A Comparative Study of Toll Collection Systems between Philippines and Taiwan

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Abstract. The paper focuses on transportation, an important economic activity among the components of a business logistics system. The objective of the paper is to compare the existing toll collection systems between a developing and a developed country to get some insights on transportation improvement. The study was undertaken to assist transportation planners, operators, investors, managers, and other related professionals in the field. The latest technologies in transportation, management and infrastructure can provide better logistics efficiency. The paper concludes that Taiwan's electronic toll collection system can solve the existing vehicular traffic flow problem in the Philippines.

1. Introduction

Various researches focused logistics in different applications since the beginning of its advancement in the 1950s. In the recent decades, logistics management evolved rapidly and became significant due to the trend of nationalization and globalization. It helped industries in managing their production, distribution processes, and in improving their efficiency and competitiveness in the market. Part of logistics management is ensuring the smooth flow of delivering the products. Transporting is necessary in the whole process of production, from manufacturing to delivery to the final consumers and returns. Hence, transportation system is a key element in a logistics chain.

In the field of transportation, there exists numerous types of infrastructure. One of them is an expressway, which is a high-speed road that connects a country's important cities. There is an expressway where you need to pay a fee to be able to travel on that road, and they are called Toll Roads. Toll fees are collected in toll roads to help recoup the cost of road construction and maintenance. They can be collected in three ways: (1) open, (2) close and (3) open road. Open system consists of mainline barrier toll plazas, close system has entry and exit tolls and open road consists no toll booths, only electronic toll collection gantries at entrances and exits. The type of system used, however, has an impact to flow of traffic and congestion.

The purpose of the study is to compare the toll collection systems between a developing country, Philippines, and a developed country, Taiwan, through collecting and analyzing their various practices regarding the implementation of such system from related websites and literatures. It is to provide a significant information, which could assist emerging countries with making progress in their transportation industry. The paper starts by establishing questions it aims to answer, specifying its significance, and setting its scope and delimitations. Afterwards, it presents the methodology used in the study followed by the review of literatures. It expresses how toll collection system affects the flow of transportation and the importance of transportation in logistics activities. Furthermore, the study

independently presents the comparative analysis of the two countries in order to emphasize their current situations in terms of logistics and transportation. Finally, the paper discusses and concludes the differences in toll collection systems of the two countries and the potential of a developing country for further development in the industry of transportation.

1.1. Statement of the Problem

The researcher intends to address the following problems:

a. How do Philippines and Taiwan implement their toll collection systems for their respective tollways or expressways?
b. What are the challenges that affect the performance of toll collection system in the Philippines and how did Taiwan overcome these challenges?
c. What are the best practices that the Philippines can adapt from Taiwan to alleviate traffic problems?

1.2. Significance of the Study

The comparative study will be beneficial to the entire logistics and transportation industry especially the emerging countries. It can be a learning paradigm to both public and private sectors engaged in managing businesses and transportation systems. Planners, managers, and other professionals in the industry will be provided with insights related to the emerging technologies in transportation that could enable greater efficiency and more systematized operations in the supply chain. Considering Taiwan as a country that is more advanced in the industry of transportation, she can provide Philippines with techniques to minimize congestion and traffic problems. It is hoped that the comparative study will take lead to further enhancements of transport systems in the Philippines.

1.3. Scope and Delimitations of the Study

The focus of the researcher covers transportation. The geographical scope of the study is limited only within the island of Luzon in the Philippines, and Taiwan. Three of the current thirteen operational expressways in the Philippines are the focus of this research. Toll collection systems are evaluated based only on their efficiency and their impact in terms of vehicle flow.

2. Literature Review

Logistics plays a significant role in a country's economic development. An efficient logistics sector contributes to trade performance and economic development by lowering transaction costs and creating more customer value, thus providing firms with opportunities to increase their earnings and enhance their competitiveness (Tongzon, 2018). Therefore, a country's road infrastructure is an important element in the activities of logistics. Without well-developed transportation systems, logistics could not bring its advantages into full play (Taylor et al., 2005). Transportation is around one-third to two-thirds of the expenses in logistics costs. According to the investigation of National Council of Physical Distribution Management (NCPDM) in 1982, transportation averagely costs 6.5% of market revenue and 44% of logistics cost (Taylor et al., 2005). Vehicles used for the delivery of goods travel on the major road arterials, which are usually toll roads. Toll roads vary in systems used for collecting the fees. They can be collected manually wherein the car stops at toll plazas to pay cash or electronically wherein sensors are used to recognize vehicle details and fees are paid using cards. The electronic toll collection (ETC) system has the application of modern technology to increase safety and efficiency of transport systems. They are expected to greatly reduce service times at toll plazas by reducing transaction times compared to manual toll collection (Gugol et al., 2013). The efficiency of ETC systems have already been a subject of several studies. Take for example, the findings of Galanda et al. (2015), Masurekar et al. (2016), and Chauhan et al. (2018) in their respective studies. They have unanimously concluded that an ETC system, if implemented properly, has the potential, among other advantages, to generate a seamless movement of traffic. Karsaman et al. supported this claim thru his study in 2015. He stated that an ETC system helps in smooth and efficient payment transaction at toll plaza, without waiting in long queues on expressways. But perhaps, the most enlightening was the 2003 study of Padayhag et al. of Metro Manila's ETC system. In their study, he found out that the services of the toll plazas vary significantly by the modes of

payment employed at the tollbooth. They have also concluded that ETC system is ten times faster than manual lanes. Indeed, the toll collection system significantly affects the flow of traffic in urban areas. They have a huge impact on the movement of goods in the supply chain. If a good transport system exists in logistics activities, then there would be a better logistics efficiency, reduced operation cost, and higher service quality.

3. Methodology

Data used in the study were gathered from related researches conducted by various individuals and agencies, such as Taiwan's Freeway Bureau and the Philippines' Department of Public Works and Highways. The data gathered were then, analyzed to evaluate the effectiveness of toll systems that currently exist in both countries.

3.1. Toll Collection System in Philippines

3.1.1. Selected Expressways

The expressway network that currently connects the Northern and Southern regions of Luzon thru Metro Manila, are composed of 10 controlled-access highways, owned and operated by private institutions. Eventually, thru the initiative of the Philippine government, these highways will be connected, along with other expressways that are currently in the drawing board, to form the Luzon Spine Expressway Network (or Philippine Expressway Network). In total, the Philippines has 13 operational expressways and others are under planning and construction. In order to facilitate the goal of this study, three expressways were selected for the analysis such as North Luzon Expressway (NLEx), Subic-Clark-Tarlac Expressway (SCTEx), and the Tarlac-Pangasinan-La Union Expressway (TPLEx). They are briefly described as follows.

North Luzon Expressway (NLEx)

The NLEx is a 2 to 8-lane limited-access toll expressway that connects Metro Manila to the provinces of the Central Luzon region in the Philippines. It was built in the 1960s and has a total length of 84 km. It is considered as one of the major logistics corridors according to the JICA High Standard Highway Study in 2010.

Subic-Clark-Tarlac Expressway (SCTEx)

The SCTEx is a four-lane expressway north of Manila in the Philippines. It was built in 2005 and currently the country's longest expressway at 93.77 km. The expressway also crosses four rivers in Central Luzon region.

Tarlac-Pangasinan-La Union Expressway (TPLEx)

The TPLEx is a four-lane expressway north of Manila in the Philippines. It connects central to northern Luzon, with its southernmost terminal located in Tarlac City. It has a total length of 88.85 km and crosses the three rivers within the province of Pangasinan.

3.1.2. Toll Collection Systems

All of the expressways in the Philippines collect tolls to finance the operation and maintenance, and recoup the investment during the construction of toll facilities. The expressways implement barrier tolling, a fixed-rate toll to collect toll at the plaza. Other expressways have already adopted the use of electronic toll collection (ETC) system.

NLEx has both an open and closed sections. The open section charges a flat toll rate based on vehicle class while the closed section is distance-based or charging based on the vehicle class and the distance traveled. To speed up the transactions, NLEx adopted the use of ETC system that was set up for Class 1 vehicles; prepaid magnetic cards were assigned for Class 2 and 3 vehicles. A unified ETC system, operated by Easytrip was then added to supplement the system.

3.1.3. Current Traffic Situation

The Philippines has a unique geographic position verging the key global and regional trade routes. For this reason, coupled with its historical ties to the United States, the country is being provided with a significant advantage in the competitive global transport and logistics.

To this date, the transportation in the Philippines is relatively underdeveloped. The land transit corridors still need development as congestion in and around the capital, Metro Manila, is extremely severe and of a great concern for the Philippine government. Companies and the people suffer from heavy traffic especially during working days and holidays. As a result, pick-up and delivery time of goods are sometimes experiencing delays, which could affect the companies' integrity. In addition, the heavy traffic is also risky for the perishable goods. In order to prevent this kind of situations, the logistics companies should stretch their pick-up and delivery time to give some allowance for heavy traffic and other unpredicted circumstances.

In 2015, traffic in Metro Manila has the "worst traffic on Earth" based on the Global Satisfaction conducted by Waze. Manila scored 0.4 out of 10 in the study, which was based on a 1-10 ranking system within six categories. Moreover, in 2017, as part of a study called "Unlocking Cities", a global firm, Boston Consulting Group (BCG), conducted a survey. It was done for a month and participated by around 300 respondents from Southeast Asian cities. The result placed Manila as 3rd worst in the region, with an average of 66 minutes stuck in traffic daily.

3.1.4. Urban Logistics Issues

In terms of logistics, Philippines ranked 60th among 160 countries based on the 2018 Logistics Performance Index conducted by World Bank. The overall score in this kind of survey reflects perception of a country's logistics based on some activity measures including its transport-related infrastructure. Currently, the Philippines is facing some urban logistics issues. One of these is its poor logistics infrastructure. Its road network has not been developed fast enough to meet the ever-increasing transport demand and has been focused on road widening and construction of grade-separations at intersections. With the rapid increase in the volume of vehicles and the interconnectivity issues on the existing expressways, traffic congestion will remain a serious problem (Castro, 2015). Another issue that the country is facing relates to the effect of this traffic problem. In order to ease traffic congestion, the truck ban policy is being implemented. The policy prohibits trucks with gross weights of more than 4.5 tons to travel along major arterial roads. In addition, there are only specific time schedules that these large trucks can travel. Consequently, several businesses are getting affected particularly when it comes to delivering their products. Since large trucks are prohibited in some areas, the truck drivers will use secondary road network, where routes are usually longer and this will directly result to increased travel distances. Also, the limited schedule due to truck restriction reduces the quantity of products to be delivered. Thus, trucking companies who want to maintain their service levels are forced to use smaller trucks that are exempted from the ban (Castro, 2005). For these reasons, the businesses suffer from the additional costs incurred in their operations.

3.1.5. Economic Impact

The Metro Manila traffic, which is the most critical problem of Philippines for so many years, has a huge impact in its economy. According to a study by Japan International Cooperation Agency (JICA) in 2012 entitled "Roadmap for Transport Infrastructure Development for Metro Manila and Surrounding Areas," the traffic snarls cost the country P2.4 billion ($53.3 million) per day and could increase to P6 billion ($133.2 million) per day by 2030 if the problem will remain unresolved. This cost amounts to over P20 billion per year in the greater Metro Manila area, which is equivalent to more than 10% of the country's GDP. On the other hand, the economic cost of truck ban based from the study conducted by Citigroup in 2014 amounts at as much as $7.3 billion. In response to this enduring problem, the Philippine government has responded with several road projects including the target of seamless electronic toll collection systems in all of its expressways.

3.2. Toll Collection System in Taiwan

3.2.1. Expressways in Taiwan
Taiwan's current tollway system is composed of ten National Freeways.

3.2.2. Toll Collection Systems
Over the years, various toll collection systems were launched in several toll stations like the Exact Change Toll Gate in February 1983 and the Toll Tickets Only Gate in December 1996. Taiwan then began launching the use of ETC systems in February 2005. For a long time, these ETC tollgates also had a flat-rate collection of toll fees. According to statistics, at the time of this flat-rate toll station, about 65% of cars did not go through toll stations by instead using alternative local roads. As a result, they did not have to pay tolls resulting a "Toll Equity" issue. To address the issue, the government decided to implement the distance-based toll collection system. However, if manual toll collection system would be adopted, there were land requisition and labor recruitment issues yet to be encountered. Therefore, a distance-based system, which combines electronic toll collection and technologies of computer and communication, became the solution. The old flat-rate manual and electronic toll stations were replaced by a distance-based pay-as-you-go all electronic collection on all of its major freeways in December 30, 2013. Taiwan government created a two-step transition to help them get accustomed to the new system. First, parts of the flat-rate tollgates at toll stations were changed to ETC system to acquaint the freeway users. After some time, the manual toll collection system was completely overhauled, allowing the distance-based ETC system a complete take over. When the freeway users completely adapted the new ETC system, the ETC utilization rate significantly increased. The ETC system can process about 16 million transactions a day in average as of February 2015, the tolling rate has reached 99.97%, and the vehicle detection accuracy rate has reached 99.9%. In summary, the distance-based ETC system is a milestone in Taiwan's transportation industry. It helps eliminate traffic bottlenecks and reduce travel time, as vehicles do not need to stop to pay for tolls when travelling on freeways. Most importantly, this advanced technology and the outstanding construction efficiency truly set models for other countries to learn from.

3.2.3. Taiwan's Recognitions
With the development of ETC distance-based toll collection system, Taiwan gained the following world records:

a. The first country in the world to transfer from flat-rate toll stations to distance-based pay-as-you-go tolling system on all of its freeways.

b. The first country to transfer from manual tolling to all electronic, multi-lane free flow tolling on all national freeways in the country.

c. The country that has the longest ETC freeway mileage in the world.

3.2.4. Urban Logistics
Taiwan, being an exported-oriented nation, has invested into intelligent and topnotch logistics management technologies. Considering these advantages, Taiwan is a natural partner in the logistics industry. In comparison to the Philippines' LPI ranking, Taiwan ranked 27th in World Bank's 2018 Logistics Performance Index. The major contributor in this achievement was the quality of its infrastructure. Because of this, Taiwan is able to provide convenience and efficiency in freight handling.

3.2.5. Economic Impact
Taiwan's freeways have contributed to its economic growth for the past decades. By now, they continue to contribute hugely especially with the development of the distance-based ETC system. It covers 1,050 km of freeway, making it the world's largest system of its kind. Since the introduction of this ETC system, motorists can travel at speed of 50 to 70 km/h on ETC lanes, leading to considerable fuel savings, shortened travel time, reduced CO2 emission and an eliminated cost of printing toll

tickets. Combining all these benefits, the total estimated cost of savings amounts to NT$2.4 billion (US$80 million) annually.

4. Conclusion and Future Research

Based on the comparative study, the following conclusions can be made:

1. The Philippines should learn from Taiwan in the use of a distance-based system which combines electronic toll collection and technologies to solve the toll equity issue and to shorten toll collecting time. Seamless toll collection technology should be imported from Taiwan.
2. The ETC system in Taiwan could alleviate queuing brought about by build-up of traffic at toll plazas due to the tedious nature of conventional transactions for toll plazas. Since the ETC system in Taiwan provides uninterrupted flow for vehicles; it could possibly solve traffic problems in the Philippines if implemented. This is significant especially when she has a plan to connect all of its expressways. If ETC system of Taiwan is used; vehicles no longer need to stop at toll plazas to pay tolls. By this way, vehicle queueing can be eliminated.

The study only focused on the review and comparison of existing toll collection systems in the Philippines and Taiwan. A more comprehensive study of toll collection systems could be the subject for future works. The future researcher may include the feasibility of Taiwan's ETC systems in the Philippines. In particular, the cost of existing ETC systems and the construction cost of toll plazas in the Philippines.

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