AN ANALYSIS OF LOGISTICS IN HAI PHONG, VIETNAM BASED ON A COMBINED COMMODITY FLOW AND TIME USE SURVEY

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Abstract

One of critical issues in logistics is how to reduce the total lead time. For this purpose, it becomes important how to properly capture the movement of goods across the whole process, in which various tasks are involved, such as loading/unloading, transporting within transportation network, packaging, labeling, inspection and custom procedure and so on. In this study, we proposed to combine the commodity flow survey and the time use survey and implemented the combined survey in Hai Phong, which has the biggest port in the north part of Vietnam. However, the inefficiency of logistics systems has been causing various problems. In the survey, we successfully interviewed 60 companies in September to October, 2013 and obtained commodity flow and time use with respect to 160 shipments. We will report detailed findings from this survey by especially looking at the time use patterns of all tasks involved in the logistics process.

Keywords: Time use, Commodity survey, City Logistics, Multi-input and multi-output stochastic frontier analysis, Efficiency analysis.

1. Introduction

In our social life, efficiency is considered as one of the crucial elements to judge a success of an organization. Especially in the logistics field, time use might be the most important factor to evaluate the efficiency of operation of a logistics company.

For most developing countries like Vietnam, logistics has emerged as one of the most promising industries. Logistics can bring much more profits and consequently contribute to the economic growth of a country. According to World Bank[1], logistics cost occupied 25% of GDP in Vietnam while that in developed countries such as USA is just about 10%, and the Logistics Performance Index (LPI) in Vietnam was ranked the 53th with a score of 3.00 (1: worst … 5: best) in 2012,as measured by the International LPI (no reference?). Thus, if logistics companies in Vietnam can control and manage their

[1] http://www.worldbank.org/en/news/feature/2014/01/07/efficient-logistics-a-key-to-vietnams-competitiveness

logistics operation in a more efficient way, they are more likely to enhance their competitiveness in the world market.

Time and cost are two important elements that have received much attention of logistics researchers. How to optimize logistics cost and minimize time use in logistics field become more and more essential for companies to achieve much more benefit.

In case of city logistics, recently, it has been becoming very common that when treating time window in vehicle routing and scheduling, how to monitor fleet vehicles as well as their own schedules for the just-in-time delivery.

However, to date, little has been done in literature to capture the time use at different steps across the whole process of logistics operation. Motivated by this, the purpose of this paper is to fill in the gap. For this purpose, first, we designed a new logistics survey by combining the commodity flow survey and time use survey. To the best of our knowledge, this may be the first attempt in literature to investigate the time use across the whole process of logistics operation. Second, motivated by serious inefficient operation of logistics in Vietnam, we conducted the new survey in Hai Phong, Vietnam. Haiphong is the third largest city in Vietnam, with a population of about 2.0 million and has the second largest port (seaport) in Vietnam, with its deep-water anchorage and large maritime facilities. Third, some preliminary analysis is done. After that, the efficiency of logistics from the perspective of time use is analyzed. Finally, this study is concluded.

2. Literature Review

To date, in the field of urban freight studies, there have been so many types of survey forms used by countries all over the world. In a report by Allen and Browne (2008), several different types of survey techniques were provided such as establishment surveys, commodity flow surveys, freight operator surveys, roadside interview surveys, driver surveys, vehicle observation surveys, parking surveys, vehicle trip diaries, and service provider surveys. In the commodity flow survey, data mainly focus on information about types and quantities of goods flowing to or from a particular company by face to face interview, telephone interview or self-completion. However, there is no survey in which both commodity flow and time use are captured.

For capturing time use in a city logistics study, Munuzuri et al. (2010) showed that modeling the complexity of urban freight transport needs large amount of data related to supply chain management, delivery practices, tour configuration, and time window. From the perspective of efficient time use management in the city logistics field, Grzybowska et al. (2012) developed a decision support system for real-time urban freight management. This target is based on integration of selected vehicle routing models and dynamic traffic simulation models in the case of the pickup and delivery vehicle routing problem with time windows, dealing with the dynamic case of the addressed problem through dynamic modifications of the current routing and scheduling plan on the basis of the newly revealed information, providing the initial routing and scheduling plan include both the New Pair Insertion Procedure and the Complete Route Reconstruction Method. They used an optimization method by using Parallel Tabu Search and post-optimized with the Normal pickup and delivery Rearrange Operator Post-Optimization

Procedure. Besides that, Ehmke et al. (2011) performed a study dealing with city logistics by a floating car survey and found that the impact of rush hour traffic is significant for routing of vehicle fleet.

In addition, Kwon et al. (2014) used a “Procedure Tree” for Radio Frequency Identification (RFIS) data mining, which can manage massive RFID data effectively and perform real time process management efficiently. With their proposal system, predicting and tracking works of real time process and inventory control can be controlled with the numerous data collected from the Enterprise Resource Planning (ERP) database.

3. Multiple-Output Stochastic Frontier Model: A Distance Function Approach

In stochastic frontier analysis (SFA), the distance function is adopted and the existence of production possibility frontier is explained in more detailed.

The distance that any company is out of the frontier is a function of the set of inputs (x) used and outputs (y) produced. The output-oriented model can be expressed as follow:

$$D_0(x,y) = min\{\theta|(y/\theta) \in P(x)\}$$

where: $D_0(x,y)$ is the distance from the company’s output set to the frontier,

θ is the corresponding level of efficiency.

The distance function gets a value which is less than or equal to one if the output vector y is an element of the feasible production set P(x).

If $D_0(x,y) = \theta = 1$, it is said that company is full efficient and level of efficiency is on the frontier. Otherwise if $D_0(x,y) = \theta < 1$, it means that company is inefficient.

In order to estimate the distance sets from the frontier, we need to evaluate not only the frontier but also the relationship between inputs and outputs. This means that some form of multiple-output production function P(x) need to be determined. According to Subal et al. (2003) the most common functional form applied is the translog production function, as it does not impose restrictive assumptions regarding substitutability between inputs or outputs. The translog distance function with M(m = 1,2,…,M) outputs and K(k = 1,2,…,K) inputs, and for I(I = 1,2,…,I) companies can be given below:

$$\ln D_{0i} = \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_{mi} + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \alpha_{mn} \ln y_{mi} \ln y_{ni} + \sum_{k=1}^{K} \beta_k \ln x_{ki}$$

$$+ \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M} \delta_{km} \ln x_{ki} \ln y_{mi} \quad (1)$$

In order to maintain the homogeneity of degree +1 in outputs, restrictions required are:

$\sum_{m=1}^{M} \alpha_m = 1 \; and \; \sum_{n=1}^{M} \alpha_{mn} = 1 \qquad m,n = 1,2,\dots,M$

$\sum_{m=1}^{M} \delta_{km} = 1 \qquad k = 1,2,\dots,K$

And those required for symmetry are shown below:

$\alpha_{mn} = \alpha_{nm} \qquad m,n = 1,2,\dots,M$

$\beta_{kl} = \beta_{lk} \qquad k.l = 1,2,\dots,K$

With $D_0(x, \omega y) = \omega D_0(x, y)\ for\ any\ \omega > 0$

Hence, setting $\omega = \frac{1}{y_M}$, the distance function can be obtained as follows $D_0(x, y/y_M) = D_0(x, y)/y_M$

Therefore, the homogeneity restrictions can be imposed thought normalizing the function by one of the outputs. This provides

$$\ln D_0/y_{Mi} = \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln y_{mi}{}^* + \frac{1}{2}\sum_{m=1}^{M-1}\sum_{n=1}^{M-1} \alpha_{mn} \ln y_{mi}{}^* \ln y^*{}_{ni} + \sum_{k=1}^{K} \beta_k \ln x_{ki} +$$

$$\frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M-1} \delta_{km} \ln x_{ki} \ln y^*{}_{mi} \qquad \text{with i = 1,2,…, N}$$

where $y^*{}_{mi} = y_{mi}/y_{Mi}$.

The level of inefficiency can be estimated from a stochastic frontier production function of the form

$$y = f(x) + v - u$$

where v is the error term (assumed to be N[0,δ]) and u is the one-sided inefficiency term that follows some probability distribution.

The level of efficiency is estimated as exponent of the negative of the error term (exp(-u)). Consequently, $\ln D_{0i} = -u_i$ and normalized equation can be expressed below:

$$-\ln y_{1i} = \alpha_0 + \sum_{m=1}^{M-1} \alpha_m \ln(y_{mi}|y_{1i}) + \frac{1}{2}\sum_{m=1}^{M-1}\sum_{n=1}^{M-1} \alpha_{mn} \ln(y_{mi}|y_{1i}) \ln(y_{ni}|y_{1i}) + \sum_{k=1}^{K} \beta_k \ln x_{ki}$$

$$+ \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln x_{ki} \ln x_{li} + \sum_{k=1}^{K}\sum_{m=1}^{M-1} \delta_{km} \ln x_{ki} \ln(y_{mi}|y_{1i}) + v_i + u_i$$

The frontier model used here is based on a cost frontier initial as the actual interval time use is expected to be larger than corresponding frontier. The error component u_i captures the effect on expenditure of inefficiency, either technical inefficiency or input allocative inefficiency or both, v_i represents statistical noise.

4. Empirical Study: Data and Analysis

To estimate performance of the SFA model, we carry out an empirical analysis. The data set (Table 1) used here are from survey which is performed by interviewed companies that provided transport and logistics service in Haiphong, Vietnam from September 21st to October 20th, 2013. The database includes the data of 60 companies with 160 shipments concerning information of company, time use of commodity flow and some assessments of respondents about the influent factors related to the way they use time in dealing with their shipment as well as the logistics service quality of company. Since logistics is rather new industry in developing countries includes Vietnam, there is a lack of study about time use in this field. This survey can be considered as a new proposal for capturing the real situation of companies that deal with logistics and transport services. In addition, because of confidential reasons in companies' competitive, there has been some missing data related to cost in logistics chain. Here, only time use is targeted. Some aggregation results are shown in Figures 1 – 4.

Table 1. Major information in survey form

Form 1: Information of company	1. What type of service applies to your company? 2. What type of typical commodity does your company operate? 3. What is your main customer? 4. How many employees in your company? 5. What is the number of business vehicle that your company own/rent?
Form 2: Time use of commodity flow	1. Status 2. Origin 3. Destination 4. Mode of Transport 5. Value of shipment 6. Commodity weight 7. Commodity Type 8. Load factor 9. Activities (time start, time end, duration time, activities, facilities, cost)
Form 3: Assessments	1. What factors influence on total time to handle goods of your company? 2. What factors influence on logistics service level? 3. What is the most frequent claim about your logistics service quality? 4. What should local government do to improve City logistics performance?

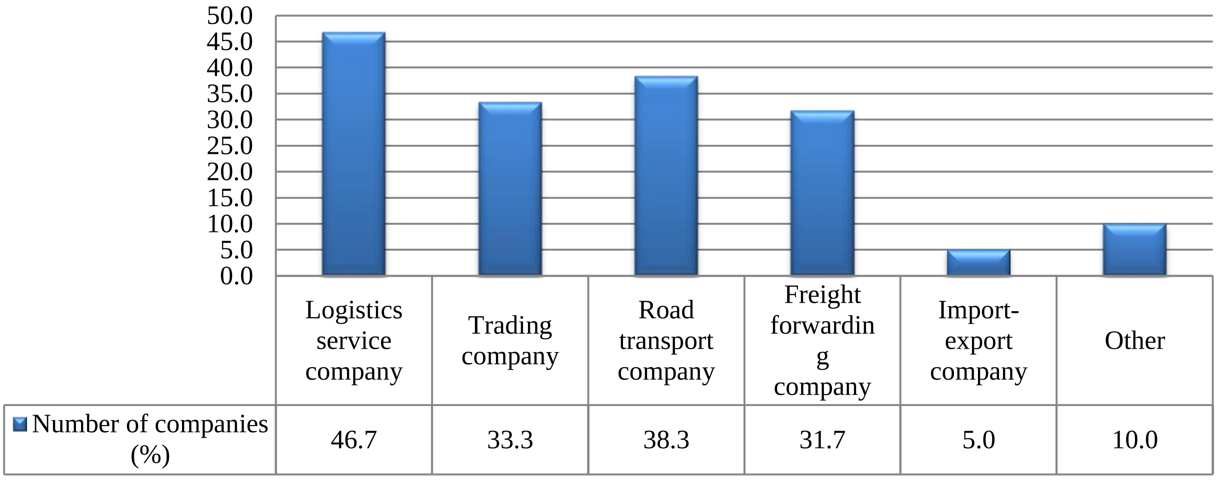

Figure 1. Types of services of companies surveyed

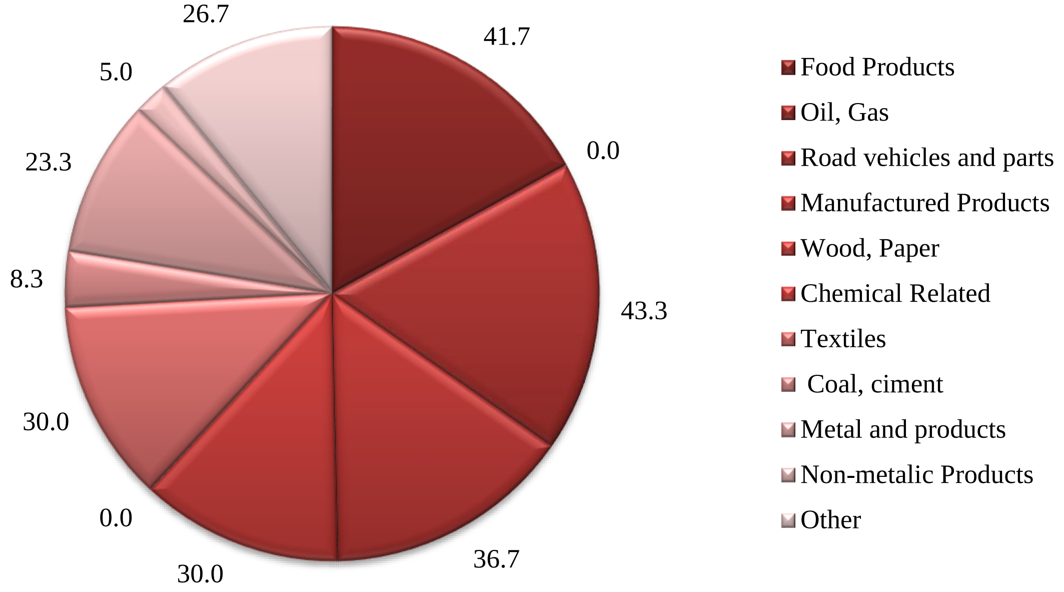

Figure 2. Types of typical commodities (%)

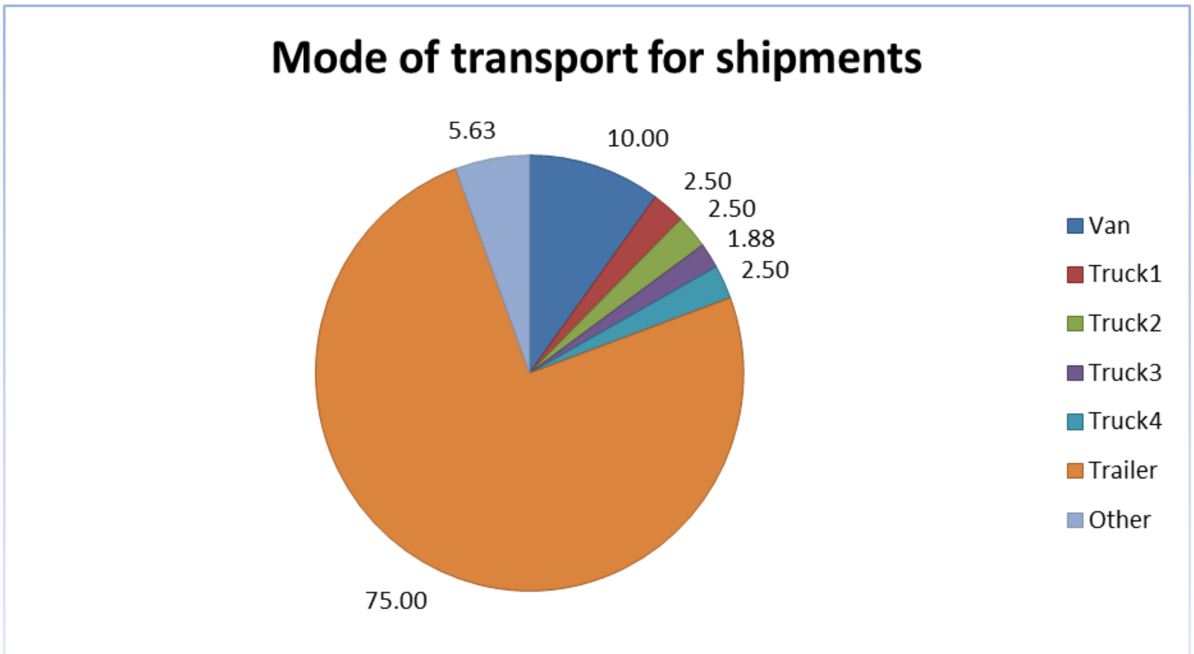

Figure 3. Mode share of transport for shipments (%)

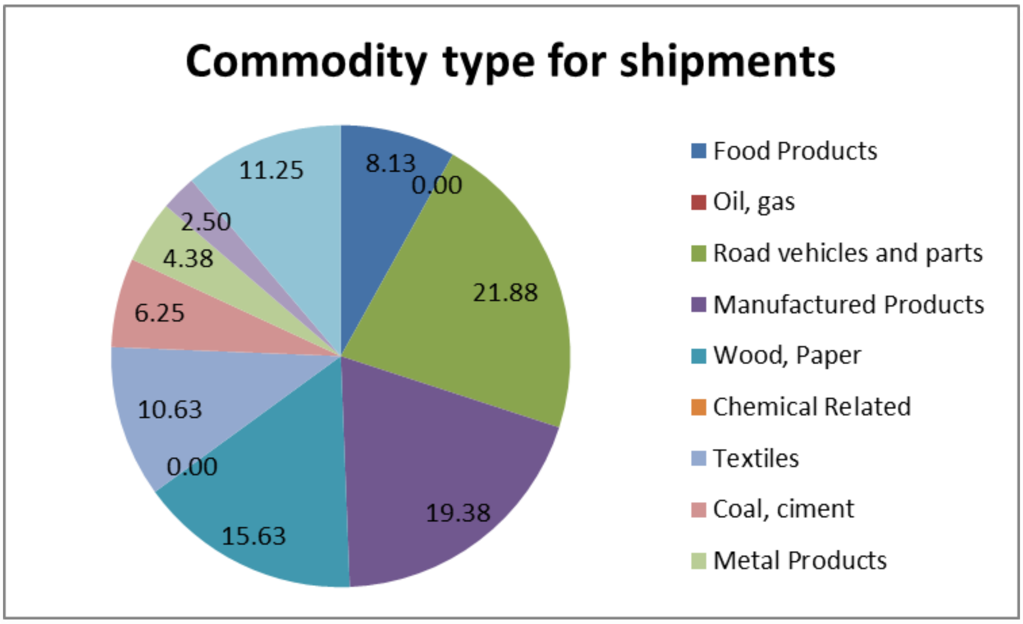

Figure 4. Commodity type for shipments (%)

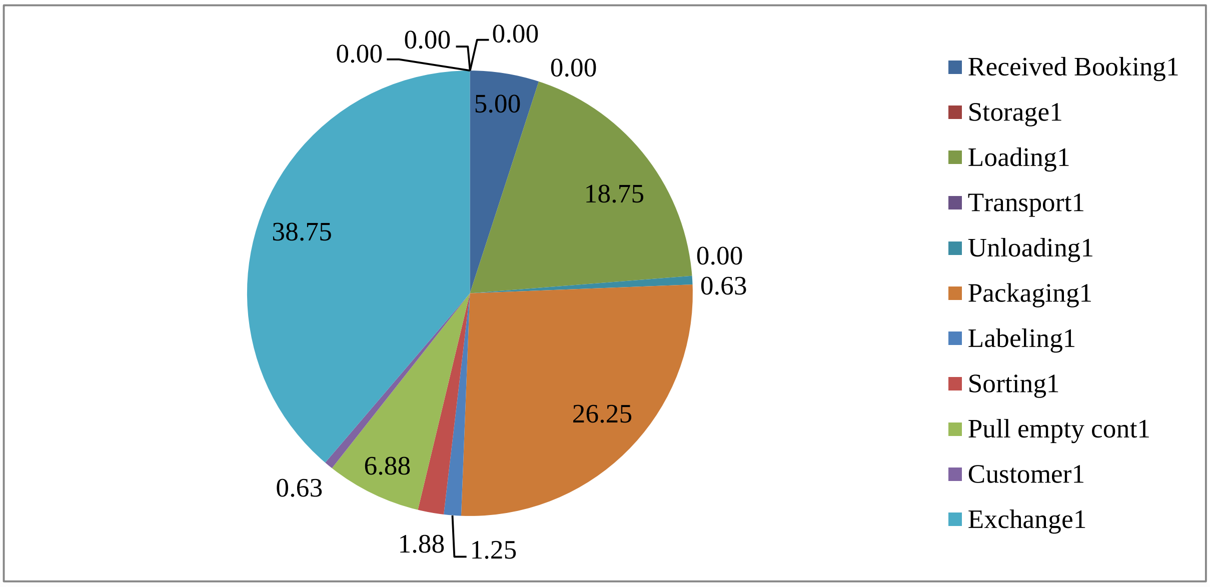

Figure 5. Shares (%) of activities in the 1st step of logistics across the whole process

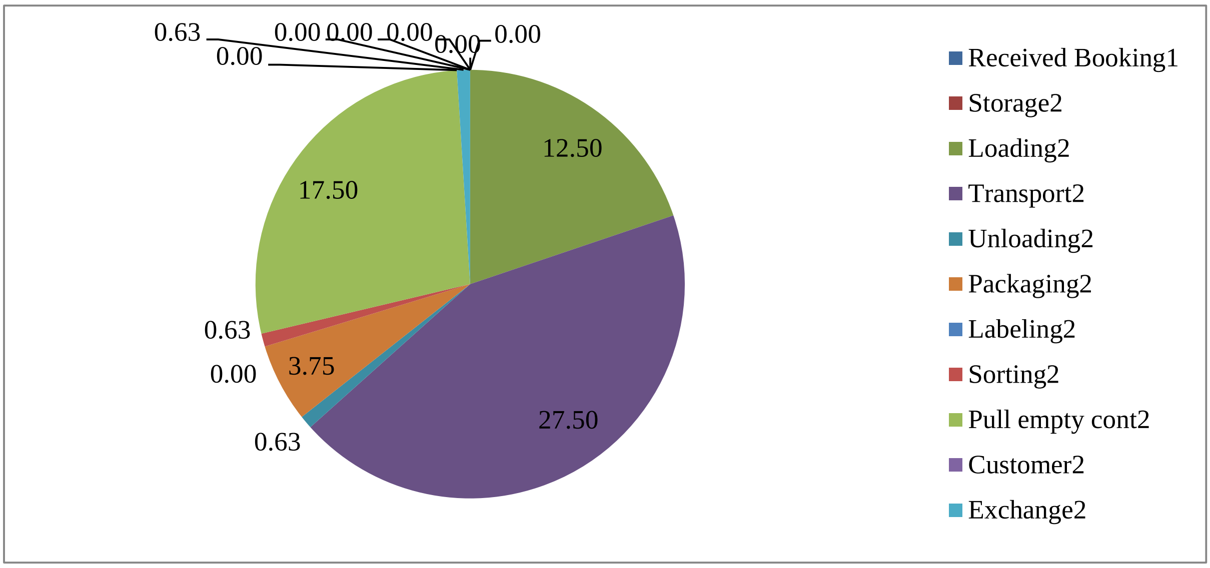

Figure 6. Shares (%) of activities in the 2nd step of logistics across the whole process

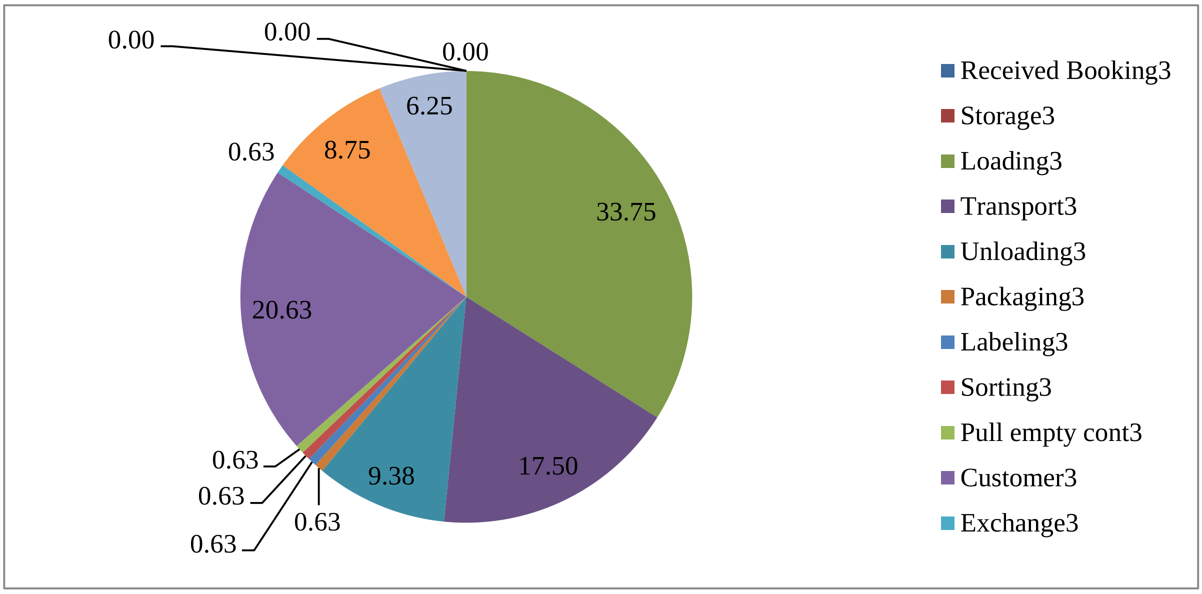

Figure 7. Shares (%) of activities in the 3rd step of logistics across the whole process

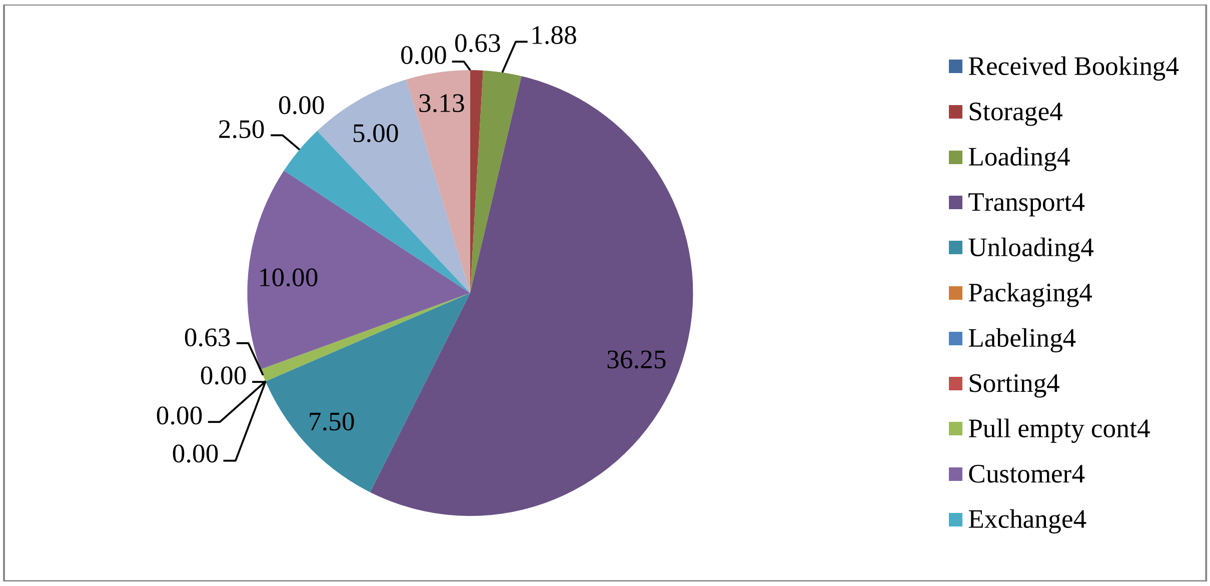

Figure 8. Shares (%) of activities in the 4th step of logistics across the whole process

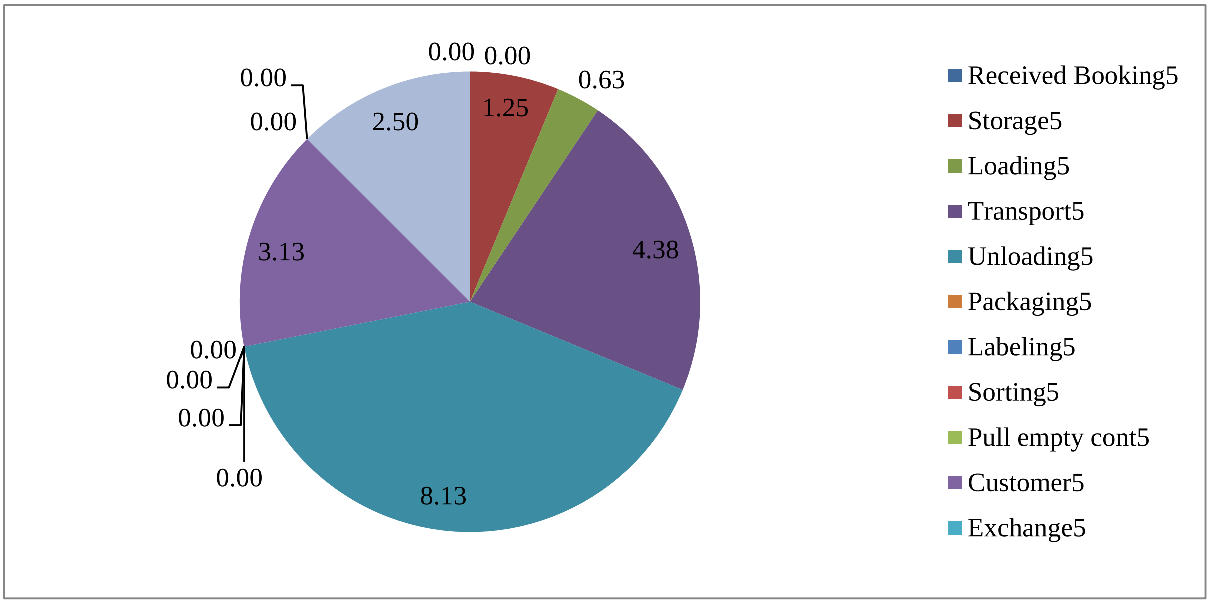

Figure 9. Shares (%) of activities in the 5th step of logistics across the whole process

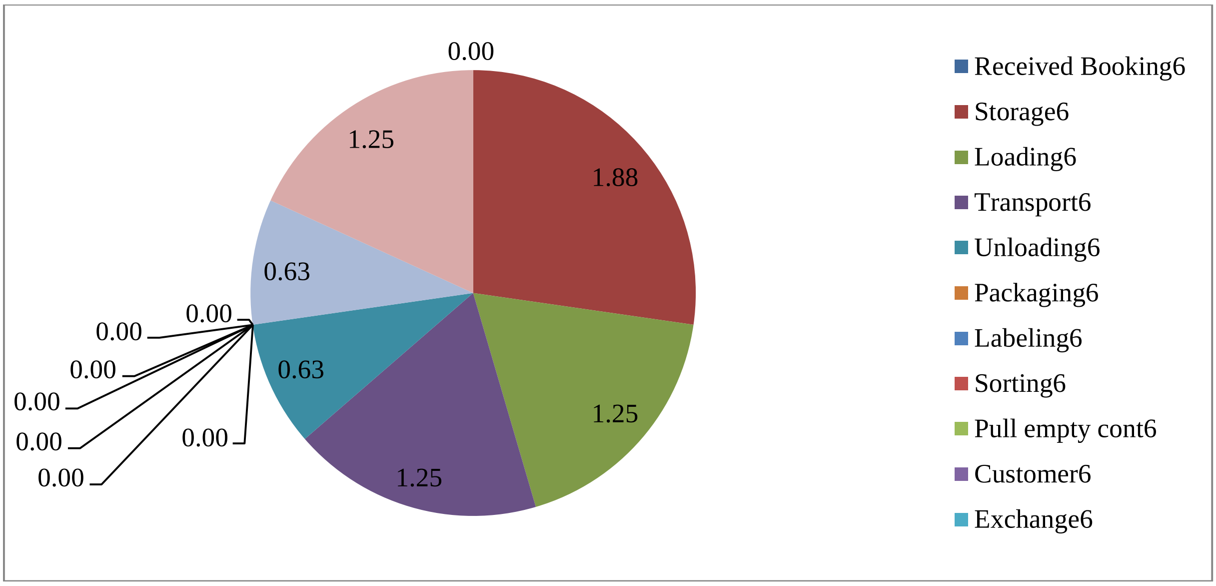

Figure 10. Shares (%) of activities in the 6th step of logistics across the whole process

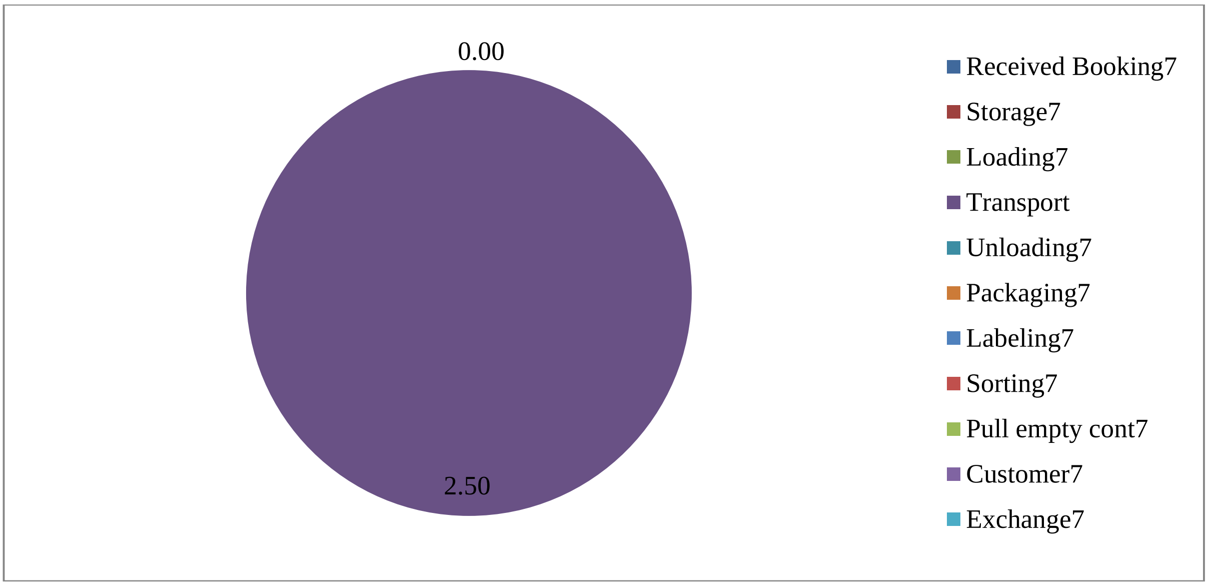

Figure 11. Shares (%) of activities in the 7th step of logistics across the whole process

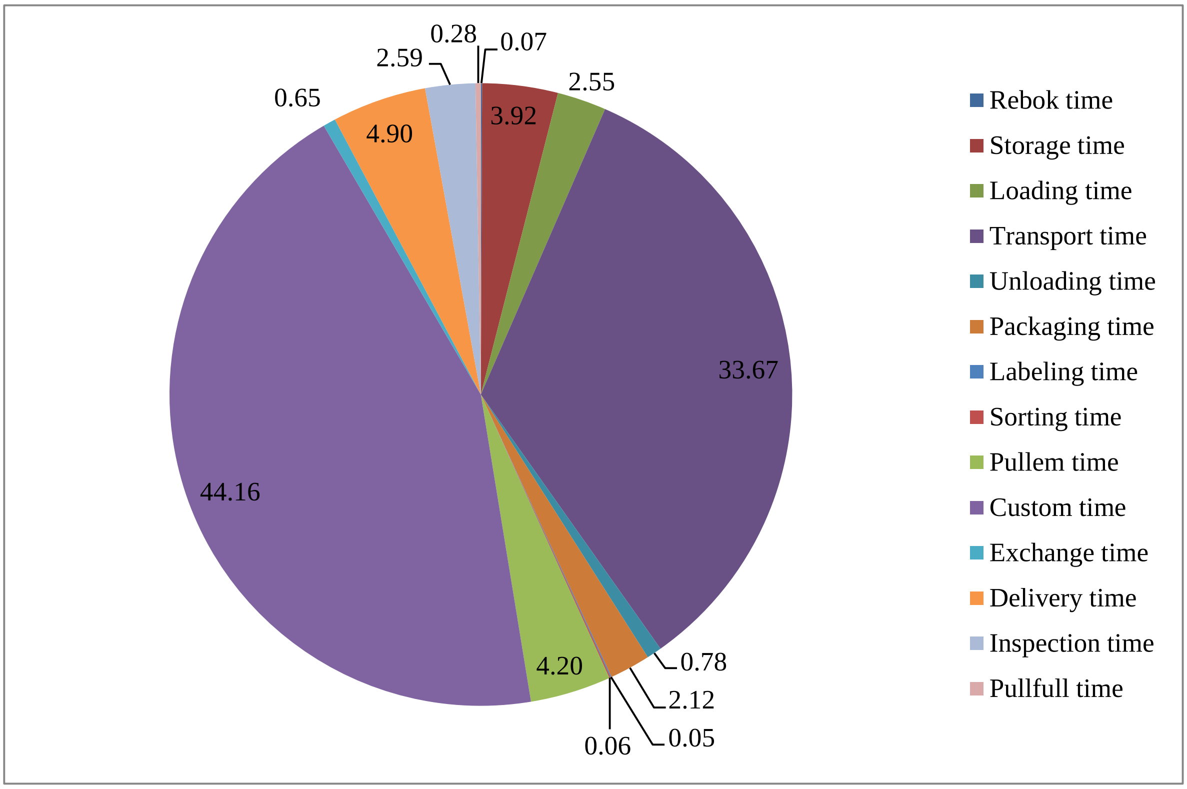

Figure 12. Share of time use by logistics task (%)

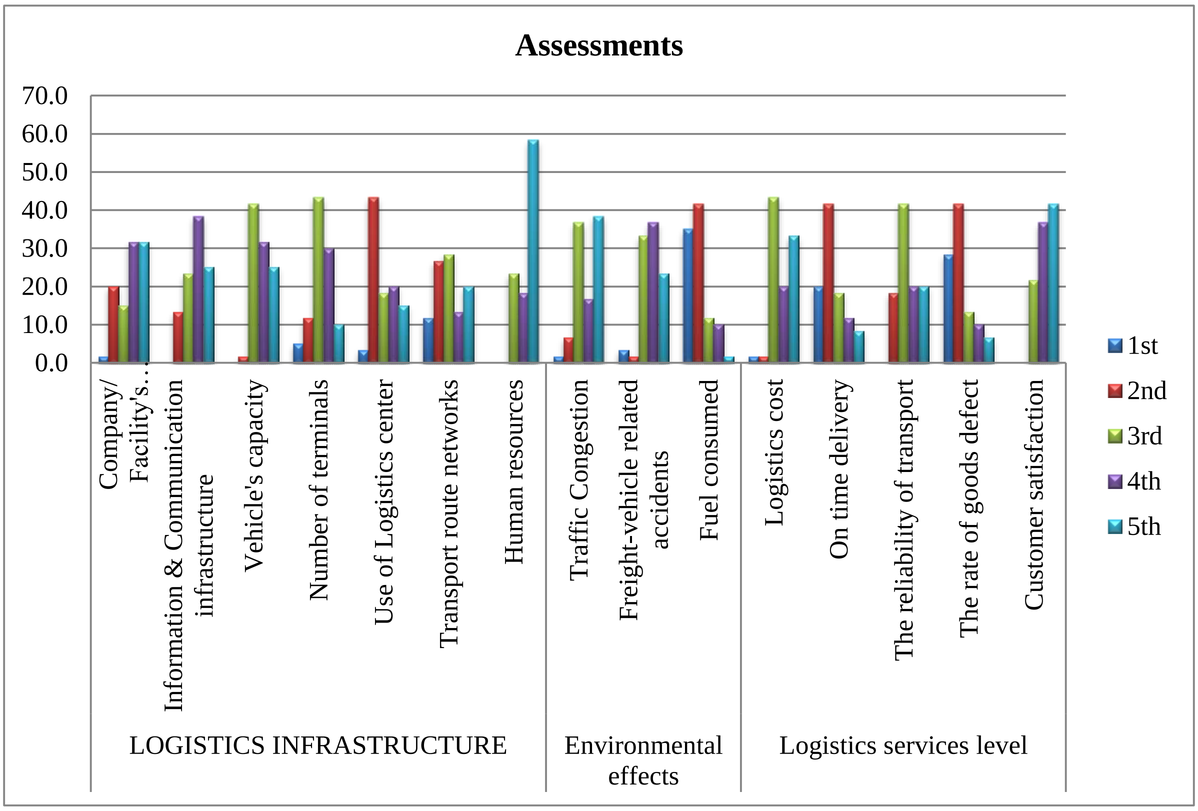

Figure 13. Assessments of logistics (% for each assessment score: 1-worst, …, 5-best)

5. Model Estimation and Discussion

5.1. Analysis Target, Inputs and Outputs for SFA

Logistics is considered as a field that can make much more profit for both companies in particular and country's economy in general. How to maximum profit with limited input resources become one of the key points for company's manager. Besides that each company has their own process for dealing with their logistics chain. The question is how to know that company operation gets efficiency or not. And how much efficiency they get became more and more concern for government. Therefore, it is necessary to acknowledge all the process that transport and logistics companies are now dealing with in market economy.

As we can know that there are so many elements to evaluate the efficiency of company such as cost, benefit, profits and energy consumption or so on. This study focus on analyzing the efficiency in time use while carrying out all the activities in transport and logistics companies such as ordering, packaging, sorting, transport, loading and unloading, etc. Here, time use intervals for dealing with commodity flow by companies are taken as output for SFA model. The inputs are all the information related to the shipments. Detailed description of inputs and outputs for SFA model as table below:

Table 2. Factors used to explain time use efficiency

Outputs	1. Transport time use	y_1
	2. Custom time use	y_2
	3. Exchange time use	y_3
	4. Delivery time use	y_4
	5. Inspection time use	y_5
Inputs	1. Number of total employees	x_1
	2. Number of logistics employees	x_2
	3. Number of trucks	x_3
	4. Number of vans	x_4
	5. Number of trailer	x_5
	6. Commodity weight	x_6

Table 3. Statistical properties of the variables

Variables	Mean
y_1	2.375
y_2	135.8
y_3	88.22
y_4	1211.4
y_5	27.06
x_1	41.34
x_2	4.306
x_3	0.9062
x_4	1.312
x_5	16.38
x_6	44.01

5.2. Results of SFA estimation

Table 4. Estimation results of multi-output SFA model

Parameter	Items	Estimated Parameter value	Standard Error	t-score	Pr(>|t|)
α_0	Constant	3.609779	1.792837	2.013	0.046838 *
α_1	Out1	0.654802	0.195668	3.346	0.001165 **
α_2	Out2	0.770840	0.183559	4.199	5.94e-05 ***
β_5	Inp5	-5.415419	1.902443	-2.847	0.005394 **
α_{12}	Ito1	-0.085220	0.034965	-2.437	0.016621 *
α_{23}	Ito5	0.124556	0.026046	4.782	6.18e-06 ***
α_{24}	Ito6	-0.121103	0.047279	-2.561	0.011964 *
β_{35}	Iti11	-1.944809	0.785015	-2.477	0.014963 *
δ_{14}	oi14	0.236089	0.135109	1.747	0.083733 .
δ_{15}	oi15	0.561567	0.140227	4.005	0.000122 ***
δ_{21}	oi21	-0.076213	0.025024	-3.046	0.002991 **
δ_{23}	oi23	-0.066308	0.037392	-1.773	0.079313 .
δ_{31}	oi31	0.095599	0.040259	2.375	0.019536 *
δ_{33}	oi33	0.143896	0.063662	2.260	0.026036 *
δ_{55}	oi55	0.424136	0.216137	1.962	0.052587 .
R-squared		0.7928 (0.7713)			
P_value/Sample size		2.2e-16 /160			

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

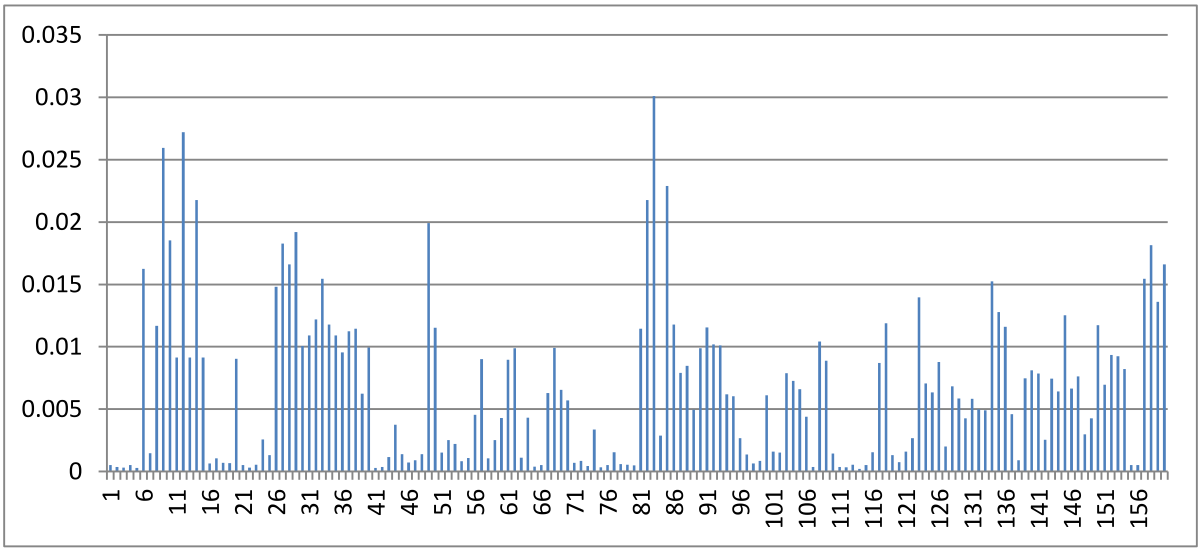

Figure 14. Inefficiency measures of each shipment (Total: 160 shipments)

Summary of the results:

Table 4 shows the detailed estimation results. Correlation coefficient (R-squared) is 0.7928 (adjusted value: 0.7713), meaning that the model accuracy is not good enough to explain the result. However, according to Subal et al. (2003), the efficiency model with multiple ouputs cannot always get the expected result.

- We can conclude that total time use by activity of inspection commodity among the whole process performing logistics service has significant influent to the efficiency of logistics chain in surveyed companies. It means that the more time use in the period of goods inspection, the more time use efficiency was waste
- Besides that interaction of the amount of commodity needed to transport and the vehicle specified here as trailer can affect to evaluate the efficiency in total time use of logistics process.
- Based on the Figure 14, we can see that all of shipment in survey data collected in companies in Haiphong was carried out without efficiency of time use, proved by all number estimated is much smaller than one.

6. Conclusions and Future Research Issues

This study conducted a new logistics survey that contains the information of both commodity flow and time use across the whole process of logistics operation, in Hai Phong with the second largest port in Vietnam in 2013. As a result, the information about 160 shipments was collected from 60 companies. This is probably the first attempt of incorporating time use into logistics survey in literature, at least in Vietnam, to the best of our knowledge. Even though the survey suffers from the missing data problem, it surely shows a new picture about the logistics in Vietnam based on a preliminary aggregation analysis. Focusing on the time use, a multiple-input multiple-output stochastic frontier analysis (SFA) model was built to quantify the efficiency of logistics operation by introducing several major company-specific factors (e.g., number of employees, number of vehicle, logistics chain with time use specification). A distance function approach with multiple inputs and multiple outputs is applied to analyze the efficiency of time use for logistics operation at different companies. The time use information covers the time spent on transportation, loading, unloading, packaging, sorting, and custom clearance procedure and so on.

First, the effectiveness of the SFA model was empirically confirmed. Second, the model results revealed that the efficiency levels of logistics in the collected 60 companies were considerably low. This might indirectly explain why logistics cost in Vietnam, especially in Hai Phong, is very high, compared to other countries all over the world. This findings suggest that the Vietnam government should make more efforts to provide better business environment by enhancing the efficiency of logistics activities.

Having summarized the findings, there are many unresolved issues that should be addressed. It is necessary to conduct statistical tests with respect to those aggregation analyses in order to figure out significant features of logistics operation in Vietnam. More variables specific to each step of logistics operation should be introduced in the SFA analysis. Needless to say, better survey instruments should be developed in order to track the time use and cost across the whole logistics process. To clarify the logistics issues in Vietnam, large-scale surveys should be implemented with respect to more companies in more cities. To further understand influential factors to more efficient logistics operation, better analysis methods should be developed by making full use of the proposed commodity flow and time use survey and other existing surveys based on data fusion theories.

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