ENHANCING THE BUS PAYMENT METHOD USING ANDROID AND RFID TECHNOLOGY

Michael John M. Belda[1], Girlie M. Enero[1], Rhendell John M. Pariño[1],
XyrilMaicah F. Saul[1], Mariel Ruth S. Villegas[1], Rhowel M. Dellosa[2],
Rionel B. Caldo[2]
[1]*Undergraduate Student, Computer Engineering Department*
[2]*Faculty Member, Computer Engineering Department*
Lyceum of the Philippines University-Laguna (LPU-L), Laguna, Philippines

ABSTRACT

Public utility buses are the most commonly used vehicle in a long distance journey passing through provincial and national roads. Problems in bus transactions are being encountered. Usually, the passengers do not have exact amount in paying bus fares and the conductors' method of collection is time-consuming. This project study focuses on the use of available technologies, such as RFID and Android. These are the tools used by the proponents to develop an improved system of bus fare transactions. This system includes an electronic card, which will be used by the passenger to pay for their fares, an RFID reader will also be used to accumulate and to store the information from the card, and an Android operated device, which will process each transaction. This system will be connected via Bluetooth. The software is linked to the hardware as well. The proponents conducted series of tests and concluded that the proposed system is much faster than the existing methods. It is verified as well that it is more capable of performing necessary actions in accumulating bus fares.

Keywords: *Android, Radio Frequency Identification (RFID), fare, bus conductor, passenger*

INTRODUCTION

According to the Philippine Transportation Statistics, the Philippines encountered an increase of usage in public vehicles, such as tricycles, jeepneys, buses, etc. An increase of passengers who travel every day is also an increase of opportunity for public vehicles. The table below shows the number of registered motor vehicles in the Philippines until year 2007 including the buses [1].

Table 1.1a.Philippine Transportation Statistics Year 1990 – 2007

YEARS	CARS	UV	SUV	TRUCKS	BUSES	MC/TC	TRAILERS	TOTAL
1990	454,554	615,603	*	130,973	18,341	382,426	18,345	1,620,242
1991	456,606	670,848	*	138,338	20,690	409,927	18,957	1,715,366
1992	483,622	744,190	*	146,689	25,827	458,938	20,297	1,879,563
1993	531,240	834,168	*	165,280	24,603	547,655	22,169	2,125,115
1994	572,766	912,675	*	179,793	27,595	624,292	24,348	2,341,469
1995	626,571	998,331	*	192,792	28,192	708,059	27,409	2,581,354
1996	702,578	1,101,077	*	220,388	29,330	821,599	29,515	2,904,487
1997	743,299	1,191,392	*	242,842	31,950	952,044	32,022	3,193,549
1998	749,204	1,244,019	*	231,342	31,806	1,032,594	27,852	3,316,817
1999	773,835	1,310,865	*	243,443	33,193	1,144,666	27,730	3,533,732
2000	767,948	1,388,117	*	248,369	33,886	1,236,241	26,612	3,701,173
2001	729,350	1,425,880	63,386	253,596	31,686	1,338,263	23,701	3,865,862
2002	749,553	1,554,619	97,695	257,774	33,915	1,470,383	23,734	4,187,673
2003	742,665	1,570,086	116,231	255,509	31,349	1,552,579	23,853	4,292,272
2004	798,160	1,647,524	141,447	267,977	35,003	1,847,361	23,121	4,760,593
2005	788,408	1,633,856	157,938	266,915	30,977	2,157,737	23,922	5,059,753
2006	792,373	1,618,101	172,794	285,901	29,144	2,409,363	23,898	5,331,574
2007	751,092	1,602,619	192,991	281,261	30,159	2,647,574	24,356	5,530,052

Public utility buses are one of the most commonly used public vehicle for it can travel in a much longer distance than any other transportation vehicles. It is a large motor vehicle carrying passengers by road, especially one serving the public on a fixed route and for a fare. Bus, most of the time, passes through the national roads, provincial roads, city roads and municipal roads. There are also two types of public utility buses: the ordinary bus and the air-conditioned bus, it is

the fact that these two differs in the bus ambiance.

Public utility buses in the Philippines, nowadays, used two methods of payment process: the manual payment method, in which the conductor uses puncher to release tickets for the passenger, and the digital one, in which the conductor uses a handheld device that print outs receipts to be given to the passengers. These existing methods are time-consuming, because some bus operators tend to calculate the amount of fare with the given kilometer and sometimes, inaccurate. Usually, passengers don't have an exact amount of money to pay for the bus fare and what they have to do is to wait for the conductor's change. Another issue is the accuracy of giving change.

To lessen and somehow prevent these issues encountered, the proponents have come up with the idea of enhancing the methods of paying fares in the bus, by means of using an Android device, an electronic card and an RFID reader with printer, which will be used by the conductors to accumulate the passenger's fares, This payment method will be using both the RFID and Android technology.

Radio Frequency Identification (RFID) is the system used in identifying objects. It is somehow similar to the process and concept of bar codes but this system transmits radio waves and used wirelessly to identify objects. It is most often used in personal identification such as in schools for student's attendance, controlling access to restricted areas, tracking

process, etc. According to American Barcode and RFID, they are also dissimilar when it comes to the reading process, RFID can be read outside the line-of-sight whereas barcodes must be aligned with an optical manner. In these case it would be easier to use a RFID for in a single tap process, information will be conducted [2].

According to Technovelogy.com, RFID has three parts, a scanning antenna, and a transceiver with a decoder to interpret the data, and a transponder – the RFID tag – that has been programmed with information. These three has their respective functions to make and perform [3].

An Android Operating System is the most available software application today. It powers hundreds of mobile devices in more than 190 countries around the world. It also gives the user a world-class platform for creating applications for Android users.

As defined in Wikipedia.org, Android is a Linux-based operating system that designed primarily for touch screen mobile devices. Its user interface is based on direct manipulation using touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching and reverse pinching to manipulate on-screen objects. The response to user input is designed to be immediate and provides a fluid touch interface, often using the vibration capabilities of the device to provide feedback [4].

Objectives

The prime objective of this study is to enhance the payment method in a bus through the use of an electronic card and a device with Android and RFID technology.

Specifically, this study aims to:

a) Enhance the process of paying fares
b) develop a more accurate and faster way of processing the payments
c) introduce the use of electronic cards in transportation
d) Develop a device that accepts cards as mode of payment for the fare of the passenger.

Bus Payment Method Using RFID and Android Technology

Description of RFID Technology

The article of D. McFarlane et al. (2003) says that, Radio Frequency Identification (RFID) is an automatic identification and data capture technology which is composed of three elements: a tag formed by a chip connected with an antenna; a reader that emits radio signals and receives in return answers from tags, and finally a middleware that bridges RFID hardware and enterprise applications [5].

Figure 2.1a. – *RFID System*

The proponents used a RFID technology as a method of transaction of the passengers and as a substitute of the previous method that has been used such as the punching of tickets and the mPad (Mobile Processing Automated Device).

Description of Android Application

Android application is created as a remote controller of the bus conductor to get the source and destination of the passengers and communicate through Bluetooth connection with the device to print the receipt of the transaction.

How it Works: Bus Fare System

The proponents create android application as the remote controller of the bus conductor. Since the application is easy and user-friendly, the bus conductors will not get confuse once they are using it already. An orientation and tutorials is required to every bus conductors for them to familiarize the device and its features used.

The bus conductors will just connect via Bluetooth and the android phone will automatically pair and recognized the device or the hardware system. Once the connection is

success the bus conductor may start getting the source and destination of the passenger, tap the RFID card with available amount of load and the receipt as the output will print as a proof that the transaction is process successfully.

In case the card of the passenger does not have enough load to pay their fares, the reloading process is included in the application as additional feature, and the passenger may ask for a load to the bus conductor.

In these particular situations, the accuracy in terms of the change of the passenger is accurate and is faster compared to the existing method of paying fares.

METHODOLOGY

Bus Payment Method Using Android and RFID Technology

The basic process of Bus Payment Method Using Android and RFID Technology involves five (5) steps:

a) **Gathering information needed for the input.** This is the required information that needs to be considered in order to be accepted in the program. This includes the android application and its features such as the Log-in process and menus.

b) **Designing the user interface** This involves the visual representation of the program. The desired interface that is less confusing for the users. Managing the information is easier to take an action and organizing it to the best way possible and understandable by everyone who will use it.

c) **Coding of Android Application.** The process of taking the application and program into action and response to the specific task with their respective functions and purposes in the system. Making the whole program possible and is the step-by-step procedure.

d) **Prototype Assembly.** Assembling the hardware portion of the system. Including the RFID reader, Bluetooth connection, MCU, the rechargeable battery and the printer.

e) **Testing the prototype and the android application** Performs consecutive testing for the stability of the program and hardware, to assure that it is running in an expected manner. Aside from that, the debugging includes in this process if in case it encounters.

Input, Process, Output (IPO)

Table 3.2a.Input Process Output of the Bus Fare Method

Input	Process	Output
Knowledge about ● *Microcode Studio Ide* ● *Picbasic Pro* ● *Proteus* ● *Basic 4 Android* ● *Android SDK* ● *RFID* ● *PCB*	● *Research* ● *Data Gathering* ● *Assembly of Materials* ● *Construction of Module* ● *Testing per part of the Prototype* ● *Programming* ● *Final Testing*	*ENHANCING THE BUS PAYMENT METHOD USIG ANDROID AND RFID TECHNOLOGY*

Table 3.2a shows the input, process and output of the prototype. This also shows the expected output of the prototype and the outline of how it process.

Flowchart and Block Diagram of the prototype

A flow chart is a graphical or symbolic representation of a process. Each step in the process is represented by a different symbol and contains a short description of the process step. The flow chart symbols are linked together with arrows showing the process flow direction [6].
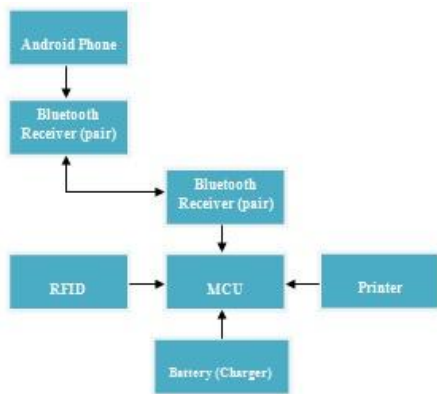

Figure 3.3a.Block Diagram of the Prototype

The figure 3.3a shows the flow diagram of the prototype. Its internal hardware that is included in order to make the prototype works properly.

The two portion of the prototype needs a bridge to connect and to be able to print the receipt. Bluetooth connection will be the key way to successfully meet the output expectation of the proponents.
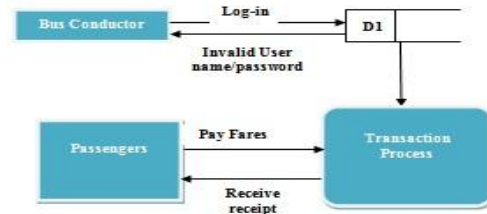

Figure 3.3b.Context Flow Diagram

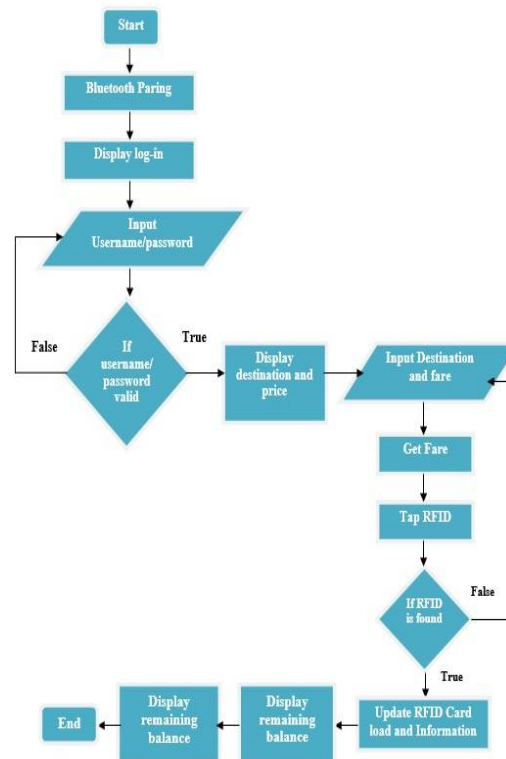Figure 3.3b shows the flow diagram of the summarized process of the system.

Figure 3.3c.Process Flow Diagram

Figure 3.3c shows how the whole system flow process from its input, which is the log-in process of the administrator and output a receipt that indicates that the transaction process is successful.

At this point, pairing of Bluetooth, android phone and the hardware must perform once the user exit or accidentally exit the application. But

the database of the transaction will not disappear or erase but rather add another transaction if the user perform and successfully paired the two portion.

Figure 3.3d.Flowchart for Option Menu
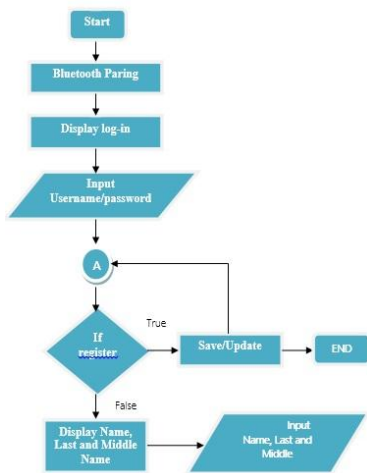
Figure 3.3e.Flowchart for Loading

The loading process of the system is used if ever the passenger does not have enough load. Basically, they could ask for a load to the bus conductor. This loading process can or cannot be separated to the android phone, it is

still depends on the management of the bus company.

Project Description

This project aims to enhance the system of paying fares in a bus that will use an RFID and Android operated device that will improve the use of the existing methods, and will make the works of the bus conductors easier, so as to the passengers.

a.   Functions of the System

To understand each functions of the project, the proponents tabulate the following function. Refer to table 3.4a below for the Functions of Reservation and Monitoring system.
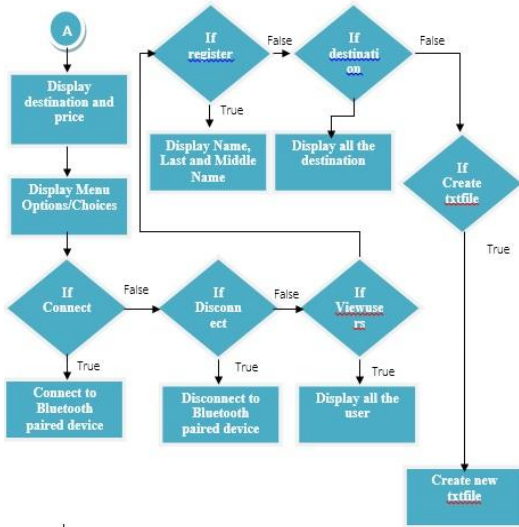
Table 3.4a.Functions of Bus Fare Method

Item No.	Functions	Definitions/Description
1	Faster Data Updates	Real-time and automatic updating of data upon encoding
2	Data Monitoring	Data are being monitored upon encoding.
3	Fool-Proofing Methodologies	To avoid occurrences of bugs like data type mismatch and insufficient values for inputs, the system has built in pop-ups, disabling/enabling properties and message boxes
4	User Friendliness	The system was made under Visual Basic platform and has a design that can be easily understood by its user

b. Tools and Methodologies of the System

Figure 3.4a *The Prototype*

Figure 3.4b.Android Phone

Figure 3.4bshowed the prototype of the project which is composed of both hardware and software. The proponents used PICBASIC PRO (PBP) compiler as software. It has several tools, specifically Microcode Studio IDE to create and edit the program. PBP compiler also converts BASIC program language to Assembly Language. The proponents used Basic4Android as a bridge to design the application for the android device itself, as shown in Figure 15.0, and create its user-interface. The assembler in the said compiler software is used to convert Assembly Language to a Machine Code that will be sent and read by the Microcontroller Unit (MCU) to

run the whole program. The printer and the RFID reader are connected to the MCU.

Figure 3.4c.*Internal (MCU, Battery, RFID reader)*

Figure 3.4c, shows the connection of printer, RFID, MCU, Bluetooth Receiver, Voltage Regulator and Battery inside the casing.

Figure 3.4d. *Printer*

Project Capabilities

The proponents come up with this project to utilize the RFID as a replacement of money for the payment in bus fares with the aid of Android device. The system stores information of registered e-card users and the credit of the e-card. The bus conductor will be the operator of the device; thus having the tasks of selecting the destination, getting the fare and scanning the e-card of the passenger. The system will automatically deduct the payment from the e-

card, update and display the information of the e-card and then print the receipt.

One of the main features of the device is its wireless connection. Through Bluetooth, the Android device will receive and send information to the RFID reader and printer, respectively. Without attaching the Android device to the printer and RFID reader, the bus conductor may use it by hand.

The destination can be selected, customized, added or deleted, depending on the route of the bus. It has an option of Northbound if the route of the bus is going north and the selection will be reversed if the bus conductor chooses the Southbound. The minimum fare and fare per kilometer can be changed depending on the bus company's regulations.   The bus can load and unload passengers along the way.

The system computes the total amount of fare of the passengers. The Android device displays the remaining load of the e-card so that e-card users are updated to their load balance.

The software compiler which is PICBASIC PRO used in Microcode Studio IDE can work with multiple OS Platforms.

The program can operate to the other models of Android devices but the resolution is not justifiable.

RESULTS AND DISCUSSION

The proponents conducted a series of test to measure the functionality, speed and accuracy versus the existing method, which is the punching ticketing and the mPad (Mobile Processing Automated Device)

Table 4.1a Card VS Punching

Card VS Punching Ticketing Method (in seconds)				
Bus company	Test	Puncher	Card	Remarks
P&O Transpo	Test 1	15.74	5.76	Passed
Jac Liner	Test 2	17.45	5.45	Passed
Lucena Lines	Test 3	21.82	13.8	Passed
Jac Liner	Test 4	19.36	11.13	Passed
Lucena Lines	Test 5	18.56	9.06	Passed

Table 4.1a shows the results of comparing the two methods on which of the two is faster to use or the speed test. And it turns out to have the remarks of **passing** the test and consider that the prototype of the proponents is faster than the punching method.

Table 4.1b Card VS mPad

Card vs Mpad (in seconds)				
Bus Company	Test	Mpad	Card	Remarks
DLTB	Test 1	10.87	9.82	Passed
JAM	Test 2	10.3	10.7	Passed
DLTB	Test 3	9.12	8.73	Passed
Dela Rosa	Test 4	7.64	5.1	Passed
JAM	Test 5	7.73	7.36	Passed

Table 4.1b shows the results of comparing the two methods on which of the two is faster to use or the speed test. And it turns out that the prototype of the proponents passed all the series of test versus the mPad.

Figure 4.1a. *User Interface in Android Phone*

The system should be in a network connection so that the RFID card can be used in other same device, discounted fare for the students and senior citizen should also be considered in computing fares, and lastly, the device must be more compact and handy to use.

CONCLUSION

After the project has been conducted, the proponents have concluded that the prototype can automatically get the total fares of the passengers from its source to destination. The printer and RFID reader is link via wireless connection, RFID can replace money as mode of payment in bus fares, it was also found that the system is more accurate and faster compares to the existing method of payment in bus fares and the use of electromagnetic card could lessen the queues of the change of the passenger's fare.

RECOMMENDATION

The proponents provided several recommendations for the better and improved performance of the system. These will help the future researchers to have an advanced and improved version of the system.

REFERENCES

[1] S. F. D. Javier, Philippine Transportation Statistics, 2007.

[2] A. B. a. RFID. [Online]. Available: http://www.abrfid.com/.

[3] [Online]. Available: http://www.technovelgy.com/ct/Technology-Article.asp?ArtNum=2.

[4] [Online]. Available: http://en.wikipedia.org/wiki/Android_%28operating_system%29.

[5] D. McFarlane, S. Sarma, J. Chirn and C. Wong, Auto ID systems and intelligent manufacturing control: Engineering Applications of Articial Intelligence.

[6] G. M. Enero and X. M. F. Saul, Computerized Reservation for the use of Equipment in LPU-Laguna using Excel-VBmacro, 2013.