A Multi-Stage Impact Assessment Method for Freight Transport Management Measures

The Example of Vietnamese Rice Production and Logistics

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Abstract

The concept of freight transport management (FTM) is perceived as an aspect of traffic management that has a significant influence on freight transport. A review of relevant literature gives descriptions of numerous FTM measures. Multi-dimensional approaches to optimize freight transport, production and logistics processes should be considered when assessing the impacts of FTM measures. 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. In addition, for efficiency reasons, it is not appropriate to carry out impact assessments of all measures or to select only one single method for all circumstances. Therefore, a multi-stage assessment method is necessary for first assessment and classification, and then a detailed quantitative analysis of the selected measures only needs to occur. With this approach, the risk associated with limitations of individual measures is mitigated in initial pre-selection stages and efficiency is improved, as a thorough and detailed impact assessment of the core effects of measures shortlisted in the classification stage are examined.

The objective of this study is to develop a method to investigate and assess the impacts of FTM measures on production, logistics and traffic. In this study, firstly, a framework for FTM is discussed to provide a theoretical foundation for this study as a whole. It includes freight transport system analysis, an overview of the FTM concept, and a summary of FTM measures identified in various case studies. Secondly, a multi-stage impact assessment method for FTM measures is developed, which enables quick classification of adopted measures, and detailed quantitative impact analysis. Explanation of the development process starts with a review of the overall transport decision-making process in general and the impact assessment methods for FTM measures in particular. The discussion of pros and cons of existing assessment methods is brought into focus. Subsequently, a multi-stage impact assessment method for FTM measures is developed by which the core effects of the measures can be effectively estimated and captured. The proposed method is composed of two main stages. The first stage serves as a pre-selection of measures with a focus on defining and classifying the measures based on qualitative or partly-quantitative methods. The second stage investigates the core effects of selected measures using quantitative methods to carry out detailed analysis.

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.

The results of the first assessment stage in the rice industry show that high ratings have been given to two FTM measures: the establishment of a regional rice logistics centre and the improvement of national highway (NH) 1A from the Mekong Delta to HCMC. The second assessment stage is a detailed impact assessment of pre-selected measures based on a detailed

and comprehensive sector analysis. In this stage, quantitative assessment is carried out to determine impacts related to changes in the supply chain, and impacts on transport mode choices in the rice industry. A total logistics cost (TLC) model serves as the core tool for analysis of the rice industry, differentiating a disaggregated population of rice commodity flows and distribution centre locations. Final assessment results show that an establishment of a regional rice logistics centre can result in a modal shift away from trucks and this is contributing to improved traffic safety and the quality of the environment in affected areas. The improvement of NH 1A is expected to increase average speeds and reduce freight transport time from the Mekong Delta to HCMC. Combining the measures of rice logistics centre establishment and NH 1A improvement can maximise economic efficiency through significant reduction in TLC for the rice industry. Safety and environmental benefits can also be achieved at the rice industry and transport network level.

In summary, with a multi-stage impact assessment approach it has been demonstrated that it is possible to investigate and assess the impacts of FTM measures on production and logistics. Also, the proposed method in this study emphasises the involvement of multiple stakeholders in the assessment process, and allows for capturing and estimating the core effects of these measures. As noted above, the TLC model is utilised to assess the impacts of FTM measures and the application of the TLC model, as in this study, can be seen as one of the key methods in assessing FTM measure impacts that is based on comprehensive sector analysis. The study is expected to be of value for governmental and local transport authorities in providing suitable methods for assessing FTM policies.

Although the study has achieved its goal, there are some inevitable limitations. Firstly, detailed quantitative impact assessment can only take place when extensive data is available, which may hinder the application of the proposed method in practice. Secondly, the application of the method developed in this study focuses on the Vietnamese rice industry and the specific constraints and demands of freight transport management in this context. Therefore, it should be applied to other sectors to determine further the potential generalization of findings in other contexts. Lastly, the study addresses a new and complex field of research in its focus on impact assessment methods for FTM measures. However, this field continues to receive less attention than passenger transport due to the complex characteristics of freight transport systems. This study is expected to contribute to enriching the theoretical and empirical understanding of FTM measures and their effective management.

Zusammenfassung

Das Konzept des Güterverkehrsmanagements, im Englischen „Freight Transport Management“ (FTM), wird als ein Aspekt des Verkehrsmanagements betrachtet, das einen signifikanten Einfluss auf den gesamten Güterverkehr nimmt. Eine Übersicht relevanter Literatur gibt Beschreibungen zahlreicher FTM-Maßnahmen wieder. Multidimensionale Ansätze zur Optimierung des Gütertransports, der Produktions- und Logistikprozesse müssen bei der Bewertung der Auswirkungen solcher Steuerungsmaßnahmen berücksichtigt werden. Die in den einzelnen Stufen des Planungsprozesses angewandte Bewertungsmethode zur Einschätzung solcher Einflüsse sollte auf geprüften Maßnahmen und dem betrachteten Sektor basieren. Aus Effizienzgründen ist es zudem nicht angemessen, Wirkungsanalysen aller Maßnahmen durchzuführen oder nur eine einzelne Methode auf alle möglichen Bedingungen anzuwenden. Dazu ist ein mehrstufiges Verfahren zur Klassifikationsbewertung notwendig. Danach muss nur noch eine detaillierte quantitative Analyse ausgewählter Maßnahmen erfolgen. Mit diesem Ansatz wird das mit den Einschränkungen von Individualmaßnahmen verbundene Risiko bereits in den Anfangsphasen der Vorauswahl gemildert und damit die Effizienz gesteigert. Dies wird durch eine sorgfältige und detaillierte Wirkungsanalyse der Kerneffekte der in der Klassifikationsstufe bestimmten näheren Auswahl von Maßnahmen ermöglicht.

Das Ziel dieser Studie ist die Entwicklung einer Methode, um die Wirkung von FTM-Maßnahmen auf Produktion und Logistik zu untersuchen. In dieser Studie werden zunächst die Rahmenbedingungen für Güterverkehrsmanagement diskutiert, um ihr eine theoretische Grundlage voranzustellen. Sie beinhaltet eine Güterverkehrssystemanalyse, einen Überblick über das FTM-Konzept und eine Zusammenfassung von FTM-Maßnahmen, die in zahlreichen Fallstudien identifiziert wurden. Daran anschließend wird eine mehrstufige Methode zur Wirkungsanalyse für FTM-Maßnahmen entwickelt, die eine schnelle Klassifikation der übernommenen Maßnahmen sowie eine detaillierte quantitative Wirkungsanalyse ermöglichen. Die Erläuterung des Entwicklungsprozesses beginnt mit einer Übersicht über den grundlegenden Entscheidungsprozess im Transportwesen und die Methoden zur Wirkungsanalyse für FTM-Maßnahmen. Die Diskussion um das Pro und Kontra bestehender Bewertungsmethoden wird ebenso aufgegriffen. Daran anschließend wird eine mehrstufige Methode zur Wirkungsanalyse von FTM-Maßnahmen entwickelt, die als Grundlage dient, um Kerneffekte dieser Maßnahmen effektiv einzuschätzen und festzuhalten. Die vorgeschlagene Methode besteht aus zwei Stufen. Die erste Stufe dient der Vorauswahl der Methoden zur Definition und Klassifikation der auf qualitativen oder zum Teil quantitativen Methoden basierenden Maßnahmen. Die zweite Stufe untersucht die Kerneffekte ausgewählter Maßnahmen unter Einbeziehung quantitativer Methoden, um eine detaillierte Analyse durchzuführen.

Die vietnamesische Reisindustrie diente als Fallbeispiel für diese Studie, da genügend Daten verfügbar sind, um verschiedene Wirkungsarten von FTM-Maßnahmen zu testen. Zusätzlich findet in der Reisindustrie eine hohe Güterverkehrsauslastung, gebündelt mit FTM-Maßnahmen Anwendung. Das durch den Reistransport rapide anwachsende Verkehrsvolumen trägt rund 21% des Güterverkehrsgesamtvolumens in bestimmten Verkehrskorridoren, beispielsweise aus dem Mekong Delta nach Ho Chi Minh City (HCMC). Vietnam ist gegenwärtig der zweitgrößte Reisexporteur weltweit. Die Reisindustrie schließt zahlreiche Stakeholder, wie zum Beispiel den Farmer und den Aufkäufer, Müller, Polierer, Lebensmittelunternehmen, Großhandelsunternehmen, Einzelhandel usw. mit ein. Es ist unbedingt erforderlich, das Entscheidungsverhalten dieser Stakeholder zu kennen, um ihre Reaktionen hinsichtlich entsprechender FTM-Maßnahmen abschätzen zu können.

Die Resultate der ersten Bewertungsphase in der Reisindustrie zeigen, dass zwei FTM-Maßnahmen hohe Bewertungen erhielten: der Aufbau eines Reis-Logistikzentrums und die Verbesserung der Bundesstraße (National Highway) 1A, die das Mekong Delta mit Ho Chi Minh City verbindet. Die zweite Bewertungsstufe ist eine detaillierte Wirkungsanalyse ausgewählter Maßnahmen, basierend auf einer detaillierten und umfassenden Sektoranalyse. In dieser Stufe wird die quantitative Bewertung durchgeführt, um die Auswirkungen im Hinblick auf Veränderungen in der Lieferkette und Auswirkungen auf die Wahl der Transportart in der Reisindustrie zu bestimmen. Ein Logistik-Gesamtkostenmodell, im Englischen „total logistic cost" (TLC) model, dient als zentrales Instrument für die Analyse der Reisindustrie, das eine disaggregierter Population von Handelsströmen und Standorten von Distributionszentren differenziert. Die abschließenden Bewertungsergebnisse zeigen, dass der Aufbau eines Reis-Logistikzentrums zu einer modalen Verlagerung, weg von Kraftfahrzeugen, und damit zu einer Verbesserung der Verkehrssicherheit und der Umweltqualität in betroffenen Gebieten führt. Die Verbesserung der Bundesstraße 1A soll erwartungsgemäß die Durchschnittsgeschwindigkeit erhöhen und damit die Gütertransportdauer vom Mekong Delta nach Ho Chi Minh City reduzieren. Die Kombination von Maßnahmen zum Aufbau von Reis-Logistikzentren und der Verbesserung der Bundesstraße 1A kann durch eine signifikante TLC-Reduktion die ökonomische Effizienz erheblich maximieren. Erhöhte Sicherheit sowie Umweltvorteile können dadurch ebenso in der gesamten Reisindustrie und dem Transportnetzwerk entstehen.

Zusammenfassend wurde mit einem mehrstufigen Wirkungsanalyseansatz demonstriert, dass es möglich ist, den Einfluss von FTM-Maßnahmen auf die Bereiche Produktion und Logistik anzuwenden. Die in der Studie vorgeschlagene Methode betont zudem die Beteiligung zahlreicher Stakeholder an dem Bewertungsprozess und ermöglicht damit das Festhalten und die Bewertung der Kerneffekte dieser Maßnahmen. Wie oben erwähnt wird das TLC-Model verwendet, um die Einflüsse von FTM-Maßnahmen abzuschätzen. Basierend auf einer umfassenden Sektoranalyse, kann das in dieser Studie verwendete TLC Modell, als eine der Kernmethoden zur Bewertung der Auswirkungen von FTM-Maßnahmen betrachtet werden. Die Studie soll von großer Bedeutung für die Regierung und die lokalen Verkehrsbehörden haben, indem sie passende Methoden für die Erfassung von FTM-Richtlinien bereitstellt.

Obwohl die Studie ihr Ziel erreicht hat, so gibt es dennoch unvermeidbare Einschränkungen. Zunächst einmal kann eine detaillierte quantitative Bewertung der Auswirkungen nur dann stattfinden, wenn umfassende Daten zur Verfügung stehen. Dies kann die Anwendung der vorgeschlagenen Methode in der Praxis behindern. Zweitens, bezieht sich die Anwendung der in dieser Studie entwickelten Methode auf die vietnamesische Reisindustrie sowie deren spezifischen Hürden und den FTM-Bedarf in diesem Bereich. Deshalb sollte die Methode auch auf andere Sektoren angewandt werden, um eine potentielle Generalisierung der Forschungsergebnisse in weiteren Kontexten zu bestimmen. Schlussendlich greift die Studie in ihrem Fokus auf Bewertungsmethoden für FTM-Maßnahmen ein neues und komplexes Studienfeld auf. Nichtsdestotrotz erhält dieser Forschungsbereich aufgrund seiner hohen Komplexität nachwievor weithin weniger Aufmerksamkeit als der Personentransport. Die Studie soll dazu beitragen, das theoretische und empirische Verständnis des gesamten Themenfeldes „FTM- Maßnahmen" und dessen effizientes Management zu bereichern.

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1 Introduction

This chapter provides an overview of the research work. Section 1.1 presents the context and rationale for the study. Research questions, goal, objectives and methodology are introduced in Section 1.2, 1.3 and 1.4. Finally, the structure of the overall report is outlined in Section 1.5.

1.1 Background and motivation

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. Traffic management measures like HGV (Heavy Goods Vehicle) toll in Germany or load factor control in Vietnam are examples. These measures have apparently influenced carriers or logistics service providers deciding on modes and routes. Production and logistics processes are also influenced by these measures as, for example; orders or stocks can be changed to minimize negative impacts on costs.

It is a fact that there are lots of methods that could be utilised to measure the impacts of freight transport management (FTM) measures. However, the research in multi-stage assessment method is considerably scarce as compared to the number of single methods. Qualitative methods such as expert consultation or multi-criteria assessment (MCA) permit a quick classification and a first assessment of adopted measures and their impacts, but they do not give a precise analysis of those impacts. Quantitative analysis of the core effects of the measures can, however, overcome some limitations associated with qualitative methods, but data availability and overall efforts are usually limited. Therefore, the incorporation of both qualitative and quantitative approaches in assessing the impacts of the measures can yield more understanding of the impacts of FTM measures on production and logistics.

A literature review shows that most of the analysed impacts of freight transport management (FTM) measures are changes in mode and route choices (Browne et al., 2005; Hosoya and Sano, 2003; Regmi and Hanaoka, 2015; Taniguchi and Tamagawa, 2005a). Many impacts analyse in a relatively abstract way, with little quantification of core effects caused by FTM measures. The reason for this may be that core effects of the measures can only be analysed if sufficient data is available. Also, to predict behavioural changes, the analysis of core effects requires detailed knowledge of the structure or network, stakeholders involved and factors influencing their decisions. Without access to this information, the impacts of FTM measures may emerge as modal shift or changes in route choice but with little insight into causalities and explanatory factors.

Clearly, the methods selected for detailed analysis should depend on planning process stages, on the type of measure, and on the sector considered. For efficiency reason, it is not appropriate to select only one single method for all circumstances. Therefore, in this study, a multi-stage method of impact assessment will be developed. The first stage serves as a pre-selection of measures and will define and classify the measures based on qualitative methods. The second stage investigates specific measures with a detailed quantitative impact analysis.

The rice sector in Vietnam is chosen as an application case. It is suitable for this experiment, as data is available to test various kinds of impact. In particular, there are numerous 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 (VITRANSS-2, 2009), 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 has the involvement of various stakeholders such as farmers, collectors, millers, polishers, food companies, wholesalers, retailers, and so forth. The knowledge on decisions of those stakeholders is very useful for the prediction of their reactions to FTM measures.

1.2 Research questions

The focus of this study is to answer four concrete research questions as follows:

Research question 1:

> ***What is the theoretical foundation of FTM?***

Research question 2:

> ***What are the existing methods to assess the impacts of FTM measures? What are their pros and cons as well as their application?***

Research question 3:

> ***What does a multi-stage impact assessment for FTM measures look like?***

Research question 4:

> ***How could the multi-stage impact assessment of FTM measures be applied in an example sector?***

1.3 Goal and objectives

The overall goal of this study is to develop a method to investigate and assess the impacts of FTM measures on production and logistics.

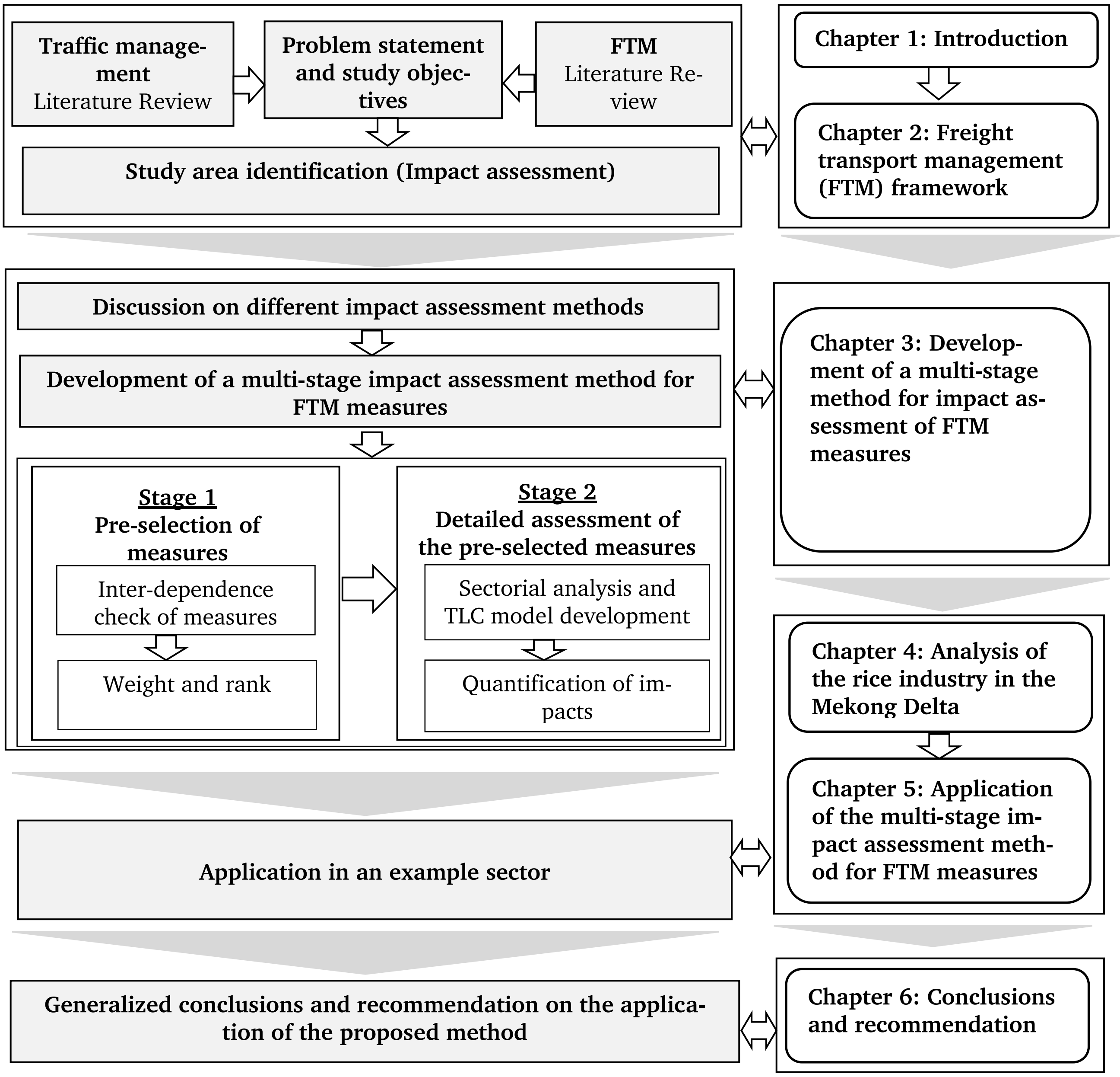
To reach such a goal, the following objectives should be fulfilled:

- Review of literature on the freight transport system, freight transport management (FTM) measures, and potential impacts of such measures;
- Discussion on different approaches to impact assessment;
- Development of a multi-stage impact assessment method for FTM measures;
- Analysis of the Vietnamese rice industry to identify freight transport problems and causes;
- Application of the developed method for assessing the impacts of FTM measures in the example sector;
- Generalized conclusions and recommendations on the application of the developed method for the impact assessment.

1.4 Methodology

The research flow of this study is presented in **Figure 1-1**. 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 traffic management and FTM measures to define the objectives as well as the scope of the study. Next, a large body of literature relating to the methods for assessing the impact of FTM measures has been identified and an attempt has been made to compare and assess those different approaches. The analysis shows the gaps in existing assessment methods and their practical application. Consequently, the study develops a multi-stage assessment method by which the core effects of FTM measures can be identified and economic, safety and environmental impacts can be estimated.

Figure 1-1: The research flow of the study



Source: Own representation

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). For impact assessment of the FTM measures on production and logistics processes in the rice industry, this study differentiates two levels of analysis as mentioned above.

Qualitative or partly-quantitative methods such as expert consultation or the MCA method are used for a first classification of the measures. Usually, FTM measures aim to achieve more than one goal, and there is always a trade-off needed between the objectives of different stakeholders involved. Within this context, expert consultation or the MCA method are likely suitable tools since they enable to deal with multi-criteria analysis in weighting and ranking

FTM measures. Several impact assessment criteria, specifically transport, social-economic and environmental effects are taken into account when selecting measures. The initial results of the first assessment stage in the rice industry have revealed that high ratings have been given to two freight transport management measures: the establishment of a regional rice logistics centre and the improvement of NH 1A from the Mekong Delta to HCMC.

The next stage is a detailed impact assessment of pre-selected measures, based on a comprehensive sector analysis and defined measure application scenarios. The first scenario considers only the establishment of a new regional rice logistics centre. The second scenario is only the improvement of NH 1A. The third scenario is the combination of the two measures above: regional rice logistics centre establishment and NH 1A improvement. In this stage, a detailed quantitative assessment is carried out to determine the impacts related to the changes in the supply chain, and the impacts on mode choices in the rice industry. A total logistics cost (TLC) model serves as the core of the analysis, differentiating a disaggregated population of commodity flows and locations of distribution centres. The model takes into account mode and route choices for each rice commodity flow. Consequently, the traffic, economic, safety and environmental benefits can be estimated at the sector level and transport network level.

1.5 Structure of the Study

The structure of this study is shown in Figure 1-1. After the Introduction, Chapter 2 provides theoretical foundations for the whole study in its entirety. It comprises a system analysis of freight transport, presentation of the FTM concept, and a compilation of FTM measures identified in various case studies.

Chapter 3 focuses on developing a multi-stage assessment method that enables the capture of core effects of FTM measures. Following this objective, firstly, overall transport decision-making processes are introduced briefly to understand the position of impact assessment in this process. Next, a review of the impact assessment methods for FTM measures and discussion on their pros and cons are presented. In addition, meta-criteria used for the assessment of methods in the freight transport sector are also discussed. Finally, a multi-stage assessment method for FTM measures is developed and recommended as the important outcome of this study.

In Chapter 4, the current situation of the rice industry in Vietnam‘s Mekong Delta is presented in details to identify freight transport problems and their causes. The analysis is conducted by examining the rice supply chain, vehicles used, frequency, TLC and route choice from the commodity origin to domestic and export markets. As a result, the limitations of freight transport in the rice industry are identified, highlighting the need for the consideration and application of various traffic management measures that can contribute to increased efficiency.

A commentary on the detailed application of the method developed for this study is carried out in Chapter 5. More specifically, the study takes the rice industry as a case study for analysing the utility of a multi-stage method to FTM impact assessment. This part contains two stages of assessment. The first stage is conducted by inventorying, interdependency checking and assessing FTM measures applicable to the rice industry. Partly-quantitative methods such as MCA or the expert consultation method is employed to estimate the applicability and effectiveness of these measures. Consequently, a list of the most effective and applicable measures for the unique conditions of the rice industry are recommended. In the second stage, a deep quantitative impact assessment of recommended measures is implemented. A total logistics cost (TLC) model serves as the core of the analysis, differentiating a whole population of rice commodity flows and location of distribution centres. The model takes mode and route choices for each commodity flow into account. Accordingly, the traffic, economic, safety and environmental benefits can be estimated at sector level and transport network.

Generalized conclusions and recommendations on the application of methods for the impact assessment of FTM measures are presented in the last chapter.

2 Freight Transport Management Framework

The purpose of this chapter is to provide the theoretical framework for FTM. Section 2.1 gives a basis for the study of FTM. Particularly, it comprises the analysis of stakeholders involved in freight transport system and their goal conflicts; the consideration of components constructing freights transport supply and demand inside the transport system are also addressed. Section 2.2 provides a thorough review of the concept of FTM and its classification. The final section focuses on the compilation of FTM measures through the review of numerous case studies, where measures have been successfully or unsuccessfully applied in a range of contexts.

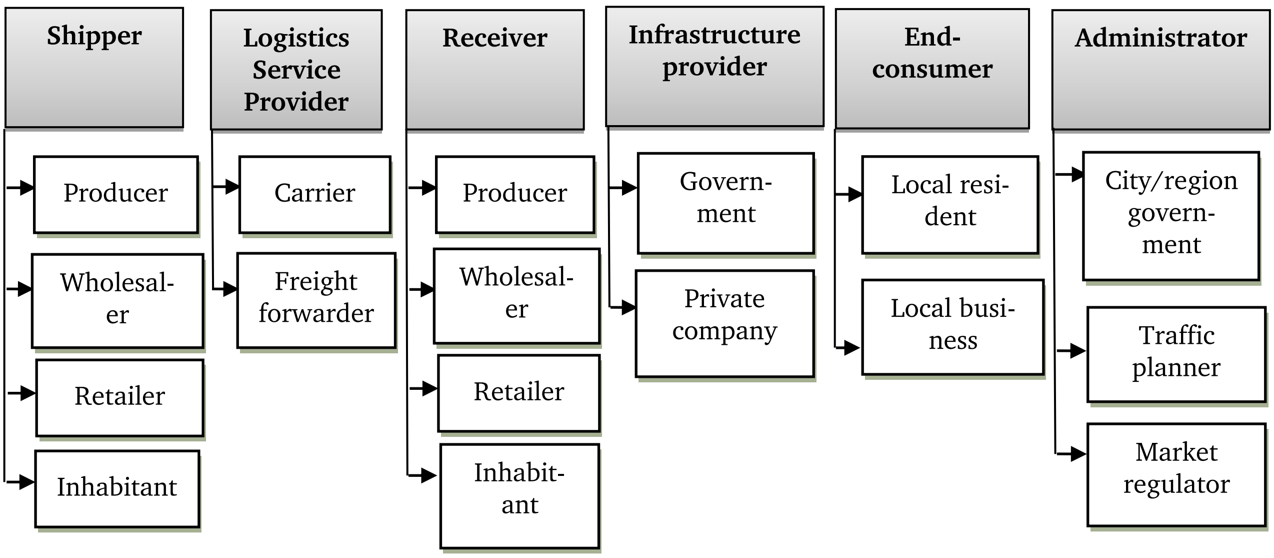
2.1. Systematic analysis of the freight transport

The first fundamental step in the systematic analysis of freight transport involves determining all stakeholders whose decisions affect freight transport operations. Next, goal conflicts of these stakeholders shall be discussed in details. Throughout this analysis, the study shall determine component parts of freight transport demand and supply which constitute the freight transport system.

2.1.1. Stakeholders

A number of attempts have been made to describe stakeholders involved in the freight transport system. Comprehensive reviews of the freight transport system (Visser et al., 1999; Boerkamps et al., 2000; Taniguchi and Nemoto, 2003; Wisetjindawat et al., 2006; Friedrich, 2010; Russo and Comi, 2011; Anderson et al., 2005) have shown that it involves very complex linkages among many stakeholders, including shippers, carriers, receivers, infrastructure providers, residents, administrators, and so on. Stakeholders may have different perspectives on the freight transport system. Figure 2-1 presents an overview of stakeholders involved in the freight transport system.

Figure 2-1: Stakeholders involved in the freight transport system



Source: Own representation

Shippers are people or agents who send goods to other companies or persons. **Logistics service providers (LSPs)** do not work on the production of goods but provide logistic services to other companies. They can be either carriers who provide the physical transport service or freight forwarders who organize the transport. **Receivers** are people or agents receiving the goods. **Infrastructure providers** are the actors responsible for providing infrastructure for transporting goods (e.g. roads, bridges, terminals, etc.); in most cases, this is the task of the government. **End-consumers** are people indirectly affected by freight transport activities. They could be residents who are living in a particular place in a city, or local businesses who are working in a city. **Administrators** are people responsible for the performance of transport system and are required to play a major role in resolving any conflict among these stakeholders.

In the context of the chosen example sector in this study - the rice industry, key stakeholders involved are described as follows. Shipper refers to economic agents associated with production and the shipping of rice (e.g. farmers or food companies). The carriers represent the agents or companies that are physically in charge of transporting rice from the origin - the Mekong Delta to final destination - HCMC (e.g. collectors, transport companies, LSPs). Carriers represent a very heterogeneous group, ranging from very small companies with a single truck or small boat/vessel to conglomerates that operate hundreds of trucks, or vessels of thousand-ton capacity. Receivers represent the consignees of rice cargo. This group of wholesalers/retailers or export companies typically represents the end consumers of the rice supply chain.

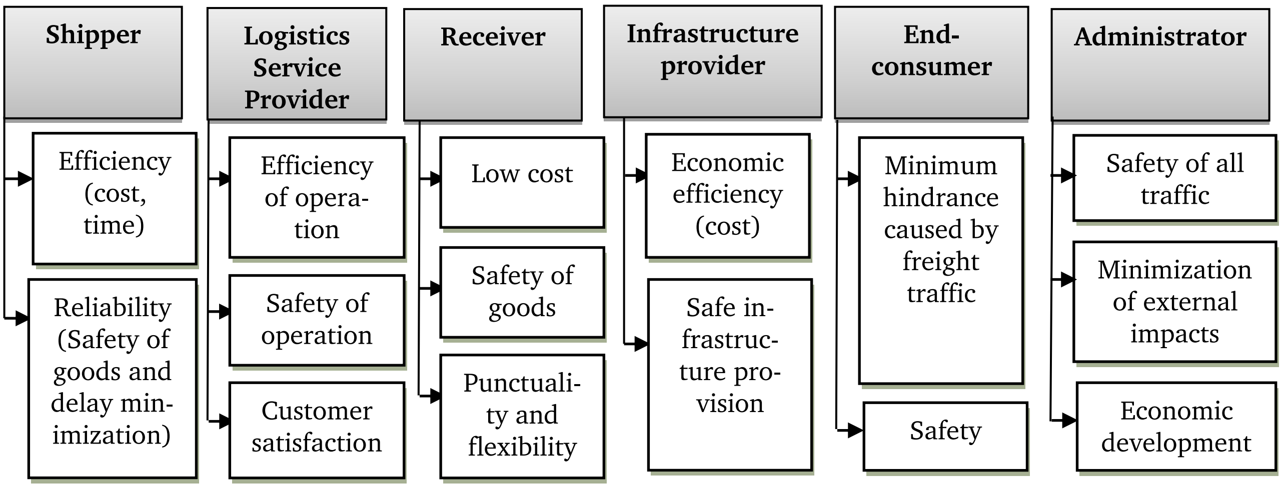
2.1.2. Stakeholder Objectives

As mentioned above, there are quite a lot of actors involved in the freight transport system. Some actors are directly involved (e.g. shipper, logistics service provider, and receiver) whereas some others provide supporting factors for freight transport activities (e.g. infrastructure providers, and administrators). Residents, however, do not really have a direct involvement; they have a certain effect on the policy of freight transport by way of voicing their opinions to administrators. Obviously, each stakeholder plays a different role in the freight transport system. The goals of the stakeholders involved are identified based on their individual viewpoint. Figure 2-2 provides an overview of the objectives of different stakeholders as follows.

The objectives of the **shipper** often concentrate on the efficiency in terms of cost and time and reliability of transport (safe delivery of goods to customer without delay). Following the study of Gibson et al. (2002) costs hold the highest importance for shippers when doing business with carrier partners. They tend to prioritise minimizing transportation costs. After deciding the shipment size/delivery frequency, the shipper will announce this to all carriers for bidding. In addition to the cost element, commodity characteristics are also a critical consideration for the shippers and carriers/logistics service providers. To some extent, the products' characteristics determine the transport modes, and thereby dictate the transporting time and cost. For example, looking at the modal split of the freight transportation in Vietnam, it revealed that most heavy raw materials such as construction materials (73%) and coal (79%) are shipped by IWT. Meanwhile, a large proportion of manufactured goods (88%) and animal meat products (85%) are transported by road (VITRANSS-2, 2009). Obviously, the inland waterway transport (IWT) mode is much cheaper than roadway but it is not competitive in terms of time. Therefore, bulk low-value goods are often favoured for transport via IWT. Beside the interests of cost and time, shippers take into consideration the safety of goods, reviewing freight loss history before doing business with a carrier (Premeaux, 2009).

With respect to **Logistics Service Provider (LSP)**, operational efficiency is considered as their most important objective. LSPs typically attempt to minimize the costs related to collecting and delivering goods to customers, thereby maximizing their profits. At the same time, they usually assure that their operation is safe and damage to goods minimized. They also place importance on customer satisfaction through providing good quality services. In the long-term, the objectives of LSPs should be in line with customer needs and expectations. As stated by the study by Aguezzoul (2012), customers often consider the following aspects when evaluating LSPs: logistics information systems, on-time deliveries, capacity to handle specific business requirements, responsiveness including accessibility to contact persons, price, experience in a similar industry, reputation, market share, logistic equipment, and business development strategy. If LSPs take all elements into account, they can satisfy customer needs and also fulfil their business objectives. Ultimately, customer satisfaction emerges as the most crucial objective of LSPs.

Figure 2-2: Goal conflicts of stakeholders involved in the freight transport system



Source: Own representation

Similar to shippers, the objective of **receiver** is efficiency in term of cost and time. Generally speaking, receivers want to receive the right goods at low cost at the right time. Furthermore, they are also greatly concerned about the safety of goods, reliability, punctuality and flexibility of deliveries. Regarding the transport chain, the receiver is seen as an end point in this study. A receiver has the power in making decision related to delivery time in normal cases. However, in cases where specific FTM measures put in place (e.g. toll pricing to push trucks working in off-peak hours); this decision is jointly made by receivers and carriers (Holguín-Veras et al., 2007). Receivers and carriers, to some extent, have to agree on mutual objectives, for example minimization of total logistics cost.

Infrastructure provider has two main objectives, namely “economic efficiency” and “providing safe infrastructure”. Criteria associated with these objectives include saving transport costs and reducing emission costs. Additionally, infrastructure providers are further interested in safe infrastructure provision, which can ensure the sustainable development of freight transport system.

The objectives of **end-consumer** can be identified as minimum negative impacts and safe movement of freight traffic. End-consumer would like to receive their commodities at a convenient time. However, they do not welcome large trucks coming into local streets for fear that these trucks will cause traffic congestion, traffic accidents and air pollution near/within their residential areas. End-consumer is therefore indirectly involved in freight transport but their opinions, to some extent, can affect the feasibility of FTM measures.

The objectives of **administrator** could vary in the following ways: ensuring safe movement of all kinds of traffic, minimizing external impacts caused by transport activities; improving environmental quality in the city/region; or enhancing economic development. Given the potentially differing objectives, administrators play the most important role in resolving conflicts among the stakeholders, which possibly makes sense for smooth and effective freight transport.

2.1.3. Freight transport supply

This section will focus on the analysis of components of freight transport supply from stakeholders' perspectives. In general, transport supply is expressed in term of infrastructure (capacity), services (frequency) and network (coverage). According to Sinha and Labi (2007) there are basically two aspects of transport supply: quantity and quality. Quantity refers to the amount of products or services that the providers make available or the capacity of the transport system. Quality refers to the level of services. Examples of transit quality are cleanness, security, and vehicle track condition. For highway systems, examples are the level of traffic congestion and the road surface condition. A well-functioning transport system should allow transport supply to meet transport demand in order to satisfy the mobility needs of both passengers and goods.

In the context of stakeholder involvement in freight transport, the supply side comprises of actors that are physically in charge of transporting goods (e.g. carriers, LSPs) or providing transport facilities (e.g. infrastructure providers). The carriers are considered to be the central part of the freight transport supply, whereas infrastructure providers play a structuring role in the formation of freight transport supply. The operation of carriers are often characterised by the kinds of service offered, frequency, and itinerary. The provision of these services is closely connected to the characteristics of items being transported such as their origin-destination, type, size of shipment, and value. In operational processes, carriers often require the use of fixed transport facilities (e.g. road, railway, warehouse, and transhipment points) supplied by infrastructure providers. The location of these fixed facilities can affect the decisions of carriers. For example, carriers may consider designing different commodity flow options, and tours; depending on the location of distribution warehouses, transhipment terminals or other fixed transport facilities (Combes and Leurent, 2009).

2.1.4. Freight transport demand

Transport demand is built on the foundation of the theory of goods demand in economics. Ultimately, transport is one kind of goods processing full characteristics as the others goods such as use value, demand and supply sides. The term of transport demand, in general, is defined as the number of trips that an individual or firm is prepared to make under a given set of conditions (i.e. trip time, cost, security, comfort, safety) (Sinha and Labi, 2007). Passenger and freight transport demand have several key differences that make the estimation of freight transport demand more difficult. Fundamentally, there are many actors involved in the decisions leading to freight transport demand. To explain the emergence of freight transport demand, Rühl and Ottemöller (2013) work on the analysis of stakeholders with a direct impact on freight transport (i.e. shippers, carriers, receivers, infrastructure operators, public authorities), and assign them to the markets for goods, traffic and transport which determine freight transport demand. According to Combes and Leurent (2009) the decision of these stakeholders has a substantial effect on the original formation of freight transport demand for two reasons. First, it initially determines the commodity flow from shippers to carriers. Second, it can enhance the movement of these flows if rational location for inbound and outbound transportation is set out.

The decisions determining freight transport demand essentially involve in designing flows of goods, choices of logistics facilities (e.g. warehouse, transhipment points, terminal), and choices of mode and frequency of transport. Addressing these decisions is a complicated task and has been investigated in some recent research, for instance Tavasszy et al. (2000) represent production-consumption flows as physical commodity flows, and Friedrich (2010) has attempted to model the food supply chain in Germany, which focuses more on the optimization procedures for warehouse structures within the food retailing sector.

Looking back to stakeholders involved in the freight transport system, the main agents formulating freight transport demand are shippers. Shippers are very heterogeneous in that they can be producers, wholesalers, retailers, or even individuals. Their decisions to mandate carriers often require considerations of multiple dimensions such as freight rate, transport time, reliability, delivery tracking, and safety of goods. Freight transport demand, finally, emerges as flows of freight movement through many steps and measured by various units such as ton, ton.km, container, truckload, and so forth.

2.2. Freight transport management measures - Concepts and classifications

2.2.1. Basic concepts

Traffic management

The term traffic management occurs in different contexts, for example in transport demand management (Taniguchi and Nemoto, 2003), congestion control (Strickland and Berman, 1995), mobility pricing (Roth, 2009), or freight road pricing (Holguín-Veras et al., 2006). All these authors express basically the same meaning of traffic management, which is a system which "influences the supply of traffic and transport systems as well as the demand for travel and transport through a bundle of measures with the aim to optimize the positive and negative impacts of traffic and transport" (Boltze, 2003). It is obvious that the mechanism of traffic management deals with the conflict and trade-off between transport demand and supply sides to optimize the efficiency of the existing transport situation.

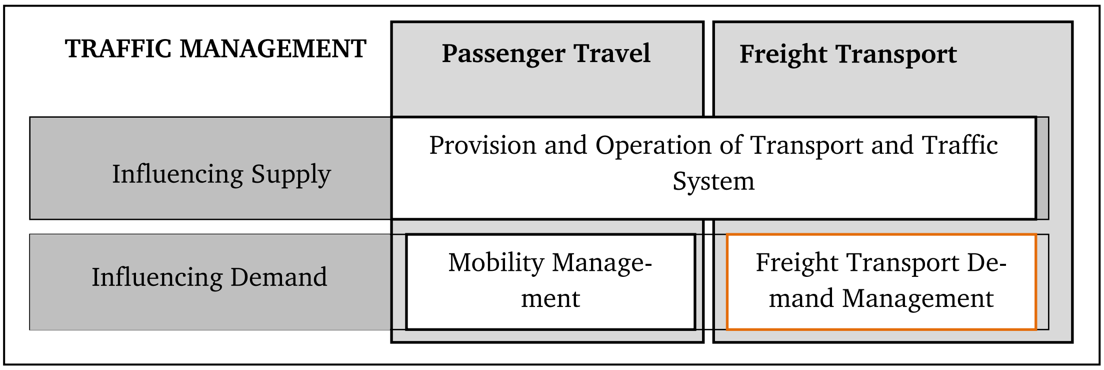
Traffic management measures

The conventional thinking about traffic management measures is simply the application of traffic control devices in order to perform traffic regulation and road operation. Along with the development of new concepts, many new traffic management approaches and measures have been applied and implemented. Khuat (2006) defined traffic management measures as "a set of activities that creates technical traffic management impacts toward desired improvements of a defined transport situation". Under the given aims of traffic management, a bundle of activities should have impacts on the both sides of transport system, demand and supply. The technical impacts of those activities should lead to changes in characteristics of transport demand and supply and this will be explored in detail the following section.

Freight transport demand management (FTDM)

In the research on freight transport strategies and measures, Browne et al. (2007) have pointed out the nature of FTDM measures that attempt to reconcile two objectives: supporting safe, reliable and efficient freight movement and limiting negative impacts. Sharing the same view, Boltze, M (2013) considers freight transport demand management (FTDM) as a part of traffic management, which aims to influence the demand for freight transport by implementing a bundle of measures with the target of optimizing the positive and negative impacts of traffic and transport. The position of FDTM under the concept of traffic management is presented in details in Figure 2-3.

Figure 2-3: Freight transport demand management as a part of traffic management



Source: Boltze, M (2013)

Taniguchi and Nemoto (2003) also highlight that FTDM includes implementing measures to facilitate the delivery and collection of goods in towns and cities, to reduce traffic congestion, and to improve the environment. They mention some differences between the demand management for freight transport and passenger transport. Passengers often behave independently whereas there is more interaction among actors in freight transport, hence it is more difficult, to some extent, to analyse the impact of FTDM measures. Also, influencing passenger traffic demand just focuses on affecting individual demand for mobility, whereas FTDM has to consider the interaction between components involved in the generation of freight transport (e.g. commodity flows, shippers, carriers, and so forth). In addition, economic principles seem to be more meaningful in FTDM since freight carriers tend to accept transport management schemes if they can benefit from them economically.

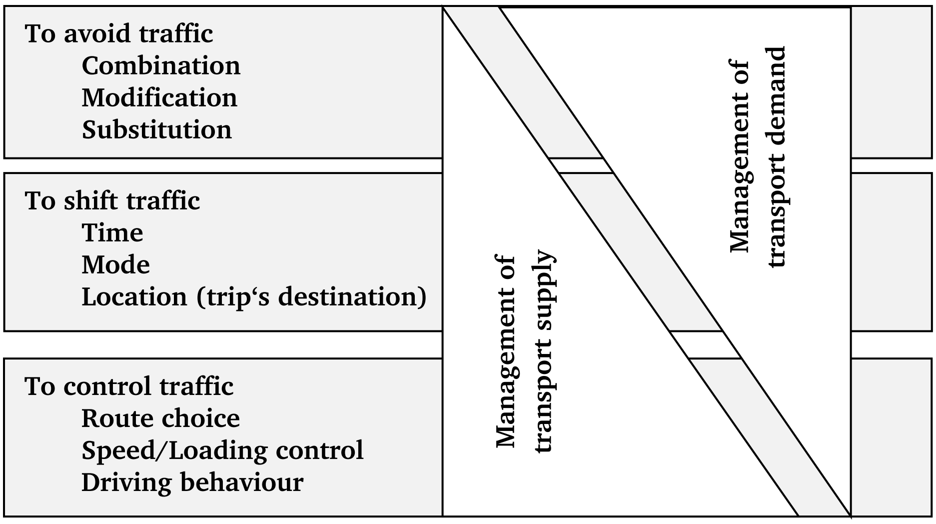
To sum up, FTDM is a part of traffic management and is comprised of a bundle of measures with the target of improving safe and efficient freight movement in balance with environmental, social, economic objectives. This study considers not only FTDM measures but also freight transport supply measures.

2.2.2. Classification

The review of literature gives numerous collections of FTM measures. For instance, Taniguchi and Nemoto (2003) classify these measures following the source of the nuisance, change of mode, route, time window, efficient use of freight vehicles and comprehensive measures (e.g. establishing logistics platforms). According to Visser (2006), policies and measures leading to sustainability in a freight transport system can be grouped in five categories: licensing and regulations, freight centres and consolidated deliveries, environmentally friendly modes, technology-based service improvement and driver training, and new freight transport systems.

Browne et al. (2007) emphasize that the classification of measures should address the problems caused by freight operation. In particular, those measures can be directly divided into four groups namely land use, the freight transport system itself, vehicles, and the traffic system. Boltze et al. (1996) identify and arrange the measures according to the hierarchical levels of traffic management, including traffic reduction, traffic diversion and traffic control. Following the concepts mentioned above, the FTM measures in this study are addressed from the perspective of transport engineering and sorted by the objectives of the measures in a defined traffic situation. These objectives are to avoid traffic, to shift traffic, and to control traffic. This is presented in detail in Figure 2-4 below.

Figure 2-4: Classification of FTM measures by their potential impacts



Source: Adapted from Boltze (2003)

Measures to avoid freight traffic are aiming at reducing freight transport demand in the targeted area by combining, modifying and substituting trips. Mechanisms for combining trips are applied to reduce the number of trips and trip length. Modifying trip is related to the trip chain and multi-purpose trips. Freight traffic demand can be also reduced by e-commercial transport. **Measures to shift freight traffic** try to move freight traffic demand between different modes, times and destinations. Mechanisms for shifting traffic involve shifting to high capacity freight transport modes, shifting to off-peak hours to reduce the peak period traffic, and shifting destination closer to trip origin to reduce the average trip length. **Measures to control freight traffic** are usually part of the traffic supply management but they also have an influence on traffic demand. These measures include truck route restriction, controlling speed or loading of vehicle, and the enhancement of driving behaviour to stabilize traffic condition of a specific area.

2.3. Compilation of FTM measures

There are a number of studies on FTM measures and their application. Based on the classification in the previous section, the study compiles FTM measures identified from the literature review as illustrated in Table 2-1.

Table 2-1: Compilation of freight transport management measures

No	List of candidate FTM measures	To avoid traffic			To shift traffic			To control traffic		
		Combination	Modification	Substitution	Time	Mode	Destination	Route choice	Speed/Loading control	Driving behaviour
M1	Freight centres and consolidated deliveries	●						○		
M2	Co-operative freight transport system	●						○		
M3	Harvesting time				●					
M4	Time window for truck entering the city				●		○			
M5	Time window for loading and unloading at curb-side parking places				●		○			
M6	Incentive for off-peak delivery				●		○			
M7	Promotion of intermodal transport					●		○		
M8	Image campaigns, concept for "Green Logistics"					●			○	
M9	Low-emission zones					●			○	
M10	Vehicle restrictions (weight -, width-, based)					●			○	
M11	Promotion of regional products	○					●			
M12	Business cooperation	○					●			
M13	Provision of loading/unloading areas						○	●		
M14	Truck routes/Freight – exclusive lanes							●	○	
M15	Infrastructure capacity improvement					○	○	●		
M16	Road pricing schemes					○		●		
M17	Load factor control or speed limit				○	○			●	
M18	Technology-based route planning and fleet management	○							○	●

● Primary impact ○ Secondary impact

Source: Boltze, M. (2013); Boltze et al. (2012); Browne et al. (2007); Castro and Mario (2010); Holguín-Veras et al. (2007); Hung (2006); Taniguchi and Nemoto (2003); VITRANSS-2 (2009), Loc (2010)

For this study, eighteen FTM measures have been identified, which are categorised by their potential impacts such as avoiding traffic, shifting traffic, and controlling traffic. The measures are numbered from M1 to M18. Some of the described measures are already applied in practice while others are currently the subject of research. Therefore, the following text will focus on a detailed analysis of the application of all measures in order to show what is working and what is not, identifying underlying causes of success or failure.

Table 2-2: List of examples for the application of FTM measures

No	List of candidate FTM measures	Examples for relevant case studies	Source	Application level		
				Study	Trials	Opera-tional schemes
M1	Freight centres and consolidated deliveries	Multimodal freight centre in Bremen Germany	Browne et al. (2005) https://www.wfb-bremen.de			x
		Bologna and Vicenza freight village, Italy	Boile et al. (2009) Ville et al. (2010)			x
		Urban freight centre in Kassel, Germany	Browne et al. (2005) Wisetjindawat (2011)			x
		Consolidation centre in Heathrow Airport	Browne et al. (2005)			x
M2	Co-operative freight transport system	Tenjin co-operative delivery system in Japan	Taniguchi, E and Nemoto, T (2003)			x
M3	Harvesting time	Research on potential impacts of climate change on freight transport	Caldwell et al. (2002)	x		
M4	Time window for truck entering the city	Governmental time-window schemes in the Netherlands	Quak and De Koster (2006)			x
		Truck ban in Manila, Philippine	Castro, J.T and Mario, R (2010)		x	
M5	Time window for loading/unloading at curb-side parking places	The case of London and Norwich, England	Allen et al. (2000) Browne et al. (2007)			x
M6	Incentive for off-peak delivery	Off-peak deliveries in New York City	Holguín-Veras et al. (2007)			x
M7	Promotion of intermodal transport	A study of FTM measures in selected European countries	Nemoto, T et al. (2006)			x
M8	Image campaigns, concept for “Green Logistics”	Green Logistics at Eroski (food distribution sector in Spain)	Ubeda, S et al. (2011)	x		
		Green Logistics management in Chinese manufacturing exporters	Lai, K. and Wong, C.W.Y. (2012)	x		
M9	Low-emission zones	Application in Austria, Denmark, Italy, the Netherland, and Germany	Allen and Browne (2010)		x	
M10	Vehicle weight-based /width-based restriction	Limited accessibility of large trucks to enter certain areas in the Netherlands	Browne et al. (2007) Quak and De Koster (2006)			x
		Truck ban in Manila, Philippine	Castro, J.T and Mario, R (2010)		x	

Table 2-3: List of examples for the application of FTM measures (cont.)

No	List of candidate FTM measures	Examples for relevant case studies	Sources	Application level		
				Study	Trials	Operational schemes
M11	Promotion of regional products	The development of Japanese regional products	Januszewska, R et al. (2005)	x		
M12	Business cooperation	The project of co-operation between fashion shop retail chains in Amsterdam	Visser et al. (1999)	x		
M13	Provision of loading/unloading areas	Loading/unloading zone restriction in London, Paris, Fukushima cities	Browne et al. (2005) Wisetjindawat (2011)			x
M14	Truck routes/Freight – exclusive lanes	Case studies on some freeways of the United States and Canadian urban areas	Allen and Browne (2010)			x
M15	Infrastructure capacity improvement	The development of multimodal freight facilities and railway system in European countries including Germany, Italy, France	Nemoto, T et al. (2006)			x
M16	Road pricing schemes	Distance-based charging system for heavy goods vehicles in selected European countries	Vrtic, M et al. (2009)			x
M17	Load factor control (LFC)	LFC in Amsterdam and Copenhagen	Taniguchi, E and Nemoto, T (2003)			x
M18	Technology-based route planning and fleet management	The case of IT applicability or e-commerce in Hong Kong and Taiwan	http://www.pland.gov.hk/	x		
		Application of ITS such as Electronic Toll Collection (ETC) and the Global Positioning System (GPS) in Singapore	Chan and Al-Hawamdeh (2002)			x

A summary of the most important findings from each case study is provided in the following texts.

M1. Freight centres and consolidated deliveries

Freight centres and consolidated deliveries can refer to the terms such as multimodal freight centres, or urban consolidated deliveries. Typical case studies for establishing freight centres and consolidated deliveries are:

- Multimodal freight centre in Bremen, Germany
- Bologna freight village, Bologna, Italy
- Urban freight centre (UFC) in Kassel, Germany
- Consolidation centre in Heathrow Airport, the United Kingdom

These case studies have one thing in common - promoting the consolidation of commodities and reducing freight road traffic. The first project of this kind is the multimodal freight centre in Bremen (Germany) which is currently in operation. Bremen freight centre is located in a specific area, which connects to three important seaports including Hamburg, Bremen and Wilhelmshaven ports. This centre is seen as a multimodal transport hub dealing with road, rail, and inland waterway and many kinds of commodities with the involvement of various LSPs (i.e. freight forwarders, shippers, and transport operators). In addition to this, it serves as a transhipment point where both short-and long-distance freight traffic meet. The essential aim of such a centre is to promote co-operation between industries by creating common logistic terminals. Bologna freight village in Italy is another example of a multimodal freight centre, which was created with the crucial objectives of reducing heavy truck traffic from cities by promoting rail transport. This freight village is located in an important area of economic production, crossing by five major rail routes and four motorways. In order to operate the Bologna freight centre, there is strong Public-Private-Partnership (PPP) cooperation, including at city level, at provincial level, with the road haulage association, transport operators, and freight forwarding companies.

Urban freight centre (UFC) is another type of freight centre and consolidated delivery system on a smaller scale that provides facilities for a single transport mode only (typically road transport). This model can be seen in the case of the urban freight centre in Kassel and the consolidation centre at Heathrow Airport (Browne et al., 2005). Kassel is known as the location of many important German industries including automobile, transport, software, and energy technologies. Kassel freight centre was established by the co-operation of many freight forwarding companies in order to facilitate the deliveries of commodities, thereby reducing commercial vehicles and congestion levels in the city centre. Since the operation of this model is based on the voluntary involvement of freight forwarders, forwarders could easily leave the cooperation if they find benefit from participation intangible. The consolidation centre at Heathrow Airport operates with the objective of reducing commercial vehicle traffic and improving of goods handling in the terminals. The empirical studies have shown that this model has brought many improvements to the traffic situation in and around the airport (Browne et al., 2005).

In essence, crucial benefits identified in the literature on practical application of freight centre and consolidated delivery system are the reduction in the number of commercial vehicles via promoting consolidation and multimodal transport (e.g. Bremen, Germany; Bologna, Italy). This measure also addresses the change in number of vehicle trips or vehicle-km, ton-km, changes in vehicle emissions (e.g. Kassel, Germany). However, these measures are not always successful in practice, especially the urban freight centre model as illustrated in the case of Vicenza, Italy (Ville et al., 2010). There are a number of reasons behind this failure. One reason is inaccurate estimation of potential demand for UFC. Unsuccessful initiatives usually assume a far higher level of demand for UFC, often resulting in not enough goods handling at the UFC (Takahasi and Hyodo, 1999). Furthermore, failure is associated in a deficiency in strict delivery regulation, and in some cases, transport and forwarding companies are reluctant to use the facilities due to the fear of losing competiveness.

M2. Co-operative freight transport system

Typical case studies for co-operative freight transport systems have been seen in many cities of Japan, of which Tenjin co-operative delivery system in Fukuoka city is considered the oldest model. This initiative stems from a particular problem faced by the city that loading spaces on and off street are very limited which generates illegal parking and compounds traffic congestion. Twenty-nine freight carriers established the Tenjin District Joint Distribution Company Ltd. to address these problems by promoting co-operative delivery.

The operation of the co-operative delivery systems gets strong support and involvement from stakeholders like shippers, freight carriers, local residents and administration. Particularly, freight carriers take responsibility for bringing their goods to the distribution centre located in the suburb of Fukuoka, and then these commodities are sorted by customer orders and delivered by member carriers. Those members, at the same time, collect goods from customers in central districts and unload them at the distribution centre.

Empirical studies have identified significant beneficiaries from this kind of model such as a decrease in numbers of trucks in the served area, a decrease in total distance travelled, frequency of parking, and total parking time (Browne et al., 2005). However, similar to the initiatives of freight centre and consolidated delivery systems, the co-operative delivery system is only successful if key stakeholders are actively involved and the government enforces sufficiently rigorous regulation on deliveries.

M3. Harvesting time

Very little literature has focused on how interventions at harvesting time can effect on freight transport demand. This is likely because this approach requires consideration of many complex conditions such as weather condition, geological condition, and custom production. In his study on the potential impacts of climate change on freight transport, Caldwell et al. (2002) suggest that climate change may result in shifting agricultural production spatially, causing the demand for freight transport in some regions in the United States to increase and to decrease in other regions. With the expectation of Caldwell however, quantitative evaluation of the impact of harvesting time measure on freight transport demand was rarely seen in the literature.

M4. Time window for truck entering the city

Typical case studies for this measure focus on in various European and Asian cities, for example London, Paris, Parma, Bologna, Copenhagen, Amsterdam, Manila, and Seoul. Its form and objective are highly differentiated across different cities. For example, time restriction can be applied in morning peak times (e.g. Parma city) to reduce the impacts of trucks on congestion or night time and weekends (e.g. London) to reduce noise nuisance, all day long (e.g. Bologna), or entry may be allowed only during a specific given period of time for deliveries (The Netherlands). Among these strategies, truck bans in the Netherlands and Philippine (Manila) are good examples where clear explanation of impacts of the restrictions on traffic characteristics and supply chain operation are provided (Castro and Kuse, 2005; Quak and De Koster, 2006). As Castro and Kuse ‘s study shows the application of restriction in Manila has resulted in a temporal shift in truck traffic from day time to night time and a modal shift from heavy trucks to smaller vehicles. The research in the Netherlands placed more emphasis if policies impact the supply chain. In particular, Quak and De Koster argued that the restriction scheme could add more costs to retailers who have to use vehicles nearly 24 hours per day. Also, the emission situation might not be improved remarkably due to the rapid increase in deliveries before and after regulated time. Many other researchers also confirm the negative impacts possibly arising from delivery time restriction and night time deliveries (Browne et al., 2005). For example, a very restrictive delivery time-window can lead to an increase in supply chain costs, vehicle trips and vehicle-km ratios. The only obvious positive effect of this approach is a shift in the number of truck trips into off-peak times that potentially leads to a reduction in congestion, improving social and environmental problems in given areas. However, finding an acceptable way to practice and balance private economic and social economic costs caused by this measure remain a point of contentions.

M5. Time window for loading and unloading at curb side parking places

Another form of time restriction is regulated times for loading and unloading in urban areas. This practice can be seen in the case studies of London and Norwich (Allen et al., 2000). Analogous to time restrictions for vehicles entering cities, this measure can affect the operation of supply chain and have impacts on freight transport. Taking Norwich city is an example, loading time restrictions on streets in the morning can conflict with the times at which the premises would like to receive deliveries. Consequently, the total number of vehicle trips and vehicle kilometres for receiver s' premises could actually increase, thereby potentially having an effect on fuel consumption, and pollutant emission. However, this measure seems more suitable in city centre locations where there is likely a high density of deliveries, and there are few available parking places. For that reason, the application of this measure might either shift truck traffic into off-peak loading/unloading times (night time for instance) and better protect pedestrianized areas located around loading/unloading bays in the city.

M6. Incentive for off-peak delivery

The relevant case study for incentives for off-peak delivery is New York City, where more than 67 million trucks operate every year (Holguín-Veras et al., 2007). The rational for incentives for off-peak deliveries stems from the fact that New York City faces the severe traffic congestion and high transportation cost. As a result, increasing off-peak deliveries can reduce truck traffic during the peak hours, thereby reducing in pollution and congestion in the city. The most obvious impact from such a measure is to shift large traffic from peak to off peak periods. However, successful implementation of incentive policy for off-peak delivery should incorporate financial incentives such as tax deductions, shipping cost, discounts, toll savings, and financial rewards.

M7. Promotion of intermodal transport

For a long time, the coordination of regional rail networks with urban distribution networks or the combination of road and IWT in many EU member countries has been an important part of public policy aimed at encouraging a modal shift from road freight traffic to rail and coastal shipping (Nemoto et al., 2006). The reason behind these measures is the growth of road freight traffic in Europe, averagely 2.1%/year (EU, 2012) as a source of environmental and social problem. Under the concept of city logistics, Nemoto et al. (2006) also put forward a strong argument for the case of Japan, noting that improvement of access routes to railway stations and seaports is a crucial condition for promoting intermodal freight transport, and for increasing the attractiveness of shifting road cargo transport into intermodal system. However, the implementation of the intermodal transport framework faces many obstacles in practice due to the complexity of different transport modes involved. The practice of the intermodal transport framework in Europe is an example as these networks may potentially create an increase of friction costs for transport operation because of a lack of infrastructure interconnectivity, transport means and regulations (EU, 2005).

M8. Image campaigns - the concept of "Green Logistics"

The concept of "Green Logistics" has recently been recognised as a new research trend in FTM literature, dealing with the integration of environmental management and supply chain operation. It has been found that environmental issues can impact numerous logistical decisions such as sourcing of raw material, modal selection, and warehouse, and terminal location (Wu and Dunn, 1995). Among these factors, transport is often considered a central part of the concept of "Green Logistics" due to the high proportion of negative impacts-freight transport has on the environment. Thus, decisions regarding transport modes, vehicle types, lot-sizes, and consolidation of goods can determine the extent of adverse environmental impacts. "Green logistics" image campaigns have taken place at national level via EU regulations on NOx, SO2 and PM emissions for trucks (Dekker et al., 2012), or at sector level such as the green logistics-strategy for the food distribution sector in Spain (Ubeda et al., 2011) and among Chinese manufacturing exporters (Lai and Wong, 2012). At the governmental level, using "Green Logistics" concepts encourages cleaner and less polluting freight transport modes; and at company or industry levels benefits of this approach include optimizing the operation of supply chain through improved delivery routes scheduling; reducing the number of trips by adding backhaul movements, and developing an environmental friendly method to solve routing problems (for instance in the case of the food distribution sector of Spain). However, the extent to which "Green Logistics" policies are implemented seems very modest in practice. At a business level, Gong and Kong (2013) explain how a "Green logistics" approach is implemented in the supermarkets of China and Sweden, and explore how to improve such approach in the future. "Green logistics" in these supermarkets can start with green packing that does not require coals or other fossil fuel as raw materials. Next steps are green transport by using friendly-environmental vehicles and green warehousing by main use of eco-technology when designing facilities (e.g. roofs with solar panels, doors with sensor which can automatically close, etc.)

M9. Low-emission zones

The aim of such zones is the control of emission and charging polluting vehicles when their emission exceeds the set level. By doing so, a low-emission zone (LEZ) can lead to better air quality, especially in contexts where road freight is experiencing rapid growth. This practice is seen in regulation in many European countries like Austria, Denmark, Italy, The Netherlands, and Germany. Initial results have shown that the application of this measure has impacts on the supply chain organization and operation, but not really significant for overall emission levels with statistics indicating for the reductions in PM, NOx, and SO2 emission in zones where low-emission regulations are in place (Allen and Browne, 2010). The case of Germany is an example (Wei et al., 2016). The introduction of LEZ could bring positive impacts on fleet compositions, but the potential in further reducing air pollution under the current characteristics of Germany seems to be modest. The reason for this is that vehicle emission standards in Germany are reached 89%. To deal with, stricter limit and regulation combining with comprehensive optimization of traffic signal control should be developed as new instrument of LEZ (Wei et al., 2016). To sum up, with the concept of "Green Logistics", this measure can potentially contribute to safer and cleaner freight transport modes in the economy.

M10. Vehicle weight-based/width-based restriction

Reviewing the literature has shown that vehicle weight/width-based restrictions alongside time restriction are the most commonly adopted regulation in urban freight transport policies in many European countries. The main function of these measures is to restrict large vehicles (up to certain weight) entering specific urban areas, where there are many pedestrians and road users, thereby reducing commonly perceived impacts of trucks such as noise, pollution, safety concerns and vibration (Browne et al., 2007). The application of such measures has the biggest impact on the operation of retailers and transport companies. According to the research findings of Quak and De Koster (2006), the impacts of vehicle weight restriction can lead to an increase in smaller vehicles carrying out distribution, thereby increasing the number of vehicle kilometres, number of round-trips, and transport cost. Emission is not improved as expected since even though smaller vehicles produce fewer emissions than large vehicles, total sum of CO2 emissions of those smaller vehicles can actually be higher. Browne et al. (2005) also confirm that the level of impacts of this measure depend much on the scale of a company's vehicle fleets. Those companies operating heavy goods vehicles, which are restricted, have to make significant changes to their fleet by acquiring smaller vehicles or to their distribution patterns. Consequently, total operating costs are likely to increase. Although many researchers have raised questions about the impact of vehicle restrictions, from governmental perspectives those measures are still believed to improve traffic condition in urban city centres. A good topic for further research could be which cities would benefit from implementing these policies and which would be better off avoiding vehicle restrictions, as well as how to integrate vehicle restriction regulation into broader governmental urban freight policies.

M11. Promotion of regional products

The promotion of regional products has long been regarded as a tool for regional development (Januszewska et al., 2009). This measure stems from the economic development agendas, which aim to create competitive advantages for traditional products, and then promote regional development and attract tourism. Regional products are typically characterised as of special quality, as authentic, as trademark or special services. They are also recognized as specialized production areas with high production volume. The development of Japanese regional products is an example (Davis and Weinstein, 1999). The consolidation of freight transport appears hidden behind the establishment of such regions; however, shifts in trip destination are likely occur since more of efforts are placed on promoting regional products, thereby increasing consumption of those products in a wide range of contexts. So far, there has been very little research on the impacts of this measure on traffic and transport activities. Significantly, however this approach is utilised in the rice industry in Vietnam; therefore potential impacts will be justified more clearly in the later part of this study focused on the rice sector in Vietnam.

M12. Business cooperation

Business cooperation measures for FTM have been investigated using case studies on the co-operation of different interest groups involved in the supply chain. The co-operation initiative between fashion shop retail chains in Amsterdam is an example (Visser et al., 1999). The results of this project is expected to brings spatial shift to traffic since it promotes cooperation among fashion retail shops for upstream consolidation purposes, thereby potentially reducing independent transport by fashion shop owners. The cooperation of farmers, collectors, millers and export companies in the rice supply chain in Vietnam is another example (Loc, 2011). In essence, striking qualitative effects can be seen as middleman in the rice purchasing process are reduced considerably, and also trip destinations (export companies) tend to located closer to trip origins (production site) to achieve increased efficiency. A detail analysis of this approach contents will be in a later part of this study focused on the rice sector in Vietnam.

M13. Provision of loading/unloading areas

The efficient usage of infrastructure capacity in urban areas has become an urgent need for many European countries. Provision of loading/unloading areas is one of a number of supply side freight transport measures. If the time window for loading/unloading in the city centre is considered as "software", "loading/unloading areas" are seen as "hardware". This is because this measure aims to provide dedicated spaces or locations for carriers loading and unloading their goods. As a matter of fact there are not always enough spaces for such areas in cities such as London and Paris, and some bus lanes are also used for loading/unloading activities in Fukushima (Japan) (Dablanc, 2009). Barcelona (Spain) municipality has implemented an initiative for dynamic usage of traffic lanes during the day by, for example devoting them to traffic in peak hours, loading/unloading and handling activities during off-peak hours, and residential parking at night. Loading/unloading zone restriction can, however, bring a spatial shift in traffic flows since delivery vehicles are only allowed to perform their activities in regulated areas in the city; therefore high traffic density may occur in and around these areas. Furthermore, this approach increases the total number of vehicle trips and vehicle kilometres necessary to deliver goods at any one time. However, these impacts are likely not addressed comprehensively in the literature, where primary focus is mainly on lack of loading/unloading spaces and handling problems in urban areas.

M14. Truck routes/Freight – exclusive lanes

Truck routes or freight-exclusive lanes are considered as another infrastructure measure deployed to control freight traffic in the city. The concept of freight-exclusive lanes can be understood as a traffic lane dedicated to trucks only, and trucks are separated from other traffic either through physical or operational techniques (TAC, 2014). Truck routes are expected to address traditional issues associated with urban freight transport such as mobility, safety, and environmental impacts. Although we can find this practice in urban freight policies in many countries (e.g. United States, Canada, the United Kingdom; the Netherlands), there is a little comprehensive researches on its impacts, except for a small sample of case studies on some freeways in the United States and in Canadian urban areas (TAC, 2014). In the research on the United States, Cost-Benefit Analysis tool was employed for impact assessment, and recommendation concerning potential implementation was made. The proposal for truck-lanes implementation in Canada takes careful consideration of the operation and impacts of that measure, in which mobility issue and safety performance of truck lanes are analysed qualitatively. Lack of experience in implementing such measures and insufficient data emerge as hindering the exploration of the real effects of this measure.

M15. Infrastructure capacity improvement

Infrastructure capacity improvement is a common supply side measures but has quite a strong influence on freight transport demand. Freight infrastructure not only refers to roads, railways, and inland waterway systems, but also refers to facilitating the handling of goods or multimodal freight facilities such as freight centres, intermodal terminals, and loading/unloading bays. Within the boundary of a city or urban area, inadequate infrastructure capacity can be one of the great obstacles to efficiency, leading to poor accessibility for freight transport and increased congestion. The case of Mexico City is an example (OECD, 2004). For long-distance freight transport, insufficient freight transport infrastructure for bulk transport modes like railway and inland waterborne vessels makes it difficult for transport operators to use options other than trucks. Vietnam and Thailand are also exemplifies for this problem, where rail freight represents only 2% of the total freight transport volume (VITRANSS-2, 2009). Since rail and IWT is often cheaper than road transport; improving railway IWT capacity is a very promising option for affecting a modal shift in freight transport. Alongside these measures, many countries have allocated resources to the development of multimodal freight facilities in an effort to facilitate transhipment between different transport modes. Germany is an example (Dablanc, 2009). Multimodal freight centres like those in Bremen, Berlin and Nurnberg are considered an important part of freight infrastructure systems responsible for handling goods from different transport modes. In supporting the development of these centres, the use of railway and IWT in Germany has increased (Umwelt bundes amt, 2009). Furthermore, German policies have also promoted the consolidation of shipments resulting in reduced transport costs and energy expenditure for companies as well as a reduction in emissions.

M16. Road pricing schemes

Road pricing schemes differentiated by time, space and/or emission have long been seen as ideal measures for traffic control by urban planners (Anderson et al., 2005; Holguín-Veras et al., 2007; TRT, 2008) . The aim of such schemes is to reduce the negative impacts of road transport (including passenger and freight transport) on the environment, society and the economy. Road pricing schemes can be separated into two areas: one focusing more on impacts on passenger transport in urban areas for which the London Congestion Charge Scheme and the Stockholm Congestion Charge are very typical examples; another affects freight transport via introducing distance-based charging system for heavy goods vehicles in various European countries namely Austria, the Czech Republic, Germany and Switzerland, or via time-based systems in other countries like Belgium, Denmark, and The Netherlands. Early results given in those studies suggest that the expected impacts of road freight charging systems are as follows. There are little indications of modal shift, except for the case of large shippers in Germany that likely increased the use of railway transport due to a relative rise in road freight transport costs. Tendencies to re-route in order to avoid road system usage charges can be seen as a negative impact of this measure (there is evidence for this in the case of Germany and Austria for instance). The striking positive effect of this measure however is the increased efficiency in the road freight transport sector as well as in increasing load factor. According to the research results on pricing system for road freight transport in EU member states and Switzerland (TRT, 2008) there is some evidence indicating the positive changes related to fleet composition (the case of Germany for instance), fleet renewal (the case of Switzerland for instance), and a load factor optimisation (the case of Austria for instance). However, due to lack of data, the effects of this measure are quantified in very few studies. Consequently, further research into the implication of freight road pricing scheme would be useful.

M17. Load factor control

Load factor schemes are often employed by policy makers alongside other schemes in traffic management such as vehicle weight-based /width-based restriction or road pricing scheme (Browne et al., 2007; Castro and Mario, 2010; Kohler, 1997). The concept of load factor control can function differently, which depends on the specific situation. The objective of load factor control - in the past - was to encourage maximum utilization of truck capacity. The case of Amsterdam and Copenhagen are practical examples (Taniguchi et al., 2002). It is engaged with regulation on satisfaction of certain load factor and environmental standard. The rational of this scheme comes from the fact that small vehicles are often more preferable in the cities given their flexibility in meeting individual/company demands and limitation of delivery time. Today, this measure can be used to control overloading vehicle, and the case of Vietnam is an example for this. Implementing load factor control regulation is recommended for long-distance transportation in Vietnam. That is because most of trucks are overloaded, which enables an increase in road competitiveness in term of cost. It is recognised that controlling overloaded trucks would help to reduce the negative effects on the infrastructure system. Also, it would cause an increase in road transport cost, thereby reducing its competitiveness of the road system. One could argue that traffic on the highways will likely increase since the more trucks used to transport all the goods. Consequently, the traffic condition may not improve as expected. According to the experience of some countries, this solution should coexist with the road pricing scheme which can manage traffic congestion efficiently (Teo et al., 2014). By application of those measures, transport companies may consider modal shift from road to waterway to achieve more efficiency.

M18. Technology-based route planning and fleet management

Application of technology in the process of production, logistics, transport and traffic has become an attractive option for both private and public sector, and has contributed significantly to the improved economic performance of those activities. As a freight transport management measure, this scheme aims to facilitate freight transport activities. The impacts of technology advancement on traffic and transport have been examined in many recent studies (Quayle, 2002; Chan and Al-Hawamdeh, 2002). The first traffic engineering impact to be considered is reduction in freight transport demand. The applicable cases of information technology or e-commerce in Hong Kong, Taiwan, and Singapore are examples. These approaches involve e-commerce, and e shopping, which can potentially reduce the retail level through online trading, thereby likely affecting the overall freight transport demand. Other technologies that also enable to change traffic and transport patterns are Intelligent Transport Systems such as Electronic Toll Collection (ETC) and the Global Positioning System (GPS). Freight vehicles under the operation of ETC can reduce delay time that typically occurs at tollgate; or can identify vehicle real-time position on the network map, giving the exact location of vehicles and guiding vehicles on the most efficient routes.

To sum up, all the case studies above are typical examples of the application of FTM measures employed worldwide. Many of them have been implemented within the boundaries of cities or urban areas, therefore, in some contexts; they are recognized as City Logistics measures. Obviously, there are many commonalities between FTM and City Logistics measures, since both aim to improve safe and efficient freight movement in balance with environmental, and social, economic issues. Apart from that, most of distribution centres and intermodal terminals are often located in urban areas. However, the range of activities that comprise freight transport management is broader than those associated to City Logistics. Specifically, freight transport management focuses not only on urban areas but also on long-distance deliveries. In this study, FTM measures are analysed both locally in the Mekong Delta and in the transport corridor from the Mekong Delta to HCMC, and relevant measures are discussed in relation to the rice industry production and logistics in the region.

2.4. Conclusions

This chapter reviews the available contemporary research related to several key aspects of

FTM including stakeholder involvement in the freight transport system and competing stakeholder priorities, the components of freight transport demand and supply, definitions of FTM measures and their classification, case studies of FTM applications and discussion on the reasons behind their success or failure.

In general, FTM is a part of traffic management, which is comprised of a bundle of measures with the target of improving safe and efficient freight movement in balance with environmental, social, and economic issues. The literature review presents numerous collections of FTM measures that can be classified into many groups depending on the research objectives or the impacts of measures. The FTM measures, in this study, focus on transport engineering and are sorted by impacts in a defined traffic situation, where key impacts are defined as avoid traffic, to shift traffic, and to control traffic. Based on each measure description, the study comes up with a qualitative assessment of its effectiveness and applicability, which would be very useful for the consideration of FTM measures in the example sector of this study.

Table 2-4: Qualitative assessment of the effectiveness and applicability of FTM measures

No	List of candidate FTM measures	Effectiveness	Applicability
M1	Freight centres and consolidated deliveries	++	+
M2	Co-operative freight transport system	+	+
M3	Harvesting time	+	--
M4	Time window for truck entering the city	+	++
M5	Time window for loading and unloading at curb-side parking places	+	-
M6	Incentive for off-peak delivery	+	o
M7	Promotion of intermodal transport	++	-
M8	Image campaigns, concept for “Green Logistics"	o	--
M9	Low-emission zones	+	-
M10	Vehicle restrictions (weight -, width-, based)	++	o
M11	Promotion of regional products	+	+
M12	Business cooperation	+	+
M13	Provision of loading/unloading areas	o	-
M14	Truck routes/Freight – exclusive lanes	o	o
M15	Infrastructure capacity improvement	++	o
M16	Road pricing schemes	++	+
M17	Load factor control or speed limit	++	+
M18	Technology-based route planning and fleet management	+	-

Explanation:
++: very high +: high **o**: average - : low --: very low

To sum up, although numerous FTM measures are currently utilised, studies on measuring impacts are few. Therefore, a more specific analysis should be carried out to ascertain for the strengths and limitations of these measures. FTM measures relevant in the case study sector of this thesis, which will be discussed in detail in later chapters.

3 Development of a Multi-Stage Impact Assessment Method for Freight Transport Management Measures

This chapter aims to develop a multi-stage assessment method for FTM measures. The first section reviews the overall transport decision-making and impact assessment process. The requirements and criteria for the selection of the assessment method are presented in section 3.2. Section 3.3 provides a review on the impact assessment methods and discuss their pros and cons. Lastly, a multi-stage impact assessment method for FTM measures is proposed and recommended as the outcome of this chapter.

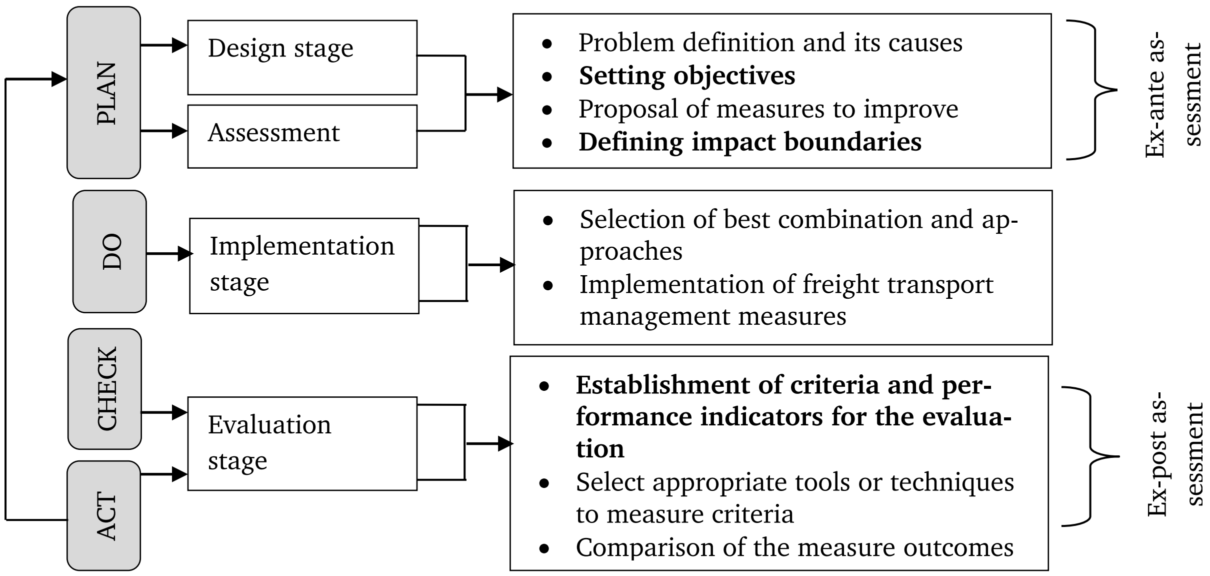
3.1 Overall transport decision-making and impact assessment process

3.1.1 Transport decision-making

Impact evaluation or assessment is an important tool in the decision-making process. Thus, it is critical to have a clear grasp of the foundation content of the decision-making chain in order to arrive at in-depth understanding of the impact assessment process. In general, the decision-making process consists of four key phases, including problem definition, policy design, policy legitimation and policy implementation (Giorgi and Tandon, 2002). Assessment can be carried out in one or all phases and it has become the key element of transport planning.

Until now, the cycle of "Plan-Do-Check-Act" (PDCA) has been recognised as a dynamic approach to the decision-making process, since this method promotes explorations of a range of innovative possible alternatives to solve problems, and adjust potential solutions in a controlled way before implementation. In the freight transport sector, the decision-making on freight transport management can be represented in detail as a quality loop based on the continuous PDCA cycle as shown in Figure 3-1.

Figure 3-1: Decision-making process in freight transport management based on PDCA cycle



Source: Adapted from Taniguchi (2014)

In general terms, impact assessment is the process of exploring the expected and/or unexpected social, economic and environmental impacts of policy intervention. Impact assessment can serve many purposes, such as providing feedback as parts of the monitoring process; assessing the outcomes of a policy intervention; drawing lessons learned for future interventions.

The impact assessment process starts with the identification of problems and their causes. Then, the objectives and potential measures for problem solutions are defined. Also, in this step, boundaries of the assessment need to be identified prior to detailed analysis of the impacts. The boundaries include the analysis of stakeholders affected, types of impacts and the scope of impacts. The next steps involve the selection of best combinations and approaches measures. In the evaluation stage, establishing criteria to evaluate objectives and selecting appropriate methods to measures those criteria are needed. Since collection of assessment information is generally costly, it is important to concentrate on the main indicators and using standardized approaches. The final step of this process is to compare the observed outcomes with expected outcomes. If the outcomes are not good, they can feedback and the re-start from the beginning.

Looking closely into the whole process, there are two kinds of impact assessment carried out in the phase of policy design (ex-ante) and policy implementation (ex-post). **Ex ante impact assessment** aims at estimating potential initial impacts and likely future impacts of proposed policies/measures for a given target area. **Ex post impact assessment**, in contrast, tries to clarify real impacts during and after implementation, to enable responsive action or to provide information to improve the design of future interventions.

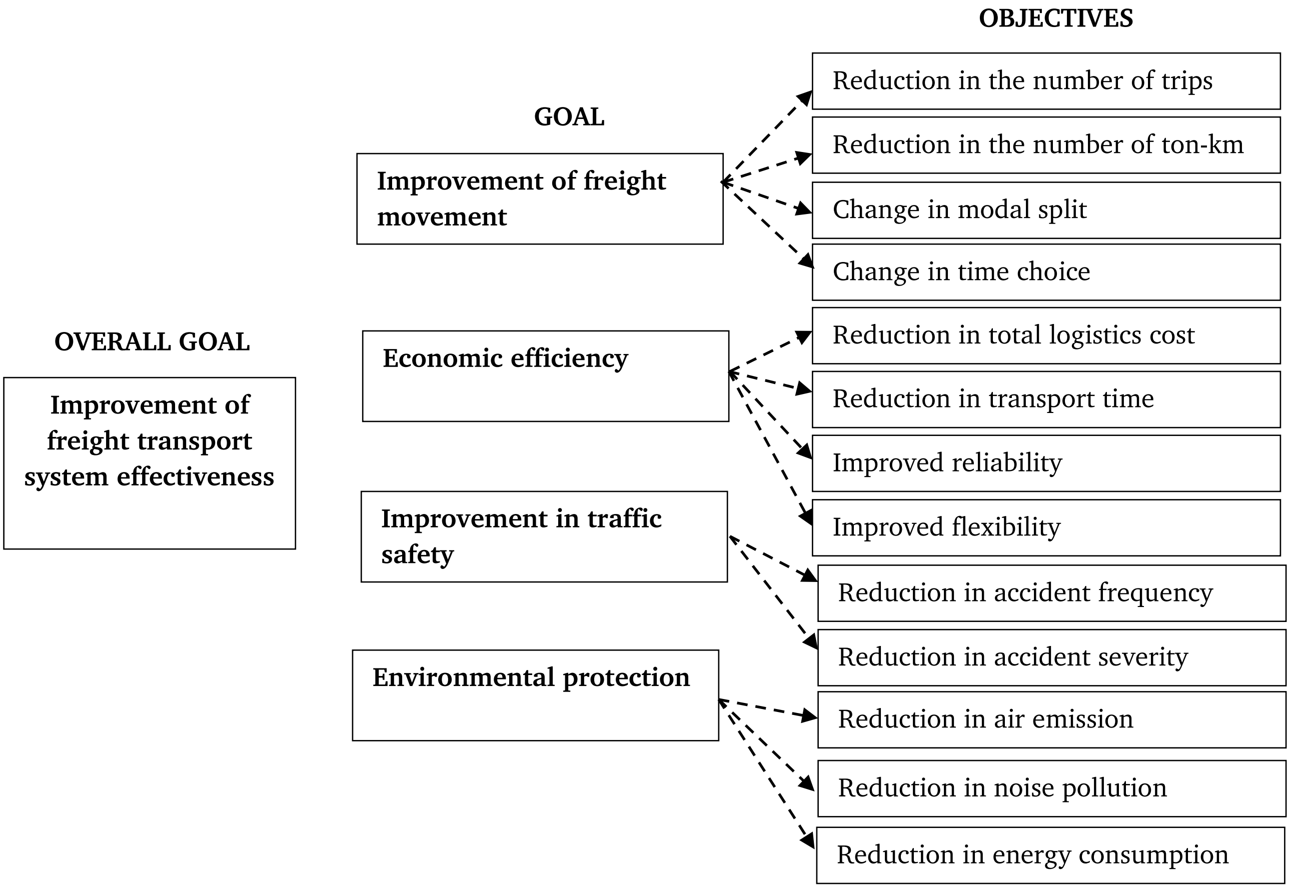
Throughout the whole PDCA cycle, the definition of objectives and impacts boundaries as well as the establishment of criteria and performance indicators utilised for assessing the objectives is essential, since without which it is difficult to solve problems and establish concrete measures to improve freight transport activities. Therefore, the following sections will review the art of objectives setup and identification of various types and levels of impacts as well as assessment criteria in evaluating freight transport management.

3.1.2 Objectives setup

Identification of objectives is an important stage in the impact assessment process. This is because the objectives are considered as a link between problems identified and the ulterior implementation scheme oriented to problem solutions. When describing and formulating the objectives, it was found that no clear and defined method has been developed or applied at this stage in the process. The most common qualitative techniques used are “goals system” or “objective tree” analysis. A diversity of objectives represented in “goal system” or “objective trees” is desirable for the impact assessment since it reflects the different expectations held by various stakeholders. The following example about improved freight transport effectiveness exemplifies the use of “objective trees” in impact assessment process in detail.

The example in Figure 3-2 shows that the objective is clearer when it defined by a hierarchy of desired outcomes. In “objective tree” models, a diversity of goals and objectives are derived, which are geared towards achieving the overall goal. For example, from the overall goal of the improved freight transport effectiveness, goals may involve improvement of freight movement, improvement of economic efficiency, improvement of traffic safety, and environmental protection. If the goal is to improve freight movement, the corresponding objectives could be to reduce the number of trips, to reduce the number of ton per km, change in modal split, or change in time choice of freight traffic. Analogous to this, multiple objectives can be associated with other goals of the freight transport system

Figure 3-2: An example of "objective trees" in assessing the efficiency of a freight transport system



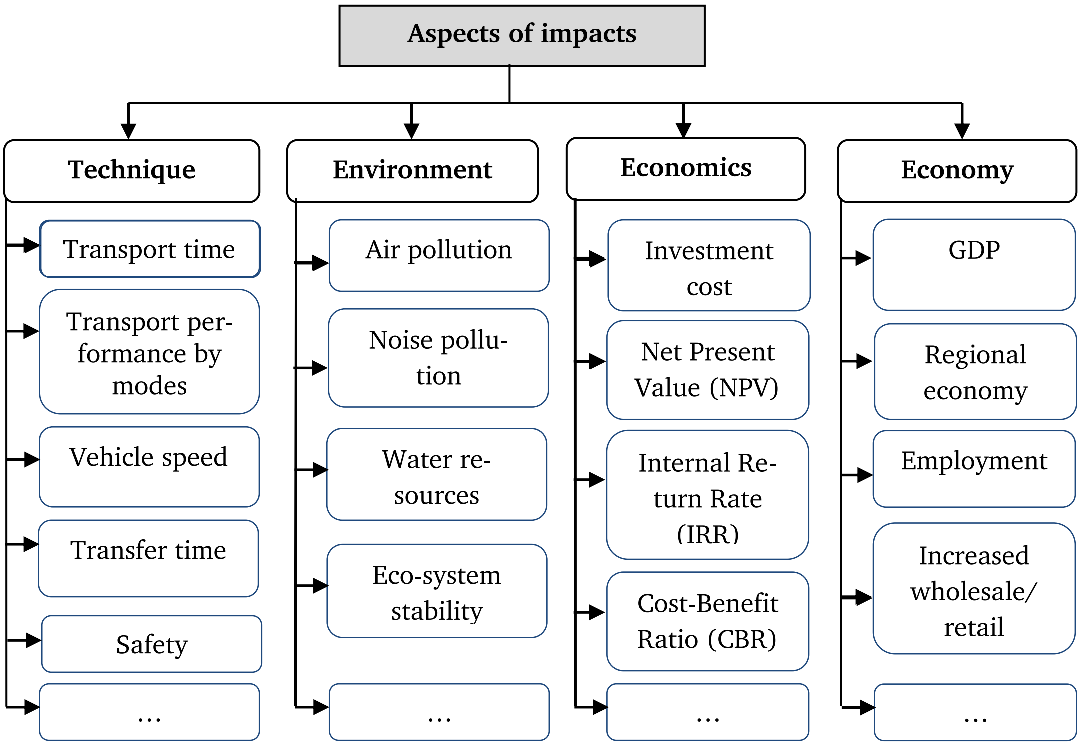
Source: Own representation (2014)

3.1.3 Impact categories and types

Determination of impact boundaries is also a primary component of the objective formulation process. This step can help to outline the content of the objective tree more clearly and establish timelines more easily for better implementation and monitoring. Technical impacts are directly associated with the change in movement of goods as tangible impacts. The specific contents of these impacts could be decreasing/increasing transport time, total tonnage moved by modes, and vehicle speed, for example.

The literature review shows some quantification of the technical impacts of FTM measures (Browne et al., 2005). FTM measures contribute not only to changing traffic and transport dynamics but also impose impacts upon the environment and the society (so called environmental impacts and socio-economic impacts). These impacts can be either positive or negative. The decline in air quality and noise associated with the construction of intermodal freight logistics centre is an example of negative impacts where the implementation of a specific measure may be linked to health problems from increased CO2 emissions due to rising freight traffic volume in and around a centre. On the other hand, however, this centre would be expected to increase the number of jobs in the area, and promote the development of wholesale and retail networks in the region. Figure 3-3 briefly demonstrates various aspects of impact possibly occurring as the results of measure implementation within the freight transport system.

Figure 3-3: Aspects of impact caused by FTM



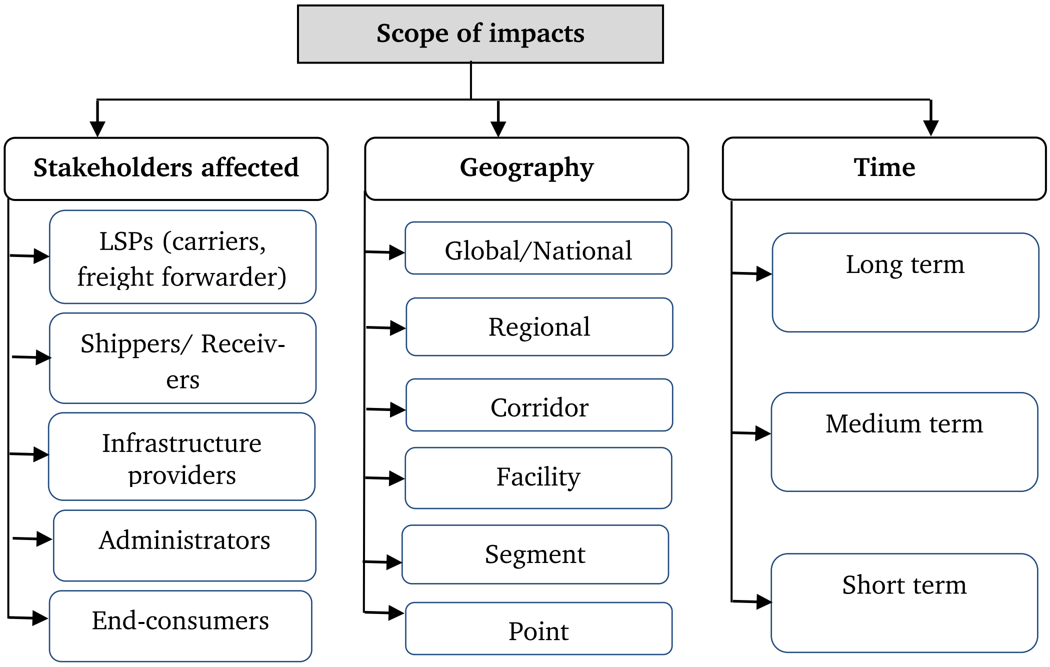
Source: Sinha and Labi (2007)

In carrying out impact assessment work, it is critical to take into consideration not only various aspects of impact but also the dimension of the evaluation or the scope of impacts. By doing so, we can clearly decline scope of the study and identify the appropriate performance criteria to be considered in the evaluation. The possible scope of FTM measure impacts is shown in Figure 3-4.

The scope of impacts can be classified into three dimensions: stakeholders affected, geographical aspect, and temporal scope. Stakeholders affected are identified not only from within transport user groups but also include non-transport users. For example, the construction of an intermodal freight logistics centre may affect: (i) LSPs (by changing the mode and route choices or their total logistics cost); (ii) shippers (by changing shipment size or frequency); (iii) residents or end-consumers living near an intermodal freight logistics centre (by creating noise pollution and air pollution); (iv) receivers (by improving delivery reliability or reducing less storage cost); (v) city government or administrators (by possibly creating new jobs, and making the area more attractive for economic development).

The quality of impact assessment is influenced by the geographical scope of the impacts. As shown in Figure 3-4 a range of spatial scopes for the analysis exists, from be small locations such as a point (i.e. intersection) and segment (i.e. transport link), to bigger ones like facility (combination of nodes and segments) and corridor (collection of facilities), and even very large areas like city, region, country, and globe. Normally, the degree of impact assessment complexity is aligned with the study area, and a specific geographical scope is typically connected to a specific impact type and stakeholder demographics. For example, policies on time-window for trucks entering the city applied to a specific location may strongly affects LSPs (i.e. carriers, forwarding companies) and receivers (i.e. wholesalers/retailers) by dictating delivery time and route choice.

Figure 3-4: Scope of FTM measure impacts



Source: Adapted from Sinha and Labi (2007)

3.1.4 Assessment criteria and performance indicators

Based on the identification of objectives, the criteria and performance indicators for evaluation can be established. The aims of such criteria are to supplement the specified goals and objectives mentioned in the previous section. There are two kinds of criteria: qualitative and quantitative criteria. Both of these can be used to measure physical and visible (measurable) outcomes as well as changes in attitudes and behaviour, which are often less tangible and not always easy to count.

In practice, the choice of criteria depends very much on which stakeholders are focused in the impact assessment, and the types of impacts to the assessment team want to better understand and assess. For example, if we want to assess the impacts of a consolidation centre on carriers, the assessment criteria could be the change in the number of vehicle trips, change in the number of vehicle-kilometres, change in the number of vehicle used, change in total fuel consumed, or change in vehicle emissions. Clearly, those criteria are directly associated with carriers and geared toward achieving economic freight transport efficiency.

The literature review has revealed that a multi-criteria system is often employed for transport impact assessment (BESTUFS II, 2006; Browne et al., 2005; Sinha and Labi, 2007). This criteria system allows the evaluation of various alternatives (policy measures, scenarios and technologies for examples) by taking into account different objectives of the stakeholders involved in the decision-making process. Steer Davies Gleave's (2009) research on the evaluation of EU's Common Transport Policy (CTP) from 2000 to 2008 identifies three assessment criteria groups for transport policies as presented as Table 3-1.

Table 3-1: Assessment criteria categories

Society	**Mobility and Accessibility**	Concerned with the ability to move and reach different facilities and locations
	Safety	Concerned with reducing number of vehicle collisions and accidents
Economy	**Economic improvement**	Concerned with improving economic efficiency for transport users and non-users.
Environment	**Environment and resources**	Involves reducing direct and indirect impacts of transport facilities on the environments of both users and non-users.

Source: Steer Davies Gleave (2009)

All assessment criteria obviously correlate closely with the objective system mentioned in the previous section. They cover various aspects of impacts, however still at the abstract level. Looking more closely at the freight transport system, the study reviewed five studies on performance indicators for freight transport policy impact assessment. By matching the performance indicators from reviewed studies with general assessment criteria given by Steer Davies Gleave (2009), a comparison with the results from other case studies becomes possible (see Table 3-2).

Sinha and Labi (2007) proposed a long list of candidate performance indicators for various transportation program goals and objectives. They are represented in qualitative and quantitative terms. Accordingly, the freight transport sector is often evaluated on four main aspects: mobility and accessibility, operational efficiency, economic development and quality of life, and safety and environment consideration. For each aspect, there is a set of possible performance indicators stated in measurable terms that reflect the satisfaction of the transport user as well as the concerns of the administrators or other stakeholders. However, since the objectives of Sinha and Labi 's assessment is project development, multiyear programming, budgeting, and financing, most proposed indicators are considered from project level.

BESTUFS II project (2006) suggested a multi-criteria impact assessment for urban freight measures and structured criteria them into six categories. They are freight volumes in urban areas, urban freight transport fleets, urban deliveries, contribution to economy, environment, and safety. For each category, a number of performance indicators are defined and an initial data set is collected. These proposed indicators clearly reflect all impact dimensions of freight transport within urban areas.

Browne et al. (2005) authored a large body of literature relating to urban consolidation centres and established a bundle of performance indicators used to assess the impacts of these centres. Among them, relatively few of the indicators contain quantification criteria for the mobility, accessibility, and safety and environment impacts. The most commonly quantified impacts are changes in vehicle trips, vehicle kilometres, parking time and frequency, total fuel consumed, and vehicle emissions.

At the early stage of freight transport impact assessment research, Taniguchi and Tamagawa (2005b) examined the methodology of assessing the city logistics measures while taking into account various behaviours of stakeholders involved in freight transport activities. There are five stakeholders considered in their research, including freight carriers, shippers, residents, administrators and urban express operators. From their research, performance indicators for each stakeholder are developed. Since these proposed indicators are mostly based on assumptions that stakeholder's behaviour is pre-defined and stakeholder economic attributes (e.g. economic scale, amount of sales) are fixed, they may be meaningfully applied at the micro level to assess the impact of a single freight measure on a specific transport corridor.

Table 3-2: Overview on impact assessment performance indicators concerning FTM measures

Categories defined in Steer Davies Gleave (2009)	Summary of performance indicators concerning impact assessment of FTM measures			
	Taniguchi and Tamagawa, (2005b)	Browne et al., (2005)	BESTUFS II, (2006)	Sinha and Labi, (2007)
Mobility and Accessibility	Freight transport time Time reliability Delay time at customer	Change in number of vehicle trips Change in number of vehicle kilometres Changes in number of vehicles used Changes in travel time Vehicle load factor	Volume transported into urban areas Logistics costs Share of urban transport costs compared to total supply chain Population density and share of population in urbanized areas	Travel time Delay, congestion Connection and transfer Modal choice Population access to destination Percentage of wholesale and retail operators in the economic centre
Safety	Not mentioned	Injuries and death resulting from freight traffic accidents	Number of accidents Number of fatalities	Number and cost of incidents Involvement of freight vehicles in accidents
Economic improvement	Minimize transport freight costs Reduce total shipper costs Increase toll revenue for expressway operators	Changes in operating costs Contribution to congestion	Number of jobs in transport Number of transport related companies	Indirect jobs supported and created
Environment and resources	Reduce NOx truck emissions Reduce number of complaints from residents	Change in fossil fuels consumption Change in vehicle emission Other quality of life issues	Fuel consumption by vehicle types Energy consumption in urban FT Non-renewable fuel consumption	Air pollution Fuel usage Impacts on wetlands and other ecosystems

Source: Taniguchi and Tamagawa (2005b); Browne et al. (2005); BESTUFS II project (2006); Sinha and Labi (2007)

Table 3-3: Summary of criteria and performance indicators for FTM impact assessment

Objectives	Criteria category	Performance indicators (*)
Improvement of freight movements	Freight transport performance	▪ The number of ton-km ▪ The number of vehicle trips ▪ Total travel time ▪ Vehicle load factor ▪ Average trip length ▪ Average line-haul speed ▪ Loading/unloading time ▪ Transfer time between modes ▪ Modal split by ton-km ▪ Temporal shift
	Accessibility	▪ The number of intermodal facilities ▪ Time to access intermodal factilities ▪ Delay of freight vehicle at facility per ton-km ▪ Percentage of whosales, retails and manufacturies within a specified distance from freight facilities
Improvement in economic efficiency and development	Economic efficiency	▪ Revenue per ton-km by mode ▪ Cost per ton-km by mode ▪ Tons transported per hour ▪ Total time of the whole supply chain ▪ Total logistics cost ▪ Reliability ▪ Flexibility
	Economic development	▪ Percent increase of freight facilities used ▪ Direct and indirect jobs created ▪ Increase of business sales ▪ Economic attractiveness of the city and region
Improvement in safety	Safety of goods	▪ Risk of damaged shipments ▪ Risk of lost shipments
	Safety of road-user	▪ The number of accidents caused by freight transport ▪ Cost of accidents caused by freight transport ▪ Percentage of accident frequency ▪ Percentage of severe accidents ▪ Involvement of freight vehicles in accidents
Environmental and resource conservation	Exhaust emissions	▪ Share of freight transport in exhaust emissions ▪ Tons of pollutants generated ▪ Air pollution ▪ Noise pollution
	Resource conservation	▪ Typical fuel consumption by vehicle type ▪ Energy consumption in freight transport ▪ Consumption of non-renewable fuel resources ▪ Water quality ▪ Habitat degradation ▪ Land use ▪ Wetland and ecosystem

(*) This list of indicators is not exhaustive and each assessment criterion only provides simple examples among the various formulations in literature

To sum up, Table 3-3 summaries criteria and performance indicators for FTM impact assessment, and these are compared with the four impact dimensions identified by Steer Davies Gleave (2009). Having established the dimensions on scope and potential impact assessment criteria for FTM measures, the next section is to focus on discussing the requirements and criteria for the selection of an assessment method.

3.2 Requirements and criteria for the selection of the assessment method

This section discusses meta-assessment criteria, which are used for the selection of an assessment method. TASTe (1999) proposes objectives of an assessment process and their relevant criteria as presented in Table 3-4.

Table 3-4: Assessment process objectives and evaluation criteria

	Maximize significance	Minimize errors	Minimize efforts	Maximize acceptance
Input	Consider all relevant influences	Recognition and consideration of errors in the database	Minimize cost of data collection and preparation	
Implementation	Accurate representation of reality Ensure the consistency of the applied models	Minimize errors in the impact appraisal	Minimise cost for hardware and software Minimize cost for the execution	Ensure the reproducibility of the evaluation process
Output	Aiming to full and high quality results Describe the correctness of statements	Minimize errors in reading results Minimize errors in inter-pretting the results	Shorten the decision -making process within the planning process	Ensure comparability of results
Others	Enable the applicability of results to other plans		Enable the continuation of the assessment process	Proper selection of actors and communications in the assessment process

Source: TASTe (1999) and Boltze/Plank Wiedenbeck (1998), S.19f

Following the proposal of TASTe (1999), the selection of the assessment method should comply with the objectives of the study and also fulfil the objectives of the assessment process defined as maximize significance, minimize errors, minimize efforts and maximize acceptance. When analysing the detail assessment criteria some conflicts may arise. For example, minimizing the errors or an increase in acceptance will be difficult to achieve without significant expenses in term of costs, personnel and time. Further, higher quality and therefore accuracy of results generally requires an increased effort in dealing with specific measures.

In a study on the assessment of method for the modelling and appraisal of the sub-national, regional, and local economic impacts on transport, McCartney et al., (2013) develop a set of meta-assessment criteria which can help to identify the features of a good method including its strengths and weaknesses. Fornauf, L (2015) also complies a list of meta-assessment criteria that can be used for the strategy selection in the dynamic traffic management context. The detail of meta-assessment criteria are presented in both studies is presented in Table 3-5.

Table 3-5: List of meta-assessment criteria used to evaluate the suitability of various methods

Meta-assessment criteria		**Explanation**
McCartney et al., (2013)	**Fornauf, L (2015)**	
Consistency	Structural consistency	A good method should provide a strong foundation in terms of the underlying theory and principle that form the framework for the method.
Empirical evidence	Reliability	A good method should provide empirical evidence to support the claimed impacts of the scheme and indicate the robustness and uncertainties associated with the evidence.
Dependency on other factors	Inter-subjectivity Comprehensive Spatial reference	The method should clearly explain whether the impacts are dependent on the transport policy alone or other factors
Counterfactual	Transparency Traceability Practicality	The method should make the impacts transparency and allow for easier comparison regarding to cost-benefit analysis.
Data use and availability	Minimization of efforts Time reference	It is important to understand the requirement of data used in the method, and the limitations of the approach if required data is not available.
Calibration and validation	Validation Compatibility with other methods	These criteria determine the suitability and robustness of the methods.

Source: McCartney et al. (2013) and Fornauf, L (2015)

To sum up, the selection of a suitable assessment method should depend on the objectives of analysis and data availability. For this study, the chosen method is expected to capture effectively the impacts on different stakeholders involved and understand the core effects of FTM measures. Therefore, a list of key meta-assessment criteria possibly used for the method assessment is proposed in the following table (see Table 3-6).

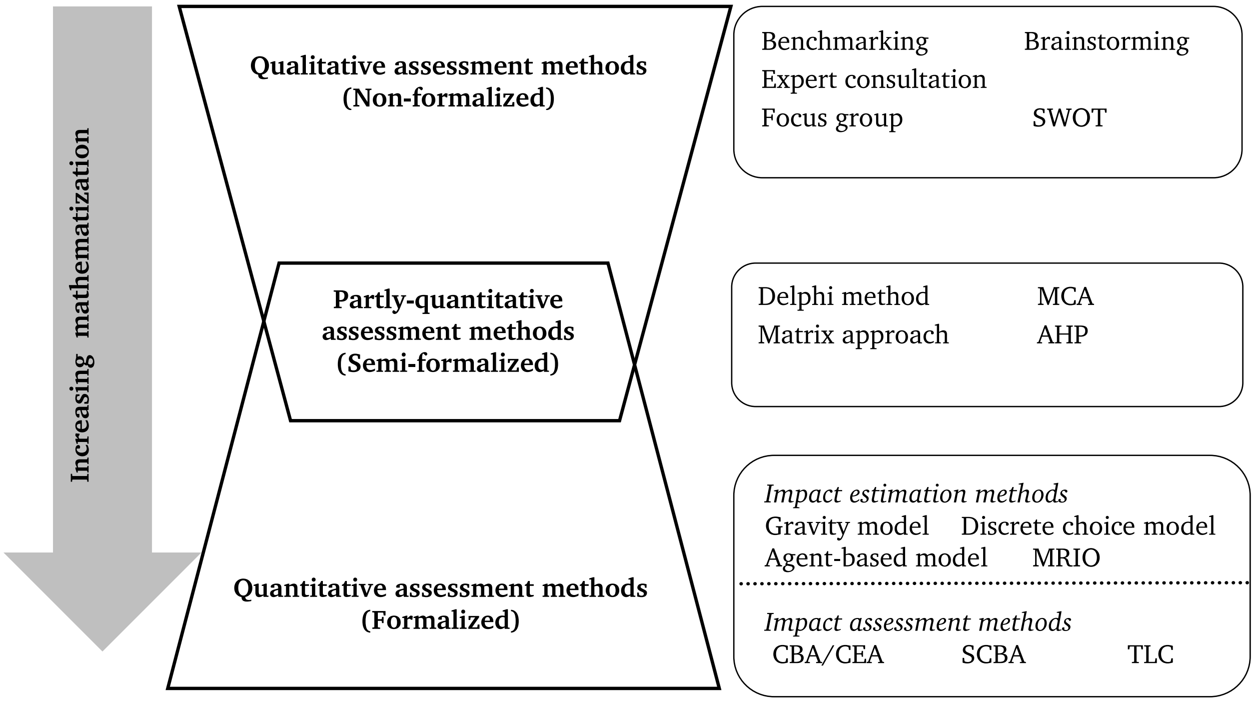
Table 3-6: Proposal of meta-assessment criteria for the selection of FTM assessment methods

Effectiveness in capturing impacts	**Availability of reliable data**	**Minimization of cost and time**	**Acceptance maximization**
Clear objective and mechanism to assess the impacts Take into consideration different stakeholder interests Ability to prioritize of the measures Ability to give insight and explore the causality of impacts Provide scientific or quantitative tools to support policy decision-makers	Ability to collect enough data for to meet requirements at different levels of analysis	Minimizing cost for data collection and preparation Minimizing cost for implementation of evaluation	Ensuring the reliability of results from the assessment process Easy application for similar phenomenon

3.3 Review of 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, in order to develop an impact assessment method for FTM measures, it is necessary to identify and examine comprehensive and innovative existing impact assessment methods employed in the freight transport sector.

Figure 3-5: Categorisation of impact assessment methods for FTM measures



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 Fornauf, L (2015)

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.

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 3-5 summarizes impact assessment methods which have been applied in the freight transport sector and identified in the literature review. The following paragraphs will not explore in depth the rationales underpinning those methods; however, some key aspects and some illustrative examples of application in the freight transport sector shall be highlighted.

3.3.1 Qualitative methods

Benchmarking

Benchmarking is defined as a continuous and systematic process of comparing products, services, processes and outcomes with other organisations or exemplars, for the purpose of improving outcomes by identifying, adapting and implementing best practice approaches (Scott, 2011). There are two types of benchmarking: qualitative and quantitative benchmarking. Illustrative examples of benchmarking methods are identified as follows:

- Benchmarking Intermodal Freight Transport by OECD (2002)
- Use of Benchmark Methodology in Environmental Impact Assessment (Pubule and Blumberga, 2010).

In OECD (2002), the focus is comparing the most important dimensions of intermodal performance among EU members contributing to sustainable development, and then insight is provided into the reasons for performance differences. Attention is then paid to theoretical foundations for performance improvement. The OECD research also points out various difficulties in benchmarking intermodal activities such as the use of aggregated freight indicators (e.g. ton-kilometres), the complexity in defining intermodal transport chain, high level of data requirement. Finally, the research comes up with the need to draw conclusions carefully from the application of benchmarking methods in the intermodal freight transport sector for two reasons. First, it is immensely complex to benchmark the entire intermodal transport performance since this chain includes a broad range of activities and their interactions, and second, there is often a lack of consistency in comparable data.

The benchmarking method is also used in the initial assessment of environmental issues caused by projects in Latvia (Pubule and Blumberga, 2010). The benchmark methodology to evaluate environmental impacts involves three main steps. First, indicators from relevant environmental assessment research are collected. Then the choice of eco-criteria for benchmarking method is made based on the judgment of these above indicators in qualitative and quantitative manners. For this step, regression analysis is employed to set up first equation to measure the eco-criteria. Finally, different empiric benchmark equations are proposed to determine range of criteria values which conform to principles of sustainable development.

These illustrative examples indicate that benchmarking method can be employed for first assessment of initiative impacts. In order to carry out further analysis of impacts, other methods need to be incorporated alongside benchmarking in order to identify and address the core potential benefits and problems that may arise during the application of specific measures.

Brainstorming

Brainstorming is typically viewed as a process of generating creative ideas and solutions through intensive and free group discussion (Osborn and Alex, 1963). Analysis, discussion, or criticism of the arisen ideas generated is allowed only when the brainstorming session finishes and the evaluation session begins.

A representative example of the application of a brainstorming approach is the study of "Intelligent Growth in the Transport Corridor Germany-Scandinavia; Visions for Sustainable and Connecting Infrastructures and Strategies" (Gaßner and Christian Kamburow Robe, 2006) within the COINCO project (2006). At the outset of the project, a group of experts were invited to join a workshop on the topic. Three groups were formed; each group drafted a list of criticisms of the development of Germany-Scandinavia transport corridor and associated impacts. The study gathers a list of ideas spontaneously contributed by experts during brainstorming session, and based on session outcomes, conclusions on potential impacts can be generated.

The method is quite simple, inexpensive and needs few material resources. Also, many ideas can be generated in a short time. However, there is often a lack of reliable criteria to determine the quality of solutions. Therefore, this method is recommended for use during the initial stage of assessment procedures.

Expert consultation

This method is often adopted in the process of developing policy and legislation. However, in some cases, it can be applied in the ex-ante impact assessment process to identify the potential impacts of some specific measures. The formulation of the proposal for the Logistics Action Plan in the EU (EU, 2007) is an example. During the preliminary stage of the project, the EU launched a number of workshops and conferences as forums for consulting industry actors, experts and other interested parties over choices for action. Next, an interview survey of representatives was carried out and the data generated was used to rank the importance level of measures contained in the Action Plan based on their perceived benefits.

It is clear that consultation of interested parties is a qualitative method which is more suitable for the step of option analysis in ex-ante assessment processes. Throughout the consultation phase, the policy maker can listen to, take note and consolidate as much information as possible from all interested parties - a necessary process for policy makers responsible for deciding and implementing selected measures.

Focus groups

Focus groups are also a common qualitative method used to identify impacts of freight transport systems. This method focuses on interviews with affected communities (public and private), often taking place during initial stage of the assessment procedure.

As stated in the guideline for freight policy, planning and programming in small-and medium-sized metropolitan areas (Cambridge Sys., 2007), focus groups are frequently used in assessing the potential impacts of freight transport projects. Stakeholders consisting of industry representatives (carriers, manufacturers, and retail operations for example.) and the general public (for instance, residential areas, community centres) located in close proximity to the project area are involved in series of meetings and discussions to identify qualitative impacts and issues. Based on discussion outcomes, a summary of potential impacts is generated and fed into prioritization and funding activities. There is often a dynamic within focus groups, which makes them quite different to individual expert interviews.

Focus groups are employed widely in initial stages of the impact assessment process, and can help to outline key impacts of proposed measures, however do not yield precise analysis of those impacts.

Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis

SWOT analysis is seen as an effective qualitative assessment tool. This approach originates from business and marketing literature and encourages groups to analyse and assess the strengths, weaknesses, opportunities and threats of a particular strategy and develop an implementation plan accordingly. SWOT analysis is used for various qualitative impact assessments in different fields including in freight transport measures and city logistics solutions. Interviews or surveys with decision-makers, key stakeholders, strategic planners, experts, and employees are necessary to identify the strengths, weaknesses, opportunities and threats, which are basis for building up a SWOT matrix.

Focusing specifically on the topic of freight transport, SWOT analysis can be utilised in assessing a group of freight transport and logistics measures within a city or in an organization. For example, Papoutsis et al. (2012) employed SWOT analysis to assess the best practice in urban logistics solutions. A range of city logistics solutions such as urban consolidation centres, clean vehicle standards, urban freight transport management procedures, and supply chain monitoring with the use of information and communication technology (ICT) tools are investigated via SWOT analysis. Also, this research process identifies the needs and implications for successful implementation of each measure. Chen (2011) used SWOT analysis to evaluate logistics processes in a company. He divided the logistics processes into multiple stages including purchasing and ordering, warehousing, transportation and delivery, and reserve logistics. The advantages, disadvantages as well as opportunities of each step are then investigated through interviews survey with experts and key stakeholders involved in logistics processes.

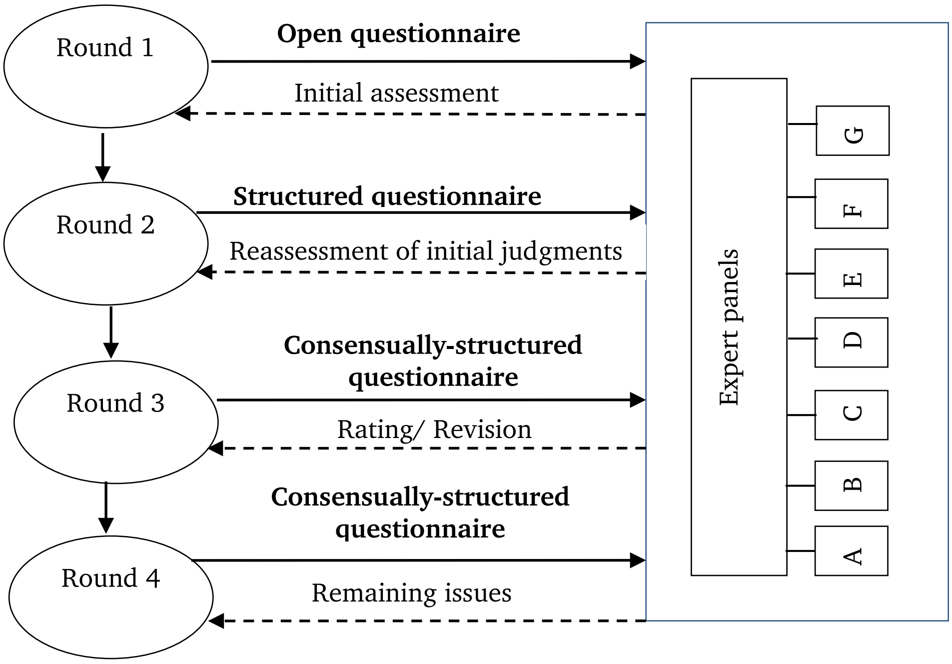
SWOT analysis is a useful tool for qualitative assessment even though its structure is quite simple. It enables decision-makers to deal with a complex problem at reasonable cost by using structured brainstorming session. However, this tool does not provide a mechanism for ranking the significance of one factor versus another within any list. As a result, it is difficult to offer key solutions or alternatives to deal with problems identified via the analysis.

3.3.2 Partly-quantitative methods

Delphi method

The Delphi method is understood as “a structured communication technique, originally developed as a systematic, interactive forecasting method which relies on a panel of experts. The experts answer questionnaires in two or more rounds" (Hsu and Sandford, 2007).

Figure 3-6: Organisation of the Delphi process



Source: Adapted from Hsu and Sandford, 2007

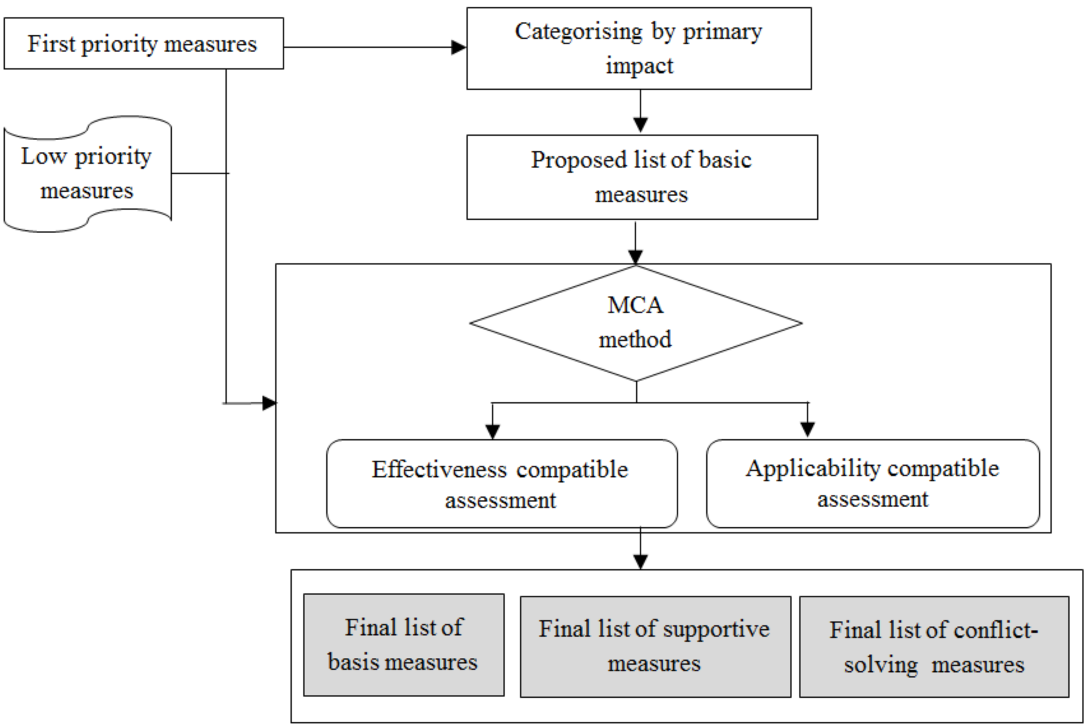
This method is used in various studies such as program planning, policy determination, impact assessment, and resource utilization. The ultimate goal of this technique is to gain a convergence of opinion concerning real-world knowledge solicited from experts within topic areas. Theoretically, the Delphi method is a continuous circle designed to achieve consensus among experts. However, this process, in practice, often consists of three or four rounds of data collection, depending on the degree of consensus. In the first round, the Delphi process traditionally starts with sending an open-ended questionnaire as a cornerstone to gather the opinions of exerts on the study area. After receiving this initial feedback, investors convert this information into well and consensually-structured questionnaire. This questionnaire is then used to survey experts in the second round. Each Delphi participant is asked to review and reassess his/her initial judgments about the information provided in the previous stage. As a result of the second round, areas of disagreement and agreement are identified (Wigan et al., 1995). In the third round, all interviewees receive the final questionnaire which summarizes all items and their rating restructured by the investigators, and participant experts are asked to revise or make further clarifications on their judgments regarding the relative importance level of different items. For the final round, the results of the weighting exercise, remaining issues and minority opinion are distributed to all participants.

Delphi method involves qualitative and quantitative estimates. The first step of this process deals with judgements of Delphi participant as a kind of qualitative data. Statistic technique are employed in the next stage to measure tendencies (mean, medium) and level of dispersion (standard deviation, range) of the collective responses of survey participants. The incorporation of qualitative and quantitative analysis aims to ensure that opinions generated by each Delphi participant are well represented in the final iteration (Hsu and Sandford, 2007). In the literature review of freight transport research, application of Delphi method includes assessing the environmental impacts of road freight transport (Piecyk and McKinnon, 2009), prioritizing events that have an impact on operations in the maritime domain (Victor et al., 2008), factors that affect location decisions in international operations (MacCarthy and Atthirawong, 2003), and even forecasting the most important issues for transport research needs in the future (Wigan et al., 1995). In most the aforementioned studies, the Delphi method is established as the most appropriate method for getting high consensus in ranking and prioritizing research problems and alternatives. However, the application of this method, in practice, has potential difficulties in terms of subject selection, expert choices and time frame for conducting and completing a Delphi survey. These advantages and disadvantages will be discussed further later in this study.

Multi-Criteria Assessment (MCA)

In theory, MCA mainly involves the following phases. The first is defining alternative management initiatives and identifying what are potential impacts. Usually, the effects of a given measure are presented in ordinal or cardinal scales. Next, a list of assessment criteria needs to be established in order to measure impact. Since it is possible to use different scale factors, a wide range of qualitative impact categorises and criteria can be represented in formats that can be meaningfully compared. Finally, a rating system is employed to compare various measures from both qualitative and quantitative perspectives. Within this method, the rating system involves two steps: weighting and scaling. The weighting of assessment criteria is often obtained through expert survey. The qualitative scaling of an initiative is based on the understanding of the measure under given criteria. Therefore, results of measure comparison must carried out on the expert judgment and argumentative basis.

Figure 3-7: Illustration of the MCA method in the assessment and selection of measures



Source: Khuat, V.H. (2006)

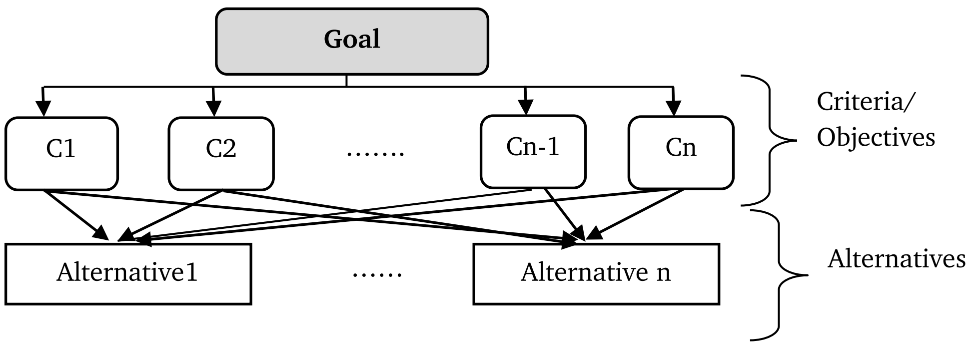
An application of MCA can be found on the work of Khuat, V.H (2006), which focuses on the assessment of traffic management measures and strategies in motorcycle dependent cities (MDCs) (see Figure 3-7). For this study, several FTM measures have been considered for the impact assessment. FTM measures often aim to achieve more than one goal; these can be the improvement of mobility, accessibility, safety, economic efficiency or environmental enhancement. There is always a trade-off among those objectives advocated for by different stakeholders and interest groups.

Many difficulties can arise when attempting to measure all relevant impacts of an FTM initiative with intangible impacts, particularly problematic to evaluate. In this context, the MCA is seen as a suitable tool since it enables multi-criteria analysis to take place via the weighting and ranking of a proposed FTM measure. Also, MCA is useful for a quick classification and initial assessment of a proposed initiative from a social-economic perspective, since this method takes into account multiple stakeholder's opinions on soft and indirect effects. In addition to this, MCA further incorporates the perspectives of researchers, which could reduce bias and eliminate the gap in stakeholders' opinions and therefore can provide a solid foundation for pre-selection. For these reason, MCA will be explored further in the later section of the impact assessment work in this study (in particular in Chapter 5).

Analytical Hierarchy Process (AHP)

The AHP is a typical branch of multi-criteria analysis. It is often used to address different alternatives featuring high degrees of uncertainty, conflicting objectives, different forms of data and information, and multiple interests and perspectives (Beria et al., 2012). The main steps of the AHP are, firstly, the establishment of goal system progressing from the general to the specific. Next, a matrix is constructed addressing the relative values of a set of criteria. Mathematical tools are then employed to generate a list of the relative weights, importance, or value, of the criteria. Finally, a consistency ratio (CR) is calculated to measure how consistent the evaluations are relative to large samples of purely random judgments. In a simplest form, the AHP method can consist of three levels as presented in the Figure 3-8 below.

Figure 3-8: Overview of AHP structure



Source: Saaty (1980)

The AHP is a partly-quantitative impact assessment method since it combines both qualitative and quantitative data in the process. In-depth interviews with experts are conducted to provide data. Normally, experts with deep understanding of the issue are chosen to present their evaluation of the relative importance of assessment criteria. These evaluations are then expressed verbally, numerically or graphically to determine the overall level of importance of each criterion. A pairwise comparison is then performed to verify the evaluation and sensitivity analysis is carried out to determine how strongly the ranking of measures/alternatives is influenced by priorities of the individual expert.

Increasing popularity of the AHP method can be observed in modern theories of freight transport and supply chain management. Berrittella et al. (2007) used the AHP method for evaluation of transport policies designed to reduce climate change impacts. Kayikci (2010) applied the AHP and artificial neural networks (ANN) methods in order to select the most appropriate for a location of logistics centre. Furthermore, Dung (2012) listed out 70 papers published in high quality management journals from 1999 to 2009 that reference use of the AHP method assessment of a range of different supply chain processes.

The AHP has a big advantage that allows for a hierarchical structure assessment criteria. Based on that, the established hierarchy, priorities for different courses of action are formulated. Significantly, AHP incorporates both subjective and objective data in the assessment process, and provides a rigorous mechanism for checking the consistency of evaluations, thus reducing bias in decision making (Beria et al., 2012). Although the use of AHP is quite appealing, limitations remain. This method is often associated with considerable mathematics, and is time-consuming which somehow limits its application in practice. Founauf, L (2015) identifies potential problems that can arise when using the AHP method for the impact assessment. For example, the results of the process change when different goal hierarchies are included. Furthermore, there is often also the problem of an insufficient link between semantic and numerical ratio scales. If a hypothetical alternative A is ranked slightly better than an alternative B, and in turn the alternative B outperforms an alternative C; alternative A will be superior to alternative C, but in reality this is often not the case. However, this is quite justified in the AHP method since assessment outcomes using this method should be arrived at intuitive reasons. For these reasons, the AHP method should be considered carefully in the context of the FTM impact assessment. Advantages and disadvantages of this method will be discussed in further in the later section.

Matrix method

The primary objective of a matrix approach is to indicate cause and effect by listing activities along a horizontal axis and their potential impacts along a vertical axis. Where an impact is anticipated, the matrix is marked with a symbol or number. A pair-wise comparison is then carried out to identify the preferred course of action.

A matrix approach can be employed to assess the impacts of freight transport projects on the environment (Banerjee et al., 2015; Canter, 1996; Glen Dhu, 2010). In the research project on cumulative impact assessment (CIA) for the Eastern dedicated freight corridor 's Ludhiana to Mughalsarai section (Banerjee et al., 2015), series of matrixes on potential environmental impacts have been developed in order to better understand the implications of shifting freight movement from rail to road. Conclusions in terms of broad cumulative impacts of the eastern dedicated freight corridor are also generated.

This approach provides a relatively simple way to list out a large number of potential impacts, which can help to compare options and identify a short list of preferred actions. The drawback of these matrixes is that they often consider primary impacts but do adequately represent the cross cause-effect links of a proposed change and other aspects of freight transport system.

3.3.3 Quantitative methods

Quantitative impact assessment is a key aid for governmental and transport authorities justify implementation of the measures under consideration. For the goal of this study, detailed impact analysis of the measures will be carried out by using some quantitative methods. Hence, general discussion on quantitative impact assessment methods is first discussed. According transport planning process, there are two kinds of quantitative method: methods for impact estimation and methods for the assessment of identified impacts. The common characteristic of these methods is that they enable to provide quantitative results. However, the objectives of these methods have a slight difference. Specifically, the methods for impact estimation often aim at estimating the impacts that can be attributed to a particular intervention or to examine the reaction of actors to innovative policies. Discrete choice model is as for example. A review on the literature has shown that this method could be applied to estimate the impacts of some urban transport policies like road pricing schemes or parking charges on mode choices of different groups of transport-user. The model results are simply reflected the change of mode choices of commuters to policy introduction. The primary objective of methods for the assessment of identified impacts is to assess quantitatively the indicators associated with proposed policy interventions. The indicators are often adequate reflection of the objectives of the measures and stated in measurable term, hence can provide transparent results that are easily compared. A typical method for the assessment of identified impacts is cost-benefit analysis. All relevant effects possibly caused by the measures are translated into costs and benefits, which uses common measure unit of a direct comparison for assessment. The detail contents and illustrative examples for the use of these different kinds of method will be presented in details in the following texts.

Impact estimation methods

Gravity model

The gravity approach is often used to model freight distribution flows. In a such model, the flows between zone i and j is assumed to be directly proportional to the level of economic activity in these zones and negatively related to the distance (proxy for transport cost) between them. Note that the gravity model usually considers a "balancing" of productions and attractions. Balancing means that total productions and attractions for a study area are equal. The basic form of gravity model is:

$$T_{ij} = \frac{A_J F_{ij} K_{ij}}{\sum(A_j F_{ij} K_{ij})} * P_i$$

Where

T_{ij}: Freight trips produced at zone i and attracted at zone j

P_i: Total freight trips produced at zone i

A_j : Total freight trips attracted at zone j

F_{ij}: Impedance between zone i and zone j (generalized transport cost)

K_{ij}: A socioeconomic adjustment factor

The parameters of the gravity model are based on historical data and are usually statistically significant.

A review of the existing literature on the gravity model has shown that it works at the level of aggregated flows. The SIMLE model (Tavassy, 1998) is an example. Under this aggregated model, the differences of various commodities and trade patterns between regions are often neglected, leading to a challenges in reaching conclusions for decision-makers in regard to particular sectors and commodities.

For this study, to capture the core effects of FTM measures in a particular sector, the analysis requires detailed knowledge of the sector, stakeholders involved and their decisions. Consequently, the feasibility of the gravity model is limited as it does not adequately address the effects of sector-specific information or stakeholder behaviours on the outcomes of regulatory changes.

Discrete choice model

Discrete choice models are often used to explain and predict choices between two or more discrete alternatives, such as the choice of transport mode and vehicle size. An overview of discrete choice model methodology can be found in the work of McFadden (2001). This model is based on random utility theory that predicts customer behaviours or purchasing choices as influenced by utility maximisation or cost minimization. The basic forms of discrete choice models are logit and nested logit types. These models closely relate the choice of each person or sector to the attributes of the person/sector and the attributes of the alternatives, by which the probability of choosing a particular alternative can be estimated.

There is quite a large body of literature relating to the application of discrete choice models in the freight transport sector. The work of de Jong and Ben-Akiva (2007); Ben-Akiva, Bolduc, & Park (2008); Arunotayanun (2009); Fries. N et al., (2010) are typical examples. Most of these studies employed discrete choice models to estimate impacts associated with modal shift between road transport, railway and combined road and railway transport.

There are some challenges associated with the application of discrete choice models in freight transport. The difficulties are caused by the high degree of heterogeneity in stakeholders and diversity of freight transport alternatives. There are many stakeholders involved in freight transport activity and they often have different concerns of their own (see Section 2.1.1). Friedrich, H. (2010) pointed out some main causes for heterogeneity and diversity in freight transport. Firstly, each of stakeholders (i.e. companies) can have different logistics structures, different possibilities for bundling commodity flows, and also different outsourcing of logistics services. Hence, availability of logistics service alternatives can be very different depending on the actor. Secondly, the existence of numerous discrete alternatives can result in combinatorial problems (i.e. the warehouse location problem).

For this study, in order to apply a discrete choice model in the example sector, many behavioural data on micro level are needed. The logic behind different behaviours is that their use of modal choice and route choice differ. Therefore the detailed data associated with modal choice decision (i.e. transport time, freight rates, lot-size, frequency) should be analysed. Unfortunately, such data is not available in this study. Instead, the approach of minimizing total logistics cost based on the detailed knowledge of stakeholders and their behaviour is used to model modal choice decision-making patterns. Therefore, TLC model seems to be more powerful in explaining the structure of a specific sector when articulation of the influence of cost and other factors on transport selection and resulting modal shift.

Agent-based model

The agent-based model increasingly applied in assessing urban freight and city logistics initiatives (Tamagawa et al., 2010; Taniguchi and Tamagawa, 2005a; Wisetjindawat et al., 2006). In agent-based modelling, the stakeholders are described individually with their own objectives outlined, and they tend to behave in line with achieving those objectives. Since this approach deals with very detailed behavioural level analysis, it can connect to discrete choice models. More specifically, both models try to identify possible reactions of stakeholders to policy interventions. The model of Taniguchi and Tamagawa (2005) is an example. This study works on modelling logistics decisions involving shipment size, use of distribution centres, mode and vehicle type, and loading units at the firm level. Following this detailed analysis, the impacts of urban freight measures such as truck ban, road pricing, or logistics consolidation centre emerge as changes in delivery time, truck size, shipment size or mode shift occurs at firm level.

The big advantage of the agent-based model commonly recognised in the literature is the ability of the model to facilitate the explicit examining and modelling of different behavioural changes of stakeholders to policy interventions potentially capturing the causality of impacts (Holmgren et al., 2014). However, Knaak and Kruse (2006) have identified limitations to this method in terms of model validation and calibration.

Multi-regional input output (MRIO)

It is apparent from the literature that the impacts of FTM measures can be effectively evaluated via the application of the MRIO model. The MRIO is often used to generate inter-sectorial and inter-regional commodity flow matrices with high levels of aggregation. The MRIO model put forward by Cascetta (2009) and Cascetta et al., (2013) are examples. These studies seek to determine the deliveries between sectors based on "observational data of economic links between zones by sector pairs" (Tavasszy et al., 2014). Within this model, there are often two conversions including from sector classification to commodity classification and from flows in money units to flows in tons. In order to construct an MRIO model, existing standard conversion tables and value-to-weight data are necessary. According to Tavassy et al., (2014), a MRIO approach is useful for freight modelling given its focus on from economic linkages since freight transport demand is considered as directly related to these linkages. The results of this freight model can then provide freight transport-land use interactions, namely the influence of spatial distribution on transport. Because of the existence of intermediate warehouses systems however, the MRIO model does not accurately reflect freight transport flows. Furthermore, the behaviours of stakeholders involved in freight transport system are neglected in this approach. This fact may cause difficulty in explaining the causality of identified impacts.

To sum up, MRIO model is useful for analysis at the level of aggregated flow, however, is based on fix coefficients from statistics. The impacts best explored by the MRIO model are hence often those related to some typical aspects of a transport network such as new modal splits, altered aggregate traffic assignment, or other change in logistics structure.

Impact assessment methods

Cost-Benefit Analysis (CBA) and Cost-Effectiveness Analysis (CEA)

Cost-Benefit Analysis has historically been the standard technique used in transport infrastructure appraisal. Today, it is still widely recognised as a basic tool in a majority of European countries and the international consulting agencies (Eliasson, 2009; Lambert and Bray, 2012). According to the Guide to CBA for investment projects (EU, 2008), the CBA appraisal method is defined as a process of quantifying the costs and benefits of the impacts of a proposed initiative in order to have a single scale of comparison for evaluation. From a practical point of view, the performance of CBA across different countries could have some differences in term of unit prices and general economic parameters used; however, it always refers to a single theoretical framework. CBA is based on monetisation and temporal discount (Beria et al., 2012). All transport costs and benefits related to a measure or policy are translated into a similar monetary unit. It should be noted that the monetizing process covers not only visible costs and benefits but also their non-monetary attributes. Temporal discounting is used to convert future costs and benefits into present values for consistency of comparison.

Cost-Effectiveness Analysis (CEA) is an alternative to CBA when the benefits are not able to monetised within method standard CBA framework. Unlike the CBA method, CEA compares the relative cost to the effectiveness of the measures in fulfilling a particular objective, i.e. the volume of CO2 emission that can be reduced per unit of implementation cost of the measure. The literature review has shown that CEA can help decision-makers to answer basic questions such as which measure can bring the highest effectiveness at the lowest cost or which measure can provide the highest effectiveness for a given total cost (Kok et al., 2011). It is obvious, within the CEA approach, expected outcomes are pre-defined and this ensures that the measure being applied will contribute to accomplishing stated outcomes.

Regarding the freight transport sector, the application of CEA for the impact assessment of freight transport initiatives is often limited to specific issues such as pollution emissions and noise. For example, Corbett et al. (2009) employed CEA to assess the impact of vessel speed reduction on CO2 mitigation for international shipping. The authors structured a profit-maximization function with three variables of the speed, fuel use and CO2 emissions. In the next step, they tried to investigate how shipping firms ‘motivation for profit maximization CO2 emissions affects ship speed and CO2 emission generation. They achieved quite a good ratio of cost and effectiveness. Specifically, average speed-related CO2 reduction could reach 20%-30% if fuel tax is set at $150/ton fuel. However, estimation based on the assumption of constant shipping demand is a significant limitation of this study.

Moving to the topic of the freight transport sector, although widely applied in the evaluation of transport infrastructure projects, CBA and CEA are rarely utilised in assessing the impact of FTM measures. Instead, the combination of CBA and multi-criteria analysis (MCA) is seen more often in the literature review. For example, Kapros (2011) assessed the expected impacts of intermodal freight villages in term of their financial and socio-economic aspects. CBA is one criterion in their integrated method focusing on potential private benefits and contribution to national economy.

It can be said then that, difficulties in defining fully and accurately the scope of costs and benefits, to some extent, makes CBA and CEA appraisal methods less popular in the freight transport sector. To overcome these limitations, the incorporation of CBA and MCA has become a promising approach for the impact assessment of freight transport management policies or initiatives.

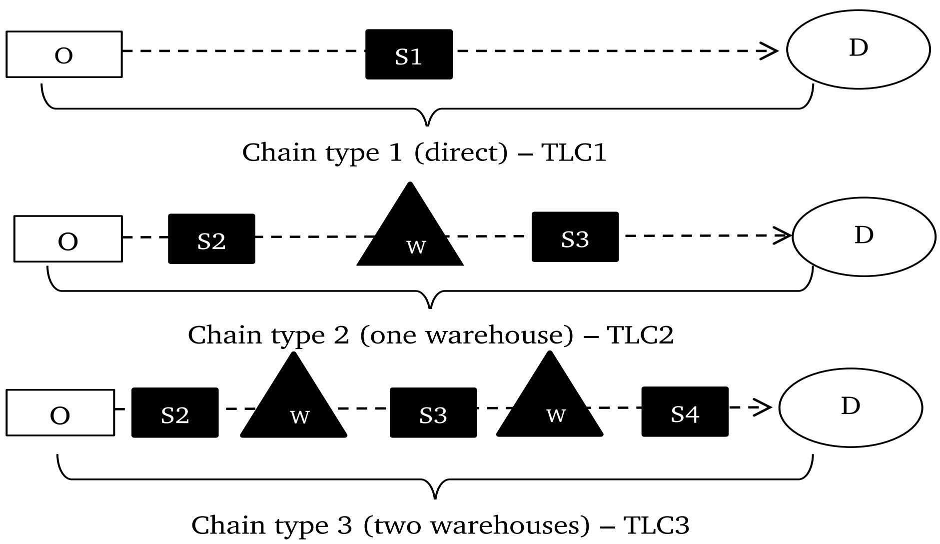
Social cost benefit analysis (SCBA)

Social-cost benefit analysis (SCBA) is seen as an extension of CBA that incorporates non-monetary costs and benefits related to social and environmental impacts. In the other word, SCBA aims at quantifying economic, social and environmental costs and benefits, by using monetary values. Gonzalez-Feliu (2014) developed an SCBA-based analysis framework for the assessment of a strategy scenario in the context of railway project development, which covers all kinds of possible costs and benefits generated for investors, carriers, passengers, and society. The proposed framework is applied in evaluating the freight tramway project in Paris (France). The interesting result demonstrated that the project is not effective from a CBA evaluation due to negative internal rate ratio (IRR). However, solid equilibrium can be arrived by adding non-monetary costs and benefits such as a decrease in pollution, noise and congestion for example. SCBA can therefore be a useful tool for decision-makers seeking to impose policy interventions without discussion and consensus among stakeholders. As a result, a SCBA appraisal should provide a solid foundation for decision-making groups justify implementation of the measures under consideration.

Total Logistics Cost (TLC) 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 3-9: 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 (Chapter 5).

3.3.4 Conclusions

With such a large body of literature reviewed, a number of impact assessment methods for FTM measures have been identified, methods that differ in scopes and core objectives as well. It is difficult to compare these methods directly due to the fact that each of them is identified as suitable for a given objective, scale of activity and resource set. For this study, the question of how to develop a comprehensive method for FTM impact assessment cannot be answered by advocating for one method or another, but requires utilising a combination of approaches, for example TLC used within a logit model. The next section will focus on the evaluation of all methods mentioned above in terms of advantages, disadvantages, and application to the freight transport sector.

3.4 Discussion of existing methods

As noted above, this section aims to discuss advantages and disadvantages of each impact assessment method relevant to the freight transport sector.

Qualitative assessment methods

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. Furthermore, some qualitative methods have the ability to explore the causality of impacts within their context, SWOT methods for instance. It can be stated then that most qualitative assessment methods are relatively simple and inexpensive compared to other assessment techniques. The common characteristic of these methods is that they allow the issue under analysis to be explored not through one lens alone, but rather multiple lenses, which enables solid justification of FTM measures with reference to different aspects of anticipated impacts. The input data for these approaches require less use of mathematical formula during analysis. However, the key disadvantages of qualitative methods lies in the challenges associated with explaining the core effect of measure. Qualitative methods support thorough understanding of a range or list of important impacts, but hardly provide a rigorous mechanism for ranking the significance of one impact versus another within the list. In addition to this, most indicators used in the qualitative impact assessment processes are formed at an aggregate level, thus limiting the quality of assessment. Qualitative methods are further prone to higher degrees of subjectively and therefore potentially bias in research results. Detailed pros and cons of each qualitative method used in FTM impact assessment process are presented comprehensively in **Table 3-7.**

To summarise, qualitative approaches provide a major advantage in quickly highlighting a range of problems and their potential impacts. Also, they often facilitate significant involvement of stakeholders in the assessment process, which can allow for multiple aspects of the problems to be revealed and understood. The most significant disadvantages of these methods are potential subjectivity and limited explanation of the causality of impacts. Furthermore, analysis of qualitative data lacks a rigorous and scientific base for the generalisation of conclusions.

For the purpose of this study, to formulate a comprehensive framework for the impact assessment of FTM measures, qualitative methods are suggested for use in defining a list of potential impacts possibly caused by FTM measures. Based on possible impacts generated from qualitative assessment, quickly screening and narrowing down of the list of measures for assessment can take place. Among the methods considered, brainstorming, expert surveys and focus group could be ideal for achieving this stated objective. The rational is that these methods often consider multiple dimensions of impacts by considering the opinions of various stakeholders involved in freight transport. Moreover, they have the ability to generate a clear mechanism for classifying and assessing qualitatively the impacts of specific measures. For these reasons, the study will employ these qualitative methods for the first assessment stage of FTM measures.

Partly-quantitative assessment methods

As discussed previously, 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. Detailed advantages and disadvantages of each method are discussed as follows.

The Delphi method produces a high level of consensus in the impact assessment through use of multiple iterations of expert surveys, which results in the generation of a list of impacts under consideration and rating for relative levels of importance each potential impact. However, the disadvantage of this method is that implementation can be complex in practice due to the need for the selection of panel experts, making the method time and cost consuming.

MCA and AHP are powerful tools for selecting alternative policies or strategies since they take into account various impact dimensions (for example, socio-economic, environmental, safety, and mobility aspects) and further facilitate involvement of different stakeholders in the assessment process. More specifically, intangible and soft impacts are better measured within MCA and AHP methods; therefore, conclusions arrive at via MCA and AHP widely acknowledged in transport decision-making processes. Broadly speaking, the MCA and AHP appear more rigorous and formal, providing a rational framework for weighting and ranking the relative level of importance of FTM measures. Nevertheless, the technical procedures involved MCA and AHP are quite complex and sensitive to the changes in the goal hierarchy system and the scales established at the beginning of the impact assessment process. Additionally, the assignment of a numerical scale in qualitative assessment, from the most important to the least important, is not always sufficient. The reason for this is that the assessment of experts as verbal comparison can go through such a varied range of emotion than numbers. Both methods also neglect to provide sufficient insight into the causality of policy impacts. Particularly, the reaction of stakeholders to policy intervention cannot be adequately captured via these methods, and their usefulness in identifying causality is limited.

The matrix method is a simple technique for listing out a large number of potential impacts and it enables the inclusion of qualitative comments on their causes and effects. However, given specific characteristics of freight transport as heterogeneous and the diversity of potential alternatives; the limitation of this method is that typically only primary impacts are illustrated within matrices. In addition, the overall impact estimate is a number or single mark, thus the ranking order of overall impacts can be quite different when qualitative data is represented in numerical scale. Detailed pros and cons of each partly-quantitative method are presented in **Table 3-8**.

Moving to focus of this study, there is often a bundle of measures that can be applied in the freight transport sector. Given a specific situation, these measures can have differences in their degree of importance. For the reason of efficiency, it is not appropriate to evaluate all measures for an impact assessment. Therefore, this study will carry out a pre-selection and classification process to identify which initiatives to assess. A review and analysis of the pros and cons of partly-quantitative methods has revealed that the Delphi, MCA and AHP methods can be powered useful tools for fulfilling this objective. Those methods allow for screening of the impacts under considerations with reference to of socio-economic, environmental, safety, and mobility implications in order to provide useful overall comparisons between proposed FTM measures. However, the Delphi, MCA and AHP methods are often more subjective in nature and do not provide sufficient insights into the causality which noted above. For these reasons, within a comprehensive framework for impact assessment that this study will develop, the recommendation is to use these tools for initial selection and quick assessment of potential impacts. This step in the process will provide input data for the prioritisation of measures for assessment, allowing the selection of specific measures for detailed quantitative analysis.

<u>Quantitative assessment methods</u>

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, CBA, CEA, and SCBA deal with the detailed quantitative level of costs and benefits possibly caused by freight transport activities. These methods are especially useful in assessing impacts in terms of economic efficiency, hence can provide transparent results that are easily communicated. In addition, CBA, CEA, and SCBA facilitate the comparison between different policy interventions since they generally use common units of measurement. SCBA methods in particular usually reflect the interests of various stakeholders involved, which can provide compelling evidences for policy decision-making. Nevertheless, CBA, CEA, and SCBA also face some limitations in practice. Most encounter difficulty in precisely defining and quantifying all kinds of external costs and benefits caused by freight transport. Therefore, the potential for double counting is a visible risk. Moreover, these methods do not take into account interactions among stakeholders. Instead, they are based on the assumption that there is equal willingness-to-pay among stakeholders (for example CBA, SCBA). This may consequently provide assessment outcomes that focus on quantitative data related to policy implications in terms of costs and benefits but that do not offer sufficient explanation the reasons behind those impacts.

The TLC, discrete choice and agent-based models are seen as disaggregate approaches that focus on detailed analysis of stakeholder behaviours. The big advantage of such methods is the ability to model fundamental reactions of stakeholders to policy intervention, which ultimately enables explanation of the causality of impacts. The TLC model focuses on detailed population of commodity flows and allows taking into account mode and route choice for each commodity flow in the impact assessment process. Also, TLC has the ability to explain the most important drivers within a sector and their interdependencies which determines the behaviour of stakeholders. Meanwhile, the agent-based model deals with detailed behavioural level and then explains possible reactions of stakeholders to policy interventions. However, the agent-based model often encounters numerous difficulties related to validation and calibration. The discrete choice model can be applied to estimate and explain freight modal section based on shipper characteristics. However, while the discrete choice model is a powerful tool in analysing of discrete alternatives for passenger transport, its application is challenging in the freight transport sector due to the heterogeneity of stakeholders and diversity of alternatives present. Finally, three disaggregate approaches mentioned above demand high volumes of data and large amounts of processing work in order to model all entities at a micro-level.

Unlike disaggregate approaches; gravity model and MRIO are especially useful in large-scale impact assessments at s international, national or regional levels. Data requirements for these models are limited compared to disaggregate approaches. However, they operate based on the assumption of deterministic stakeholder relationship, and this presents a difficulty in explaining policy impact causality. Detailed information on pros and cons for each quantitative method is shown in **Table 3-9**.

Table 3-7: Advantages and disadvantages of qualitative impact assessment methods

	Benchmarking	Brainstorming	Expert consultation	Focus groups	SWOT analysis
Application in the evaluation process	Ex-ante Ex-post	Ex-ante	Ex-ante	Ex-ante	Ex-ante Ex-post
Pros of method	Clear objective and mechanism to compare different aspects of freight operation to similar phenomenon Possibly classify and assess qualitatively (or even quantitatively) the impacts of measures Simple and low cost	Involvement of many stakeholders in the qualitative impact assessment Ability to generate ideas around potential impacts in a short time Simple and inexpensive technique	Utilization of deep knowledge of experts for the impact assessment Quick highlighting of problems and potential improvements	Participation of many stakeholders in impact assessment process Ability to define anticipated impacts with low level of effort Consideration of a wide range of impacts	Possibly deals with complex issues through a simple structure Ability to explore the important factors affecting measure implementation and its impacts
Cons of method	Utilises aggregate indicators which could make the assessment results misleading Need large range and volumes of data, sometimes unavailable Narrow scope	Lack of reliable criteria to determine the quality of assessment Does not provide insights into causality of impacts	Potential subjectivity Hard to explain the causality of impacts	Lack of rigorous scientific basis for conclusion generalisation Potential divergent data collection possibly influencing the results	Does not provide mechanism to rank the significance of one factor versus another within the list Does not sufficiently explain core effect of the measure under assessment

Source: Own representation

Table 3-8: Advantages and disadvantages of partly-quantitative impact assessment methods

	Delphi	MCA	AHP	Matrix approach
Application in evaluation process	Ex-ante Ex-post	Ex-ante Ex-post	Ex-ante Ex-post	Ex-ante
Pros of method	Ability to assess impacts and prioritize measures Possibly reach consensus in assessment of the impact intervention Combination of qualitative and quantitative techniques in impact assessment	Suitable for the assessment of socio-economic aspects of FTM measures Participation of many stakeholders in the impact assessment which can enlarge "democracy" in term of public discussion Combination of subjective judgments and quantitative estimation in the assessment process	Clear and rigorously applied mechanism to measure and compare different alternatives featuring high uncertainty and conflicting objectives Allows ranking and prioritizing of measures	Indicates qualitatively the causes and effects of a measure and its potential impact Useful in environmental impact assessment Simple technique
Cons of method	Difficult to design effective Delphi study due to high demands associated with of expert selection Potential subjectivity Time and cost consuming involves many rounds of expert survey)	Potential ambiguity and subjectivity Does not provide insight on causality of impacts Does not consider public expenditure efficiency Extensive data requirement Possible lack of consistency in comparing data	Potential insufficient link between semantic data and numerical scale Inaccurate sensitivity to changes 's stakeholders behaviour Involves considerable computing and is time-consuming	Only considers primary impacts Simple comparison of different impacts using single mark or verbal explanation Does not sufficiently explain core effects of the measure under assessment

Source: Own representation

Table 3-9: Advantages and disadvantages of quantitative impact assessment methods

	Gravity	Discrete choice model	Agent-based model	MRIO	CBA/CEA	SCBA	TLC
Application in evaluation process	Ex-post	Ex-post	Ex-post	Ex-post	Ex-ante Ex-post	Ex-ante Ex-post	Ex-post
Pros of method	Enables modelling freight transport demand between a particular spatial distribution and origin Ability to assess impacts on a large-scale, such as international, national or regional levels	Enables prediction of mode and logistics choices Potential to include many causal variables in the model	Ability to model stakeholder behavioural changes resulting from policy intervention Potentially captures the causality of impacts	Links to wider economy (production and consumption sectors) Ability to consider the impacts of land-use on transport systems	Clearly define the impact in term of economic efficiency Use common unit of measurement when screening and ranking measures Transparent results and easily communicated	Incorporates both monetary /non-monetary costs and benefits Provides scientific tools to support policy decision-makers	Focuses on detailed level of commodity flows and locations of distribution Enables explanation of stakeholder behavioural changes resulting from policy intervention
Cons of method	Based on deterministic stakeholder relationship Neglects the differences in commodities and trade patterns across regions	Needs disaggregated data (shippers, commodity flows, Stated Preference Survey)	Limitations to model validation and calibration High requirement of input data and large amount of processing power	Does not consider intermediate steps in the spatial distribution (i.e. warehouse systems)	Limited ability to monetise external impacts Based on various assumption (e.g. equal willingness-to-pay) Extensive data requirements	Difficulty in determining exact external costs and benefits Potential double counting of costs and benefits Complicated estimation process	Acknowledges only TLC driver factors leading to changes in stakeholder behaviour Extensive data requirement and completed analysis

Source: Own representation

Conclusion

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. For efficiency reason, it is not appropriate to do impact assessment of all measures as well as select only one single method for all circumstances. Therefore, a multi-stage assessment method is necessary for first assessment of classification of measures, and then detailed quantitative analysis of specific measures.

3.5 Developing a multi-stage impact assessment method for FTM measure

This section focuses on formulating a method for assessing FTM measures. The formulation is based predominantly on the analysis of the cons of each impact assessment method as discussed in the outcomes of the previous section. Next, the detailed processes associated with each step in the method are discussed. Finally, conclusions and recommendations are provided in the last part of this section.

A literature review on impact assessment methods enables this study to propose a comprehensive impact assessment method for FTM measures as presented in **Figure 3-10**. As presented in Figure 3-10, a multi-stage impact assessment method has been developed which systematically integrates various FTM measures and evaluates them at different levels of detail. Essentially, the proposed method is comprised of two main assessment stages. The first stage aims to assess and classify FTM measures via qualitative or partly-quantitative methods. The second stage focuses on specific measures identified in the first stage and core anticipated effects are assessed using methods that employ detailed quantitative analysis. The following parts of this paper will discuss the contents as well as the techniques possibly used in each assessment stage.

<u>The first assessment stage</u>

The first assessment stage involves two main objectives: defining problems and a list of potential FTM measures to deal with those problems; and weighting and ranking these measures. In fact, **it is of critical importance to determine and sufficiently understand the problems to be solved and list of potential measures**. This is because the quality of subsequent impact assessment stages depends on whether problems are correctly defined or not. Numerous techniques are useful for problem definition at this stage. The most common qualitative techniques are brainstorming, focus groups, and expert consultation. These methods enable highlighting of problems associated with freight transport and of potential FTM measures to deal with these problems. It is of note that most of these techniques involve a wide range of stakeholders in the assessment process, which allows multiple existing aspects and potential freight transport problems to be identified and understood. These techniques also facilitate formal recording via listing of potential measures to solve these problems.

After defining the problems and understanding their reasons, latent effects and amplitude, as well as proposing a list of potential FTM measures, it is necessary to **check the interdependency of proposed measures**. The rational for that is there are existing interdependencies between measures in freight transport, production and logistics. This results in a strong need to assess these interdependencies and design a measure package that will achieve system optimization. Therefore, for each goal in freight transport management (mentioned in Section 2.1.2), the relationship between measures is qualitatively assessed to determine the way in which the proposed measures are independent, complementary or substitutability. The assessment can be facilitated through expert consultations or a survey of stakeholders.

For effectiveness assessment criterion, the relationship between measures are evaluated as the followings:

- *Independent:* the implementation of two measures (M_i and M_j) together yields a similar level of effectiveness as the implementation of each measure individually, as presented in the following formula:

  $$\text{Effectiveness } (M_i + M_j) = \text{Effectiveness } (M_i) = \text{Effectiveness } (M_j)$$

- *Complementary:* the implementation of two measures (M_i and M_j) together yields a higher level of effectiveness than the sum of effectiveness attained by implementing each measure individually

  $$\text{Effectiveness } (M_i + M_j) \geq \max \text{ (Effectiveness } (M_i)\text{; Effectiveness } (M_j)$$

- *Substitutability:* the implementation of two measures (M_i and M_j) together yields a lower level of effectiveness than the implementation of each measure individually, as presented in the following formula:

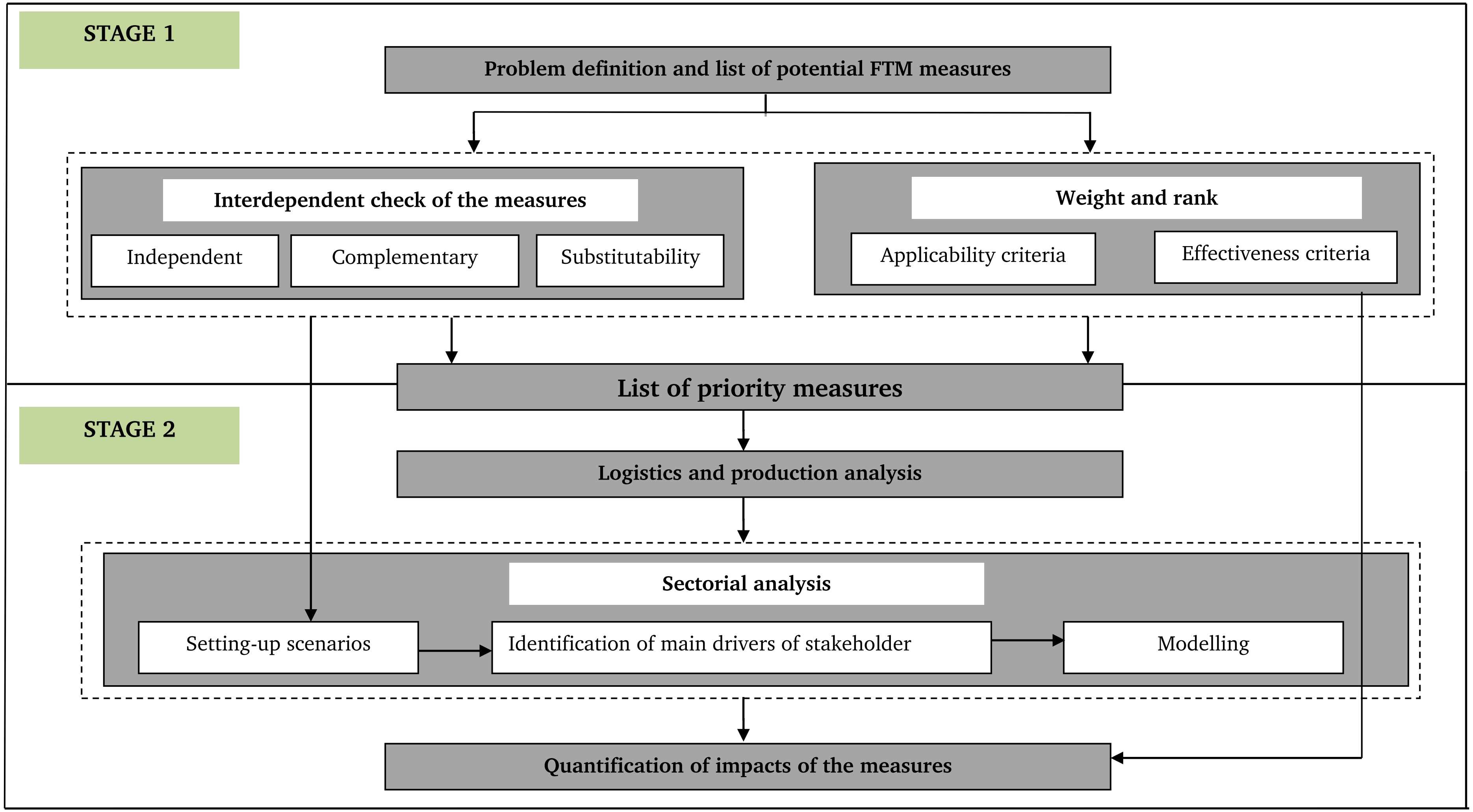
  $$\text{Effectiveness } (M_i + M_j) < \max \text{ (Effectiveness } (M_i)\text{; Effectiveness } (M_j)$$

After checking the interdependency of measures, a method is established **to weight and rank the importance level of these measures**. A review and analysis of the pros and cons of the assessment methods has revealed that the Delphi, MCA, and AHP methods are powerful tools for fulfilling this objective. These methods allow for screening of the impacts under considerations to determine socio-economic, environmental, safety, and mobility implications, which ultimately allows for an overall comparison between FTM measures. In addition to this, the involvement of multiple stakeholders in the assessment process demonstrates the effectiveness of these methods in terms of generalization of inclusions.

Following process outlined above, two hierarchical groups of criteria are employed to weight and rank FTM measures, namely ***Effectiveness*** representing the expected impacts and ***Applicability*** representing the main barriers in implementation of the measures.

Effectiveness is measured by estimating the impacts of measures towards four objectives (criteria): improvement of freight movement; improvement of economic efficiency; improvement of traffic safety; and improvement of environmental protection. Under each objective, there is a set of sub-criteria used to measure impacts and to provide more detail. For example, if the objective is to improve freight transport, the corresponding sub-criteria could be change in the number of trips; change in the number of ton-km; change in modal split; and change in temporal traffic. All objectives are similarly further broken down into relevant sub-criteria, which are geared towards achieving corresponding higher objectives.

Figure 3-10: Proposal of a multi-stage impact assessment method for freight transport management measures



Applicability is also an important criterion for assessing proposed FTM measures. It is often indirectly measured by estimating the barriers or difficulties, which an FTM measure will likely to face in the implementation process. A higher level of difficulty in implementation indicates a lower level of applicability, and vice versa. Normally, there are two main barriers to increasing the applicability of FTM measures - financing the measure and public acceptance.

The criterion of financing proposed measures involves costing, which determines the affordability to the government/city council of the implementing measures. Costs consist of two main components: investment costs and operational costs. In addition, the applicability of measures depends on the support of stakeholders, who are divided into two groups: transport users and non-transport users. Transport users can be defined as actors who directly involved in the transport activities such as carriers, or LSPs. Other actors who do not use any mode of transport but who are indirectly influenced by the implementation of FTM measures are referred to as non-transport users (e.g. shippers, receivers, residents, and public authorities).

Once criteria and sub-criteria in terms of the effectiveness and the applicability have been established, a weighting of criteria is required. The weight assigned represents the relative importance of a criterion; sub-criterion and weighting can be done verbally, numerically or graphically. **The technique commonly adopted to assign weighting and ranking is via expert survey**. In fact, as noted previously, FTM measures aim to achieve multiple goals related to mobility, accessibility, safety, economic efficiency and environmental enhancement. Therefore, there is always a trade-off among those objectives advocated for by different stakeholders and interest groups. Within this context, the selection of experts participating in weighting and rating different criteria need to be handled carefully. Experts may place greater emphasis on objectives that align with their individual perspectives of the perspectives of the group they present; therefore, there is a risk of subjectivity associated with the weighting process. It is recommended then that a range of experts selected for this process represent all interested parties involved in the freight transport system. Specifically, this requires the inclusion of experts representing carriers, shippers, LSPs, transport authorities, residents and administrators. Appropriate representation on the panel or all interest groups can reduce bias and help to eliminate the gaps in criterion selection and overall outcomes of the qualitative assessment. At the end of this stage, a final weight will be estimated for each measure.

The second assessment stage

This stage focuses on **detailed quantitative analysis of pre-selected measures based on a comprehensive sector analysis.** Because of the multi-dimensional nature of FTM measure impacts, interdisciplinary consideration of production, logistics and freight transport system is necessary to identify the main factor driving changes in stakeholder behaviour following policy intervention. Policy application scenarios can then be defined and detailed quantitative impact analysis can take place.

A review and discussion on the pros and cons of different assessment methods has shown that the application of disaggregate models is highly necessary to capture and estimate the core effects of an intervention. Consequently, this study proposes methods for possible use in detailed analysis of the impacts of FTM measures including the TLC model, agent-based model, and discrete choice model. These models focus on analysis at a detailed behavioural level and differentiate disaggregate population of commodity flows. In particular, it allows for detailed knowledge of structure (of network or sector), stakeholders involved and their potential behavioural changes by which the core effects of proposed measures can be estimated and explained their causalities explained. Finally, as a result, traffic, safety, economic and environmental benefits can be quantified at both company level and transport network level.

To summarise, through this multi-stage impact assessment method for FTM measures it has been established that it is possible to define and classify the FTM measures and their potential impacts. Significantly, this method can help to capture and estimate the core effects of these measures. The proposed impact assessment method also facilitates involvement of a broad range of stakeholders in different stages of the assessment process, increasing the validity of conclusion. The limitation to this method is the need for the extensive data and the large amount of processing work required in the assessment process.

This study plans to take the Vietnamese rice industry as an example sector for application. Among various methods presented in the proposed multi-stage impact assessment method, it is necessary to define methods most relevant to assessing the impacts of FTM measures in the context of the Vietnamese rice industry. Currently, there is a wide range of different stakeholders involved in the rice industry, namely farmers, collectors, millers, polishers, freight transport operators, food companies, wholesalers, retailers, and individual/household consumers. Furthermore, FTM measures in the rice industry have been recognised as closely related to rice production and logistics processes. Rice freight transport plays a connective role in several immediate steps that involves in moving rice commodities from farmers to final consumers in HCMC.

In order to both establish a comprehensive understanding of the context and achieve precise analysis of policy intervention impact, assessment of FTM measures in the Vietnamese rice industry should take into consideration different stakeholders' opinions. Furthermore, significant impacts related to traffic and transport, environment and safety should be assessed quantitatively in order to identify the core effects of proposed measures. By employing the proposed meta-assessment criteria for selection of methods presented in **Table 3-6** this study conducts qualitative evaluation of available assessment methods before reaching conclusions on the most suitable approach possibly to assessing the impacts of FTM measures in the rice industry. Details are presented in **Table 3-10.**

Following the evaluation results, MCA is recommended for the first assessment stage of FTM measures in the rice industry since they take into account several stakeholders' interests and a wide range of impacts. Furthermore, it enables to rank and weight various FTM measures, which are already and potentially applied in the rice industry. Significantly, the application of this method can cause less cost than other ones since this study gets strong cooperation from VINAFOOD 2 and VFA in introducing stakeholders joining the expert interview survey. In the second assessment stage, TLC model could be very useful for the detail impact analysis of the measures in the rice industry. This is because TLC model has a strong ability in quantifying the impacts of FTM measures and explaining their causes. In addition, TLC is also one of the most crucial factors for transport mode choice which has been widely seen in the literature. Meanwhile, modal selection has for long seen as the most traditional decision from shippers' perspective in the rice industry. This decision is not only simply influenced by transport cost but also by other cost elements facing the particular shipper such as rice handling and inventory cost. All of them form total logistics cost for using a particular transport mode. Apart from that, available data is also a strong argument to choose TLC model as key method for the detailed analysis of the impacts of FTM measures in the rice industry.

Table 3-10: Qualitative assessment of different potential methods for the assessment of FTM measures in the Vietnamese rice industry

Meta-assessment criteria	Focus group	Brain-storming	Expert consulta-tion	Delphi method	MCA	AHP	TLC	Agent-based model	Discrete choice model
Effectiveness in capturing impacts									
Clear objective of impact assessment	+	+	+	+	+	+	+	+	+
Taking into consideration of perspectives of different interest groups	+	+	o	o	+	+	+	+	o
Ability to rank measures	-	-	-	+	+	+	o	o	o
Ability to explain causality	-	-	-	-	-	-	+	+	+
Providing scientific or quantitative ana-lytical tools	-	-	-	-	-	-	+	+	+
Availability of reliable data									
Ability to collect enough data to meet requirement at different levels of analysis	+	+	+	o	o	o	+	-	-
Minimization of cost and time									
Minimizing cost for data collection and preparation	+	+	+	o	o	-	+	-	-
Minimizing cost for implementation of evaluation	+	+	+	o	o	-	+	-	-
Acceptance maximization									
Ensuring the reliability of results	-	-	-	o	o	o	+	+	+
Easy application for similar phenomenon	+	+	+	+	+	+	+	+	+

Notes: + Good o Neutral - Bad

☐ Important for the 1st stage of impact assessment

☐ Important for the 2nd stage of impact assessment

3.6 Conclusions

So far, there have been many attempts paid to develop the methods for the impact assessment of transport policies or measures. The application of those methods much depends on the purpose of assessment, the socio-economic context, available budget, available data and other factors. In this chapter, the study tried to comply all methods which can be applied in assessing FDTM measures. They are basically divided into three groups: qualitative, partly-quantitative and quantitative methods. The contents as well as the pros and cons of each method are discussed in detail. The discussion lays an emphasis on the detailed level of impact analysis as the results of the method application. Qualitative methods often allow a quick classification and the first assessment of adopted measures and their impacts, but they do not provide precise analysis of those impacts. Quantitative analysis of the core effects of the measures can, however, overcome some limitations of the qualitative process, but data availability and overall efforts are usually critical. Partly-quantitative methods are somehow useful in weighting and ranking the measures, but they are hardly in explaining the causes of the impacts. As a consequence, the study proposes a comprehensive multi-stage impact assessment method for FTM measures, which comprises of two main stages. The first stage covers two main working items including the definition of problems and list of potential FTM measures to deal with these problems; and weighting/ranking the important level of these measures. In the second stage, a detailed quantitative assessment is implemented to analyse the core effects of FTM measures. The proposed framework also recommends different methods that could be used to fulfil the objective of each stage. Within the multi-stage impact assessment for FTM measures, it is possible to comprehend the whole picture of the impacts, also by which the core effects can be estimated. The limitations of this method may be the requirement of a large involvement of stakeholders in the first weighting and ranking process of the FTM measures; and extensive data together with a complicated estimation process in the stage of detailed analysis of the impacts.

In next chapters, the study plans to take the rice industry in Vietnam as an application case. The reason for choosing this sector is that it has available data to test various kinds of impact possibly caused by FTM measures. Besides, there are a lot of FTM measures applied in the rice industry. Traffic volume due to rice transport is increasing quickly. Vietnam is also known as the second largest rice exporter in the world. The rice industry involves various stakeholders such as farmers, collectors, millers, polishers, food companies, wholesalers, retailers etc. The knowledge on decisions of those stakeholders is very useful for the prediction of their reactions to FTM measures.

4 Analysis of the Rice Industry in the Mekong Delta of Vietnam

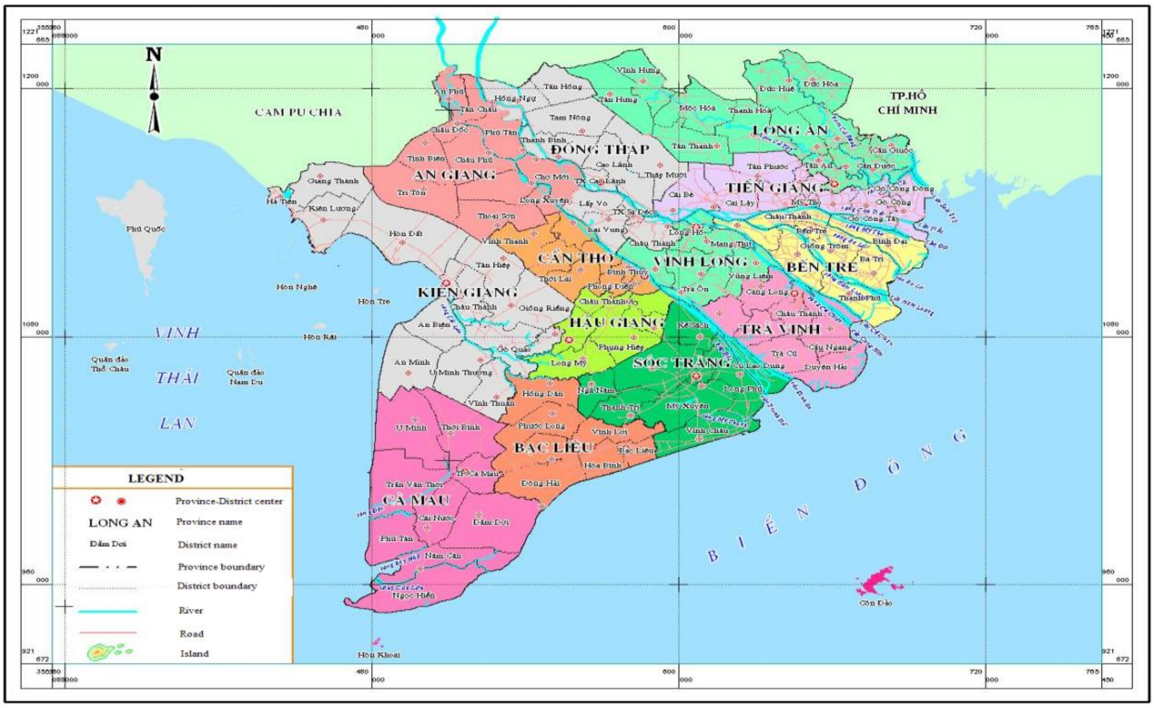
This chapter focuses on analysing the problems of the Vietnamese rice industry and their causes. In section of 4.1, an overview of the rice industry in the Mekong Delta is presented, which firstly briefly introduces briefly the Mekong Delta, then the role of the rice industry in the economic development of Vietnam. Section 4.2 describes in-depth the rice supply chain including its transport modes and transport routes. The performance of the rice supply chain will then be examined in Section 4.3 through analysis of typical indicators such as logistics cost and lead time. Selected safety and environmental issues associated with the rice industry are discussed in Section 4.4. Analysis in all sections is conducted predominantly based field survey data, and reference to data from other studies will be made for the purpose of comparison.

4.1 Overview of the rice industry in the Mekong Delta

4.1.1 Introduction to the Mekong Delta

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 4-1: The Mekong Delta transport networks



Source: http://cuulongcipm.com.vn/Trangchu/tulieu.aspx

The Mekong Delta is adjacent to the Southern Focal Economic Zone (SFEZ) - the most dynamic economic development zone in Vietnam, and is also close to numerous South East Asian countries such as Thailand, Cambodia, Singapore, Philippine and Indonesia. These countries are known as emerging economies (with the exception of Singapore), and are some of the most important partners in the economic development of Vietnam as a whole, and in the economic development of the Mekong Delta in particular.

The freight transport infrastructure system in the Mekong Delta is dominated by two modes, inland waterway (IWT) and road. Generally, the region is generously endowed with an extensive networks of rivers, lakes and canals. Therefore, IWT has always been the primary mode of transportation in the region. Road transportation is mainly concentrated on a number of arterial highways and often fragmented by canals. Maritime and air transport are relatively weak while railway transport does not exist in the region.

To date, this region is still an undeveloped region of Vietnam. Particularly, in comparison with the Red River Delta, the quality of transport in the Mekong Delta is much lower than in the Red River Delta. Only 30.53% of road networks in the region are covered with plastic and concrete, while the percentage is 52.72% in the Red River Delta. The road density is also lower than that of the Red River Delta; however, it is higher than the national average.

Table 4-1: Comparison of the Mekong Delta road network to other regions

No	Region	Road surfaced with plastic and concrete (%)	Density of road network (km/km^2)
1	The Mekong Delta	30.53	1.29
2	The Red River Delta	52.72	1.35
3	All of Vietnam	**28.91**	**0.77**

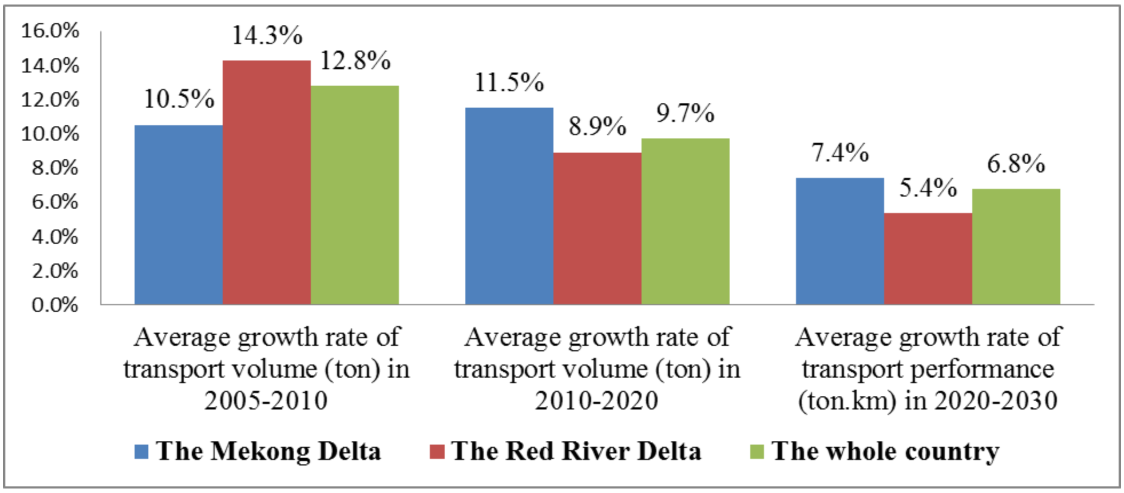
Source: MOT (2010, 2014)

Although the Mekong Delta has many favourable conditions for developing inland waterway (IWT), this system has only been exploited based on existing nature inland waterway lines. The scale of inland ports is very small with low average capacity. The port system in the Mekong Delta is only exploited about 20%-50% of capacity, and only accommodate vessels smaller than 10.000 DWT. Most import-export goods volume are transported through the port system in HCMC. The reasons for this are, firstly, transport access to smaller ports is often limited by the shallowness of channels; secondly, loading/unloading technology at ports is still backward, and so does not adequately support the handling of large cargo volume.

Transport volume in the Mekong Delta has increased quickly from 59 million tons in 2005 to 87 million tons in 2010 (GSO, 2011), making the average growth rate of transport volume for the whole period is approximately 11%/year. In comparison with other regions and the whole country, the growth rate of transport volume in the Mekong Delta is lower than that of the Red River Delta (14.3% per year), and lower still than the average for the whole country (12.8% per year). However, it is forecast that the cargo volume in the Mekong Delta will increase rapidly in the period 2020-2030, even exceeding the average growth rates for the Red River Delta and the country. Detail are summarised in Figure 4-2.

The Mekong Delta is projected to be one of the most rapid growth rate regions in Vietnam. This region also is expected to become a focal economic zone, contributing greatly to the volume of key export items from Vietnam in the period 2020-2030 (MOT, 2010). A typical trend observed in freight traffic distribution in the Mekong Delta is the concentration of its goods trading with HCMC. Specifically, up to 94.4% of commodity volume produced in the region is transported to HCMC for domestic consumption and export. The detail is presented in Table 4-2.

Figure 4-2: Comparison of the freight transport growth rate for the Mekong Delta with other regions of Vietnam



Source: GSO (2011); MOT (2014)

Table 4-2: Distribution of inter-regional freight traffic from the Mekong Delta, 2009

Unit: tons/day

Regions	Red River Delta	Northeast	North Central Coastal	South Central Coastal	Central Highland	Southeast (HCMC)	Total
From the Mekong Delta	3,706	6,229	1,172	892	686	**213,363**	226,048
%	1.6	2.8	0.5	0.4	0.3	**94.4**	100

Source: VITRANSS-2 (2009)

As HCMC is the biggest destination for freight flows in the Mekong Delta, this study will pay special attention to analysis of freight transport activities as well as freight transport policies applied on this corridor. According to VITRANSS-2 (2009) there are thirteen main commodities transported on the corridor from the Mekong Delta to HCMC, of which construction materials and rice have the highest freight volume. The detail of main commodity flows is shown in Table 4-3.

The Mekong Delta is known as an area rich in limestone resource and possesses one of the biggest cement factories in Vietnam. For this reason, the region often provides a huge volume of cement (construction material) for other regions throughout the country. At the same time, the Mekong Delta is also seen as a “rice-bowl” of South East Asia as it is able to contribute up to 90% of Vietnam’s rice export volume. Most of the rice product is transported to HCMC for export purpose.

Table 4-3: Main commodity flows from the Mekong Delta to HCMC

No	Commodity	Total volume (1000 tons/day)	%
1	Rice	47.7	21%
2	Sugar & Sugarcane	5.2	2%
3	Wood and Forestry Products	4.5	2%
4	Iron & Steel	2.8	1%
5	Construction Materials	114.7	51%
6	Cement	5.7	3%
7	Fertilizer	3.9	2%
8	Coal	0.8	0%
9	Petroleum Products	4.6	2%
10	Industrial Crops	2.6	1%
11	Manufacturing Goods	7.6	3%
12	Fishery	6.9	3%
13	Meat and Other Product for Daily Consumption	19.1	8%
Total		**226.1**	**100%**

Source: VITRANSS-2 (2009)

4.1.2 The role of the rice industry

For a long time, rice has been a dominant food item for approximately 55% of the world's population, widely distributed from Asia to Africa, and the Americas. From the early 1990s until now, Vietnam has been ranked among the three leading rice-exporting countries in the world.

Table 4-4: Ten biggest rice exporters in the world, 2010

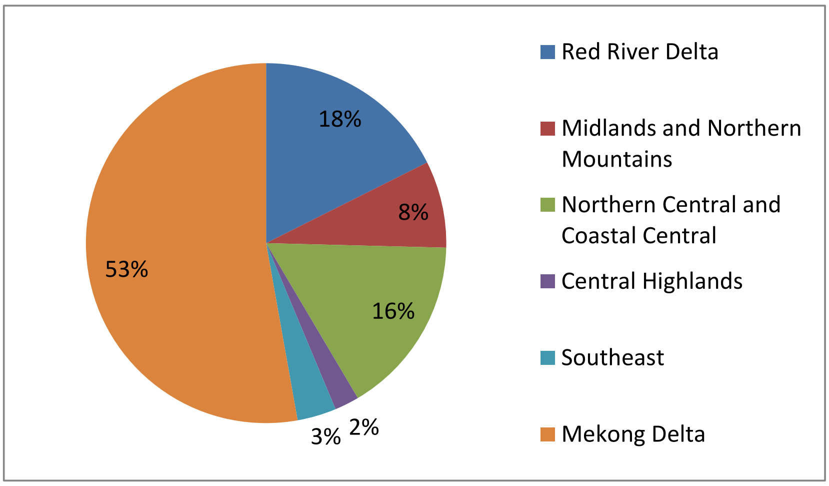
Export Country	Export Volume (Mio ton)	%
Thailand	9,047	29.1%
Vietnam	**6,734**	**21.6%**
United State	4,501	14.5%
Pakistan	4,000	12.8%
India	2,150	8.0%
Cambodia	0,85	2.7%
Uruguay	0,804	2.6%
Burma	0,800	2.6%
China	0,619	2.0%
Brazil	0,423	1.4%
Total global exports	31,135.000	

Source: UNDP (2011); VFA (2011)

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 4-3.

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.

Figure 4-3: Rice production by region in Vietnam, 2010

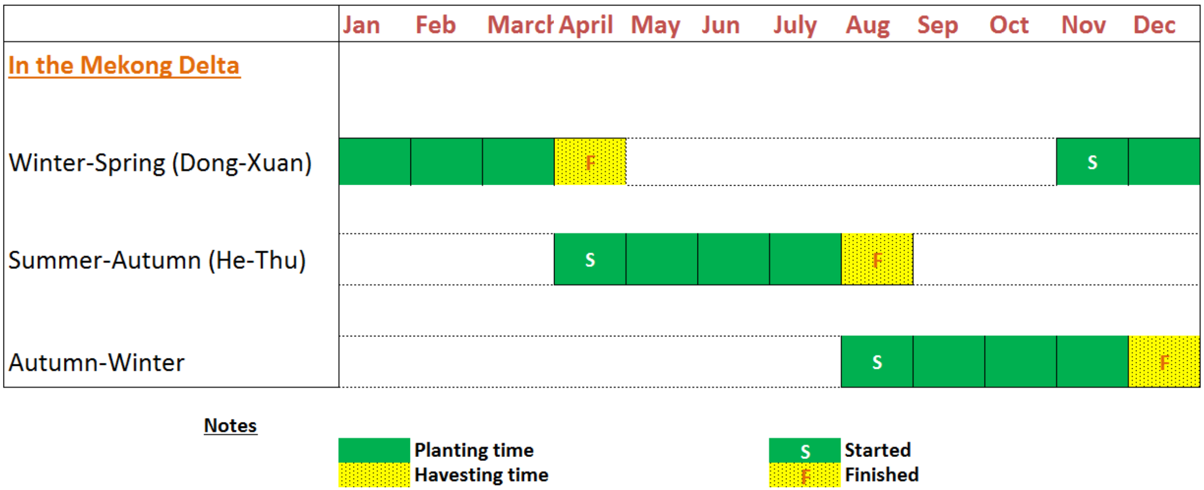


Source: GSO (2011)

4.1.3 Rice growing seasons

The Mekong Delta has many natural features and a favourable climate for agriculture, especially rice production. There are often three crop seasons in the Mekong Delta. They are Winter-Spring, Summer-Autumn, and Autumn-Winter. Planting and harvesting time for each is presented in Figure 4-4.

Figure 4-4: Rice growing seasons in the Mekong Delta

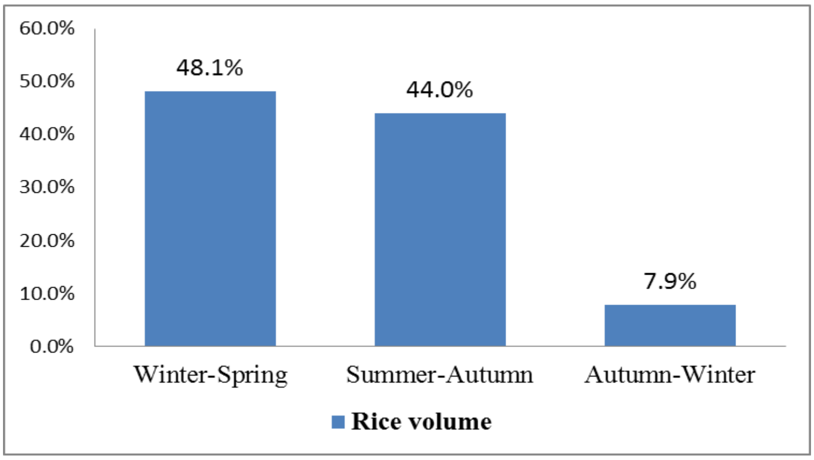


Source: Own synthetics from http://www.vaas.org.vn/images/caylua/03/01_thoivu.htm

The Winter-Spring crop starts in November annually and harvests take place in the next April. This is the most productive season, for which average yields have approached 6.5 tons/hectare. The Winter-Spring crop accounts for 50% of the annual paddy production in the Mekong Delta and is the primary rice source for export.

The second most important season is the Summer-Autumn. The Summer-Autumn crop is planted in April and harvested in mid-August. This crop is frequently impacted by extended periods of flooding. Average regional yields are about 4.7 tons/hectare. The Autumn-Winter crop often begins in August or September each year. The entire crop cycle occurs in the wet season; therefore the production process encounters many difficulties, and yield are low. The rice production distributed seasonally in the Mekong Delta is shown in Figure 4-5.

Figure 4-5: The rice production distributed seasonally in the Mekong Delta (2009)



Source: GSO (2011)

In summary, rice production in the Mekong Delta mainly takes place in Winter-Spring and Summer-Autumn (accounting for more than 90% of production volume). Freight traffic flow is believed to have certain fluctuations in the period of harvesting.

4.2 Rice supply chain

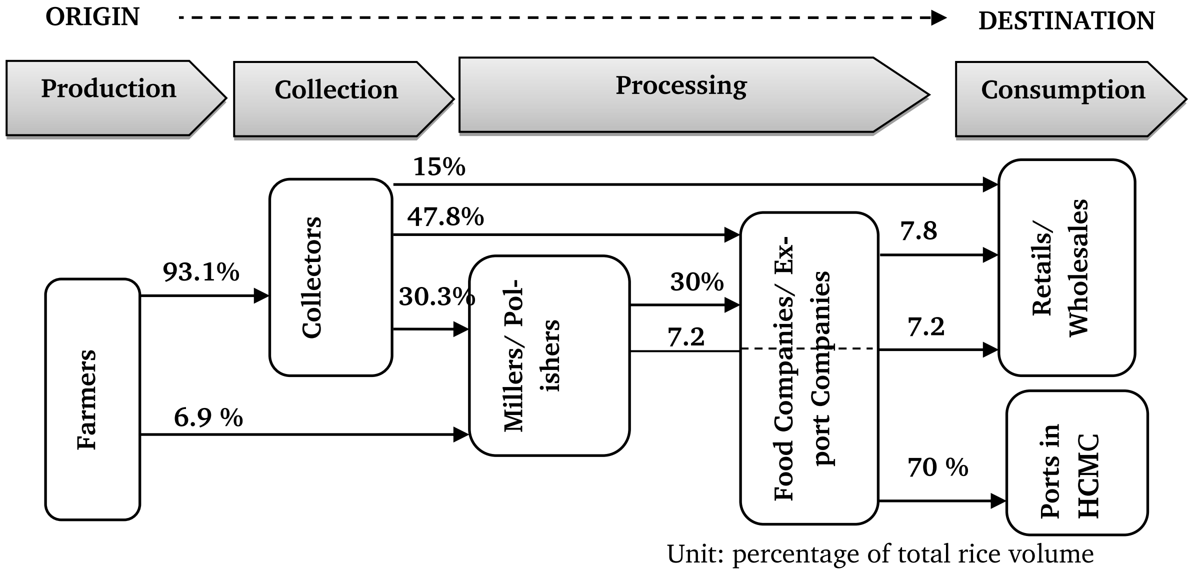
In order to examine the rice supply chain, the study conducted practical data collection/survey/discussion with the key units (public and private) involved in production, transportation, processing, storage, consumption and export in the Mekong Delta. To gather survey data, meetings between logistics experts and company managers in key positions were carried out. 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. Full survey contents and list of interviewees are presented in Appendix A.

4.2.1 Overview of the rice supply chain

There are two kinds of rice supply chain in the Mekong Delta, domestic and export rice supply chain. Figure 4-6 shows the relationship among key stakeholders in the rice supply chain.

After harvesting, farmers sell most of unmilled rice (93.1%) 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 (30.3%) for milling or directly to food companies (47.8%). Only 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.

Figure 4-6: Rice supply chain in the Mekong Delta



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

Characteristics of each stakeholder in the rice supply chain are briefly outlined as follows. Farmers are the most abundant group, benefits for the Mekong Delta farmers appear to have been modest. That is because most of them are smallholder farmers with utilising limited farming technology. Moreover, their habit is to sell the majority of their paddy, and then buy back rice with a value equivalent or greater than the value of their paddy sales and this is not really efficiency from a financial perspective.

As mentioned above, collectors play a key role in collecting rice in the supply chain. While there are some state-owned companies involved in collecting rice, it is very hard for them to go directly to individual farmers, so collectors have taken up this role. There are thousands of collectors with different sized barges operating at localized levels in the Mekong Delta. They are very flexible in determining price, payment method, and supporting farmers. Furthermore, having a good geographical knowledge, they are well positioned to carrying out the challenging task of travelling to remote and isolated areas to buy paddy from farmers and sell on. Many collectors, however, are not focused on the quality of rice, which can explain the lower quality of Vietnamese compared with Thai rice.

The milling industry is a traditional industry in the Mekong Delta. Milling is often done in two stages with the initial process involving husking the paddy. There are currently nearly 500 state-owned milling companies and thousands of private millers in Vietnam. Private millers have limited milling capacity (about 0.5 -2 ton/hour) and are typically located near farmer granaries. Once first-stage milling is finished, the intermediate product is transported to larger millers for the production of white rice and, if for export, of polished rice.

Also participating in the rice market in the Mekong Delta are also Polishers and Food Processing Enterprises (FPEs). They may be state-owned companies, provincial or private companies. Most of these companies are parts of VINAFOOD 2. VINAFOOD 2 is a State-owned Co-operation, which was established by the Vietnamese government with aim of ensuring national food security, developing the rice exporting industry, supplying rice for consumption in the whole country as well as conducting other business. Most FPEs under the Food Company operate as multi-functions organizations as assembling, milling, polishing and storing.

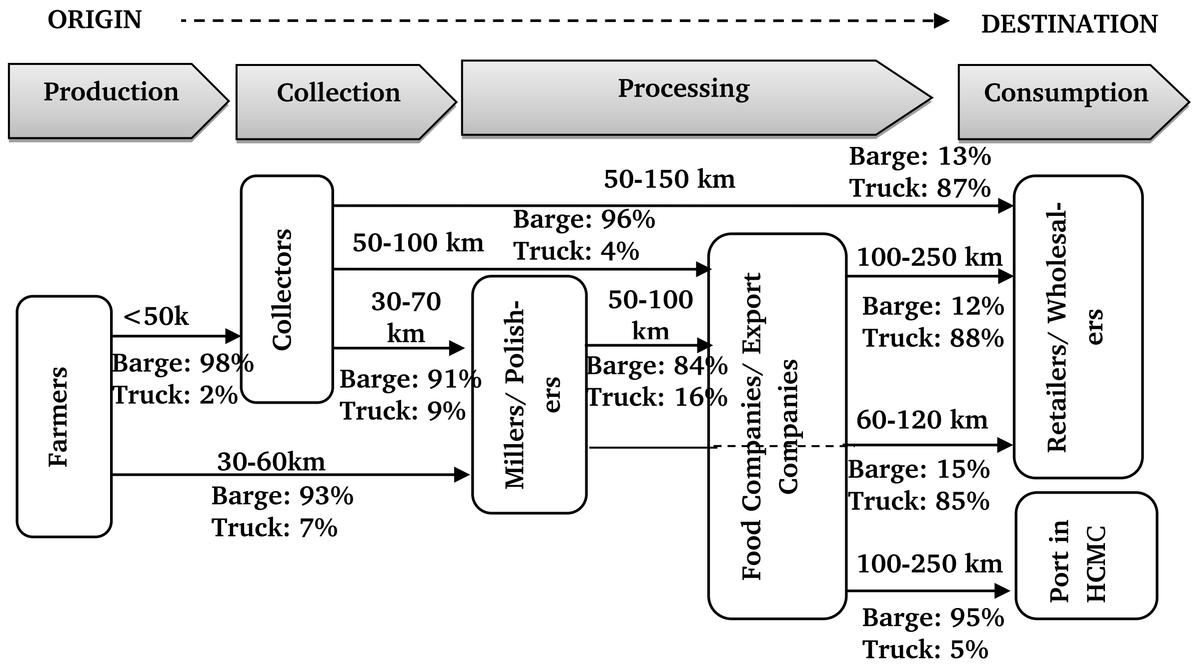
Export companies include VINAFOOD 2, provincial food companies established and managed under the authority of Provincial People Committees, or private companies. Under the food company management, there are also warehouses that function as agricultural product centres. They further provide a free rice drying ground, as well as warehouses for hire at a low price in an effort to support farmers. Furthermore, the company has a convenient storage system for rice produced for domestic consumption in order to stabilize prices in the national market.

At present, about 30% of rice production volume from the Mekong Delta serves for domestic consumption demands. Rice distribution to the domestic market has been handled via wholesale and retail system located in the Mekong Delta and HCMC. Most companies participating in the system are in small and medium scales, managing rice volumes ranging from hundreds to thousands of tons per year, and the use of road transport dominates for rice distribution to HCMC.

4.2.2 Transport modes

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. A detailed representation of transport modes used in each stage of the rice supply chain is shown in Figure 4-7.

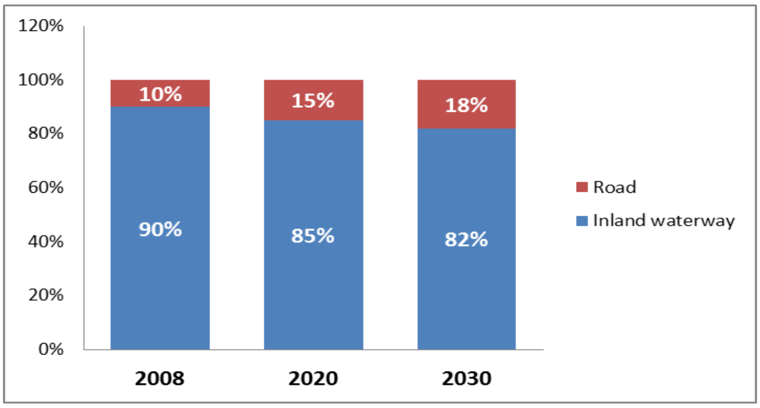
Figure 4-7: Transport modes used in the rice supply chain



Source: Own illustration based on data from Loc (2011) and field survey in the Mekong Delta (2013)

It becomes apparent that IWT (95%) is very popular in transporting rice to export ports whereas road (98%) 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. Specific changes in road modal share for the rice industry are projected in Figure 4-8.

Figure 4-8: Freight modal share in the Mekong Delta rice industry



Source: Data from Blancas and M. Baher (2014); MOT (2014)

Rice typically transported by small vessel (less than 1000 tons) and/or large truck (15 tons) to HCMC. The haulage characteristics of long-distance trips from cities in the region, for instance Can Tho (the centre of the Mekong Delta), to HCMC are given in Table 4-5.

Table 4-5: Haulage characteristics for long-distance freight transport

Haulage characteristics	Estimated value
Age of truck (year)	17.2
Truck weight without cargo (ton)	12.7
Actual average load (ton)	21
Average overload (ton)	8.3
Average load/truck weight	1.7

Source: WB (2010)

It is found that most truck shipments from the Mekong Delta to HCMC are overloaded. The trucking industry in Vietnam is, in fact, very competitive and shippers prioritise minimizing transport costs, so truckers tend to drive transport costs down at the expense of service quality. Consequently, infrastructure network deteriorate quickly.

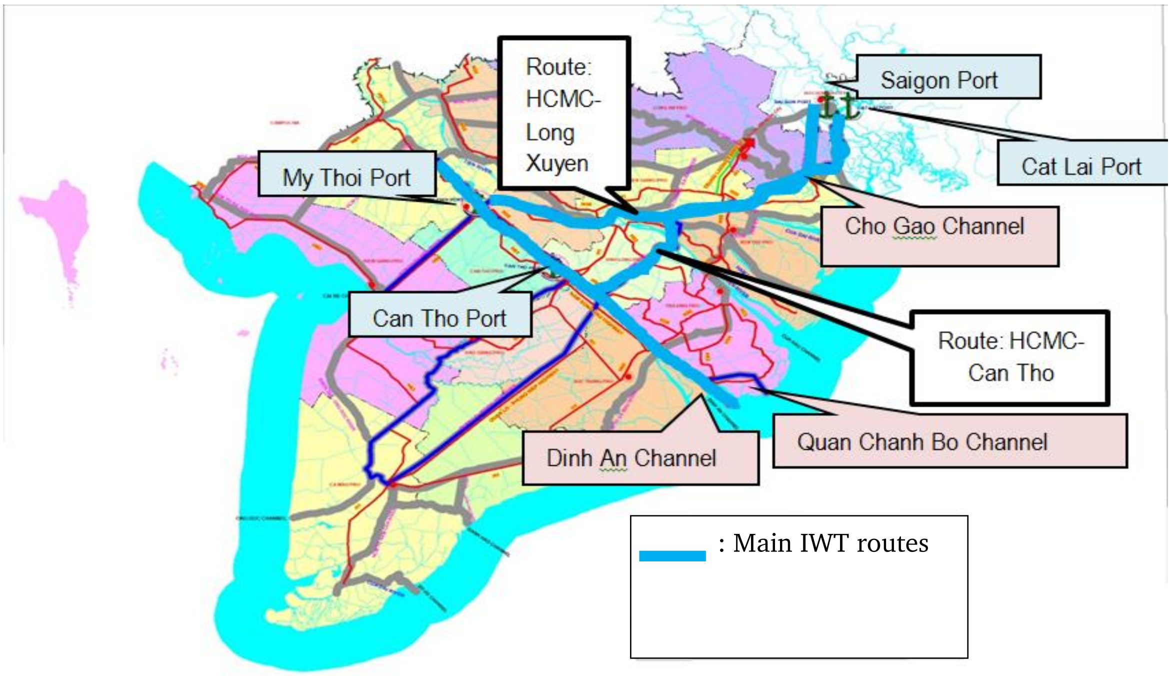
4.2.3 Transport routes

Since the Mekong Delta has an interlacing canal system, IWT is considered the most dominant mode of transport for rice. In fact, there are two major IWT routes from the Mekong Delta to other areas of the country or foreign countries: the route via Can Tho and My Thoi Ports and the route via Sai Gon and Cat Lai ports. Routes are represented in Figure 4-9.

Routes via Can Tho and My Thoi ports: These routes can only accommodate vessels smaller than 10.000DWT because of the shallowness of the Hau river (Dinh An channel) represents a limitation. Only 8% of the total rice volume transported via Can Tho and My Thoi ports. Actually, rice is collected in bulk in My Thoi and Can Tho ports, and then loaded to large ships and transported along the Hau River to export directly to South- Earth Asian countries such as Singapore and Philippine.

Routes via Saigon Port and Cat Lai Ports: It is possible to export rice on bigger vessels through Saigon Port (maximum 36,000 DWT) and Cat Lai Port (maximum 15,000 DWT). Both road and inland waterway are utilized as transport access routes. Up to 92% of total rice volume from the Mekong Delta is transported through the port system in HCMC. The itinerary of these routes is as follows: Rice consolidated either at Can Tho and My Thoi ports or warehouses belonging to food companies along the Hau River is loaded onto barges of 700-1000 tons, and then transported along two main IWT corridors to HCMC. These are the HCMC-Long Xuyen and HCMC- Can Tho corridors. Notably, both corridors involve passing through Cho Gao Channel - the essential IWT channel connecting the Tien and Van Co Rivers. According to the master plan for inland waterway transportation for the Mekong Delta for the period 2010-2020 (MOT, 2010), 65%-70% of cargo transportation from the Mekong Delta to HCMC will pass through this channel. Traffic jams at Cho Gao channel are currently a serious problem.

Figure 4-9: Transportation of rice by inland waterway

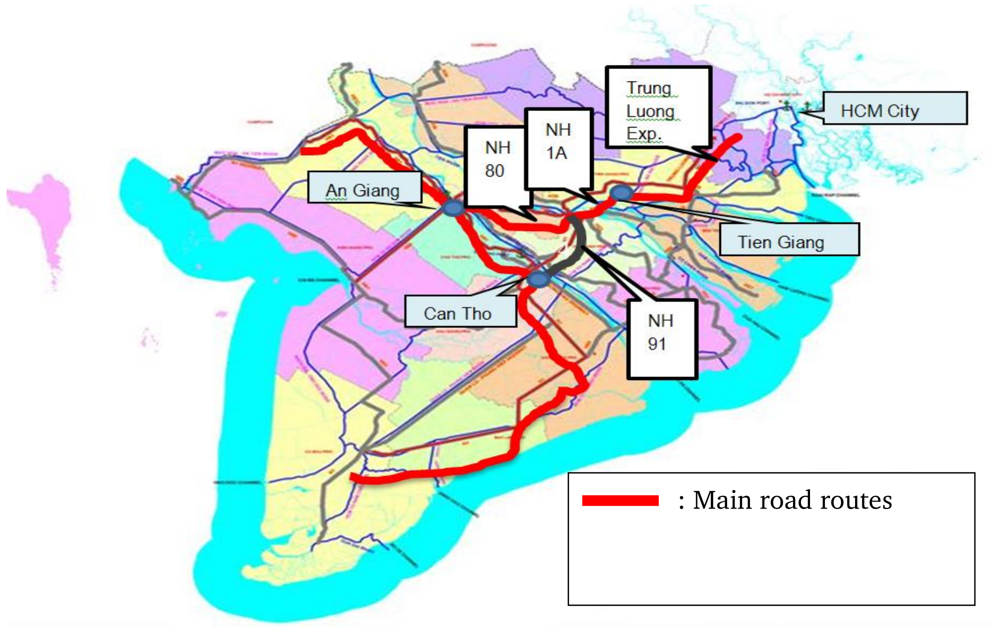


Source: JICA (2010)

For road transportation, the main roads utilised for rice transport are shown in Figure 4-10. Clearly, the NH1A, NH 91 and NH 80 play the most important role in rice transport to HCMC. A typical itinerary is from An Giang to Can Tho via NH 80 and NH 91 and then NH1A and the Trung Luong Express to HCMC.

Traffic volume on the NH 80 and 91 is very high and these highways are seriously degraded as a result. The growth in traffic volume is estimated at about 13.02% per year (MOT, 2014). Given the present volume of traffic, the Ministry of Transport has had to implement the BOT type project to improve NH 91 and 80. This project is expected to be finished in 2016 and to meet traffic demand between Can Tho and An Giang. Regarding NH1A, this motorway is currently seen as a key road for transporting rice from the Mekong Delta to HCMC but is much overloaded. Freight traffic has increased on averagely 10-14% per year (GSO, 2011), which is faster than the growth rate of transport construction. To date, NH1A has been partly upgraded in the section from Trung Luong-Can Tho, which has contributed significantly to managing freight traffic demand in the region. Plans are in place for the entire remainder of the highway to be upgraded in 2016.

Figure 4-10: Transport of rice by road



Source: JICA (2010)

4.3 Logistics

4.3.1 Costs

Logistics cost is one of the most important indicators in analysing the efficiency of the rice supply chain. As stated previously, there are two kinds of the rice supply chain in the Mekong Delta. The biggest difference between the two supply chains is the transport mode used. For the domestic supply chain, trucks are mostly used while barges/other vessels are dominant in the export rice supply chain.

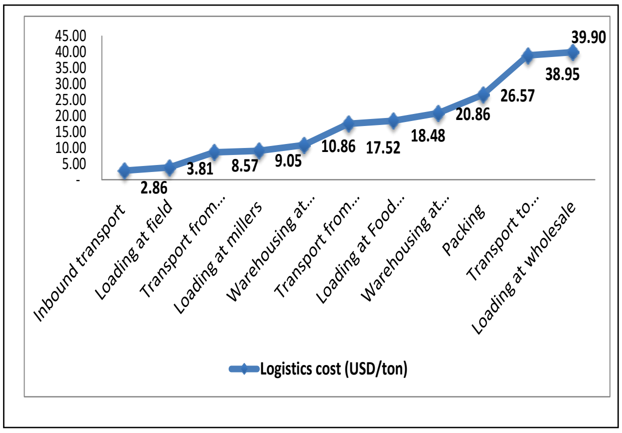
Logistics cost for the rice supply chain is divided according to many elements involved in moving rice from farmer to final destination. In particular, the logistics activities include inbound collection transport; loading and unloading; miller, polisher and food company warehousing; packaging, and trucking/barging. Figure 4-11 and Figure 4-12 illustrate the logistics cost breakdown for 1 ton of rice delivered at port or wholesale in HCMC.

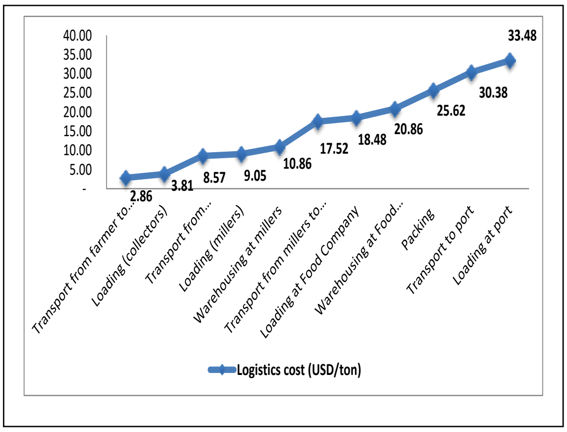
In the rice industry, it seems that transport cost is more important than time-response. Transport cost makes up the largest proportion in total logistics cost figures, nearly 60% and 43% for the domestic and export rice supply chains, respectively.

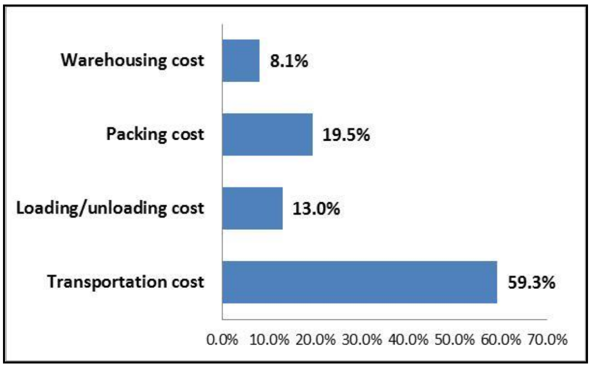
The Vietnamese rice supply chain is often complicated. Rice is mostly exported via ports in HCMC, located about 200 km from the Mekong Delta. Only a small quantity is exported via ports in the region, such as Can Tho and My Thoi ports, due to the limited shallowness of the Hau River. Therefore, the "last mile" of the rice supply chain is increased, leading to a rise in transport cost. The case of Thailand is more efficient where once the rice polishing process is completed, rice is moved onto tug-boats and then transported for export by large ships (Wilasinee et al., 2010).

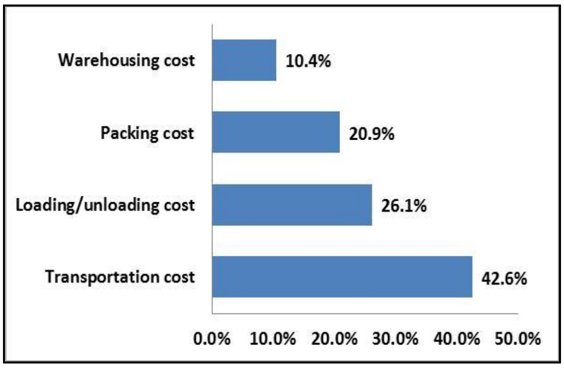
Figure 4-12: TLC in the domestic rice supply

Figure 4-11: TLC in the export rice supply chain



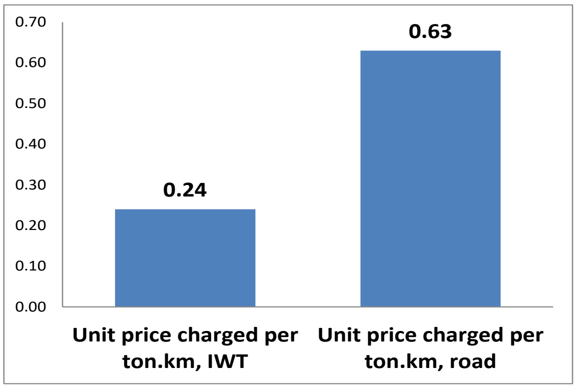






Source: Binh (2013)

Figure 4-13: Comparison of unit transport price by mode (USD/ton-km)



Source: Binh (2013)

There is a large difference between unit transport cost (per ton-km) by road and IWT with road transport cost up to 2.6 times greater than IWT (Figure 4-13). Although, the cost of road transport is much more expensive than IWT costs, road transport dominates in the domestic rice supply chain. This can be partly explained by the fact that IWT system is not directly accessible to wholesale or retail network in HCMC, and multimodal transport is at an early stage of development in the Mekong Delta.

Unlike the domestic rice supply chain, road transport has not been significantly competitive for the export rice supply chain. Export rice is predominantly shipped using IWT. However, road transportation is forecast to increase quite rapidly when the road infrastructure network in the Mekong Delta is significantly expanded and upgraded in the period 2020-2030. A road -intensive transport situation could, however, become a potential danger by leading to increase in traffic accidents and environmental issues in the future.

4.3.2 Lead-time

Lead-time is another important part of logistics. Lead-time, in this context, is the clock time spent in the supply chain to convert paddy into rice and to place it into the hands of the distributor (export ports or the wholesale system in HCMC). Like logistics cost, lead-time is broken down into many elements involving moving paddy from farmer to the final destination of the supply chain. For example, it includes the time required for collecting, loading/unloading, warehousing, and outbound transport. Lead-time is shown in detail in Figure 4-14 and Figure 4-15.

Figure 4-15: Total lead-time in the domestic rice supply chain

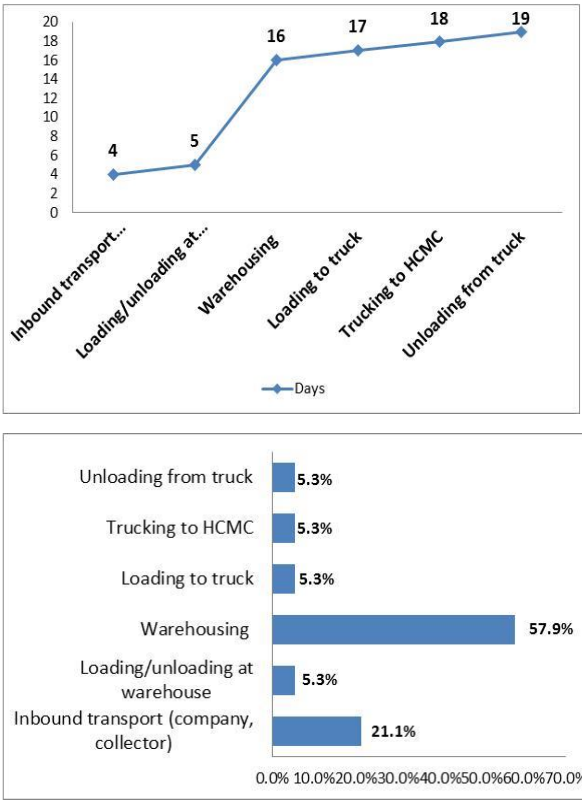
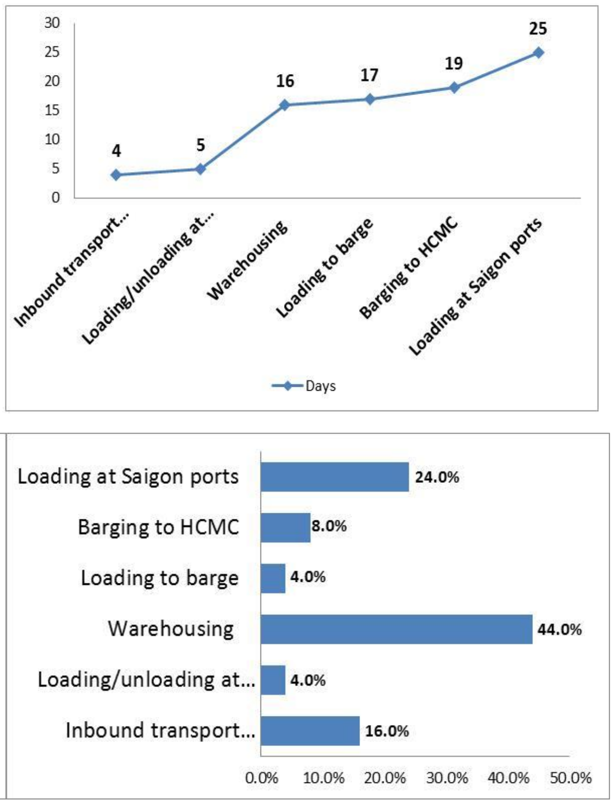


Figure 4-14: Total lead-time in the export rice supply chain



Source: Binh (2013)

As Figure 4-14 and Figure 4-15 indicate, there is no big difference between the two modes. In fact, transporting rice from the Mekong Delta to HCMC takes one day and two days by road and IWT, respectively (Binh, 2013). Interestingly, most time is spent on warehousing by food companies or export companies in the Mekong Delta. This can be partly explained by the food storage habits in the Mekong Delta in particular and in Vietnam in general. As rice export orders annually are not stable, export/food companies often keep a portion of their stock in reserve to cope with the volatility of the market.

4.4 Safety and environmental issues

Like most developing countries, Vietnam's traffic accident situation is getting more serious and is already alarming. According to traffic accident data form ASEAN countries, the level of traffic safety in Vietnam is very low. Regarding the total number of fatalities, Vietnam ranked third after Thailand and Indonesia in 2000 but had overtaken them to become the country with the highest number of traffic fatalities by 2006 (VITRANSS-2, 2009). Traffic accidents have become a critical social problems and traffic safety is currently viewed by the government as an urgent policy issues.

Table 4-6: Traffic accidents by mode, 2006

Modes	Accidents	%	Fatal	%	Injury	%
Road	14,161	96,16	12373	96.99	11097	98.31
Rail	292	1.98	136	1.07	158	1.40
IWT	215	1.46	210	1.65	18	0.16
Shipping	59	0.40	38	0.29	13	0.13
Total	14,727	100.00	12757	100.00	11,288	100.00

Source: VITRANSS-2 (2009)

In terms of modal shares, road accidents dominate (96%). Table 4-6 shows in detail traffic accident by mode data in 2006. Vietnam's heavy dependence on road transport in recent years is one of the main reasons for the increase in road traffic accidents.

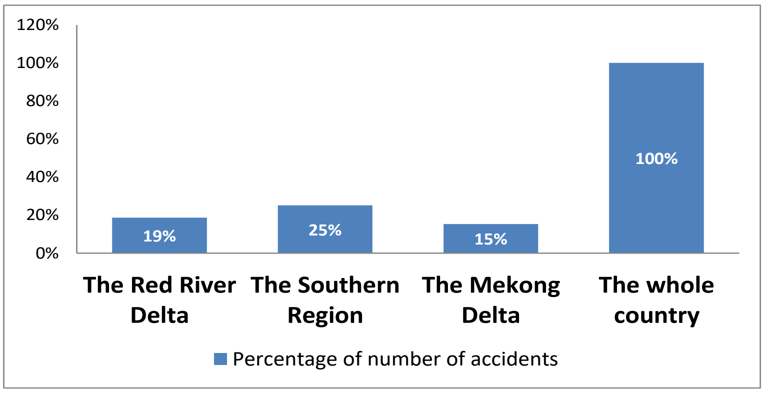
The distribution of road traffic accidents in various main regions of Vietnam is quite different. Statistics shows that the traffic accident situation in the Mekong is less serious than other main regions such as the Red River Delta and the Southern region. Table 4-7 and Figure 4-16 provide statistic on the traffic accident situation in the Mekong Delta.

Table 4-7: The distribution of road traffic accidents in some regions of Vietnam, 2006

Region	No. of accidents	Traffic accident per 10,000 population	Fatality per 10.000 population	Injury per 10.000 population
The Red River Delta	2716	1.5	1.2	1.0
The Southern Region	3667	2.7	2.2	2.1
The Mekong Delta	**2230**	**1.3**	**1.1**	**1.2**
The whole country	14572	1.7	1.4	1.4

Source: VITRANSS-2 (2009)

Figure 4-16: The percentage of road traffic accidents by some key regions in Vietnam



Source: VITRANSS-2 (2009)

The dominance of IWT in the Mekong Delta's freight transport market is a key factor in explaining why the number of road accidents in this region is lower than the other regions. However, road transport networks in the Mekong Delta are projected to increase significantly in 2020-230, which potentially carries the risks of an increase in road traffic accidents.

Table 4-8: Estimated emission rates in Vietnam by freight transport mode

CO_2 Emission Factors	2010	2030
Truck (gCO_2/ton. km)	110	80
IWT (gCO_2/ton. km)	71	50

Source: Data from Blancas and M. Baher (2014)

In the Vietnamese transport sector, about 92% of CO2 emissions originate from road transport and about 5% from waterborne transport (IWT and coastal shipping). Based on Blancas and M. Baher (2014), emission factors for road and IWT freight transport in Vietnam are estimated as in Table 4-8.

Emissions of CO2 per ton-km depend much on the mode of transport used. Transport emissions by road are relatively higher than IWT. It seems that environmental pollution caused by the rice industry has not yet reached not alarming levels since IWT is the predominant mode for rice transportation to date. However, substantial growth in dependence on road transportation in the rice industry will potentially lead to an increase of GHG emissions as road freight transport generally generates much higher CO2 emissions than IWT. Vehicle sizes are also relevant. Rice is at present typically transported by small vessel (less than 700 tons) and/or small or medium and big truck (under 15 tons). Usually, the smaller a vehicle or vessel engine, the higher emission per unit of service. Consequently, mirroring the experience of many developed countries such as the Netherlands, reduction in emissions could be obtained via modal shift away from the roads and towards utilization of larger vessels (Blancas and M. Baher, 2014).

4.5 Conclusions

In this chapter, an analysis of the current situation of the rice industry in Vietnam has been presented. This analysis indicates some challenging issues facing the rice freight transport.

Increase in freight road transport

It is likely that increased heavy dependence on road transport will lead to an increase in GHG emissions as road freight transport generally generates much higher CO2 emissions than IWT. Furthermore, an increase in the density of road transport carries the potential danger of an increase in traffic accidents.

High transport and logistics cost

In the rice industry, it seems that minimising transport cost is prioritised over reduced time-response. At present, rice is mostly exported via ports in HCMC, located about 200 km from the Mekong Delta. Only a small quantity is exported via ports in the region such as Can Tho and My Thoi ports, the shallowness of the Hau River, and consequently the "last mile" of the rice supply chain is increased, leading to increased transport costs.

Overloading in long-distance freight transport

The average loading factor for road freight from the Mekong Delta to HCMC is 1.7. The trucking industry in Vietnam is highly competitive placing downward pressure on transport costs. Freight companies in the rice industry tend to reduce transport costs to remain competitive by overloading vehicles. Monitoring and management systems for long distance freight are also weak making the issue more severe. Consequently, infrastructure network deteriorates quickly.

In short, the rice industry in the Mekong Delta faces various problems related to emissions, safety, and economic efficiency. More effective management for freight transport system are therefore necessary to address these problems, and support the development of the rice industry in the future.

5 Application of Multi-Stage Impact Assessment for FTM Measures

In this chapter, the multi-stage impact assessment method for FTM measures is applied in the Vietnamese rice industry as an example. Following this proposed method, firstly, a list of measures including potential intervention and measures already applied in the rice industry, will be compiled. Then, the inter-dependency among the selected measures will be checked to eliminate overlapping or opposing impacts. The MCA method is employed for weighting and ranking the importance level of these measures. Building on these results, different scenarios are identified for detailed quantitative assessment. TLC is employed as the core of this analysis, differentiating a disaggregate population of rice commodity flows and locations of distribution centres in HCMC. Consequently, traffic, safety, economic and environmental benefits can be estimated at the rice sector level and the transport network level.

5.1 Definition of FTM measures in the rice industry

5.1.1 Compilation of FTM measures in the rice industry

To solve the increasing issues associated with freight transport problems in the Mekong Delta, various traffic management measures need to be considered and applied. Table 5-1 presents a compilation of FTM measures that have already been applied and can potentially be applied in the rice industry as follows:

Table 5-1: Compilation of FTM measures in the context of the rice industry

FTM measures identified in the literature (Table 2-2)		List of FTM measures in the rice industry		Level of application
M1	Freight centres and consolidated deliveries	M1-VN	A regional rice logistics centre Hau Giang province	Potential
M2	Co-operative freight transport system	M2-VN	Major markets for rice/paddy in Can Tho, Long An, and Tien Giang provinces	Potential
M4	Time window for trucks entering the city	M4-VN	Prohibition of trucks entering HCMC from 6:00 am to 12:00 pm	Already
M11	Promotion of regional products	M11-VN	The establishment of centralized areas for paddy production	Already
M12	Business cooperation	M12-VN	Co-operation between collectors and millers and export companies in An Giang province	Already
M15	Infrastructure capacity improvement (inland waterway, road, port)	M15-VN	Improvement of NH 1A from the Mekong Delta to HCMC	Potential
M17	Load factor control or speed limit	M17-VN	Restricting overloaded trucks on the highway from the Mekong Delta to HCMC	Already

Source: Own compilation from JICA (2010)

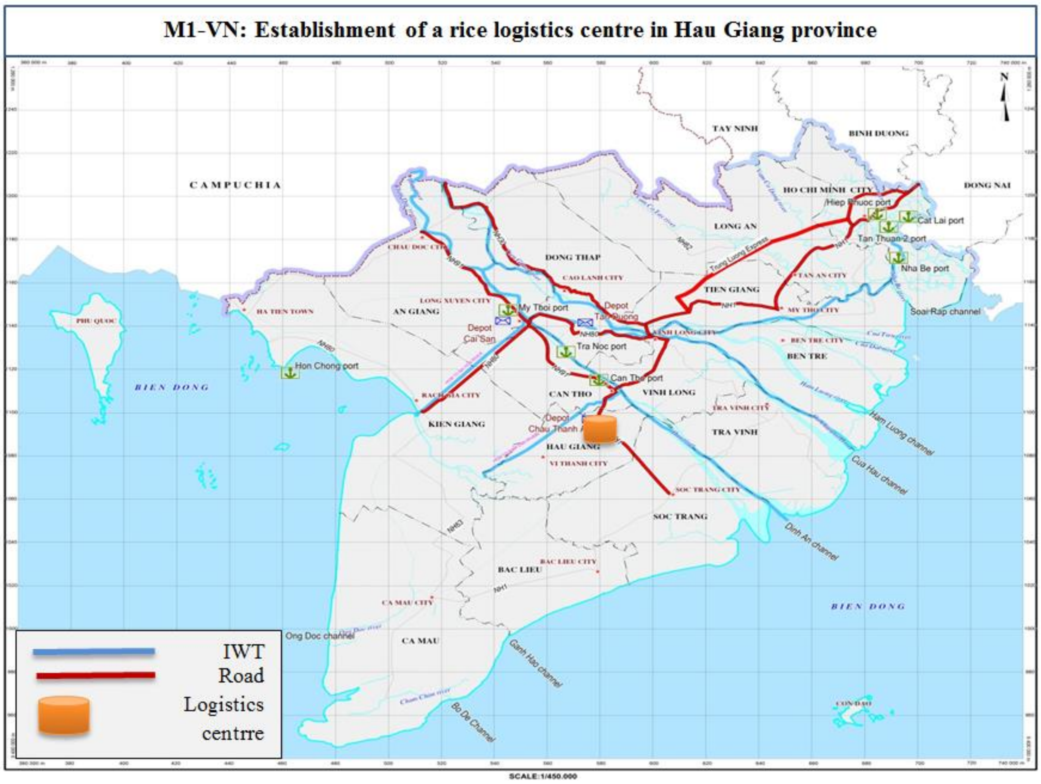
There are seven FTM management measures in the rice industry in which only three potential measures are listed. This list is incomplete since many others measures which already be applied in the world could be utilised for the Vietnamese rice industry. For this study, the selection is firstly based on the literature review and the qualitative assessment of effectiveness and applicability of each measure (Table 2-4) carried out in chapter 2. Secondly, the measures selected should deal with identified problems in the Vietnamese rice industry. In particular, the detailed analysis in Chapter 4 indicated some specific challenges facing the rice industry including increased heavy dependence on road transport, high logistics cost and overloading in long-distance freight transport. Therefore, in this case, there are seven measures considered because of their highly potential implementation. The others, for example the measures on harvesting time, incentive for off-peak hours, low-emission zones or technology-based route planning management, are seen as the next-best measures in the long-term. Besides, with the aim of illustration of how the proposed multi-stage impact assessment method works, particularly how MCA method and TLC model look like in the different impact assessment stages, the chosen measures should be compatible for the application of these two methods. A review on the literature has shown that the use of logistics facilities can potentially result in traffic, environmental and social benefits, which will be better measured through MCA method. Meanwhile, TLC seems to be easier to model in detail with the highway improvement measures. Therefore, the most interesting measures including the establishment of rice logistics facilities and the improvement of NH from the Mekong Delta to HCMC will be further analysed in detail in this study. The following section will briefly review the contents of seven measures in the rice industry in the Mekong Delta.

5.1.2 Detailed content of FTM measures

M1-VN. Establishment of a regional rice logistics centre in the Mekong Delta

This measure aims to construct a regional rice logistics centre in Hau Giang province to improve rice procurement and to promote consolidated deliveries in the Mekong Delta. The rice logistics centre would be built on a large land and in a convenient location for traffic and trading. The intended location is shown on the following map.

Figure 5-1: Location for rice logistics centre in Hau Giang province



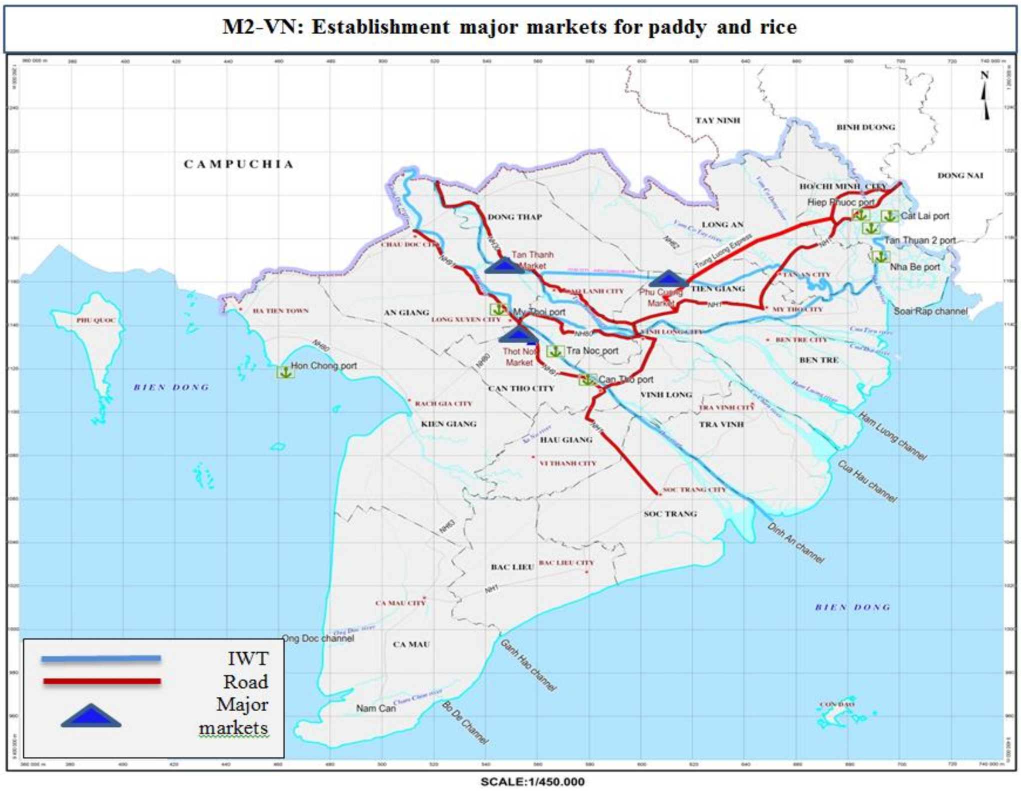
Source: Own illustration based on data from JICA (2010)

The regional rice logistics centre will have a reservation capacity of 60.000 tons, with two rice-processing lines of 50 tons/h capacity, processing 1000tons of rice per day at high quality (export quality). The planed location for the centre is close to important highways such as NH61, NH1A, and provincial road 92. Especially, Xa No channel - a major arterial IWT in the Mekong Delta - will go through this centre, which can contribute significantly to rice product transhipment from the west of Hau River to HCMC. This measure would help to reduce small trips to collect paddy/rice since farmers can sell directly to the centre. In addition, in the distribution stage, it would increase opportunities for consolidated delivery from the Mekong Delta to HCMC.

M2. Establishment of major markets for rice/paddy in Can Tho, Long An, Tien Giang provinces

The objective of this measure is to create direct meeting points for farmers and rice buyers in order to reduce intermediate stages. Furthermore, it can act as a key terminal to promote delivery consolidation. Performing a function analogous to the rice logistics centre, rice markets are often located in convenient areas for traffic and transport. For example, Thot Not rice market would border the Hau River on one side, which is convenient for IWT to Vinh Long, Dong Thap provinces, and the other side of the market would be adjacent to Thot Not Industrial Zone and NH 91.

Figure 5-2: Location of major markets for paddy/rice in the Mekong Delta



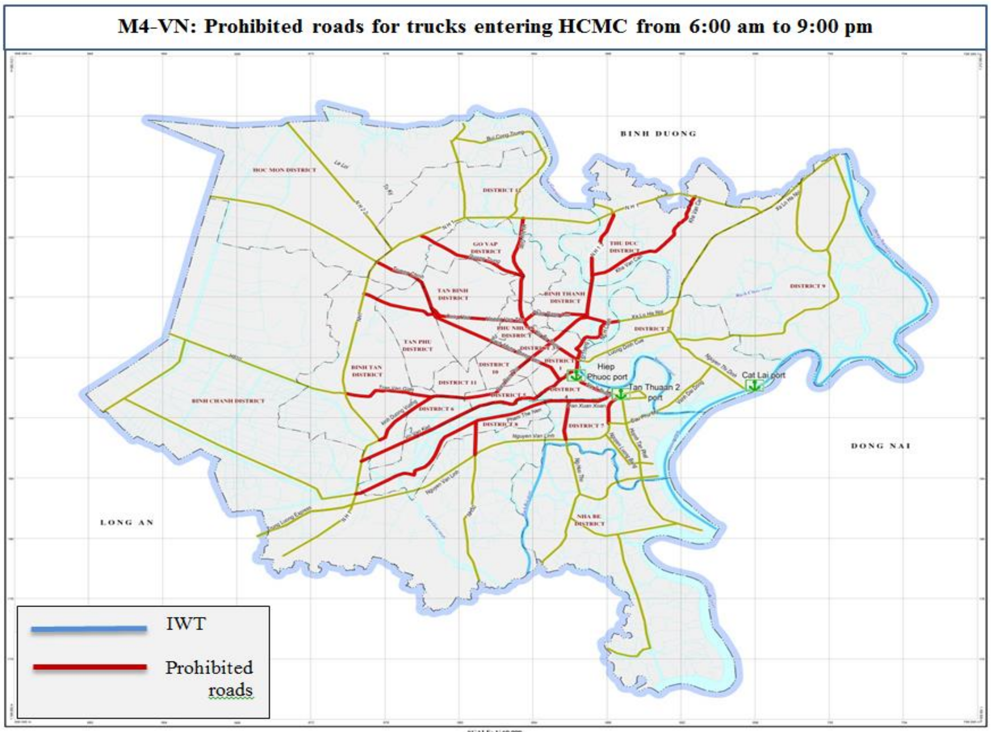
Source: Own illustration based on data from JICA (2010)

This measure will help to improve the transport infrastructure capacity of the region, because these markets are not only for collecting and delivering goods but also for consolidation and transhipment services. In addition, they can reduce markedly intermediate stages in the rice supply chain since farmers can sell directly at these markets. It is noteworthy that the formation of such markets focuses strongly on facilitating rice business, and therefore would only be introduced in key rice production provinces such as Can Tho, An Giang, and Tien Giang. In fact, the plan of rice major markets is facing many difficulties due to some the following reasons. Firstly, the network of rivers and canals is dense, which has contributed to establishing many floating markets in the Mekong Delta. The collectors and farmers have had the practice of purchasing in these markets for ages. Secondly, even located at the intersection of road and IWT transport, the accessibility to most of planned major markets are poor conditions. For example, access road (NH 91) to Thot Not market is already congested in the peak hours (MOT, 2014) Therefore, total time of the rice supply chain would be increased under the intervention of establishing major markets for rice. In addition, changing behaviours of collectors and farmers would take time and overcoming inadequate transport infrastructure would be challenging for the application of this measure.

M4. Prohibition of trucks with load in excess of 5 tons entering HCMC from 6:00 am to 9:00 pm

This existing measure aims to reduce the volume of incoming traffic to HCMC at peak-hour. Specifically, urban day-time bans on the trucks are applied along the many main corridors of the city such as Phan The Hien, Vo Van Kiet, Nguyen Huu Canh-Ton Duc Thang-Nguyen Tat Thanh; Cong Hoa-Hoang Van Thu-Hai Ba Trung, Dien Bien Phu, Cach mang thang 8, and part of Nguyen Van Linh Boulevard. These corridors also are accessibility roads to HCMC port system, namely Hiep Phuoc port, Tan Thuan 2 port, Cat Lai port.

Figure 5-3: Prohibited roads for trucks entering HCMC from 6:00 am to 12:00 pm



Source: Own illustration based on data from JICA (2010)

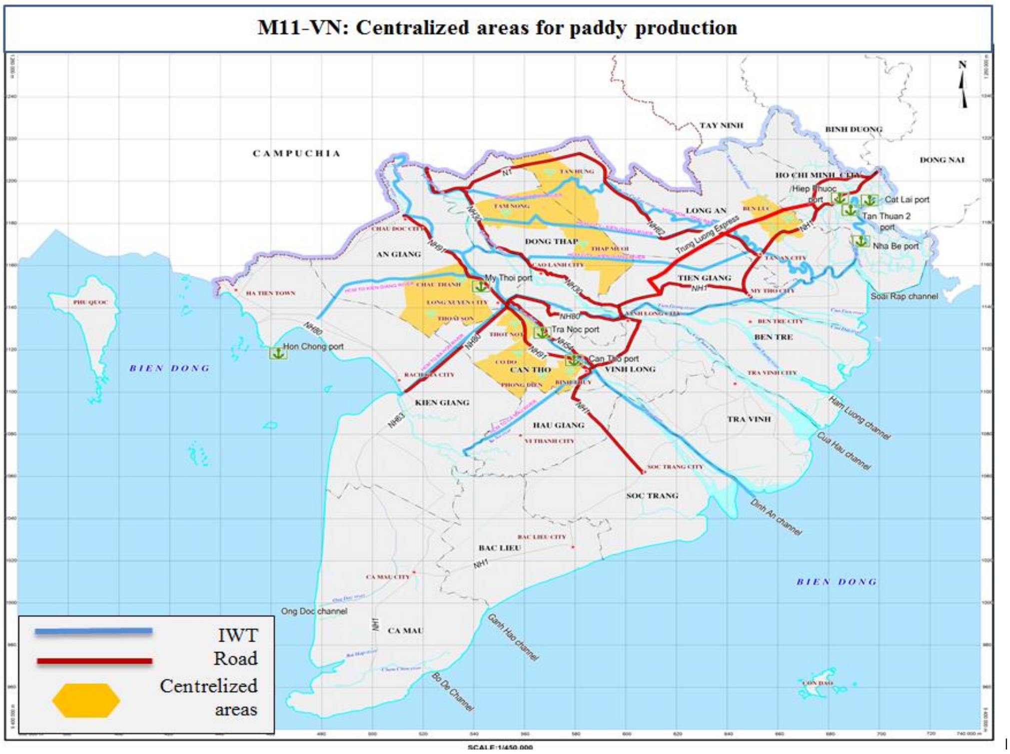
Goods flows from the Mekong Delta to ports in HCMC have to change their itinerary or to wait outside the city until night-time. For example, the old itinerary of Trung Luong Expressway - Nguyen Van Linh Boulevard - Tan Thuan Port has been changed to a longer one: Trung Luong Expressway - Nguyen Van Linh - Nguyen Luong Bang-Huynh Tan Phat-Tan Thuan Port.

In fact, this measure is already in place and has partly relieved traffic congestion on the main routes into HCMC. The primary impact of the measure is time shift of trucks to off-peak hours including night time, and a route shift (resulting in longer trips) to avoid prohibited roads. However, it has also a large effect on the transport companies and port companies due to the increase in transportation cost and bottlenecks at ports.

M11. Establishment of centralized areas for paddy production

The objective of this measure is to promote the development of regional products. Each centralized zone has about 500-1000ha, and is responsible for appropriate cropping and harvesting practice, aiming at paddy production which meets the Viet GAP (Vietnam Good Agriculture Production) standards. Standards are widely applied in a number of key rice production provinces in the Mekong Delta such as An Giang, Long An, Đong Thap, and Can Tho. The locations of these provinces are convenient for transportation, mechanization, irrigation, and also for rice production and procurement. For example, paddy production areas in Chau Thanh and Phong Dien are very near to three main ports (My Thoi, Can Tho, and Tran Noc) and an important highway of the Mekong Delta (NH 91), which means IWT and road transport vehicles can access to those areas.

Figure 5-4: Location of centralized areas for paddy production



Source: Own illustration based on data from JICA (2010)

The change in destination of transport demand in local regions is identified as one of the most important impacts of this measure. This is because most rice production from the region as a whole is concentrated densely in these centralized areas, and then transported high volumes to HCMC and other regions of the country. Additionally, it can improve economic efficiency for farmers and food companies since it promotes close association between farmers and food companies in order to reduce unnecessary immediate stages in the supply chain.

M12. Co-operation between collectors, millers and export companies in An Giang province

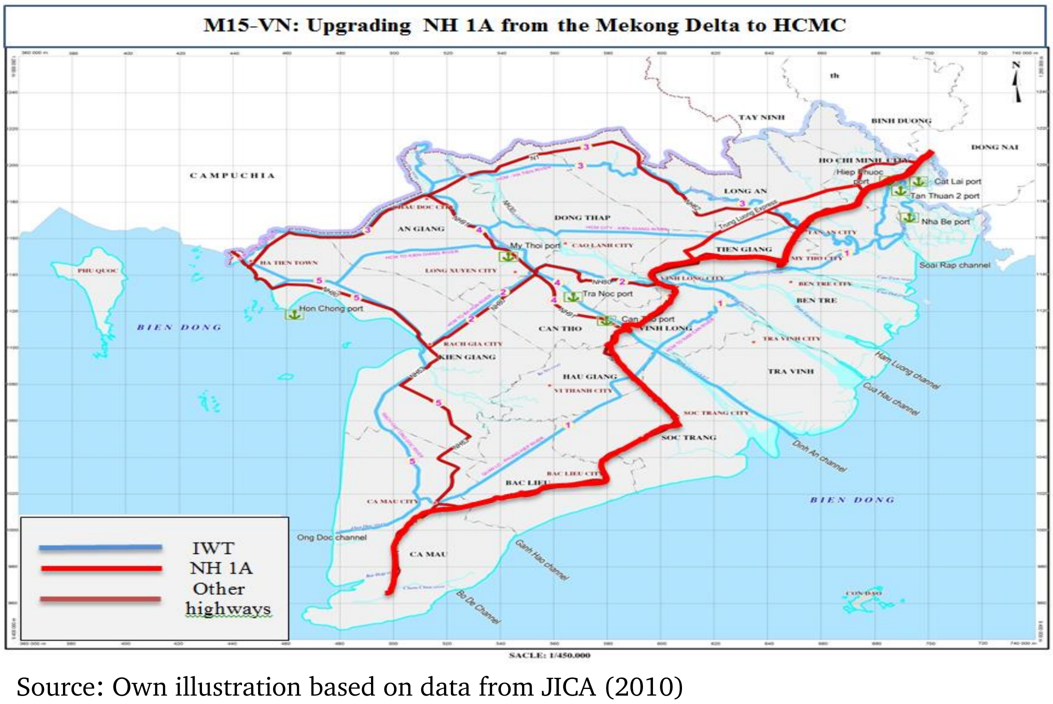
From the outset, the objective of this measure has been purely agricultural economics with aims of controlling rice-purchasing price when deemed necessary based on market behaviour while simultaneously reducing the intermediate stages in the rice supply chain. The core approach taken to achieve these aims is the promotion of close cooperation between key stakeholders involved in the rice supply chain such as farmers, collectors, millers, polishers and export companies, and all of them have commitment of keeping price stable. Through these links, the purchasing price of rice is kept stable in each period, adjusted flexibly according to market fluctuations. This is favourable for all involved, farmers, collectors, and food companies. This model is widely applied by food companies under VINAFOOD 2 such as An Giang Food Company, Song Hau Food Company, and Tien Giang Food Company.

Looking at potential traffic and transport implications, this cooperation could facilitate transportation directly from the farmers to food companies as stakeholders in the rice supply establish close trade relations. Therefore, it may help to reduce the number of pick-up trips in the region. The co-operation between these stakeholders can also help to shift trip destinations closer to trip origins, thereby reducing average trip lengths. However, these impacts of the measure are still emerging, and have only been documented qualitatively. There has not been any concrete research carried out on the traffic and transport impacts of promoting closer business cooperation.

M15-VN. Improvement of NH 1A from the Mekong Delta to HCMC

The NH 1A plays the most import role in the road transport in the Mekong Delta. This NH connects eight provinces in the Mekong Delta to HCMC, and has an overall length of nearly 380 kilometres. The itinerary for NH 1A is presented in Figure 5-5.

Figure 5-5: Improvement of NH 1A from the Mekong Delta to HCMC



Source: Own illustration based on data from JICA (2010)

NH 1A is identified as a main artery since it is responsible for 78% of road freight volume in the Mekong Delta (MOT, 2014). The NH 1A improvement project is expected to significantly contribute to the socio-economic development in the Mekong Delta. In particular, it is anticipated that the NH 1A improvement would provide greater accessibility to key production zones and reduce transport time to HCMC. For the case of the rice industry, the NH 1A accounts for most rice freight flows to HCMC for domestic consumption. Furthermore, improvements are expected to be creating “door-to-door” service for rice freight transport.

This measure is a transport supply management initiative. However, it may also influence traffic demand in terms of shifting trip mode or trip destination. Improvement of NH 1A in the Mekong Delta is expected to reduce transport time and transport cost from the Mekong Delta to HCMC, which potentially improves the economic efficiency in the rice industry.

M17-VN. Restricting overloaded trucks on the highway from the Mekong Delta to HCMC

As mentioned previously, the average loading factor for the road freight from the Mekong Delta to HCMC is 1.7. Freight companies tend to reduce transport costs to compete with each other by overloading. Monitoring and management systems for long distance freight are ineffective, increasing the severity of the issue. The Ministry of Transport of Vietnam has recently strengthened road freight load factor control by implementing Decision No 1526/QD-BGTVT dated 5th June 2013. This scheme proposes short-term and long-term measures to control road factors for long-distance freight. It includes strengthening state management of load factor for road, strict punishment for oversized and overloaded vehicles, and rationally restructuring transport modal share of the economy.

Initially, this scheme generated positive impacts, although it has also has the potential to create less desirable outcomes. On the one hand, the transport market is more transparent as the road transport prices have reverted to true value, and the deterioration of road infrastructure is better controlled. On the other hand, the regulation may increase the total transportation cost born by carriers. As a result, the price of goods and services could go up. Consequently, traffic conditions may not improve as expected. According to the experience of some countries, this solution should be combined with a road pricing scheme which can manage traffic congestion efficiently (Teo et al., 2014). Through application of those measures, transport companies may consider a modal shift away from road to waterway to achieve increased efficiency.

In short, the rice industry in the Mekong Delta faces various problems related to emission, safety, and economic efficiency. This necessitates better management of freight transport system to address these problems, thus maintaining the role of the rice industry in the future. So far, there have been a total of seven FTM measures applied in the rice industry, including hard measures (e.g. improving NH1A) and soft measures (e.g. load factor control). To address comprehensively the issues facing the industry, a range of complementary measures will be required. However, it is important to determine a number of specific measures to address the immediate issues. In order to do this, the interdependency of the proposed and existing measures need, firstly, to be checked in order to eliminate overlapping or opposing impacts. After that, a quick assessment and ranking of the measures will be carried out as a tool for recommending specific measures. Finally, a detailed quantitative assessment will take place to determine impacts related to changes in the supply chain as well as impacts on mode choices in the rice industry.

5.2 Interdependency check, weighting and ranking FTM measures

5.2.1 Interdependency check

The objective of this section is to investigate the interdependencies among FTM measures in the rice industry. Relationships among measures are classified into three basic types: independence, complementary and substitutability. The definition of each form was clearly discussed in Section 3.5.

Table 5-2: The qualitative analysis of interdependencies of potential FTM measures in the rice industry

The potential FTM measures in the rice industry			Qualitative assessment	Expected impacts for the rice industry	Implication of interdependency
Pair 1	M1-VN	Rice logistics centre in Chau Thanh A (Hau Giang province)	Allow farmers to sell paddy directly to the distribution centre and reduce the role of intermediaries	Reduction in the number of trips and ton-km	Substitutability
				Reduction in TLC	
	M2-VN	Major markets for rice/paddies in Can Tho, Long An, Tien Giang provinces	Facilitate rice business and reduce immediate stages	Reduction in TLC	
			Limited access to the major markets due to poor infrastructure condition	Increase in total time of the rice supply chain	
Pair 2	M1-VN	Rice logistics centre in Chau Thanh A (Hau Giang province)	Allow farmers to sell paddy directly to the distribution centre and reduce the role of intermediaries	Reduction in the number of trips and ton-km	Complementary
				Reduction in TLC	
	M15-VN	Improvement of NH 1A from the Mekong Delta to HCMC	Reduce transport time from the Mekong Delta to HCMC	Reduction in total time of the rice supply chain	
				Reduction in TLC	
Pair 3	M2-VN	Major markets for rice/paddies in Can Tho, Long An, Tien Giang provinces	Facilitate rice business and reduce immediate stages	Reduction in TLC	Complementary
			Limited access to the major markets due to poor infrastructure condition	Increase in total time of the rice supply chain	
	M15-VN	Improvement of NH 1A from the Mekong Delta to HCMC	Reduce transport time from the Mekong Delta to HCMC	Reduction in total time of the rice supply chain	
				Reduction in TLC	

The first step of investigation of interdependencies is related to qualitatively analysing the expected impacts (benefits) of individual measures in the rice industry. In order to do it, an introduction of the FTM in the rice industry was given and stakeholders affected were further described by highlighting their characteristics. The comparison of expected impacts in pairs of measures then allows conclusions on the type of interdependency as well as reveals the potential interdependence among these measures. The interdependency analysis process is mostly based on acknowledging the perspectives of multiple stakeholders and to be open-minded with regards to unforeseen factors. Table 5-2 presents the detail of qualitative analysis of interdependencies among potential measures in the rice industry. The result of this analysis is strongly supported from the detailed description of measures that presented in the previous section.

The qualitative analysis gives a first sight into the emergence of interdependencies between measures. In particular, the implementation of two measures of M1-VN and M2-VN together could generate lower level of effectiveness than the implementation of each measure individually. That is because; firstly, both two measures share the common objective as creating a key terminal to promote consolidated delivery in the region, and hence concurrent implementation of two measures, in some cases, is not necessary. Secondly, traffic restriction and supply chain time could be increased due to the accessibility problem under the intervention of M2-VN. For this reason, the implication of interdependencies of pairs of M1-VN, M2-VN could be substitutive relationship. This is in contrast to the combination of measures of M1-VN, M15-VN and M2-VN, M15-VN, which are expected to yield a higher level of effectiveness than the sum of effectiveness realised by implementing each measure individually. The reason for this is that the intervention of both measures would facilitate inbound and outbound rice commodity flows in the Mekong Delta. The total time of supply chain is also expected to reduce through the combination of these measures.

The results of the independency check will serve as input for the weight and rank of FTM measures in the next section.

5.2.2 Weighting and ranking of FTM measures

Following the framework of the proposed method mentioned in the chapter 3, MCA was employed to weight and rank the importance level of FTM measures in the rice industry. A review on literature has shown that MCA approach can allow screening the impacts under considerations in regards to socio-economic, environmental, safety, and mobility aspects, which ultimately provides an overall comparison between FTM measures. In addition to this, the involvement of multiple stakeholders in the assessment process can increase the acceptance of assessment results in the rice industry in particular and in society in general. The study will not rank the total list of measures in the rice industry, just potential measures according to MCA methodology as a tool for selecting potential initiatives.

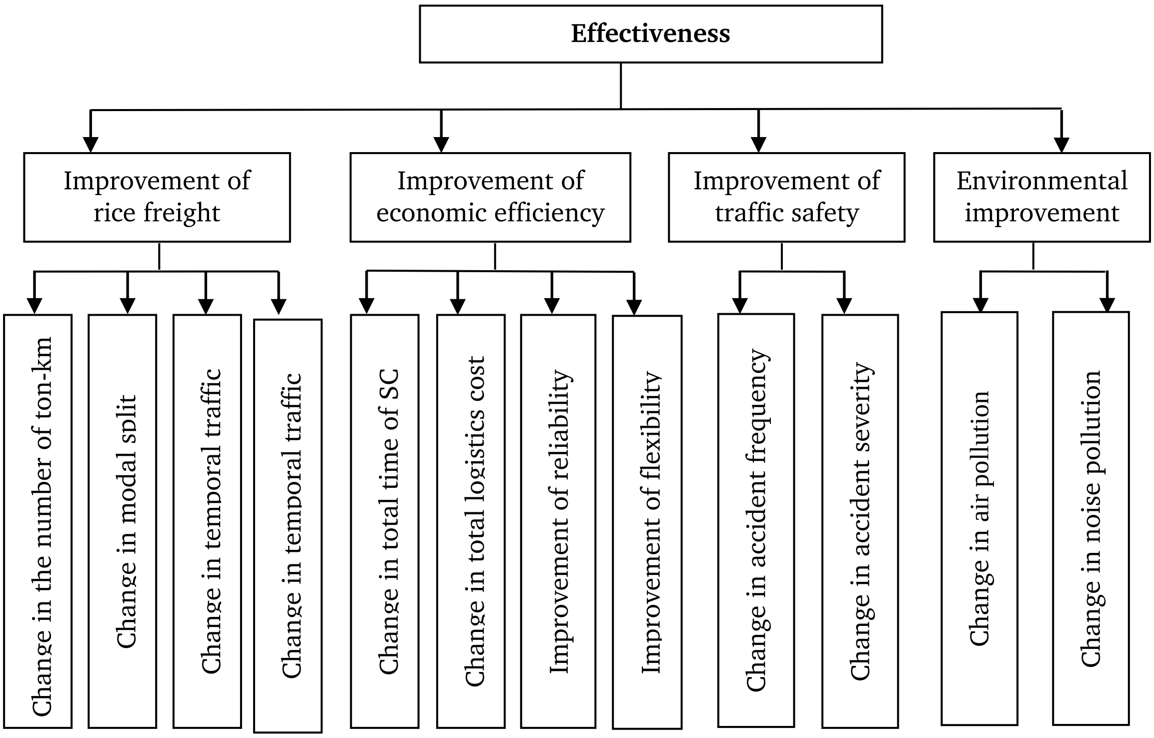
Set-up criteria for the assessment

There are two groups of criteria used for the first assessment and ranking the FTM measures in the rice industry. They are Effectiveness and Applicability (or Barrier) criteria. Effectiveness represents the expected impacts and applicability represents the main barriers in implementation of these measures in the rice industry.

The analysis of the current state of the rice industry conducted in chapter 4 has shown that challenging issues for the rice freight transport are as follows. Firstly, the increase in road freight transport which can potentially lead to a rise in GHG emissions and traffic accidents. Secondly, high transport and logistics cost are reducing the economic efficiency of this sector. Lastly, overloading in long-distance freight transport has damaged and deteriorated infrastructure network quickly.

Stemming from this analysis, the assessment criterion of *Effectiveness* was measured by estimating the expected impacts of FTM measures toward four objectives of the rice industry. These objectives are the improvement of rice freight transport, improvement of economic efficiency, improvement of traffic safety, and environmental protection. Under each objective, there is a set of criteria stated in measurable term and geared toward achieving that objective. Figure 5-6 presents these criteria in detail.

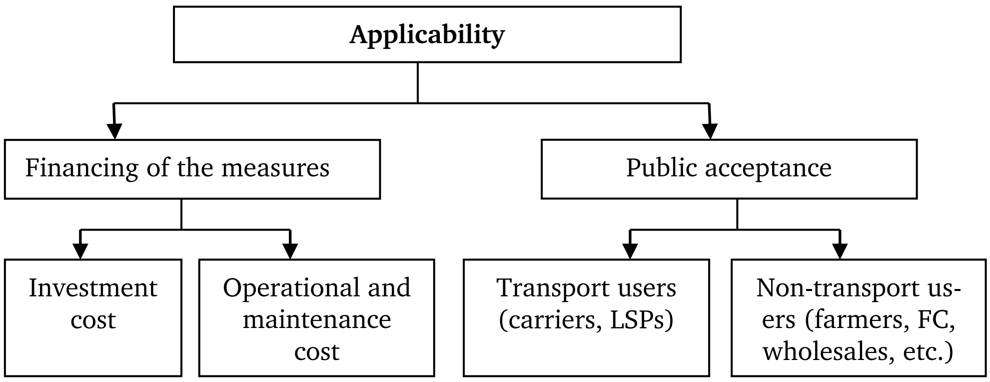
Figure 5-6: Hierarchical structure of assessment criteria for effectiveness



Note: SC – Supply chain

Similarly, the criterion of *Applicability* is measured indirectly by estimating the barriers to implementation of FTM measures in the rice industry. The major barriers are financing for the measures and public acceptance. Financing for the implementation of an intervention represent the affordability to the state or local provinces of implementing measure in practice. It covers two main components of cost: investment cost and operational and maintenance cost.

Figure 5-7: Hierarchical structure of assessment criteria for applicability



The applicability of measures also depends on whether authorities get the support from the public or not. The hierarchical structure of the assessment criteria on applicability is shown in

Figure 5-7. There are two main groups of public concerned: transport users and non-transport users. The transport users can be clearly defined as people who are directly involved in rice transport activities such as collectors, carriers or LSPs. Non-transport users are other people who do not use any mode of transport but who are indirectly influenced by implementing FTM measures (e.g. farmers, food companies, wholesalers, retailer, and transport authorities).

Weighting the assessment criteria

The weight of effectiveness and the applicability criteria group were obtained by conducting an expert survey. The main objective of this survey in the context of this study was to gain insights from experts on the relative importance of the assessment criteria. Because of the complexity and scale of freight transport issues in the rice industry, experts with deep understanding of the issue were chosen to participate in interviews.

Figure 5-8: Questionnaires sample

PART 2: EXPECTED EFFECTIVENESS

Q2.1: To achieve the sustainable development of the rice industry in the Mekong Delta, how should the goals of FTM be ranked? (*From the most important (1) to the least important (4), the same rank can be given for different criteria)*

Goals	Rank
Improve freight transport (FT)	Give here your rate
Improve economic efficiency (ECO)	Give here your rate
Ensure traffic safety (SF)	Give here your rate
Protect environment (EN)	Give here your rate

Q2.2. TO IMPROVE FREIGHT TRANSPORT in the context of rice industry in Mekong Delta, which criteria used to measure this goal are important than the others? (*Give your rank from the most important (1) to the least important (4). The same rank can be given for both)*

Criteria	Rank
Reduction in the number of ton-km (TON.KM)	Give here your rate
Change in modal split (SPLIT)	Give here your rate
Change in temporal traffic (TEMPORAL)	Give here your rate

Please formulate the criteria-matrix according to the ranks that are given in Q 2.2 and conduct a simple pairwise comparison between the impacts by the following rule:

Give “1” if two criteria are equally important.
Give “3” if the basic criterion is slightly more important than the other
Give “5” if the basic criterion is significantly more important than the other
Give “7” if the basic criterion is extremely more important than the other

Criteria-matrix					
Rank		**1**	**2**	**3**	**4**
Rank	Title (abrv.)	title	title	title	title
Rank 1:	title			Give here your rate	Give here your rate
Rank 2:	title				Give here your rate
Rank 3:	title				

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 weight of assessment criteria for the FTM measures in the context of the Vietnamese rice industry. An extract of the questionnaire is presented in Figure 5-8.

It should be noted that one expert might display bias towards criteria relevant to his area of expertise or economic interests; therefore subjectivity is a risk in the weighting process. To minimize subjectivity and fronting individual interests, experts were provided with a short presentation about this study and the questionnaire by email before direct interview. They were also assured that all their personal assessments would be kept confidential and only published with written permission. Interviews were carried out at the different workplaces of the experts involved. On the interview day, at the beginning of the process, objectives of the study were again explained, as was the interview process. A direct discussion of over an hour then took place between the author and the experts based on questionnaire designed for the interview.

After collecting different assessments of the experts on the importance levels of criteria, results were documented in form of assigned percentages using Excel software. The comparison matrix is based on a standard seven-point scale. The resulting relative weights of importance were then fixed for further analysis. Table 5-3 presents the scale for pairwise comparison.

Table 5-3: Scale for pairwise comparison

Numerical scale	Definition	Explanation
1	Equal Importance	Two criteria contribute equally to the effectiveness
3	Moderate importance	Moderate importance of one criteria over another
5	Significant importance	Significant importance of one criteria over another
7	Extreme importance	Extreme importance of one criteria over another

The pairwise comparison matrix of each expert was analysed individually to determine the relative weights of the importance by percentage. The final weighting of importance of each for each assessment criteria was estimated by using geometric means as an indicator of the central tendency across individual weighting of all selected experts. Results of the analyses therefore represent and aggregate expert opinion on the importance level of assessment criteria. Results are presented in detail in Table 5-4.

Following these final results, the most likely expected impacts of FTM measures in the rice industry are a change modal in split and reduction in total logistics cost which have a relative weight of 20% and 16%, respectively. "Reduction in the numbers of trips" and "reduction in total time of the supply chain" are evaluated as the second most important factors with a relative weight of 10% and 9%, respectively. The factors marked third and fourth in terms of importance are improved traffic safety and enhanced environmental protection with a relative weight of 8% and 6%, respectively.

In terms of barriers to the implementation of FTM measures in the rice industry, the relative weight of importance indicates that financing of the measure is rated as the most difficult factor with a relative weight of 71%, while the requirement of public acceptance is ranked as the second in difficulty. More specifically, investment cost and the acceptance of non-transport users (e.g. food companies, wholesalers, and retailers) have the strongest effect on putting

FTM measures into practice.

Table 5-4: Relative weight of assessment criteria for FTM measures in the rice industry

Assessment criteria group	Assessment criteria	Factor weights (1)	Assessment sub- criteria	Sub-criteria weights (2)	Final weight of criteria (1) x (2)
Effectiveness (100%)	Improvement of freight transport	0.38	Reduction in the number of ton-km	0.27	0.10
			Change in modal split	0.52	0.20
			Change in temporal traffic	0.21	0.08
	Improvement of economic efficiency	0.36	Reduction in transport time	0.25	0.09
			Reduction in logistics cost	0.45	0.16
			Improved reliability	0.16	0.06
			Improved flexibility	0.15	0.05
	Improvement of traffic safety	0.14	Reduction in accident frequency	0.58	0.08
			Reduction in accident severity	0.42	0.06
	Enhancement of environmental protection	0.12	Reduction in air pollution	0.49	0.06
			Reduction in noise pollution	0.51	0.06
Applicability (100%)	Financing for the measures	0.71	Investment cost	0.74	0.53
			Operation and maintenance cost	0.26	0.18
	Public acceptance	0.29	Transport users (carriers. LSPs)	0.43	0.12
			Non users (shippers, receivers, residents...)	0.57	0.16

Notes: 20 experts in total were involved in the expert interview process. Experts are from freight transport companies, food companies, and traffic management authorities

Rating the FTM measures

In this step, qualitative rating of FTM measures in the rice industry based on the fulfilment of the assessment criteria was carried out. This qualitative scaling is dedicated to the effectiveness and the applicability of these measures. It should be noted that the detailed description of the FTM measures relevant to the rice industry presented in the previous section are used as a guide to assign scale ratings for different measures.

Levels of effectiveness and applicability are rated as high, medium, and low corresponding points from 3 to 1. Thus, a measure that has the highest level of effectiveness in meeting the given assessment criteria is rated as 3. Similarly, a measure that has the highest level of applicability is also rated as 3. Detailed definition of qualitative scaling of effectiveness and applicability in this study is presented in Table 5-5.

Table 5-5: Definition of qualitative scaling of effectiveness and applicability

Score	Effectiveness (Levels of impact)	Applicability (Levels of difficulty)
1	low positive impact	low applicability
2	medium positive impact	medium applicability
3	high positive impact	high applicability

An example on the scaling of cost difficulty of the measures is given in Table 5-6.

Table 5-6: Example of scaling cost difficulty of measures

Level of difficulty	Investment cost	Operational cost	Point
High	Total investment cost of the measure is more than 1500 billion VND (*)	A new organization with new equipment and staffs need to be created to implement this measure	1
Medium	Total investment cost of the measure is from 75-1500 billion VND (*)	A moderate increase in operation and maintenance costs are required to implement this measure	2
Low	Total investment cost of the measure is from 1 -75 billion VND (*)	Some minor changes in the costs of operation and maintenance are required to implement this measure	3

(*)According to Decree number 12/2009/ND-CP on transport project management in Vietnam, dated February 12th 2009 and approved by the Vietnamese Prime Minister

It is noteworthy that quantitative reference is highly necessary to ensure the accuracy of assessment. However, some quantitative data is difficult to obtain in practice. Therefore, assessment based on the author's understanding of the measures has been applied in some cases to qualitatively evaluate the effectiveness and difficulty in implementation of these measures.

In fact, there are seven FTM measures in the rice industry but only three of them (M1-VN, M2-VN, M15-VN) are potential future intervention. Therefore, these three measures were chosen for qualitative rating in terms of level of effectiveness and level of difficulty. The following section describes the criteria for assessment for each measure.

Improvement of freight transport

Each of the three measures is evaluated based on its effectiveness in reducing the number of trips, reducing the volume of ton-km, influencing freight transport mode choice, and influencing temporal traffic. However, the level of effectiveness of a measure will depend on its aim, and the known or intended impacts. As mentioned in the detailed descriptions of FTM measures, the establishment of a regional rice logistics centre and major markets for paddy/rice aim to establish logistics facilities located close to rice production areas to improve the ability of rice procurement and to promote consolidated deliveries within the area. The technical impact of this measure is to allow farmers to sell paddy directly to the distribution centre and reduce the role of intermediaries, which would result in a reduction the number of trips and ton-km. In the distribution stage, it would increase opportunities for consolidated delivery by road from the Mekong Delta to HCMC since these centres would be in convenient locations for road transport (e.g. NH61, NH1A, and provincial road 91) and Xa No channel. Improvement of NH1A from the Mekong Delta to HCMC is expected to increase the average speed of vehicle, resulting in the reduction in transport time from the Mekong Delta to HCMC.

Improvement of economic efficiency

Each measure is evaluated based on its effectiveness in reducing the total time of the rice supply chain, reducing total logistics cost, and improving flexibility and reliability. Looking back to the descriptions of the proposed measures, the intention is to create a rice logistics centre close to NH 1A, which can provide more accessibility to into and out of this central bub. In addition, better access road would result in reduced total time and total logistics cost as well as improved flexibility and reliability in the rice supply chain. The establishment of major markets for rice/paddy mostly focuses on improving rice business activities with effects on traffic and transport rather limited.

Improvement of traffic safety

Each measure is evaluated based on its effectiveness in reducing accident frequency and accident severity in the rice industry in particular and the transport system in general. Among three potential measures, only NH 1A upgrading project is expected to improve the traffic safety situation in the Mekong Delta. This is because NH 1A from the Mekong Delta to HCMC is facing with a big problem as a result of the degraded condition of the road and excessive traffic volume. This can implicitly cause accidents on this highway. One can argue that the application of this measure could further exacerbate the situation, thereby potentially increasing road traffic accidents.

This is in contrast to the two measures discussed previously (M1-VN and M2-VN) which are mainly focused on improving the economic efficiency of the rice supply chain rather than improved traffic safety.

Environmental protection

Each measure is evaluated based on its effectiveness in reducing vehicle emissions and noise pollution. Improvement of NH 1A is projected to attract more road freight traffic from the Mekong Delta to HCMC, which may put pressure on the environment. Meanwhile, the two other interventions, namely the establishment of a rice logistics centre and major markets for rice/paddy are expected to generate positive environmental impacts since they promote IWT as a transport option for inbound logistics.

Financing for the measures

The cost of the implementation of FTM measures is one of many factors to estimate the applicability of a measure. Many measures that even satisfy most effectiveness but not be selected due to the high costs involved in their implementation. Financing for the measures involves two cost elements, namely investment cost, operation, and maintenance cost. For the case of Vietnam, the government has a specific regulation on classifying the investment cost of transport project stated in detail in Table 5-6. Based on this qualitative scaling of cost difficulty, detailed assessment of each FTM measures in the rice industry is shown in Table 5-7.

It should be noted that cost difficulty criteria do not cover external costs related to congestion, emissions, safety, or any other external impact. In qualitative way, the establishment of a rice logistics centre could generate traffic congestion around this centre due to a high concentration of traffic volume, which potentially leads to the increase of delays cost and human health costs.

Table 5-7: Assessment on the cost difficulty of each measure

No	FTM measures in the rice industry	Estimated investment cost (Billions VND)	Assessment of difficulty in the cost of measure	Point
M1-VN	A rice logistics centre in Chau Thanh A (Hau Giang province)	1000 (Ref: VINAFOOD 2)	Medium	2
M2-VN	Major markets for rice/paddy in Can Tho, Long An, Tien Giang provinces	1200 (Ref: VINAFOOD 2)	Medium	2
M15-VN	Improvement of NH1A from the Mekong Delta to HCMC	6000 (Ref: MOT)	High	1

Similarity, the improvement of NH 1A could have an intrinsic risk of increased traffic accidents on this highways due to high speed limit. This implies that external costs generated by transport accidents such as medical costs or production losses would be increased. For this study, it was not possible to consider all external impacts but CO2 and local air (SO_x and NO_x) pollution and traffic accident borne by rice freight transport will be taken into account when assessing the impacts of FTM measures.

Public acceptance

For implementing a FTM measure, two main demographics of the public are concerned: transport users and non-transport users. The transport users are defined as people who are directly involved in rice transport activities such as collectors, transport companies or LSPs. Non-transport users are other people who do not use any mode of transport but who are indirectly influenced by implementing FTM measures (e.g. farmers, food companies, wholesalers, retailer, residents). The adopted qualitative scaling index ranges from 1 to 3, in the decreasing order of difficulty in getting public acceptance. Thus, the measure that provokes the highest acceptance due to any factors related to the implementation of the measure is rated as 3.

After describing the assessment criteria, the study will scale qualitatively the effectiveness and applicability score for each measure. As mentioned above, effectiveness of measure is assessed by the impacts on the rice transport towards four dimensions including improvement of freight transport, improvement of economic efficiency, improvement of traffic safety, and enhanced environmental protection. Applicability of measures is evaluated by estimating the difficulty level in getting the basic requirements involving costs and the support of stakeholders. The final qualitative scaling of three potential measures in terms of the effectiveness and applicability is presented in Table 5-8.

The tables show the initiatives of establishing a regional rice logistics centre **(M1-VN)** is expected to change significantly freight mode share towards more IWT usage, reduce the number of ton-km and improve remarkably the economic efficiency of the rice industry. The measure on improving NH1A **(M15-VN)** will face the difficulty of high investment cost (1 point in applicability level) but expect to gain many supports among the public (3 point in public acceptance of transport users) because of their potential benefits in term of improvement of freight transport and economic efficiency. Non-transport users may have a little concern on negative impacts on the environment and traffic safety when a regional rice logistics centre and the project improving for NH 1A is implemented. The implementation of major markets for rice/paddies **(M2-VN)** is very hard to get the support from collectors, transport companies or LSPs in the Mekong Delta (1 point in applicability level) due to congested access in and out of these markets. To date, there is little in the literature that provides quantification of the actual transport impacts in implementing major markets for rice or paddy in the Mekong Delta. Therefore, communicating the initiative to the public and generating support from both transport and non-transport users may be challenging.

Table 5-8: Qualitative scaling of three potential FTM measures in the rice industry

		M1-VN	M2-VN	M15-VN
Criteria	**Sub-criteria**	Regional rice logistics centres in Hau Giang province	Major markets for rice in the Mekong Delta	Improvement of NH1A from the Mekong Delta to HCMC
EFFECTIVENESS				
Improvement of rice freight transport	Reduction in the number of ton-km	2	2	3
	Change in modal split	3	1	3
	Change in temporal traffic	1	1	1
Improvement of economic efficiency	Reduction in total time of the supply chain	2	1	3
	Reduction in logistics cost	3	1	2
	Improved reliability	2	1	3
	Improved flexibility	1	1	2
Improvement of traffic safety	Reduction in accident frequency	2	2	1
	Reduce in accident severity	2	1	1
Environmental protection	Reduction in air pollution	3	1	1
	Reduction in noise pollution	2	1	1
APPLICABILITY				
Financing of the measures	Investment cost	2	2	1
	Operation and maintenance cost	2	2	3
Public acceptance	Transport users	3	1	3
	Non-transport users	2	1	2

5.2.3 Final evaluation of FTM measures

Qualitative assessment model has been developed to calculate the final effectiveness and difficulty score of each measure. The formulas consist of three elements: (i) the relative weight of assessment criteria (C_m or C_x), (ii) the relative weight of assessment sub-criteria ($C_{S,mn}$ or $C_{S,xy}$), (iii) author's rating of the measure (e^{ij}_{mn} and a^{ij}_{xy}). A measure would be more effective and more easily applied if the effectiveness and applicability scores are higher and vice versa.

$$E_{ij} = \sum_{m=1}^{4} \left(C_m * \left[\sum_{n=1}^{p} C_{S,mn} * e_{mn}^{ij} \right] \right)$$

In which

E_{ij}: Total effectiveness score of FTM measure i under modal category j

C_m: Weight of criteria m (m=1 to 4)

$C_{S,mn}$: Weight of sub-criteria n under criteria m

e_{mn}^{ij} : Effectiveness point of measure i on category j, on criteria m and sub-criteria n

$$A_{ij} = \sum_{x=1}^{2}\left(C_x * \left[\sum_{y=1}^{q} C_{S,xy} * a_{xy}^{ij}\right]\right)$$

In which

A_{ij}: Total applicability score of FTM measure i under modal category j

C_x: Weight of criteria x (x=1 to 2)

$C_{S,xy}$: Weight of sub-criteria y under criteria x

a_{xy}^{ij} : Applicability point of measure i on category j, on criteria x and sub-criteria y

The calculation of effectiveness and difficulty scores of the measures provided the formation of priority classes of FTM measures. Table 5-9 gives the detailed results of the qualitative assessment of FTM measures in the rice industry.

Table 5-9: Final assessment of pre-selected measures

Measures		Effectiveness score (E_{ij})	Applicability score (A_{ij})	Ranking
M1-VN	A regional rice logistics centre in Hau Giang province	2.3	2.1	**First priority**
M2-VN	Major markets for rice in Can Tho, Long An, Tien Giang provinces	1.2	1.7	Third priority
M15-VN	Improvement of NH1A from the Mekong Delta to HCMC	2.1	1.8	**Second priority**

The assessment of FTM measures in the rice industry inferred that the measures that have the highest level of effectiveness and applicability would belong to the first priority group. The second priority group consists of measures that either have a high level of effectiveness and a medium level of difficulty or a medium level of effectiveness and a low level of difficulty. Remaining measures will belong to the last priority group.

According to the assessment results, an establishment of a regional rice logistics centre in Hau Giang province is recommended as the first priority measure because of its high level of effectiveness and low level of difficulty in implementation. Next, improvement of NH 1A is ranked in the second priority group since it involves a moderate level of effectiveness and ease to application. The establishment of major markets for rice/paddy is assigned as last priority measure due to low level of effectiveness and high level of difficulty involved in implementation. M1-VN and M15-VN will be the focus of a detailed quantitative impact assessment in the next section.

5.3 Detailed analysis of impacts of FTM measures

In this step, a detailed quantitative assessment is carried out to determine the impacts related to the change in the supply chain, and the impacts on mode and route choices in the rice industry. According to the proposed framework for impact assessments defined in the Chapter 3, the application of disaggregate models, i.e. TLC, is highly necessary. This is because such a model allows understanding detailed knowledge of structure of sector, as well as stakeholders involved and their decisions making behaviours, key underlying factors for the analysis of core effects. Before going into detail regarding the application of TLC model, the study presents some scenarios for detailed quantitative impact assessment.

5.3.1 Determination of scenarios

The scenarios, presented in this section, are formed based on the assessment results of the first step. Particularly, the results of the first step have revealed that a high rating was given to the following FTM measures: the establishment of a regional rice logistics centre (M1-VN) and NH 1A improvement (M15-VN). Building on this, three scenarios can be set-up for impact assessment. The first scenario is if only a new rice logistics centre is established. The second scenario is the improvement of NH1A. The third scenario is the combination of the two measures above.

Table 5-10: Different scenarios for the application of FTM measures in the rice industry

<table>
<tr><th colspan="2">Base scenario
(including all already applied measures)</th><th>Scenario 1</th><th>Scenario 2</th><th>Scenario 3</th></tr>
<tr><td>M4-VN</td><td>Prohibition of trucks entering HCMC from 6:00 am to 12:00 pm</td><td rowspan="4">Base scenario + implementation of M1-VN</td><td rowspan="4">Base scenario + implementation of M15-VN</td><td rowspan="4">Base scenario + implementation of both M1-VN and M15-VN</td></tr>
<tr><td>M11-VN</td><td>The establishment of centralized areas for paddy production</td></tr>
<tr><td>M12-VN</td><td>Co-operation between collectors and millers and export companies in An Giang province</td></tr>
<tr><td>M17-VN</td><td>Restricting overloaded trucks on the highway from the Mekong Delta to HCMC</td></tr>
</table>

Explanations:
M1-VN: A regional rice logistics centre in Hau Giang province
M15-VN: NH1A improvement from the Mekong Delta to HCMC

Base scenario

For this case study, the base scenario reflects existing condition in the rice industry. It includes all FTM measures already applied in practice, namely M4-VN, M11-VN, M12-VN, and M17-VN. The base scenario is compared to other scenarios for which the impacts of freight transport management can be measured.

Scenario 1

Scenario 1 is defined by the establishment of a regional rice logistics centre in Hau Giang province. This centre will hold a key position, bordering Can Tho city and Kien Giang province - “the rice bowls” of the Mekong Delta; and Xa No channel; and be close to important highways such as NH61, NH1A, provincial road 92.

Scenario 2

Scenario 2 is developed by the implementation of the project on upgrading NH 1A from the Mekong Delta to HCMC. Construction is scheduled to commence in early 2016 and plans indicate the project should be completed at the end of 2018. The planned NH 1A upgrade is believed to increase road access to many key rice production areas in the Mekong Delta, which can facilitate commodity flows in and out of the region.

Scenario 3

Scenario 3 is the combination of the establishment of a rice logistics centre and upgrading NH 1A from the Mekong Delta to HCMC. The concurrent implementation of these two measures is believed to strongly influence the economic efficiency in the rice industry.

The following sections will apply a TLC model to assess deeply the impacts of these scenarios. 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 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.

5.3.2 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.

Table 5-11: Rice production and consumption in the Mekong Delta

Unit: Million tons

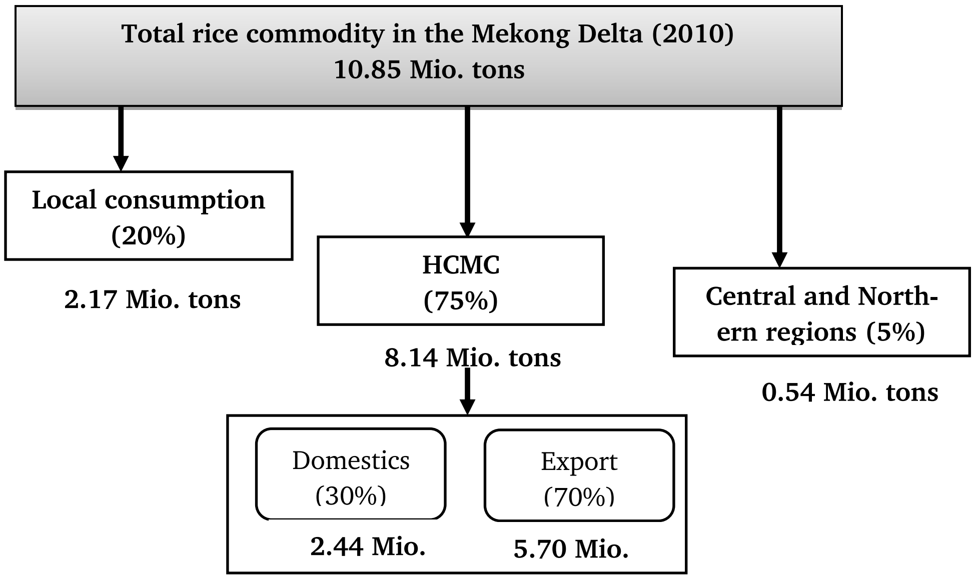
Items	Paddy	%	Rice
1. Total volume (Q)	**21.995**		**14.517**
2. Losses in harvesting process	2.156	9.8	**1.4226**
3. Total consumption output (Q1)	19.839		**13.094**
4. Materials and animal breeding	1.445		**0.954**
- Rice seeds: 165kg*3,870 mil.ha	0.64		0.42
- Animal breeding: 3,13%*Q rice	0.41		0.27
- Materials for industries: 2%*Q1 rice	0.40		0.26
5. Losses in processing rice		9.8	**1.287**
- Milling: 2,47%			
- Polishing: 4%			
- Warehousing: 1%			
- Transporting : 2,36%			
6. Rice commodity from the Mekong Delta	16.44		10.853

Source: GSO (2011)

According to GSO (2011), total rice output from the Mekong Delta in 2010 was more than 14.5 million tons. However, rice commodity was about 10.85 million tons since there is a certain percentage of total output lost in the harvesting process and used as materials for other industries. Detailed data is shown in Table 5-11.

Distribution of rice flows from the Mekong Delta to other regions is presented in Figure 5-9 This figure shows that HCMC is the focal point of rice demand and trade. Meanwhile, central and northern regions have very small rice flows with the Mekong Delta.

Figure 5-9 : Distribution of rice flows in the Mekong Delta, 2010



Source: GSO (2011)

According to the statistics from VINAFOOD 2, there are 74 FPEs with an annual rice handling volume of more than 25,000 tons, which can be seen as key sources of rice in the Mekong Delta.

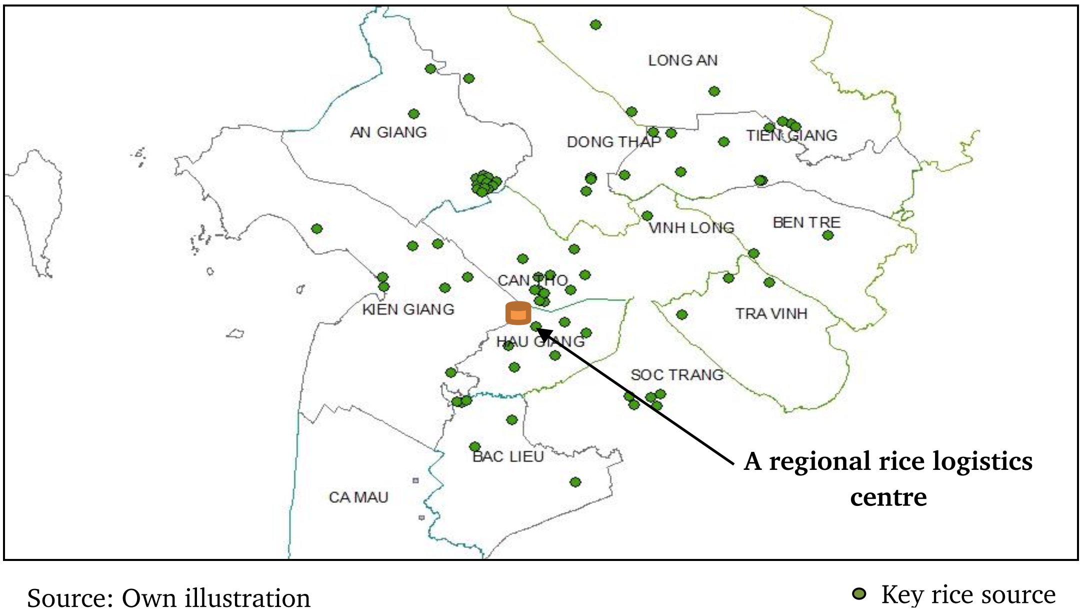
Table 5-12: Key sources of rice in the Mekong Delta

No	Name of province in the Mekong Delta	Numbers of key rice sources	Total rice handling volume per year (ton)
1	Long An	6	820,000
2	Tien Giang	8	510,000
3	Ben Tre	2	110,000
4	Vinh Long	1	170,000
5	Dong Thap	4	690,000
6	An Giang	14	2,165,000
7	Can Tho	10	828,000
8	Tra Vinh	3	120,000
9	Soc Trang	5	447,000
10	Hau Giang	6	275,000
11	Kien Giang	9	1,770,000
12	Bac Lieu	6	200,000
	Total	**74**	**7,985,000**
	Share in total rice volume of the Mekong Delta		**73.6%**

Source: VFA (2011)

Total rice volume from these sources makes up more than 73.6% of rice commodity output of the whole region. The name, address as well as annual rice handling volume of each source are presented in detail in Appendix C. The location of these sources is noted on the map of the Mekong Delta (see Figure 5-10)

Figure 5-10: Locations of key rice sources in the Mekong Delta



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.

In the both scenarios 1 and 3, a regional rice logistics centre is formed in Chau Thanh District, part of Hau Giang province, which borders with Can Tho city and Kien Giang province. Therefore, this centre is expected to attract a lot of rice sources in surrounding area because of its ability to facilitate the consolidation and deliveries of rice going to HCMC. However, most key rice sources often have their own warehouses, so the utilisation of the rice logistics centre depends much on the convenience of transport or accessibility as well as TLC optimization.

The question can be raised then, of how these scenarios can affect a modal shift from barge to road transport or vice versa on the way to HCMC. The answer is dependent mostly on changes in the TLC of road and IWT transport modes, which will be estimated in detail in the following sections.

5.3.3 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. In order to access these data, the author had to ask for a letter from VGU to introduce this study to GSO; before finally being granted permission to use data for scientific purposes only. A sample of the data provided by GSO is presented in Table 5-13.

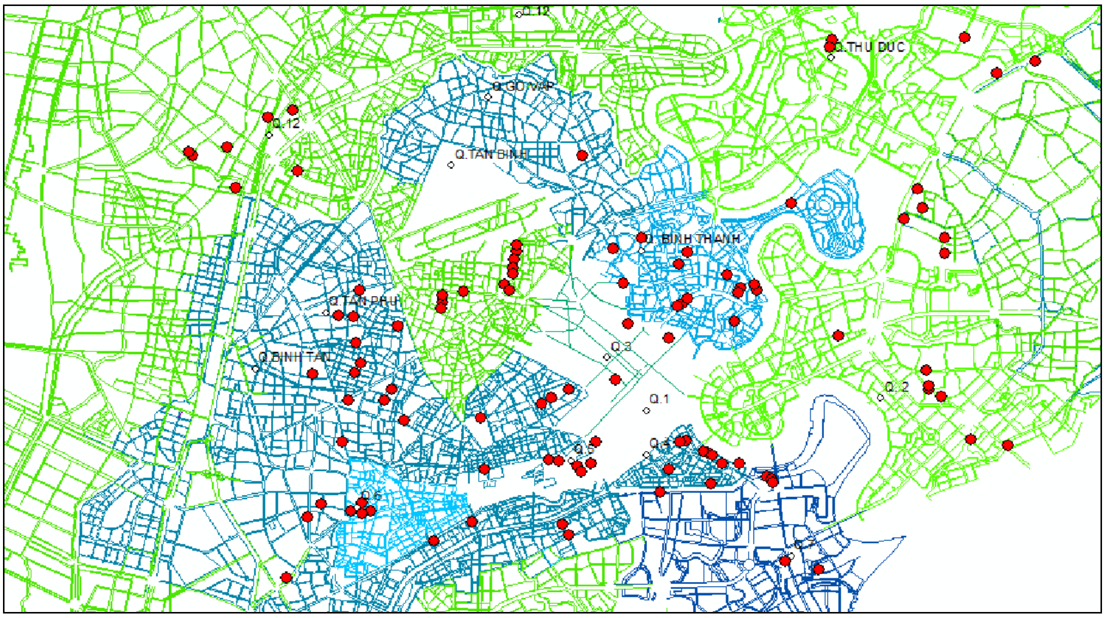
Table 5-13: Sample of data on establishment in HCMC

No	Name of Company	Code	Business Field	Address	Number of employees
1	Vinafreight	49332	Freight transport and warehousing	Truong Son, Tan Binh Dist	350
2	East Southern Shipping	49332	Freight transport and warehousing	Hoang Hoa Tham, Ward 12, Tan Binh	257
3	Tan Cang Overland Transport	49332	Freight transport and warehousing	Nguyen Thi Dinh, Cat Lai, Dist 2	390
4	Quang Chau Forwarding and Transport Service	49332	Freight transport and warehousing	Phan Van Tri, Ward 12, Binh Thanh	110
5	Sagawa Express Vietnam	49332	Freight transport and warehousing	Linh Trung, Thu Duc Dist	86
6	Transport Agri-Material Products Import Export JSC	49332	Freight transport and warehousing	Nguyen Binh Khiem, Da Kao, Dist 1	155
7	Ben Thanh New Port	49332	Freight transport and warehousing	Nguyen Thi Dinh, Cat Lai, Dist 2	280

Source: GSO (2014)

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 5-11.

Figure 5-11: Distribution of establishments in HCMC



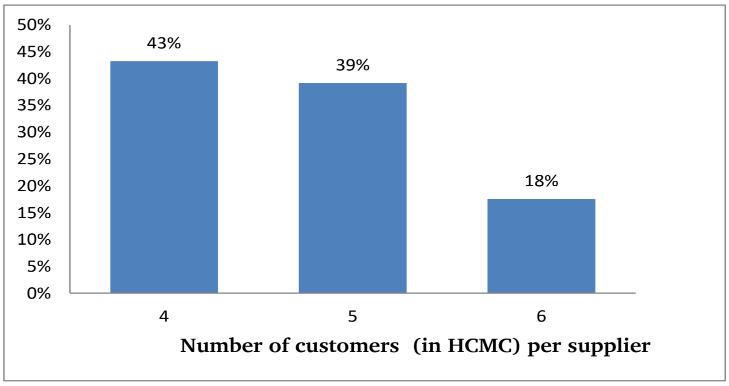
● Establishment in HCMC
Source: Own illustration

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.

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 full questionnaire is presented in Appendix C. The distribution of customers in HCMC is presented in Figure 5-12.

Figure 5-12: Distribution of number of customers per rice supplier

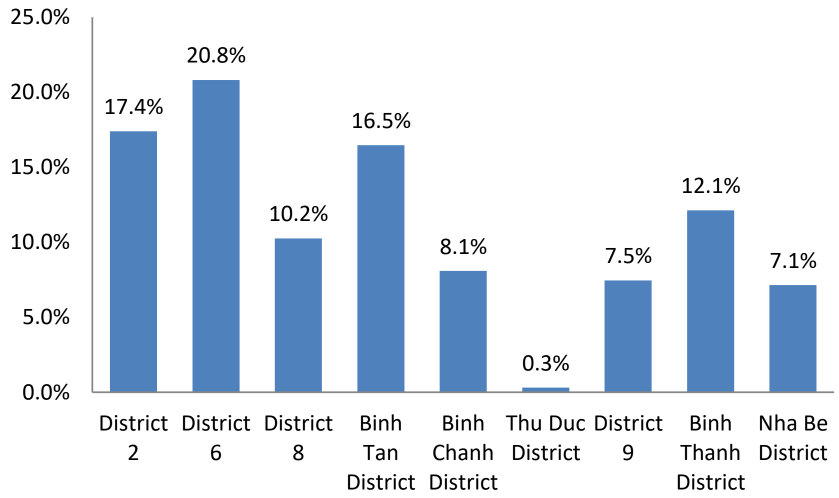


Source: Interviews carried out by author in February 2015

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.

It should be noted that rice quantities sold to customers in HCMC are not equally distributed. Particularly, rice is mostly sold for customers located in District 6, District 2, Binh Tan District and Binh Thanh District. The detail of distribution of rice volume sold for customers in HCMC is shown in Figure 5-13.

Figure 5-13: Distribution of rice volume sold for customers in HCMC



Source: Interviews carried out by author in February 2015

The analysis of distribution of customers in HCMC as well as the distribution of suppliers in the Mekong Delta is underlying data for the development of a TLC model in the rice industry, which will be presented in the next section.

5.3.4 Development of TLC model in the rice industry

The development of the TLC model 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 in section 5.3.2, HCMC is responsible for about 75% of the total rice volume of the Mekong Delta. In addition to this, the statement from the survey in section 5.3.3 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.

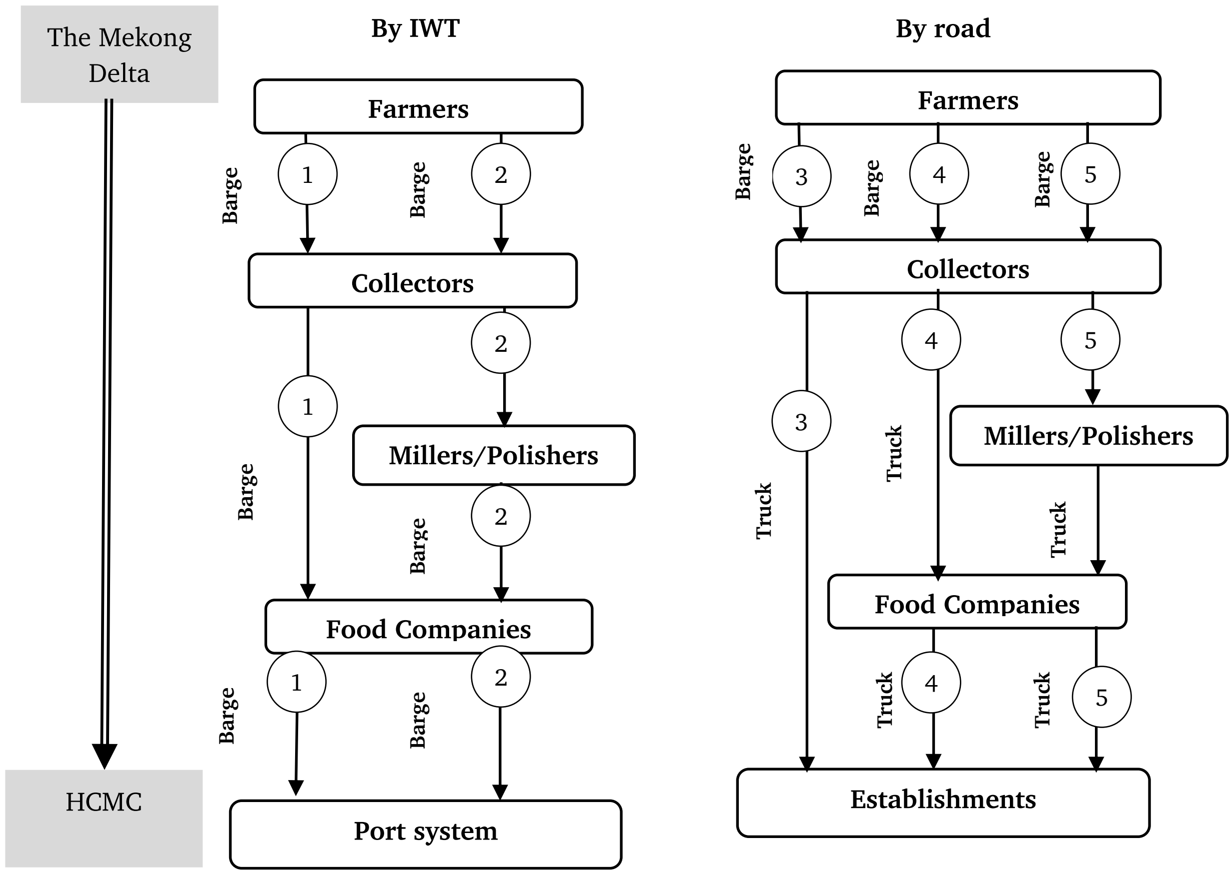
A Pareto distribution of quantities per supplier is utilised to generate the commodity flows in the rice industry. The cumulated Pareto distribution function is defined by the following formula:

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

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: $\alpha = 1$ for suppliers with annual rice handling volumes from 25,000 to 75,000 tons; $\alpha = 2$ for suppliers with annual rice handling volumes from 75,000 to 180,000 tons; and $\alpha = 3$ for suppliers with annual rice handling volumes more than 180,000 tons.

Figure 5-14: Current supply paths in the rice industry (Base scenario)



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. There are currently five rice supply paths from the Mekong Delta to HCMC presented schematically in Figure 5-14.

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		

Looking more closely into the rice industry, TLC for each supply path is estimated as below:

$$TLC_1 = TC_{F-Coll} + HC_{Coll} + TC_{Coll-FC} + HC_{FC} + Pack_{FC} + WC_{FC} + TC_{FC-Port} + HC_{port}$$

$$TLC_2 = TC_{F-Coll} + HC_{Coll} + TC_{Coll-Mil} + HC_{Mil} + WC_{Mil} + TC_{Mil-FC} + HC_{FC} + Pack_{FC} + WC_{FC} + TC_{FC-Port} + HC_{port}$$

$$TLC_3 = TC_{F-Coll} + HC_{Coll} + Pack_{Coll} + TC_{Coll-WS} + HC_{ES}$$

$$TLC_4 = TC_{F-Coll} + HC_{Coll} + TC_{Coll-FC} + HC_{FC} + Pack_{FC} + WC_{FC} + TC_{FC-WS} + HC_{ES}$$

$$TLC_5 = TC_{F-Coll} + HC_{Coll} + TC_{Coll-Mil} + HC_{Mil} + WC_{Mil} + TC_{Mil-FC} + HC_{FC} + Pack_{FC} + WC_{FC} + TC_{FC-WS} + HC_{ES}$$

In which:

F	Farmer	FC	Food company
Coll	Collector	ES	Establishment
Mil	Miller		

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 (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:

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

The transport cost rate per ton in the rice industry is estimated based on information from JICA (2012) coupled with interviews with rice LSPs and carriers as introduced in section 4.2. Also in section 4.2, small vessel (less than 500 tons) and/or large truck (15 tons) are confirmed as typical transport modes for rice shipment in the Mekong Delta. Currently, a one-way trade of full truckload to HCMC with an empty truck moving back to the Mekong Delta is common. Vehicle overload has also been better control since load factor controls were implemented on the highway from the Mekong Delta to HCMC. Average load factor is therefore assumed to reduce from 1.7 to 1.3 (MOT, 2014). Based on assumed characteristics of transport modes in the rice industry, the next section will discuss each cost component of these representative modes in detail.

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).

Table 5-14: Composition of fuel consumption by type of vehicles

	Unit	Container truck (15 ton)	Vessel (500 ton)
Vehicle cost	USD	54,000	23000-170000
Main fuel	-	Diesel	Diesel
Annual operation (1)	km	120,000	150,000
Average speed (1)	km/h	40	9
Vehicle weight, without cargo	Ton	15	300
Average load/vehicle weight	-	1.3	1
Distance from the centre of the Mekong Delta to HCMC	Km	200	200
Fuel consumption rate (2)	litter/1000	489.5	6,384
Average fuel cost (3)	US$/litter	1.03	1.03
Fuel cost	US$/ton	6.46	1.6

(1) Estimated based on interview with transport companies (Binh, 2014)
(2) From the interview with truck dealer in VITRANSS 2
(3) From Vietnam National Petroleum Corporation (2014)

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.

Table 5-15: Crew cost and overhead cost by type of vehicles

	Unit	Container truck (15 ton)	Vessel (500 ton)
Driver wages [(1)]	(US$/month)	400	450
Overhead cost [(1)]	%	20	15
Number of working days per year	day	300	300
Daily total crew and overhead cost	US$/day	19.2	20.7
Crew and overhead cost	US$/ton	2.2	1.9

[(1)] Estimated based on interview with transport companies (Binh, 2014)

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.

Table 5-16: Depreciation cost estimation

	Unit	Container truck (15 ton)	Vessel (500 ton)
Vehicle cost	USD	54,000	23000-170000
Salvage value to vehicle cost	%	15	10-12
% of depreciation of use and time			
Subject to use	%	70	70
Subject to time	%	30	30
Annual operation	km	120,000	150,000
Average speed	km/h	30	9
Vehicle life	year	12	15
Depreciation cost subject to use and time	US$/ton	0.98	0.48

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. The results of this cost estimation are shown in Table 5-17.

Table 5-17: Repair and maintenance cost estimation

	Unit	Container truck (15 ton)	Vessel (500 ton)
Vehicle cost	USD	54,000	23,000-170,000
Percentage of repair cost to vehicle cost [(1)]	%	8	3-8
Annual operation	km	120,000	150,000
Average speed	km/h	30	9
Repair and maintenance cost	US$/1000km	34	5100
Repair and maintenance cost	US$/ton	0.67	0.24

[(1)] Estimated based on JICA (2012)

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.

Table 5-18: Capital cost by type of vehicle

	Unit	Container truck (15 ton)	Vessel (500 ton)
Vehicle cost	USD	54,000	23,000-170,000
Salvage value to vehicle cost	%	15	12
Annual operation	km	120,000	150,000
Average speed	km/h	30	9
Vehicle life	year	12	15
Interest rate	%	14	14
Capital opportunity cost	US$/day	13.39	39.7
Capital opportunity cost	US$/ton	0.17	0.48

The resulting unit transport cost in dollars per ton are used as input to calculate the outbound transport cost and total transport cost of a commodity flow.

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. Table 5-19 gives an example of different handling cost rates in the rice industry which are collected through the interview survey with different carriers in the rice industry (Binh, 2014).

Table 5-19: Unit handling costs in the rice industry

Handling activities	Handling cost rate	
	VND/ton	USD/ton
Loading at field (by barge)	20,000	0.95
Loading at milling factory (by barge)	10,000	0.48
Unloading at warehouse of food company (by boat or truck)	20,000	0.95
Loading at warehouse of wholesale (by truck)	20,000	0.95
Unloading and loading at port system in HCMC (by barge)	65,000	3.10

Notes: 1USD =21,000 VND (2015)
Data is collected from field survey (Binh, 2014)

The higher number of stops will be reflected in the higher handling cost. For this study, the impacts of FTM measures would reduce some immediate stages in the rice supply chain, which can translate into the reduction in handling cost and total logistics cost.

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 5-10 gives an example of TLC model development and the estimation of TLC per ton-km via road and IWT in the rice industry.

Table 5-20: 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	

Explanation:

CS: Customer TC: Transport cost WC: Warehousing cost HC: Handling cost TLC: Total logistics cost

5.3.5 Model calibration and validation

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 5-21 lists all important inputs data derived from the field survey in section 4.2 and JICA (2012), and Blancas and M. Baher (2014), which is not changeable for calibration.

Table 5-21: Overview of model input data

Input data	Value
For trucking haulage	
Big truck (ton)	15
Economic life time (year)	12
Price (US$)	54,000
Main fuel	Diesel
Annual operation (km)	120,000
Average speed (km/h)	40
Crew size (people)	1-2
Interest rate (%/year)	14%
For IWT vessels	
Average size (ton)	500
Economic life time (year)	15
Price (US$)	23,000-170,000
Main fuel	Diesel
Design speed (km/h)	10
Operation speed (km/h)	9
Crew size (people)	5

Parameters in TLC model are mostly needed to determine four components of logistics cost: inbound transport cost, outbound transport cost, warehousing cost, handling cost, and packaging cost. An overview of fix parameters is given in Table 5-22.

Table 5-22: Overview of fixed parameters in the model

Model parameters	USD/ton
Inbound transport cost rate	
From farmer to collector (by barge)	2.86
Collectors to food company (by barge)	4.76
Millers to food company (by truck)	6.67
Packaging cost rate	
Packing cost per ton for both domestic and export purposes	4.76
Handling cost rate	
Loading at field	0.95
Unloading and loading at port system in HCMC	3.1

Source: Loc (2010) and field surveys to the Mekong Delta by author in February 2014

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. An overview of these parameters is presented in Table 5-23.

Table 5-23: 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)

As mentioned, the changes in TLC are assumed a main driver for modal choices of shippers, the indicators of the overall model are therefore oriented to TLC per ton-km and freight modal share in the rice industry. The base scenario results from the model calibration. The details of calibrated result are presented in the next section.

5.4 Results and discussion

5.4.1 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 5-24.

Table 5-24: 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 detailed calibration process is partly illustrated in Table 5-20. 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.

5.4.2 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 results of sensitive analysis is presented in details in Table 5-25.

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.

Table 5-25: 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 indicates that these changes can be feasible

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. The reason for this is that fuel cost makes up the largest proportion in total outbound transport cost. A big change of fuel cost can translate to a significant change of total truck costs and affect strongly to the choice of transport mode. 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. This region is generously endowed with navigable rivers, lakes and canals. The comparative advantage for road transport may only extend in the future of the Mekong Delta as a high-grade road network continues to expand and modernize. 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. An increase of crew cost and overhead cost leads to a higher of outbound transport cost and TLC, and resulting a lower percentage of correspondence transport modes. 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. Since in the base scenario the proportion of these costs in unit outbound transport cost is already low, an increase does not cause large changes in the indicator of TLC per ton-km, which drives the choice of transport mode the rice industry. An improvement of transport infrastructure would result in higher vehicle speed and lower round-trip times, leading to lower depreciation, repair and maintenance and total transport cost. 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. It has to be noted that, these changes should be plausible to get more attractive for shippers and LSPs to the new central warehouse.

5.4.3 Scenario 1 impacts

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. The model results for Scenario 1 are shown in Figure 5-15, Figure 5-16 and Figure 5-17.

Inbound transport cost reduces significantly, about 37.5% and 46.1% for road and IWT transport respectively. The impact of lower stops in the rice supply chain, as suggested by the intervention of Scenario 1, in the end offsets the negative impact of higher warehouse cost and handling cost rate per ton. The final rates of warehousing and handling cost are expected to reduce about 32.4% and 37.5%, respectively. There is a slight increase in IWT resulting from a decrease of inbound transport and optimization of total logistics cost.

Figure 5-15: Change in inbound transport cost in Scenario 1

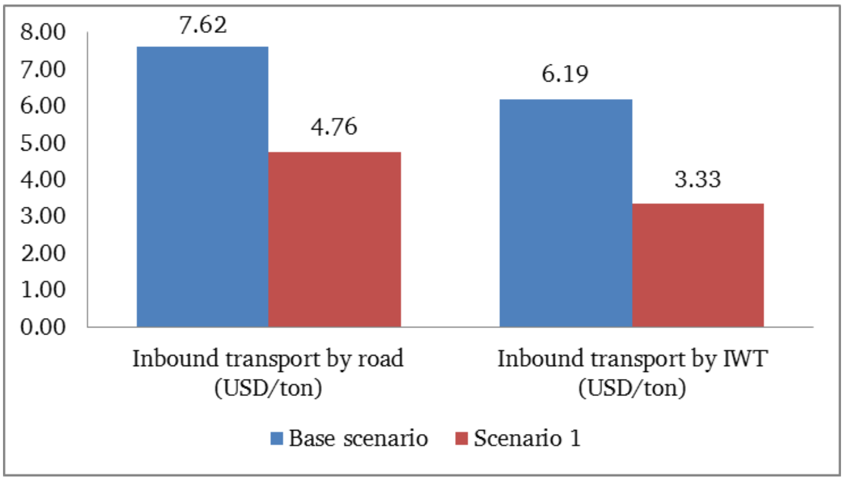


Figure 5-16: Change in warehouse cost and handling cost in Scenario 1

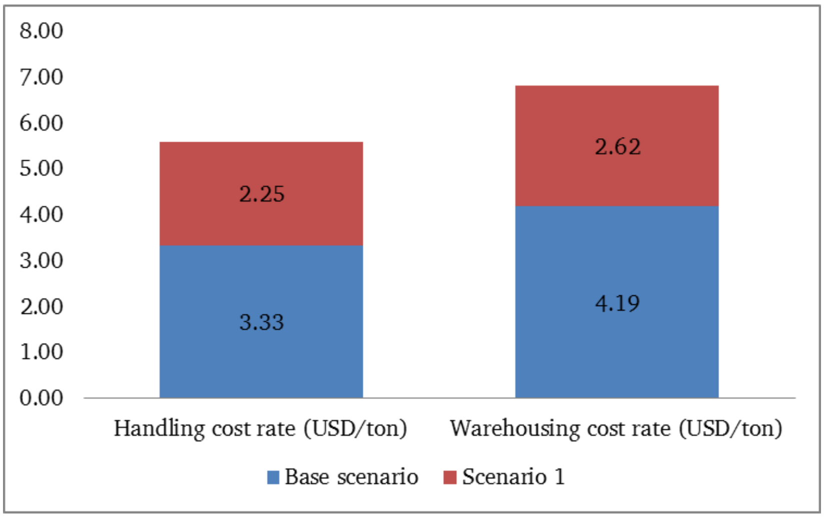
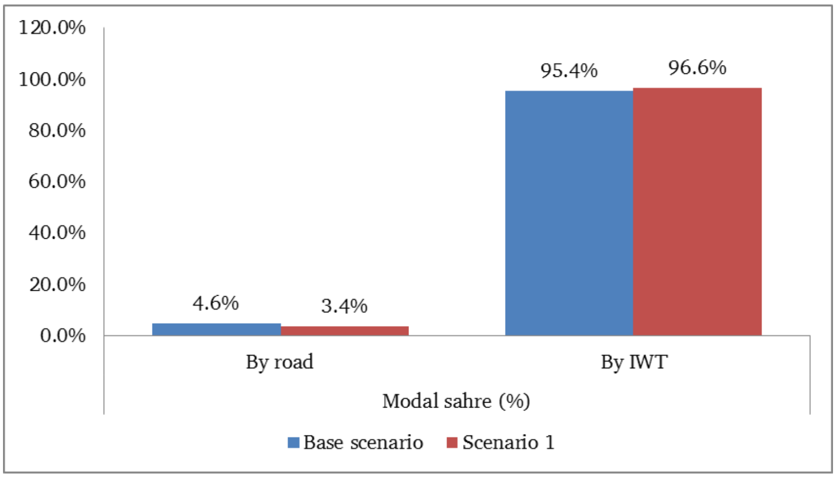


Figure 5-17: Change in modal share in Scenario 1



The modal shift away from trucks 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. The following impacts will have taken into account to evaluate.

- **Modal share of IWT and road** in the base scenario and the with-intervention scenario
- **Change in the number of ton-km per year**: this refers to the change in total number of ton-km transported in the rice industry as a result of scenario introduction.
- **Change in TLC per year**: this refers to the change of TLC in the rice industry as a result of scenario introduction. Specifically, the change of TLC will be analysed through the change of its cost components.
- **Change in shipping inventory cost for road transport:** this implies that at the beginning of the shipment, the cargo being transported had a cash amount worth. Such an amount would have gained some interest by the time the cargo reaches its destination are called shipping inventory cost. Thus, an increase in shipping speed (for example due to the improvement of NH) would result in the reduction in shipping time, which finally translates to lower shipping inventory cost. The shipping inventory cost will be estimated based on hourly discount rate, total shipping time, cargo volume and average value of cargo.
- **Economic cost of safety**: In this study, both safety value for people and cargo are considered. As for safety of people, this value is believed to gain from modal shift from roads to IWT which can generate fewer accidents and fatalities per ton-kilometre (ton-km). The safety value of goods will be measured through the changes in cost of damaged rice shipment in transport. It is assumed that damaged rate of rice shipment is directly proportional to total number of ton-km transported within different scenarios.
- **Total emission reduction per year**: this realizes through scenario implementation. It includes the reduction of carbon dioxide (CO2) as well as local air pollutant (nitrogen oxide - NO and sulphur oxide - SO). Local pollutant emission volumes are estimated about 0.1–2.0 percent of CO2 emission volumes (Blancas and M. Baher, 2014). Based on total emission reduction, the study will estimate environmental cost savings in different scenarios.

In order to estimate the economic value of these impacts, coefficients related to safety valuation and emissions in Vietnam are employed. These coefficients are widely applied in the research of transport impact assessment introduced by the World Bank and JICA (see Blancas and M. Baher,2014; and VITRANSS-2, 2009). Coefficients are presented in Table 5-26 as below:

Table 5-26: Selection of coefficients applied for safety and environmental impact assessment in Vietnam

Coefficients	Value
Valuation of transportation safety (US$/veh.km)	0.005
CO2 emission factor for truck (g/ton-km)	110
CO2 emission factor for barge (g/ton-km)	71
Economic price of CO2 emission (USD/ton)	35
Economic price of NO emission (USD/ton)	900
Economic price of SO emission (USD/ton)	1800

Source: Blancas and M. Baher, 2014; and VITRANSS-2, 2009

Finally, traffic, safety and environmental impacts resulting from Scenario 1 are presented in detail in Table 5-27.

Table 5-27: Estimation of the impacts of Scenario 1

Aspects of impact	Unit	Base scenario	Scenario 1 (Base scenario + M1-VN*)
Rice freight transport			
Number of ton-km by road	million ton-km	126.84	98.44
Number of ton-km by IWT	million ton-km	3,012.94	2,811.34
Economic efficiency			
Total logistics cost per year	million US$	**153.08**	**129.49**
- *Transport cost*	million US$	*100.61*	*90.59*
- *Warehousing cost*	million US$	*33.46*	*20.91*
- *Handling cost*	million US$	*19.01*	*17.99*
Shipping inventory cost for road transport	million US$	**0.31**	**0.19**
Safety			
Cost of damaged rice shipments in transport	million US$	**17.57**	**16.28**
Accident cost caused by rice freight transport	million US$	**6.34**	**4.92**
Environment			
Total emission cost per year (CO_2, SO_x,NO_x)	million US$	**12.39**	**8.32**
Total cost of different scenarios	million US$	**189.69**	**159.21**
Change compared to Base scenario	%		**-16.1%**

(*) M1-VN: An establishment of a regional rice logistics centre

Within Scenario 1, rice industry supply paths 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.

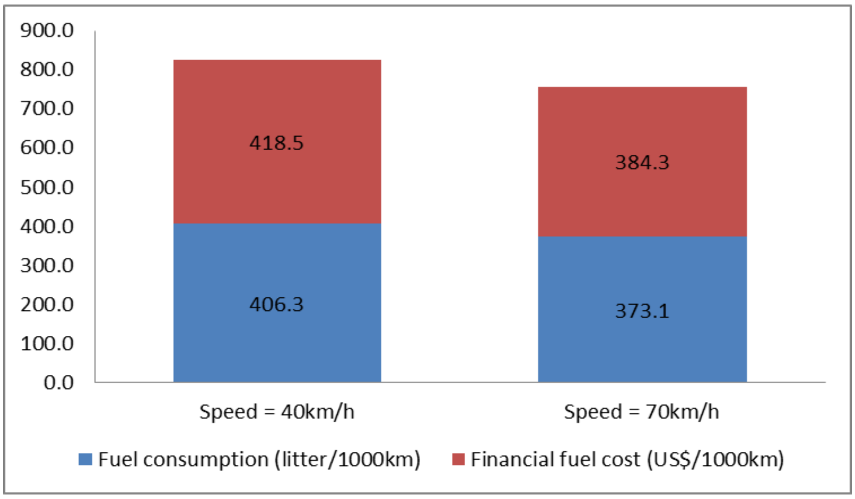
5.4.4 Scenario 2 impacts

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.

The intervention of Scenario 2 can have two directional impacts in term of environment. Economic benefits of the improvement of NH 1A are concerned with saving fuel cost resulting in lower road transport cost and TLC savings. Besides, the reduction in CO2 and local pollutant emission could also gain due to higher speed and the decrease in fuel consumption. The improvement of NH 1A would be expected to increase traffic rather than the base scenario. The reason for this is that highway measure would cause a decrease in road transport cost, thereby increasing the competitiveness of the road system. The following texts will analyse these impacts in details.

Under the intervention of Scenario 2, the average speed of vehicle is projected to increase from 40km/h to 70km/h (JICA, 2010). This increase in speed would translate to a decrease in fuel cost, which will ultimately result in a reduction in transport cost. Based on data on technical fuel consumption rates for each type of vehicle given in the JICA (2012) study, the difference in fuel consumption rates by speed is shown in Figure 5-18.

Figure 5-18: Fuel consumption rate and cost by speed of vehicle



Source: JICA (2012)

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. The detailed results are presented in Table 5-28.

The intervention of Scenario 2 would lead to a modal shift from IWT to road transport since NH 1A helps to facilitate inter-regional trade by reducing freight transport costs and transport time from the Mekong Delta to HCMC. However, the expected traffic diversion from IWT to truck in the rice industry is modest. The reason for this is that shipments of rice commodities in the Mekong Delta can become much more economical for IWT rather than road transport especially for long distance to HCMC. Nonetheless, a small increase in road usage could result in some negative implications the environment. The details of modal shift impacts and change in emission volumes are shown in Table 5-28.

Table 5-28: The change of emission in Scenario 2

	Unit	Fuel consumption savings resulting in the change of emission			Modal shift impacts resulting in the change of emission		
		CO_2 volume	SO_x volume	NO_x volume	CO_2 volume	SO_x volume	NO_x volume
Base scenario	ton	209,797	4,196	2,518	133,276	2,666	1,599
Scenario 2	ton	172,357	3,447	2,068	166,581	3,332	1,999

Comparing the results of emission volumes reveals that the positive impacts of fuel consumption savings appears to be larger than the increased road volume in emission as a result of modal shift impacts. The implementation of Scenario 2 is also expected to reduce total warehousing and handling cost for the rice industry. The primary reason for this is that the improvement of NH 1A from the Mekong Delta to HCMC offers many opportunities to increase inventory turnover ratio, which can be understood as the number of times company's inventory sold or used over a time period such as a year. For this aspect, food companies are assumed to be affected strongly under this policy intervention. That is because, for rice logistics and business in the Mekong Delta, most of food companies under VINAFOOD 2 have a system of warehouse, which is serving for a large demand of rice assembling and processing in the region. It was assumed that the warehousing and handling cost rate in the food companies would be decreased about 10% compared to Base scenario. This rate is in line with warehouse and handling cost of food companies in HCMC, where there are many freight transport activities taking place.

Regarding safety impacts, it is believes that expected traffic safety improvement under the intervention of Scenario 2 could be quite modest since road traffic is seen as more dangerous than IWT traffic. However, the impact on transport safety for this case would be relatively small because of limited shift between road and IWT.

Table 5-29 provides final implications for traffic, safety, economic efficiency and environmental issues resulting from Scenario 2.

Table 5-29: Estimation of the impacts of Scenario 2

Aspects of impact	Unit	Base scenario	Scenario 2 (Base scenario + M15-VN*)
Rice freight transport			
Number of ton-km by road	million ton-km	126.84	131.75
Number of ton-km by IWT	million ton-km	3,012.94	2,999.96
Economic efficiency			
Total logistics cost per year	million US$	**153.08**	**129.23**
- *Transport cost*	million US$	*100.61*	*79.42*
- *Warehousing cost*	million US$	*33.46*	*31.56*
- *Handling cost*	million US$	*19.01*	*18.25*
Shipping inventory cost for road transport	million US$	**0.31**	**0.17**
Safety			
Cost of damaged rice shipments in transport	million US$	**17.57**	**17.52**
Accident cost caused by rice freight transport	million US$	**6.34**	**6.59**
Environment			
Total emission cost per year (CO_2, SO_x,NO_x)	million US$	**12.39**	**12.24**
Total cost of different scenarios	million US$	**189.69**	**165.76**
Change compared to Base scenario	%		**-12.6%**

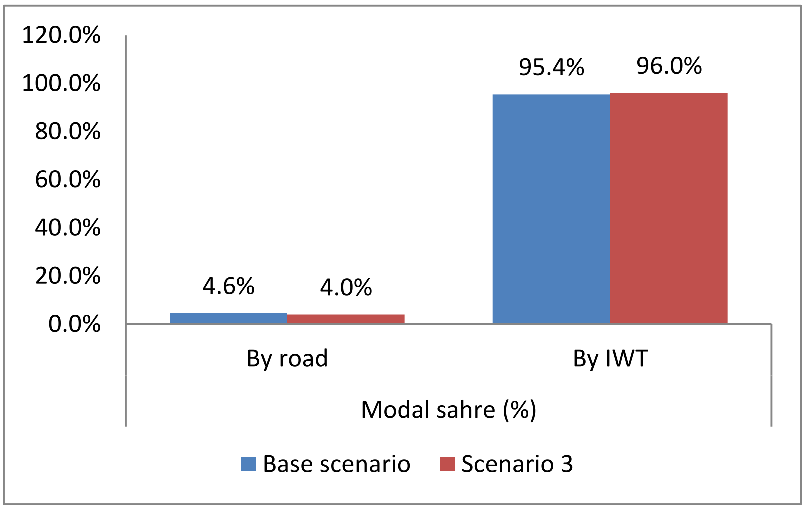
(*)M15-VN: Improvement of NH 1A from the Mekong Delta to HCMC

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 an 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.

5.4.5 Scenario 3 impacts

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. The modal shift result for Scenario 3 is shown in Figure 5-19.

Figure 5-19: Change in modal share in Scenario 3



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. Table 5-30 shows a comprehensive socio-economic impacts resulting from the implementation of Scenario 3.

It is estimated that annual savings in TLC in the rice industry can reach more than US$39 million through an establishment of a new rice logistics centre and better highway and road design. Also, the intervention of Scenario 3 is expected to provide better environmental safety performance compared with the base scenario. Economic costs of CO2 and air pollutant emissions are projected to decrease to roughly US$4.86 million per year. Through modal shift from road to IWT, traffic safety is also expected to improve, which can be valued via the economic cost savings of fewer accident and cost reduction of damaged rice shipment per year.

Table 5-30: Estimation of the impacts of Scenario 3

Aspects of impact	Unit	Base scenario	Scenario 3 (Base scenario + M1-VN and M15-VN)
Rice freight transport			
Number of ton-km by road	million ton-km	126.84	97.74
Number of ton-km by IWT	million ton-km	3,012.94	2,635.05
Economic efficiency			
Total logistics cost per year	million US$	**153.08**	**114.05**
- *Transport cost*	million US$	*100.61*	*76.86*
- *Warehousing cost*	million US$	*33.46*	*19.96*
- *Handling cost*	million US$	*19.01*	*17.22*
Shipping inventory cost for road transport	million US$	**0.31**	**0.14**
Safety			
Cost of damaged rice shipments in transport	million US$	**17.57**	**15.29**
Accident cost caused by rice freight transport	million US$	**6.34**	**4.89**
Environment			
Total emission cost per year (CO_2, SO_x,NO_x)	million US$	**12.39**	**7.53**
Total cost of different scenarios	million US$	**189.69**	**141.90**
Change compared to Base scenario	%		**-25.2%**

To sum up, 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.

5.4.6 Discussions

In the above sections, 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. Table 5-31 summaries the breakdown of economic benefits associated with each scenario.

According to the assessment results, Scenario 1 focusing on the establishment of the rice logistics centre in Hau Giang province, can affect a modal shift toward more IWT usage. There could be a reduction in some intermediate stages of inbound transport, which could potentially lead to a decrease in collecting trips from production sites to the consolidated centre. A reduction in the number of stops in the rice supply chain is expected to generate high level of economic efficiency through reducing inbound transport cost, warehousing and handling cost as well as TLC as a whole. A modal shift away from truck under the intervention of Scenario 1 could also generate impacts to the broader economy. More specifically, ton-kilometres shifts from road to barge would lead to a reduction in CO2 emissions and the improvement of traffic safety for both transport users and rice commodity.

Under Scenario 2, the improvement of NH 1A is expected to increase average speeds and reduce freight transport time from the Mekong Delta to HCMC. While some transport cost savings would be obtained via fuel efficiency, the larger impacts under the intervention of Scenario 2 is expected to originate from much higher savings of shipping inventory cost compared with the base scenario. That is because; NH 1A improvement would really help to facilitate inter-regional trade by reducing significantly transport time from the Mekong Delta to HCMC. In addition to positive impacts, the implementation of Scenario 2 is also expected to counter some impediments in term of traffic safety and environment because of a small modal shift from road transport to IWT. However, as for rice commodities, IWT is confirmed as an economically robust transport mode in the Mekong Delta, leaving limited room for shifting to road. Finally, traffic, safety and environmental impacts resulting from Scenario 2 could also be gained, albeit yielding slightly lower levels than Scenario 1.

Table 5-31: 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%**

Scenario 3 is the combination of the two measures mentioned above. The improvement of NH 1A is projected to enable lower transport cost and transport time from the Mekong Delta to HCMC. The impacts associated with establishment of the rice logistics centre, as suggested by the above analysis, can provide inbound transport cost, warehousing and handling cost reduction. Building on these effects, the concurrent implementation of the two measures in scenario 3 is believed to strongly influence the economic efficiency in a positive way through significantly reducing TLC, benefiting all stakeholders involved in the rice industry. Additionally, the modal shift impact of the establishment of a rice logistics centre appears to be larger than that expected from improvement of NH 1A, resulting in a slight increase in IWT transport in the rice industry. Therefore, the intervention of Scenario 3 could generate positive impacts on traffic, environment and safety in the rice industry. Finally, Scenario 3 is confirmed to have the biggest impact in terms of improvements to rice freight transport, economic efficiency, traffic safety and environment for the rice industry.

In the second assessment stage, the results of detailed quantitative impact estimation in the rice industry has provided good evidence to support the claimed impacts of the measures, which are realized by the experts in the first assessment stage. Specifically, the results of both assessment stages confirmed that the important impacts of FTM measures in the rice industry are change in modal split, reduction in total logistics cost, reduction in total ton-km, and reduction in transport time from the Mekong Delta to HCMC. However, if the first assessment results have shown more road transport usage as the most significant impact of FTM measures in the Vietnamese rice industry (Table 5-4), the quantitative impact estimation in the second assessment stage indicates that this impact is quite modest compared to the others. The primarily reason is related to economic geography factor. Particularly, transport system in the Mekong Delta is featured by an extensive networks of rivers and channels, which is more favour for IWT. Conclusively, with the multi-stage impact assessment 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.

5.5 Conclusions

In this chapter the proposed multi-stage impact assessment method for FTM measures is applied comprehensively to the Vietnamese rice industry. There are seven measures, including initiatives already in place and potential future interventions. Following the proposed method, a partly-quantitative method (MCA) was employed for a first classification of FTM measures in the rice industry. The results of this stage 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 Conclusions and Recommendations

6.1 Contributions of the study

The impact assessment for FTM measures remains a field with a need for comprehensive evaluation methods in order to understand the core effects of measures applied in the industry. The main contribution of this study is the development of a multi-stage assessment method through which the core effects of FTM measures can be identified and impact estimated. In order to achieve these objectives, four key research questions have been addressed the study.

The response to **Research question 1** about the theoretical foundation of FTDM is a systematic review of innovations in freight transport management and their application. It includes aspects such as the analysis of stakeholders involved in the freight transport system and stakeholder goal conflicts; concepts associated with FTM measures and their classification; and the introduction of typical successes and failures of FTM measures in various contexts around the world. The first research question contributes to the overall objectives of the study by increasing understanding of how freight transport systems perform and by identifying what lessons can be learned from how FTM measures are applied around the world and the resulting implications for the example sector the study focuses on (the Vietnamese rice industry).

Research question 2 provides an in-depth review of the impact assessment methods available for evaluating FTM measures, including their pros and cons. In discussing these different methods, it is established that qualitative methods often permit quick classification of measures under consideration and their impacts, but they do not give precise analysis of those impacts. Quantitative analysis of the core effects of a measure can, however, overcome some of the limitations inherent in the qualitative assessment process, but data availability and overall efforts are usually critical to successful assessment outcomes. Partly-quantitative assessment is somehow more useful in the initial evaluation of the importance level of different measures, providing a short list of potential measures for further detailed analysis. However, the main shortcoming of this approach is the limited insight provided on causality. From this analysis of current impact assessment methods for FTM measures, a new approach has therefore been developed and this approach is presented in detail in Research question 3.

The objective of **Research question 3** is to frame a multi-stage impact assessment method for FTM measures. With this approach, the risk associated with limitations of individual measures is mitigated in initial pre-selection stages and efficiency is improved, as a thorough and detailed impact assessment of the core effects of measures shortlisted in the classification stage are examined. The multi-stage impact assessment method for FTM measures, as in this study, can be divided into two stages of assessment. The first stage covers two main working items including listing and checking the interdependence of FTM measures and then weighting/ranking the importance level of these measures. In the second stage, a detailed quantitative assessment is carried out to capture and estimate the core effects of the FTM measures. The framework also recommends different methods that could be used to fulfil stated objectives at each stage. The findings of Research question 3 contributes to the overall goal of this study by providing a comprehensive framework for the impact assessment of FTM measures. In particular, the proposed method could, to a certain extent, overcome the limitations of existing approaches in impact assessment as covered in the findings from Research question 2.

Research question 4 describes the application of the proposed method to the Vietnamese rice industry. The major contribution of this research question is to empirically validate and generalize the research results over several contexts. Regarding the scale of application, seven FTM measures are currently or could potentially be applied in the context of the Vietnam rice industry. Among these, two FTM measures namely the establishment of a regional rice logistics centre and the improvement of NH 1A from the Mekong Delta to HCMC are identified as first and second priorities, respectively. Detailed quantitative assessment of these measures has shown that the establishment of a regional rice logistics centre can bring increased economic efficiency through markedly reducing TLC for the rice industry. Additionally, this measure can potentially lead to a modal shift away from trucks, significantly contributing to increasing traffic safety improvement and reduction in CO_2 emissions. The improvement of NH 1A is projected to increase average speeds. This increase in speed would translate to a decrease in fuel cost, which will ultimately result in a reduction in transport cost and transport time from the Mekong Delta to HCMC. The combination of the two measures above could cause a slight modal shift from roads to IWT and yield the highest economic efficiency outcomes for the rice industry. Since these results are quite specific for this case study, the transferability of assessment results should not be assumed. Rather, the study findings advocate for using the same methodology for quantitative impact assessment of FTM measures across other sectors, adjusted for sector-specific parameters. More specifically, the TLC model, as part of a multi-stage impact assessment process, can be applied to evaluate quantitatively the impacts of FTM measures based on comprehensive sector analysis. Although more research may be required, the application of the TLC model in this study can be used for further research as it is identified as one of the key models in the impact assessment of FTM measures.

To sum up, the multi-stage impact assessment method for FTM measures presented in this study proved that it is possible to investigate and assess the impacts of FTM measures on production and logistics. Specifically, this method can help to identify relevant interventions and estimate the core effects of these measures. Additionally, the proposed method has been applied to a specific sector, taking the rice industry in Vietnam as an example. Quantitative estimation of impacts has been carried out in the second stage of assessment at both governmental and company levels. This research is therefore expected to be of value for the government and local transport authorities in providing suitable methods for assessing decisions in freight transport management.

6.2 Discussion on the generalization of the proposed method

This section discusses generalisation of the research results, identifying the extent to which the findings are valid in different contexts. As presented, the multi-stage impact assessment method for FTM measures in this study is developed primarily from a comprehensive literature review and then applied in a case study of the Vietnamese rice industry. It is developed with the aim of being generalised across multiple contexts and it should, therefore possible to apply this assessment approach to different sectors.

In the first stage of the proposed impact assessment process, there are two working items including an interdependency checks, and weighting and ranking of the measures selected for assessment. There are numerous techniques that could be useful for this stage. Among them, qualitative methods such as focus groups, brainstorming exercises and expert consultation can be used for problem definition, listing of potential measures and interdependency check. Partly-quantitative methods such as the Delphi, MCA and AHP methods can fulfil the objective of a quick classification of adopted measures and their impacts. It is a fact that FTM measures seek to achieve multiple goals. These goals can be the improvement of mobility and accessibility, safety, economic efficiency or environmental improvement. Consequently, there is always a trade-off between those goals advocated for by different stakeholders. Within this context, the methods proposed for the first stage correspond well to the essence of FTM measures identified in the literature review. In particular, these methods enable identification and increased understanding of multiple aspects of the challenges facing the freight transport industry. Also, the method identified have the ability to form a clear mechanism for classifying and qualitatively assessing potential impacts. The approach emphasises the involvement of multiple stakeholders in the assessment process, should increase the generalization potential of the proposed assessment method.

The first assessment stage was tested within the context of the Vietnamese rice industry, and a MCA method was chosen for screening impacts related to socio-economics, the environment, safety, and mobility. It should also be possible to apply this assessment process to other sectors with similar features (e.g. existing interactions among production, transport and logistics; or the involvement of a lot of freight transport modes with a bundle of FTM measures applied to the sector). However, it should be noted that while the MCA method is applied to a single case in this study, in other contexts other methods could be usefully employed, e.g. Delphi method which has the advantage of getting high consensus in ranking and prioritizing research problems and alternatives. It is also worth considering whether the impact assessment framework for this stage can be employed on a large scale, for instance, at city or regional level. Detailed description of the first stage of the proposed assessment method presented in Figure 3-10 does not imply the approach should be restricted to a single context. It is feasible therefore, that the methodology used in the first assessment stage could be applied on different scales.

The second stage involved a detailed quantitative assessment to determine the core effects of the selected FTM measures. As stated in Section 3.5, the use of disaggregate models is highly necessary in this step. Such models allow 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. As such, TLC, discrete choice or agent-based models are most relevant for a quantitative analysis of the impacts of specific measures. Again, the second stage of the proposed assessment framework is applied to the specific case of the Vietnamese rice industry. A TLC model is employed to assess the impacts of FTM measures on disaggregating populations of rice commodity flows and distribution centre locations in HCMC. There are other methods for possible use when carrying out detailed impact analysis in other contexts, e.g. discrete choice models or agent-based model, which has the advantage of explaining and predicting choices between discrete alternatives or modelling of different behavioural changes of stakeholders to policy interventions. However, the TLC model covers extensively the interaction of production, transport and logistics, and could more easily apply because discrete choice model and agents models require a lot of behavioural data. As presented in chapter 5, some of the results of the case study are relatively specific such as the prioritisation of specific FTM measures and their impacts on the supply path choices of rice commodity flows. However, the rice industry in Vietnam has experienced freight transport problems that have led to many issues related production and logistics. The case study therefore addresses many elements of FTM that are relevant to other manufacturing sectors (e.g. procurement, processing and physical movement of goods), and as such it presents an opportunity to generalize the research findings to different industries where different FTM measures require assessment.

6.3 Limitations and recommendations for future research

Although the study has achieved its goal, there were some inevitable limitations. This section summarises some of the main limitation of the study, and suggests areas for further research.

Firstly, the application of the proposed method focuses on the Vietnamese rice industry, which may limit the generalization of conclusions regarding the impact assessment of FTM measures to other sectors, as discussed in the previous section. Despite the fact that the Vietnamese rice industry presents ideal conditions for the application of a multi-stage impact assessment method for FTM measures, future research focused on applying the assessment approach to other industries would be useful, for example, the seafood industry, the garments and the textiles industry, and the automobile industry. This would provide greater evidence of generalizability and extend current knowledge of the impact assessment method.

Secondly, in the first stage of the impact assessment, the sample size was constrained by limited financial resources and time. Although the sample size was sufficient for the demands of the model, future research projects should increase the number of experts involved in the interview survey to reduce the possibility of bias in responses as much as possible.

Thirdly, the detailed quantitative impact assessment implemented in the second stage can only be carried out with extensive data, which may hinder the application of the proposed methods in other sectors. If future research intends to extend the application of the method, it is suggested that prior to beginning a research project, the availability of data associated with the target sector is reviewed or assumptions identified that could simplify the analysis required by the model.

Fourthly, this study addresses a new and complicated research area in the field of impact assessment methods for FTM measures; hence the theoretical framework developed and validated in chapter 3 and chapter 5 should be more thoroughly examined in future research. Although, this proposal for a multi-stage impact assessment method for FTM measures is carried out based on extensive examination of the existing literature on impact assessment methods; and it has been implemented comprehensively in assessing FTM measures in the Vietnamese rice industry, findings can only by fully confirmed through a series of research initiatives that further refine and test the results across different contexts and sectors.

Finally, impact assessment methods for FTM measures are significant research topic from both academic and practical perspectives. However, it still seems to attract less attention than passenger transport due to the complicated characteristics of freight transport. This study was implemented with the aim of investigating and assessing the impacts of FTM measures on production and logistics. It may contribute to enriching theoretical and empirical understanding of FTM measures, and their effective implementation.

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List of Abbreviations

ADA	Aggregate-Disaggregate-Aggregate
ADB	Asian Development Bank
AHP	Analytical Hierarchy Process
BOT	Build-Operate-Transfer
CEA	Cost-Effectiveness Analysis
CBA	Cost-Benefit Analysis
CBR	Cost-Benefit Ratio
CTP	Common Transport Policy
DoT	Department of Transport
EOQ	Economic Order Quantity
ETC	Electronic Toll Collection
EU	European Union
ES	Establishment
FC	Food Company
FGSV	German Road and Transport Research Association
FPEs	Food Processing Enterprises
FTDM	Freight Transport Demand Management
FTM	Freight Transport Management
FTL	Full Truck Load
GHG	Greenhouse Gas
GIS	Geographical Information System
GPS	Global Positioning System
GSO	General Statistics Office of Vietnam
IO	Input-Output
IRR	Internal Rate of Return
JICA	Japanese International Cooperation Agency
LFC	Load Factor Control
LSPs	Logistics Service Providers
HC	Handling Cost
HCMC	Ho Chi Minh City
HGV	Heave Goods Vehicles
IT	Information Technology
ITS	Intelligent Transport System

IWT	Inland Waterway Transport
MCA	Multi-Criteria Analysis
MDCs	Motorcycle Dependent Cites
MOT	Ministry of Transport
MPI	Ministry of Planning and Investment
MRIO	Multi-Regional Input-Output
NH	National Highway
NPV	Net Present Value
OECD	Organization for Economic Co-operation and Development
PDCA	Plan-Do-Check-Act
TC	Transport Cost
TLC	Total Logistics Cost
UFC	Urban Freight Centre
UNDP	United Nations Development Programme
SCBA	Social Cost Benefit Analysis
SCGE	Spatial Computable General Equilibrium
SFEZ	Southern Focal Economic Zone
SWOT	Strengths-Weakness-Opportunities-Threats
VFA	Vietnam Food Association
VINAFOOD II	Vietnam Southern Food Corporation
VISSTRANS	Comprehensive Study on the Sustainable Development of Transport System in Vietnam
VOT	Value of Time
WB	World Bank
WC	Warehousing Cost

Appendices

Appendix A. Survey on rice transport and logistics in the Mekong Delta

A1. Sample of questionnaire with Food Companies

SURVEY ON RICE TRANSPORT AND LOGITSICS OF FOOD COMPANIES INTHE MEKONG DELTA

I. GENERAL INFORMATION

1.1. Name of company

1.2. Type of business

1.3. Address

1.4. Name of interviewee

1.5. Professional working position

1.6. Tel

1.7. Email

II. RICE PROCUREMENT

Average annually rice handling volume (tons):

Share of purchasing source:

Farmers (%):

Collectors (%):

Millers/Polishers (%):

Other companies (%):

2.1. Rice inbound transport

Source of purchas-ing	**Distance to the company (km)**		**Transport time (hour)**		**Transport cost (VND/ton)**		**Main transport route**	
	By road	**By barge**	**By road**	**By barge**	**By road**	**By barge**	**By road**	**By barge**
Farmers								
Collectors								
Millers/Polishers								
Other companies								

2.2. Handling and warehousing activities

	Handling cost (VND/ton)		**Handling time (VND/ton)**	
	By road	**By barge**	**By road**	**By barge**
Handling				
Average volume of warehouse (ton/period)				

III. RICE DISTRIBUTION

3.1. Annual rice distribution volume?

3.2. Share of distribution market

- Domestic (%):
- Export (%):

3.3. Rice outbound transport

Distribution market	Distance to the company (km)		Transport time (hour)		Transport cost (VND/ton)		Main transport route	
	By road	By barge	By road	By barge	By road	By barge	By road	By barge
Domestic								
Export								

3.4. Handling at HCMC port system (for export purpose)

- Time waiting at port (day)
    - Average
    - Maximum
- Handling cost at port (VND/ton):

3.5. Your assessment on major barriers to improve rice logistics performance in the Mekong Delta?

Thank you for your kind cooperation!

A2. Sample of questionnaire with Waterway Transport Companies in the Mekong Delta

**SURVEY ON WATERWAY TRANSPORT COMPANY
IN THE MEKONG DELTA**

Profile of Organization and Business

Type of company: ☐ State-owned (equitized) ☐ State-owned (non-equitized) ☐ Private
Year company established: ________
What kind of services do you provide? ☐ IWT freight ☐ IWT passenger ☐ Cross-border IWT ☐ Storage/ warehousing ☐ Cargo handling/ Forwarding ☐ Others, specify
Which services do you consider are/is your primary or core service? ☐ IWT freight ☐ IWT passenger ☐ Cross-border IWT ☐ Storage/ warehousing ☐ Cargo handling/ forwarding ☐ Others, specify
The share of rice transport volume of total transport in your company?

Rice barging rate and trip time

Please indicate your approximate shipping rates

Trip distance	Bulk (VND/ton)	Break-bulk (VND/ton)	Container (VND/TEU)	How long is one way trip (hrs) – main route
50 km				
100 km				
200 km				
Loading and unloading				n/a
Other charges				n/a

In-case of charter, illustrate your approximate rates (please cite typical case of one of your vessels, if applicable)

Vessel type: ______________ voyage charter rate: ____________ (VND) assumed route: ____________

Vessel size: __________ DWT time charter rate: ______________ (VND) period: ________________

Transport operation cost

Please indicate approximately the operational cost parameters of one typical vessel in your fleet
Type of vessel: ☐ Self-propelled barge ☐ Tow/push barge ☐ Ferry ☐ Others, specify:

_______________ Size of vessel: _____________ Reg. Ton Typical operating speed: _____________ km/hr Purchase price: _________________☐VND ☐ USD Age of vessel when acquired: _________ yrs. old Average fuel consumption: _________ lit/km Price of fuel: ______________ VND/lit Ave. maintenance and repair cost per year (labor, supplies, and spare parts): _________________ VND No. of crew: _________________ Average wage of crew: ______________ VND/month Other annual expenses: ____________________ VND/yr Days in a year, not available for service (i.e. under repair or maintenance): _______ (days/yr) Days in a year operating for revenue: __________ (days/yr) Average load factor (note, if full one way and empty on the return LF=50%): ________ (%)

Accidents and Cargo Safety

Average number of accidents per year:		
In the last three years, in your opinion IWT accidents have been: ☐ Stable ☐ Increase ☐ Decrease		
What do you think is the primary cause of accidents:	☐ weather ☐ human error ☐ vessel problem	☐ navigational aids problem ☐ port and channel problem ☐ others: ____________________
Estimate the average cost per accident in your company: ________ VND/accident		

Please give your assessment on major problems in IWT operation in the Mekong Delta?

Thank you for your kind cooperation!

A3. Sample of questionnaire with Trucking Companies in the Mekong Delta

SURVEY ON ROAD TRANSPORT COMPANY IN THE MEKONG DELTA

Profile of Organization and Business

Type of company: ☐ State-owned (equitized) ☐ State-owned (non-equitized) ☐ Private
Year company established: ________
What kind of services do you provide? ☐ Trucking ☐ Forwarding ☐ Custom clearance ☐ Cross-border trucking ☐ Storage/ warehousing ☐ Others, specify
Which services do you consider are/is your primary or core service? ☐ Trucking ☐ Forwarding ☐ Custom clearance ☐ Cross-border trucking ☐ Storage/ warehousing ☐ Others, specify
The share of rice transport volume of total transport in your company?

Rice transport rate and trip time

Please indicate your approximate rice trucking rates in your company

Distance	Truck (<5 ton)	Truck (5-15ton)	20' container (VND)	40' container (VND)	45' container (VND)	How many hours is the trip (one way)-for main routes
50 km						
200 km						
800 km						
1,600 km						
Loading and unloading						n/a
Other charges						n/a

In-case of charter, illustrate your approximate rates (please cite typical case of one of your trucks, if applicable)
Truck type: ________________ trip charter fee (2-way): ______________ (VND) assumed route: ________________
time charter fee: ______________ (VND) period: ____________________

Transport operation cost

Please indicate approximately the operational cost parameters of one typical truck in your fleet
Type of truck: ☐ Container ☐ Gen. Cargo ☐ Tanker ☐ Others, specify: ______________ GVW (truck+max. load): _____________ (tons) Purchase price: _________________☐VND ☐ USD Age of truck when acquired: _________ yrs. old Average fuel consumption: _________ lit/km Price of fuel: ______________ VND/lit Ave. maintenance and repair cost per year (labor, supplies, and spare parts): _________________ VND

No. of drivers and assistants: _________ Average wage of operators: ___________ VND/month	
Other annual expenses: ____________________ VND/yr	
Days in a year, not available for service (i.e. under repair or maintenance): _______ (days/yr)	
Days in a year operating for revenue: __________ (days/yr)	
Average load factor (note, if full one way and empty on the return LF=50%): ________ (%)	

Accidents and Cargo Safety

Average number of accidents per year:		
In the last three years, in your opinion IWT accidents have been: ☐ Stable ☐ Increase ☐ Decrease		
What do you think is the primary cause of accidents:	☐ weather ☐ human error ☐ vessel problem	☐ navigational aids problem ☐ port and channel problem ☐ others: ________________
Estimate the average cost per accident in your company: ________ VND/accident		

Please give your assessment on major problems in trucking operation in the Mekong Delta?

Thank you for your kind cooperation!

A4. List of surveyed companies

No	Name	Type of company	Address	Tel
I. Food Companies				
1	Song Hau Food Company	State-owned	Tra Noc ward, Binh Thuy district, Can Tho city	84. (0)710. 3841299
2	Tra Noc Food Processing Enterprise	State-owned	Tra Noc Industrial Zone, Binh Thuy district, Can Tho city	84. (0)710. 3842284
3	Thoi Lai Food Processing Enterprise	State-owned	Lo Vong Cung, Ninh Kieu district, Can Tho city	84. (0)710. 3689437
4	An Giang Food Company	State-owned	Nguyen Du, My Binh ward, Long Xuyen city, An Giang province	84 (0)76 3955802
5	Chau Phu Food Processing Enterprise	State-owned	Thanh Trung commune, Chau Phu district, An Giang province	84 (0) 76 3955802
6	Phu Cuong Agriculture Product Centre	State-owned	5 commune, Cai Lay district, Tien Giang drovince	84 (0) 73.3827338
7	Tien Giang Food Company	State-owned	Ward 10, My Tho city, Tien Giang province	84 (0) 73) 3855 47
8	Food Processing Enterprise No 2	State-owned	Thach Hoa commune, Thach Hoa distric, Tien Giang province	84 (0) 73.3853042
9	Viet Nguyen Food Processing Enterprise	Private	Binh Duc commnune, Chau Thanh district, Tien Giang province	84 (0) 73.3853036
10	Thanh Hong Trading-Service Company	Private	An cu commune, Cai Be district, Tien Giang province	84 (0) 73 3722 529
11	Cuu Long Food Processing Enterprise	Private	Thoi Thuan commune, Thot Not District, Can Tho city	84 (0)7103859639
12	Thanh Tin Food Compnay	Private	Bach Dang ward, Soc Trang City, Soc Trang province	84 (0) 793 621226
II. Waterway Transport Company				
1	Can Tho Port Company	State-owned	Tan Phu ward, Cai Rang district, Can Tho city	84 (0) 7106 516 463
2	An Giang Port Joint-Stock Company	State-owned	NH91, My Thanh ward, Long Xuyen city, An Giang province	84 (0) 76 3831447
3	VINALINES Can Tho	Private	Le Hong Phong Street, Tra An ward, Binh Thuy district, Can Tho city	84 (0) 710-3842801
4	Can Tho-Ha Noi Maritime Company	Private	Hung Loi ward, Ninh Kieu district, Can Tho city	84 (0) 7109 523 469
5	GEMADEPT Can Tho	Private	Le Hong Phong street, Binh Thuy district, Can Tho city	84 (0) 7103 885 818

No	Name	Type of company	Address	Tel
II. Road Transport Company				
1	Nhon Hoa Transportation Corporation	Private	Long Xuyen city, An Giang province	84 (0)76 39340002
2	VINALINES Can Tho	Private	Le Hong Phong Street, Tra An ward, Binh Thuy district, Can Tho city	84 (0) 710-3842801
3	GEMADEPT Can Tho	Private	Le Hong Phong street, Binh Thuy district, Can Tho city	84 (0) 7103 885 818
4	Hung Phu Thinh Forwarding Transport Company	Private	An Phu ward, Ninh Kieu district, Can Tho city	84 0977220488

Appendix B. Expert survey documentation

B1. Weighting of Assessment Criteria

The objectives of this survey is to get a proper rating of the importance of criteria, which are employed to assess freight transport demand management measures applied in the rice industry in the Mekong Delta. Results of this questionnaire survey will be only used for scientific purposes of the doctoral thesis. Experts are assured that all their personal assessments would be kept confidential and only published with written permission.

PART 1: EXPERT'S INFORMATION:

Q1. Name:

Q2: What is your professional working position?

Q3. How long have you been working in the professional?

Q4. What is your highest professional degree?

PART 2: EXPECTED EFFECTIVENESS

Q2.1: To achieve the sustainable development of the rice industry in the Mekong Delta, how should the goals of traffic management be ranked? (*From the most important (1) to the least important (4), the same rank can be given for different criteria)*

Goals	Rank
Improvement of freight transport (FT)	Give here your rate
Improvement of economic efficiency (ECO)	Give here your rate
Improvement of traffic safety (SF)	Give here your rate
Enhanced environmental protection (EN)	Give here your rate

Q2.2. Please formulates the goal-matrix according to the ranks that are given in question 4 and conduct a simple pairwise comparison between the goals by the following rule:

Give "0" if two goals are equally important.
Give "1" if the basic goal is slightly more important than the other
Give "3" if the basic goal is significantly more important than the other
Give "5" if the basic goal is extremely more important than the other

GOAL MATRIX						
		Rank	1	2	3	4
Basis goals	Rank		title	title	title	title
	Rank 1	title		give here your rate	give here your rate	give here your rate
	Rank 2	title			give here your rate	give here your rate
	Rank 3	title				give here your rate
	Rank 4	title				

Q2.3: For the goals of the IMPROVEMENT OF FREIGHT TRANSPORT in the context of rice industry in Mekong Delta, which impact of MEASURE is important than the others? (*Give your rank from the most important (1) to the least important (4). The same rank can be given for both***)**

Impacts	Rank
Reduction in the number of ton-km (TON.KM)	Give here your rate

Change of modal split (SPLIT)	Give here your rate
Change in temporal traffic (TEMPORAL)	Give here your rate

Q2.4. Please formulates the impact-matrix according to the ranks that are given in Q 2.3 and conduct a simple pairwise comparison between the impacts by the following rule:

Give “0” if two impacts are equally important.
Give “1” if the basic impact is slightly more important than the other
Give “3” if the basic impact is significantly more important than the other
Give “5” if the basic impact is extremely more important than the other

Impact-matrix				
Rank		**1**	**2**	**3**
Rank	Title (abrv.)	title	title	title
Rank 1:	title		Give here your rate	Give here your rate
Rank 2:	title			Give here your rate
Rank 3:	title			

Q2.5: For the goals of ECONOMIC EFFICIENCY in the context of rice industry in Mekong Delta, which impact of MEASURE 1 is important than the others? (*Give your rank from 1 to 4 - the same rank can be given for both)*

Impacts	**Rank**
Change in total time of the supply chain (TIME)	Give here your rate
Change in total logistics cost (TLC)	Give here your rate
Improved reliability (RELIA)	Give here your rate
Improved flexibility (FLEX)	Give here your rate

Q2.6. Please formulates the impact-matrix according to the ranks that are given in Q 2.5 and conduct a simple pairwise comparison between the impacts by the following rule:

Give “0” if two impacts are equally important.
Give “1” if the basic impact is slightly more important than the other
Give “3” if the basic impact is significantly more important than the other
Give “5” if the basic impact is extremely more important than the other

Impact-matrix					
Rank		**1**	**2**	**3**	**4**
Rank	Title (abrv.)	title	title	title	title
Rank 1:	title		Give here your rate	Give here your rate	Give here your rate
Rank 2:	title			Give here your rate	Give here your rate
Rank 3:	title				Give here your rate
Rank 4:	title				

Q2.7: For the goals of IMPROVEMENT OF TRAFFIC SAFETY in the context of rice industry in Mekong Delta, which impact of MEASURE is important than the others? (*Give your rank from 1 to 2 - the same rank can be given for both)*

Impacts	**Rank**
Reduce in accident frequency (FREQ)	Give here your rate
Reduce in accident severity (SEVE)	Give here your rate

Q2.8. Please formulates the impact-matrix according to the ranks that are given in Q 2.7 and conduct a simple pairwise comparison between the impacts by the following rule:

Give “0” if two impacts are equally important.
Give “1” if the basic impact is slightly more important than the other
Give “3” if the basic impact is significantly more important than the other
Give “5” if the basic impact is extremely more important than the other

Impact-matrix			
Rank		**1**	**2**
Rank	Title (abrv.)	title	title
Rank 1:	title		Give here your rate
Rank 2:	title		

Q2.9: For the goals of ENVIRONMENTAL IMPROVEMENT in the context of rice industry in Mekong Delta, which impact of MEASURE is important than the others? (*Give your rank from 1 to 2 - the same rank can be given for both)*

Impacts	Rank
Reduction in air emission (EMISSION)	Give here your rate
Reduction in total noise pollution (POLLUTION)	Give here your rate

Q2.10. Please formulates the impact-matrix according to the ranks that are given in Q2.9 and conduct a simple pairwise comparison between the impacts by the following rule:

Give “0” if two impacts are equally important.
Give “1” if the basic impact is slightly more important than the other
Give “3” if the basic impact is significantly more important than the other
Give “5” if the basic impact is extremely more important than the other

Impact-matrix			
Rank		**1**	**2**
Rank	Title (abrv.)	title	title
Rank 1	title		Give here your rate
Rank 2	title		

PART 3: BARRIERS IN IMPLEMENTATION

Q3.1: In condition of Vietnam in general and in the rice industry in particular, how do you rank the DIFFICULTIES in implementation of freight transport demand management measures? (*From the most difficult (1) to the least difficult (4) - the same rank can be given for different criteria)*

Barriers	Rank
Cost of measures (MCOST)	Give here your rate
Public acceptance (ACCEPT)	Give here your rate

Q3.2. Please formulates the criteria-matrix according to the ranks that are given in question 3.1 and conduct a simple pairwise comparison between the criteria by the following rule:

Give “0” if two criteria are equally difficult
Give “1” if the basic criterion is slightly more difficult than the other

Give “3” if the basic criterion is significantly more difficult than the other
Give “5” if the basic criterion is extremely more difficult than the other

CRITERIA MATRIX				
RANK		1	2	3
Rank	Title	Title	Title	Title
Rank 1			give here your rate	give here your rate
Rank 2				give here your rate

Q3.3: To implement FTM MEASURE, what type of COST is more difficult to finance than the other? (Give your rank from 1 to 2- the same rank can be given for both)

Sub-criteria	Rank
Investment cost (INV-COST)	Give here your rate
Operation and maintenance cost (O&M_COST)	Give here your rate

Q3.4. Please formulates sub-criteria-matrix according to the ranks that are given in Q3.3 and conduct a simple pairwise comparison between the costs by the following rule:

Give “0” if two sub-criteria are equally difficult
Give “1” if the basic cost is slightly more difficult to finance than the other
Give “3” if the basic cost is significantly more difficult to finance than the other
Give “5” if the basic cost is extremely more difficult to finance than the other

Sub-criteria-matrix			
Rank		1	2
Rank	Title (abrv.)	title	title
Rank 1:	title		Give here your rate
Rank 2:	title		

Q3.5: To implement FTM MEASURE, how do you rank the importance of acceptance of the two groups of USERS and NON-USERS in the society by the following rule?

Sub-criteria	Rank
Transport users (truck drivers, transport companies. LSPs) (USER)	Give here your rate
Non users (residents, vehicle manufacturers, others) (NON)	Give here your rate

Q3.6. Please formulate sub-criteria-matrix according to the ranks that are given in Q 3.5 and conduct a simple pairwise comparison between the two groups of USERS and NON-USERS by the following rule:

Give “0” if two sub-criteria are equally difficult
Give “1” if the basic cost is slightly more difficult to finance than the other
Give “3” if the basic cost is significantly more difficult to finance than the other
Give “5” if the basic cost is extremely more difficult to finance than the other

Sub-criteria-matrix			
Rank		1	2
Rank	Title (abrv.)	title	title
Rank 1:	title		Give here your rate
Rank 2:	title		

THANK YOU FOR YOUR COPERATIONS!

B2. Calculating the weight of assessment criteria

The first respondent

PART 1: GENERAL INFORMATION

Record No: #1

Working organisation: VINALINE Can Tho

Experience: Forwarding and Logistics, LEAN management

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	5	5	1
ECO	1/5	1	3	3
SF	1/5	1/3	1	3
EN	1	1/3	1/3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1/5	1/7	1/3
TON-KM	5	1	1/5	1/5
SPLIT	7	5	1	1
TEMPORAL	7	5	1	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1	3	5
TLC	1	1	**5**	**3**
RELIA	1/3	1/5	1	**5**
FLEX	1/5	1/3	1/5	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	3
SEVE	1/3	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1/3
POLLUTION	3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	5
ACCEPT	1/5	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	3

O&M - COST	1/3	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/5
NON-USER	5	1

The second respondent

PART 1: GENERAL INFORMATION

Record No: #2

Working organisation: GEMADEPT Can Tho

Experience: Sales, forwarding and supply chain management

Year of working: 8

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	3	3	3
ECO	1/3	1	5	7
SF	1/3	1/5	1	3
EN	1/3	1/7	1/3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1/3	1/5	1/3
TON-KM	3	1	1/5	1/3
SPLIT	5	5	1	1
TEMPORAL	3	3	1	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	3	3	5
TLC	1/3	1	**5**	**3**
RELIA	1/3	1/5	1	**1**
FLEX	1/5	1/3	1	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1/3
SEVE	3	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	3
POLLUTION	1/3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	5

ACCEPT	1/5	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	3
O&M - COST	1/3	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/5
NON-USER	5	1

The third respondent

PART 1: GENERAL INFORMATION

Record No: #3

Working organisation: Huong Can Transport Company

Experience: Freight transport operation and logistics

Year of working: 15

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	5	3	5
ECO	1/5	1	5	7
SF	1/3	1/5	1	3
EN	1/5	1/7	1/3	1

Q2.1. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1	1/3	1/3
TON-KM	1	1	1/5	1/3
SPLIT	3	5	1	1
TEMPORAL	3	3	1	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/3	3	5
TLC	3	1	**3**	**3**
RELIA	1/3	1/3	1	**3**
FLEX	1/5	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	3
SEVE	1/3	1

Q2.10. Environmental protection

	EMISSION	POLLUTION

EMISSION	1	1/3
POLLUTION	3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	**ACCEPT**
MCOST	1	3
ACCEPT	1/3	1

Q3.4. Cost of measures

	INV-COST	**O&M - COST**
INV-COST	1	5
O&M - COST	1/5	1

Q3.6. Public acceptance

	USER	**NON-USER**
USER	1	3
NON-USER	1/3	1

The forth respondent

PART 1: GENERAL INFORMATION

Record No: #4

Working organisation: Tra Noc Port Company

Experience: Forwarding and supply chain operation

Year of working: 6

PART 2: EFFECTIVENES

Q2.1. Rank the goal

	FT	**ECO**	**SF**	**EN**
FT	1	1/3	3	3
ECO	3	1	5	5
SF	1/3	1/5	1	1
EN	1/3	1/5	1	1

Q2.4. Freight transport improvement

	TIME	**TLC**	**RELIA**	**FLEX**
TRIP	1	1	1/5	3
TON-KM	1	1	1/5	1/3
SPLIT	5	5	1	3
TEMPORAL	1/3	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	**TLC**	**RELIA**	**FLEX**
TIME	1	1/3	3	3
TLC	3	1	**3**	**3**
RELIA	1/3	1/3	1	**3**
FLEX	1/3	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	5
SEVE	1/5	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1/3
POLLUTION	3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	7
ACCEPT	1/7	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	7
O&M - COST	1/7	1

Q3.6. Public acceptance

	USER	NON-USER
USER	**1**	**1/5**
NON-USER	**5**	**1**

<u>The fifth respondent</u>

PART 1: GENERAL INFORMATION

Record No: #5

Working organisation: VINALINES Can Tho

Experience: Logistics and industrial management, LEAN management

Year of working: 8

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1	3	3
ECO	1	1	3	1/3
SF	1/3	1/3	1	1
EN	1/3	3	1	1

Q2.1. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1	1/7	5
TON-KM	1	1	1/5	1/3
SPLIT	7	5	1	3
TEMPORAL	1/5	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX

TIME	1	1/5	3	5
TLC	5	1	**5**	**3**
RELIA	1/3	1/5	1	**3**
FLEX	1/5	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1
SEVE	1	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1/7
POLLUTION	7	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	1/3
ACCEPT	3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	3
O&M - COST	1/3	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	5
NON-USER	1/5	1

<u>The sixth respondent</u>

PART 1: GENERAL INFORMATION

Record No: #6

Working organisation: My Thoi Port Enterprise

Experience: Freight transport and logistics

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1/5	5	3
ECO	5	1	3	1/3
SF	1/5	1/3	1	1
EN	1/3	3	1	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL

TRIP	1	1	1/7	3
TON-KM	1	1	1/5	1/3
SPLIT	7	5	1	3
TEMPORAL	1/3	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/3	3	3
TLC	3	1	**5**	**3**
RELIA	1/3	1/5	1	**1**
FLEX	1/3	1/3	1	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	3
SEVE	1/3	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1
POLLUTION	1	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	3
ACCEPT	1/3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	1
O&M - COST	1	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/5
NON-USER	5	1

The seventh respondent

PART 1: GENERAL INFORMATION

Record No: #7

Working organisation: HCMC University of Technology

Experience: Road freight transport, logistics and industrial management

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1/3	3	3
ECO	3	1	3	1/3
SF	1/3	1/3	1	1
EN	1/3	3	1	1

Q2.4. Freight transport improvement

	TRIP	**TON-KM**	**SPLIT**	**TEMPORAL**
TRIP	1	1/3	1/5	1
TON-KM	3	1	1/5	1/3
SPLIT	5	5	1	3
TEMPORAL	1	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	**TLC**	**RELIA**	**FLEX**
TIME	1	1/5	3	3
TLC	5	1	**5**	**3**
RELIA	1/3	1/5	1	**1**
FLEX	1/3	1/3	1	1

Q2.8. Traffic safety improvement

	FREQ	**SEVE**
FREQ	1	1/5
SEVE	5	1

Q2.10. Environmental protection

	EMISSION	**POLLUTION**
EMISSION	1	3
POLLUTION	1/3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	**ACCEPT**
MCOST	1	5
ACCEPT	1/5	1

Q3.4. Cost of measures

	INV-COST	**O&M - COST**
INV-COST	1	5
O&M - COST	1/5	1

Q3.6. Public acceptance

	USER	**NON-USER**
USER	1	1
NON-USER	1	1

The eighth respondent

PART 1: GENERAL INFORMATION

Record No: #8

Working organisation: University of Transport and Communication

Experience: Maritime transport and logistics

Year of working: 12

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1	5	3
ECO	1	1	3	1/3
SF	1/5	1/3	1	1
EN	1/3	3	1	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1/3	1/7	1
TON-KM	3	1	1/5	1/3
SPLIT	7	5	1	3
TEMPORAL	1	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/3	3	3
TLC	3	1	**5**	**3**
RELIA	1/3	1/5	1	**1**
FLEX	1/3	1/3	1	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	7
SEVE	1/7	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1
POLLUTION	1	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	5
ACCEPT	1/5	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	5
O&M - COST	1/5	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1
NON-USER	1	1

The ninth respondent

PART 1: GENERAL INFORMATION

Record No: 9

Working organisation: University of Transport and Communication

Experience: Logistics and supply chain management

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	3	3	5
ECO	1/3	1	5	3
SF	1/3	1/5	1	1
EN	1/5	1/3	1	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1	3	5
TON-KM	1	1	1/5	1/3
SPLIT	1/3	5	1	3
TEMPORAL	1/5	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/3	3	3
TLC	3	1	**5**	**3**
RELIA	1/3	1/5	1	**1**
FLEX	1/3	1/3	1	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1
SEVE	1	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1
POLLUTION	1	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	3
ACCEPT	1/3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	3
O&M - COST	1/3	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/3
NON-USER	3	1

The tenth respondent

PART 1: GENERAL INFORMATION

Record No: #10

Working organisation: Indochina Logistics Corporation

Experience: Forwarding and logistics, supply chain organisation

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1/3	5	7
ECO	3	1	7	7
SF	1/5	1/7	1	3
EN	1/7	1/7	1/3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	3	1/5	1/3
TON-KM	1/3	1	1/5	1/3
SPLIT	5	3	1	3
TEMPORAL	3	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/5	1/5	1/3
TLC	5	1	**5**	**3**
RELIA	5	1/5	1	**1**
FLEX	3	1/3	1	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1/5
SEVE	5	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1/3
POLLUTION	3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	1
ACCEPT	1	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	5
O&M - COST	1/5	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/3
NON-USER	3	1

The eleventh respondent

PART 1: GENERAL INFORMATION

Record No: 11

Working organisation: Song Hau Food Company

Experience: Rice procurement and distribution

Year of working: 18

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1	3	5
ECO	1	1	3	5
SF	1/3	1/3	1	3
EN	1/5	1/5	1/3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	3	1/3	5
TON-KM	1/3	1	1/5	1/3
SPLIT	3	1/5	1	3
TEMPORAL	1/5	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/3	1/3	1/5
TLC	3	1	**5**	**3**
RELIA	3	1/5	1	**3**
FLEX	1/5	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	3
SEVE	1/3	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1
POLLUTION	3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	3
ACCEPT	1/3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	5
O&M - COST	1/5	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/3
NON-USER	3	1

The twelfth respondent

PART 1: GENERAL INFORMATION

Record No: #12

Working organisation: An Giang Food Company

Experience: Rice supply chain management

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	3	3	5
ECO	1/3	1	3	5
SF	1/3	1/3	1	3
EN	1/5	1/5	1/3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1/5	1/3	3
TON-KM	5	1	1/5	1/3
SPLIT	3	5	1	3
TEMPORAL	1/3	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/5	1/3	1/5
TLC	5	1	**3**	**3**
RELIA	3	1/3	1	**3**
FLEX	5	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	5
SEVE	1/5	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1
POLLUTION	1	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	5
ACCEPT	1/5	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	5
O&M - COST	1/5	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/7
NON-USER	7	1

<u>The thirteenth respondent</u>

PART 1: GENERAL INFORMATION

Record No: #13

Working organisation: Thanh Tin Food Company-Soc Trang province

Experience: Rice production and distribution

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1/5	3	5
ECO	5	1	5	7
SF	1/3	1/5	1	3
EN	1/5	1/7	1/3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1	3	3
TON-KM	1	1	1/5	3
SPLIT	1/3	1/5	1	3
TEMPORAL	1/3	1/3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	3	3	5
TLC	1/3	1	**3**	**3**
RELIA	1/3	1/3	1	**3**
FLEX	1/5	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1/7
SEVE	7	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1
POLLUTION	1	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	3
ACCEPT	1/3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	5
O&M - COST	1/5	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	3
NON-USER	1/3	1

<u>**The fourteenth respondent**</u>

PART 1: GENERAL INFORMATION

Record No: #14

Working organisation: Soc Trang Food Company

Experience: Rice procurement and distribution

Year of working: 14

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	3	3	5
ECO	1/3	1	3	5
SF	1/3	1/3	1	1
EN	1/5	1/5	1	1

Q2.1. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1	1/5	1/3
TON-KM	1	1	1/5	1/3
SPLIT	5	5	1	3
TEMPORAL	3	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1	3	5
TLC	1	1	**3**	**3**
RELIA	1/3	1/3	1	**3**
FLEX	1/5	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1
SEVE	1	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	3
POLLUTION	1/3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	1/3
ACCEPT	3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	3
O&M - COST	1/3	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/3
NON-USER	3	1

<u>The fifteenth respondent</u>

PART 1: GENERAL INFORMATION

Record No: #15

Working organisation: Chi Cong Food Processing Enterprise

Experience: Logistics and industrial management, LEAN management

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	3	3	5
ECO	1/3	1	3	5
SF	1/3	1/3	1	1
EN	1/5	1/5	1	1

Q2.1. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1	1/5	1/3
TON-KM	1	1	1/5	1/3
SPLIT	5	5	1	3
TEMPORAL	3	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1	3	5
TLC	1	1	**3**	**3**
RELIA	1/3	1/3	1	**3**
FLEX	1/5	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1
SEVE	1	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	3
POLLUTION	1/3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	1/3
ACCEPT	3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	3
O&M - COST	1/3	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/3
NON-USER	3	1

The sixteenth respondent

PART 1: GENERAL INFORMATION

Record No: #16

Working organisation: HCMC Department of Transport

Experience: Traffic management

Year of working: 7

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	7	5	3
ECO	1/7	1	5	7

SF	1/5	1/5	1	3
EN	1/3	1/7	1/3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	3	3	3
TON-KM	1/3	1	5	7
SPLIT	1/3	1/5	1	5
TEMPORAL	1/3	1/7	1/5	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/5	5	1/3
TLC	5	1	**5**	**3**
RELIA	1/5	1/5	1	**7**
FLEX	3	1/3	1/7	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	7
SEVE	1/7	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	3
POLLUTION	1/3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	1/3
ACCEPT	3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	3
O&M - COST	1/3	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/3
NON-USER	3	1

<u>The seventeenth respondent</u>

PART 1: GENERAL INFORMATION

Record No: #17

Working organisation: HCMC University of Technology

Experience: Traffic Engineering and transport planning

Year of working: 13

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	3	3	3
ECO	1/3	1	5	5
SF	1/3	1/5	1	1
EN	1/3	1/5	1	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1	1/3	3
TON-KM	1	1	1/5	1/3
SPLIT	3	5	1	5
TEMPORAL	1/3	3	1/5	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/7	5	5
TLC	7	1	**5**	**5**
RELIA	1/5	1/5	1	1/5
FLEX	1/5	1/5	5	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1
SEVE	1	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	5
POLLUTION	1/5	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	3
ACCEPT	1/3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	3
O&M - COST	1/3	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	5
NON-USER	1/5	1

<u>The eighteenth respondent</u>

PART 1: GENERAL INFORMATION

Record No: #19

Working organisation: An Giang Port Company

Experience: Maritime transport management

Year of working: 15

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	E O	SF	EN
FT	1	5	/3	1/5
ECO	1/5	1	1/5	1/5
SF	3	5	1	1
EN	5	5	1	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	3	3	3
TON-KM	1/3	1	5	3
SPLIT	1/3	1/5	1	7
TEMPORAL	1/3	1/3	1/7	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/3	1/3	1/3
TLC	3	1	**3**	**5**
RELIA	3	1/3	1	3
FLEX	3	1/5	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	1/5
SEVE	5	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	1/3
POLLUTION	3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	1
ACCEPT	1	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	1
O&M - COST	1	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/3
NON-USER	3	1

The nineteenth respondent

PART 1: GENERAL INFORMATION

Record No: #19

Working organisation: Can Tho Department of Transport

Experience: Traffic and transport management

Year of working: 10

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1	3	7
ECO	1	1	5	5
SF	1/3	1/5	1	1/3
EN	1/7	1/5	3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1/3	1/5	1
TON-KM	3	1	1/5	1/3
SPLIT	5	5	1	1
TEMPORAL	1	3	1	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/3	3	3
TLC	3	1	**5**	**7**
RELIA	1/3	1/5	1	1
FLEX	1/3	1/7	1	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	3
SEVE	1/3	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	5
POLLUTION	1/5	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	7
ACCEPT	1/7	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	5
O&M - COST	1/5	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	3
NON-USER	1/3	1

The twentieth respondent

PART 1: GENERAL INFORMATION

Record No: #20

Working organisation: Can Tho Port Company

Experience: Freight transport management

Year of working: 11

PART 2: EFFECTIVENESS

Q2.1. Rank the goal

	FT	ECO	SF	EN
FT	1	1	3	1/7
ECO	1	1	7	5
SF	1/3	1/7	1	1/3
EN	7	1/5	3	1

Q2.4. Freight transport improvement

	TRIP	TON-KM	SPLIT	TEMPORAL
TRIP	1	1/3	1/5	3
TON-KM	3	1	1/7	1/3
SPLIT	5	7	1	3
TEMPORAL	1/3	3	1/3	1

Q2.6. Economic efficiency improvement

	TIME	TLC	RELIA	FLEX
TIME	1	1/3	1/7	1/7
TLC	3	1	**3**	**3**
RELIA	7	1/3	1	3
FLEX	7	1/3	1/3	1

Q2.8. Traffic safety improvement

	FREQ	SEVE
FREQ	1	5
SEVE	1/5	1

Q2.10. Environmental protection

	EMISSION	POLLUTION
EMISSION	1	3
POLLUTION	1/3	1

PART 3: BARRIERS

Q3.1. Rank the barriers

	MCOST	ACCEPT
MCOST	1	1/3
ACCEPT	3	1

Q3.4. Cost of measures

	INV-COST	O&M - COST
INV-COST	1	1/5
O&M - COST	5	1

Q3.6. Public acceptance

	USER	NON-USER
USER	1	1/3
NON-USER	3	1

Appendix C. Key sources of rice in the Mekong Delta

C1. List of key sources of rice in the Mekong Delta

No	Key rice sources in the Mekong Delta (2010)	Average rice handling volume per year (ton)	Commune/ Ward	District/ City	Province
1	Food Processing Enterprise (FPE) No1	150,000	Ward 5	Tan An	Long An
2	FPE No2	140,000	Thach Hoa	Thach Hoa	Long An
3	Tan Thanh FPE	120,000	Tan Thach	Tan Thanh	Long An
4	Cau Tre FPE	90,000	Loi Binh Nhon	Tan An	Long An
5	Vinh Hung FPE	100,000	Vinh Hung	Vinh Hung	Long An
6	Long An Foodstuff Enterprise	220,000	Ward 3	Tan An	Long An
7	Phu Cuong Agricultural products center	80,000	Commune 5A	Cai Lay	Tien Giang
8	FPE No 2	85,000	Binh Duc	Chau Thanh	Tien Giang
9	FPE No 3	75,000	Hau Bac My A	Cai Be	Tien Giang
10	FPE No 4	65,000	Phu An	Cai Lay	Tien Giang
11	Viet Nguyen FPE	80,000	Binh Duc	Chau Thanh	Tien Giang
12	My Phuoc Warehouse	50,000	Tan Phuoc	Tan Phuoc	Tien Giang
13	Convenience store system	30,000		Châu Thành	Tien Giang
14	My Loi B Warehouse	45,000	My Loi	Cai Be	Tien Giang
15	FPE No1	50,000	Binh Thanh	Giong Tom	Ben Tre
16	Cho Thom FPE	60,000	Thanh Thoi B	Mo Cay Nam	Ben Tre
17	Vinh Long Food Co.	170,000	Hung Dao Vuong	Vinh Long	Vinh Long
18	FPE No 1	150,000	QL 80	Sa Dec	Dong Thap
19	FPE No 2	140,000	QL30	Cao Lanh	Dong Thap
20	Tam Nong FPE	160,000	An Long	Tam Nong	Dong Thap
21	DOCIMEXCO JSC	240,000	Phuong 1	Cao Lanh	Dong Thap
22	Long Xuyen FPE	120,000	My Thanh	Long Xuyên	An Giang
23	Chau Phu FPE	80,000	Vinh Thanh Chung	Châu Phú	An Giang
24	Binh Khanh FPE	75,000	Phan Boi Chau	Long Xuyen	An Giang
25	An Giang Import-Export Co-Agrimex	350,000	Ngo Gia Tu	Long Xuyen	An Giang
26	An Giang Agriculture and foods import & export joint stock company- Afiex	150,000	My Thoi	Long Xuyen	An Giang
27	Hoa Binh FPE	70,000	Hoa Binh	ChợMới	An Giang

No	Key rice sources in the Mekong Delta (2010)	Average rice handling volume per year (ton)	Commune/ Ward	District/ City	Province
28	An Giang Tourimex	200,000	Tran Hung Dao	Long Xuyen	An Giang
29	An Giang Plant Protection joint-stock company	200,000	Ha Hoang Ho	Long Xuyen	An Giang
30	Angiang food and foodstuff company	300,000	Nguyen Du	Long Xuyen	An Giang
31	Khiem Thanh Company Limited	140,000	Long Hòa	Phú Tân	An Giang
32	Phu Vinh food corporation	100,000	Phú Hòa	Thoai Son	An Giang
33	Tam phong joint stock company	100,000	Thanh Nien, Phu Hoa	Thoai Son	An Giang
34	Hung Lam Joint Stock Company	100,000	Da Phuoc	An Phú	An Giang
35	Toan Cau Corporation Company	180,000	Phu Lam	Phú Tân	An Giang
36	Song Hau Food Co.	300,000	Tra Noc	Bình Thuy	Can Tho
37	Cuu Long Food Enterprise	100,000	Thoi Thuan	Thot Not	Can Tho
38	Thoi Lai factory	35,000	Thoi Lai	Thoi Lai	Can Tho
39	Tan Thanh factory	30,000	Lê Bình	Cái Rang	Can Tho
40	Co Do factory	30,000	Co Dođỏ	Co Dođỏ	Can Tho
41	Cai Rang FPE	30,000	An Bình	Cai Rang	Can Tho
42	Trung An FPE	50,000	Trung Kiên	Thot Not	Can Tho
43	Mekong CanTho factory	150,000	Ly Tu Trong	Ninh Kieu	Can Tho
44	Can Tho Food Import-Export Enterprise	43,000	Tân Thanh	Thoi Lai	Can Tho
45	Thanh Tam Factory	30,000	Trung Kiên	Thoi Lai	Can Tho
46	Vinacam Can Tho Factory	30,000	Dong Thang	Co Do	Can Tho
47	Cang Long FPEs	50,000	Càng Long	Càng Long	Tra Vinh
48	Cau Ke FPEs	30,000	Cau Ke	Cau Ke	Tra Vinh
49	Tra Vinh FPEs	40,000	Long Đức	Trà Vinh	Tra Vinh
50	Thanh Tin Food Co.	100,000	Bạch Đằng	Soc Trang	Soc Trang
51	Xen Granary	30,000	Phú Giao	My Xuyen	Soc Trang
52	Ms Ha Granary	37,000	Phú Loi	Soc Trang	Soc Trang
53	Central warehouse of Soc Trang Food Co.	120,000	Long Duc	Soc Trang	Soc Trang
54	Thuan Thanh Factory	40,000	Phú Giao	My Xuyen	Soc Trang
55	Hau Giang Food JSC	125,000		Vi Thanh	Hau Giang
56	Phat Loc Factory	40,000	Võ Nguyên Giáp	Vi Thanh	Hau Giang
57	Son Loan Factory	25,000	Vinh Vien	Long My	Hau Giang
58	Vna Thuan Loi Factory	30,000	Long Phú	Long My	Hau Giang
59	Thuan Phat Factory	30,000	Nhon Thuan	Chau Thanh	Hau Giang

No	Key rice sources in the Mekong Delta (2010)	Average rice handling volume per year (ton)	Commune/ Ward	District/ City	Province
60	Le Tran Rice Basket	25,000	Thi Tu	Chau Thanh	Hau Giang
61	Tan Phu FPE	250,000	Tan Hiep B	Tan Hiep	Kien Giang
62	Hon Dat FPE	160,000	Kien Son	Hon Dat	Kien Giang
63	An Hoa FPE	140,000	An Bình	Rach Giá	Kien Giang
64	Thanh Hung FPE	120,000	Thanh hung	Giong Rieng	Kien Giang
65	Vinh Thang FPE	180,000	Vinh Thang	Gò Quao	Kien Giang
66	Tân Hiệp FPE	350,000	Tan Hiep A	Tân Heệp	Kien Giang
67	Giong Rieng FPE	220,000	Thanh Hung	Giong Rieng	Kien Giang
68	Kien Giang Agriculture Product Trading, JSC.	350,000	Ly Tu Trong	Rach Giá	Kien Giang
69	Ninh Quoi A FPE	40,000	Ninh Quoi A	Hong Dan	Bac Lieu
70	Bac Lieu FPE	45,000	QL1A	Bac Lieu	Bac Lieu
71	Phuoc Long FPE	35,000	Phuoc Long	Phuoc Long	Bac Lieu
72	Chi Cong III FPE	25,000	Long Thanh	Vinh Loi	Bac Lieu
73	Hai Quyen Factory	30,000	Long Taạnh	Vinh Loi	Bac Lieu
74	Tai Loi Factory	25,000	Châu Hung	Vinh Loi	Bac Lieu
Total		7,985,000			
Share in total rice volume of the Mekong Delta		**73.6%**			

C2. Additional survey on rice distribution from key rice sources to HCMC

ADDITIONAL SURVEY ON RICE DISTRIBUTION ON HO CHI MINH CITY

General information

Name of interviewee:	Professional working position:
Working organization: Address: Tel:	

Profile of rice distribution

Approximately how much is the volume of your rice distribution __________ (tons) ☐ monthly , or ☐ yearly						
Approximately how much is the volume of rice distributed in HCMC? __________ (tons) ☐ monthly , or ☐ yearly						
How many customers do you have in HCMC?						
Please specify some information related to your customers in HCMC as below:						
Customers in HCMC	**Approximate share in volume (%)**	**Estimate distance to buyers (km)**	**Typical frequency of delivery (delivery per month or day)**	**Delivery mode**	**Average order quantity (ton)**	**Lead time (from placing of order to delivery) (specify hrs. or days)**
Customer 1						
Customer 2						
Customer 3						
Customer 4						
Customer 5						
Customer 6						
Customer 7						
Customer 8						
Customer 9						
Customer 10						

Thank you for your cooperation!

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