Barcode Parking System for Majlis Perbandaran Malaysia

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Abstract: This is a prototype project for Malaysian Agency in Malaysia. Its named as barcode parking system for Majlis Perbandaran. Objective of the project is to integrate and replace the current system that was using coupon as their parking ticket. The barcode system is an idea taken from coupon parking system that required people to park a vehicle around the town and must show the coupon as ticket parking. Problem from this system mainly is the coupon ticket itself where one coupon represent one hour and required more than one coupon for the rest of the hours. Barcode parking system is one of the problem solving method which use a technology of barcode to represent as parking ticket in this project. Barcode parking system developed for both mobile and website application. This project is an application which requires installation on mobile phones and use to pay their parking ticket anywhere and any time they want without using coupon to display on their vehicle. This application make it easy for people to update their parking ticket without having go to their vehicle and payment made through electronic transaction. Without the use of paper, barcode parking system also indirectly contribute to green life style adopted in Malaysia.

Key words: Barcode, parking system, mobile application, automate, application, website

INTRODUCTION

Currently, technology has to skip a level that is higher than the 19th century reforms that created a facility for all the community in solving the problem of daily routine. This was no exception in the growth of technology in mobile applications where in the past only used as a hub by voice. The technology involve hardware and software embedded together with the internet which can be found in the phone such as cameras, wireless internet, applications in android platform as well as iOS and touch-screen technology.

Paying for mparking a vehicle can be a hassle for some people. City councils in some part of Malaysia (BPS., 2019; Anonymous, 2016) still use the scratch and display coupon ticket for parking while others used the parking machines (Nair, 2017; Bernama, 2019) which use coins and card payments. According to report in the USA (Paul and Bergeron, 2015) barcode parking technology installed in residential areas help to make residents feel safer and happier. Group of researchers from India (Patel *et al.*, 2015; Mudey and Rojatkar, 2015; Nikhitkumar *et al.*, 2015) focused on the hardware development of the parking not on the application software in managing the system developed. Findings by Mogarkar and Gulhane (2016) reported that using RFID technology make the parking lot management operation cheaper and faster. They focused more on automation and controlling of the parking system. Using the same technology, other researchers (Dorjee *et al.*, 2016; Bhosale *et al.*, 2015; Patel *et al.*, 2015; Dogo *et al.*, 2016)

also concluded that the system make the process of authentication faster and efficient in reducing waiting time. One of the application use a prepaid method of payment. Both application system do not focus on the user interface of the system but more on hardware implementation. A QR code parking locator developed by Tekade *et al.* (2017) can only register the user and provide parking space for users. Another finding by researcher is using positioning method (Song and Lee, 2016) of black-box camera and a two dimensional barcode for indoor parking lot.

This project study propose a parking system using barcode for the local city council in Malaysia. The system use the barcode as the method to pay the parking fee instead of using coupon ticket. Current parking system (Ch'ng, 2017) employed by majority of the City Council Agency in Malaysia is using coupon ticket. Summons are issued for not displaying these coupons. The coupon ticket priced at RM6.00 per book. The current system used by the agency has one vulnerability where user who want to park their vehicle, need to provide more than one coupon ticket to display on the vehicle. It is difficult for the city council enforcement officers to check the coupon ticket validity because many coupon tickets displayed on the vehicles.

To solve the problem, it is proposed to implement a barcode parking system to replace the current conventional parking system. The system is in a form of application suitable for mobile phone users. It can help users to update their coupon ticket online and for the enforcement officer's agency to validate the displayed

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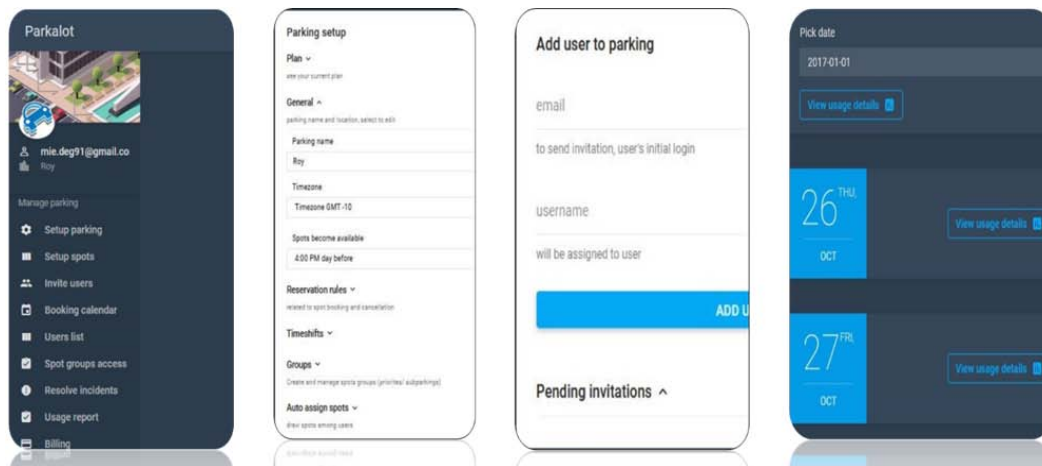
Fig. 1: Parkalot.io system screen capture (Parkalot, 2019)

coupon tickets. The application system make use of the barcode and scanner to update the coupon ticket. A prototype of the application system built to be review and implement by the agency. Why barcode? Barcode is selected for this application due to the following reasons:

- Elements of the barcode is much smaller and lighter than RFID (Radio Frequency-Identification technology) tags, make it easier to use and generate
- Less costly because barcodes are directly stamped on the surface of any materials. Thus, only the price of ink considered expensive but still affordable
- Barcode are easily available and only require the barcode reader or scanner to process it and
- Barcode has the same function and accuracy of RFID tags

With the above advantages in mind, the system with barcode is suitable. Objective of this final year project is to develop the website for user registration and to produce the mobile application using android and barcode scanner for the local city council in Malaysia to use.

Literature review: Android system let us gain many of opportunities to develop something that useful to community even in small categories or parts. Technologies even from small but simple application can contribute with helping communities get through in daily life.

Group of researchers (Gowdal *et al*., 2017) build a prototype system that provide security using barcode system. At the entrance, camera took pictures of the driver and save in the database. This system could also detect vacant car parks. In a parking system built by researchers (Zalawadia, 2015) in focused on hardware design. Another application, Parkalot (2018) is a website to create a parking system on your own. It is easy because of friendly interface where user can access the website everywhere and create their own parking system. Easy to

use facility parking booking and management system for your organization. The system required register and login for security and identification purpose. Figure 1 shows Parkalot.io screen captures.

Another application (Anonymous, 2019) using barcode scanner lets the customer make their own barcode scanner app and use the company web based barcode system. The application is available on Google Play and App Store. Figure 2 and 3 shows the screen captures of the said system application.

Parktron Technology Ltd (2018) a company in Taiwan provides many range of automated parking product systems. They used parking ticket solution using MIFARE IC card, barcode and ChipCoin. It uses barcode and has panel to scan also make payment for parking ticket. MIFARE IC technology is a contactless card system just like the usage of the Touch-n-go card in Malaysia. While barcode imitate the barcode (Code 128C), make use of the Ethernet and still print the ticket. ChipCoin made from a plastic but with a chip inside for saving data. No ticket is printed. Figure 4 is the Parktron parking system flow.

Comparison of the existing product with proposed prototype, Table 1, based on the selected features. The propose application have links for enforcement officers to monitor the parking rate.

Barcode system: Barcode system in Fig. 5, uses Universal Product Code (UPC) created to classify products for helping big retail and grocery stores in the USA. It was an idea from two persons bernard silver and Woodland in early of 1949 derived from the idea of the Morse code and movie soundtrack. Item in inventory can be trace quickly and efficient by using barcode to prevent from uncounted product.

The early barcode-scanning equipment uses a conventional lamp to illuminate product labels and a photomultiplier (a crude type of photoelectric cell) to read the light reflected off them.

Table 1: Comparison of systems

Features	codeREADr	Propose barcode parking system	Parkalot.io	Parktron
Android/web base application	Android	Both	Web based	Web based
Scanner for barcode	Yes for mobile app	Yes for mobile app	No scanner, a reservation	Yes
Barcode in system	Yes	Yes	No	Yes
Hardware in system	Mobile phone	Mobile phone and Computer	Use of cloud	Barcode and camera scanner
Internet requirement	Internet for storage	Yes	Yes for website	Yes
Security purpose	Register and login	Register and login	Login and registration	Not required

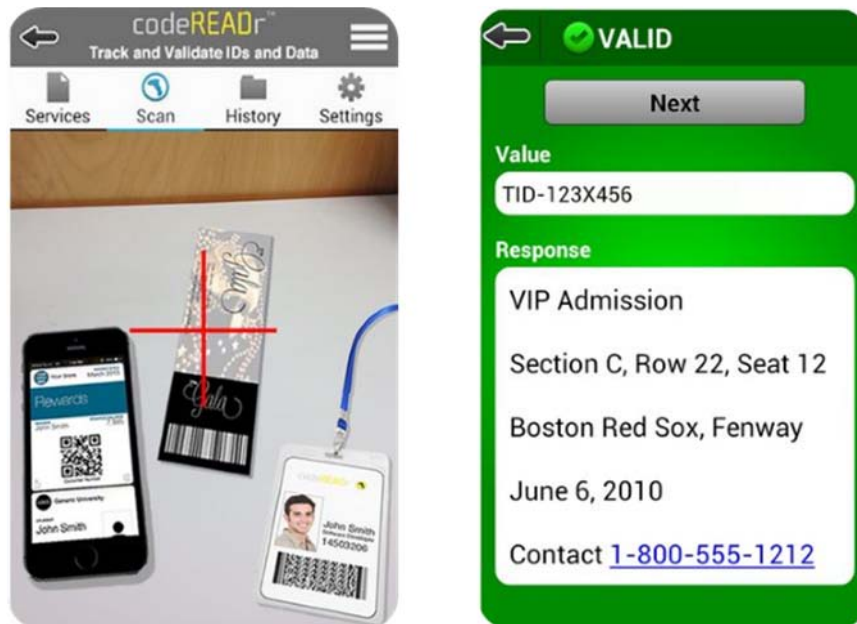Fig. 2: codeREADr screen capture (Anonymous, 2019)

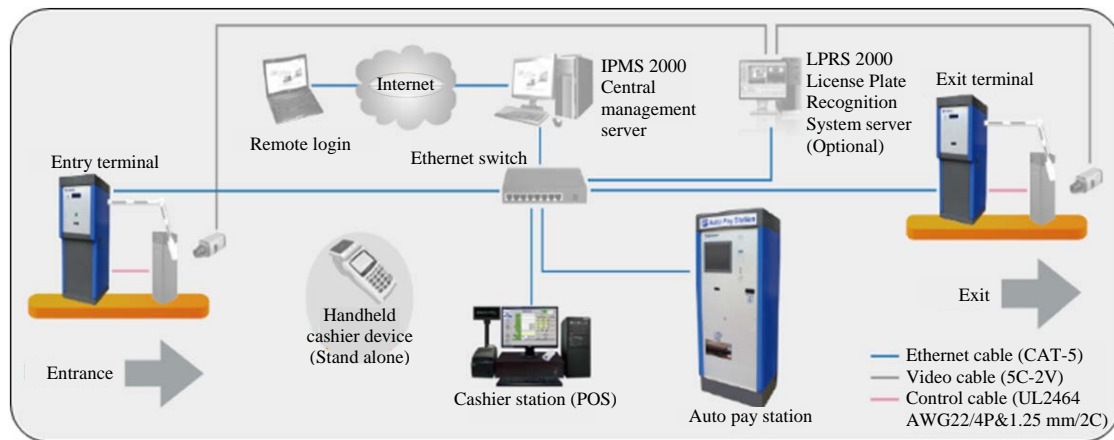Fig. 3: codeREADr screen capture (Anonymous., 2019)

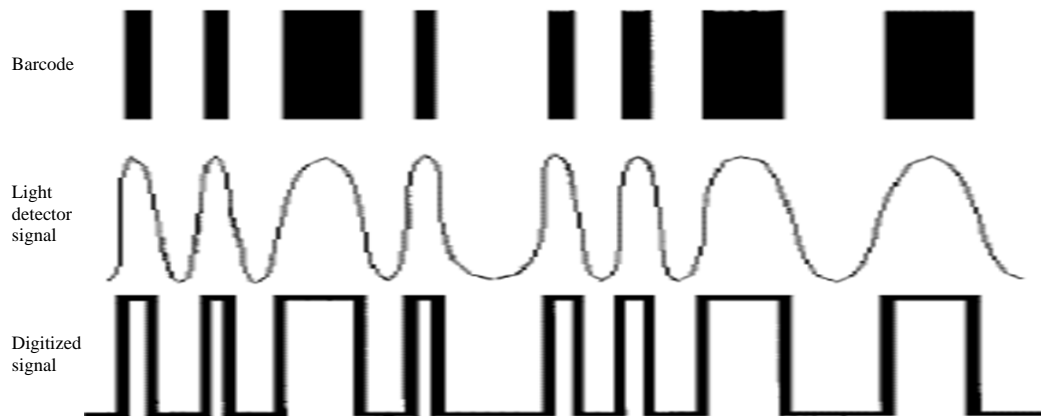Fig. 4: Parktron parking system flow (Parktron Technology Ltd, 2018)

Fig. 5: Barcodes (Anonymous, 2014)

The system act to identify product with a specific code (number, alphabet, symbol) and not duplicate or redundant with other product barcode. Reliability on the barcode has proved for example in a shopping mall on counter site, every cashier provided with scanner and money machine. This scanner will scan the barcode in every item to count for their price and print in the receipt. After barcode being scan, information of price will be retrieve from the database.

Barcode code system has a unique symbol that only readable by specific scanner (Anonymous, 2014). It consist of a symbol such a black lines with several lines to keep a number as only readable by barcode scanner. The lines have a unique identification use for product purpose.

In Europe, the European Article Numbering (EAN) is used same as to UPC but consists of extra digit that identify from which country it originated. The process of reading barcode is shown in Fig. 6.

Common linear symbolizes include UPC/EAN, Interleaved 2 of 5 (1-5), Codabar, code 39 and code 128. code 39 shown there are consist of character inside the barcode include the number, symbol and alphabet. It has a characteristic that user can set the character include number, symbol, alphabet and code 8 (EAN-8) or 13(EAN-13) only consist of numerical digits.

Each code is for different implement or area for example code EAN use for regular industry like point-of-sale software while code 39 in big industry such automotive industry or electrical industry. According to Anonymous (2014) two-dimensional code is increasingly popular with the growth in telecommunication technology.

Types of barcode: There are two types of barcode: one dimension and two dimension, depicted in Fig. 7. One dimension barcode is a barcode having several black lines separated by space and thickness of barcode. The barcode will store the number and character regularly use in industry. It cannot be modify after it have been set for a security purpose.

Two-dimensional barcode name as Quick Response (QR) code. QR code is a new generation of barcode not only provide a simple and inexpensive method to present

(a)

(b)

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Fig. 6: Device read barcode (Anonymous, 2013)

1-Dimensional
UPC/EAN

UPC version A

EAN-13, Flag digit 1
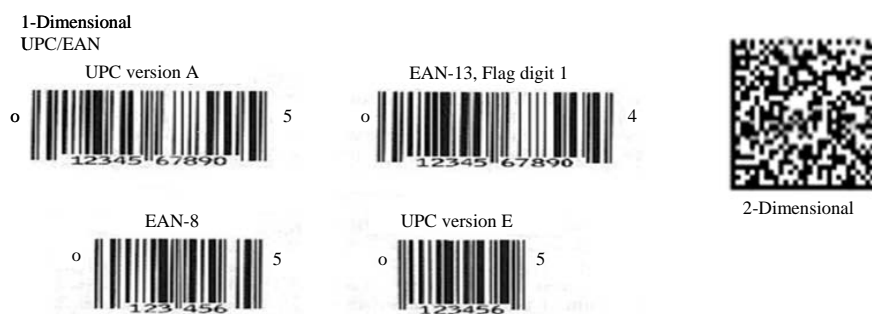
EAN-8

UPC version E

2-Dimensional

Fig. 7: 1 and 2 dimensional barcode system (Zalawadia, 2015)

diverse commerce data but also improve mobile user experience by reducing their inputs. The shape of QR code was integrate from lines to shape in square.

The difference is in retrieving information where two-dimensional cannot use the laser scanner to get the information. It only can be captured by the scanner with functional relate to image capture. The height as well as the length of the symbol stores information for both types. "A 2-dimensional code is often referred to as a stacked symbology or multi-row code" quoted from (Anonymous, 2014)

As internet technology evolving, so does other technology related application, industries and human. New things or application produced by person or industries that can be used by others, continuously. Barcode system also experiencing the same thing as many 2-dimensional symbologies produce for personal reason or industry related use. However, not all can be used as there are certain industry standards that have to be followed.

MATERIALS AND METHODS

Method used: The prototype project starts with reading tasks on similar projects, Fig. 8 on next page, finding the differences about the current coupon ticket system used by local city council in order to rectify and further develop the system.

The coupon ticket system make use of paper and manually issued by local city council. Users have to buy the coupon tickets in bulk in order to use it then manually scratch and displayed in the vehicle.

This prototype project make use of Rapid Application Development (RAD) methodology, shown in Fig. 9, for the system development of this prototype project. It is chosen due to the usage of structured techniques and prototyping to refine user requirements and design the final system. RAD is one of the software methods development which requires little or no planning during the prototype software. Principally, this methodology use prototypes to present to the users as a starting point for an iterative development process.

Using structured techniques the developer first builds a conceptual prototype based on the initial high level data and business process models and predefined high level business requirements. Cutover is where a part of system being validated by the user and developer whether the project are successful or not.

Software requirement specification: Requirements for this project taken from stakeholder (Local City Council and users), functional and non-functional requirement are considered. Based from these, Table 2 is the outcome of functional requirement.

Table 2 showed the functional requirement for mobile application. Functional requirement is to specify on function of component such as expected input and output. A function is describe as a set of inputs, the behavior and outputs. Functional requirement also illustrate the feature of system on what the system can do or cannot do.
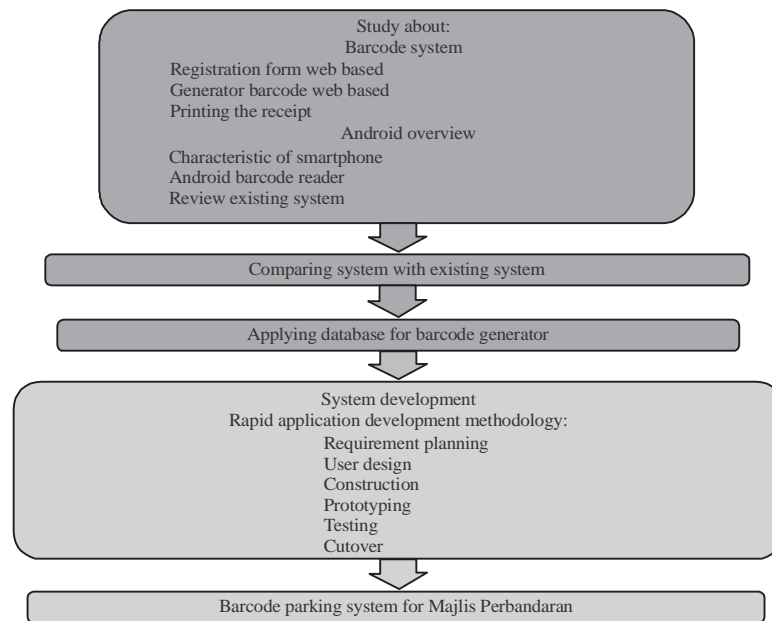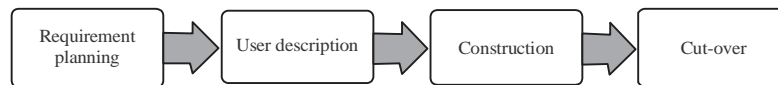
Fig. 8: Research steps
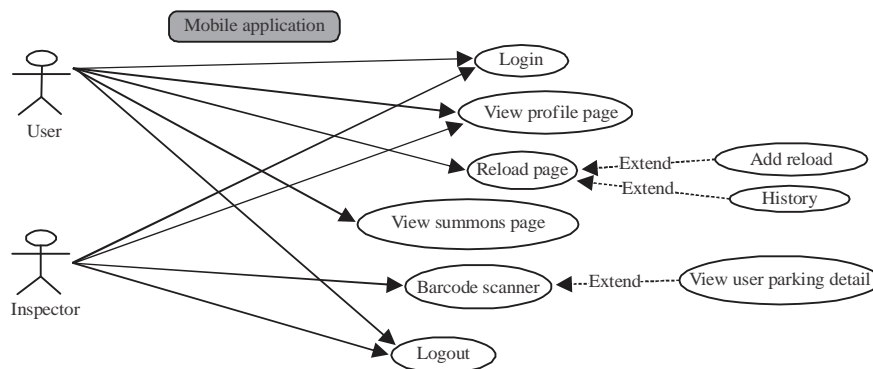

Fig. 9: RAD Model (Kumar and Bhatia, 2014)

Fig. 10: Use case diagram for registering new user

Table 2: Website functional requirement

Functional requirement	Requirement description
Website	Must connect to database
Login and registration	Any user can register and login
Vehicle registration	User can register, generate and print barcode
Summon	User able to view summons details in the summons page
View profile	User can update password, view, delete and edit their profile

Table 3: Mobile application functional requirement

Functional requirement	Requirement description
Login	Download and login to mobile app
Reload page	Can reload into the e-wallet
Parking ticket	User can pay ticket parking by hour option and select their own vehicle to pay
Change password	User can change password
Barcode scanner app	Inspector can scan barcode on the ticket
Summon	Inspector can issue summon

It is important to know the capability of system when error occurs (Fig. 10). Non-functional requirements describe how the system works, description of other characteristics, features and quality that clarify a satisfactory system which is include safety, security and usability, reliability and performance requirements. Table 3 listed the non-functional requirement for this project.

Table 4: Non-functional requirement for barcode parking system

Products	Requirement description
Website and mobile application	**Performance**
	The capability of website and mobile app to connect and interact with database
	The confirmation of inserting and manipulating data in database successfully
	Searching of data correctly for every single login have be made
	Validation message for every access whether it similar with data in database or not
	Ensure the generating of barcode are not similar for every registration vehicle
	Print for reload and barcode confirm successful
	Output for parking ticket and wallet are correctly in stress mode tester
	Usability
	Website and mobile application are easy to use as provide with description on 'how to use'. The interface also friendly user as user can understand simply without having any mistaken.
	Reliability
	Website and mobile app can use wisely by user as website it come with bootstrap that provide with mobile view version, and mobile app that only required internet connection to use it
	Portability
	Mobile application were being develop to make user easy use on paying their ticketing parking fee
Website page, button and manipulating data	**Operational requirement**
	Function of every page include profile, user profile, inspector registration, frequently asked question, vehicle registration, summons, and about us page were test under operational requirement.
	Button for every page and make sure it does not come with error.
	Manipulating data such button print, edit profile and delete vehicle function as well without any error.
	Ensure the button function relate and have connection with database.
Mobile app for user and inspector	**Security requirement**
	Login in mobile application to differentiate between user and inspector even use same mobile application.
	Ensure the profile information same as login profile user.
	Ensure scanner barcode only can be access by inspector and not by user.
	Verification
	Ensure payment for parking ticket success with any problem rise such payment has be deduct but ticket parking are not show it up
	The wallet added after user has made a reload

Three features or products were considered for this project as shown in Table 4 in the non-functional requirements setting.

Unified Modelling Language (UML): Figure 10 showed a sample of the use case diagram for mobile application development.

UML is one of the way to describe the functionality of system and interconnection between upper class and lower class such inheritance, override and overload process. In software documentation, it is a critical part to identify requirement before develop project started. For this project use case diagram selected to describe the functionality of the screen design for each pages.

RESULTS AND DISCUSSION

Design and implementation: Figure 11 and 12 are the screenshot of the prototype system for website application.

Mobile application design: Figure 13-16 are the screenshot for the mobile application of barcode parking system. The web application for this prototype project developed using Ionic framework and Laravel framework, local host used is HeidiSQL for the database. Most of the time data is stored using Cloud. Laravel, a platform for creating web based application combines other frameworks in other languages such as Sinatra, ASP.NET and MVC. While for mobile application development,

Ionic is the best choice as it is a free software, open source and suitable for native iOS, Android and the web.

Testing and results: Website application used functionality, usability, interface and compatibility testing while mobile application tested on usability, compatibility, services and performance testing.

Test case: Figure 17-20 are the sample of acceptance test done for this prototype.

Results: About 20 public users have tested the system website and mobile on the prototype phase and construction phase to gather information on understanding user regarding to barcode parking system for local city council. Survey with questionnaires were done:

- From the survey while they used the prototype system
- About 65% agreed should use the prototype barcode parking system
- About 70% of them found that the website and mobile application are interesting.
- About 50% found that the instruction are clear and easy to understand
- About 75% said that the registration, login and vehicle registration are easy to use and understand, 20% said moderate and 5% said not easy to use
- About 100% success recorded for the scanner for inspector

(a)   (b)
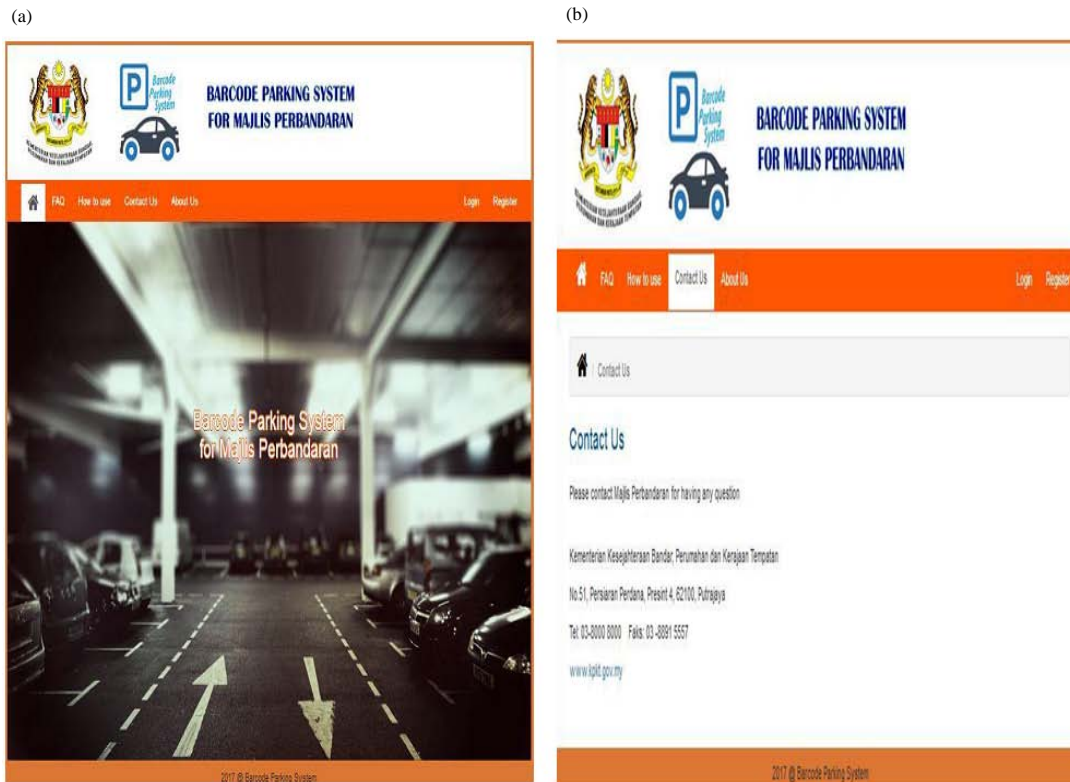

Fig. 11: Home page screenshot
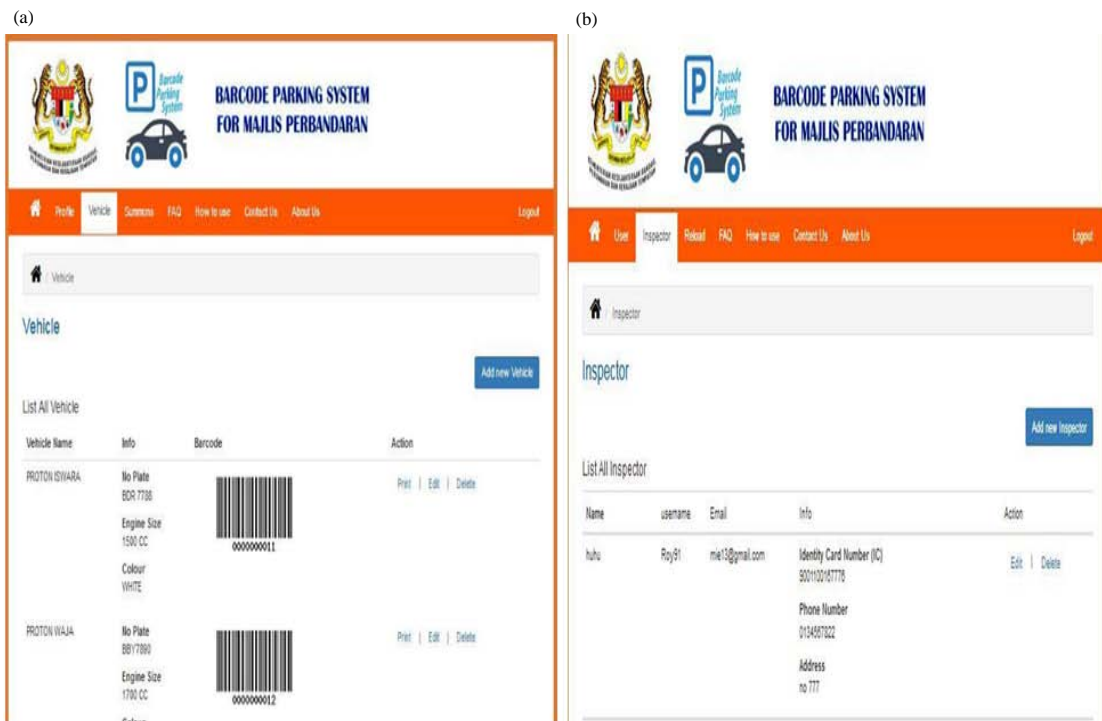
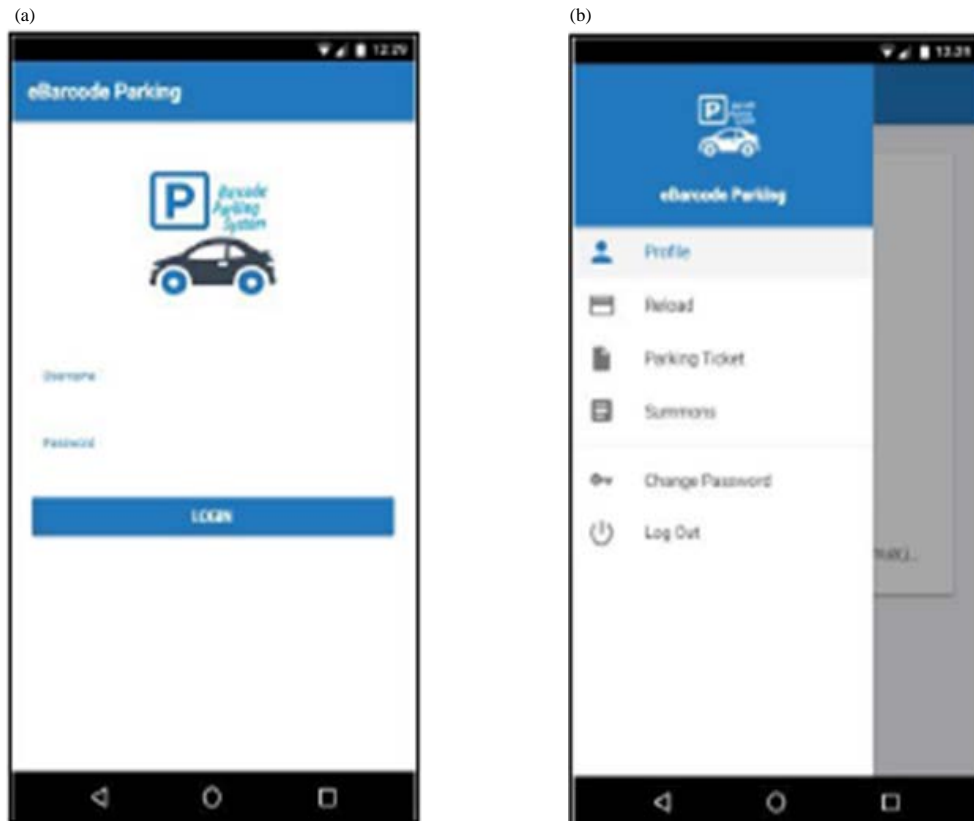(a)   (b)

Fig. 12: Vehicle and city council enforcement officer's page
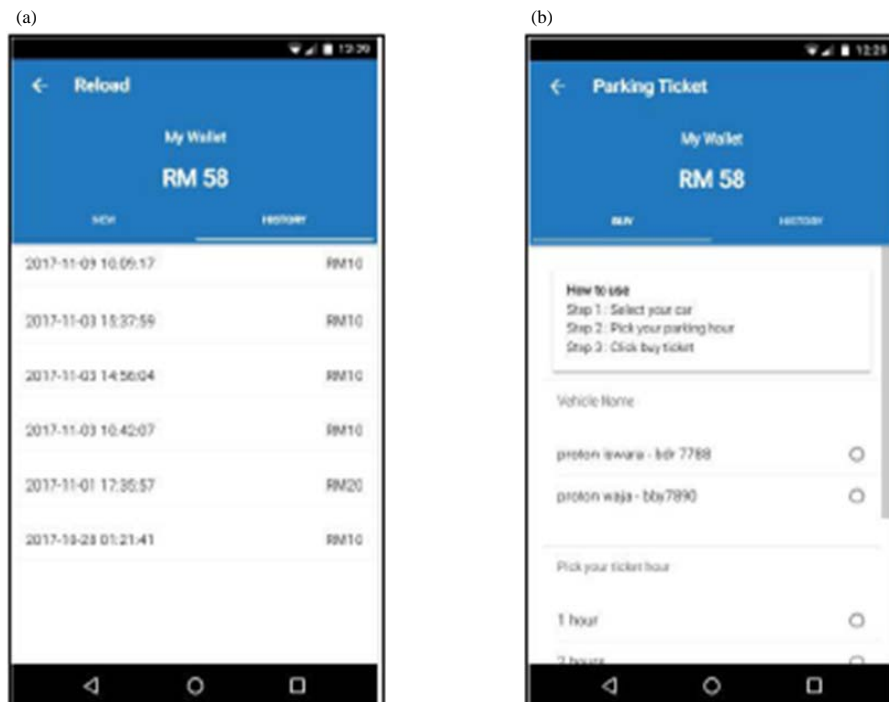
Fig. 13: Mobile application of barcode parking system

Fig. 14: Screen shot of e-Wallet
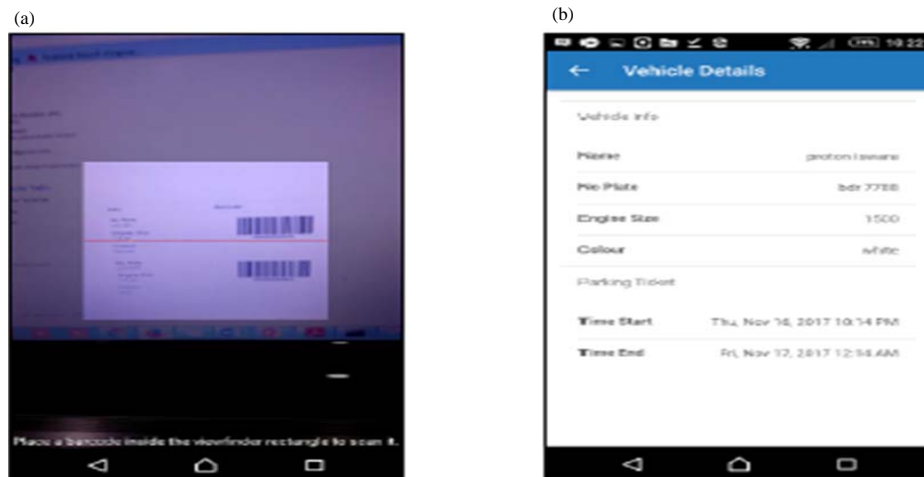
(a)

(b)

Fig. 15: Profile screen shot

(a)

(b)

Fig. 16: Barcode ccanner

Test Case	TC-05	Test Case Name	Interface testing	
System	Barcode parking system (website)	Subsystem		
Designed by	Mohamad Zul Helmi bin Azilla	Design Date	5/4/2017	
Executed by	Haziqah Hanun	Execution Date	21/10/2017	
Related Requirement to be tested				
Test in other platform and device				
Test Data				
Pre-Condition	Admin using the web based application			
Step	Action	Expected System Response	Pass/ Fail	Comment
1	Browse in chorme	Website work properly	Pass	
2	Browse in firefox	Website work properly	Pass	
3	Browse website in android phone (Xiomi Mi3) and tablet (Samsung tablet S2)	Website work property with their functionality	Pass	
4	Browse in ios phone (iphone 7)	Website work property with IOS version 11.3 (latest version)	Pass	
5	Icon position	Website icon does not change in different browser and devices	Pass	
Post-condition				
Note				

Fig. 17: Interface test form

Test Case	TC-06	Test Case Name	Usability test
System	Barcode parking system (website)	Subsystem	
Designed by	Mohamad Zul Helmi bin Azilla	Design Date	29/3/2017
Executed by	Haziqah Hanun	Execution Date	21/10/2017
Related Requirement to be tested			
Instruction and information on how to use the system			
Test Data			
Pre-Condition	Admin and user using the web based application		

Step	Action	Expected System Response	Pass/Fail	Comment
1	FAQ page	Have a faq page for question always been asking	Pass	
2	How to use page	Instruction to use website and mobile application	Pass	
3	About us page	About us tell information of Majlis Perbandaran information contact	Pass	
4	Contact us	Linked page to 'Kementerian Kesejahteraan Bandar, Perumahan dan Kerajaan Tempatan' and address	Pass	
Post-condition				
Note				

Fig. 18: Usability test form

Test Case	TC-09	Test Case Name	Compatibility test
System	Barcode parking system (Mobile Application)	Subsystem	
Designed by	Mohamad Zul Helmi bin Azilla	Design Date	28/4/2017
Executed by	Haziqah Hanun	Execution Date	21/10/2017
Related Requirement to be tested			
Test application mobile with different android version			
Test Data			
Pre-Condition	User using the mobile application		

Step	Action	Expected System Response	Pass/Fail	Comment
1	Test on android 2 (Gingerbread)	Cannot install as not supported requirment	Pass	
2	Test on android 4 – 4.2 (Ice cream sandwich)	Support with success installation and take around 24 second to install	Pass	
3	Test on android 5 (Lolipop) and 6 (Mashmallow)	Support with success installation and take around 10 second to install	Pass	
4	Test on android simulator (bluestack) with android 6	Supported and properly run function of every part	Pass	
Post-condition				
Note				

Test Case	TC-10	Test Case Name	Service testing
System	Barcode parking system (Mobile Application)	Subsystem	
Designed by	Mohamad Zul Helmi bin Azilla	Design Date	29/3/2017
Executed by	Haziqah Hanun	Execution Date	21/10/2017
Related Requirement to be tested			
Run application in offline and online mode			
Test Data			
Pre-Condition	User using the mobile application		

Step	Action	Expected System Response	Pass/Fail	Comment
1	Login page	Run in online and cannot run in offline	Pass	
2	Reload page	Cannot reload in offline and history not update in offline	Pass	
3	Pay ticket	Online mode: can pay ticket Offline mode: cannot pay ticket and error handling popup	Pass	
4	Error handling	Loading icon will popup if there is no internet connection	Pass	
Post-condition				
Note				

Fig. 19: Compatibility and service testing

Test Case	TC-13	Test Case Name	Barcode scanner and summon button
System	Barcode parking system (Mobile Application)	Subsystem	
Designed by	Mohamad Zul Helmi bin Azilla	Design Date	25/7/2017
Executed by	Haziqah Hanun	Execution Date	21/10/2017
Related Requirement to be tested			
Test on scan barcode and summon functionality			
Test Data			
Pre-Condition	Inspector using the mobile application		

Step	Action	Expected System Response	Pass/Fail	Comment
1	Barcode scanner	Barcode scanner work proper with proper auto rotation	Pass	
2	Instruction of barcode scanner	Provide with on how to use the barcode scanner	Pass	
3	Retrieve data from barcode scanner	Data can be retrieve and certainty of information were correctly	Pass	
4	Detail of vehicle information	Vehicle infomation can be show	Pass	

Test Case	TC-11	Test Case Name	Interface test
System	Barcode parking system (Mobile Application)	Subsystem	
Designed by	Mohamad Zul Helmi bin Azilla	Design Date	6/5/2017
Executed by	Haziqah Hanun	Execution Date	21/10/2017
Related Requirement to be tested			
Test for interface in different device			
Test Data			
Pre-Condition	User using the mobile application		

Step	Action	Expected System Response	Pass/Fail	Comment
1	Run in 2G	Application success and take 25 second to login, and others page	Pass	
2	Run in 3G	Applicatiom success and take 18 second to login and others page	Pass	
3	Run in LTE (4G)	Application success and take 8 second to login and others page	Pass	
4	Error handling	Loading icon show while the data retrieve from database	Pass	
Post-condition				
Note				

Fig. 20: Functionality and interface testing

CONCLUSION

The prototype application functions successfully tested by mobile users and it performed well during the implementation and testing phases. The application is useful for local council to deploy but to enforce the agency to use it is another story. The management of city council is not centralize and some parts of the country still prefer to use the coupon ticket system. It is considered successful prototype as it provide the developer to enhance their skill of programming, testing and developing application for mobile phones which is not available freely. The application is useful as it help users to monitor their own parking and its cashless element through the use of electronic payment.

RECOMMENDATIONS

It may have some drawbacks on the font, background and language difficulty, captured from the user's response in distributed questionnaires. Future work for the application would be deploying it in another language for example Mandarin or Bahasa Melayu, national language of Malaysia and to other mobile phone operating system.

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