



Mobile Bus Ticketing System: Development and Adoption

Ramonsito B. Adducul¹, Ian Monel C. Adducul²

¹University of La Salette, Inc., Santiago City, Philippines, mbadducul@gmail.com

²University of La Salette, Inc., Santiago City, Philippines, adduculian25@gmail.com

ABSTRACT

The adoption of mobile applications on smartphones and tablet computers has become increasingly common among businesses and service providers. It has been proven to be rapid and successful in engaging the attention of consumers, communicating new technologies, and developing processes such as ticketing systems for transport companies. This research employed agile methodology in developing an Android-based mobile ticketing system that involves assessing current processes, suggestions for improving and optimizing processes, designing software, creating, implementing, and system evaluation. The ISO 9126 Software Quality Characteristics were used as a survey questionnaire to determine the user's acceptance level on the quality of the develop system in terms of functionality, reliability, usability, efficiency, maintainability and portability where participant ratings were scaled, mean scores were measured and interpreted qualitatively using a 5-point Likert scale. Results indicate that mobile bus ticketing system (MBTS) implementation and adoption is generally acceptable using the ISO 9126 characteristics as viewed by system users and were participants in this research work. Therefore, for the adoption by the bus operator, MBTS is highly recommended for successful and more efficient transactional processes, knowledge generated is readily accessible and useful for taking decision. In the future, further development of this research can be considered and work on the incorporation of other emerging technologies. Widespread use of mobile apps allows the production of more sophisticated mobile applications and more potential to be explored. Researchers working on similar study can find operators of large bus companies operating in the northern part of the Philippines.

Key words: mobile application, bus ticketing system, Agile methodology, Android technology, Android Studio

1. INTRODUCTION

The development and advancement of information technology is moving rapidly, as most application systems are now enabled utilizing the capabilities of mobile devices, such as smart phones and tablets. A mobile application, or generally referred to as apps, created to operate on mobile gadgets, often serving to deliver services that can be accessed through personal computer systems. Applications

are relatively small, individual software units accessed on mobile devices with restricted functions [1]. Modern businesses have used information technology and mobile apps to increase consumer usability rates for their processes. The goal is to communicate and engage with customers, making it a powerful resource for most companies and businesses.

In their paper, Tulaev, et al. conditionally defined information technology as maintaining, rationalizing, and developing. Technology saves energy, material resources, time and a system that produces knowledge, utilizes and manifests it. Advances in information technology indicate the need to create more application systems, such as mobile apps, that would increase labor productivity and boost efficiency rates [2]. Song, et al. offered evidence that perceived technical features, human characteristics and social impact all play a role in the adoption of IT technologies such as mobile phone applications. The paper refined understanding of factors affecting platform adoption that emphasizes not only the functions of user-friendliness and utility-related factors but also the theoretical growth of the system itself and its network effects [3].

Agile methods are used for designing mobile applications. Santos, et al. investigated problems in the development of mobile apps and benefits of designing mobile applications. Defining the user interface and user experience followed by meeting the expectations of different users is the main challenge in developing mobile applications. The benefits pose enhancements to management and control as well as pace of growth.

The project supplied numerous fields such as games, public transport, services and productivity. Their analysis can be used to assist developers in choosing the software development approach for creating a project for mobile applications [4]. The implementation of agile development also stated by Flora and Chande makes processes of application systems more versatile, helps in continuous learning and incremental delivery, adapting quickly and easily to changes in requirements and technologies [5].

Ceipidor, et al. mentioned that the creation and acceptance of mobile applications for user-friendly online transactions had been growing globally without frontiers. Users can buy tickets via their smartphones, transportation tickets and can

pay online directly when they book their travel itinerary, validate and retrieve tickets using mobile application [6]. Mobile phone use and usage have extended considerably from single-purpose use to various applications such as online booking, shopping, browsing, etc. [7]. The green mobile products should, however, be included in the range of smartphones. Users must have a clear interest in using the app and consider the mobile phone's eco-friendly features[8].

At the other hand, with the support of mobile devices and technology, Skarica et al. describes mobile ticketing as being used for booking, acquisition and related services [9]. Eicher et al. reported that mobile ticketing is a relatively recent and growing part of the rapidly developing e-commerce sector [10]. Apanasevic and Markendahl lately examined the interest that mobile ticketing services generate for companies in the public transport sector. The paper suggests that mobile ticketing services generate multiple value dimensions, namely enhanced technological functionality; financial value; improved working environment; operational value; and value for the credibility and relationship between customers. Its passenger importance takes the form of greater comfort and operation. These factors force public transit companies to introduce mobile ticketing and mobile payment services[11].

The mobile revolution is continuing to influence the way businesses understand and communicate with consumers. Son, et al. contributed intellectually and practically to experiencing the upside and downside of rapid mobile-driven innovation. Mobile platforms have allowed retailers to communicate regularly with customers and understand their needs accurately, while serving as key outlets for promoting company products and collecting customer data. Furthermore, while mobile technology improves connectivity and customer interaction, innovation does not guarantee a return on relationships [12]. In this way, technology can help small businesses boost interaction with their customers. The web and mobile device usability assessment indicates consumers are ready in terms of technology and competencies. Customers perceived that the communication capabilities of the mobile application tools could be used to foster engagement and provided with less intervention the information they needed [13]. The concept of an integrated Android mobile application and web-based system was addressed by Alfred and Kaijage, as a solution to commuter problems that use bus rapid transit system for public transport. It offers a solution by designing and creating a prototype framework of an integrated Android Mobile application and Web-based network capable of communicating with a central database [14], and using a wi-fi receiver to incorporate Android system works [15].

In the Philippines, especially in the northern part of Luzon, the possibilities of applying information technology to transport systems need to be explored. Transportation within the country is quite underdeveloped. It may be due to the

scattered islands in the region, and most areas are mountainous. Government, however, has been pushing an initiative to upgrade the transport system through various infrastructure projects [16]. Busses are one of the most commonly used modes of public transportation for long-distance commuting commuters across provinces in the Philippines. Fares for the use of bus transport networks are charged depending on the distance the commuter travels. Passenger fares are charged by the bus ticketing booths before the scheduled departure or by the bus conductor when on board in exchange for the bus tickets. A modern ticketing system makes the preparation of tickets inconvenient for the conductor. This research project aims to develop an integration of mobile application and technology as an alternative method to be adopted for bus ticketing and to overcome the inconveniences of current processes.

The literatures examined have helped the project proponents assess the scope of this research project in relation to the development and adoption of an Android-based mobile ticketing application system for the bus transport network. Adopting this Android-based system will considerably boost the processes involved in handling and securing the ticket for passengers.

This research project aimed at developing a mobile bus ticketing application system for a local bus company. The adoption of a mobile application system would enhance the current processes of preparing tickets for passengers through the use of Android-enabled mobile devices or smart phones. In the following phases, the rationale for this project is discussed:

The first phase involves studying and identifying the bus company's bus fare ticketing system problem. In order to develop the mobile bus ticketing system, it focuses on understanding and gives a simple sense on problems of the present ticketing system. This phase will provide a strong understanding and analysis of the problems faced in the modern bus ticketing system processes.

The second phase aims to design and develop the prototype of the mobile ticketing system through the identification of the necessary specifications, analyze, design, production and testing of the application system prototype. In this phase, an agile approach to software development [17] was used to guide the project proponents in the design and coding of the mobile application system. With this approach, the requirements gathered, database relationships, application system analysis and the development of the system required were the outcomes of this phase.

The third phase includes evaluation of evaluation of the mobile bus ticketing application system. Upon finalization of the developed system, this is being tried-out to the actual users and assessed using Software Quality Characteristics (ISO 9126) to assess the consistency of the application system being developed [18].

In the context of this study, it seeks answers to the following questions concerning the development and adoption of mobile bus ticketing (MBTS) system:

1. What are the processes and problems encountered in the manual bus ticketing system of the bus company?
2. What tools can be used to improve the manual processes?
3. How would the MBTS be designed and developed using software development tool?
4. What is the level of acceptability of users regarding the quality of the mobile application system being developed?

2. METHODOLOGY

2.1. Research Design

The research project was performed through an Agile software development approach to build an Android-based ticketing application system for mobile devices, for which the project proponents adopted it. Shrestha defined Agile as a software design methodology with focus on incremental delivery, team cooperation, continuous planning, and ongoing learning [17]. Adopting Agile methodology includes reviewing the company's existing processes and structure; recommendations for enhancing and optimizing processes; designing applications together with the client; creating and implementing applications; and analyzing and tracking the software being built. Some of the concepts used by papers [19], [20], [21] were also used in crafting the methodology of this research.

The proponents of this research project have made use of a qualitative approach to assess the quality of mobile application system being developed. Because this application system is implemented using Android technology smart phones, user application and acceptance testing are needed to check the quality and performance of the systems using a survey questionnaire tool. According to Mukadam and Logeswaran, several participants should be involved in user acceptance testing and focused on the application and ease of use when performing some tasks[22].

2.2. Participants

The participants of this research project involves managers or operators, inspectors, bus drivers, and conductors who are the primary users of the developed mobile bus ticketing system. These participants are from Northern Luzon Bus Line and 3rd Generation Trans (NLBL3GT) located at Santiago City, Region 02, Philippines.

2.3. Data Gathering Instrument

The research project employed an interview and the use of a survey questionnaire. The ISO 9126 Software Quality Characteristics [18] was used as a survey questionnaire tool to determine the user's level of acceptance of the quality of the mobile application system being built with respect to its functionality, reliability, usability, efficiency, maintainability and device portability. ISO 9126 is an

international standard model of software quality which helps to build a solid framework for software evaluation. Document analysis was also used to classify different types and documentation used in the program and online tools were used to collect relevant information and guide the proponents in the design and implementation of the mobile application system.

2.4 Data Gathering Procedure

The proponents of this research project employed three types of procedure for collecting data. (a) The proponents checked similar materials from various journals, books, papers, and web pages for the initial data collection. (b) In the course of planning, designing, developing, testing and implementing the system, permission to conduct interview was granted through formal communication with the participants of this study.

Based on the feedback collected, the proponents created a prototype program that was subjected to attempts to gather participants' suggestions for further improvement of the system before its final implementation. (c) During final testing, participants were floated with a survey questionnaire to assess the quality of the mobile bus ticketing system delivered. Any form of data obtained from the participants was kept confidential.

2.5. Data Analysis

Diagrams were used to present the schema of these data in the analysis of the data collected. They were also used to present the transformation of data to information in the developed system. Data obtained from the survey questionnaire administered from the participants were tabulated and analyzed employing the 5-point Likert scale of 1 to 5 with numerical interpretation as 1 - Very Unacceptable, 2 - Unacceptable, 3 - Slightly Acceptable, 4 - Acceptable, and 5 - Very Acceptable, respectively. The data obtained from the questionnaire were analyzed using a weighted mean formula. This formula is represented as

$$\bar{X}_w = \frac{\sum w_i X_i}{\sum w_i}$$

where X_w = weighted item,
 w_i = weight of i th item X , and
 X_i = value of i th item X .

3. RESULTS AND DISCUSSION

3.1. The processes and problems encountered in the manual bus ticketing system

The bus company (NLBL3GT) under research with travel routes throughout northern Luzon for more than 30 years now. Since then, two (2) ways of issuing ticket fares to passengers have been practiced on the bus line. Bus ticket fares can be purchased through the ticket booths of the company located at their designated terminals, particularly for longer distance travel. However, tickets are issued by the

conductor inside the bus when on board for short distance travel. Ticket fares purchased from ticket booths were prepared manually by writing ticket information such as the date of travel, kilometer point of departure to kilometer point of destination, departure time and the estimated amount of fare based on the passenger's distance traveled. Once on board, tickets were prepared by a bus driver using a single hole puncher to mark the ticket with the date of travel, kilometer point of departure to kilometer point of destination and the estimated amount of fare based on a passenger's distance travel.

These procedures and problems require a new system to handle the bus company's ticketing system. This is deemed necessary to automate ticket fare computations correctly and to store ticket details digitally for company purposes such as ticket sales inventory and for reference purposes.

3.2. Tools used to improve the manual processes of bus ticketing system.

Table 1: PC Hardware and Software Tools used in the development of mobile bus ticketing system

PC Hardware Tools	
Particulars	Minimum Requirements
Processor	Intel Core i3 6100 3.30GHz
Motherboard	DDR4 HDMI M-ATX
Memory/RAM	8GB DDR4 PC2133MHz
Storage	1.0 Tb SATA HDD
Mouse	USB Optical Mouse
Keyboard	USB Keyboard
Monitor	15.6" 16M37A LED
AVR/UPS	500VA
Network	1 Gb LAN, USB 2.0 (1) Mini Portable Handheld POS Thermal Bluetooth Receipt Printer with 58mm Width Thermal Paper for Android (2) Inkjet Printer
Printer	
Software Tools	
Particulars	Minimum Requirements
OS	Windows 10
Web Server	Apache 2.4.25
DBMS	MySQL 5.6.30/ SQL lite
IDE	Android Studio
Web Browser	Mozilla Firefox/ Google Chrome
MBTS	Client-Server Application System Desktop-based system

The hardware and software tools used to help the development and implementation of the Mobile Bus Ticketing System are listed in Table 1. Developing the application system needs the hardware requirements listed while the software requirements listed, which include Android Studio and MySQL/SQL lite, are sufficient for the design and production of the actual application system

In implementing a desktop based ticketing system operating on a client-server application system, the specified specifications for both hardware and software were also being used. Such specifications will be used at the bus line's central office to produce reports for a given time span on different transactions such as inventories of transactions. Such devices will also be installed and used at the bus company's ticket booth areas to buy passenger tickets.

Table 2: Smart Phone Hardware and Software Tools used in the implementation of mobile bus ticketing system

Smart Phone Hardware Tools	
Particulars	Minimum Requirements
Processor	1.3 GHz Quad Core
Memory	16 Gb ROM + 2 Gb RAM
Storage	16 Gb Micro SD card
Screen size	5.0" HD
Wireless	Wifi 802.11 b/g/n
Bluetooth	4.0 2G: 850/900/1800/1900 MHz
Network	3G: 900/2100 MHz 4G: B1/B3/B5
Battery	2800 mAh Mini Portable Handheld POS
Printer	Thermal Bluetooth Receipt Printer with 58mm Width Thermal Paper for Android iOS Windows System
Software Tools	
Particulars	Minimum Requirements
Operating System	Android 4.4
Mobile Bus Ticketing System	mT-Bus Mobile App
DBMS	SQL lite

Table 2 indicates the minimum specifications for smartphone hardware devices when implementing a mobile bus ticketing system with their corresponding software requirement. The conductor will use these tools in preparing and issuing tickets for passengers when they are on board. To ensure successful implementation of the program, there should be an Android smartphone device with enabled mobile bus ticketing application system and a handheld thermal printer. Implementing the above tools mentioned in Tables 1 and 2 as contrasted with the ticketing system, manual processes increases the bus company's processes and services.

3.3. The MBTS design and development

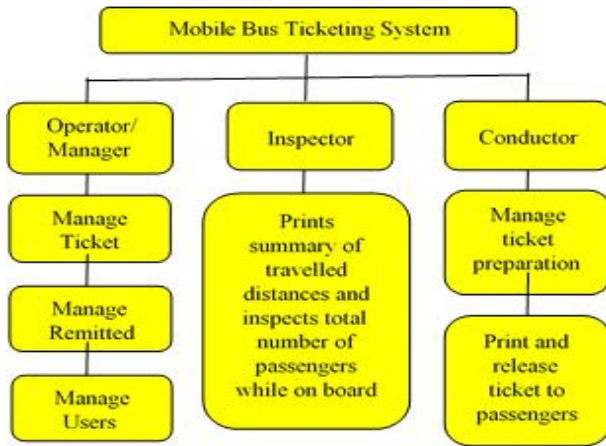


Figure 1: MBTS Work Breakdown Structure

Figure 1 demonstrates design of work breakdown structure of Mobile Bus Ticketing System (MBTS). The mobile application project design consists of three (3) users: the operator or manager, the inspector and the conductor whose main role is to access the application system. The role of the bus company's operator or manager shall handle ticket inventories and collections of bus drivers' and passengers' fares handed down. The operator is also responsible for maintaining user accounts and settings for the usage of mobile-based application systems. The inspector shall conduct summary printing of the distances travelled by passengers and carry out detailed inspections of the total number of passengers that are on board. This is to ensure passengers have obtained tickets and are dropped to their destinations properly. The conductor is responsible for handling passenger ticket preparations. By entering kilometer post where a passenger comes from and kilometer post where a passenger is dropped-off, he establishes a ticket record. The system shall save the record automatically, measuring the distance and its corresponding fare. Fares are available for two categories of passengers: regular and discounted, which extends to students, disabled people and senior citizens. The record may be changed by the conductor before printing the ticket record when an incorrect entry has been made. After the ticket has been printed via the thermal handheld printer, the ticket will be issued to the passenger, and payment for the fare will be collected by the conductor.

The contextual framework for the MBTS developed is shown in Figure 2. It describes how external entities communicate with the mobile-based application system. The manager and the inspector have the primary access to the system while the conductor handles the passenger ticket preparation, printing, and release. The bus manager or operator has the responsibility to manage device configurations and user accounts. The inspector's access to the system is to track and check ticket purchases and print summary of released tickets.

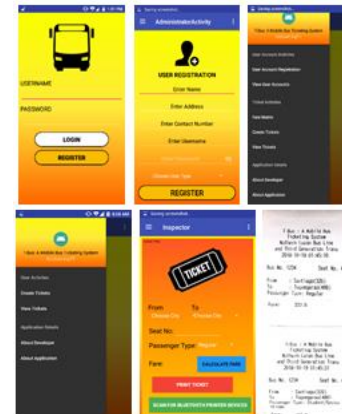


Figure 3: Sample Screenshots of MBTS

Figure 3 displays sample screenshots from developed MBTS. The system was built on Android operating systems using an integrated development environment platform such as Android Studio and SQLite as their database management tool. These tools enable the system accessible to users on Android enabled mobile smart phones once installed.

3.4. Users' level of acceptability of the developed mobile application system

Table 3: Users' level of acceptability on the functionality of the mobile bus ticketing system

FUNCTIONALITY	MANAGERS	INSPECTORS	CONDUCTORS	MEAN	INTERPRETATION
Suitability	4.50	4.67	4.31	4.49	Acceptable
Accuracy	4.50	4.67	4.19	4.45	Acceptable
Compliance	5.00	5.00	4.25	4.75	Very Acceptable
Interoperability	5.00	5.00	4.19	4.73	Very Acceptable
Security	5.00	5.00	4.81	4.94	Very Acceptable
TOTAL	4.80	4.87	4.35	4.67	Very Acceptable

Table 3 demonstrates user expectations about the acceptability functionality characteristics of ISO 9126 on the developed application system. Table indicates that accessibility requirements of suitability, accuracy, compliance, interoperability and security have a total mean of 4.67 with a qualitative interpretation in a five-point Likert scale of "Very Acceptable." The result means that the mobile application system developed meets the users requirements and specifications.

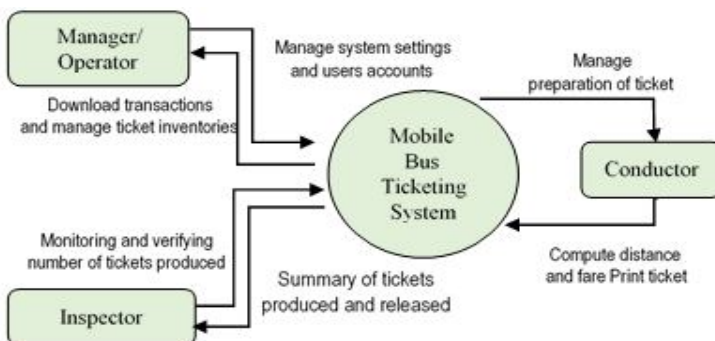


Figure 2: MBTS Contextual Framework

The conductors, who are the direct users of the developed system, rated the functionality with a mean of 4.35 among the three groups of participants, results indicate that the form of their smartphones where the application was activated and tested is below the minimum requirements. The application system, however, could still respond to their mobile devices, and the functions run smoothly. The application system also includes a security feature, which prevents unauthorized access.

Table 4: Users' level of acceptability on the reliability of the mobile bus ticketing system

RELIABILITY	MANAGERS	INSPECTORS	CONDUCTORS	MEAN	INTERPRETATION
Maturity	4.50	4.33	4.25	4.36	Acceptable
Fault Tolerance	4.50	4.33	4.25	4.36	Acceptable
Recoverability	4.50	4.00	4.31	4.27	Acceptable
TOTAL	4.50	4.22	4.27	4.33	Acceptable

Results shown in Table 4 that the user level of acceptability on the developed system under the ISO 9126 reliability characteristics has a total mean of 4.33 with a "acceptable" qualitative interpretation, implies that the developed application system has the capability to recover missing data after system breakdown. In addition, the system is consistent on maturity, fault tolerance and recoverability.

Table 5: Users' level of acceptability on the usability of the mobile bus ticketing system

USABILITY	MANAGERS	INSPECTORS	CONDUCTORS	MEAN	INTERPRETATION
Understandability	5.00	4.33	4.56	4.63	Very Acceptable
Learnability	5.00	5.00	4.19	4.73	Very Acceptable
Operability	5.00	4.33	4.19	4.51	Very Acceptable
Attractiveness	4.50	4.67	4.38	4.51	Very Acceptable
TOTAL	4.88	4.58	4.33	4.60	Very Acceptable

Table 5 indicates users' level of acceptability of the developed system on the usability characteristics of ISO 9126 has a total mean of 4.60 and is qualitatively translated as "Very Acceptable" According to the three user groups, they can use the developed mobile application system with better understanding and learning of device operations. The operability and usability of the developed application system with a qualitative interpretation called "Very Acceptable" means that users like the system's interface design.

Table 6: Users' level of acceptability on the efficiency of the mobile bus ticketing system

EFFICIENCY	MANAGERS	INSPECTORS	CONDUCTORS	MEAN	INTERPRETATION
Time Behavior	4.50	4.33	3.81	4.22	Acceptable
Resource Behavior	5.00	4.33	3.63	4.32	Acceptable
TOTAL	4.75	4.33	3.72	4.27	Acceptable

As shown in Table 6, the user-level results of acceptability on the efficiency characteristics of the developed application system based on ISO 9126 have a mean value of 4.27 and are qualitatively interpreted as "Acceptable." This means that the developed mobile application system is able to react quickly and use its resources according to user needs. Nevertheless, the system's behavior differs depending on the type or model of mobile devices that users are using.

Table 7: Users' level of acceptability on the maintainability of the mobile bus ticketing system

MAINTAINABILITY	MANAGERS	INSPECTORS	CONDUCTORS	MEAN	INTERPRETATION
Analyzability	4.50	4.00	3.94	4.15	Acceptable
Changeability	4.50	4.33	3.94	4.26	Acceptable
Stability	4.50	4.33	4.31	4.38	Acceptable
Testability	4.50	4.67	3.94	4.37	Acceptable
TOTAL	4.50	4.33	4.03	4.29	Acceptable

Table 7 shows the features of the application system when it comes to maintainability characteristics of ISO 9126 with a total mean of 4.29 and qualitatively interpreted as "Acceptable," which implies that the developed mobile application allows easy analysis of design documents and programs when a bug is found. It allows simple expansion and system alteration. In addition, alteration of the system does not affect others, and after adjustment, laborious tests are not necessary. While end-users of the developed system can easily manage the overall operation.

Table 8: Users' level of acceptability on the portability of the mobile bus ticketing system

PORTABILITY	MANAGERS	INSPECTORS	CONDUCTORS	MEAN	INTERPRETATION
Adaptability	5.00	4.00	3.94	4.31	Acceptable
Installability	5.00	4.33	4.00	4.44	Acceptable
Conformance	4.50	4.33	3.81	4.22	Acceptable
Replaceability	4.50	4.00	4.06	4.19	Acceptable
TOTAL	4.75	4.17	3.95	4.29	Acceptable

Table 8 results show that the portability characteristics of the developed system under ISO 9126 are capable of adapting wherever it is installed on an Android-enabled smartphone according to the level of user acceptability. In a qualitative interpretation, it has a total mean of 4.29, or "Acceptable." This could be due to the robust development of the system, which meets the requirements of portability among Android-enabled smartphones. This can also be modified to extend the competencies related to the functional capabilities and

cope with evolving conditions of the mobile application system created.

Table 9: Summary of users' level of acceptability on the Software Quality Characteristics of the developed mobile bus ticketing system

QUALITY CHARACTERISTICS	MANAGERS	INSPECTORS	CONDUCTORS	MEAN	INTERPRETATION
Functionality	4.80	4.87	4.35	4.67	Very Acceptable
Reliability	4.50	4.22	4.27	4.33	Acceptable
Usability	4.88	4.58	4.33	4.60	Very Acceptable
Efficiency	4.75	4.33	3.72	4.27	Acceptable
Maintainability	4.50	4.33	4.03	4.29	Acceptable
Portability	4.75	4.17	3.95	4.29	Acceptable
TOTAL	4.70	4.42	4.11	4.41	Acceptable

Results in table 9 provides a description of the acceptability level of the users on the different system quality characteristics of ISO 9126. Features such as functionality, usability, reliability, efficiency, maintainability, and portability have an overall average of 4.41 and are qualitatively defined in a 5-point Likert scale as "Acceptable" The results suggest that the developed application system for mobile bus ticketing is found to be very useful to bus operators and/or managers including their bus conductors and inspectors. The opportunity to develop required mobile application system is considered a timely and cost-effective method that could affect technology acceptance and deployment. This also helps enhance teamwork, assisted with research using different automation that involves computer-aided system design. The developed application system is therefore useful, appropriate and able to work efficiently for the bus company's numerous users.

4. CONCLUSION AND FUTURE WORK

Integrating emerging developments in mobile technology with advanced application infrastructure will be of great help in enhancing service quality, saving time, expense and preserving data that is stored in every company's system. Using various technology and the presence of open source software, integrated development environment tools and various methodologies, the project proponents have been driven to achieve their goal of developing a mobile bus ticketing application system for a local bus company.

Analyzing the problems encountered in the existing processes surrounding the bus company's ticketing system has helped the proponents define the conditions for designing a new system that would improve those processes and eliminate those problems. The Mobile Bus Ticketing System (MBTS) implementation was designed as an Android mobile application system running on Android-enabled smartphones.

In an Android Studio IDE software tool, the agile software development approach has guided the proponents in the design specifications, programming, and system coding. The developed application system can provide tickets for passengers while on board and could be printed using thermal handheld printer. It provides necessary information and processes of the operation of the bus company.

In general, the development and adoption of the MBTS is acceptable as perceived by system users using the assessment tool ISO 9126 Software Quality Characteristics. The assessment consists of functionality, reliability, usability, efficiency, sustainability and portability of the systems. Thus, the developed mobile application system is highly recommended for the local bus company to implement for faster and more effective transactional processes, information generated is readily accessible and useful for decision taking by the bus company operators.

This research project's output could be considered for enhancement in future studies that would focus on incorporating other mobile technologies. In the age of the fourth industrial revolution, in which widespread use of mobile devices, it is possible to explore more opportunities and challenges in developing mobile application systems for future research work. Researchers who would work on similar study can also include in their participants the operators of major bus companies operating across regions in the northern part of the Philippines.

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