# Data Management via QR Code Using Android Smart Devices

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**ABSTRACT**

Smart devices have become one of the most important facilities in managing the data in the organizations recently. In this research, Android Application has been developed with taking advantage of Quick Response codes technology for storing different types of data (ex: documents, goods or employees) within organizations, and retrieving it on demand on the smart device screen or sharing it to other devices as Excel reports. Discussion of the study assumptions, delimitations, and limitations resulted in developing several approaches for tackling the process of generating unique QR codes representing the items in the organizations, in addition to developing a QR code reader by making use of the camera in the smart device. Office goods have been chosen in this research project as a data sample. Based on the experiments, the findings have proven that QR code technology is highly useful in the data management process, for storing and retrieving information within smart devices, showing a high response speed and accuracy.

**KEYWORDS**: Android; Quick Response code; Data Management; Mobile Application.

الخلاصة

أصبحت الأجهزة الذكية واحدة من أهم أساليب إدارة البيانات في المؤسسات مؤخراً. في هذا البحث، تم تطوير تطبيق يعمل على منصة أندرويد مع الإستفادة من تقنية رموز الإستجابة السريعة (QR Code) لتخزين أنواع مختلفة من البيانات الخاصة بالمؤسسات أو المنظمات (مثل المستندات أو السلع المكتبية أو الموظفين) ، وإستعادتها عند الحاجة على شاشة الجهاز الذكي أو مشاركتها إلى أجهزة أخرى كتقارير وجداول ورقية تعمل على برنامج (MS Excel). أنتجت مناقشة افتراضات الدراسة وتحديد الحدود والقيود لعملية إنشاء رموز QR فريدة تمثل العناصر في المؤسسات ، بالإضافة إلى تطوير قارئ لرمز QR من خلال استخدام الكاميرا في الجهاز الذكي. تم اختيار السلع المكتبية (الموجودات الثابتة) في هذا المشروع البحثي كعينة بيانات. بناءً على التجارب ، أثبتت النتائج أن تقنية QR تعتبر أداة مهمة في عملية إدارة البيانات ، وتخزين واسترجاع المعلومات داخل الأجهزة الذكية ، مع إظهار سرعة ودقة استجابة عالية. تم تقييم وإختبار التطبيق في عملية من مرحلتين. أولاً ، من قبل الباحث ، حيث تم تطبيق تقنيات اختبار الصندوق الأسود على البحث للتحقق من صلاحيتهِ وحدودهِ. ثانياً ، بإشراك خمسة عشر مستخدمًا في عملية تقييم التطبيق ، وكان متوسط النتائج جيدًا بشكلٍ عام. ومع ذلك ، يمكن تمديد الدراسة الحالية من خلال إستخدام طرق إضافية لدعم العمل على بنية الخادم-العميل عبر شبكة محلية أو عبر شبكة الإنترنت.

## INTRODUCTION

The key part of the success of each organization is measured by the use of modern technology systems in managing its data, these make the process of creating, storing, organizing and maintaining the data easy and straight forward while provides high efficient solutions for accessing and retrieving different types of reports about these data, [1] for instance, office goods, documents or the employees.

Depending on the demand, the researcher initiated the development of a data management system using Android smart devices with taking advantage of the power of Quick Response (QR) codes technology for storing and retrieving information about different types of office goods. Such as goods name, model, status, real picture and location in the organization in addition to the employee who is responsible for it,

this could aid in preserving public goods and managing its data in the government institutes, in addition, to make the processes of Periodic inventories accurate and fast.

Moreover, the proposed research contributes to verifying the use of smart devices to create a QR code generator and reader under the Android platform, and the limits of big data management.

The rest of this paper is structured as follows: Section 2 presents the research methodology and system development process; Section 3 shows the results and discussions; finally, Section 4 presents the conclusions and suggestions for future work of this project.

## Literature Review
Several related types of research have been studied to improve the knowledge of using QR codes in these situations. Some of them proposed using QR codes for storing and retrieving information about the temples within the districts of Dusit and Phranakorn in Bangkok, and their experiment shows that tourists could request various types of information by scanning the QR codes located on the specific locations in the temple by using a smart device and obtain requested temple inquiries on the displays. [2] Others, make use of QR codes in generating CSV file to record student's attendance system by using android smart device. [3] However, some researches have been studied for understanding the environment of android based mobile development. [4] In addition to, the benefit of utilizing QR codes [5], the process of creating SQLite databases for Android applications [6], and the use of JXL library in android studio for creating reports in Excel format. [7]

# RESEARCH METHODOLOGY
In this research study, the following methodology has been researched:

## Data Collection
In this project, a questionnaire has been formed to collect data directly from employees with different qualifications who working in managing and preserving the public goods within the organization in the government sector, these data have been analyzed and used for designing the database of the management system and developing the mobile application with the most needed functions.

## System development tools
The following tools have been used in developing the system:

- Adobe illustrator cc: used to create and modify the images and buttons shapes.
- Android SDK manager: used for handling the user interface (UI) of the application.
- SQLite DB: used for storing and organizing the data.

## System Design
Unified Modeling Language (UML) has been used by the researcher to draw the main design of the system; they established three types of diagrams (activity diagram, class diagram, and use case diagram) which are the most important in this step, to clarify the working processes of the system. Moreover, it illustrates the relations between the classes and methods of the system, furthermore, to aid in determining the scope of the project clearly, as shown in Figure 1.

## Application Development
The application has been designed after taking into account the target audience and the educational background in working with Android mobile applications.

It has been developed to be capable for registering goods by its properties with using the mobile camera to register a real image for each, and generating QR code consist of all the information mentioned earlier, then adding the commodity record in the database as follows:

(ID, Responsible Dept., Commodity Name, Commodity Location, Responsible Employee, Commodity Status, Real Commodity Image, QR Code Image). The application assigns only one unique QR code and ID for each commodity. Therefore, the process of editing information of the office commodity could change only the following: (Commodity Name, Commodity Location, Responsible Employee, Commodity Status, and Real Commodity Image). Since the (Responsible Dept.) needs paper works to be changed as advised by the institutes. Finally, different types of reports could be generated as excel sheets, many capabilities for sharing the generated reports with other devices having the Bluetooth facilities, or consider using the email for sending the reports.

(a)                                                                                    (b)
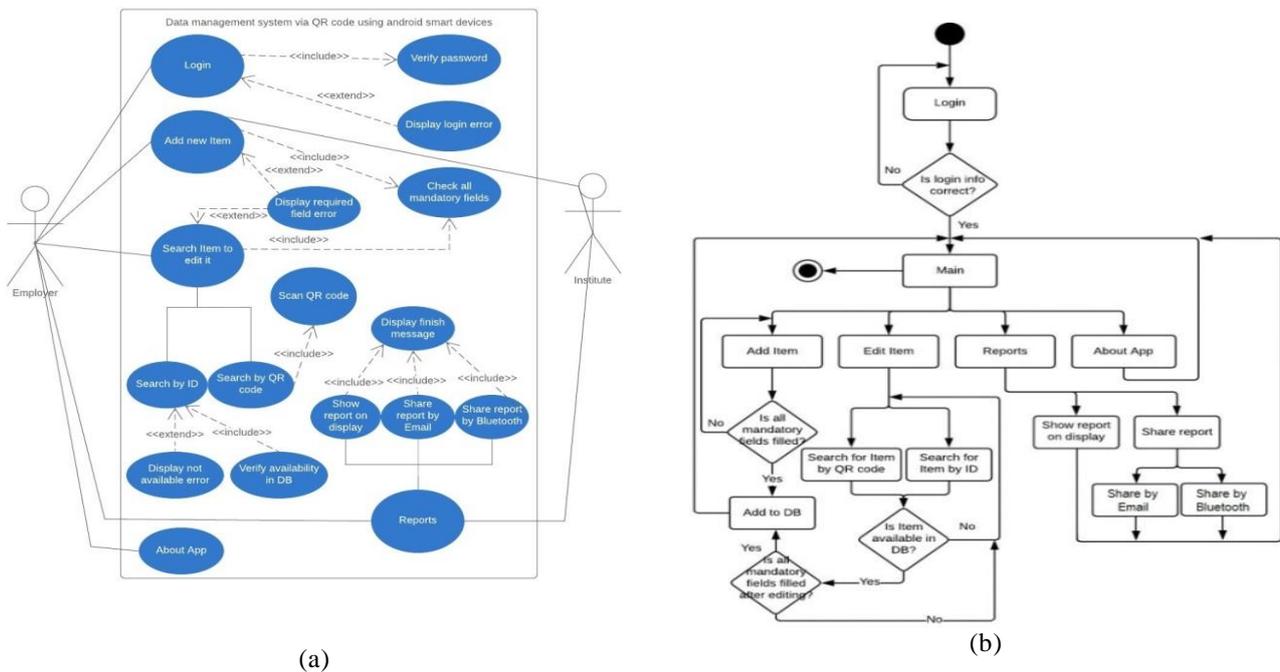
**Figure 1**. (a) Use Case Diagram; (b) Activity Diagram

The application development stage is composed of three sub-stages discussed as follows:

*Application Compatibility*
The application has been designed to be compatible with most of the versions of Android, for example (Nougat, Oreo, and Pie), besides, to be running by different smart devices types such as (mobiles or tablets). However, the smart device should include a camera to be used as a QR code scanner, Bluetooth and a sufficient space for storing commodities' information and images.

*QR Code Generator and Reader*
Two QR code methods have been developed. The first one is for creating a unique code representing each commodity in the organization and in the application database, and the second is for scanning and analyzing the QR codes that affixed on the commodities by using the camera in the smart device. The later method aids in searching for commodities in the database to be edited or deleted when necessary, also, to facilitate the periodic inventory process.

*Reports*
Since some of the employees used to work on PC devices, we considered adding functions for sharing the outputs of the system to these devices. The application could generate different types of reports depending on user demands, for instance, the goods of the responsible dept., goods status, the goods of the responsible employee and goods location. In addition to creating an excel sheet to be shared with PCs devices by Bluetooth, or sent by Email. However, these reports could also be displayed on the smart device screen as a list.

## RESULTS AND IMPLEMENTATION
This section composed from the following subsections:

### Graphical user interface (GUI) design
The number of application pages has been restricted to five pages, to facilitate the process of controlling and understanding the application, taking into account the utilization of comfortable colors, the sizes of fonts and buttons. See Figure 2.



**Figure 2**. Block diagram for proposed key generation.

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## Generating QR-Code process

The key operation of this application is generating a unique QR code for each office commodity in the institute to organize a centralized database for all commodities. The process of creating these codes takes in consideration merging information of the commodity within it, for example (Commodity Name, Commodity Location, Responsible Employee, Commodity Status, Real Commodity Image), the result QR code then will be accurate and ready to be added to the SQLite database located on the local memory of the android device. In other processes, all the generated QR codes will be inserted into an excel file as a report. In a later step, the user could use this report to affix each QR code to its relevant commodity; this process will facilitate the QR code scanning and analyzing process and reduce the time consuming when responding to user requirements. See Figure 3.
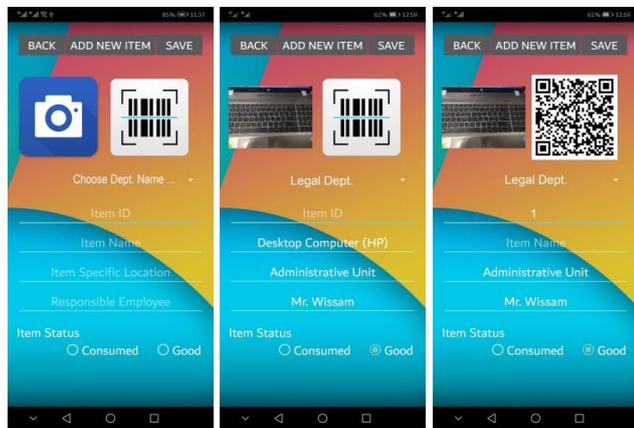


**Figure 3**. The process of adding commodity to the application.

## Reading QR-code Process

Other methods have been developed to handle the process of using the camera in the android device for scanning and analyzing the affixed QR codes on the goods. This operation decodes the QR code and retrieving information stored with it which aids in the process of searching for the commodity in the database and displaying it on the device screen to edit its information or doing other demanded actions. See Figure 4.

## Displaying Reports and Excel sheets generator

Application methods have been developed to handle the process of creating different kinds of reports depending on user requests; these reports can be displayed directly on the screen of the smart device. See Figure 5.





**Figure 4**. The process of searching for commodity by scanning and reading QR code.



**Figure 5**. The types of application Reports.

Also, as a previous step for sharing the outcomes of the system, the application creates an excel sheet contains commodities information. The requested information retrieved from the database along with the image of the commodity and its QR code, and inserted serially in the excel sheet. Finally, the sheet is organized, colored, and adjust text format and size. See Figure 6.

**Figure 6**. Excel file report.

## Sharing Reports

As mentioned earlier, the application can share its reports by two methods.

Firstly, sharing reports by using Bluetooth technology to any other device support this technology. The programmed application methods are responsible for handling the process of granting the needed permission to enable the Bluetooth on the device to send the report after selecting the targeted device by the user. See Figure 7.
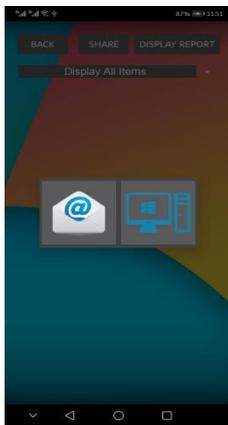


**Figure 7**. The methods of sharing application reports.

Secondly, sending the reports by email, this process has been developed to be done with one click; the application is responsible for filling email addresses, body and attaching the report (.xls) within it, as shown in Figure 8.



**Figure 8**. Example of the auto generated email.

However, this operation is done after granting the required permission to access the internal memory of the smart device.

It's worth mentioning that the process of granting permissions is done only once during application lifetime on the first run of the methods.

## Application Validity Checking

Black box testing techniques have been applied to the system to check its validity and boundaries, by utilizing test cases using equivalence partitioning to categorize maximum possible test cases into few classes while covering most of the requirements. Moreover, the decision table, as illustrated in Table 1, has been created to clarify the test scenarios.

**Table 1**. Decision table tests to check the system validity and boundaries.

| TC | Sno | Validations | | Expected Result | Combinations | Final Test Result |
|---|---|---|---|---|---|---|
| | | User ID and Password are blank | User ID and Password are valid? | | | |
| Login | 1 | YES | NO | Display Message "Invalid credentials" | Both blank or Either of them invalid | Success |
| | 2 | NO | YES | Login | N/A | Success |
| | | One of the mandatory fields blank | Is commodity Picture captured? | | | |
| Add Commodity | 3 | YES | NO | Display Message "fill all mandatory fields" | Blank or commodity picture not captured | Success |
| | 4 | NO | NO | Display Message "fill all mandatory fields" | blank or commodity picture not captured | Success |
| | 5 | NO | YES | Add Commodity info. to DB | N/A | Success |

## User Evaluation

Fifteen users who working in managing and preserving the public goods have been involved in the testing process and filled in a survey consisting of twelve questions in four categories (e.g., Innovation, Graphic Design, Usability, and Comprehensibility) about the application, the average results have shown a very good satisfaction overall, as shown in Table 2.

**Table 2**. Evaluation results.

| Field | Very Poor | Poor | Good | Very Good | Excellent |
|-------|-----------|------|------|-----------|-----------|
| Innovation | | | x | | |
| Graphic Design | | | | | x |
| Usability | | | | | x |
| Comprehensibility | | | | x | |
| Overall satisfaction | | | | x | |

## CONCLUSIONS

Depending on the findings of the study, the researcher concluded that QR code technology is highly useful in the data management process, for storing item's information in SQLite database and excel files, and retrieving it when needed using the devices running by the android operating system. Moreover, this technology demonstrated a high response speed in the data retrieval process. Furthermore, the process of inserting the QR code image into an Excel file does not consume much memory on the desk drive.

Findings comparison has been made with a previous related study [2] and shows that the application is capable for creating QR codes contained specific information about different items taking in consideration its uniqueness which allow the user to fetch the requested information accurately, while the other study introduced methods for storing information about temples manually, and using QR codes scanner to retrieve this information.

The present study can be further extended by testing other kinds of data such as official documents. Also, we suggest utilizing additional methods for making the application able to work on client-server architecture to standardize the reports of the institute's departments on the local network or the internet.

## REFERENCES

[1] Lee, S. (2012). Creating and Using Databases for Android Applications. International Journal of Database Theory and Application, 5(2), 99-106.

[2] Margaret Rouse, Craig Stedman, Jack Vaughan. (2010, 08 02). TechTarget. (WhatIs.com) Retrieved 01 06, 2020, from https://searchdatamanagement.techtarget.com/definition/data-management

[3] Wei, X. (2017). QR Code Based Smart Attendance System. International Journal of Smart Business and Technology, 1-10.

[4] Patel, D. (2016, 07 18). Medium.com. Retrieved 10 09, 2019, from https://medium.com/@dhrupal1987/write-to-excel-file-using-jxl-lib-2aaf32fe523c

[5] Rujijan Vichivanives; Sakolphak Ralangarm. (2015). Temple Information Retrieval System using Quick Response Code via Mobile Application. 7th World Conference on Educational Sciences. Novotel Athens Convention Center, Athens, Greece.

[6] Soon, T. J. (2008). QR Code. synthesis journal, 59-78.

[7] Suhas Holla; Mahima M Katti. (2012). ANDROID BASED MOBILE APPLICATION DEVELOPMENT and its SECURITY. International Journal of Computer Trends and Technology, 3(3), 486-49.