



E-Purse Transit Pass: The Potential of Public Transport Smart Card System in the Philippines

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Abstract— Public transport in the urban areas in the Philippines, takes several trips everyday with Philippines being the second populated country in the South East Asia. Buses and jeeps accounts for these trips, which people utilizes for their work and living. With greater demand to use public transportation, fare collection payment could be very hassle for both driver and passengers. The main objective of this study was to explore the potential of implementing a smart card system in the Philippines to improve the fare payment matrix in public transport utilities and analyze its impact to hypothetically solve issues on the worsening of traffic problem in urban areas, variability in implementation of fare matrix, and nondiscriminatory request to avail of PWD, student and senior citizen discount. A survey questionnaire was used for data collection and snowball purposive sampling was applied to draw the 300 research participants from several demographic, which includes public utility passengers categorized into four (4) namely regular, student, Person With Disabilities (PWD) and senior citizens; public transport operators and drivers. Quantitative method and deductive approach was used in the process to assess the validity of findings. Participant observation was also conducted to understand the participant's gratification on the benefits that the framework may offer to the people thus resulting to a qualitative research and to understand the correlation of the quantitative findings based from the survey. With the proposed framework, the acceptability of the visualized used of smart card could result to a highly sustainable transport payment system in the country that can help promote faster, convenient, standardized fare payment collection and matrix, gratified and placated passenger experience within the region and positive realization of a cost-effective way of transportation for economical commuters.

Index Terms — e-purse, fare matrix, smart card, payment system, Philippines, public transport, transportation

I. INTRODUCTION

TRANSPORTATION is the basic need of the economic activity. These activities require transport of goods and people – to work, to shop, to see different tourist spots, and to other meeting locations. It empowers trading, technology

advancement, financial capacity, and government functions [1]. In human civilization stage, transportation plays a very important role to transfer people and goods from one place to another. Economic, social, political and cultural developments have evolved because of the continuous innovation in the field of transportation [2]. Further, economic growth and formation of several cities had contributed to fast changing growth on the lifestyle of residents in developed countries. With essential need to provide a good transportation services and efficiency of transactions, research authors have attested that several countries have started adopting new trends in improving their ticketing and payment system in their public transportation. Subsequently, research authors have seen that from the day to day operation of the transit system in public transit agencies to their strategic-term planning of the network, the transit agencies have been continually using smart card for their fare collection system [3]. Moreover, this smart card was used to produce useful data on onboard transactions. Thus, researchers have discovered technological innovations in bus rail transit is worth adopting as it promotes efficiency in most their transactions. Fare payment collection has been one of the dominating modernization that is considered an exogenous parameter in optimizing the bus services [4].

The word smart card is typically referred to as any types of card having an approximate size with that of a credit card. Smart card can be both contact and non-contact cards that can be use as payment in a variety of applications such as telephone, identification system, fare payment, etc. It has an integrated circuit that is capable of storing and processing transactional information. Also, a transceiver is integrated to communicate with smart card communication device wherein it is connected through the transceiver or contacts on the smart card to access the saved information. Afterwards, smart card communication device just simple read the information, load the information into the memory device and/or modify existing data in the memory device [5]. Additionally, a smart card is microchip that performs all the necessary functions it was conceived for, mainly storing, processing and writing data. This capacity for the card for transferring data makes it very useful for a number of possibilities [6].

Smart card technology is now making its way into the hands and wallets of everyone worldwide. It increases speed for throughput processes on public transport, offering efficiency

and convenience for purchase transactions, and providing overall ease and versatility in multiple applications. In the last decade, smart cards were already being integrated to public transit in automating their fare collection system [7]. There are many cities all over the world, electronic payment systems in public transit has been positively embraced [8]. The advantage of using smart card provides a greater opportunity for bus transit owners to improve their services [9]. Hence, using smart card, abundant data can be collected such as proportion of linked trips, smartcard turnover rates and trip rates per card can be used for mining. Thus, these data can be used to improve services and strategize innovation in public bus transits. This however requires to stimulate more study on concept definition and rules-based processing of smart cards.

Additionally, it was confirmed that smart card users recognize its benefits and this has spurred the extensive development and growth in the transport area. It provides simplicity, speed, security (prevent fraud), and flexibility [7]. One of the significant benefits of smart card is security. It is use worldwide on applications where security and privacy of information are necessary [10]. Moreover, smart card transactions can easy produce accurate financial reports for the transit authority [11]. The most fascinating technologies from the ITS area that are available to transit planners is the Smart card automated fare collection systems.

Within London transportation, Oyster card has permitted customers to use the public transport without the necessity to carry cash or coin, queuing for tickets and getting the lowest fare. Octopus card in Hong Kong and EZ Link in Singapore are the comparable systems in the Asia countries. Similarly, the benefits of advanced fare technology includes convenience for the passenger, managing demand and/or addressing equity concerns through differentiated fares, cost savings and revenue-raising for the operator, and improved data collection [12]. It was also discovered that Smart card makes driver's job easier, gives transit a more modern look, and provides new opportunities for fare structuring [13]. Moreover, smart card was used as smart ticketing in the public transport wherein it provides clear benefits to both the public sector and transport operators. It increased revenue passenger numbers and revenue to operators [14].

Consequently, it was also found out that development doesn't end with just implementing facilities and innovation. It requires sustainability, safety and smartness to realize a continuous and modern transportation system [15]. Evidently, the use of smart card from various countries has resulted not only to social, economic and cultural growth and changes but also, it has improved the service management in the field of transportation [16].

In the Philippines, the highly used mode of transportation is the Public Utility Buses (PUB's)-both provincial and city buses. Most cities in Metro Manila is primarily drove by a road-based transportation. In 2005, Metro manila alone has 31.2% of the 5.1 million total of registered motor vehicles. An additional 1.4 million vehicles contribute to the surrounding regions of Calabarzon in south and central Luzon, which most of them routinely enters metro manila in a daily basis. With this vast number of vehicles, problems in the area continue to persist such as (a) fare evasion, (b) miscalculation of fare and change, and (c) inefficient fare payment procedures. Though

the Philippine local and national government has been working together to perform strategies and experiments in promulgating new transport policies and guidelines, it is not yet strictly implemented. Still, the public utility bus (PUB) remains to be the most frequently used mode in Metro Manila and in most urban areas in the Philippines because of its reasonable cost, habitual acceptability flexibility and ubiquity [17].

However, despite its demand, people are not convenient and therefore encounters routinely problems such as (1) inefficient system, intense traffic and overcrowded vehicles (2) Most of the PUB's came from a neighboring foreign land so it doesn't fit with the setup that drivers and passengers are used to [18]. Also, Epifanio delos Santos Avenue (EDSA), the busiest highway, most important road artery in the Philippines, and the infamous traffic log jam, has been tremendously suffering from cost in terms of losses in productivity, inefficient outcomes, frayed nerves among commuters and consumption of unnecessary fuel. With the continuing problem in the city, Metro Manila Development Authority (MMDA), one of the government agency that manages traffic rules have tried several solutions yet nothing remained successful. Among the imposed solution were: (1) to restrict passage on certain days of the week, stricter traffic management and number coding of vehicles was put in place (2) impound buses found to be operating in that highway without a franchise called -colorum buses [19]. Despite large part of the road network remains poor condition and intermodal integration is generally weak, the Philippines has seen modest improvement in the quality of its transport services [20].

While public transport owners in developed countries have embraced technological innovations in their fare collection system, undeniably, Philippines is one of the countries that is yet to apply innovations to improve its public transport services [21]. With the positive outcome in using smart card services in other countries, visualizing its use in Philippines might also be possible by working together with several sectors such as transport operators, bank sectors, government agencies, and the involvement of passengers.

The existing Frameworks

Several studies in developed countries such as Singapore, Hongkong, China, and Australia were conducted to understand the demand to improve the services in their public utility transport [22]. Thus various framework were also adapted that has successfully contributed to their intelligent transportation system. Public operational planning framework was initially adapted which includes four (4) activities: (1) Network Route Design, (2) Timetable development, (3) Vehicle scheduling, and (4) crew scheduling[23]. To support the evaluation and planning of Bus Rapid Transit services in urban transportation networks, a dynamic traffic assignment simulation modeling framework (DYNASMART-P) was used [24]. Hence, the use of smart payment cards was introduced for automatic fare collection in a transit system by integrating the fare processing framework using identification token infrastructures [25][26]. Customers can avail for this smart payment cards thru commercial card issuers and banks following industry standards such as ISO 14443 standard for contactless payment card. The cardholder will be granted with a quick access after presenting the smartcard to an RFID-enabled device a transit

system entrance. This assumes that the smartcard is not listed as lost or stolen, expired or delinquent cards. All transactions made with the smartcard will be recorded to the transit payment platform, which is linked by card issuers and banks' payment-by-card electronic network for authorization, clearing and settlement [26].

Whilst, to measure the reliability of bus schedules, Automatic Vehicle Location (AVL) can provide the necessary data. Additionally, to yield a valid summary measure from reliability indicators, Data Envelopment Analysis was used. While the statistical confidence boundaries for each route-direction's Data Envelop A score was provided using the Panel Data Analysis (PDA). Whereas, it is identified that it is in need of immediate attention if the route-direction of most DEA score is below its lower boundary [27]. The implementation of Philippine National Railways (PNR), Manila Rail Transit (MRT) and Light Rail Transit (LRT), has open the door for Philippines to adapt the existing frameworks to cover the longest distance across the metropolis and the surrounding areas in Manila area [17].With the adaptation of above-mentioned framework, it was made possible to use smart card in Philippine Rail transit which has benefited most of commuters in manila.

This study provides answer to the needs of the transport sectors and passengers on a framework that can be used for a cashless transport transaction. This served as a benchmark that can be used by the government agencies in the implementation of a smart card technology in the Bus transport sector of the country. [29] It shall also be useful to the passengers for it provides standard fare matrix and fare collection policy.

1.2 Conceptual Framework

This study uses the Input-Process-Output (IPO) diagram. An IPO diagram is widely used approach in system analysis and software engineering because it is a graphical representation of all of the factors that make up a process. An input-process-output diagram includes all of the materials and information required for the process, details of the process itself, descriptions of all of the products and by-products resulting from the process.

The input is composed of the passenger's information, government sector's policy and fare matrix, bank sector, and transport agency information. The process includes analysis of data and the development of the framework. The output is the E-Purse Transit Pass: The Potential of Public Transport Smart Card System in the Philippines. Figure 1 shows the paradigm of the study which uses the Input-Process-Output Model.

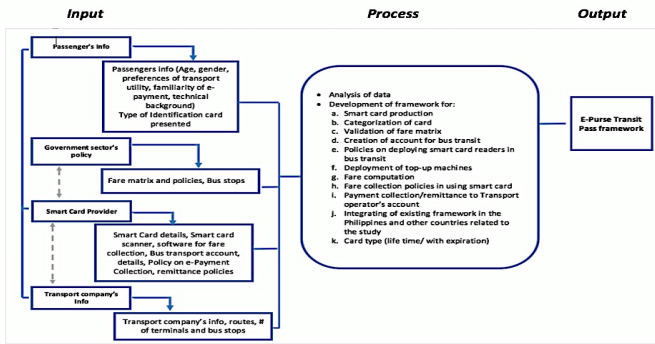


Figure 1: Paradigm of the Study

1.3 Research Goal

This study discerns to address the (1) issues encountered by both commuters and public bus transport sector in urban areas in terms of (a) fare matrix and discounts (b) payment collection and (c) ticketing , (2) factors to be considered in conceptualizing the framework in terms of (a) sectors Involved (b) facilities (c) Production of smart card, (d) Categorization of cards (e) policies and (e) acceptability of the framework by the entities (3) suitable framework in the implementation of smart card payment for public bus transport utilities and (4) the likelihood of the framework to address the issues encountered by commuters, public transport sectors and government units from the current situation in fare payment collection. Thus, the study aims to explore the potential of implementing a smart card system in the Philippines to improve its fare payment matrix in public transport utilities and analyze its impact to hypothetically solve issues on the worsening of traffic problem in urban areas, variability in implementation of fare matrix, and nondiscriminatory request to avail of PWD, student and senior citizen discount.

II. METHODOLOGY

A pre-tested questionnaire, observation and interview were applied for data collection. The survey instrument was reviewed and approved by the Department of Transportation (DOT) in Dagupan City, Philippines. Data was collected from PUB passengers and bus transport companies in Dagupan City, Philippines. Snowball purposive sampling was applied to draw the 300 research participants from several demographic, which includes public utility passengers categorized into four (4) namely regular, student, Person With Disabilities (PWD) and senior citizens; public transport operators and drivers. Quantitative method and deductive approach was used in the process to assess the validity of findings. Participant observation was also conducted to understand the participant's gratification on the benefits that the framework may offer to the people thus resulting to a qualitative research and to understand the correlation of the quantitative findings based from the survey.

III. RESULTS AND DISCUSSIONS

A total of 300 copies of questionnaire were distributed and 221 filled-in useable questionnaires were received back resulting to a response rate of 74%. Whereas 71.9% (159) of them were regular passengers, 17.2% (38) of them belongs to discounted passengers who are considered as student/PWD/senior citizen passengers while 10.9% (24) of them were employees from a bus transport company. Study shows that majority of respondents are regular passengers. This means that majority of the passengers pays the regular fare in public transport utility. Surprisingly, three (3) nationality of research participants was recorded comprising of 213 Filipinos, 6 Americans and 2 Singaporeans. The proportion of gender is 67% males and 33% females. As for the age groups, 67.4% of the respondents were in the age group of less than 26, 14.5 % of them belongs to 26-30, while 18.1% of them are in the age group of 31-35 years.

3.1 Card usage

The data analysis revealed that 69.7% of the respondents uses card for transactional purposes such as payment of bills for utilities and telephone bill, groceries and online shopping and transportation fare when boarding at Manila Rail Transit and Light Rail transit in Manila area. Whereas 19.5% of them does not use card for any transaction because they are not knowledgeable in using a card and because of their fear to make mistakes. Study revealed that an equal proportion of 14.7% of them uses the card for everyday and weekly basis for participants using a card for transportation and groceries while 36.5% of them seldom uses card only when needed and for emergency purposes and only 0.5% never used a card in any way while the remaining 33.5% did not answer the question because of insufficient knowledge to understand the usage of card in the Philippines. A further data analysis revealed that 13.1% of respondents who board in a train for their work uses card for their fare payment.

3.2 Issues encountered in PUB's

Public Utility Bus passengers were asked of their most preferred utility transportation. Table1 shows the commuters preference wherein 59.7% (132) of them board on bus more frequently than the common public utility vehicle because its faster and allows standing especially when passenger is in hurry while 24.1%(53) of them chose to board the train because of convenience and considered to be the fastest mode of transportation in manila to reach the desired destination. Around 13.1% (29) commuters still opt to ride on a jeepney because of the short distance and route of their destination while the remaining 3.2%(7) opt not to reveal their preference.

Preference on Public Utility Transportation		
Utility	N	%
Bus	132	59.7%
Train	53	24.0%
Jeepney	29	13.1%
No answer	7	3.2%
Total	221	100.0%
Mean	1.519	
SD	0.723	

Table1: Commuters Preference on Public Utility transport

Consequently, participants were asked of their experiences in riding on a public transport utility. Among the issues, majority of the commuters is looking at the speed of fare payment collection, speed of transportation and convenience when riding in a public utility transport (M:4.60), surprisingly, among the situations that is alarming on the part of driver is the possibility of not paying the fare of a passenger especially when no collector is assigned to a task and the driver is unable to monitor the paid passengers(M:4.55). [30]Also, the accuracy of fare collection in bus and jeepney is not standardized which give the commuters the option to ride in a train with more accurate fare collection (M:4.25) this is why some commuters prefer to board on a train (M:4.25).Bus stops/stations plays an important role also for passengers to observe proper alighting (M:4.13). Availing of discounts for

students, senior citizens was also considered as issue because discounts are hardly given to them especially when no ID is presented by the commuter (M:4.18). Among related issues includes (M:3.90) increase in fare even without memorandum from Land Transportation Franchising and Regulatory Board (LTFRB) and scarcely claiming of change (M:3.81).

3.3 Adapting technologies to improve fare payment process

Participants were asked to identify technologies that can be adapted to improve the fare payment collection in PUB's and its services (Table2). Analysis has revealed that passengers and PUB companies can adapt the use of smart card and RFID scanners to improve the fare collection process (M:4.74). [25] However, the need to adapt smart card requires a third-party partner company that could provide a unified card for various transport group in the Philippines-this might adhere to the continuous production of the smart card based from the demand of commuters. Further findings include the advocacy in promoting cashless payment that can be possibly done through the use of smart card (M:4.73) and implementing bus stop to promote discipline and orderliness(M:4.73). Additionally, policies, rules and ordinance may support the implementation of smart card thus, it should be put in place (M:4.62). Classification of card for regular and discounted passengers might also be implemented to help the students/PWD/senior citizens to instantly avail of their discount. However, expiration date should also be applied to card used by students to ensure proper fare collection even when already been employed (M:4.48)

Passengers thoughts in implementing smart card to improve fare payment collection in PUB's				
	STATEMENT	N	ME AN	SD
a.	Placing a bus stop station can promote discipline and orderliness to both passengers and bus drivers.	197	4.74	0.607
b.	It might be more convenient to use smart card system for fare payment collection and RFID scanners to promote cashless payment.	197	4.74	0.581
c.	Passengers may possibly adapt innovation in fare payment collection if fully aware on the procedures, rules and policies of implementing electronic card for fare payment collection.	197	4.62	0.607
d.	Using smart card in fare collection may help reduce the fare evasion among passengers.	197	4.61	0.610
e.	Using a classified smart card for fare payment may automatically give discounts to students, PWD and senior citizens.	197	4.65	0.744
f.	It might be better if card has an expiration date to ensure that students will not continually use the card even when already employed.	197	4.49	0.786

Table2: smart card to improve fare collection process

IV. CONCLUSION

There is a paradigm shift to improve the public transport utilities and services in the Philippines by adopting technologies such as smart card. [29] Since an existing rail transit framework was already been applied in Philippines where smart card was already being used, the use of smart

card system in public bus transport could potentially be applied. With the positive response among commuters to adapt the use smart card (73%) and promote cashless payment (72%), thus it would be more convenient for students/PWD/senior citizen passengers to avail of discount with the aid of new technology (71%). Additionally, with the involvement of foreign participants in this study, their answer to the questions might have been reflected in their positive experience in using smart card in their own land. Thus, provides a justifiable potential smart card system can be possibly adapted in the Philippines. With its potential implementation, it is highly expected that issues on fare collection and discounts, fare evasion, and traffic could be resolved through standardization of fare, policies, rules and franchising procedures of buses that adhere only to the rules and policies of smart card system [29]. It would be more interesting however to further investigate the logistics of implementing the smart card in terms of bus design and network facilities. Thus, further study is recommended to generalized the acceptance of the smart card system in the Philippines.

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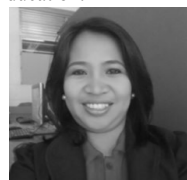
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