

My Locker : Loaning Locker System Based on QR Code



Ridha Muldina Negara, Rohmat Tulloh, Nandy Hadiansyah P.N, Rizka Triani Zahra

Abstract: Locker is a place that people usually use to keep things. Commonly, lockers are found in campus hall, tourist site, or other public places. Lockers that we face in a daily activities usually still using a conventional keys that we can't guarantee the security of it. The focus of this research is on online locker rental system that can be accessed through android smartphone and MyLocker application by scanning the QR code. Within this system, occurred website that can be used to see the filled locker or the unfilled locker and there's admin page, to see the summary of data user and the agreement of top up request. The devices component that we used are NodeMCU, Relay, solenoid door lock and magnetic door switch. From the result of the test that done by system worked so well and delayed that we achieved while we did the QR code reading experiment with of lux, gap, and gradient slope with optimal condition is 1.45 seconds.

Keywords: E-Locker, Microcontroller, NodeMCU, QR-Code, Website, Android.

I. INTRODUCTION

There are so many QR code users on daily basis. QR code is helpful for the user to get information in an easier way. There are a lot of benefits that we can get from QR code start from online transaction, shortcut download application, data encoding, promotion media, and gate access. Therefore, it's not a new thing anymore among Indonesian people. But, QR code utilizing still not can't reach the optimum target, one of services that can courage the utilizing of QR code is the conventional locker, that commonly still using key for the security. The previous research in [1] and [2], QR Code was used on door and for the android application was just for scanning using Bluetooth so smartphone can be connected with device. On other research named 'Sistem Kunci Locker Otomatis Menggunakan Teknologi RFID Berbasis Mikrokontroler'[6], that already used locker, but still using RFID as the unlocker. But, we have to increase our budget if using the RFID system, because we need RFID tag and also the reader. On research called 'IOT Based Low Cost Smart Locker Security System'[9], system that valid to open the locker is use the fingerprint. Unfortunately, the weakness of this system is we must add more scanner to read the

fingerprint and this system is not match for locker rental. Hence, we make a project called 'MyLocker' that the purpose of this project is make an easier way for the user to rent a locker. The android application is use for user to rent a locker and the website is use for the admin to manage the income and total using in a month, by seeing the user data that registered on the application and admin can see the recap of the locker rental. The android application and the website was formed from hardware for the system. With MyLocker system, we hope we can help people with alternative security system and replace the conventional keys, RFID, or barcode with QR Code. possible.

II. METHODOLOGY

Locker rental system that implied in this research composed by some main parts such as android application as interface for the user and website for admin and hardware. On android application site user can see the condition of the locker, filled or unfilled, and also can do the top up by themselves. Main benefit of this application is rent a locker, user can also see the locker rental duration and price that user have to pay. On the website section, we would know that the locker is filed or unfilled that provided for user to place their things. Only admin can do the login on website and see the income and also rental user in a month, balance validation request, see the registered user on MyLocker application, and see the rent history. You can check the diagram block from the implied system on the picture 1 below.

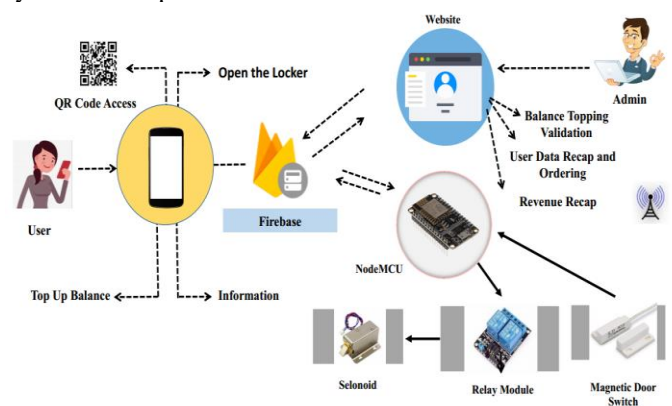


Fig. 1. Block diagram of the whole system

Based on the picture 1, explained that user can see where's the locker that filled or the unfilled one, and user can check the available locker on website or MyLocker application, after that user can start order or scan the QR code on locker that they want to rent. If the data when scanning the QR code is match, thus data will be sent to NodeMCU, furthermore odeMcu will process the data to manage the solenoid to be opened.

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Magnetic door switch is used for cause of notification that inform the information about the locker, close or open on the android application. You can check the function explanation of every component that used on next part :

1. QR Code

QR code is used for saving a data information [13]. Data on the QR code were saved in firebase database, therefore data can be accessed from MyLocker application. QR Code on every locker is different, the QR Code is filled by ID that different from other to other.

2. Firebase

The function of firebase is used as the database and on this system is for saving realtime data. Firebase feature that used on this system is firebase authentication that work for user membership service [4]. Firebase realtime database to save data that saved in JSON forms and synchronizing in realtime in every client that connected and will receive data reform automatically [8] and firebase storage enable the developers to post or download a file [3].

3. Android

There are some features that available on the MyLocker android application that can do rental by scanning the QR Code, application can show the feature to see the condition of locker that filled or unfilled and the application also can do balance top up even though there's no balance left to be top up-ed.

4. NodeMCU

Node MCU itself is one of the firmware module ESP8266 that already open-source [7]. The function of the NodeMCU as microcontroller that manage all the logic of MyLocker system. The benefit of NodeMCU against Arduino is NodeMCU has wi-fi module that connect the system with internet.

5. Magnetic door switch

Magnetic door switch is one of the security system base components and hazardous alarm system (most of it used for secure thing, usually for the cause of alarm) [12]. The function of the magnetic door switch is for giving the notification to android that locker is opened or closed.

6. Relay

Relay is electric switch that using the electromagnetic to move switch from off to on [10]. In this system, the function of relay is for cutting and connecting flow to solenoid door lock.

7. Solenoid door lock

Solenoid door lock is an electromagnetic spool that designed in certain way, usually use for locking door [16]. In this system, solenoid used as the lock of locker.

8. Website MyLocker

The function of the website is to show where's the filled locker and the unfilled one that ready to use. There is admin menu for monitoring and controlling such as see the registered user data, see the online user, see rental history, see the locker income and locker that rented in a month, and admin can augment user's balance.

9. Internet of Things

Internet of things (IoT) is network of physical or electric things, software, sensor, and connective system that make things possibly placed on one place or changed data. The IoT concept that used for many creative application to be implied on real life problem [14]. This IoT network has begun to be widely applied, for example

on smart home [5][11] and other examples on health [15].

A. My Locker Android Application

My Locker application has minimum operation system named API 21 : Lollipop. Android application that can be connected with website through internet so can be accessed by admin. Application using firebase as its database for saving locker rental data and firebase authentication for saving user data. Every input datum that success towards the application, thus data will be saved in firebase database. In picture 2 below, explained that user can do some activities on MyLocker application, such as augment balance, see profile, do the rental transaction, see the detail of rent, and scanning QR Code.

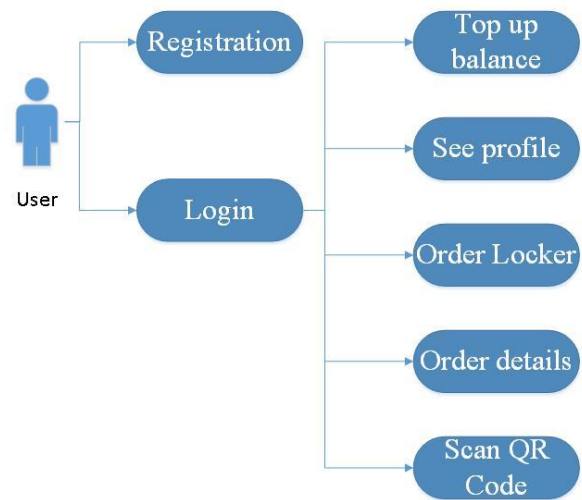


Fig. 2. Use case diagram for MyLocker application

TABEL I. : Description of every case menu

No.	Use Case Name	Description
1.	Registration	New users must sign up on the MyLocker application to order a locker and registered on the system
2.	Login	Users must login to be able to access and view the features available in the MyLocker Application.
3.	See Profile	Users can change passwords, and delete accounts.
4.	Top up Balance	The user can top up the balance by inputting the nominal and uploading proof of payment in accordance with the nominal input by the user

No.	Use Case Name	Description
5.	Order Locker	Users can order lockers by selecting the locker size, available locker numbers, and can scan the QR Code to open the locker door.
6.	Order Details	The user can view the order details, such as the duration of the loan, the total price of the loan and can scan the QR Code and can end the loan
7.	Scan QR Code	Users must scanning the QR Code to continue the loan process.

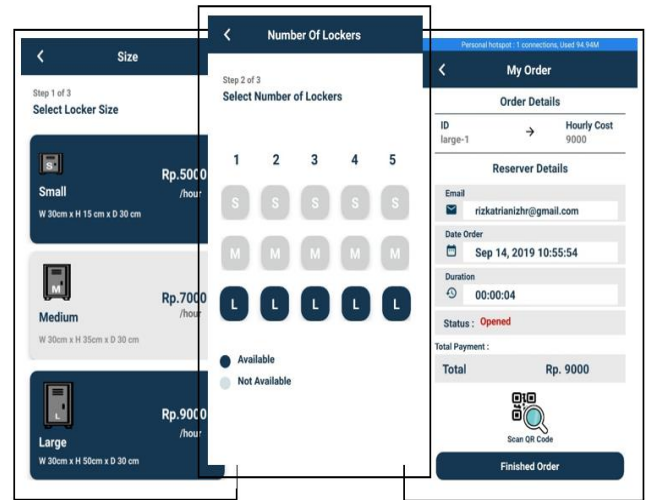


Fig. 4. Order Locker Menu

On the MyLocker application, we just need to scan the QR Code that written on locker thaw he chose. After scanning the QR Code, data will be sent to Firebase Database. Database will try to match the user data, if it did, database will give a command to the device based on data in database. If user has finished the rent, thus balance will be automatically lessen and if user has not enough balance, MyLocker also provide top up feature. Check the display of MyLocker application.

In this application, there are also a few features that have certain functions on each of them. One of the menu is locker order, that shown on the picture 4 that show the size of the locker, number of the locker, and realtime of locker loaning information. All of the information could be known from this menu start from size of locker, locker number, email, locker price, and etc.

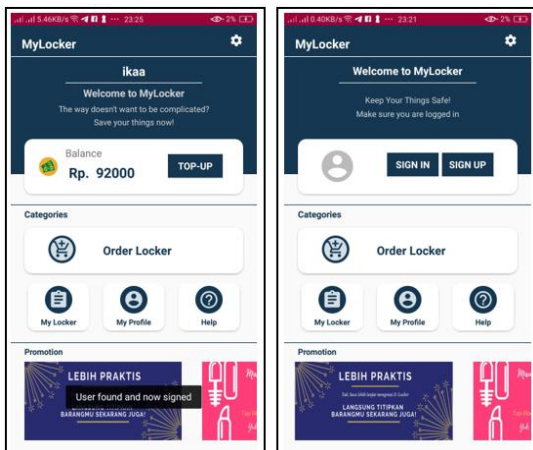


Fig. 3. Main Page Display

A view that shown on the picture 3, is a form of the main view of first page after doing the login processed. There are also a few features, which is top up, locker order, my locker, my profile, and help. All of them could be accessed after the user has login. Meanwhile, picture that shown on picture 3 is a view when the user hasn't login yet and user couldn't access all of the features.

B. My Locker Website

MyLocker intend to keep track of any information that happened in locker loaning. Start from the user that has been registered, watching the income and outcome that used every month, top up balance validation. The admin also downloads the user data that has been registered and history of locker booking into excel file. The making of this website is using Sublime Text 3 as text editor language program PHP, CSS, HTML, bootstrap and also hosting so could be accessed from the user and MyLocker admin. in the plan of the website, website could be connected from internet so that could be accessed from the admin. firebase realtime database are used in this website in order to keep and save the MyLocker order. Use case of the diagram for the website are explained on picture 7 below To make this website, we used Sublime Text 3 as a text editor to programming language PHP, CSS, HTML, bootstrap and in hosting so it can be access by user and admin MyLocker. On website design, the website will connected from the web so it can be accessed by admin. Firebase realtime database is used on this website to attached and saved the data of MyLocker order. The diagram of use case for the website is illustrated by the picture below :

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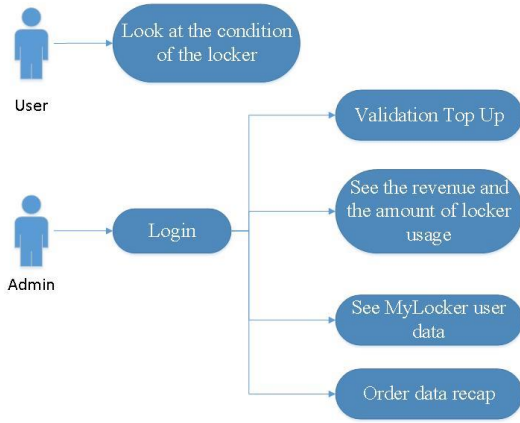


Fig. 5. Use case diagram for website application

Picture 5 is explained 2 levels of user on MyLocker website. The first level is user. User only can see the locker is filled or not. The second level is admin. Admin can login themselves on admin menu, top up validation, see the incomes and the usage of locker monthly, see account user MyLocker and the summary of data ordering MyLocker



Fig. 6. Display menu Home Page on website

Picture 6 is the first display from the website MyLocker. This page showed the condition of the available locker and unavailable locker. The locker that still available will be colored by gray and the unavailable locker will be colored by blue.

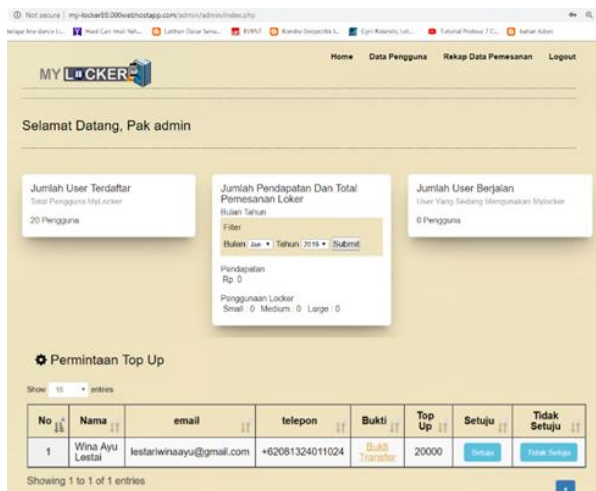


Fig. 7. Display menu Home (admin) Page website

Picture 7 is the display of Home Admin. This page will show the income from the locker usage and how much the order of the locker monthly. Admin can see the amount of users that

registered and rented the locker too. There is a feature to show the request to top up from the user and then it will be validate by the admin if the receipt of the payment is matched.



Fig. 8. Display Data Recapitulation Page on website

Picture 8 is showed the order list, this page is divided into two section. The first section is the on-going user data and the second section is order history. The function of on-going user data is to help admin to know who is using MyLocker. The showed data on this section are order date, name, email, id locker and time. The order history section is made to help admin to list the previous orders on MyLockers. The showed data on this section are order date, email, id locker, price, order time, duration and a bill. The data can be downloaded by admin in excel form.

C. My Locker Hardware

Picture 9 is a diagram of hardware design. On hardware design used a Node MCU as a microcontroller, a Magnetic door switch, a relay module one channel, and a solenoid lock. This component is only for 1 locker.

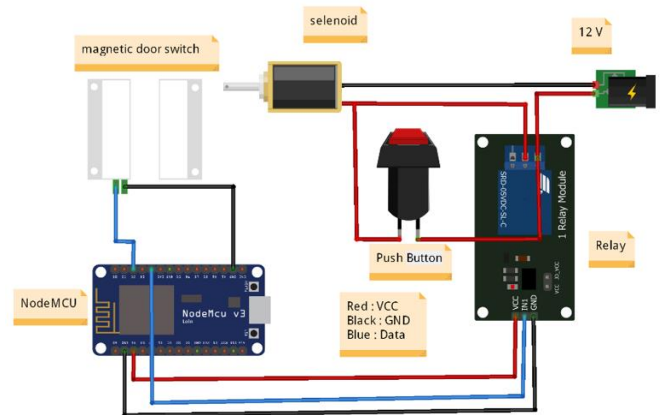


Fig. 9. Block system hardware MyLocker

Picture 10 is where we put the Magnetic door switch and solenoid which is inside the locker door. The solenoid is a lock system of the locker and Magnetic door switch is to sent a notification to MyLocker application.



Fig. 10. Magnetic door switch and Selenoid

Picture 11 showed the position NodeMCU and connected relay. This component is placed on the back side of the locker with a casing on it. A locker is consisted of a hardware and there is three hardware for three locker. This casing cannot be put permanently because if there is a malfunction on the hardware it can be fixed.



Fig. 11. NodeMCU and Relay

Picture 12 showed the shape of the locker from the front and the back side. From the front side, we can see a different QR Code to each of lockers. On the back side, we can see a microcontroller in a casing.



Fig. 12. Implementation locker

III. RESULTS AND DISCUSSION

This research is to do a set of test for MyLocker application on Android, website and hardware.

3.1 My Locker Android Application

3.1.1 The Successes of Scanning QR Code

Picture 13 is a scenario of the test. On picture (a), we use the Lux Meter to establish the exposure, an arc to show the angle and a ruler to get the scanning length of QR Code with a Tripod so the smartphone is steady and picture (b) is explained about the position of scanning the QR Code when we do the tests in a variants angles.

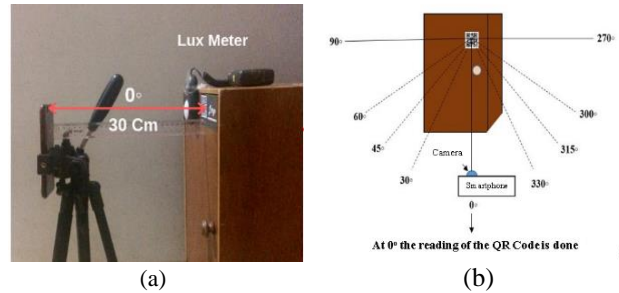


Fig. 13. Scenario of the test

The successes test of scanning QR Code is different condition of Lux Meter when we scan the QR Code, the length to scan the QR Code on Lux is optimal (400 Lux) and the angle to scan the QR Code on the optimal length. We did these tests 10 times. And this is the results of the test.

TABEL II. : The successes of scanning qr code

Parameter		
LUX	Distance (cm)	Angle
5- 4000	10 – 90	0° – 45°
		300° - 330°

Based on Table 2, it showed that the scan QR Code is steady for Lux 5 to 4000 Lux, if its below Lux 5 it cannot be read because the exposure is not enough and if its beyond Lux 4000 it cannot be read because the exposure is too bright. The optimal length is from 10 cm to 90 cm with 0°, 30°, 45°, 315°, 330°. And then we measure the delay of reading QR Code data when the Lux in an optimal condition, length, and angle which is 400 Lux, 50 cm and 30°. The table below is the results of the delay test.

TABEL III. : Delay scanning QR Code test

Testing	Delay (s)
1	1.571
2	1.419
3	1.505
4	1.464
5	1.309
6	1.475
7	1.503
8	1.436
9	1.368
10	1.488
Average	1.45

Table 3 showed about how much of the time that we need to read the QR Code and we did this tests about 10 times. The optimal delay time is 1.309 seconds when we do the fifth test and the biggest delay time that we got is when we do the first test, its 1.571 seconds. This tests showed that the average delay that we got is already matched with the ITU-T.G.1010 standard.



3.1.2 Compatibility Test

This test is to decide the minimum SDK that can use the MyLocker Application nicely. This test is using the emulator and a smartphone with different API Level. The table below is the result of compatibility test of MyLocker Application.

TABEL IV.: Delay scanning QR Code test

Release Name	Target	Status	Results
KitKat	Android 4.4 API level 19	Not Installed	Matched
Lollipop	Android 5.0 API level 21	Installed	Matched
Lollipop	Android 5.1 API level 22	Installed	Matched
Marshmallow	Android 6.0 API level 23	Installed	Matched
Nougat	Android 7.0 API level 24	Installed	Matched
Nougat	Android 7.1.1 API level 25	Installed	Matched
Oreo	Android 8.0 API level 26	Installed	Matched
Oreo	Android 8.1 API level 27	Installed	Matched
Pie	Android 9.0 API level 28	Installed	Matched

In a making of MyLocker Application, the operation system minimum that can use this application is Android Lollipop version on API 21. If the smartphone doesn't have the minimum operation system, the application cannot be installed. Based on the result of Compatibility test in table 3, this application is already matched with the first design.

3.2 My Locker Website

3.2.1 Functionality Website Test

This test is to know that what we made is matched with the initial design. We did this test by comparing the expected data with the result of this test. And this test is to recognize the trouble on the website. The results of the functionality website test is on the table below.

TABEL V. : Functionality test

Testing Name	Action	Test Result	Result
Monitoring	Enter the Home Page	The locker showed blue for the available and grey for the unavailable	Matched
Login	Log in with the right username	Entering the Admin Page	Matched

Testing Name	Action	Test Result	Result
	and password		
	Log in with the wrong username and password	Cannot enter the Admin Page	Matched
Monitoring Admin	Entered the Home Page (Admin)	Showed list of the users, incomes and total order monthly, the amount of online users and top up request.	Matched
Monitoring Admin	Entered the Users Data Page (Admin)	Showed the users data	Matched
Monitoring Admin	Entered the Recapitulation Page (Admin)	Showed the online users data and history of MyLocker order	Matched
Logout	Log out from the Admin Page	Log out from the Admin Page and entered the Home Page	Matched

Table 5 showed the results of functionality test. From the table we know that the results its matched as we expected.

3.2.2 Delay Website Test

The purpose of this test is to know how long that we need to see the data from Firebase Database.

TABEL VI. : Delay website test

Testing	Delay Home (s)	Delay Home (admin) (s)	Delay Data Pengguna (s)	Delay Rekap Data Pemesanan (s)
1	0.475	1.912	1.582	1.625
2	0.538	2.059	2.097	1.623
3	0.4	2.158	1.967	1.401
4	0.641	1.854	2.082	1.406
5	0.401	2.042	1.941	1.725
6	0.404	2.117	2.383	1.582
7	0.442	1.856	2.379	1.433
8	0.501	2.033	2.461	1.55
9	0.477	1.954	2.428	1.607
10	0.599	1.914	2.375	2.147
Average	0.5094	1.5331	2.26535	1.64735

From table 6 we can see the average time that we need to see the data from Home Page is 0,509 second. Home Page (admin) average delay time is 1,53 second, the User Data Page is 2,26 seconds and to Recapitulation Data Page is 1,64 second.

Based on standard ITU – T its a proper result because still below 4 seconds.

3.3 My Locker Hardware

3.3.1 Functionality Hardware Test

We did Functionality Hardware test 10 times. 5 times when the condition 1 on Firebase and 5 times when the condition 0 on Firebase. This test is to see is the solenoid matched with the data from Firebase.

TABEL VII. : Functionality hardware test

Data Small locker	Solenoid Small Locker	Data Medium Locker	Solenoid Medium Locker	Data Large Locker	Solenoid Large Locker	Result
1	ON	1	ON	1	ON	Matched
0	OFF	0	OFF	0	OFF	Matched
1	ON	1	ON	1	ON	Matched
0	OFF	0	OFF	0	OFF	Matched
1	ON	1	ON	1	ON	Matched
0	OFF	0	OFF	0	OFF	Matched
1	ON	1	ON	1	ON	Matched
0	OFF	0	OFF	0	OFF	Matched
1	ON	1	ON	1	ON	Matched
0	OFF	0	OFF	0	OFF	Matched

From table 7 the tests of hardware functionality showed that solenoid on small locker, medium locker and large locker is working to run the MyLocker system. When the data from Firebase is one, the solenoid will respond with ON and when the data from Firebase is zero, the solenoid will respond with OFF.

3.3.2 Delay Hardware Test

The purpose of this test is to know how long that relay and solenoid need to respond after the data from Firebase is already sent and the time that magnetic door needed to respond the condition and send it to Firebase.

TABEL VIII. : Delay hardware test

Testing	Delay Large (s)	Delay Medium (s)	Delay Small (s)
1	0.83	0.81	0.65
2	0.87	0.56	1.13
3	1.2	0.48	0.64
4	0.7	0.47	0.7
5	1.4	0.59	0.62
6	0.65	0.67	0.68
7	0.9	0.61	1.3
8	0.5	0.59	1.49
9	0.7	0.48	0.7
10	0.65	0.63	0.65
Average	0.84	0.589	0.856

From table 8 we can conclude that on large locker, the average time that solenoid and relay need to open the key is 0,84 second. On medium locker, the average time that it need

is 0.589 second and to small locker, the average time that it need is 0.85 second

IV. CONCLUSION

From the analysis, prototyping and test of MyLocker system, we can conclude that:

1. MyLocker system is just as we expected, it can open the door automatically when we scanned the QR Code, and the website can be monitored the user data of MyLocker and allowing top up for the user.
2. Based on functionality hardware test and softwarw, MyLocker has been working as the function.
3. Based on the results of average delay time test from Lux, length, and optimal angle scanning QR Code which is 1.45 seconds, it is compatible as the ITU-T G.1010 standard (*Preferred* < 15s).
4. MyLocker application can be work on the Android platform with 49.08 MB application size data.

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