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Impact of Decisions in Freight Transport Management on Rice Logistics in the Mekong Delta of Vietnam

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Abstract

Vietnam is known as the world´s sixth largest producer of rice and the second largest rice exporter. Half of Vietnamese rice is derived from the Mekong Delta, and 90% of Vietnam´s rice export comes from this area. The dependency on the freight transport system has always been a key issue in the rice production industry in the Mekong Delta. Therefore, the goal of this study is to investigate and assess the influences of freight transport management on rice logistics in Vietnam. The focus of freight transport management in this context refers to public decision-making addressing freight transport issues like the development of new logistics locations or improvement of transport infrastructure. Based on the investigation, effective measures will be recommended for improving transport system thereby improving rice logistics in Vietnam.

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Keywords: Freight transport demand management; impact assessment; Vietnamese rice industry

1. Introduction

There are strong interactions among the three sectors of production, logistics and traffic, especially in the context of global supply chains. Decisions made in one sector often have impacts on the others. 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.

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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 FTDM 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.

This paper aims at investing and assessing the impact of decisions in freight transport management measures on rice logistics in the Mekong Delta of Vietnam. The focus of freight transport management in this context refers to public decision-making addressing freight transport issues like the development of new logistics locations or improvement of transport infrastructure. For this investigation, effective measures will be recommended for improving transport system thereby improving rice logistics in Vietnam. In order to achieve these objectives, the study firstly describes the current situation of rice logistics including the overall supply chains from production in the Mekong Delta to consumption. Next, a list of freight transport management measures influencing rice logistics will be mapped out, and the importance of these measures is examined by conducting an expert's interview survey based on the Analytical Hierarchy Process (AHP). The results will be critically discussed. Based on that discussion, effective measures will be recommended for improving transport system thereby improving rice logistics in Vietnam.

The study is structured into 5 chapters. After the first chapter with an introduction, chapter 2 provides a compilation of freight transport management identified from the literature review. The chapter 3 describes the current rice supply chain with a focus on the issues of rice freight transport and logistics. In the chapter 4, traffic management measures in the context of rice industry will be complied. The level of importance of these measures will be assessed. Conclusions and some recommendations for further study can be seen in the last chapter.

2. Literature review on freight transport management

2.1. Concepts of freight transport management

In the research on freight transport strategies and measures, Browne et al. (2007) have pointed out the nature of FTM 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 management (FTM) as a part of traffic management, which aims to influence the demand and supply 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 FTM under the concept of traffic management is presented in details in Fig. 1

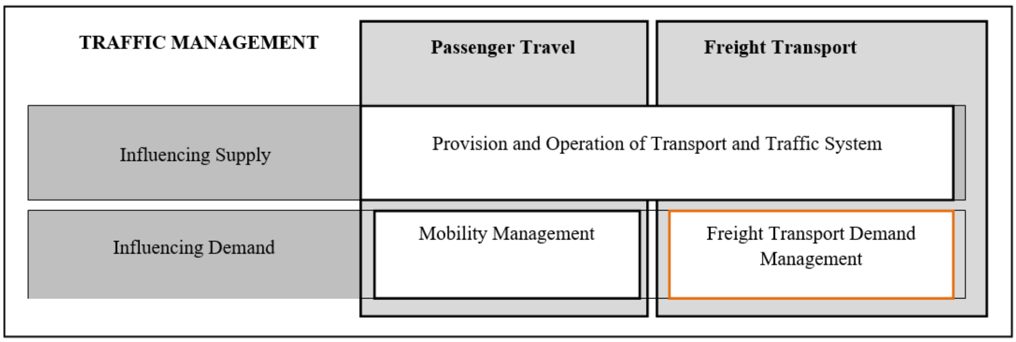

Fig. 1. Freight transport management as a part of traffic management
Source: Boltze, M (2013)

2.2. Freight transport management measures

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 Fig.2 below.

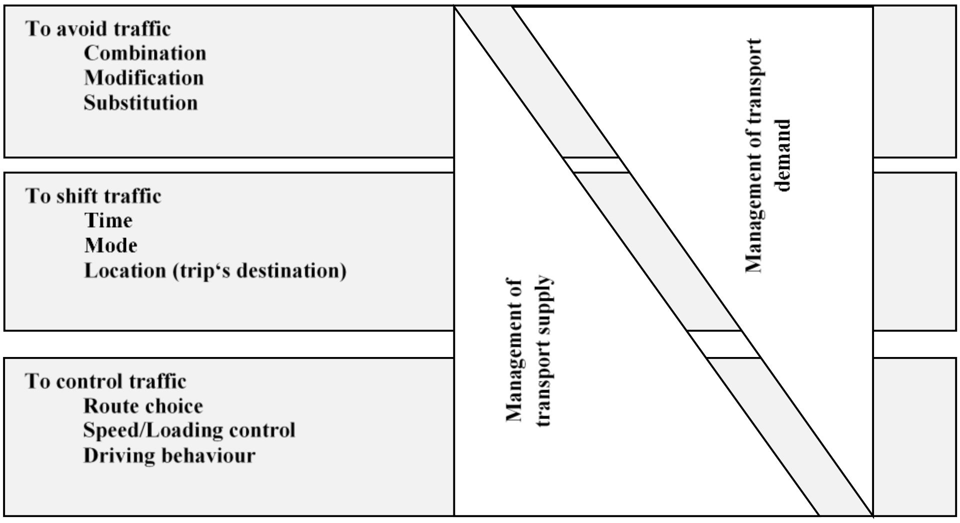

Fig. 2. Classification of FTM measures by their potential impacts

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.

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 1. These 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 table will focus on a detailed presentation of the application of all measures in order to show what is working and what is not, identifying underlying causes of success or failure.

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. 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.

Table 1. List of the application of FTDM measures.

No	List of candidate FTM measures	Examples for relevant case studies	Sources	Application levels		
				Study	Trials	Operational schemes
M1	Freight centers 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 et al. (2003)			x
	Harvesting time	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 et al. (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 et al. (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 et al. (2010)		x	
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	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 Electronic Toll Collection and the Global Positioning System in Singapore	Chan and Al-Hawamdeh (2002)		x

3. Analysis of the rice industry in the Mekong Delta of Vietnam

3.1. Rice supply chain

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 Vietnam. The Mekong Delta is also 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.

From the early 1990s until now, Vietnam has been ranked among the three-leading rice-exporting countries in the world. The Mekong Delta 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. There are two kinds of rice supply chain in the Mekong Delta, domestic and export rice supply chain. Currently, up to 70% of the rice volume produced in the Mekong Delta is for export, with the remaining 30% consumed domestically. IWT and road are considered main transportation modes in the rice industry. Motorcycles are used mainly for purchasing material inputs such as fertilizers, and pesticides. A detailed representation of transport modes used in each stage of the rice supply chain is shown in Fig.3.

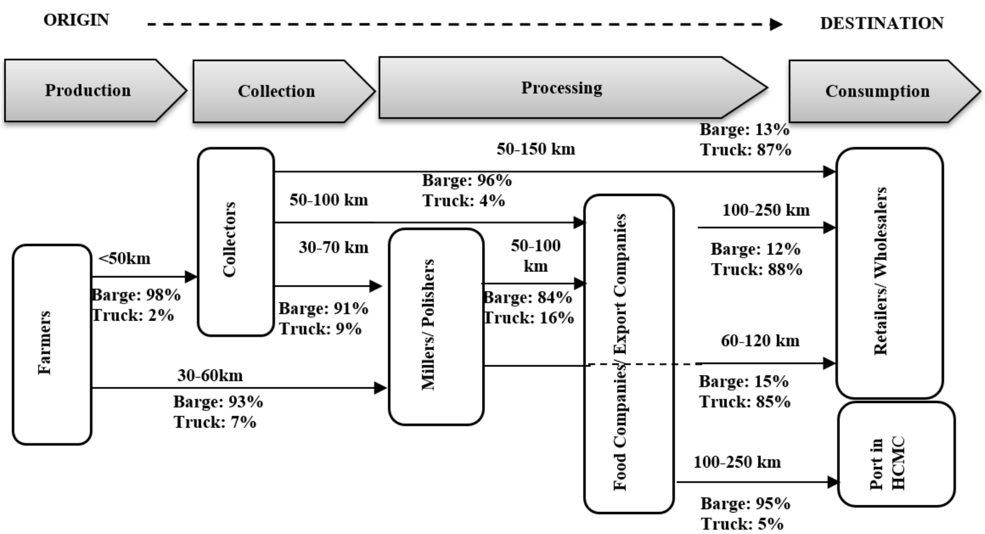

Fig. 3. Transport modes used in the rice supply chain

Source: Own illustration based on data from Loc (2011) and field survey in the Mekong Delta (2015, 2016)

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. Rice typically transported by small vessel (less than 1000 tons) and/or large truck (15 tons) to Hochiminh City (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 2.

Table 2. 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: World Bank (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 prioritie minimizing transport costs, so truckers tend to drive transport costs down at the expense of service quality. Consequently, infrastructure network deteriorates quickly.

3.2. Logistics cost and lead-time

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. Fig.4 and Fig.5 illustrate the logistics cost breakdown for 1 ton of rice delivered at port or wholesale in HCMC.

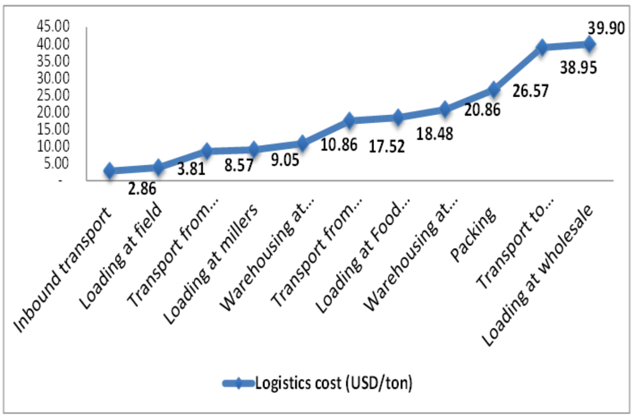

Fig. 4. TLC in the domestic rice supply chain

Source: Binh (2015)

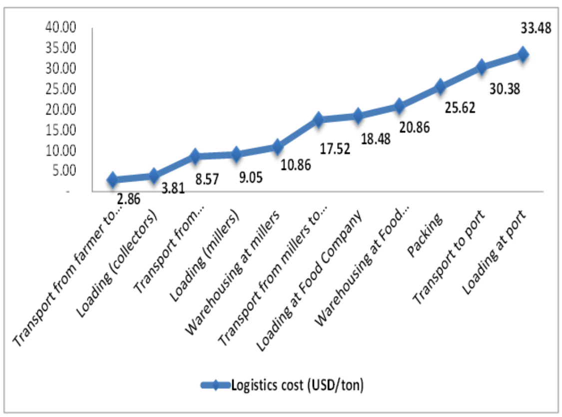

Fig.5. TLC in the export rice supply chain

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 (Fig.6). 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.

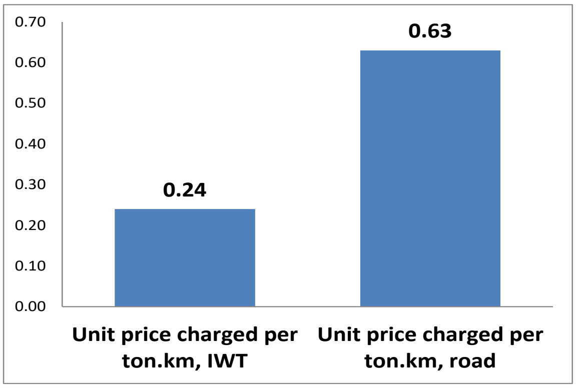

Fig.6. Comparison of unit transport price by mode (USD/ton-km

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.

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 Fig.7 and Fig.8.

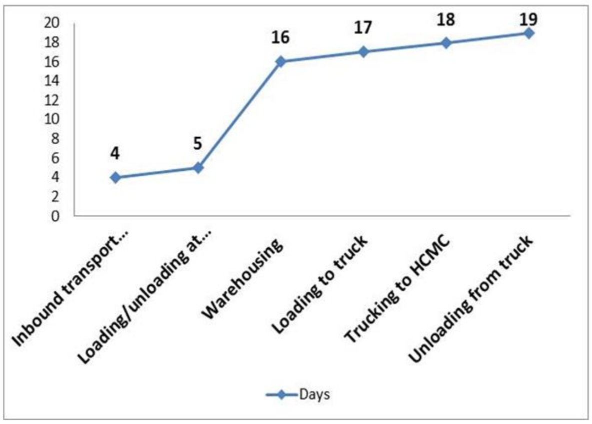

Fig. 7. Total lead-time in the domestic rice supply chain

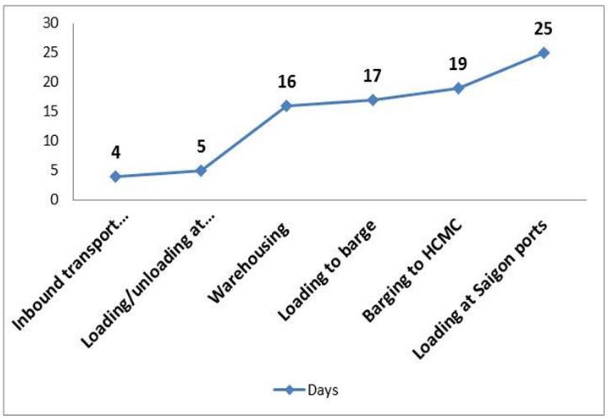

Fig.8. Total lead-time in the export rice supply chain

As Fig.7 and Fig.8 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, 2015). 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.

3.3. Safety and environment 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 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.

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. 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.

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 3.

Table 3. Estimated emission rates in Vietnam by freight transport mode.

CO2 Emission Factors	2010
Truck (gCO2/ton. km)	110
IWT (gCO2/ton. km)	71

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

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).

3.4. Compilation of FTM measures

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 4 presents a compilation of FTM measures that have already been applied and can potentially be applied in the rice industry as follows:

Table 4. Compilation of FTM measures in the context of the rice industry.

FTM measures identified in the literature		List of FTM measures in the rice industry	
M1	Freight centres and consolidated deliveries	M1-VN	A regional rice logistics centre Hau Giang province
M2	Co-operative freight transport system	M2-VN	Major markets for rice/paddy in Can Tho, Long An, and Tien Giang provinces
M4	Time window for trucks entering the city	M4-VN	Prohibition of trucks entering HCMC from 6:00 am to 12:00 pm
M11	Promotion of regional products	M11-VN	The establishment of centralized areas for paddy production
M12	Business cooperation	M12-VN	Co-operation between collectors and millers and export

			companies in An Giang province
M15	Infrastructure capacity improvement	M15-VN	Improvement of NH 1A from the Mekong Delta to HCMC
M17	Load factor control or speed limit	M17-VN	Restricting overloaded trucks on the highway from the Mekong Delta to HCMC

There are seven FTM management measures in the rice industry are listed. This list is incomplete since many others measures which already be applied in the world (mentioned in Chapter 2) could be utilised for the Vietnamese rice industry. However, in this case, there are seven measures considered because of their highly potential implementation to deal with those problems in the near future of the rice industry. 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.

4. Impact assessment of FTM measures in the rice industry

In this section, the Analytical Hierarchy Process (AHP) was employed to weight and rank the importance level of FTDM measures in the rice industry. A review on literature has shown that AHP 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.

4.1. 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 3 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. Fig.9 presents these criteria in detail:

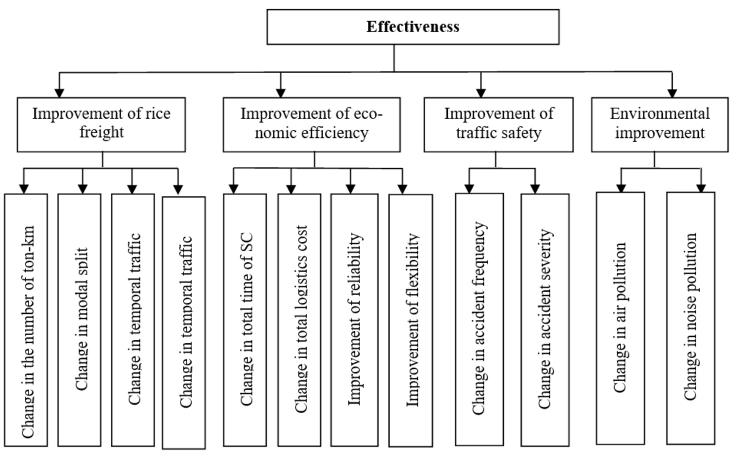

Fig. 9. Hierarchical structure of assessment criteria for effectiveness

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. The applicability of measures also depends on whether authorities get the support from the public or not. 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).

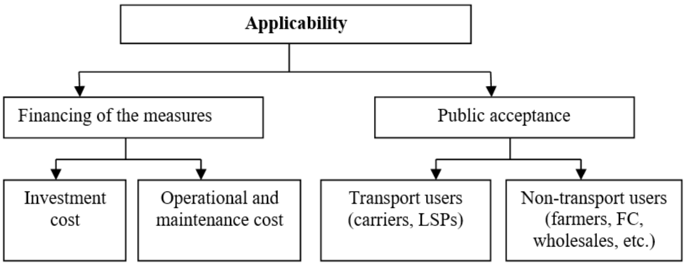

Fig. 10. Hierarchical structure of assessment criteria for applicability

4.2. Weighting 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.

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				

Fig. 10. Questionnaire sample

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. 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 Fig.11.

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 presents the scale for pairwise comparison.

Table 5. Scale for pairwise comparison.

Numerical scale	Definition	Explanation
1	Equal Importance	Two criteria contribute equally to the effectiveness
2	Moderate importance	Moderate importance of one criterion over another
3	Significant importance	Significant importance of one criterion over another
4	Extreme importance	Extreme importance of one criterion 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 6.

Table 6. 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

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.

4.3. 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 has to do carefully in advance 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 7.

Table 7. 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 8.

Table 8. 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

Note: (*) 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. The final qualitative scaling of FTM measures in the rice industry in terms of the effectiveness and applicability is presented in Table 9.

Table 9. Qualitative scaling of FTM measures in the rice industry

Criteria	Sub-criteria	M1-VN	M2-VN	M4-VN	M11-VN	M12-VN	M15-VN	M17-VN
Effectiveness								
Improvement of freight transport	Reduction in the number of ton-km	2	2	1	1	2	3	1
	Change in modal split	3	1	2	2	1	3	2
	Change in temporal traffic	1	1	2	1	1	1	2
Improvement of economic efficiency	Reduction in transport time	2	1	1	1	1	3	1
	Reduction in logistics cost	3	1	1	2	2	2	1
	Improved reliability	2	1	1	1	1	3	1
	Improved flexibility	1	1	1	1	1	2	1
Improvement of traffic safety	Reduction in accident frequency	2	2	2	1	1	1	2
	Reduction in accident severity	2	1	2	1	1	1	2
Enhancement of environmental protection	Reduction in air pollution	3	1	1	1	1	1	1
	Reduction in noise pollution	2	1	1	2	1	1	1
Applicability								
Financing for the measures	Investment cost	2	2	2	1	1	1	1
	Operation and maintenance cost	2	2	1	1	1	3	1
Public acceptance	Transport users (carriers. LSPs)	3	1	1	2	2	3	1
	Non users (residents...)	2	1	1	2	1	2	2

4.4. Final evaluation of FTM measures

Finally, qualitative assessment model has been developed to calculate the final effectiveness and difficulty score of each measure. In particular, the total effectiveness score is estimated as follows: 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 : The relative weight of assessment criteria *m* (m=1to 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

The total applicability score is estimated as follows:

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

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 10 gives the detailed results of the qualitative assessment of FTM measures in the rice industry.

Table 10. Final assessment of pre-selected measures.

Measures		Effectiveness score ($\mathbf{E_{ij}}$)	Applicability score ($\mathbf{A_{ij}}$)	Ranking
M1-VN	A regional rice logistics centre in Hau Giang province	2.3	2.1	**The first priority**
M2-VN	Major markets for rice in Can Tho, Long An, Tien Giang provinces	1.6	1.7	The third priority
M4-VN	Prohibition of trucks entering HCMC from 6:00 am to 12:00 pm	1.4	1.5	The fourth priority
M11-VN	The establishment of centralized areas for paddy production	1.5	1.3	The fourth priority
M12-VN	Co-operation between collectors and millers and export companies in An Giang province	1.3	1.1	The fourth priority
M15-VN	Improvement of NH1A from the Mekong Delta to HCMC	2.1	1.7	**The second priority**
M17-VN	Restricting overloaded trucks on the highway from the Mekong Delta to HCMC	1.7	1.5	The third priority

According to the assessment results, an establishment of a regional rice logistics centre in Hau Giang province (M1-VN) 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 (M15-VN) is ranked in the second priority group since it involves a quite high level of effectiveness and ease to application. The establishment of major markets for rice/paddy (M2-VN) and restricting overloaded trucks on the highway (M17-VN) is assigned as the third priority measure since they involve in a moderate level of effectiveness and applicability. The other measures including M4-VN, M11-VN, M12-VN are assigned as last priority measure due to low level of effectiveness and high level of difficulty involved in implementation.

5. Conclusions

Various problems associated with rice logistics in Mekong Delta necessitate to form schemes to analyze the interactions between freight transport activities and rice production and logistics. The objectives of this study are to investigate and assessing the impacts of public decision making in freight transport management on rice logistics in the Mekong Delta. The Analytical Hierarchy Process (AHP) model is applied to assess the possible measures. The results of this preliminary assessment revealed a high rating for two FTM measures, the establishment of a regional rice logistics center and improvement of NH 1A. These measures are expected to reduce inbound transport cost, warehousing and handling cost and facilitate inter-regional trade by reducing significantly transport time from the Mekong Delta to HCMC.

The methodology applied in the study brings a better understanding of the complex impacts on stakeholders of the rice supply chain. It can serve as a basis to assess potential consequences of any recommended measures in the Vietnamese rice industry. However, the methodology has some limitations. In some phases of the assessment process, it is subjective rather than definitive. That is because the quantity of experts involved in the survey is 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. Besides, the research results provided some evidences that a change of the rating of measures by assessment criteria may lead to a little different final ranking. As a next step the quantitative assessment of specific freight transport management measures in the context of the rice industry should be undertaken.

In short, the research described in the paper can be considered as the first step to a decision support system for freight transport demand management measures focusing on the rice industry in Vietnam. Especially in developing countries such as Vietnam, improved understanding of the influences of public decisions on rice production and logistics systems can contribute to a sustainable development.

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