Proceedings of the Eastern Asia Society for Transportation Studies, Vol.11,2017

A Total Logistics Cost Model for Detailed Impact Assessment of Freight Transport Management Measures – Using the Example of the Vietnamese Rice Production and Logistics

Binh NGUYEN THI [a]

[a] *University of Transport and Communications, Hanoi, 084-04, Vietnam*
[a] *E-mail: ntbinh1907@gmail.com*

Abstract: The concept of freight transport management is perceived as an aspect of traffic management that has a significant influence on freight transport. There are lots of methods that could be utilised to measure the impacts of freight transport management. This study presents a total logistics cost model for a detailed impact assessment of freight transport management. Such a model allows detailed understanding of sector knowledge of structure, stakeholders involved and stakeholder decision-making behaviours, which are key underlying factors requiring consideration in the analysis of core effects. The Vietnamese rice industry will serve as an example for using the total logistics cost model to assess the core effects of freight transport management initiatives. Following this detailed analysis, traffic, economic, safety and environmental benefits can be estimated at the rice sector level and transport network level.

Keywords: Freight transport management, total logistics cost, impact assessment

1. INTRODUCTION

There are strong interactions among the three sectors of production, logistics and traffic, especially in the context of global supply chains. Decisions made in one sector often have impacts on the others. A review of relevant literature gives descriptions of numerous FTM measures and their impact assessment methods. The assessment method utilised during the planning process stages for estimating these impacts should be based on the type of measures being reviewed, and on the sector under consideration.

The objective of this study is to present a total logistics cost model (TLC) for the detailed impact assessment of freight transport management (FTM) measures on production, logistics and traffic. The rice industry in Vietnam was selected to be a case study for this application since data is available to test various kinds of impacts caused by FTM measures. Additionally, there is a high level of freight traffic with a bundle of FTM measures applied in the rice industry. Traffic volume due to rice transport is increasing quickly and contributes up to 21% of the total freight traffic volume on some key transport corridors, for example from the Mekong Delta to Ho Chi Minh City (HCMC). Vietnam is also currently the second largest rice exporter in the world. The rice industry involves various stakeholders such as farmers, collectors, millers, polishers, food companies, wholesalers, retailers and so forth, and knowledge of the decision-making behaviour of those stakeholders is needed to predict their reactions to FTM measures.

2. LITERATURE REVIEW ON IMPACT ASSESSMENT METHODS FOR FTM MEASURES

From the literature review, many attempts have been made to develop methods for carrying out effective impact assessment on transport policies or measures. The selection and application of a particular method much depends on the purpose of assessment, the socio-economic context, available budget, available data and other factors. For this study, before reaching to TLC model to assess quantitatively the impacts of FTM measures, it is necessary to identify and examine comprehensive and innovative existing impact assessment methods employed in the freight transport sector.

2.1 Categorisation of impact assessment methods for FTM measures

It is apparent from the literature review that the methods used to assess the impacts of FTM measures are diversified. These methods can be classified by their purpose, their objects, or their scope. In his research on the development of methodologies for the assessment of dynamic (road) traffic management strategies, Fornauf, L (2015) classified different assessment methods based on transport planning process defined by the German Road and Transport Research Association (FGSV, 2010a). In principle, these methods can be assigned to one of three groups: formalized, semi-formalized and non-formalized assessment methods. With formalized or standardized assessment methods, quantitative results are provided which allow a direct comparison between different alternatives. For non-formal methods, the assessment is evaluated on an argumentative and qualitative level. The semi-formalized methods, ultimately, are a hybrid of the two methods described above, in which, for example, different alternatives are compared based on individual criteria, and consequently, a plausible basis for decision-making can be generated. The degree of mathematization increases with the degree of formalization.

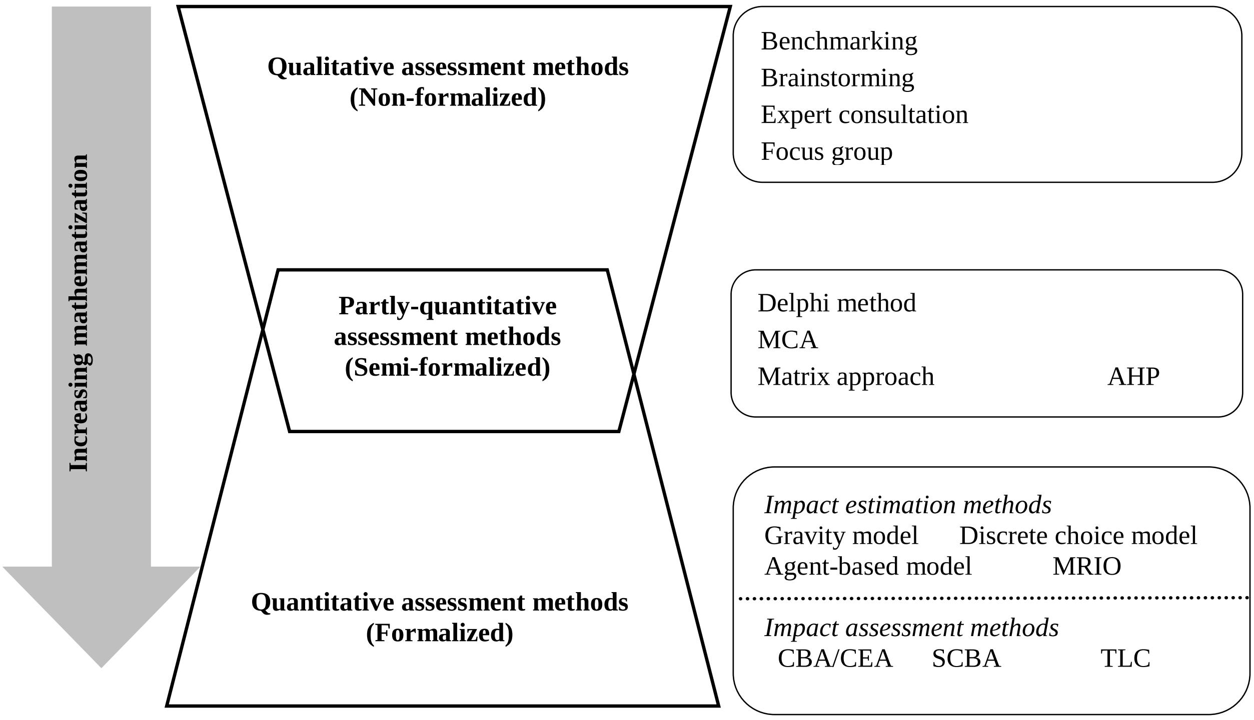


Figure 1: Categorisation of FTM impact assessment methods

Explanations

SWTO	Strengths-Weakness-Opportunities-Threats	**CEA**	Cost-Effectiveness Analysis
AHP	Analytical Hierarchy Process	**SCBA**	Social Cost-Benefit Analysis

MCA	Multi-Criteria Analysis	**TLC**	Total Logistics Cost
CBA	Cost-Benefit Analysis	**MRIO**	Multi-Regional Input-Output

Source: Adapted from Fornauf, L (2015)

Building on the work of Fonauf, L (2015), assessment methods for FTM measures, in this study, are categorised by data generated in the research process. Specifically, they are divided into three groups: qualitative; partly-quantitative, and quantitative methods. The qualitative assessment methods are mostly based on data stated in prose or textual form while quantitative assessment methods tend to use data in the form of numbers. Partly-quantitative assessment has similarities with qualitative methods in regards to data collection but then goes on to provide numerical values or scaling for the qualitative data when conducting the impact assessment.

Figure 1 summarizes impact assessment methods which have been applied in the freight transport sector and identified in the literature review. Within the context of freight transport, qualitative approaches have shown the most advantage in their ability to assess complex issues through relatively simple structures. In particular, most qualitative methods such as brainstorming, expert survey or focus group discussion accommodate extensive involvement of stakeholders in the impact assessment process, which enables a quick highlighting of problems and consideration of a wide range of potential impacts. Partly-quantitative methods involve both qualitative and quantitative data analysis. This means that these methods incorporate a combination of subjective judgments and quantitative estimations in the assessment process. Therefore, their first advantage is the potential ability to provide sound reasoning for an impact assessment. Secondly, most of these methods employ rigours mechanism for comparing and assessing data, which is useful for the process of pre-selection of measures. A review of the application of quantitative assessment methods has shown that they can actually be performed on different aspects of policy under assessment. Specifically, gravity model discrete choice and agent-based models are seen as disaggregate approaches focusing on detailed analysis of stakeholder behaviours, which could be utilised to estimate the impacts. Other methods like CBA, CEA, SCBA, and TLC model deal with the detailed quantitative level of costs and benefits possibly caused by freight transport activities, which are useful in assessing impacts in terms of economic efficiency, hence can provide transparent results that are easily communicated.

To sum up, the assessment method utilised for estimating these impacts should depend on planning process stages, on the type of measure, and on the sector considered. Qualitative methods typically allow quick classification of measures to be adopted and their potential impacts, but they do not provide precise analysis of those impacts. Quantitative analysis of the core effects of policy intervention can, however, overcome some of the limitations associated with the qualitative assessment processes, but data availability and overall efforts required are usually critical. Partly-quantitative assessment is in some ways more useful in the first stage of an assessment when policy measures are ranked in terms of importance, generating a list of potential measures for further detailed analysis. Nevertheless, these approaches do not sufficiently explain causality.

2.2 Total logistics cost model

The total logistics cost (TLC) model is an application of microscopic analysis in the impact assessment. Theoretically, total logistics cost is the sum of transport cost, handling cost, inventory cost and any other costs of doing business with a particular mode of carriers. Many innovative models are based on choices associated with total logistics cost rather than just transport cost only. For example, Sheffi et al ‘s (1988) model was developed to look at mode choice from the shippers’ point of view, based on EOQ-type optimal trade-offs between inventory carrying costs and transportation cost. Also, using this model, one can easily see the impact of, for example long transit time or unreliable service on shippers’ inventory cost. More recently, Chow (2007) attempted to develop a TLC model to assess the potential impacts of security initiatives or other supply chain improvements to a particular routing and gateway alternative.

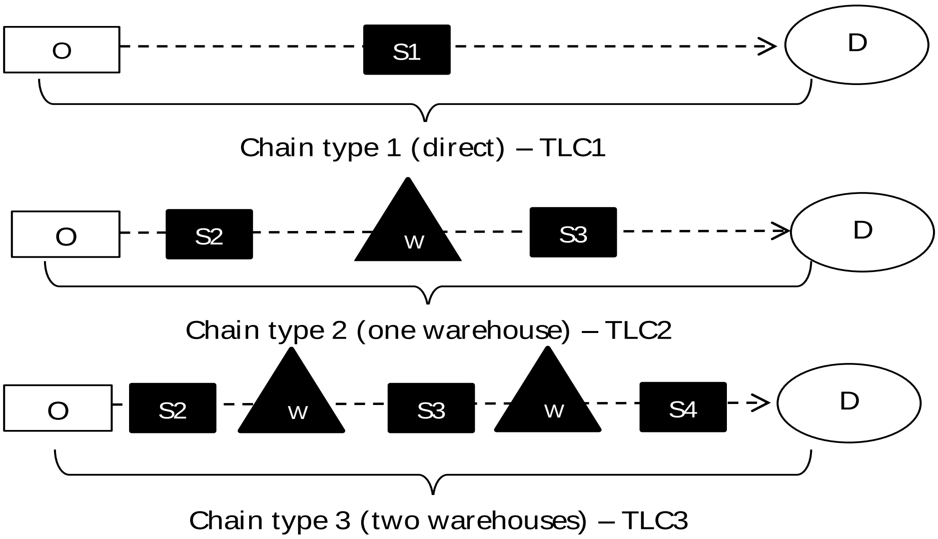


Figure 2: Example of TLC model for impact assessment of changes in logistics and transport systems on distribution structures

Notes: O – Origin; D- Destination; S- Segment; W-Warehouse
Source: Tavassy et al. (2014)

The ADA (aggregate-disaggregate-aggregate) model given by Ben-Akiva & de Jong (2008) also bases the choice of transport chain (number of stops, mode and vehicle type, and terminal used) on lowest total logistics cost. Davydenko et al. (2012) published research results for estimating freight flow generation using a discrete choice model based on total logistics costs at sectorial level.

In his research, Davydenko et al. (2013) divided transport chains into different segments, and took into account value of time (VOT), transport mode and transport tariffs for each segment in estimating TLC. The changes in TLC are assumed a main driver for changes in behaviours of shippers as a result of policy intervention. The results of this study imply that using TLC model, the impact of regulatory changes can be quantified and causality identified. The imperative for access to detailed data, however, is one of biggest limitation of this approach.

For this study, the Vietnamese rice industry will serve as an example for the assessment of the core effects of FTM initiatives. In this context, TLC could be very useful for carrying out detailed impact analysis in the rice industry. This is because it enables differentiation of a disaggregate population of rice commodity flows and distribution locations. More specifically, it accommodates taking into account mode and route choices for each rice commodity flow. Based on this understanding, the impacts of FTM policy changes can be captured at a disaggregate level. The TLC model will be further explained and applied in more detail in a later part of this study.

3. METHODOLOGY

The research flow of this study is presented in Figure 3. It consists of a literature review, surveys, observations, and comprehensive quantitative analysis in a specific sector. The research flow starts with collecting data from a broad range of literature on FTM measures and their impact assessment method to define the objectives as well as the scope of the study. An attempt has been made to compare and assess different approaches for assessing the impact of FTM measures. The analysis shows the gaps in existing assessment methods and their practical application. Consequently, the study presents TLC model as a key method by which the core effects of FTM measures can be identified and economic, safety and environmental impacts can be estimated.

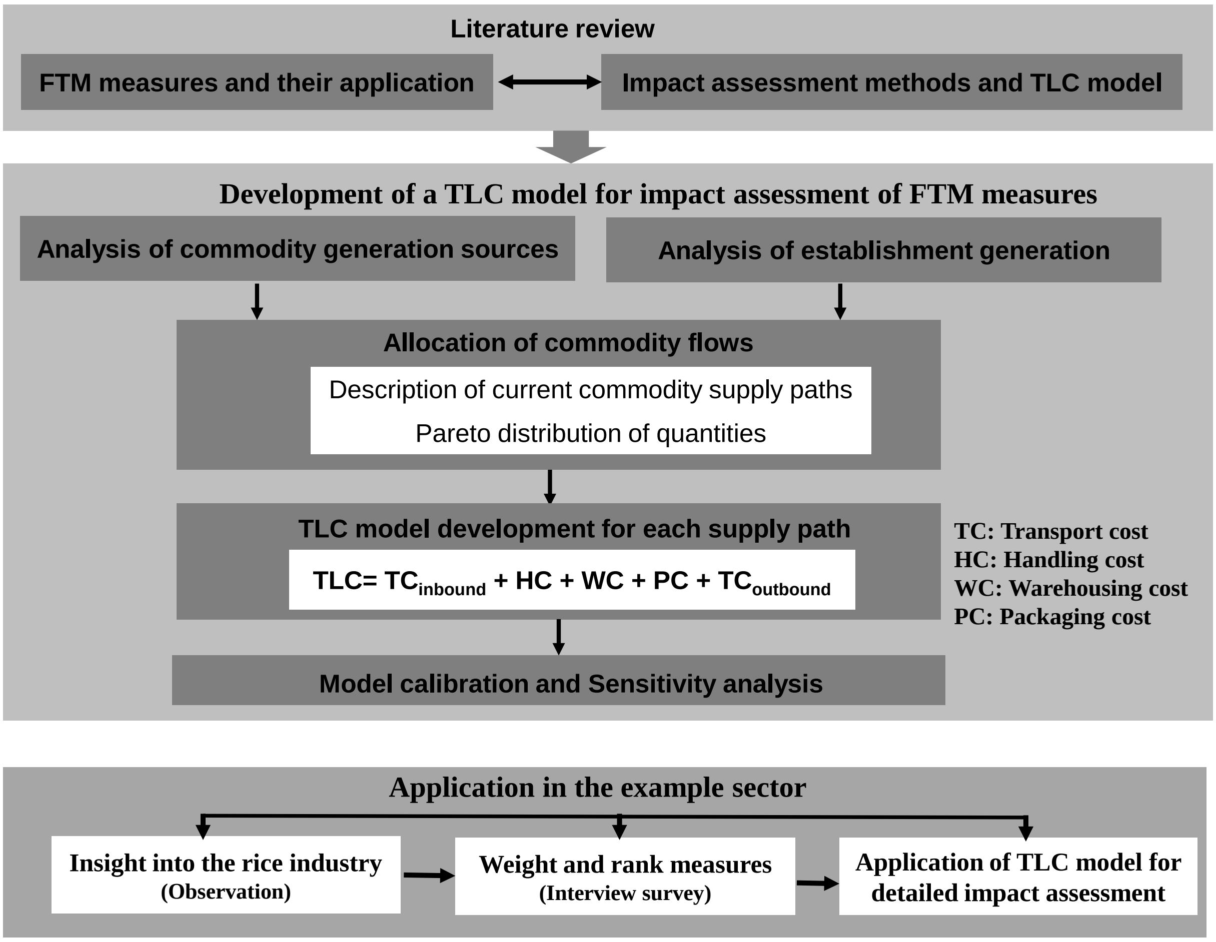


Figure 3: The research flow of the study

Notes: The locations between which goods are transported are establishments belonging to companies or households (Fiedrich, H., 2010)

The study takes the Vietnamese rice industry as an example for the application. Surveys and observations are employed to investigate current practices in the chosen example sector (rice production and logistics). In order to examine the rice supply chain, the study conducted practical data collection/survey/discussion with the key units (public and private) involved in production, transportation, processing, storage, consumption and export in the Mekong Delta. There were nice largest food companies from VINAFOOD 2, ten big IWT and road companies, and two regional port companies participating in the interview process. The main content of the questionnaire focused on areas including rice procurement, rice distribution, transport modes, transport routes, distance from suppliers to customer; typical frequency, delivery mode or lead time, and logistics cost.

In addition, to deal with some challenging issues facing the rice freight transport; various traffic management measures have been considered and applied. In order to weight and rank the importance level of these measures, the study conducted an expert survey. Three groups of experts were selected to complete questionnaires. The first group included ten experts coming from freight transport companies and LSPs in the rice industry. Though their works, this group are experience first-hand the conditions of the rice transport and logistics. The second group consisted of five big shippers who are food companies in the rice industry. The last group was comprised of five traffic management experts who have been working for more than five years as transport decision-makers for transport authorities in HCMC and in the Mekong Delta. These people also have a wide range of experiences in introducing traffic management system in major cities in Vietnam. The questionnaire was designed to get experts' opinions about the effectiveness and applicability of the FTM measures in the context of the Vietnamese rice industry.

4. RESEARCH RESULTS

This section will focus deeply on presenting the results of TLC model application in assessing the impacts of FTM measures in the Vietnamese rice industry. This model starts with analysing the generation of sources of rice in the Mekong Delta and the generation of establishments in HCMC. Then, analysis of the allocation of rice commodity flows from the Mekong Delta to Hochiminh City (HCMC) is carried out, taking into consideration mode and route choices for each rice commodity flow. Accordingly, the TLC of different transport mode choices will be estimated. Expected modal shift under the intervention of the scenarios will be based on an optimization of TLC for the individual rice commodity flows.

4.1 Overview of the Vietnamese rice industry

4.1.1. Rice production

The rice industry in Vietnam is distributed across six basis economic zones - the Red River Delta, the Midland and Northern Mountains, the North Central and Central Coast, the Central Highlands, the Southeast and the Mekong Delta. The contribution of each region to the country‘s total rice production is presented in Figure 4. The Mekong Delta, as the chart indicates, is the most important region for rice production, contributing over 50% of the total rice volume in Vietnam and 90% of the country‘s rice exports.

The Mekong Delta is located in the lower reaches of the Mekong River, which includes thirteen provinces and cities with nearly four million acres of land used for agricultural purposes, 700 km of coast line, 400 km of border and hundreds of islands. The population of the whole region is over 17 million, accounting for 20% of the total population of the country. This region contributes about 50% of total food production, including 90% of the rice export volume, 70% of fruit production, 52% of seafood output and 20% GDP of the whole country (SIWRP, 2011).

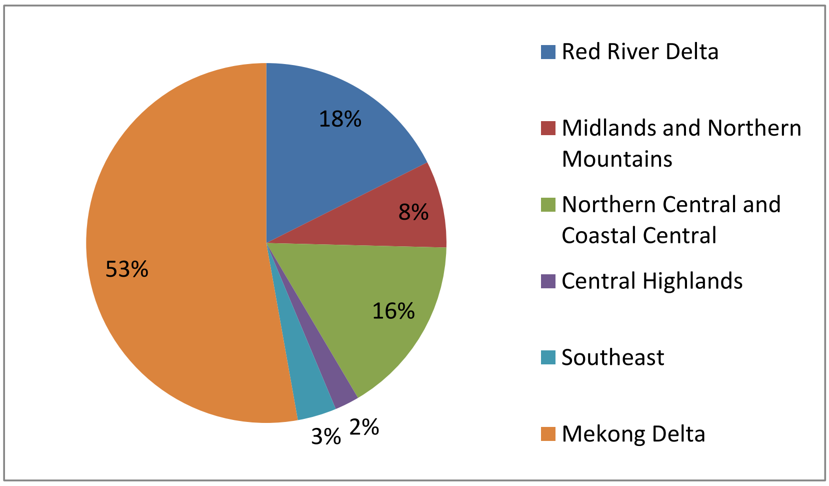


Figure 4: Rice production by region in Vietnam, 2014

Source: GSO (2015)

4.1.2. Rice supply chain

There are two kinds of rice supply chain in the Mekong Delta, domestic and export rice supply chain. Figure 5 shows the relationship among key stakeholders in the rice supply chain.

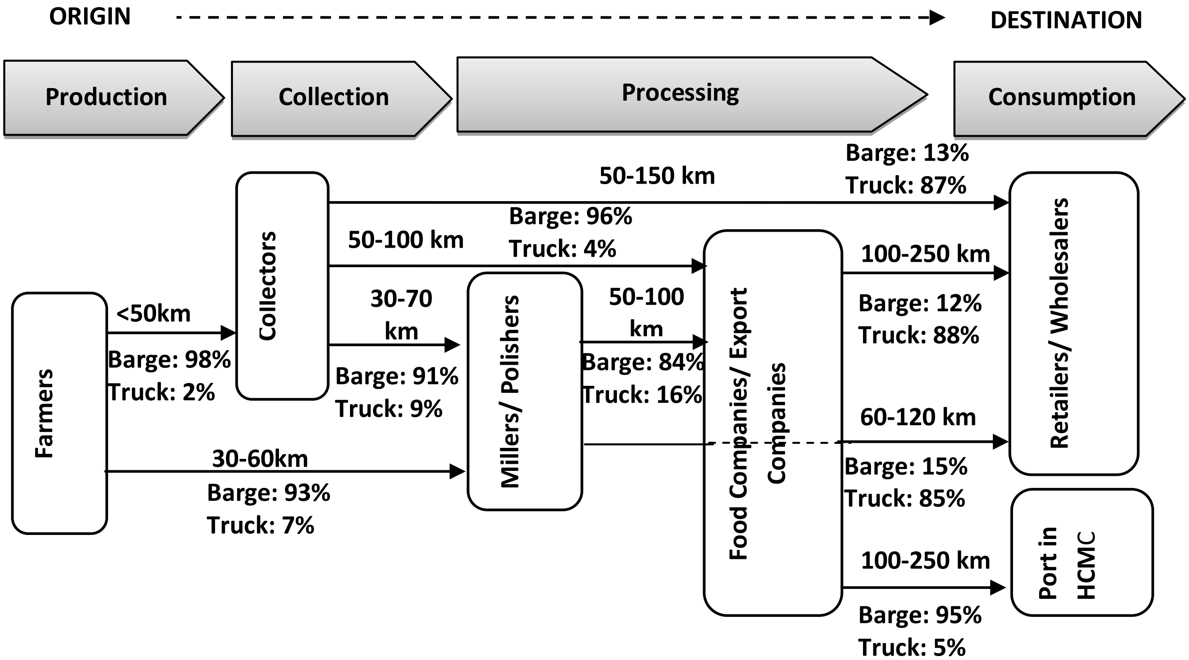


Figure 5: Rice supply chain in the Mekong Delta

Source: Own illustration based on data from Loc (2011)

After harvesting, farmers sell most of unmilled rice to collectors. In the Mekong Delta, collectors are an indispensable component in the rice supply chain. They often use small boats to visit the field and collect the paddy. They then resell the paddy to millers for milling or directly to food companies. Only about 15% of total volume is processed directly by collectors and then transported to wholesalers and retailers for domestic consumption. Once the rice milling and polishing process is finished, rice is either delivered to food/export companies or to domestic wholesalers and/or retailers. Currently, up to 70% of the rice volume produced in the Mekong Delta is for export, with the remaining 30% consumed domestically.

IWT and road are considered main transportation modes in the rice industry. Motorcycles are used mainly for purchasing material inputs such as fertilizers, and pesticides. It becomes apparent that IWT (95%) is very popular in transporting rice to export ports whereas road (88%) is primarily used to distribute rice for domestic market. Currently, the share of IWT and road transportation in the rice industry is 90% and 10% respectively (MOT, 2014). However, road transport forecasts to increase fairly rapidly when the road infrastructure network in the Mekong Delta is significantly upgraded in the period 2020-2030.

4.1.3. Freight transport management in the rice industry

To solve the increasing problems of freight transport problems in the Mekong Delta, various traffic management measures need to be considered and applied. Table 1 presents a compilation of management measures that have already been applied and considered to be potential measures.

Table 1: Compilation of FTM measures in the context of the rice industry

List of FTM measures in the rice industry		Level of application
M1	Regional rice logistics center in Chau Thanh A (Hau Giang province)	Potential
M2	Major markets for rice/paddy in Can Tho, Long An, and Tien Giang provinces	Potential
M3	Prohibition of trucks entering HCMC from 6:00 am to 12:00 pm	Already
M4	The establishment of centralized areas for e paddy production	Already
M5	Co-operation between collectors and millers and export companies	Already
M6	Improvement of NH 1A from the Mekong Delta to HCMC	Potential
M7	Restricting overloaded trucks on the highway from the Mekong Delta to HCMC	Already

Source: Own compilation from JICA (2010) and MOT (2014)

For efficiency reason, it is not appropriate to do impact assessment of all measures. Therefore the study did an expert interview survey to weight and rank the importance level of these measures. Particularly, the results of the weighting and ranking step have revealed that a high rating was given to the following FTM measures: **the establishment of a regional rice logistics centre (M1) and NH 1A improvement (M6)**. Building on this, three scenarios can be set-up for impact assessment. **The first scenario** is if only a new regional rice logistics centre is established. It should be noted that this logistics centre is reserved only for rice products as the directive on promoting the rice industry of the government. **The second scenario** is the improvement of NH1A. **The third scenario** is the combination of the two measures above.

4.2 Detailed impact assessment

4.2.1. Rice generation sources

The sources of rice in the Mekong Delta are defined based on data from GSO under People Committees in the Mekong Delta and Vietnam Food Association (VFA). GSO provides data in an aggregate form; examples are total rice outputs and aggregate distribution flows from the Mekong Delta to other regions. Data from VFA focuses on the statistics of rice volume for each FPEs and food companies. Most of these FPEs are the members of the VINAFOOD 2. In some cases, both data sources can be compared to check consistency. The location of rice generation sources is noted on the map of the Mekong Delta.

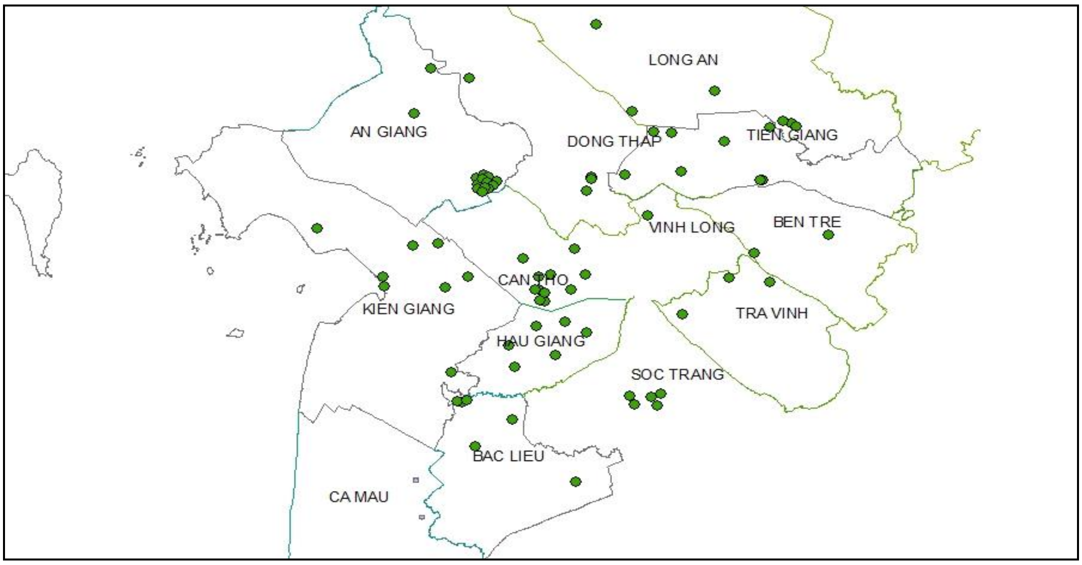


Figure 6: Locations of key rice sources in the Mekong Delta

● Key rice source

Source: Own illustration

It can be seen that key sources of rice are concentrated very much in An Giang, Kien Giang, Long An provinces, and Can Tho city. These provinces are seen as “rice bowls” of the Mekong Delta.

4.2.2. Generation of establishments in Ho Chi Minh City

As mentioned in the previous section, HCMC is the biggest consumption market for the Mekong Delta rice. Therefore, the analysis will focus more on rice transport from the Mekong Delta to establishments in HCMC. Friedrich (2010) describes the establishments as the locations between which goods are transported. Establishments belong to companies and represent the locations where companies are active. In this study, establishment can be wholesalers, distribution centres and warehouses of food companies in HCMC.

For generating data on establishments, the study employed the statistics of freight and warehousing companies located in HCMC provided by GSO. In Vietnam, GSO often provides the statistics and updates business performance in different fields every year.

There are totally 396 companies doing business in the field of freight transport and warehousing services in HCMC. However, only 107 out of them are related to rice transport and warehousing activities. They can be freight transport companies, warehousing companies, food companies, and so on. Most of them have their own warehouse containing a wide range articles, including rice. The distribution of these establishments is presented in Figure 7.

It can be seen that most establishments are concentrated in specific districts such as Binh Tan District, Binh Thanh District, District 6 and 2. Most districts are located on the West; near the transport corridors from HCMC to the Mekong Delta. For example, Binh Tan District and District 6 border with Trung Luong-HCMC Expressway that connects directly to the Mekong

Delta.

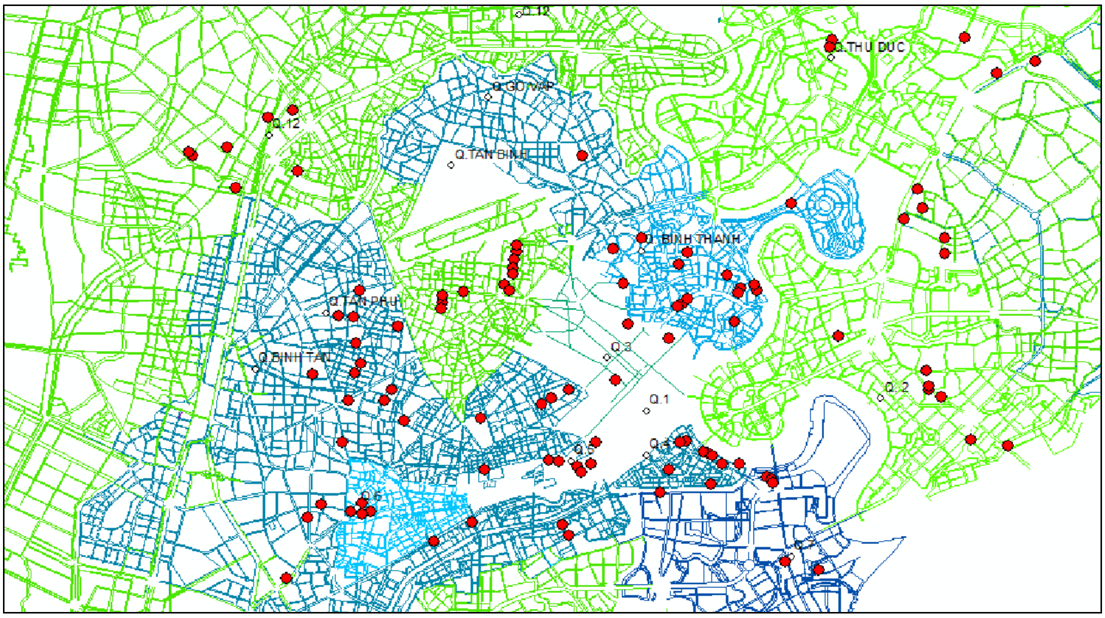


Figure 7: Distribution of establishments in HCMC

● Establishment in HCMC

Source: Own illustration

A problem arises from the fact that these statistics have not shown clear relationship between these establishments and rice suppliers in the Mekong Delta. In particular, we do not know how many rice suppliers in the Mekong Delta each establishment has.

Ten rice suppliers and LSPs were selected to participate in a short interview. Key questions included "*how many customers do you have in HCMC? Where are they? How is the share in volume of these customers*?". The distribution of customers in HCMC is presented in Figure 8.

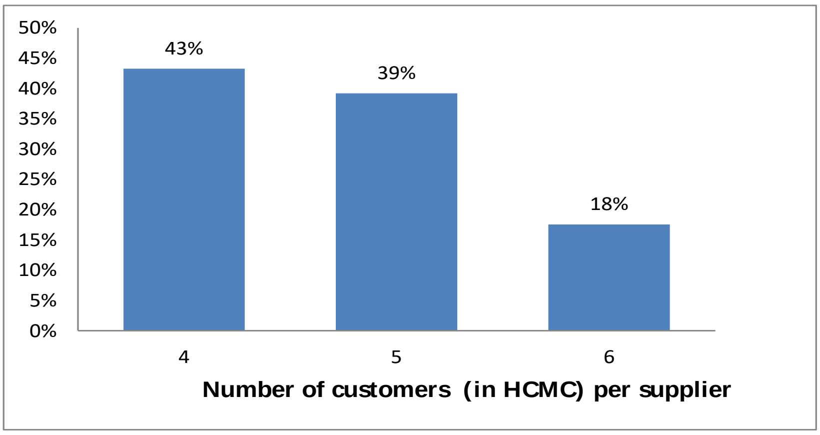


Figure 8: Distribution of number of customers per rice supplier

Source: Interviews carried out by author in February 2015

In general, the number of customers (e.g. food companies, wholesalers, distribution centres) in HCMC depends on the total rice handling volume of each key supplier. Normally, key rice suppliers with annual rice handling volumes from 25,000 to 75,000 tons often have four customers in HCMC. Meanwhile, suppliers with average rice handling volume of

75,000-180,000 tons per year typically have five customers, and suppliers with more than 180,000 tons of rice per year tend to have six customers in HCMC. The number of suppliers having four customers in HCMC makes up the largest proportion among total key rice suppliers in the Mekong Delta.

4.2.3. Allocation of rice commodity flows

The allocation of rice commodity flows involves the following assumptions. Firstly, rice demand in HCMC is met in full provided by suppliers from the Mekong Delta. Secondly, a key rice supplier in the Mekong Delta serves at least four customers in HCMC. A customer, though, involved several rice commodity flows attached to different rice supply paths from the Mekong Delta. However, since the rice demand of a customer is believed to be much smaller than the capacity of a key rice supplier in the Mekong Delta, it is assumed that these commodity flows are allocated to one supplier. These assumptions are reasonable; that is because, as stated above, HCMC is responsible for about 75% of the total rice volume of the Mekong Delta. In addition to this, the statement from the interview survey implies that the number of customers for rice produced in the Mekong Delta is concentrated densely in HCMC, ranging from 4 to 6 customers per supplier.

A Pareto distribution of quantities per supplier is utilised to generate the commodity flows in the rice industry. The cumulated Pareto distribution function is defined by the following formula:

$$F(x) = 1 - \left(\frac{x_m}{x}\right)^{\alpha}, x \geq x_m$$

Where, x_m is a positive minimum possible value of x, called a “scale parameter” and α is a positive parameter, called a “shape parameter”.

For this study, the number of customers per supplier depends on the annual rice handling volume of supplier. Suppliers in the Mekong Delta with high volume would have more customers in HCMC. For each relation of a supplier and one customer a commodity flow is generated. The number of commodity flows is determined proportionally to the number of customers. For each supplier the volume of a commodity flow is determined based on Pareto distribution and the differences in the annual rice handling volumes of suppliers. Shape parameter α indicates these differences. In particular, there are three different shape parameters assuming in this model: α = 1 for suppliers with annual rice handling volumes from 25,000 to 75,000 tons; α = 2 for suppliers with annual rice handling volumes from 75,000 to 180,000 tons; and α = 3 for suppliers with annual rice handling volumes more than 180,000 tons.

In this study, there are 351 commodity flows generated from 74 key rice sources in the Mekong Delta. In fact, rice commodity flows can pass through different supply paths, which incorporate the usage of different stakeholder warehouses, transport modes, reloading points and transport links.

4.2.4. TLC model development

We assume that supply chain managers try to minimize their total logistics cost while maintaining a certain level of service as required by their customers. Therefore, decisions on utilising supply path will be based on total logistics cost (TLC). In particular, given a volume of a commodity flow and distance from key rice generation sources to HCMC, the choice of transport mode or route will be associated with optimizing total logistics costs of individual commodity flows under the supply path i. The total logistics cost function of individual commodity flow is determined on a simple approach as follows:

$$TLC_{cf}^{i} = TC + HC + WC + Pack$$

In which:

TLC_{cf}^{i}	Total logistics cost of a commodity flow under supply path i	WC	Warehousing cost
TC	Transport cost	$Pack$	Packaging cost
HC	Handling cost		

The cost components will be described in different levels of details depending on its influence on TLC. The following text will discuss cost components of TLC in the rice industry.

Total transport cost depends on volume of goods, transport mode used, and transport distance. In particular, the model estimation for **total transport cost of a commodity flow (**$\mathbf{TC_{cf}}$**)** is composed of inbound transport and outbound transport costs.

$$Total\ TC_{cf} = TC_{inbound} + TC_{outbound}$$

As for inbound transport, lot sizes and transport rates are used as input. Due to the geographical characteristics of Mekong Delta River that has an interlacing system of long and narrow rivers and ditches, small boats are often used for the inbound transport. For this study, inbound transport cost per ton is collected through the interview with collectors in the Mekong Delta. The total outbound transport from the Mekong Delta to HCMC has to be modelled in more detail since this influences significantly total transport costs for the whole supply chain. Specifically, the outbound transport cost is determined on a simple approach including **transport cost rate per ton (**$TC_{per\ ton}$**) and the volume of a commodity flow (Q-cf)**

$$TC_{outbound} = TC_{per\ ton} * Q_{cf}$$

Usually, transport cost rate per ton is used in the descriptive analysis of influencing factors on transport cost. This rate can be expressed as a function of fuel cost, crew cost, depreciation cost, repair and maintenance cost, and capital opportunity cost. It is calculated as follows:

$$\begin{aligned} TC_{perton} = {} & \alpha * fuel\ cost + \beta * (crew\ cost\ and\ overhead\ cost) + \gamma * depreciation\ cost \\ & + \delta * repair\ and\ maintenance\ cost + \varepsilon * capital\ opportunity\ cost \end{aligned}$$

Fuel cost

Fuel cost per ton is highly correlated to the size and age of the vehicle deployed, and its average speed. Specifically, the larger the vehicle or vessel, the lower the fuel consumption per unit it is, and the lower the unit transport cost. In addition to size, higher levels of congestion also result in slower speeds and higher fuel consumption and unit transport cost.

For this study, the fuel costs are calculated based on technical fuel consumption rates for each type of vehicle, which is gathered from interviews with transport companies (Binh, 2014) and truck dealers (VITRANSS 2)

Crew cost and overhead cost

Crew cost and overhead cost per km is determined by the monthly crew cost and overhead cost divided by total tours per month. Monthly crew costs are investigated through interview with transport companies (Binh, 2014). Also, overhead costs are estimated as the ratio of total driver costs (about 8%). The daily crew cost and overhead cost are shown in Table 5-15. Based on this, crew cost and overhead cost per ton is estimated corresponding the given transport modes and average load factor of freight transport from the Mekong Delta to HCMC.

Depreciation cost

Depreciation related cost depends significantly on vehicle life and annual operation. This cost is estimated by assuming the percentage of salvage value to vehicle cost and ratios of depreciations subject to use and time. Salvage value data and the life of vehicle are assumed based on interviews with transport companies.

Repair and maintenance cost

The cost of maintenance and repair are calculated assuming the percentage of annual repair cost to vehicle cost. In fact, through the interview with transport companies, annual cost of repair and maintenance is typically ranges from 3%-8% of new vehicle purchase price depending on vehicle size and operation speed.

Capital opportunity cost

Capital costs are calculated based on the economic life of a vehicle, the salvage value, the interest rate and annual operation. With an interest rate of 14% per year, the economic life from 12-15 years and the salvage value of 12%-15%, the capital opportunity costs are 13.39 US$/day and 39.7US$/day for container truck (15tons) and vessel (500 tons), respectively.

Total handling cost (HC) is comprised of the throughout costs driven by the handling cost rate h_c and total quantity of load unit (in tons). The detailed estimation of total handling cost is defined as follows:

$$HC = h_c * Q_{cf}$$

For this study, the handling rates are different depending of the stage in the rice supply chain. For example, the unit handling cost of collectors is generally lower than that of food companies, since collectors often use small and low quality handling facilities. Therefore, the handling rate of the supply chain will be estimated by the sum of unit handling costs corresponding to each stakeholder. Handling rates by road and IWT are different.

The warehousing cost (WS) is proportional to warehousing cost per storing position (wc_{pp}) and is driven by the total commodity volume in stock, while capital costs are driven by the weighted average cost of capital (w_{acc}), the value of a commodity (v_{pc}) and total volume in stock (Q_{cf}^{stock}). The detailed estimation of total warehousing cost is as follows:

$$WC = wc_{pp} * Q_{cf}^{stock} + w_{acc} * Q_{cf}^{stock} * v_{pc}$$

For the rice industry, a food company warehouses can be used to bundle rice flows from different collectors. Cross docking is assumed at collector level, meaning that no storage cost on collector level has to be considered. The data on warehousing cost per storing position is collected from empirical surveys covering a large number of food companies and milling companies in the rice industry, and the effectiveness of one or more level of warehouse structure is discussed based on the optimization of TLC. The warehousing cost per storing position at food companies and millers/polishers are different depending on warehouse technology. Under miler/polisher's management, there are often warehouses responsible for basic functions such as assembling, drying that do need less investment in warehouse technology.

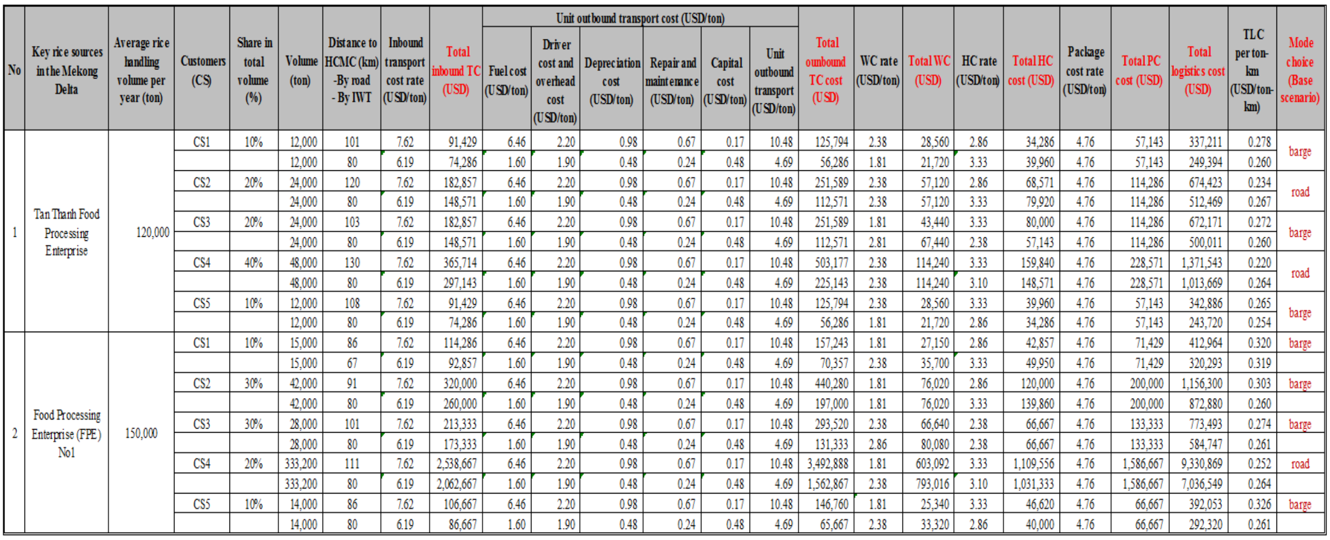
The total packaging cost of a commodity is calculated by multiplying the demand expressed as number of tons (Q_{cf}) with the packaging cost rate PC. This cost has a slightly difference between scenarios as confirmed by the expert survey in Section 4.2. Therefore, the effects of packaging cost are not so high to the change of TLC.

To sum up, the TLC modelled in this study consists of transport cost, warehousing cost, handling cost and packaging cost. The estimation of these cost components are used as input of the TLC model. The changes in TLC are assumed a main factor that determines the modal choice of shippers. The reflected indicator of the TLC model is therefore oriented to TLC per ton-km via different transport modes ($TLC^{i}_{per\ ton-km}$)

$$TLC^{i}_{per\ ton-km} = \frac{TLC^{i}_{cf}}{Distance * Q_{cf}}$$

As for the estimation of TLC per ton-km of individual commodity flow, rather than using average distance and volume, different distances, different volumes and different mode choices from key rice sources in the Mekong Delta to the establishment in HCMC are taken into consideration. GIS can delineate the distance of each origin destination pair. The quantity of one commodity flow is based on the analysis of generation of key rice sources and establishments as mentioned at the beginning of this section. Table 2 gives an example of TLC model development and the estimation of TLC per ton-km via road and IWT in the rice industry.

Table 2: Example of the TLC model development and the estimation of TLC per ton-km for different transport modes



No	Key rice sources in the Mekong Delta	Average rice handling volume per year (ton)	Customers (CS)	Share in total volume (%)	Volume (ton)	Distance to HCMC (km) -By road - By IWT	Inbound transport cost rate (USD/ton)	Total inbound TC (USD)	Unit outbound transport cost (USD/ton)						Total ounbound TC cost (USD)	WC rate (USD/ton)	Total WC (USD)	HC rate (USD/ton)	Total HC cost (USD)	Package cost rate (USD/ton)	Total PC cost (USD)	Total logistics cost (USD)	TLC per ton-km (USD/ton-km)	Mode choice (Base scenario)
									Fuel cost (USD/ton)	Driver cost and overhead cost (USD/ton)	Depreciation cost (USD/ton)	Repair and maintenance (USD/ton)	Capital cost (USD/ton)	Unit outbound transport (USD/ton)										
1	Tan Thanh Food Processing Enterprise	120,000	CS1	10%	12,000	101	7.62	91,429	6.46	2.20	0.98	0.67	0.17	10.48	125,794	2.38	28,560	2.86	34,286	4.76	57,143	337,211	0.278	barge
					12,000	80	6.19	74,286	1.60	1.90	0.48	0.24	0.48	4.69	56,286	1.81	21,720	3.33	39,960	4.76	57,143	249,394	0.260	
			CS2	20%	24,000	120	7.62	182,857	6.46	2.20	0.98	0.67	0.17	10.48	251,589	2.38	57,120	2.86	68,571	4.76	114,286	674,423	0.234	road
					24,000	80	6.19	148,571	1.60	1.90	0.48	0.24	0.48	4.69	112,571	2.38	57,120	3.33	79,920	4.76	114,286	512,469	0.267	
			CS3	20%	24,000	103	7.62	182,857	6.46	2.20	0.98	0.67	0.17	10.48	251,589	1.81	43,440	3.33	80,000	4.76	114,286	672,171	0.272	barge
					24,000	80	6.19	148,571	1.60	1.90	0.48	0.24	0.48	4.69	112,571	2.81	67,440	2.38	57,143	4.76	114,286	500,011	0.260	
			CS4	40%	48,000	130	7.62	365,714	6.46	2.20	0.98	0.67	0.17	10.48	503,177	2.38	114,240	3.33	159,840	4.76	228,571	1,371,543	0.220	road
					48,000	80	6.19	297,143	1.60	1.90	0.48	0.24	0.48	4.69	225,143	2.38	114,240	3.10	148,571	4.76	228,571	1,013,669	0.264	
			CS5	10%	12,000	108	7.62	91,429	6.46	2.20	0.98	0.67	0.17	10.48	125,794	2.38	28,560	3.33	39,960	4.76	57,143	342,886	0.265	barge
					12,000	80	6.19	74,286	1.60	1.90	0.48	0.24	0.48	4.69	56,286	1.81	21,720	2.86	34,286	4.76	57,143	243,720	0.254	
2	Food Processing Enterprise (FPE) No1	150,000	CS1	10%	15,000	86	7.62	114,286	6.46	2.20	0.98	0.67	0.17	10.48	157,243	1.81	27,150	2.86	42,857	4.76	71,429	412,964	0.320	barge
					15,000	67	6.19	92,857	1.60	1.90	0.48	0.24	0.48	4.69	70,357	2.38	35,700	3.33	49,950	4.76	71,429	320,293	0.319	
			CS2	30%	42,000	91	7.62	320,000	6.46	2.20	0.98	0.67	0.17	10.48	440,280	1.81	76,020	2.86	120,000	4.76	200,000	1,156,300	0.303	barge
					42,000	80	6.19	260,000	1.60	1.90	0.48	0.24	0.48	4.69	197,000	1.81	76,020	3.33	139,860	4.76	200,000	872,880	0.260	
			CS3	30%	28,000	101	7.62	213,333	6.46	2.20	0.98	0.67	0.17	10.48	293,520	2.38	66,640	2.38	66,667	4.76	133,333	773,493	0.274	barge
					28,000	80	6.19	173,333	1.60	1.90	0.48	0.24	0.48	4.69	131,333	2.86	80,080	2.38	66,667	4.76	133,333	584,747	0.261	
			CS4	20%	333,200	111	7.62	2,538,667	6.46	2.20	0.98	0.67	0.17	10.48	3,492,888	1.81	603,092	3.33	1,109,556	4.76	1,586,667	9,330,869	0.252	road
					333,200	80	6.19	2,062,667	1.60	1.90	0.48	0.24	0.48	4.69	1,562,867	2.38	793,016	3.10	1,031,333	4.76	1,586,667	7,036,549	0.264	
			CS5	10%	14,000	86	7.62	106,667	6.46	2.20	0.98	0.67	0.17	10.48	146,760	1.81	25,340	3.33	46,620	4.76	66,667	392,053	0.326	barge
					14,000	80	6.19	86,667	1.60	1.90	0.48	0.24	0.48	4.69	65,667	2.38	33,320	2.86	40,000	4.76	66,667	292,320	0.261	

4.2.5. Model calibration

The model calibration and validation are carried out based on the available data. More importantly, the results of TLC model calibration will be used to analyse the impacts of FTM measures resulting in shifts between road and IWT in the rice industry. In the first step, it is necessary to make clear which parameters are assumed as fix and which are utilised for calibration.

Table 3: Overview of variable parameters in the model

Model parameters	
Outbound transport cost	Fuel cost (USD/ton)
	Crew cost and overhead cost (USD/ton)
	Depreciation cost (USD/ton)
	Repair and maintenance cost (USD/ton)
	Capital opportunity cost (USD/ton)
Warehousing cost	Warehousing cost per ton (USD/ton)
Handling cost	Handling cost per ton (USD/ton)

The first assessment of FTM measures in the rice industry inferred the high importance level of the establishments of a regional rice logistics centre and improvement of NH 1A. Outbound transport cost by road and IWT from the Mekong Delta to HCMC actually can significantly affect TLC. In addition, the establishment of a regional rice warehouse is expected to reduce some immediate stages of the rice supply chain. As a result, warehouse cost and handling cost could be also affected. Therefore, for this study, outbound transport cost; warehouse cost and handling cost per ton will be variable parameters used for the model calibration.

4.2.6. Results and discussion

Base scenario

The calibration process of the outbound transport cost from the Mekong Delta to HCMC and warehousing cost and handling cost rate in the rice industry are carried out based on five biggest road freight, three main IWT companies and 5 key food companies in the region. All of chosen companies have their own fleet and more than five experiences in the rice freight transport. The results of calibration process will form the base scenario for further analysis. The values for variable model parameters resulting from calibration process are shown in Table 4.

Table 4: Value of variable parameters in the base scenario

No	**Variable model parameters**	**Unit**	**Value**	
			By road	**By IWT**
1	Fuel cost	USD/ton	6.46	1.60
2	Crew cost and overhead cost	USD/ton	2.20	1.90
3	Depreciation cost	USD/ton	0.98	0.53
4	Repair and maintenance cost	USD/ton	0.67	0.24
5	Capital cost	USD/ton	0.17	0.48
6	Warehousing cost rate	USD/ton	4.19	4.19
7	Handling cost rate	USD/ton	3.33	3.33

Finally, the TLC model is calibrated by stepwise adaptation of the model parameters. The indicator TLC per ton-km is estimated resulting via TLC model calibration and distribution of locations of supplier. TLC per ton-km by mode is then used to calibrate the mode choice model for the rice industry with the assumption that rational decision-making by supply chain managers often includes TLC maximization. More specifically, the TLC model quantifies shifts between modes as a result of changes in the determining factors that drive modal choice. Mode choice calibration is implemented for each key rice source in the Mekong Delta, which finally results in an estimate for the overall modal share in the rice industry.

Sensitivity analysis

Sensitivity analysis serves to demonstrate model behaviour to changes of parameters. For the parameters, changes from -50% to +50% to values in the base scenario are assumed. For each parameter change, other parameters are assumed stable. The result of sensitive analysis is presented in details in Table 5.

Table 5: Sensitivity analysis of variable model parameters

Model parameters		**Indicator**	**Change of indicators for a change of model parameters by**									
			-50%	-40%	-30%	-20%	-10%	+ 10%	+ 20%	+ 30%	+ 40%	+ 50%
Outbound transport cost	Fuel cost	Road modal share	9.64%	8.24%	6.24%	4.24%	1.14%	-0.56%	-1.76%	-1.76%	-1.96%	-1.96%
		IWT modal share	1.16%	0.86%	0.56%	0.56%	0.56%	-0.54%	-0.54%	-0.84%	-0.84%	-2.84%
	Crew cost and overhead cost	Road modal share	3.14%	2.24%	0.84%	0.54%	0.54%	0.04%	-0.56%	-0.56%	-0.86%	-1.16%
		IWT modal share	1.76%	0.56%	0.56%	0.56%	-0.04%	-0.54%	-0.54%	-1.14%	-2.54%	-3.44%
	Depreciation cost	Road modal share	0.54%	0.54%	0.54%	0.54%	0.04%	0.04%	0.04%	0.04%	-0.56%	-0.56%
		IWT modal share	1.76%	1.76%	0.86%	0.56%	0.26%	-0.54%	-0.54%	-0.54%	-0.54%	-0.54%
	Repair and maintenance cost	Road modal share	0.54%	0.54%	0.54%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	-0.26%
		IWT modal share	0.56%	0.56%	0.56%	0.56%	0.56%	-0.04%	-0.04%	-0.04%	-0.04%	-0.04%
	Capital cost	Road modal share	0.54%	0.54%	0.54%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	-0.26%
		IWT modal share	0.26%	0.26%	0.56%	0.56%	0.56%	-0.04%	-0.04%	-0.04%	-0.54%	-0.54%
Warehousing cost	Warehouse cost per ton	Road modal share	-0.57%	-0.57%	-0.10%	-0.06%	-0.01%	-0.02%	0.01%	0.03%	0.56%	0.56%
		IWT modal share	0.57%	0.57%	0.10%	0.06%	0.01%	0.02%	-0.01%	-0.03%	-0.57%	-0.57%
Handling cost	Handling cost per ton	Road modal share	-0.57%	-0.57%	-0.57%	-0.05%	-0.01%	-0.01%	-0.01%	0.57%	0.58%	0.56%
		IWT modal share	0.57%	0.57%	0.57%	0.05%	0.01%	0.01%	0.01%	-0.57%	-0.58%	-0.56%

Explanation: Grey columns indicate that these changes can be feasible.

It shows the changes of indicator of modal share in the rice industry by the changes of variable model parameters. In general, this indicator is affected in all cases but at different rates. Fuel cost parameter is the most sensitive factor caused to the changes of the model indicators. If it fuel cost is lowered, road modal share increase and vice versa. Fuel cost has a smaller effect for the case of IWT transport. The reason is fuel cost makes up smaller proportion than that of road transport cost. In addition, the Mekong Delta processes many advantages of waterways in transporting bulk cargo at lower costs. However, it should be noted that the change of fuel cost may be plausible from -30% to 30% to values in the base scenario. That is because; the government has so far controlled the price of fuel in Vietnam. Crew cost and overhead cost also directly affect the model indicator. Since the companies mostly regulate driver’s wages, the variation in the rate of crew cost and overhead cost can be more flexible. The model also reacts to the changes of depreciation, repair and maintenance and capital costs. However, the road modal shares do only change very little. At present, the average vehicle speed is about 40km/h and the expected speed under the policy intervention in this study is 70km/h. Thus, the model parameters on depreciation repair and maintenance cost could only be changed to a certain degree compared to the base scenario. For the change of warehouse and handling cost to the base scenario, rice commodity flows would get two effects of overlap: warehouse and handling cost reduction due to the decrease of immediate stages of the rice supply chain, and the increase of warehouse and handling cost rate because of using modern technology and facility in the regional warehouse. Finally, a small effect in the change of modal shares in the rice industry can be seen for the changes of warehouse cost and handling cost rate.

Detailed quantitative assessment of the impacts

In this section, a detailed quantitative assessment has been carried out to determine the impacts of three scenarios related to changes in the supply chain, and modal shift and other external effects in the rice industry.

It is assumed that all parameters are affected in the same way. The difference in value between the parameter values of the base scenario results in the change of total logistics cost as the determining factors that drive modal choice. The change in modal choice is expected to generate not only traffic and transport effects (e.g. fewer trucks on the road) but also environmental (e.g. fewer emission) and economic (e.g. TLC saving) benefits. Table 5 below provides final implications for traffic, safety, economic efficiency and environmental issues resulting from different scenarios in the Vietnamese rice industry.

Within the first scenario, a rice logistics centre is established in Chau Thanh district of Hau Giang province. Under this scenario, the role of middlemen (e.g. collectors or millers) can be significantly reduced since farmers can go directly (by IWT or road) to the rice logistics centre to sell paddy or rice. The functions of milling and polishing are integrated in the rice logistics centre, which also can reduce some intermediate stages in the rice supply chain. A reduction in the number of stops would help to reduce significantly total warehouse and handling cost of the rice supply chain. On the other hand, the service quality of new central warehouse is expected to improve; the handling cost and warehouse cost rate is then believed to be slightly increased. Since proposed centre will be convenient for IWT accessibility, and an extensive network of rivers, lakes and canals has long supported IWT throughout the Mekong Delta region, it is anticipated that TLC would significantly decrease, with a focus on reduction in inbound transport cost. Outbound transport cost is assumed unchangeable since the transport distance from the logistics centre to HCMC does not change between scenarios. It is assumed that all parameters are affected in the same way. The difference in value between the parameter values of the base scenario results mainly from less stops in inbound logistics resulting in the reduction of inbound transport cost, warehousing and handling cost which is directly affected by the establishment of the regional rice logistics centre

In summary, rice industry supply paths, in the first scenario, are towards more IWT usage. This would lead to a decrease in total number of ton-km for road. In addition, this intervention would result in savings more than US$23.6 million in TLC and nearly US$2.71 million in economic cost of safety for people and rice cargo as well as about US$4.07 million of emission reduction cost in the rice industry. Finally, the implementation of Scenario 1 would lead to total cost savings, about 16.1% compared to Base scenario.

Scenario 2 is defined by the implementation of the project on upgrading NH 1A from the

Mekong Delta to HCMC. This highway has been congested many years. Adding more traffic on this highway would further increase road congestion. The improvement of NH 1A is expected to reduce traffic pressure, and save freight transport time from the Mekong Delta to HCMC. It is clear that higher speed will result in more fuel efficiency and lower fuel cost. Assuming that all parameters are affected in the same way, the difference in value between the fuel cost of the base scenario and Scenario 2 will be directly affected by the improvement of NH1A. In particular, fuel consumption and fuel cost savings would obtain via fuel efficiency gains, which finally lead to emission reduction

To sum up, the majority of benefits associated with the intervention of Scenario 2 stems from lower transport cost, as higher speed enables lower fuel cost. Therefore, Scenario 2 can improve the economic efficiency for the rice industry through significantly reducing TLC as a whole. Additionally, CO2 volumes and local pollutant emissions are projected to be reduced under Scenario 2. Only projected economic benefits of safety improvement could be limited due to unexpected modal shift. However, the Mekong Delta is generously endowed with extensive networks of rivers and canals, rice products in this region are substantially captured by the waterways already, thereby leaving limited opportunities for shifting to road. Finally, the implementation of Scenario 2 is expected to result in total cost savings, about 12.6%, compared to Base scenario.

In the Scenario 3, the combination of the two measures - the establishment of a regional rice logistics centre and the improvement of NH 1A - is expected to yields a synergy of benefits. Under this scenario, improved efficiency in rice cargo flows will be facilitated through the reduction of immediate stages in the rice supply chain and the improvement of the road transport system. Within Scenario 3, the modal shift impact of establishing a rice logistics centre appears to be larger than the impacts of improvements to NH 1A. More specifically, there is a small increase in IWT (about 0.6%) in the rice industry. This can be partly explained by acknowledging that the planned rice logistics centre in the Mekong Delta intends to be situated on a convenient location for road and IWT transport. In particular, such a rice logistics centre would not only support the existing intensive use of IWT network in the region, but also support the development of the use of multi-modal transport. For this meaning, rice would be collected by trucks and then consolidated deliveries from the rice logistics centre to HCMC by barge. Additionally, many activities related to rice logistics, distribution transport and other value-added would be integrated in this centre.

In conclusion, the concurrent implementation of the two measures in scenario 3 is believed to bring highest level of effectiveness at the lowest cost for the rice industry.

Table 6: Summary of the impacts of different scenarios

Aspects of impact	Unit	Base scenario	Scenario 1	Scenario 2	Scenario 3
Rice freight transport					
Number of ton-km by road	million ton-km	126.84	98.44	131.75	97.74
Number of ton-km by IWT	million ton-km	3,012.94	2,811.34	2,999.96	2,635.05
Economic efficiency					
Total logistics cost per year	million US$	**153.08**	**129.49**	**129.23**	**114.05**
- Transport cost	million US$	*100.61*	*90.59*	*79.42*	*76.86*

- *Warehousing cost*	million US$	*33.46*	*20.91*	*31.56*	*19.96*
- *Handling cost*	million US$	*19.01*	*17.99*	*18.25*	*17.22*
Shipping inventory cost for road transport	million US$	**0.31**	**0.19**	**0.17**	**0.14**
Safety					
Cost of damaged rice shipments in transport	million US$	**17.57**	**16.28**	**17.52**	**15.29**
Accident cost caused by rice freight transport	million US$	**6.34**	**4.92**	**6.59**	**4.89**
Environment					
Total emission cost per year (**CO_2**, SO_x,NO_x)	million US$	**12.39**	**8.32**	**12.24**	**7.53**
Total cost of different scenarios	million US$	**189.69**	**159.21**	**165.76**	**141.90**
Change compared to Base scenario	**%**		**-16.1%**	**-12.6%**	**-25.2%**

Conclusively, with the TLC model approach applied in the Vietnamese rice industry, the benefits and costs of different policy interventions in the rice industry are examined in a consistent way. The results of this process would therefore help transport decision makers to design measure package that will achieve system optimization.

5. CONCLUSIONS

In this study, the TLC model is applied comprehensively to the Vietnamese rice industry. There are seven measures, including initiatives already in place and potential future interventions. The results of preliminary assessment through the expert interview survey revealed a high rating for two FTM measures, the establishment of a regional rice logistics centre and improvement of NH 1A. These measures then became the focus for a detailed quantitative impact assessment. In this stage, the TLC model serves as the core of the impact analysis related to changes to the supply chain, and mode choices in the rice industry. According to the quantitative assessment results, the establishment of a regional rice logistics centre can bring a high level of economic efficiency through reducing TLC for the rice industry. In addition, this measure is meaningful for modal shift effects. The reason is that TLC by road would be higher than by barge transport following establishment of the rice logistics centre. Within the intervention focused on the improvement of NH 1A from the Mekong Delta to HCMC, there will be much fuel-efficient and transport time savings, which could potentially lead to positive impacts on the environment and economic efficiency in the rice industry. The combination of both measures is anticipated to result in the biggest economic impact thanks to substantial TLC saving.

The assessment results from the example sector could be of interests to transport decision-makers and logistics researcher as the different scenarios above demonstrate. Significantly, this assessment model is based on a deep knowledge of the sector, which enables clear explanation of anticipated impacts and their causality. However, it is noteworthy that the detailed quantitative impact assessment aspect of the assessment process requires access to various data sources including data coming from field surveys conducted by the author and from other researches on the freight transport in Vietnam.

6. REFERENCES

Ben-Akiva, M., Bolduc, D., & Park, J. Q. (2008): Discrete choice analysis of shipper's preferences. In M. Ben-Akiva, H. Meersman, & E. van de Voorde (Eds.*), Recent developments in transport modelling: Lessons for the freight sector. Bingley, UK: Emerald*

Chow, G. (2007): A total logistics cost approach to measuring collateral benefits of security and supply chain improvements at international gateways, Presented at the Calgary Asia Pacific Gateway and Corridor Round Table, Columbia

Davydenko, I., Tavasszy, L. A., & Smeets, P. S. G. M. (2012): Commodity freight and tripgeneration by logistics distribution centres based on sectorial employment data. In: Proceedings of the ninety first annual TRB meeting. Washington, DC: Transportation Research Board

Davydenko, I., & Tavasszy, L. A. (2013): Estimation of warehouse throughput in a freight transport demand model for the Netherlands. In: 92nd annual meeting of the transportation research board, Washington DC

FGSV (2012a): Hinweise zur Evaluation von verkehrsbezogenen Maßnahmen. Köln: FGSV-Verlag

Fornauf, L. (2015): Entwicklung einer Methodik zur Bewertung von Strategien für dadynamische Straßenverkehrsmanagement, *Dissertation at Technischen Universität Darmstadt (Germany)*

GSO (2015): General Statistics Office, Ministry of Planning and Investment, Vietnam

Friedrich, H. (2010): Simulation of logistics in food retailing for freight transportation analysis (Dissertation*). KIT*, Institut für Wirtschaftspolitik und Wirtschaftsforschung (IWW), published online:,http://digbib.ubka.uni-karlsruhe.de/volltexte/1000020602

JICA (2010): Survey report on rice logistics in the Mekong Delta, Vietnam: Japanese International Cooperation Agency

de Jong, G. and Ben-Akiva, M. (2007): A micro-simulation model of shipment size and transport chain choice, *Transportation Research Part B: Methodological, Behavioural insights into the Modelling of Freight Transportation and Distribution Systems*, Vol.41 No.9, pp.950-965

de Jong, G., Gunn, H. and Walker, W. (2004): National and international freight transport models: an overview and ideas for further development, *Transport Reviews*, Vol.24 No.1, pp.103-124

Loc, V. (2010): Value chain analysis of rice product in the Mekong Delta, *Scientific Journal*, Can Tho University, Vol.19a, pp.96-108

MOT (2014): Development strategy on transport service of Vietnam to 2020 and 2030, Ministry of Transport, Vietnam.

Sheffi, Y. and Koutsopoulos, H.N. (1988): Transportation mode choice based on total logistics costs, *Journal of Business and Logistics*, Vol.9 No.2, pp.137-154

SIWRP (2011): Master plan of water resource in the Mekong Delta, the Southern Institute for Water Resource Planning

ninth World Conference for Transport Research

Tavasszy, L. and de Jong, G. (2014): *Modelling freight transport*, Elsevier Publication, ISBN: 978-0-12-410400-6

VFA (2011): Vietnam Food Association

VITRANSS-2 (2009): The comprehensive study on the sustainable development of transport system in Vietnam, Vietnam: JICA