A MODEL FOR ESTIMATION OF SHIPPING TIME BASED ON EXPERIENCES OF PAST SHIPPINGS IN LANDLOCKED DEVELOPING COUNTRIES*

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1. Introduction

Landlocked Developing Countries (LLDCs) like Mongolia, Uzbekistan, Lao PDR (Lao PDR is classified as Least developed Countries (LDCs) by UN-OHRLLS[1)]) etc. are all impossible to utilize maritime transport for freight transport from their own territories due to the nature of geographical characteristics. Utilizing maritime transport, which realizes high economies of scale comparing to other transport modes (truck, air, etc.), is nowadays getting more and more important due to the globalization. Thus, since price of goods imported/exported goods from/to LLDCs in the market gets higher due to high transportation cost, LLDCs are in quite severe environment for further economic development. In case LLDCs use seaport for international trade, it is necessary to access to seaport in the coastal countries by surface transportation such as truck, railway, etc. On the way to seaport from LLDCs (or vice versa), it is also necessary to pass across at least one border, which is generally recognized quite tough work particularly in developing counties (surrounding countries of LLDCs are also mostly developing country). For instance in Africa, total cost for cross border is accounted as being equivalent to 1,600 km land transportation or 11,000 km maritime transportation[2)]. In addition, seaport is also recognized as another bottleneck. For example, in Mombasa seaport of Kenya (gateway seaport of Uganda), dwelling time is quite fluctuated and sometimes more than 30days are required for just only waiting time as shown Figure 1.

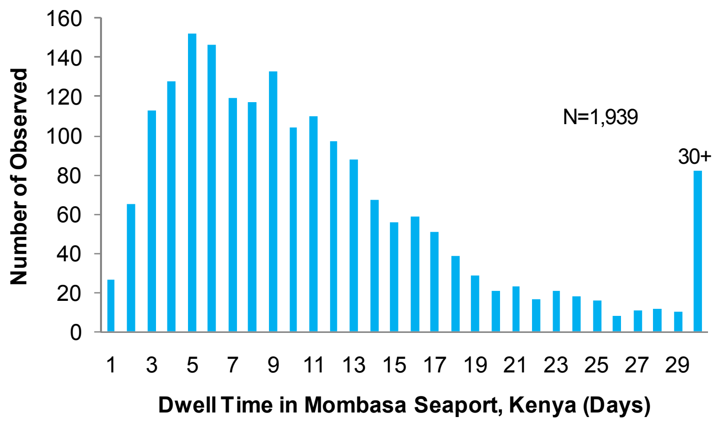

Figure 1: Dwell Time at Mombasa Seaport

Data Source: Arvis *et al.* (2007)

In international land transportation from/to LLDCs, logistics companies (in logistics field, there are a lot of players such as transport operator, shipper, freight forwarder, seaport operator, etc., however, this study consistently uses terms of "logistics player" for simplification.) are exposed to several transport risks. According to the existing studies[3), 4)], 3 risk factors are recognized as crucial for freight transport of LLDCs, such as delay, damage, disruption of goods transported. Cross border is one of the limitations of LLDCs to access to seaport of coastal countries.

Although links (roads) do not generate delay since traffic volume is quite low (almost always free-flow speed on the link), it is observed that traffic volume in nodes such as border points and seaport generally exceeds its capacity. Some of the reasons for delay are that large amount of procedures and inefficient procedures, which can often be seen in developing countries, are needed.

*Keywords: landlocked developing countries, international inland freight transport, Hölder mean, experiences of past trips

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Delay risk have been emerged as a consequence of manifestation of above 2 bottlenecks, which are both typical bottlenecks of LLDCs[5), 6), 7)]. As an example for delay risk for cross border (sometimes it is called as border barrier), there is a report[4)] that reports 10-20 days are required to pass across border of Uzbekistan/Turkmenistan.

In summary, a route between LLDCs and seaport in coastal country is recognized as route with high uncertainty in terms of shipping time, which is equivalent to low shipping time reliability. In general, delay occurred at seaport and border in developing countries are not provided prior to their departure, and thus, it is also basically not predictable. Under these circumstances, this study proposes one hypothesis for estimating next shipping time, which is that logistics company estimates next shipping time based on past shipping experiences. In order to develop a model which fulfills this hypothesis, Hölder Mean theory is used.

2. Model

(1) Hölder Mean Approach

This study treats a route with high uncertainty in terms of shipping time, and its probability of occurrence is normally random. Thus, it can be inferred that evaluation function of each individual for shipping time should be different. In general, in case developing transport behavior model, evaluation function of mean, maximum, minimum, weighted average value, etc. of factors expressing traveler's behavior mechanism are assumed. Nevertheless, traveler's behavior in real world is varied for place, scene, situation, etc. Thus, developing shipper's behavior, parameter estimation assuming solo-behavior mechanism seems to be straightforward. In this study, Hölder Mean approach is applied for shipper's estimation for shipping time. A concept of Hölder Mean is able to express several evaluation functions for different parameters estimated since Hölder Mean approach needs any assumption for evaluation function of estimation of shipping time. The difference of each shipper's evaluation function can be incorporated in parameter. Hölder Mean of n data $x_1, x_2, x_3, \ldots, x_n$ can be expressed as following.

$$\bar{x} = \left(\frac{x_1^{\alpha} + x_2^{\alpha} + \cdots + x_n^{\alpha}}{n} \right)^{\frac{1}{\alpha}} \qquad \alpha \neq 0 \tag{1}$$

Where α denotes parameter. By using equation (1), several mean operations are allowed to take place. For example, when α equals to -1, harmonic mean can be obtained, similarly, arithmetic mean can be obtained when α equals to 0[8)]. Other various mean operation is possible to take place like geometric mean (α=1), maximum value (α=∞), minimum value (α=∞) as famous mean. This paper omits detail of verification and other mean operation (see reference 6).

The weighted Hölder Mean can be expressed as equation (2) by introducing weighted parameter $w_{i.}$ The difference of importance between each variable can be known.

$$\bar{x} = \left(w_1 x_1^{\alpha} + w_2 x_2^{\alpha} + \cdots + w_n x_n^{\alpha} \right)^{\frac{1}{\alpha}} \qquad \sum_{i=1}^{n} w_i = 1 \tag{2}$$

As for a model which is for estimating next travel time based upon past trip experience, Horowitz[9)] applied this idea to link cost function of stochastic user's equilibrium model, and then discussed stability of convergence of each parameter. Iida[10), 11), 12), 13)] developed several models for the estimation of next trips by repeated route choice experiment. Nevertheless, all of these models are developed based upon linear function, and they just compare impact of timing of past trip experiences on estimation of next trips. In this study, as mentioned in chapter 1, route condition is quite fluctuated in terms of shipping time. Thus, existing study cannot consider the uncertainty of shipping time. In this context, Hölder Mean approach is preferable to incorporate uncertainty of each shipping time into the model.

(2) Formulation

The weighted Hölder Mean can be expressed as equation (2) by introducing weighted parameter w_i. The difference of importance between each variable can be known.

By using a concept of weighted Hölder Mean indicated in previous section, estimation of next shipping time considering past shipping experiences, which is applicable for the route between LLDCs and seaport in its coastal countries is formulated as equation (3)

$$E(T) = \sum_k A \cdot (w_1 st_1^{\alpha} + w_2 st_2^{\alpha} + \cdots + w_n st_n^{\alpha} + w_{gen} st_{gen}^{\alpha} + w_{\min} st_{\min}^{\alpha} + w_{ord} st_{ord}^{\alpha} + w_{\max} st_{\max}^{\alpha})^{\frac{1}{\alpha}} + C \qquad (3)$$

E(T): Next expected shipping time (hr)
A: Scale parameter
w: Weighted parameter
α: Parameter
st_n: Shipping time n terms before (hr)
st_{gen}: Generally recognized shipping time (hr)
st_{min}: Minimum perception time (hr)
st_{ord}: Ordinal perception time (hr)
st_{max}: Maximum perception time (hr)
C: Constant term

Comparing shipping experience 1 term before and 2 times before, higher impact on next shipping time is obviously shipping experience 1 term before. In order to analyze this trend, past experiences of shipping are included not only shipping time 1 term before but also 2 terms, 3 terms before till n times before (st_n). In reality, logistics companies that will be interviewed might not remember shipping time actually taken long term before, for example 10 terms or 20 terms before. Furthermore, impact on next shipping time is expected to be quite low. Thus, in the data collection for model building, shipping time until around 3-5 terms before should be interviewed in order to develop robust model.

Generally recognized shipping time (st_{gen}) is also included in the model as a variable. In case conducting shipping, it can be inferred that decision maker on departure time might firstly consider how long does it take as a general shipping time. For example, in case decision maker of logistics company estimates shipping time between Savanakhat and Densavan (abound 4 hour and 15 minutes) in Lao PDR, generally recognized information of shipping time such as provided by a book[14] will be used as reference. This kind of information must be affect on shipping time estimation process. In particular, in case a route which decision maker firstly uses, generally provided information will act quite important role.

Perception time (st_{min}) (st_{ord}) (st_{max}), which can be defined as decision maker recognizes maximum, minimum and ordinal shipping time from all of past shipping experiences, are also included in the model. By introducing these variables, individual's evaluation function for past shipping experiences can be expressed. In other words, mean shipping time from minimum to maximum can be considered by changing parameter α. Estimated next shipping time is going to be close to maximum as α is going to be large. The past shipping time is less evaluated as α will be small value. Thus, it can be said that parameter α is an indicator that which experiences on past shipping time are important for estimating next shipping time. In case α is small, an attitude of decision maker is somewhat risk loving, on the other hand, α is large, their attitude is pessimistic. By introducing weighted parameter, importance of timing of shipping experiences also observed.

3. Case Study

In this study, model parameter is estimated from a route between Lao PDR (Vientiane) and seaports (Thailand and Vietnam). Necessary data for parameter estimation can be done by questionnaire survey to logistics companies. Question would be shipping time experienced past n times. Number of n might be set arbitrary, but it should be large enough as mentioned precious chapter. Nevertheless, it should be paid to attention that not to be too small so that model develops properly. Regarding convergent calculation for parameter estimation, BFGS method would be able to be applied. Same trend of weighted coefficient of linear model and Hölder Mean model was observed for traveler's trips to home country. Thus, it can be considered that solution will not be converged to singular solution.

4. Summary

In this study, in order to analyze mechanism for estimating next shipping time under the condition of high uncertainty route in terms of shipping time, Hölder Mean approach was used to develop a model. In the model, several variables other than shipping time of past experiences are included in order to observe the relationship among those variables. The detail of data collection and parameter estimation will be presented at conference.

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