Modernization of Ticketing System Using Re-Engineering Approach

Nik Azlina Nik Ahmad
Universiti Kuala Lumpur
Malaysian Institute of Information Technology
Kuala Lumpur, Malaysia
nikazlina@unikl.edu.my

Muhammad Feezi Hamzah
Universiti Kuala Lumpur
Malaysian Institute of Information Technology
Kuala Lumpur, Malaysia
muhammadfeezi@gmail.com

***Abstract*— Ticketing system is an enormous sector in Malaysia and other countries. Its range of use is applicable to both products and services. The manual ticketing system is tedious with time consuming when the consumers need to wait in a long queue. Due to this reason, a modernization to a legacy ticketing system is proposed in this paper to overcome such problems and to support the growing business operations and technology with the use of re-engineering approach. Constant demands for mobile applications and relatively easy access to the market have been drawing researchers into mobile application development. With this new replacement, it is trusted to improve the whole business processes and increase its usability, thus becomes the solution amongst indigenes within the country. A new system architecture as well as modernization and functional models were proposed and the usability of the prototype was evaluated using two different testing methods.**

Keywords*— *Modernization; Ticketing system; Re-engineering

I. INTRODUCTION

Modernization of a system will be put under consideration when the current system has no longer be able to work efficiently, be it functional support or performance. When an old system is outdated or not be able to properly perform its duties, the needs of new system will become a priority. The new system is definitely required to replace the current system in order to support growing technology and business processes. Software modernization refers to the conversion or rewriting an old system to a modern computer programming language and hardware platform. The aim of legacy modernization is to preserve and expand the relevance of legacy investment through new relocation to another platforms [1]. One of the most prominent modernization approaches is re-engineering, where it is actually a technique that is used to restructure the legacy applications using new technologies or platforms, with similar or upgraded features [2,3].

The current manual bus reservation process is very tedious and often time-consuming where customers always stuck in a long waiting line with no ideas whether the tickets are still available when their turn arrives. These may lead to frustration and customer dissatisfaction. However, with the advent and evolution of mobile apps, the buying power of products and services has changed the consumers' behavioral patterns. Online purchases by customers using mobile applications has broadly expanded without limits or boundaries [4]. Hence, this study will propose a more efficient system to replace the old system using different platform, with the intention to increase mobility and to ease the issue of bus reservation using a mobile application that permits the customers to have better experience on ticket checking, purchase transport ticket accessibly and able to make the online payment without worrying to lost cash while standing in a long queue. The re-engineering process will use different hardware platform; mobile-based as compared to the current system which is stand on the Web. A manipulation on the programming languages will also take place to suit the development of the proposed system and involves Hypertext Markup Language (HTML), PHP Hypertext Preprocessor (PHP), Structure Query Language (SQL), Ajax, Cascading Style Sheet (CSS), and JavaScript. The new system will stand in Android operating system and allow the customers to portably access the features through their smartphones or tablets.

As the current process only allows the new reservation procedure to be carried out manually and separately at each branch, the front officer of each branch need to contact the main office in order to process customer's booking to prevent duplication or mistakes. This process requires checking on the latest bus schedule, availability of the seats, newly added limitations and other relevant details. Looking at these issues and pitfalls, it is obvious that the business requires a significant system upgrade to support the needs of their business as well as to increase the number of users. Since the new hardware platform is required, the re-engineering is seemed like the most suitable approach to modernize this old bus ticketing system. This solution will benefit both company and customers in terms of time, ease of use, efficiency and flexibility.

II. RELATED WORKS

Modernization to an old system is seemed as essential practice. Old systems in most parts are 'weak' in the sense of tolerating to changes and are non-extensible when trying to merge with new technologies. Due to that, the old systems should be modified or modernize in order to consistently support business operations, or to adapt with the new technologies that surround us [5]. In general, modernization means large changes to the system, typically due to major changes in technical and business [6]. With the rapid development of technology, and mobile applications in particular, electronic transactions have become very popular among all regardless their age. One of the services that has radically grown is ticketing. Electronic ticketing system offers great flexibility to customers as it allows them to ease themselves when making reservations or purchase according to their preferences with less effort [7]. Reengineering is an exploration of and alteration of the original software structure in a new way. It involves thorough analysis and modification of the system or part of the system in order to rebuilt it as new form [8]. Reengineering however, may not replace the whole system at once due to its time- and cost-consuming, thus cross-application will be the best solution [9]. It is actually an evolution to an old system which results in solely or partly changes. The reengineering may lead to producing a new system that has similar features with its legacy or a totally new system with new features [10,11,12]. In short, re-engineering can be viewed as a method for upgrading the existing structure.

Using mobile ticketing means the user has more flexibility in doing transactions, be it purchasing, making payment, collecting or checking for tickets. Using mobile ticketing can minimize the expense of manufacturing and delivery linked to conventional paper-based ticketing platforms and improve the convenience of consumers by offering modern and convenient ways to buy tickets. Among the advantages of mobile ticketing are time-saving, reducing the human mistakes, reduce effort for inter department communication and flexible access. A study has been met towards several existing bus ticketing system and the comparisons on its features are presented in Table 1.

TABLE I. FEATURES COMPARISON OF EXISTING SYSTEMS

	Catch ThatBus	***Red Bus***	***Easy Book***	***Travel-yaari***	***Book MyBus***
Platform	Android & Web	Android/ Web	Android/ Web	Android/ Web	Android & Web
Cancellation Option	No	Yes (Only in India)	No	Yes	No
Trip Search	Yes	Yes	Yes	Yes	Yes
Seat Selection	Yes	Yes	Yes	Yes	Yes
Live Tracking	No	Yes	No	No	No
Digital Ticket	Yes (Text Digital)	Yes (Text Digital)	Yes (Text Digital)	Yes (Text Digital)	Yes (Text Digital)

III. METHODOLOGY

A. Research Methodology

Interviews were carried out with *Transnasional* staff who are the users of the legacy system. The discussion focused on how customers made reservation to get their preferred seats, how data and information about customers are stored and how bus scheduling and management is done. A set of interview guide were designed by the researcher as a guide to the researcher during the interview.

The researcher also used questionnaire to identify the public users' satisfaction level on the modernized system. A number of 30 questionnaires have been distributed to randomly-selected public users who were also the Transnasional's customers. The evaluation was made on site using researcher's mobile phone with the modernized system pre-installed. The feedback of the customers was committed using physical questionnaire on a five-point Likert scale.

B. Modernization Method

The modernization process has followed the following approach shown in Figure 1.

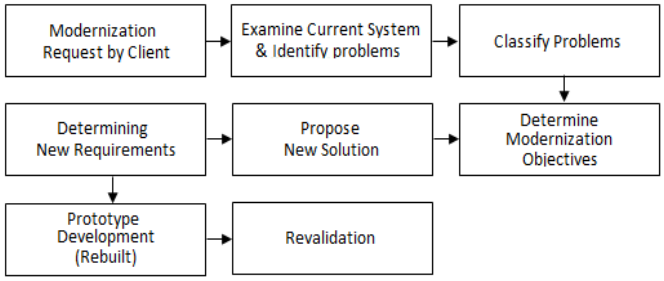

Fig. 1. Modernization Method

C. System Architecture of the Proposed System

Since the modernization of this Bus Ticketing system is applying the reengineering approach, therefore the changes to software architecture take effect. The architecture was modified and improvised to adapt with new applied technology and environment. It is horizontally rightward step as shown in figure 2.

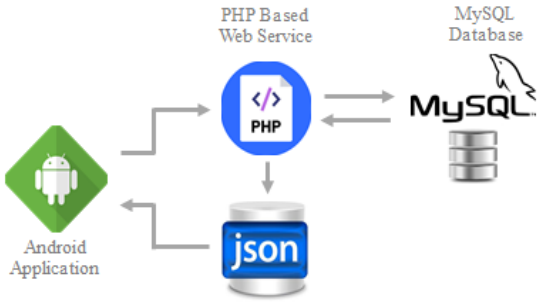

Fig. 2. System Architecture for Mobile Ticketing System

Since MySQL database and an Android app incapable to have a direct communication, therefore there is a need for PHP to allow this to work. Figure 2 illustrates the way Android application use PHP to get connected to a remote database

(MySQL). In this study, a basic PHP based web service will be developed in order to permit Android app to support users' log in, user registration and for JSON data parsing (such as a news feed) within the app. In order to do this, it will need to have a server (Apache server), a MySQL database, PHP programming language, Android Studio, as well as Android SDK.

D. The Functional Model of the System

The functional perspective of the new re-engineered bus ticketing system is described using the Use Case diagram in Figure 4 and the module list in Figure 5.

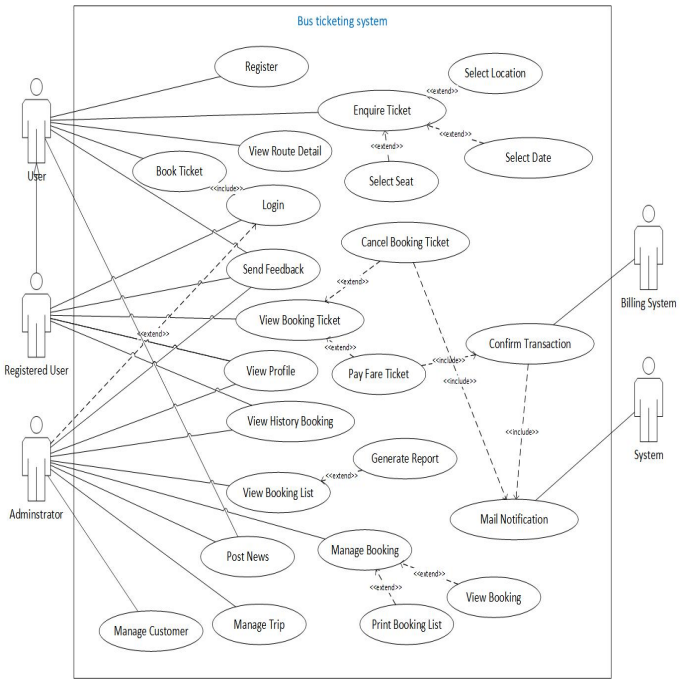

Fig. 3. Use Case Diagram for Mobile Ticketing System

Mobile Bus Ticketing System consists of two user categories, which are administrator and customer. In this system, administrator which is based on the Web application has the privileges to manage the trip details including bus schedule, bus type, prices, seats, drivers, locations of origins and destinations, etc. In addition, administrator also has the ability to manage the cancellation requests. The system allows the passenger to make cancellation after the payment has been made. Customer is categorized into two types, registered and unregistered customer. An unregistered customer has to register to the system using their email and password. However, unregistered customer can check for ticket availability without having to register. As a registered customer, the customer have to log into the system using the email and password registered into the system by the Bus Ticketing System in the first time. The customer can view their personal information and update the information by themselves.

After the new requirements have been identified, several new features were decided to be introduced in the new prototype. The re-engineering product not only take effect on the new hardware platform but adding in some new features as well, as shown in Figure 4 below.

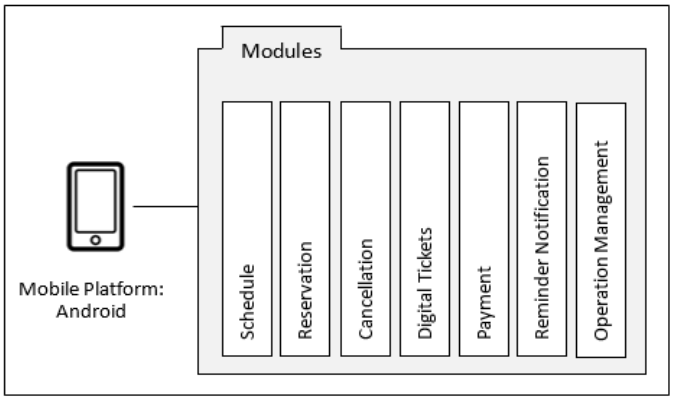

Fig. 4. The Proposed Model of Re-engineered Product Features

IV. RESULTS AND DISCUSSION

After the implementation, the system was evaluated by the real client using User Acceptance Test (UAT) as well as opened to public for general assessment. The aim of the UAT implementation is to show that the company processes are operated in a way that is relevant to the conditions of the modern world [13]. The results of both evaluations are shown below.

A. User Acceptance Test (UAT)

The UAT session was executed at the client's main office, located in Chow Kit Road, Kuala Lumpur. The user acted as an administrator and customer as well for the system, and has been given a system user manual. During the evaluation, the user has been given a series of test cases, which allow the user to give comments or feedback. Each requirement in the test cases are determined by three acceptance status which are 'Yes', 'No', and 'Need Improvement'.

TABLE II. SUMMARY OF UAT RESULTS BY MODULE

Summary of Test Cases	No. of Test Cases	Reference ID	Results		
			Pass	Fail	Unidentified
General Module	7	RQ001-007	100%	0.00%	0.00%
Schedule	5	RQ008-012	100%	0.00%	0.00%
Reservation	6	RQ013-018	100%	0.00%	0.00%
Cancellation Process	3	RQ019-021	100%	0.00%	0.00%
Digital Ticket	8	RQ022-029	100%	0.00%	0.00%
Payment	6	RQ030-036	100%	0.00%	0.00%
Reminder Notification	3	RQ037-039	100%	0.00%	0.00%
Operation Management	9	RQ040-048	100%	0.00%	0.00%

Summary of the UAT test results showed that all 47 test cases that were distributed to the clients were successfully executed with 100% passing level. Zero unidentified or unanswered response making it completely tested.

B. Indirect Stakeholders' Evaluation

The second evaluation method was conducted with different stakeholders; staffs who were not involved during the UAT and random samples of public users. The public users were the real customers whom physically visit the Transnasional office to purchase ticket manually. A number of 30 of evaluation forms were distributed to staffs and randomly selected public users. The form comprises of 7 questions, where the level of users' agreement was evaluated using five-point Likert scale. The range was set between 1 (to indicate the strongly disagree) to 5 (to indicate the Strongly Agree). The questions were organized as follows:

Q1. The system is attractive and well designed?
Q2. The system is easy to understand?
Q3. The system flow is clear?
Q4. The system functions perfectly?
Q5. The project owner is willing to answer questions related to his/her project?
Q6. The project owner has adequate knowledge about his/her project?
Q7. Overall, the project is good and gain my satisfaction?

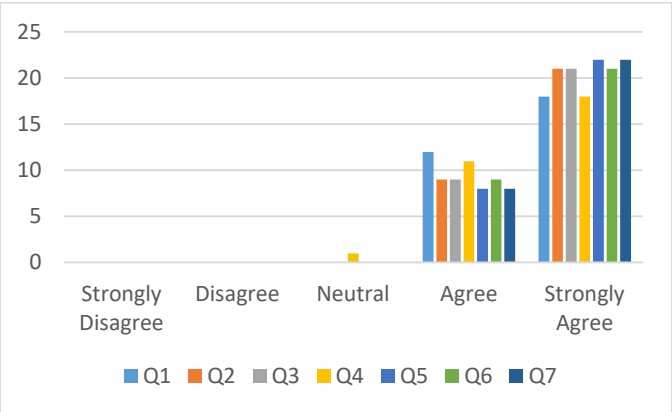

Fig. 5. Overall Test Results Based on Public Users' Perspective

Figure 5 represents the summary of evaluation from 30 public users as respondents. For Question 1, 60% of the evaluators with a total number of 18 strongly agreed with the question while the other 12 with the percentage of 40% agreed. None of them disagreed, thus it can concluded that evaluators agreed the application is attractive and well designed. Questions 2, 3, and 6 received the same score where 21 respondents were strongly agreed with the questions and another 9 agreed which turned the evaluation of the the system as easy to understand with clear system flow. On the other hand, there was one respondent felt neutral with Question 4 as he slightly thought that the system was not perfectly function, 22 and 11 of them were strongly agreed and agreed accordingly. Question 5 and 7 however, received a positive feedbacks from respondent with 22 and 8 respondents were strongly agreeed and agreed with the questions accordingly. Therefore, it can be concluded that the results of the second evaluation by staffs and public users have shown a significant interests and relatively positive feedback where almost all questions were rated as 'agree' (agree and strongly agree) and none of the questions were in the state of 'disagree' nor 'strongly disagree' in the public users' perspective.

V. CONCLUSION

The focus of this work is to improve the current ticketing system using re-engineering approach. Changes were made on hardware platform and programming languages with the aim to transform old system to a more efficient, mobile-based platform. The re-engineered system is believed to ease the whole business process, thus increase the company's profit. Based on users' perception on both evaluations, this newly developed prototype has met its intend of use, and positive feedbacks were left by most respondents; showing that this prototype has provided them great benefits and satisfaction.

REFERENCES

[1] D. Gardner (2006). Not just a nip and tuck, application modernization extends the lifecycle of legacy code assets, *ZDNet*, October 24,2006.

[2] S. Malladi, G. Ramakrishna, K. R. Rao, & E. S. Babu (2016). Analysis of Legacy System in Software Application Development: A Comparative Survey. International Journal of Electrical and Computer Engineering. Vol. 6, No. 1. Pp. 292-297. DOI: 10.11591/ijece.v6i1.8367

[3] M. F. Gholami, F. Daneshgar, G. Beydoun, & F. Rabhi (2017). Challenges in migrating legacy software systems to the cloud — an empirical study. Information Systems, Vol. 67, pp. 100–113. doi:10.1016/j.is.2017.03.008.

[4] A.K. Ibrahim, A. Ta'a (2015). Mobile-based Bus Ticketing System in Iraq, European Journal of Computer Science and Information Technology Vol.3, No.5, pp.42-55.

[5] R. Khadka, V.B. Belfrit, M.S. Amir, J. Slinger, H. Jurriaan (2014). How do Practitioners perceive Legacy Systems and Software Modernization? In Proceedings of the 36th International Conference on Software Engineering, ACM, pp. 36-47.

[6] M. Abdellatif, Shatnawi, A., Mili, H., Moha, N., Boussaidi, G. E., Hecht, G., Guéhéneuc, Y.-G. (2020). A taxonomy of service identification approaches for legacy software systems modernization. Journal of Systems and Software, 110868. doi:10.1016/j.jss.2020.110868.

[7] Bartin, B., Ozbay, K., & Yang, H. (2018). Evaluation framework for mobile ticketing applications in public transit: a case study. IET Intelligent Transport Systems, Vol. 12, No. 9, pp. 1166–1173. doi:10.1049/iet-its.2018.5248.

[8] J. Matula, & J. Zácek (2018). Reengineering legacy systems with transaction model. Computer Sccience. DOI:10.1063/1.5079079.

[9] N. A. Nik Ahmad and S. A. Syed Zamri (2014). The cross platform application development adapted Spring framework to support front-end tendering services. 2014 International Conference on Computer, Communications, and Control Technology (I4CT), Langkawi, 2014, pp. 58-62, doi: 10.1109/I4CT.2014.6914145.

[10] IEEE Std. 1219-1998, In IEEE Standards Software Engineering, 1999 Edition, Volume Two, Process Standards, IEEE Press.

[11] R. Perez-Castillo (2020). Reengineering of Information Systems Towards Classical-Quantum Systems. QANSWER 2020, Computer Science.

[12] F. J. Bermúdez Ruiz, J. García Molina, & O. Díaz García (2017). On the Application of Model-driven Engineering in Data Reengineering. Information Systems, 72, 136–160. doi:10.1016/j.is.2017.10.004.

[13] N.A. Nik Ahmad and S.N.S. Syed Dzulkarnain (2020). Utilization of Gardner's Multiple Intelligence Theory for School Counselling System with Usability Testing. International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8, Issue-6, pp. 2253 – 2260. DOI:10.35940/ijrte.E6058.038620.