentation: Causal loop diagram
Principle of CLD
Sample CLD from Sterman

8.) Presentation:
Causal loop diagram workshop

9.) Create CLD
From the main factors, this already selected from the start to create the CLD.
Each group require discussing and creating their own CLD base on their knowledge.

10.) Continue CLD
Paper poster and marker will provide for CLD presentation

11.) Participant present their CLD
Each group will have 10 minutes to present their CLD and let other group to comment

12.) Discuss and summaries outcome
Leader will discuss with participants and summaries outcome for final CLD

However, before the interview, participants will receive basic knowledge about system dynamic and CLD. This is to help participatory understanding the diagram flow and be able to participate in create a new model.

k) Causal loop diagram

Examples of CLD by William Rushing have been select to present in this focus group Figure 1, which have clearly step of creating CLD. Other finished CLD sample that relate to transport such as general traffic jams CLD Figure 2, System dynamics model of population and travel demand by Jay Forrester System dynamics model of population Figure 0-3 and other CLD by Sterman etc.

However, the CLD that will be select to present for CLD workshop might be change to Sterman CLD.

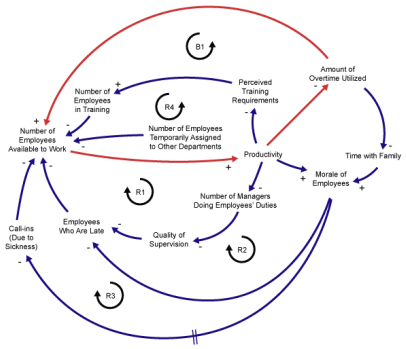


Figure 0-1

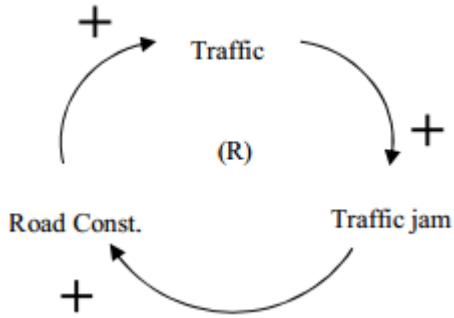


Figure 0-2: General traffic jams

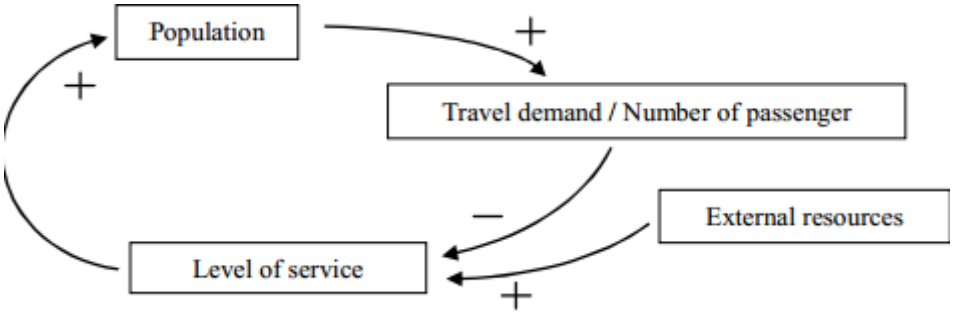


Figure 0-3 System dynamics model of population

5. Interview

l) Introduction interview guideline

Set up Interview guideline sheet table for interview; even have planning to record the interview on tape or video. However, is also depending on how participate free for the interview or can be optional to interview more than once. The interview will be separate to two main targets:

- One is unfeasible to include any systems thinking or SD modelling activity, which are the policy maker, private company and transport sector.
- Second is including CLD and SD modelling which will let the interviewee take part of the rebuilding new model, these methods will be using for academic people who interested and prefer to give more information after focus group workshop.

m) Interview guideline

Table 0-1: Interview guideline

Hello, my name is Daosadeth Soysouvanh, and I interest to interview you for my PhD research.

During the interview, I would like to discuss the following topics: Lao transportation, Freight, transport policy, import/export problem border crossing etc.

Main questions	Additional questions	Clarifying questions
• Can you tell me about the Lao transport issue encountered in your area? or • Which transport problems affect your area?	• How did you learn about these problems? • Why is this considered a problem? • Under what circumstances does the problem arise? • What is the scope of the problem? • Which places are most affected by the problem, when does it usually occur and who are the main victims? • Have you noticed any changes in the situation over the past few years? • Which safety problems give rise to complaints? • How do you explain the problem?	• Can you expand a little on this? • Can you tell me anything else? • Can you give me some examples?

• Generally speaking, are people satisfied with the services/strategies/policy offered by the government?	• Why?	• Can you expand a little on this? • Can you tell me anything else? • Can you give me some examples?
• In your opinion, how satisfied are people with the import/export system? or • Do you know of any groups who are dissatisfied with certain services/strategies/policy?	• If not, what are the main problems that you have witnessed or heard about?	
CLD question		
• Start with loop (1), what clarify about this influenced, how much you agree or disagree with the causality and polarity links? • Compare to the general CLD, how much you agree or disagree with causal link of Lao CLD	• What is your comment/argument on this loop? • If you disagree what will you change?	• Can you give me some examples?
Conclusion of interview		
• Are there any other transport/freight problems that we have not discussed and that you find worrisome? or • Do you want to add anything on transport/freight policy?		

n) Interviewing cross cultures

Even, this project area is in Laos, where the researcher is native-born. However, there are some international participants such as UNDP, ADB, etc. The awareness of this cultural differential with High-context cultures employ high context communications in which information is either represented by the physical context or internal to the person (Harris & Moran, 1993). In other words, it involves unwritten rules that can cause misunderstandings (Hall's Cultural Factors, 2009). Besides, Lao culture is quite familiar with Japanese, Chinese and many Arab countries are cultural examples of where messages are highly coded and implicit (Munter, 1993).

o) Several techniques for interview

Certainly, when designing an interview question, it is validated to get mush information about the study phenomenon as much as possible. However, several researches suggest that is usually finest to start with easily question and then continue to more sensitive or advance question respectively, Britten (1991). Moreover, in qualitative interview, good question mush avoids yes/no answer, be more neutral, sensitive and understandable, Britten (1991). More interview technique such as published guide by Quebec in Appendix (1). Robyn (2010) instructs where to meet to conduct the interview, recording and transcribing discussions and ethical issues.

p) Prepare causal loop diagram for participatory discuss model build

The CLD will be represent in three separate diagrams, first is the general landlocked transport issues, second is Lao transport issues, which adapted from the first diagram. Last diagram will be the case study of Vung-Ang Port in Vietnam. Overall, those diagrams will be representing all the factors and policies relating to generic landlocked countries, and highlight causes and effects from particular factors in a high-level causal loop diagram base on originally developed by Jay W. Forrester. Together, the participatory will have opportunity to discuss to build the new model with researcher or even create his or her own model.

However, participant might want to continue their CLD, which bring out from the focus group and discuss with the researcher.

q) Contract participation

Traditionally in Laos, to meet and arrange meeting with person whom have high figure is complicated and needed connection to asking permission. However, several procedures will be setup to avoid cultural risks.

- First Contract (informal contract, introducing)
  - Sending representative to inform participation for interview
  - Contract by personal message to inform participation for interview
- Formal contract by mail
  - Sending research abstract
  - Sending Interview question
  - Sending interview permission
- Arrange first visit
  - Mail for arrange meeting
  - Phoning for arrange meeting
- Visiting
  - Hand in hard copy research/ interview question
  - Arrange interview / discuss model build
  - Hand in Confidentiality and Anonymity contract
- Interview/Discuss model build

r) Letter/document requirement for interview

- Risk assessment
- Ethical approve
- Confidentiality and Anonymity contract
- National University of Lao approve (Option)
- Professor letter (Option)

s) Process for participatory discuss model build

- Sending abstract and aim of research
- Sending question area
- Sending causal loop diagram basic guideline
- Sending the first general CLD of landlocked transportation
- Sending the second CLD of Lao transportation
- Showing the general CLD of landlocked and the adapted to Lao CLD during the interview
- Asking participation point of view about the second CLD been adapted.
- Requesting participatory to build or suggest the third CLD base on their notion.

t) Published Guide to Organizing Semi-Structured Interviews with Key Informants by Québec

Conducting interviews: a few tips

- Start the interview with a general, open-ended question.
- Ask as few questions as possible; the respondent should do most of the talking.
- Referring (anonymously, of course) to statements made in other interviews or to findings based on other data sources can a good way to encourage respondents to express themselves. It is also useful for validating information already gathered.
- Respect the respondent's pace and do not be afraid of pauses or silences.
- Interviewers should not judge what respondents say. They must keep the interview focused on the topics previously defined (see the section "Key informant semi-structured interview plan – Instructions for use), refrain from suggesting answers and be careful not to ask leading questions.
- Be careful not to ask closed questions that leave respondents no room to elaborate and that can slow the interview's pace.
- Be sure to cover all of the pertinent topics included in the interview plan.
- Ask clear and direct questions such as How? Where? When? Who? What? Why? How much? How many?
- If necessary, formulate questions so that informants answer on behalf of the people they represent.
- Listen carefully to all answers and ask more questions to obtain additional information.
- Ensure that key informants thoroughly understand each question.

a. Participant Contract Sheet

Focus Group: Lao transport and policy

Participant Name and address	Email address	Phone Number	Contact Notes	Yes	No	Reminder Phone Call	Confirmation Letter	Thank you Letter
1.)								
2.)								
3.)								
4.)								
5.)								
6.)								
7.)								
8.)								
9.)								
10.)								
11.)								
12.)								
13.)								
14.)								
15.)								
16.)								
17.)								

6. Document Form

u) CONSENT FORM

An Analysis of Landlocked Country Transportation Policy through System Dynamics Modelling:

The Case of Lao PDR

FOCUS GROUP

Researcher: Daosadeth Soysouvanh, PhD researcher from Leeds University, UK, tsds@leeds.ac.uk

Researcher's Statement

I am asking you to participate in a focus group for the PhD research. The purpose of this consent form is to give you information you will need to help you decide whether to participate. Please read the form carefully. You may ask questions about the purpose of the focus group, what I would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the focus group or the form that is not clear. When all your questions have been answered, you can decide if you want to participate or not. This process is called ''informed consent.'' I will give you a copy of this form for your records.

PURPOSE AND BENEFITS

Landlocked countries are economically disadvantaged in term of transport position compared to their maritime neighbours. This research takes the case of Lao PDR to explore what are the key problems of landlocked countries. The research starts by using the high-level causal loop diagram to demonstrate the factor to find the effects and to capture the mental models of individuals' factors. The purpose of the focus group is to obtain information from individual Lao transport sectors to conceptualise System Dynamics model. The benefits of participating in the focus group include contributing to the researcher ability to develop and learning new tools method, which will be publishing recommendation for policy maker to improve Lao Freights and logistic provider. Moreover, participation will have opportunity to share their experience and knowledge with other people. However, this research is the fundamental knowledge for building master course by National University of Lao project plan to build human resources and develop new tools.

PROCEDURES

If you choose to be in this study, we would like you to attend a focus group. The discussion will take about 6 hours in two section, morning and afternoon. The focus group questions will centre on your perceptions of Lao transport issues and Lao transport policy in your point of view, which will transmit in to Causal Loop diagram. You will have opportunity to discuss with other participants and cooperate to create your group Causal Loop diagram. However, the morning section will be presenting about the purpose of this research and introduce system thinking and continue to basic knowledge to create the Causal Loop diagram.

I will be taking notes during the focus group, but I would like to audiotape record the focus group so that I can have an accurate record. Only the researcher will have access to the audiotapes, which will be kept in a locked file cabinet. I will use the tapes to compensate for incomplete notes and to ensure accuracy of direct quotes. I will transcribe any quotes I would like to use and then destroy the tapes within 90 days of the focus group. Please indicate your permission below, with your initials, whether you give your permission for the discussion to be audiotape recorded.

☐ I give permission for the researcher to audiotape the focus group discussion

☐ I do NOT give permission for the researcher to audiotape the focus group discussion

RISKS, STRESS, OR DISCOMFORT

Although it is unlikely that there will be any risk, stress, or discomfort involved in the focus group, some people feel uncomfortable participating in focus group or fell that being in a study is an invasion of privacy. I will do all that I can to make you feel comfortable, but at any time you may withdraw from the study without any risk to you.

OTHER INFORMATION

Taking part in this study is voluntary. You may refuse to participate or may withdraw at any time without penalty. All of the information from this study will be confidential, and only the researcher will have access to any identifiable

data. The report will not identify you or your name, but will provide general findings and suggestions for improvement. However, the researcher cannot safeguard against focus group participants sharing information learned from the group with outsiders. We ask that focus group participants keep information that has been shared with the group confidential to ensure individuals' privacy.

Printed name of researcher Signature of researcher

Date

Participant's Statement

This study has been explained to me and I volunteer to take part. I have had a change to ask questions, but if I have question later on, I can ask the evaluator listed above. If I have question about my rights as a research participant, I can call the <Phone number> I will receive a copy of this consent form.

Printed name of participant Signature of participation

Date

a) CONSENT FORM for focus group

(The original letter translated in to Lao)

b) Consent form for interview

(The original letter translated in to Lao)

CONSENT FORM FOR INTERVIEW

An Analysis of Landlocked Country Transportation Policy through System Dynamics Modelling:

The Case of Lao PDR

Researcher: Daosadeth Soysouvanh, PhD researcher from Leeds University, UK, tsds@leeds.ac.uk

Researcher's Statement

I am asking you to participate in an interview for the PhD research. The purpose of this consent form is to give you information you will need to help you decide whether to participate. Please read the form carefully. You may ask questions about the purpose of the interview, what I would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the interview or the form that is not clear. When all your questions have been answered, you can decide if you want to participate or not. This process is called ''informed consent.'' I will give you a copy of this form for your records.

PURPOSE AND BENEFITS

Landlocked countries are economically disadvantaged in term of transport position compared to their maritime neighbours. This research takes the case of Lao PDR to explore what are the key problems of landlocked countries. The research starts by using the high-level causal loop diagram to demonstrate the factor to find the effects and to capture the mental models of individuals' factors. The purpose of the interview is to obtain information from individual Lao transport sectors to conceptualise System Dynamics model. The benefits of participating in the interview include contributing to the researcher ability to develop and learning new tools method, which will be publishing recommendation for policy maker to improve Lao Freights and logistic provider. However, this research is the fundamental knowledge for building master course by National University of Lao project plan to build human resources and develop new tools.

PROCEDURES

If you choose to be in this study, we would like you to attend an interview. The discussion will take about 1-2 hours. The interview questions will centre on your perceptions of Lao transport issues and Lao transport policy in your point of view.

I will be taking notes during the interview, but I would like to audiotape record the interview so that I can have an accurate record. Only the researcher will have access to the audiotapes, which will be kept in a locked file cabinet. I will use the tapes to compensate for incomplete notes and to ensure accuracy of direct quotes. I will transcribe any quotes I would like to use and then destroy

the tapes within 90 days of the interview. Please indicate your permission below, with your initials, whether you give your permission for the discussion to be audiotape recorded.

☐ I give permission for the researcher to audiotape the interview discussion

☐ I do NOT give permission for the researcher to audiotape the interview discussion

RISKS, STRESS, OR DISCOMFORT

Although it is unlikely that there will be any risk, stress, or discomfort involved in the interview, if you feel uncomfortable participating in an interview or fell that being in a discussion is an invasion of privacy. I will do all that I can to make you feel comfortable, but at any time you may withdraw from the participant without any risk to you.

OTHER INFORMATION

Taking part in this study is voluntary. You may refuse to participate or may withdraw at any time without penalty. Data will be stored securely, and unless you state otherwise your name will not be used in reports using that data. Since we are talking to you in your professional capacity, it is possible that you may be identifiable in reports. [if applicable] If you choose, we can discuss further steps to pressure confidentiality, for instance by avoiding quotes or generalising reported information.

Initial the box if you agree with the statement to the left

1) I confirm that I have read and understand the information sheet/letter explaining the above research project and that I have read the questions in advance of the interview. I confirm that I have had the opportunity to ask questions about the project. ☐

2) I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. *Mail tsds@leeds.ac.uk UK phone: +44 07591379584* ☐

3) I understand that the data collected from my participation will be used primarily for a PhD thesis, and will also be used in ☐

summary form for journal publication, and I consent for it to be used in that manner.

4) I give permission for members of the research team to have access to my anonymised responses. ☐

5) I understand that a pseudonym of my choosing which reflects my professional position will be used when presenting my responses in any report or publication emerging from the research ☐

   If agree, you have my permission to

   Use my real name: _____

   Use a pseudonym: _____

6) I allow to be identifiable with other participants ☐

7) I am indicating my consent to participate in the research. I will inform the principal investigator should my contact details change. ☐

Printed name of researcher Signature of researcher

Date

Participant's Statement

This study has been explained to me and I volunteer to take part. I have had a change to ask questions, but if I have question later on, I can ask the evaluator listed above. If I have question about my rights as a research participant, I can call the <Phone number> I will receive a copy of this consent form.

Printed name of participant Signature of participation

Date

Inviting Applicants for Interview

Inviting Applicants for Interview

Daosadeth Soysouvanh, PhD
researcher from Leeds University
(tsds@leeds.ac.uk)

Date

Name of applicant

Address

Dear …..

I write to invite you to attend for an interview for PhD research data collection on …….. (Insert date). The interview will take place in your office or any place where you satisfy.
The interview panel will consist of transport issues and policies in Laos. The interview should last for approximately 60-120 minutes. Please telephone …….. or mail *tsds@leeds.ac.uk* if you have a problem on the day.

Lao transport issues and policies it difficult to find publishing information. This interview is designed to gather your input concerning the knowledge and point of view about Lao transport issues, Lao transport policy and plan solution. By understand these needs, I can develop model that can expression what are the main specific causes that make landlocked countries lag behind the maritime countries. The information you provide will also assist the research to publish recommendation solution for policy maker to improve Lao Freights and logistic provider.

Please confirm your attendance by contacting Daosadeth Soysouvanh (Phone number). If you have any specific access needs please do not hesitate to contract and discuss, so that we can make reasonable adjustments to enable you to attend and take part in the interview.

Yours sincerely

Name

Daosadeth Soysouvanh

c) Confirm letter focus group

(The original letter translated in to Lao)

Confirm letter

Name and address of the participant

Date

Dear ….

Thank you for agreeing to participate in this focus group. I value your views and opinions.

Lao transport issues and policies it difficult to find publishing information. This focus group is designed to gather your input concerning the knowledge and point of view about Lao transport issues, Lao transport policy and plan solution. By understand these needs, I can develop model that can expression what are the main specific causes that make landlocked countries lag behind the maritime countries. The information you provide will also assist the research to publish recommendation solution for policy maker to improve Lao Freights and logistic provider.

Location: Faculty of Engineering, National University of Lao

Sokpaluang Campus, Sisattanak District

Vientiane, Lao PDR

Date: Day, August 2014

Time: 9:00 a.m. to 15:00 p.m.

Please remember that this meeting will be recorded and your comments may be included in the final report and publishing. The identity of all meeting participants will be kept confidential.

I look forward to meeting with you on (Date). If you have any question, please call me at (Phone number)

Sincerely,

Daosadeth Soysouvanh

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