QR Code Application for Water Meter Recorder Based on Windows Mobile Platform

Dwiki-Suharta[1], Darma-Putra [2], Wira-Buana[3]

**[1]Department of Information Technology, Udayana University
Bali, 80361, Indonesia**

**[2]Department of Information Technology, Udayana University
Bali, 80361, Indonesia**

**[3]Department of Information Technology, Udayana University
Bali, 80361, Indonesia**

Abstract

Nowadays, the advancement of smartphone technology is rapidly moving forward. Several applications in smartphone were invented which aim to simplify and accelerate the process compared to the manual procedure. Moreover, the QR code usage as one coding technique is a common thing in current days. This is because QR code can save more data than barcode. QR Code can save data both vertically and horizontally, while barcode can save data in one direction only. Besides that, the reading process of QR code is faster than barcode. The usage of QR code can be combined with the smartphone technology. This study is to invent an application in windows mobile for recording the PDAM (Regional Water Company) water meter. Further, the recording process of PDAM water meter can be faster and more practical. The information of PDAM customer identity is modified into QR code form. Moreover, by utilizing the camera feature on the smartphone, the customer identity recognition in the water meter recording process can be done easily. At the end, the QR code reading result which includes the PDAM costumer identity will be connected directly with the water meter recording process.

Keywords: *Smartphone, QR Code, Reader, Generator.*

1. Introduction

The rapid development of technology nowadays has a significant effect toward mobile phone development. This development caused various smart mobile phones (smartphones) invention in a relative short time. Smartphones represent the most recent step in the evolution of portable information and communication technology. [2] Smartphone has a computer-like capability and certain operating system as one in a computer. Operating system in the smartphone is called mobile operating system. One of them that is developed is Windows Mobile operating system. This mobile operating system is invented by Microsoft which is applied in the smartphones and mobile ware. As in a desktop or laptop computer, Windows Mobile devices retain substantial information about user activities that can be relevant in a digital investigation like web browsing, user-created files, and registry entries. [6] However, it is only released for particular market so that the developer for this system is still very rare.

Smartphones offer several advanced features for their users. One of the features that always exists in a smartphone is camera. The functions of built-in camera now become popular and accept add-on to the mobile phone. The camera phone is part of an overall trend towards non-voice functions in the mobile phone. Camera phone has dramatically advanced development in a number of areas, particularly in the resolution of images. High-end terminals can reach more than 2 megapixel level, and it might include features such as auto focus, optical zoom, and removable memory card. [1] Some mobile applications have been invented in purpose to accelerate users' work compared to the manual process, besides to minimize the error possibility. However, most of the mobile existed applications have not utilized the built-in features of the smartphone. Feature utilization of the smartphone in the mobile application certainly will fasten the process and more minimize the error possibility.

The technology development of smartphone caused the inventions of several applications that can be operated on smartphone. One of them is mobile application for recording the PDAM (Regional Water Company) costumer's water meter in windows mobile platform. This application is created to fasten the water meter recording process whereas in the previous time done manually. Because of this application, now the recording process can be done by using smartphone. Further, the water meter recording process result will be sent by SMS (Short Message Service) to the computer server

automatically which will be continued by the process of recording data that contains water meter data and customer data[9]. The water meter recording process by using this application is faster and easier if compared to the manual recording process. Yet, this PDAM water meter recording technology still has drawback. This application is not more practical. It is because the officer still has to input the customer data when doing the recording process that cause less in time efficiency.

A solution that can solve the problem of PDAM customer data input when the water meter recording process will be done is by utilizing Quick Response Code (QR Code) as a tool to identify PDAM customer. By QR code technology, PDAM customer identity information can be change into QR code that is printed into a media which is briefer and simpler. In addition, it can be read easily by PDAM officer. It is done only by capturing picture of the QR code by using camera feature of the mobile phone.

Based on the QR code characteristic and technology used by mobile-ware, hence a mobile application based windows mobile platform is created. It can change PDAM customer identity data into QR code that is known as QR code generator, and also read picture data from QR code that has been captured by a camera, called QR code reader, that integrated with mobile-ware where the data in the captured QR code image will be automatically matched with database that is already inserted within the mobile-ware.

2. Quick Response Code (QR Code)

QR Code is a kind of matrix code or two dimensional barcode that is developed by Denso Wave in 1994. It is named after Quick Response Code (QR Code) because it was developed to increase the reading speed of complex-structured 2D barcodes. QR Code is capable to save information horizontally and vertically. It is different to barcode which saves information horizontally only. For this reason QR code holds a considerably greater volume of information. In addition it can encode several types of data including symbols, control codes, binary data, and multimedia data. The typical barcode holds a maximum of 20 digits, while the maximum data capacities of a QR code are 7,089 characters for numeric data, 4,296 characters for alphanumeric data, 2,953 bytes for binary data, and 1,817 characters for Japanese Kanji and Kana data. Additionally, QR Code is faster to read than other two-dimensional code, because it contains three large square patterns in the corners that are used for position detection. [5] QR Codes are machine readable only. This means that a human reading examination at the code is

unable to determine its content. QR Codes can be used for various purposes such as to market a business, to provide further information on a product or service by encoding general text, URL, phone number, business card and even provide Wi-Fi access. [4] Fig. 1 shows QR Code structure. It is explained as follows:

a.   Finder pattern
     Finder pattern is a pattern for detecting the position of QR code.
b.   Timing pattern
     Timing pattern is a pattern for detecting main coordinate point of QR code. Alternating black and white modules in the Timing Pattern enable the software decoder to determine the width of a single module.
c.   Alignment pattern
     Alignment pattern is a pattern that is used to fix any discrepancy of QR code, especially non-linier distortion. Version 1 QR code does not have alignment patterns. Further, with growing size of the code, more alignment patterns are added.
d.   Data area
     Data area is the area where the data is saved or coded. Data is converted into a bit stream and then stored in 8 bit parts in the data section.
e.   Quiet zone
     Quite Zone is the empty area in the outermost of QR code which help to recognize QR code identity by CCD censor.[7]
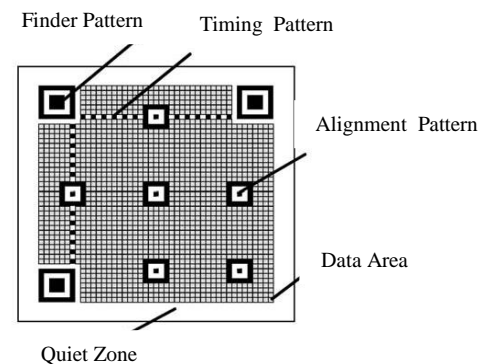

Fig. 1 Structure of QR code

Table 1 below shows specification of QR code.

Table 1: Specification of QR code

Symbol size	Min. 21x21 cell - Max 177x177 cell (with 4-cells interval)	
Information type and volume	Numerical characters	7,089 characters at maximum
	Alphabets, signs	4,296 characters at maximum
	Binary (8 bit)	2.953 characters at maximum
	Kanji characters	1,817characters at maximum
Conversion efficiency	Numerical characters mode	3,3 cells/character
	Alphanumerical/ signs mode	5,5 cells/character
	Binary (8 bit) mode	8 cells/character
	Kanji character mode (13 bit)	13 cells/character
Error correction functionally	Level L	Approx. 7% the symbol area restored at maximum
	Level M	Approx. 15% the symbol area restored at maximum
	Level Q	Approx. 25% the symbol area restored at maximum
	Level H	Approx. 30% the symbol area restored at maximum
Linking functionally	Possible to be divided into 16 symbols at maximum	

Specification of QR code is explained as follow:

a. Symbol size
    The size of QR code depends on the data volume and reading methods (minimum 21x21 cells, maximum 177x177 cells).
b. Information type and volume
    QR code can save some data types such as numerical characters, alphabets, signs and kanji characters.
c. Conversion efficiency
    QR code has four types of conversion efficiency namely numerical characters, alphanumerical/signs, binary and kanji characters.
d. Error correction functionally
    QR code has error correction function to restore the data (level L 7%, M 15%, Q 25%, H 30%). Error correction in QR code is based on Reed-Solomon

Codes. Error correction codes are stored in 8 bit long code-words in the error correction section. [8]

3. Overview Of The System

QR code mobile application is utilized by PDAM (Regional Water Company) officers in the process of customer identity recognition when the process of PDAM customer water meter recording is being done. Fig. 2 shows the overview of the system of QR code generator and reader application as the PDAM customer identity recognition.
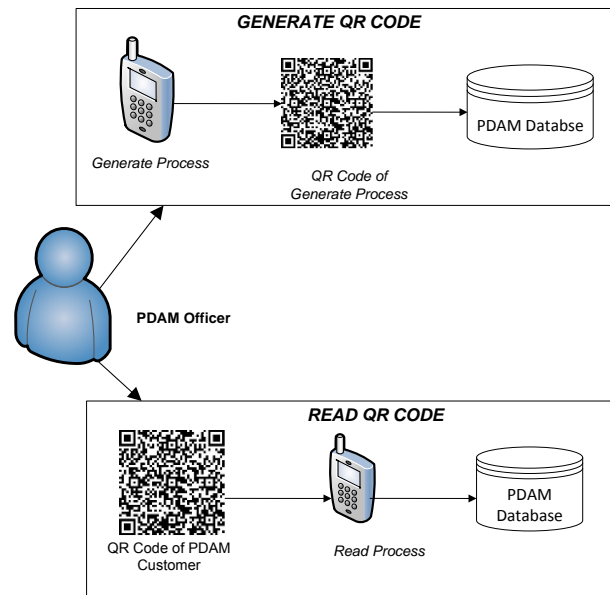

Fig. 2 Overview of the system

This application is used by PDAM officer to do two jobs. The first is to do the process of generating PDAM customer identity into QR code form. The second is to do PDAM customer id recognition through QR code reading, followed by the process of recording and storing information about the water usage on the PDAM water meter.

The role of mobile phone in the process of generating QR code is as the following:

a. Executing the process of generating PDAM customer identity information into QR code form.
b. Executing the process of storing QR code image file that consists of customer identity information after the generating process has been done.

The role of mobile phone in the process of QR code reading is as the following:

a. Executing the process of QR code reading from the captured QR code image using camera (capture image).
b. Executing the process of inputting number from PDAM customer water meter based on the PDAM customer identity.
c. Executing the process of capturing customer water meter as the proof of meter number.
d. Executing the process of QR code image storing, which is the result of QR code capturing, numeric data of PDAM customer water meter and the result of water meter captured image.

Generating process of QR code is done by PDAM officer in purpose to change PDAM customer identity into QR code, so that in the form of QR code, when it is read will contain PDAM customer identity information that is suitable with its identity number.
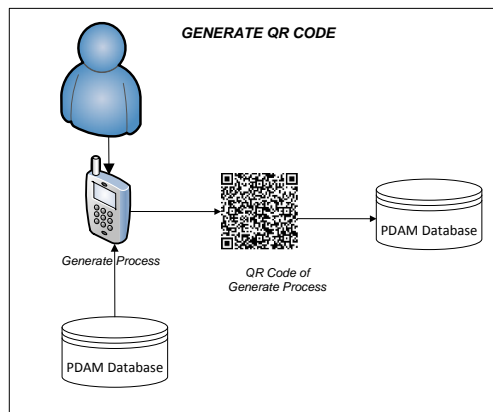

Fig. 3 Overview of the QR code generating process in the mobile phone

Below is the explanation of Fig. 3:

a. PDAM officer inputs customer data which is customer identity number into QR code generator application in the mobile phone.
b. The application will check the availability of the customer data based on the identity number that has been inputted by the officer.
c. QR code generator application will change the customer data into QR code form.
d. The application will show the result of generating process in QR code image.
e. Officer can save the result of the QR code image into PDAM customer database.

The data information of the PDAM customer that will be generated into QR code form are customer identity

number, name, address, class and area. Data format that is stored in QR code is as the following:

```
id_customer*name*address*class*area
```

The usage of asterisk symbol (*) as the divider of customer data is purposed to simplify QR code reading process.

QR code reading process is done by the officer in purpose to gain PDAM customer identity information through QR code capturing process before the officer doing PDAM customer water meter number recording.
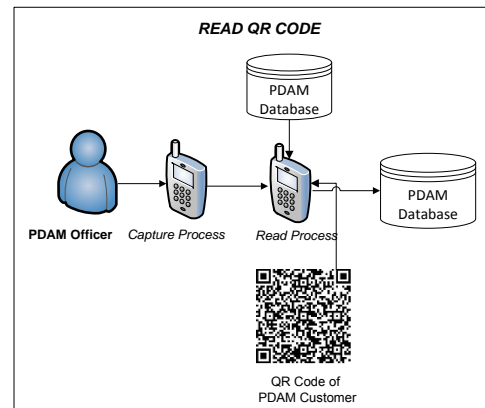

Fig. 4 Overview of QR code reading process in the mobile phone

Below is the explanation of Fig. 4:

a. PDAM officer execute QR code image capturing process on the PDAM customer water meter by using the QR code reader application in the mobile phone that is connected with a camera.
b. QR code image, as the result of camera capture will through QR code reading process.
c. The read data from QR code is the PDAM customer identity number. When the connection number has been read, then the matching process of the read connection number with customer data in the customer database will be done. If the QR code is unreadable, then the officer is required to re-execute capturing process until the captured QR code result is readable. When the QR code is read so other data about the customer identity will be shown.
d. The process after QR code is read and the data is matched is inputting the number that appears in the PDAM customer water meter and taking the picture of water meter's number.
e. The last process is the storing of QR code image capturing result, latest result of PDAM customer water meter, and image files of water meter's number into the database.

The read QR code from the beginning contains the complete information about PDAM customer namely customer identity number, name, address, class and area. But when the matching process with the customer database is happening, the information used is only the customer identity number.

The context diagram in Fig. 5 explains about the overview of the process that happens in the mobile QR code generator and reader system based on windows phone platform to recognize PDAM customer identity.
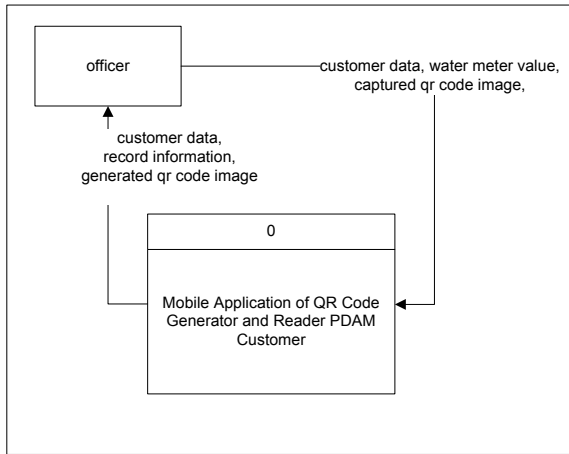

Fig. 5 Context Diagram

The entity within the context diagram in Fig. 5 is as the following:

a. Officer
   Officer is the user of the system who has a full access in the system.
   Officer can do QR code generating, reading, and data inputting process.
b. QR code generator and reader mobile application to recognize PDAM customer identity.
   QR Code Generator and Reader mobile application to recognize PDAM customer identity is the main component of this context diagram. This application is utilized to do generating process of customer identity into QR code form and also do the process of customer identity QR code reading in the field.

4. Experiments and Results

Experiment is the next step which is essential because by doing an experiment, a programmer will be able to discover any error in the system. Furthermore, it will be explained about the experiment of utilizing QR code generator and reader mobile application as the PDAM customer identity recognition.

Fig. 6 below is login form when officer will access QR code generator and reader application for PDAM customer identity.

Fig. 6 Login form PDAM QR code

Login form only can be accessed by officers who already have username and password to access PDAM QR code form. Username and password of the officers is shown on the following table.

Table 2: Officer table

Officer id	User name	Pass word	Name
pt1	dw	dw	Dwiki
pt2	eka	eka	Eka

After login process is succeeded, the officer will enter the PDAM menu form.

Fig. 7 PDAM QR code menu

IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 2, No 3, March 2013
ISSN (Print): 1694-0814 | ISSN (Online): 1694-0784
www.IJCSI.org
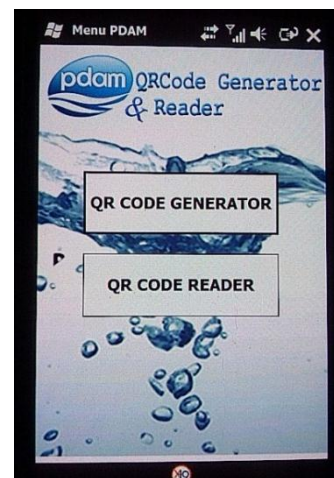
12

PDAM menu form has two buttons that will be done by the officer. They are QR code generator button and QR code reader button that is shown in the Fig.7 above.

Fig. 8 PDAM QR code generator form

Fig. 8 shows QR code generating process from PDAM customer data. It begins by PDAM customer identity number checking. If the PDAM customer identity number is matched with the database, further the complete data will be shown automatically. Next the officer can do QR code generating process and finally save the result of the QR code generating process. Customer QR code image is stored in "my documents\my pictures" directory of the mobile phone. In the customer database only the directory of the file storage that is saved. It is shown in the Table 3 below.

Table 3: Customer table where customer id "20607"

Customer id	Name	Address	Class	Area	QR code
20607	Pan Sulastri	Dsn. Wani	C6	P022119	My Documents\ My Pictures\ 20607.jpg

The QR code result after generating process of PDAM customer data is shown in Fig. 9.

Fig. 9 QR code of PDAM customer where id = "20607"

From the example of QR code picture above, there is complete information of the PDAM customer in it. The information includes the customer identity number, customer name, costumer address, costumer category, and customer areal. Rendering to QR code example with customer data which have identity number "20607", then the example data that will be saved in to QR code is:

```
20607*PAN SULASTRI*DSN.
WANI*C6*P022119.
```

QR code reading process is started by QR code image capturing process. When the officer chooses to do QR code reading process, automatically the application will activate the camera feature and the officer can capture the PDAM customer QR code image as in the Fig. 10.
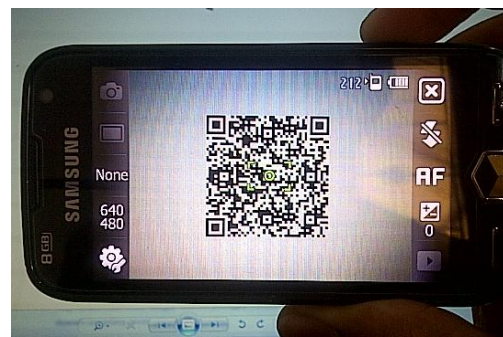

Fig. 10 PDAM QR code capturing process

If QR code is unreadable, so that the application will be automatically re-execute the image capturing process. Similarly, if the QR code is readable but the read data is not match with the PDAM customer database, the process will be repeated automatically.

The succeed of QR code reading process is marked by the appearance of PDAM customer complete data from the QR code as it is shown in Fig. 11. On the PDAM reader form, it is also shown the QR code result from the QR code image capturing process earlier. On this form,

IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 2, No 3, March 2013
ISSN (Print): 1694-0814 | ISSN (Online): 1694-0784
www.IJCSI.org

13

there are some buttons such as capture button, view image button and save button.

Fig. 11 Result of PDAM QR reading code process

It is the same as checking process of the QR code generator, the customer data that appear in PDAM reader form is taken from the customer table as it is shown in Table 3.

The last process is data storing of PDAM customer water meter recording. The stored customer data includes water meter number, water meter condition, read QR code image, and customer water meter image. All the mentioned data will be saved in the PDAM customer database. Especially for QR code image and customer water meter image, the data that is saved in the customer database is the directory of the image storage in the mobile phone as it is shown in the Table 4.

Table 4: Record table where customer id "20607"

Record id	Customer id	New value	Water meter image	QR code image
1	20607	234	My Documents\ My Pictures\ 20607_ 2_2013.jpg	My Documents\ My Pictures\ 20607.jpg

The QR code reading process is influenced by several factors, such as capture position factor, the distance between camera, object and lighting, QR code object rotation factor, and QR code object situation when the reading process is running.

QR code is readable if the camera position is perpendicular towards the QR code object when the process of capturing QR code picture is executed. Table 5 below shows the result of QR code reading experiments with different captured picture's distance and lighting.

Table 5: QR Code Reading Experiments with different capture distance and lighting

No	Lighting	Distance (cm)	Time required (second)	Result
1	Bright	6	-	Unreadable
2	Bright	8	-	Unreadable
3	Bright	10	< 5	Readable
4	Bright	12	< 5	Readable
5	Bright	14	< 5	Readable
6	Bright	16	< 5	Readable
7	Bright	18	< 5	Readable
8	Bright	20	< 5	Readable
9	Bright	22	-	Unreadable
10	Bright	24	-	Unreadable
11	Underexposed	6	-	Unreadable
12	Underexposed	8	-	Unreadable
13	Underexposed	10	7-10	Readable
14	Underexposed	12	7-10	Readable
15	Underexposed	14	7-10	Readable
16	Underexposed	16	7-10	Readable
17	Underexposed	18	-	Unreadable
18	Underexposed	20	-	Unreadable
19	Underexposed	22	-	Unreadable
20	Underexposed	24	-	Unreadable
21	Very Bright	6	-	Unreadable
22	Very Bright	8	-	Unreadable
23	Very Bright	10	< 5	Readable
24	Very Bright	12	< 5	Readable
25	Very Bright	14	< 5	Readable
26	Very Bright	16	< 5	Readable
27	Very Bright	18	< 5	Readable
28	Very Bright	20	< 5	Readable
29	Very Bright	22	-	Unreadable
30	Very Bright	24	-	Unreadable

From 30 times experiments with different distance and lighting, the analysis obtained that the QR code will be easier to be readable and take shorter time (less than five second) is in bright and very bright lighting conditions with 10 – 20cm distance from the object.

Table 6 shows the result of QR code reading process experiments with different QR code rotation direction when the process of capturing picture is executed.

Table 6: Reading Experiments with Different QR code Rotation
Direction

No	Rotation	Image file	Result
1	90' to the left		Readable
2	90' to the right		Readable
3	180'		Readable

Table 7 shows the QR code reading experiments with different QR code conditions. Different QR code conditions factor is when there are other objects besides QR code in the camera capture results when QR code capture is executed before the reading process runs. Those objects can be beside or inside the QR code.

Table 7: Reading Experiments with different QR code object conditions

No	State of the object	Image File	Result
1	There is other object outside the QR code		Readable
2	There is part of other QR code		Unreadable
3	There is other object inside the QR code		Unreadable

| 4 | There is other object inside the QR code | | Unreadable |
| 5 | There is other object inside the QR code | | Unreadable |

This application is featured with additional desktop application that can generate the QR code of all customer data in the PDAM database at once. Fig. 12 shows the initial display application where there are "view data" and "start generate" option.
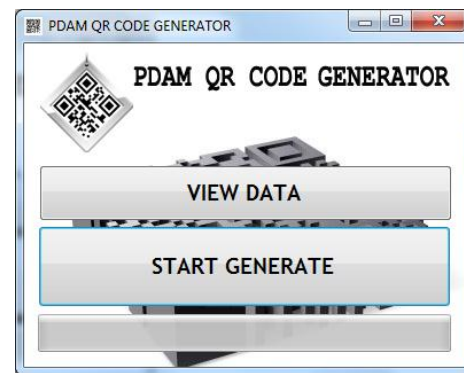

Fig. 12 PDAM QR code desktop application

If the process has not been generated, then when viewing the costumer data, the QR code picture of those customer data will not be visible on the screen as shown on the Fig.13.
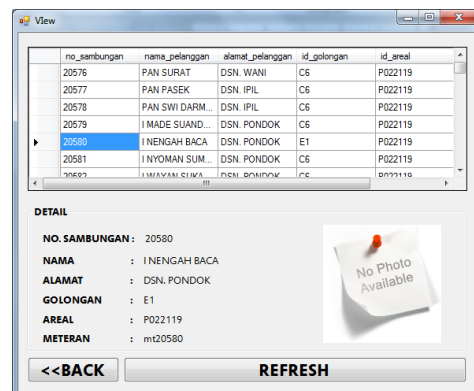

Fig. 13 Data view before the generate process is started

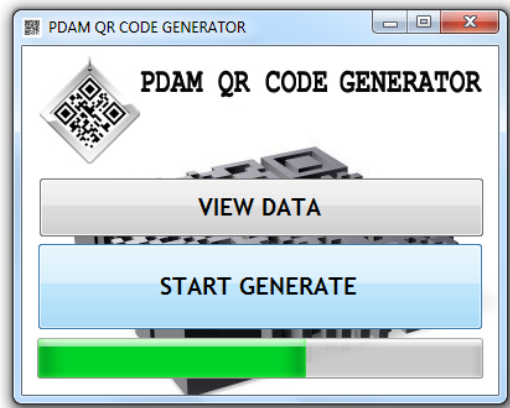Fig. 14 shows all the generate process of PDAM customer data. This process may take some time.

Fig. 14 Generating process of all PDAM customer data

Once the generating process has been completed, then when viewing the customer data, all the customer data has had QR code form, as shown in the following Fig.15.
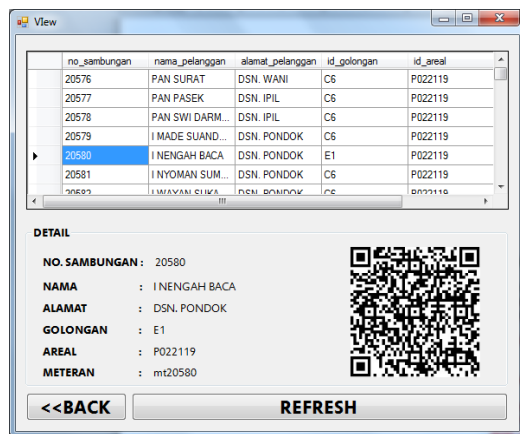

Fig. 15 Data view after the generating process is done

5. Conclusions

QR code generator and reader mobile application is capable to do data generating process into QR code form and QR code reading to gain the information that is suitable with the database in the system. Furthermore, it can save QR code result both from generating and reading process into database that exists in the mobile phone. QR code reading process is directly connected to the water meter recording process.

Acknowledgments

References

[1] Daisuke, Okabe, Emergent Social Practices, Situations and Relations through Everyday Camera Phone Use, in Mobile Communication and Social Change Seoul, 2004

[2] Oulasvirta. Antti, Rattenbury. Tye, Ma. Lingyi, Raita. Eeva, Habits make smartphone use more pervasive, Springer-Verlag London Limited, 2011.

[3] Kokoumidis. Emmanouil, Martonosi. Margaret, Peh. Li-Shiuan, Leveranging Camera for Collaborative Road Advisories, IEEE Transactions On Mobile Computing.

[4] Narayanan. A. Sankara, QR Codes and Security Solutions, (IJCST) International Journal of Computer Science and Telecommunications, Vol. 3, Issue 7, 2012.

[5] Coleman. Jason, QR Codes: What are They and Why Should You Care, (CULS) Cansas University Libraries, Vol. 1, 2011.

[6] Casey. Eoghan, Bann. Michael, Doyle. John, Introduction to Windows Mobile Forensics, Elsevire, 2010.

[7] J. Gao, V. Kulkarni, L. Chang, and H. Mei. A 2D Barcode-based Mobile Payment System, MUE, 2009, pp. 320-329.

[8] Kieseberg. Peter, Leithner. Manuel, Mulazzani. Martin, Munroe. Lindsay, Schrittwieser. Sebastian, Sinha. Mayank, Weippl. Edgar, SBA Research, 2010.

[9] Manuaba. Anom, Putra. Darma, Marini. Ika, Mobile Application of Water Meter Recorder Based on Short Message Service Transmissions Using Windows Mobile Platform, (IJCSI) International Journal of Computer Science Issues, Vol. 1, No. 2, 2013, pp. 565-575.

[10] Woodcock. Andrew, Middleton. Andrew, and Nortcliffe. Anne, Considering the Smartphone Learner: an investigation into student interest in the use of personal technology to enhance their learning, Student Engagement and Experience Journal, Vol 1, Issue 1, 2012.

[11] Y.P. Huang, Y.T. Chang, and F.E. Sandnes. Ubiquitous Information Transfer Across Different Platforms by QR Codes, J. Mobile Multimedia, 2010.

[12] QR Code library : http://en.sourceforge.jp/projects/sfnet_QRreader/downloads/MessagingToolkit.QRCode.dll/

[13] PDAM : http://www.pdamtabanan.com

I Made Dwiki Wirya Suharta is a student of Department of Information Technology Udayana University, and now working his research for S.Ti. degree.

I Ketut Gede Darma Putra received his S.Kom. degree in Informatics Engineering from Sepuluh November Institute of Technology, his MT. degree in Electrical Engineering from Gajah Mada University and his Dr. degree in Electrical Engineering from Gajah Mada University. He is a lecturer at Electrical Engineering Department (major in Computer System and Informatics) of Udayana University and lecturer at Information Technology of Udayana University.

Putu Wira Buana received his S.Kom. degree in Informatics Engineering from Sepuluh November Institute of Technology and his MT. degree in Electrical Engineering from Brawijaya University. He is a lecturer at Information Technology of Udayana University.