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A Quick Response (QR) Code Generator with Mobile Scan Application for Mobile Network Recharge Operations

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Abstract- This paper, a Quick Response (QR) Code Generator with Mobile Scan Application for Mobile Network Recharge Operations (GSM Networks) tries to implement a system with an excellent cross platform compatibility. The emergence of the Android Mobile Operating System has brought about a huge change in the smart phone industry. It has contributed to the increase in the range of services which a smart phone can provide. The Quick Response (QR) Code technology can be regarded as a key technology in the future of mobile network operators in the telecommunication industry. This work is to present a model of mobile recharge solutions using the QR Code as the communication link, enabling encryption of transaction details using the python flask framework as well as their ability to be used in the exchange of financial value. The system developed is a new android mobile wallet application which was developed using the object oriented analysis and design methodology. Our experimental result shows that the new system has better security features as it deploys dual authentication.

Index Terms: Android Operating System, Mobile Network Operators, Mobile Application Scanner, Quick Response Code (QR), Python Flask Framework, Recharge Vouchers, Smart Phone.

1.0 INTRODUCTION

The QR Code is the trademark for a type of matrix barcode (two-dimensional barcode) first designed by the automotive industry in Japan. Also, a barcode is a machine-readable optical label that contains information about the item to which it is attached. A QR code uses four standardized encoding modes (numeric, alphanumeric, byte/binary, and kanji) to efficiently store data; extensions may also be used. It has a larger set of machine readable codes as compared to the one-dimensional barcode and it can hold more data because it uses both the horizontal and vertical axis. It is widely used in different fields such as manufacturing and mobile marketing. QR codes have a more advanced error correction mechanism and are more reliable as it has a faster speed than other codes (*Adeel et al.,* 2014).

Below is a sample of a QR Code.

Figure 1: Sample of a QR Code

They were first created in 1994, its purpose was to track vehicles during manufacturing; it was also designed to allow high-speed component scanning. In 2002, when Japanese handset makers and others wanted to turn everyone's phone camera into a barcode scanner for marketing purposes, QR codes were very handy. With two dimensions of operation, QR codes are able to store several hundred times the amount of information carried by ordinary bar codes. They can contain anything that can fit into a maximum of about 4k (roughly one page of text). These codes are versatile.

Application of QR Codes include their use on newspapers, magazines, journals, websites, advertisement, and advertisement board, where they are depleted to store websites' addresses, content information and miscellaneous data. Also, the QR Code is used in advertisements to guide people to visit their websites in the business world. Additionally, the QR Code becomes an official tool that is

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utilized in governments and companies. In 2011, the Royal Dutch Mint announced that QR Code which will be embedded into the official coin would direct a user to a website about the Royal Mint's centennial. The world's largest QR Code is created by Hacherspace and painted on the top of their company's building in Charlotte, North Carolina in (2010). In China, the QR Code is used on the train tickets on the corner of the right bottom and the names of passengers and relevant personal information are also included in this QR Code (*Ahamad S. S. et al*., 2014).

Several pricing models have been postulated for services provided by MNOs. These include Pre-pay and Post-pay Pricing Model, Smart Data Pricing (SDP) model, Bundling Strategy based SDP, Micro-billing framework, Sealed-bid auction-based pricing, Sealed-bid reverse auction-based pricing, Cost-based pricing, Stackelberg game-based pricing, metered charging, Hybrid pricing model, Pay-as-you-go, Post-Paid and Pre-Paid**.** However, the most frequently used pricing model used in Nigeria is the pre-paid and post-paid pricing models. For any of these pricing models, an exchange of cash for intended services is expected (Lu et al., 2017).

Post-paid pricing model is an account-based model where subscribers are expected to deposit any amount into the MNOs bank account. However, with the pre-paid option, subscribers are expected to acquire the respective MNOs recharge vouchers. After acquisition, subscribers are expected to scratch the vouchers for the recharge codes to be revealed (*Susono and Shimomura*, 2006). The revealed recharge codes are then subsequently entered into the subscribers' mobile devices. A lot of time is consumed in this process which is prone to error as the recharge code may have up to a sequence of sixteen numbers. Repeatedly entering wrong recharge pins three times may lead to the blockage of individual's mobile line. Furthermore, the scratched recharge pins must be entered in a MNOs specified format. For instance, MTN Nigeria communications expects her subscribers to use *555*recharge_code# for their payment while GLO expects a subscriber to use *123*recharge_code#. Airtel expects a subscriber to use *126*recharge_code# while EMTS expects *222*recharge_code# to be used by a subscriber (*Frank* et al., 2011). As simple as these steps seem to be, not all subscribers can accurately employ the payment method which has led to errors and subsequent forfeiture of the acquired recharge pins as the case may be.

The objective of this study is to use a Python Flask Programming language in designing the QR Code mobile network operating recharge system, that is, a mobile application that can read, decode and upload the mobile network operator (MNOs) recharge code. The development and use of QR codes was catalyzed by the need to speed up the transaction process by reducing the number of user inputs when recharging with any of the mobile network services like MTN. A sample of the existing recharge pin is shown below.

Figure 2: Existing Recharge Vouchers

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2.0. MATERIALS AND METHODS

2.1 Materials: The materials used in the experimental work were majorly software based.

2.1.1 Python Flask Framework: Flask is a micro web framework written in Python. It is classified as a micro framework because it does not require particular tools or libraries. It has no database abstraction layer, form validation, or any other components where pre-existing third-party libraries provide common functions. However, Flask supports extensions that can add application features as if they were implemented in Flask itself. It provides the user with libraries, modules and tools to help build Web-Applications such as a blog or wiki.

The unit testing of the developed mobile network recharge voucher application was carried out using Python flask frame work. Python flask is a unit testing framework that provides a Java Virtual Machine (JVM) compliant version of the Android Mobile Scanner App. This permits developers to write codes to test each units of their android application and run them on android studio MVC IDE while still using the Android Application Program Interface (API).

2.1.2 Android Studio IDE: Android Studio is the official integrated development environment (IDE) for Android application development. It is based on the IntelliJ_IDEA, a Java integrated development environment for software, and incorporates its code editing and developer tools. Android Studio uses an Instant Push feature to push code and resource changes to a running application. It has a code editor that will assist the developer with writing code and offering code completion, refraction, and analysis. This paper work like every other project in Android Studio has one or more modalities with source code and resource files. Android Studio was implemented in this research too.

2.1.3 (Android) Application Program Interface (API): This is a set of routines, protocols, and tolls for building software applications. Basically, an API specifies how software components should interact. Additionally, a good API makes it easier to develop a program by providing all the building blocks. A programmer then puts the blocks together. This work used the API to build a solid protocol for enabling the QR Code Generator Application to function maximally.

2.1.4 The Programming Language Used:

Python flask is an interpreter, high-level, general-purpose dynamic programming language used for everything, from server automation to data science. It is an open-source software. Python is a great language for beginners, because it is easy to read and understand. You can also do so many things with Python flask that makes it easier to stick with the language for quite a while before needing something else. Python finds itself at home when creating Web Apps like Instagram and helping researchers make sense of their data (*Susono*, et al, 2006).

The syntax in python helps the programmers to do coding in fewer steps as compared to java or C++. Debugging can be done easily with this language too. Python also processes XML and other markup languages as it can run on all modern operating systems through same byte code.

The programming language used in this project is Python Flask Programming. We also made use of HTML, CSS, Bootstrap, and Java Script, and we made use of the Notepad ++ 6.7 as the code editing environment (*Sowern*, 2011).

Additionally, C-Sharp Programming Language was used. The C# is a hybrid of C and C++, it is a Microsoft programming language developed to compete with Sun's Java language. C# is an object-oriented programming language used with XML-based Web services on the .NET platform and designed for improving productivity in the development of Web applications.

2.2 METHODS

The system implementation went through some processes/stages as described below for maximum effectiveness:

2.2.1 The Study and Presentation of Mobile Scan App:

The rise of this innovative mobile technology means a phone is no longer simply a phone; it's a multimedia device with a range of potential implications for the world of packaging. Amongst the most intriguing of these is the quick-response (QR) Code, a two-dimensional code (also called a matrix barcode) designed to be scanned by smartphones. These codes, which appear as small white squares covered with patterns of black modules, allow consumers to access additional information through website links, images and videos on their phones, thus not compromising the design or available space of product packaging as indicated. Currently, the use of smartphones and internet-enabled cell phones are increasing daily. According to marketing data, we should expect smartphones to be in the hands of half of all mobile users at

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the end of the year 2020. Based on this analysis, we were convinced that QR Codes can now be read by almost all mobile phones (*Frank and Samuel,* 2011).

2.2.2 QR Code Generation: The QR Code generation went through the following development processes:

***Stage** 1: **Data Analysis**:* Usually, the QR code can be of four data types: numeric, alphanumeric, byte, and Kanji. These data types can be encoded into string of bits 1's and 0's in different ways. Hence, this stage analyzed the data to be encoded so as to determine its data type and the appropriate encoding mode to be adopted. The recharge PIN being considered here is of numeric data type hence; numeric encoding mode was adopted.

***Stage** 2: **Data Encoding**:* The data encoding process includes the following:

i. QR Error Correction Levels: There are four levels of error correction depending on their error correction capabilities as shown in table 1 below.

Table 1: Shows QR Error Correction Levels

Error Level	Error Correction Capacity (%)
L	7 percent (%)
M	15 percent (%)
Q	25 percent (%)
H	30 percent (%)

Error correction level L has the capability to recover 7 percent of damaged data while error correction level M could recover 15 percent of damaged data. Similarly, 25 percent and 30 percent of impaired data could be restored by error correction level Q and H respectively. With these conditions, one would have preferred error correction level H. However, the higher the correction level, the larger the bytes to be required as well as the size of the QR code. The appropriate QR code for recharge voucher purposes are maximum of 7,089 characters for numeric data, 4,296 characters for alphanumeric data, 2,953 bytes for binary data; and it is not usually very large hence; error correction level L was adopted (*Kieseberg* et al., 2010).

ii. Determining the appropriate data version: QR code could be in different sizes called versions. Version 1 is of 21 × 21 pixel dimension while the next version is 4 levels higher than the previous version. Furthermore, each version has different character capacities which also depend on the encoding mode. The numeric mode and version 1 was adopted as it has 41-character capacity which is sufficient for the proposed task.

iii. Determining the mode indicator: Each encoding mode has a four-bit mode indicator that identifies it. The encoded data must start with the appropriate mode indicator that specifies the mode being used for the bits that come after it. A sequence of 0's and 1's in four-bits are used to indicate the chosen encoding mode. For numeric encoding mode, 0001 is the mode indicator that will be used (*Mohamud*, 2012).

iv. Determining the character count indicator: Character count indicator specifies the number of characters to be encoded. For instance, if recharge PIN 1234 5678 1234 is to be encoded using version 1 QR code in numeric mode, its character count indicator as documented in QR code specification will be 10 bits. The length of the PIN to be encoded will be counted and converted into binary. In this case, the length is 14 and in binary is 1110. Since it's not up to the required 10 bits for version 1 QR code in numeric mode, 0's will be added to it to make it 10 bits yielding 0000001110. Attaching the numeric encoding mode 0001 before the most significant bit (MSB) makes it 00010000001110 which is the final character count indicator (*Susono and Shimomura*, 2016).

v. Encoding the input data: the chosen encoding mode will be used to encode the input data. Different data encoding can be used by QR Code. Their complexity influences the amount of actual characters that can be stored inside the code.

***Stage** 3: **Error Correction Coding**:*

Errors as a result of improper handling of the QR code may undermine the credibility of the data encoded in the QR code; therefore, when encoding the data, code words needed to correct the errors are also generated. Hence, both the encoded data and these code words will be read by the QR scanner and compared in order to ascertain if the correct data are decoded. As specified, a version 1 QR code with error correction level L can have up to 19 data code words in a single block, and only 7 error correction code words would need to be generated (*Lombardo* et al., 2012).

3.0 DISCUSSION AND RESULTS

After a successful unit testing, subsequently, user acceptance testing of the mobile application was carried out. A user acceptance test was conducted among some

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volunteers who used the application for some months. Initial crashes were reported as a result of the following reasons:

- When lower android versions were used.
- When there was low memory space in volunteers' mobile devices or as a result of programming bugs.

In the user acceptance test, a number of questions were used to capture mobile network user's awareness, opinions, interests and usage regarding QR Codes in the process of carrying out this research work (Pukkasenung, 2016).

These questions were divided into two sections that are shown at the questionnaire. In the first part of the questionnaire, QR Code technology consisted of two questions that were asked the participants. "Did you attempt to scan the QR Code symbol with your phone or other device when you saw the symbol"? 17.5% of participants answered "Yes" and 82.5% answered "No" as shown in Figure 3. The results presented show that among the current sample among mobile network users, it is found out that most of customers do not attempt to scan the QR Code symbol when they saw it.

The second question of the section two is, "Does your device have a QR Code Reader software application"? 18.1% of all students responded "Yes," and 32.2% answered, "No" and 49.7% of all students answered "No Idea"(*Madureira*,2017).

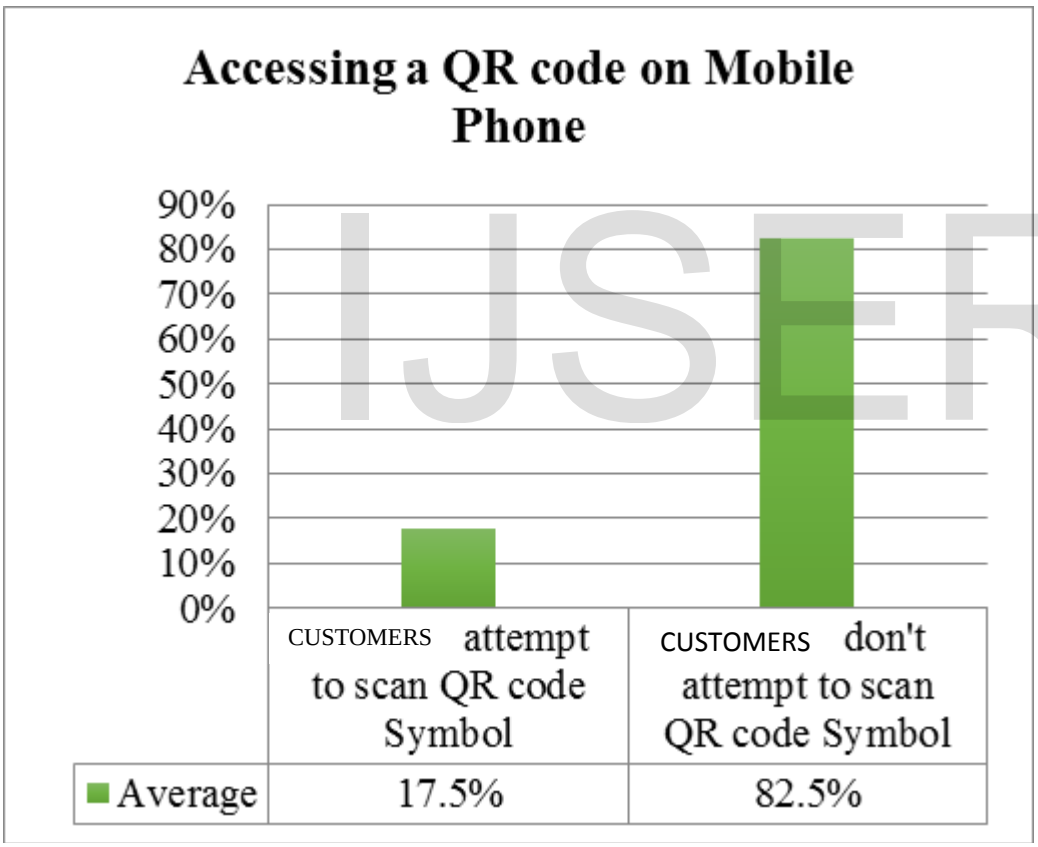

Figure 3: Accessing QR Code on Mobile Phone

3.1 Result Analysis: The result from the tests carried out from this experiment was done by the generated QR Codes in the following process stated below:

a. QR Code Creation: There are two (2) ways the QR Codes can be generated. Firstly, a user can go to a website that generates QR codes. The www.qr-code-generator.com is used here to create a QR code symbol.

b. Figure 4 below shows how a QR Code can be generated. The Admin/Users can choose the type of code (Recharge Network Code: Eg. MTN) that they wanted to create and then enter the information to be attached with the symbol. Then click "Create QR code" button and then the QR code symbol gets generated on the right side of the screen. Now it can be downloaded by clicking on "Download" button present below the generated code (*Sutheebanjard*,2010).

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Figure 4: Creating QR Codes

Secondly, the algorithm below is the second process of generating the QR Codes as explained in this work:

- Install the recharge card generation and management software application into the Computer System.
- Click on the run program from the auto run in your personal computer/android phone.
- Click next to specify the path of installation.
- Follow all the instruction displayed to complete the software installation.

The system flowchart is shown below:

- Type in the password as the administrator who manages the application.
- Follow the description in the dialogue box displayed on the screen on how to input the type of recharge voucher needed, (for instance MTN 100naira) and the batches of cards to be printed.
- Click on generate recharge card button to perform the task.
- Print the QR code images displayed in the screen.
- End

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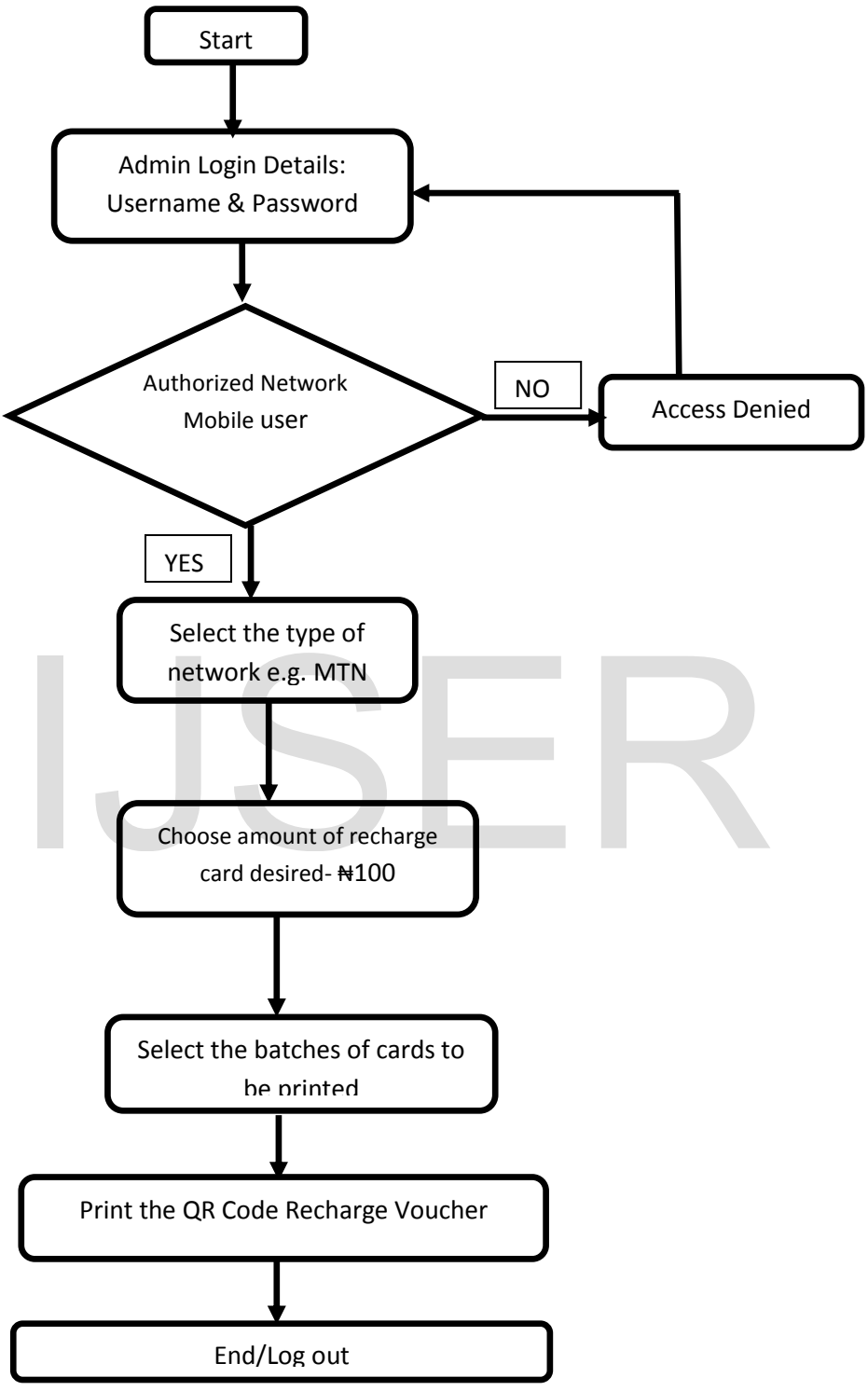

Figure 5: Flow Chart by the Administrator for the Proposed System

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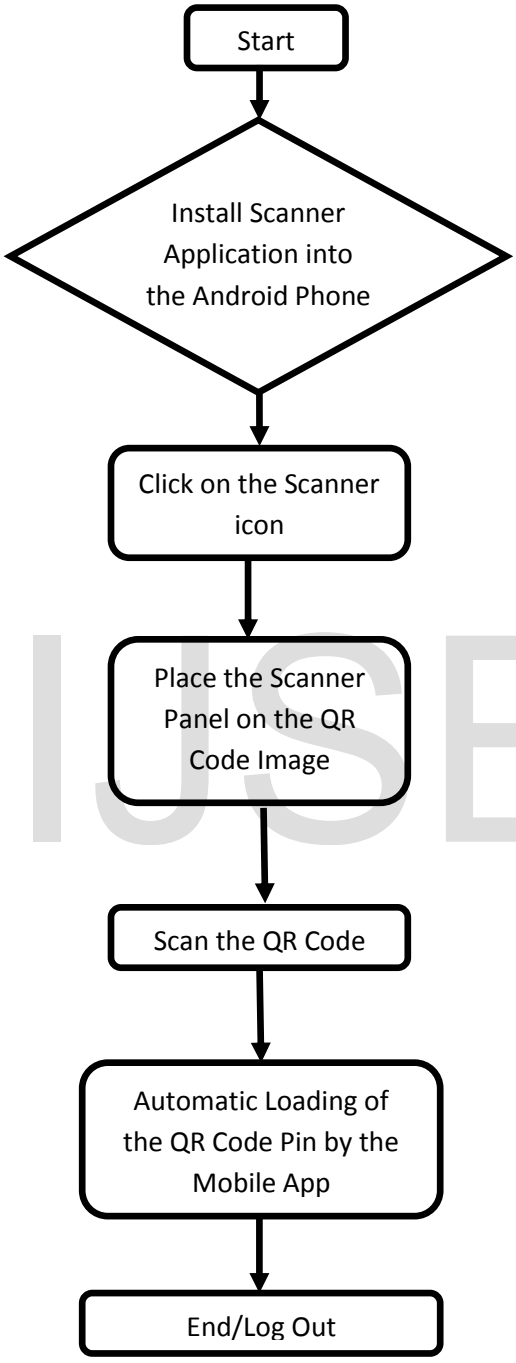

Figure 6: Flow Chart by the End User (mobile network users) of the Proposed System

c. Scanning a QR Code: To scan or read a QR code, the user is required to install a QR code scanner app on his smart phone. A number of QR code scanner apps are there on app stores for free. After installation, start the application and bring the camera of smart phone in front of the QR code to scan it. It will automatically display the content of QR code scanned as shown

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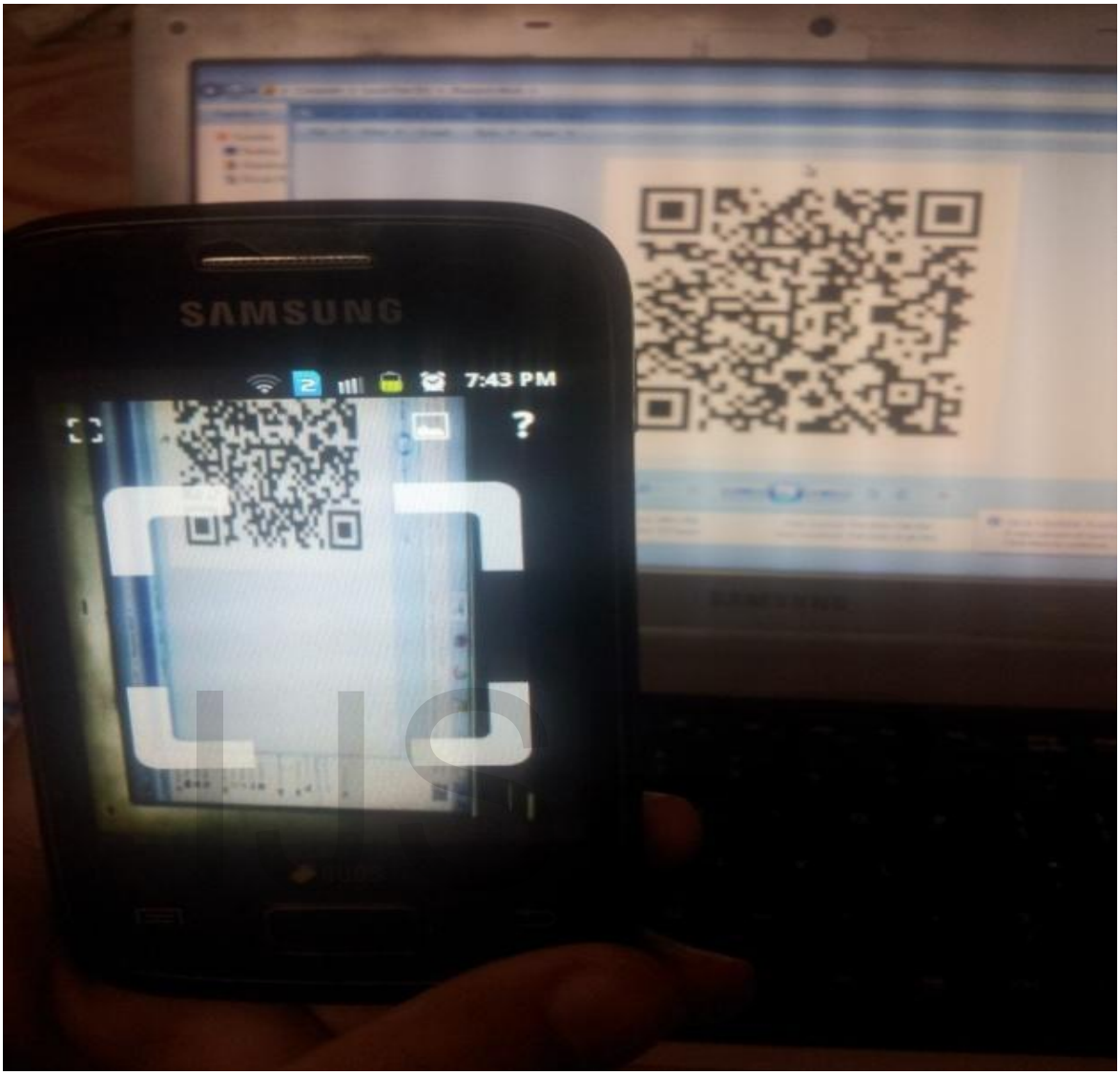

Figure 7: Scanning QR Code

c. Reading the QR Code Recharge Voucher

Users are expected to employ the developed QR Code reader application to scan the obtained QR code recharge voucher. The QR code region is expected to be placed inside the red square so as to ensure correct positioning and accurate capturing of the QR code. Afterwards, a splash screen which contains the extracted recharge codes with MNOs USSD is displayed. This splash screen is optional as it can be hidden in the settings options of the mobile application. The extracted information is further forwarded to the dialer application of the mobile phone before the subscriber will be credited with the value of the services paidfor.

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Figure 8: The Customized QR Code Recharge Voucher

4.0 CONCLUSIONS

This platform could be used by different security conscience organizations. Text files or password system could be encrypted into QR Code and be read by a mobile device, etc. The work is achieved by the use of python flask framework which is the main interface for generating the QR Codes. The system will have a login access point to prevent unauthorized user to have access to the QR code generating session. They generate QR Code one after the other in other to store the encrypted string into Sqlite Database Models. On the other hand, a mobile QR code scanner makes it easier to use mobile application to identify the encrypted code.

This work has introduced a Quick Response (QR) Code generator with Mobile Scan Application for Mobile Network Recharge Operations. It has successfully demonstrated how QR codes can be used to secure Mobile Network recharge vouchers with a view to prevent unauthorized access to recharge pins that has characterized the existing recharge voucher patterns. The standalone software application developed was used to generate the QR code while the mobile application introduced was used to read the recharge code information embedded in form of QR code. The advent of smartphones with powerful features like mega pixel camera has also made the QR code scanning process easier contributing to its wide usage and acceptability. This has shown that QR code can find

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practical applications in mobile network recharge operation services

This system as it is based on MTN network can only generate N100, N200, N400, QR recharge code. However, the software application can be improved upon to generate N750, N1500, etc recharge coupons as well as other coupons for other mobile networks, like globacom, 9mobile, etc.

REFERENCES

Adeel U., Yang S., McCann, J. A. (2014). Self-Optimizing Citizen-centric Mobile Urban Sensing Systems. Proceedings of the 11th International Conference on Autonomic computing (pp.161-167).

Ahamad S. S., Udgata S. K., Nair M. (2014). A Secure Lightweight and Scalable Mobile Payment Framework (pp. 545–553). Springer, Cham. https://doi.org/10.1007/978-3-319-02931-3_62.

Badra M., and Badra R. B. (2016). A Lightweight Security Protocol for NFC-based Mobile Payments. Procedia Computer Science, 83(Ant), 705–711.

Bojjagani S., and Sastry V. N. (2017). A secure end-to-end SMS-based mobile banking protocol. International Journal of Communication Systems, (January), 1–19. https://doi.org/10.1002/dac.3302.

Dierks T., and Rescorla E. (2017). The Transport Layer Security (TLS) Protocol Version 1.2. Retrieved.

Fei J., and Liu R. (2015). Drug-laden 3D biodegradable label using QR code for anti-counterfeiting of drugs. Materials Science & Engineering C, 63, 657–662. https://doi.org/10.1016/j.msec.2016.03.004.

Fong S., and Lai E. (2005). Mobile Mini-payment Scheme Using SMS-Credit. Computational Science and Its Applications – ICCSA 2005. ICCSA 2005. Lecture Notes in Computer Science, 3481, 1106–1114.

Frank I., Samuel J., and Emmanuel A. (2011). Online Mobile Phone Recharge System in Nigeria. European Journal of Scientific Research, 60(2), 295–304.

Fun T. S., Beng L. Y., and Razali M. N. (2018). Review of Mobile Macro-Payments Schemes. Journal of Advances in Anale. Seria Informatică. Vol. XVI fasc. 1 – 2018 Annals. Computer Science Series. 16th Tome 1st Fasc. – 2018.

Liébana-Cabanillas F., De Luna I. R., and Montoro F. (2017). Intention to use new mobile payment systems: a comparative analysis of SMS and NFC payments. Economic Research-Ekonomska Istraživanja, 30(1), 724–742.

Lisoněk D., and Drahanský M. (2008). SMS Encryption for mobile communication. Proceedings International Conference on Security Technology, SecTech 2008, 198–201. https://doi.org/10.1109/SecTech.2008.48.

Lombardo, Nancy T, Anne Morrow, and Jeanne Le Ber. (2012). "Rethinking Mobile Delivery: Using Quick Response Codes to Access Information at the Point of Need." Medical Reference Services Quarterly. 31.1.

Lou L., Tian Z., and Koh J. (2017). Tourist Satisfaction Enhancement Using Mobile QR Code

Payment: An Empirical Investigation, 9(1186), 1–14. https://doi.org/10.3390/su9071186.

Lu J., Yang Z., Yuan W., Li L., Chang C. C., et al. (2017). Multiple Schemes for Mobile Payment Authentication Using QR Code and Visual Cryptography. Mobile Information Systems, 2017, 1–13. https://doi.org/10.1155/2017/4356038.

Lu Y., Yang S., Chau P. Y. K., and Cao Y. (2011). Dynamics between the trust transfer process and intention to use mobile payment services: A cross-environment perspective. Information and Management,48(8),393–403. https://doi.org/10.1016/j.im.2011.09.006.

Lugo K. (2012). Enhancing public-private partnerships through SMS Vouchers, 10, 666–671. https://doi.org/10.1016/j.procs.2012.06.085.

Madureira A. (2017). Factors that hinder the success of SIM-based mobile NFC service deployments. Telematics and Informatics, 34(1), 133–150.

Mei L., Li W., and Nie K. – (2013). Pricing Decision Analysis for Information Services of the Internet of Things Based on Stackelberg Game. In Proceedings of 2nd International Conference on Logistics, Informatics and Service Science (pp. 1097–1104). https://doi.org/10.1007/978-3-642-32054-5.

Meng J. M. J. and Ye L. Y. L. (2008). Secure Mobile Payment Model Based on WAP. Fourth International Conference on Wireless Communications, Networking and Mobile Computing,1–4. https://doi.org/10.1109/WiCom.2008.2121.

International Journal of Scientific and Engineering Research IJSER Volume 10, Issue 7, July 2019
ISSN 2229-5518

Mihailescu M., and Teo Y. M. (2010). Dynamic resource pricing on federated clouds. CCGrid
10th IEEE/ACM International Conference on Cluster, Cloud, and Grid Computing, 513–517. https://doi.org/10.1109/CCGRID.2010.123.

Mohammad N., Barua A., and Arafat M. A. –(2013). smart prepaid energy metering system to control electricity theft. In Proceedings of 2013 International Conference on Power, Energy and Control, ICPEC 2013 (pp. 562–565).

Mohamud, A. (2012). "QR Code Usage among European Smartphone Owners Doubles Over Past Year",comScore, Inc. NASDAQ: SCOR. [Online] Available: http://www.comscore.com/Insights/Press-Releases/2012/9/QR-Code-Usage-Among-European-Smartphone-Owners-Doubles-Over-Past-Year.

Ozkaya H. E., Roxas J., Bryant F., Whitson D. (2015). Factors affecting consumer usage of QR codes. Journal of Direct, Data and Digital Marketing Practice, 16(3), 209–224. https://doi.org/10.1057/dddmp.2015.18.

Probst, A. (2012). "The Expectations of Quick Response (QR) Codes in Print Media: An Empirical Data Research Anthology", UW-L Journal of Undergraduate Research XV, PP. (1-13).

Pukkasenung P., and Chokngamwong R. (2016). Review and Comparison of Mobile Payment Protocol. Advances in Parallel and Distributed Computing and Ubiquitous Services, 368. https://doi.org/10.1007/978-981-10-0068-3.

Sowern, S. (2011). "Beyond the simple codes: QR codes in education", Proceedings ascilite Hobart: Concise Paper, PP. (1157-1161).

Susono, H. and Shimomura, T. (2006). " Using Mobile Phones and QR Codes for Formative Class Assessment", Current Developments in Technology-Assisted Education, Vol. 2, PP. (1006-1010).

Sutheebanjard, P. and Premchaiswadi, W.(2010). "QR-Code Generator" In Proc. of IEEE, 8th International Conference on ICT and Knowledge Engineering.

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