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Design and Implementation of e-Shopping System Using QR Code and Smart Mobile Phone

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Abstract— *This paper presents a system that is used in one of the most important fields in our daily life, shopping and entertainment. The system exploits a mobile application, Quick Response (QR) code technique and network system. The QR tag is attached to each item in the market, while the mobile application can be installed in the Smart Phone. The smart phone is used to scan the attached QR tag and send the result to a network system and the network system will process the received data. A brief information will be brought from the local server database. However, if the customer is interested in more details, the network system brings these details from the main server and applies them on the smart phone screen. When the customer decides to buy the item, s/he can add it to the shopping list, then the system updates the bill, sends it back to the customer and to the cashier at the same time. The items will be prepared at the checkout point after payment. This system was designed, implemented, and tested practically so that the performance of that system is achieved for two main points: quick attainment of information and network congestion avoidance.*

Index Terms— *QR Code Technique, Shopping Application, Information Retrieving, Market Guiding.*

I. INTRODUCTION

One of the problems when someone visits a market is that a person from the staff of that market is required when the customer needs information and details about any offered item, such as: price, country of origin, history …etc. Sometimes in rush hours, it is difficult to provide a guidance for each customer, which interns the need of increasing manpower and consequently increases the overall institution payment. Therefore, trading institutions start to invest in technology development to design systems that can easily guide the costumer without the need, or as minimum as possible, for manpower. One of these investments is involving the Smart Phone in their institutions and implementing applications that can be used to serve this purpose.
Some of these systems are presented depending on the user location such as the system proposed by Gabriel Villarrubia et al. [1]. Indoor Location System for Museum Tourist was designed using Wi-Fi communication protocol, routers model TL-WR740N and fingerprint technique for estimating the user location inside the building. The combination of sensors and cameras for pattern recognition and the use of Wi- Fi technology to estimate the position of the visitor allow the authors to develop a rich set of information for museum content and allow the multimedia content, such as: paintings، videos, and sets of photographs to be viewed on a mobile device by an end user.
Other systems adopt different techniques in their design, Mansi Mhaske et al. [2] developed a Shopping System using Near Field Communications (NFC) technique. In this system, the offered products are attached with NFC tag. An Android phone having NFC reader reads that tag which includes information about the product when putting it in the trolley. This information is sent to the main billing server which calculates

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the total number of purchased items and sends the calculated bill to the device attached to the trolley, then displays it on the smart phone screen. So, the customers save the time spent in long lines waiting the cashier to calculate the bill and payment.

The same idea was presented by Megha R. Mane et al. [3], where LCD display and barcode reader are used. The barcode reader scans the barcode identification of the product and accesses the server of the market in order to display price, discounts, offers and other details about the products, then it updates the total bill for payment.

Sumit Tiwari [4] presented an introduction about QR Code which is an alternative technique for barcode invented to eliminate the barcode limitations such as the capacity of encoded information and the speed of encoding and decoding process. The author explains QR code versions, their levels, error correction features, encoding and decoding processes. He also illustrates how the choosing level of error correction for QR code affects the amount of encoded information, therefore they must be balanced when generating the QR code. Finally, he made a study about the statistics usage of the QR code.

Vassilya Uzun [5] implemented QR-code based Hospital Systems for Healthcare where every patient is supported by QR code as: bracelet, printed on his room's door, printed on his bed…. etc. The QR code is scanned by doctor's smart device to get information about patient's health history and recognize the patient to avoid mixing among the patients or surgeries. This is done for admitted patients. For outpatient, this system is useful for patients who have chronic diseases, where the patient carries his QR code as bracelet, necklace, card …etc. In case any emergency ambulances, police, or any person need to access patient's information, such as his address, emergency contact number, family number, health history, or medications, this will help saving the patient as soon as possible. This system was implemented by using a mobile application to read the QR code and access the information, web page and data base.

Lambodara Parabhoi et al. [6] presented a library system that utilizes QR technology and mobile application. The proposed system was used to deliver different services, such as: providing brief information of books, promoting the library services, linking to the electronic source of the library and using library exhibitions (Videos, Audios, and websites), etc., to the readers inside and outside the libraries. This system can be implemented by scanning the QR code via a designed application installed on smart phones, then the application links each QR tag to all the resources available in the library. This system is similar to our proposed system when it is applied in the museums.

Yaoqi Peng et al. [7] proposed a quality tracing system for fresh meat based on QR code technology, where data about the environmental information of the meat such as temperature is collected by sensors. The collected data is recorded in the database and combined with QR code. The customer can get the quality information of the fresh meat by scanning the QR code with his/her mobile phone instead of having a piece of meat to purchase based only on a visual observation of the meat.

This paper suggests a system that helps to guide the visitors and get offered items information inside the markets, so that the customers don't need to ask any employee about any offered object. All what s/he needs is to connect to the existing Wi-Fi network in that area and turn on the QR code reader application in his/her phone to scan the attached QR tag on the physical object. The application will send a request to the local server, which contains a database, and the local server sends back a reply to the application including brief information about the item. In case the customer requires more details, the local server will connect to the main server in order to get the required information and display it on the mobile phone screen. In addition, the mobile application provides an interacted interface that allows the customer to add the items to shopping list, delete them from the shopping list, know the total price of the added items, buy them and pay their price

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by cash or by bank account. The proposed system is implemented by using QR tag, mobile application, microcomputer board (local server + AP), communication links and server storing the database.

II. THE PROPOSED SYSTEM STRUCTURE

The proposed system consists of three parts:

A. QR code tag

It is a small tag taking a very small space on the product's surface. This tag can be generated easily by using an online generator [8] and can encode any symbols, numbers, letters and any other data format. Letters are used in this paper to identify the products and generate QR tag for each item, for example it encoded the text "Water2L" as QR code to define the water bottle as shown in Fig. (1). After the QR tag is generated, it is printed and attached on the water bottle.

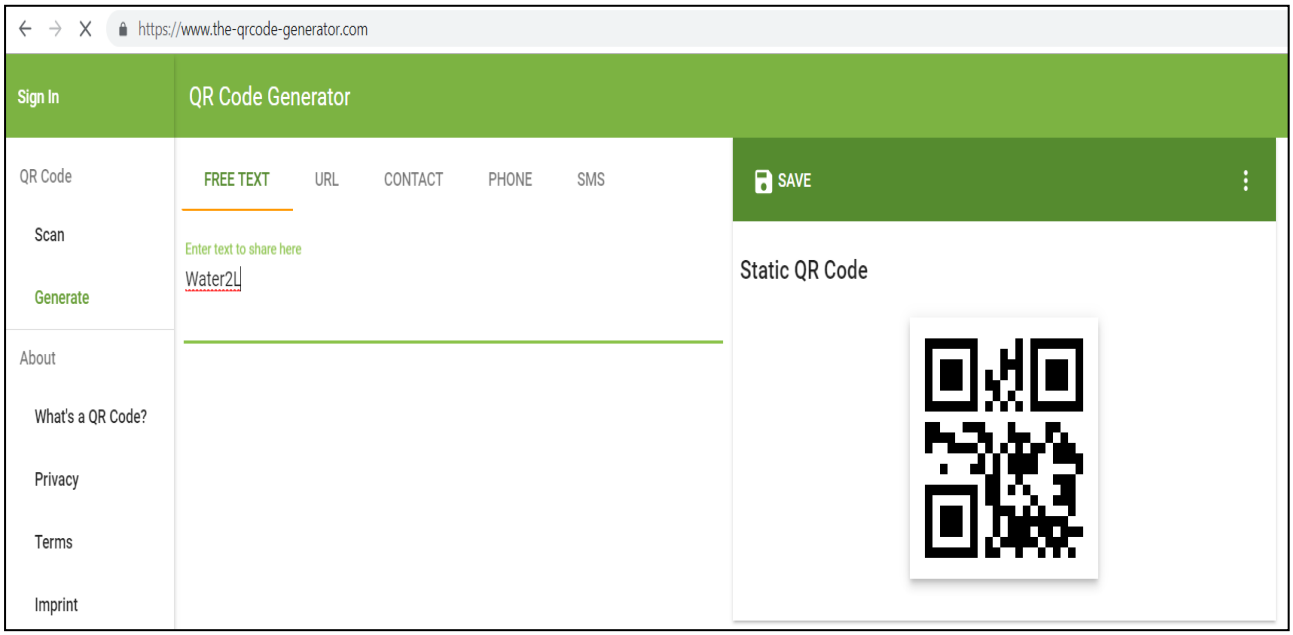

FIG. 1 ONLINE QR CODE GENERATOR

B. Mobile Application

It is designed in android studio IDE [9], [10] by Java language and installed on the android phones. The developed mobile application represents the interactive interface with the proposed system that provides different types of information and facilities for the customers, which include:

1. Get ID and Display it: when the customer arrives at the market, s/he connects to the available Wi-Fi network and runs the shopping application, then the mobile application extracts MAC address of that phone and sends it to the network. The network records that address in the main server and gives a unique ID for it. The developed application gets that ID and displays it on the screen. By that unique ID, the customer can be distinguished by the proposed system.
2. Scan the QR Tag and Get Brief Information: the developed application provides **SCAN** button to scan the QR tag and decode it, then it sends the decoding result as a request to the network system, which receives that request, extracts a related brief information from the local server and sends it back to the application for displaying.

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3. Get Detail Information: if the customer needs more information about the item, s/he can get it by clicking on **MORE DETAIL** button. In this option, the network system provides the details from the main server and displays it on the phone's screen.
4. Select (Reserve) Items: **ADD to CART** button enables the customer to reserve the items in his/her shopping list. This option compensates the customer to use the real physical cart.
5. Buy the Items: when the customer decides to purchase the reserved items, s/he clicks on **BUYALL** button, which provides two options for payment: By Cash option and By Account option. If By Cash option is selected, the customer's shopping list is recorded at the main server, the cashier receives notification about the customer's confirmation to start to prepare the selected items for delivering the selected items to the customer's home, at the same time the customer receives a notification that his/her order is done. So, s/he just goes to the checkout point after s/he ends his/her tour inside the market to pay the cash money and leave. The same procedure is done if By Account option is selected, but the payment will done through the a bank transaction, which is very fast, so the customer selects this option and ends his/her tour inside the market. The checkout point just checks the customer ID with the received transaction's notification to make sure that s/he paid. Figure (2) shows the shopping application interface and an empty shopping list.

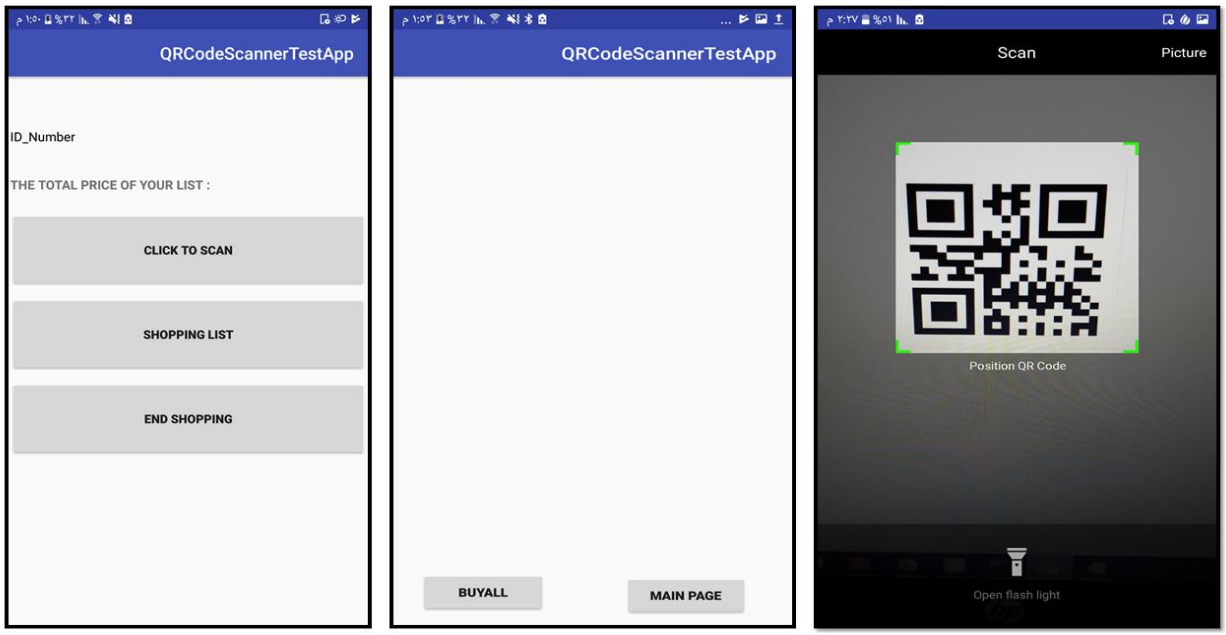

FIG. 2 APPLICATION INTERFACE

C. Network System

The network system consists of three important elements:

1. Microcomputer board: - It is an important electronic device that is used widely today in different projects and applications [11]. This paper utilizes Raspberry Pi3 to work as:
   i. **Local Server:** containing a brief database which can be accessed firstly when the customer scans the QR tag, this property helps to avoid the network congestion problem that occurs when the all customers want to access the main server.
   ii. **Access Point:** helping to provide a Wi-Fi network for the customers to get ID and interact with the designed network easily [12]. The number of the customers that can be connected to a single access point at one time depends on the DHCP configuration of the microcomputer board which is responsible

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for assigning an IP for each connected device, for example if the DHCP is configured to use the netmask of 255.255.255.0, the number of the connected customers that can be achieved is 253. While if the DHCP is configured to use the netmask 255.255.0.0, the number of the hosts can be 64000 and so on.

2. Main Server: In this work, a laptop is used as the main server by installing XAMP server software. The main server contains detailed information about all items inside the market, customer's ID, activity of each customer like: what he bought, shopping time, shopping date, customer's bill, leaving time, etc. All these pieces of information help the market administrative in analyzing purposes, which help to improve the shopping experience for the customer and get more profit for the owner.
3. Switch: It is used to expand the proposed system network in order to provide the accessibility to the database at any point inside the market. The expansion is done by increasing the access points around the building according to their Wi-Fi range then they are connected together to the main server by the switch. In this paper, the Wi-Fi range for the Raspberry Pi3 is about 10m, so if the market size is 20m*20m two, Raspberry Pi3 are needed to cover the area.

The proposed system for the shopping in this paper is implemented by using three pieces of microcomputer board, one of them is used for the registration issue and the others are used to provide guiding information for the customers inside the market.

Figure (3) shows the hardware connection between the proposed system aspects and how the connection between the smart phones and the access points is implemented by Wi-Fi communication protocol. The connection between the microcomputer boards and the main server is accomplished by the wire technique and the switch. Figure (4) illustrates the proposed system block diagram and how it works.

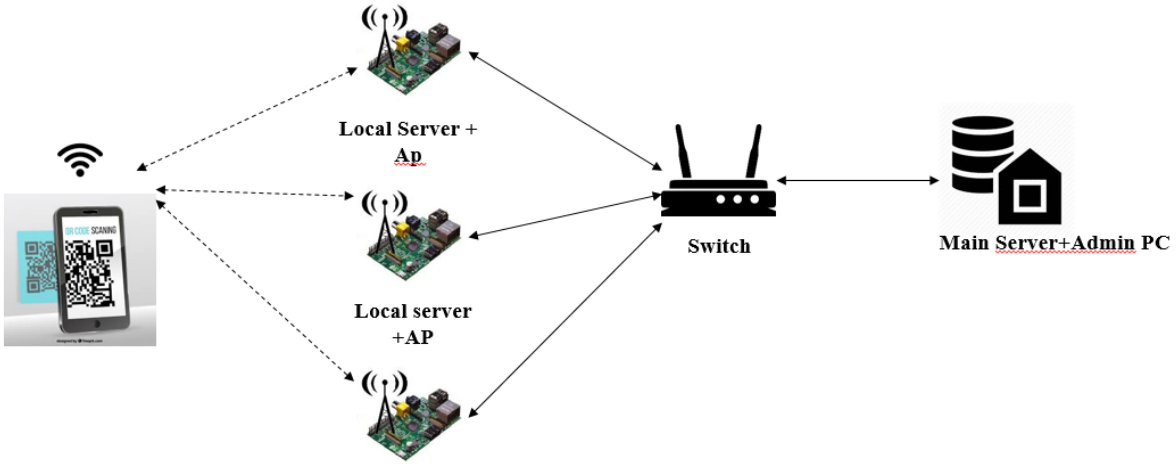

FIG. 3 HARDWARE REPRESENTATION OF THE PROPOSED SYSTEM

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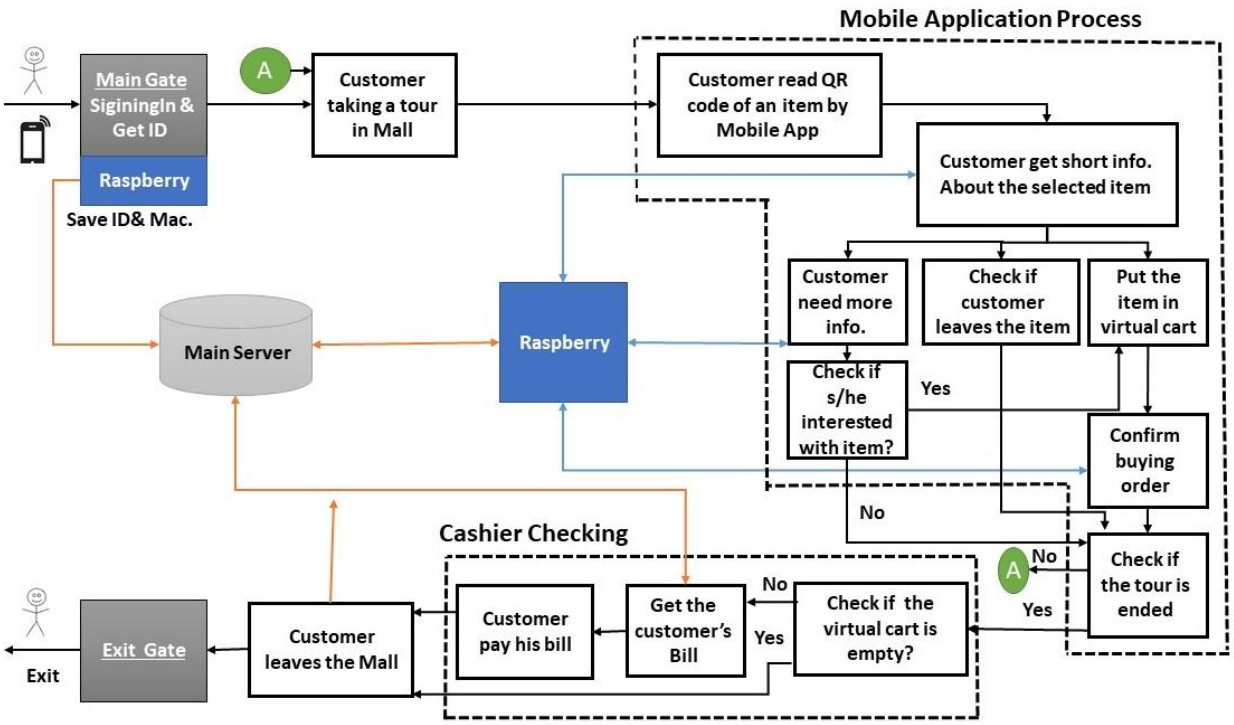

FIG. (4) THE PROPOSED SYSTEM BLOCK DIAGRAM

III. RESULTS AND EVALUATION

A simple prototype can be implemented for the proposed system that covers a small area of the building by using a single microcomputer board, in addition to the following hardware and software requirements:
-Hardware Required: Microcomputer board (Raspberry Pi3), HP laptop, Galaxy Note5 smart phone, and Cate5 cable.
-Software Required: Android Studio program, XAMP, Apache Server, MySQL, and PHP.
After installing the hardware components, as shown in Figure (5), each component will be set up by its required software to perform its duty.

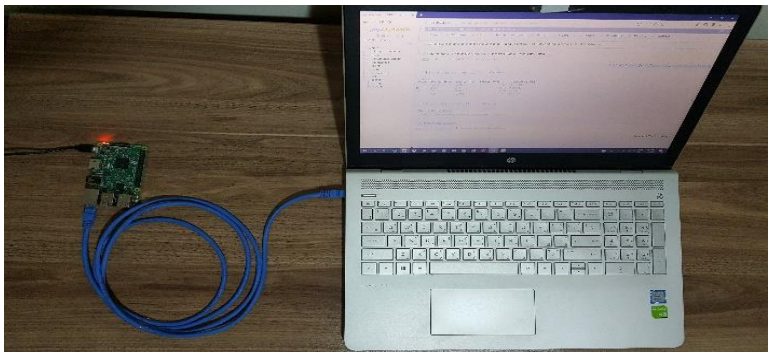

FIG. 5 HARDWARE SYSTEM CONNECTION

The smart phone is firstly connected to the system network, run the designed application to scan QR tag, then it sends the result to the microcomputer board for processing. Figure (6) illustrates the result of these processing on the designed application, while Figure (7) shows the cashier report when the customer

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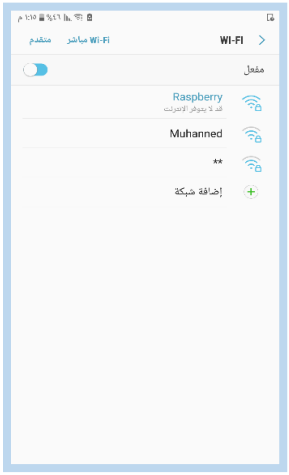
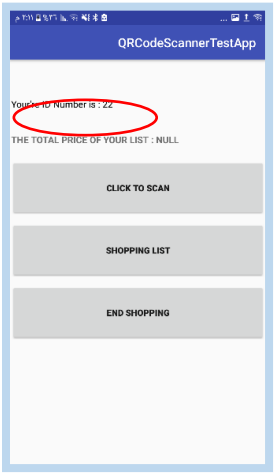
wants to end his/her tour. The results show that the designed system achieved the goals of the proposal from two points: hardware and software point of view using the QR technology.

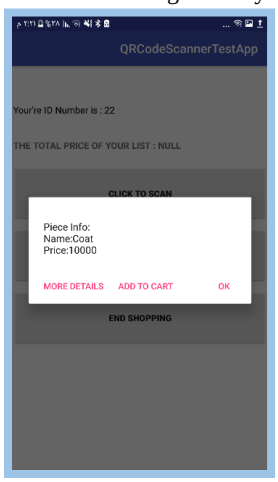


a- Connecting to the system net

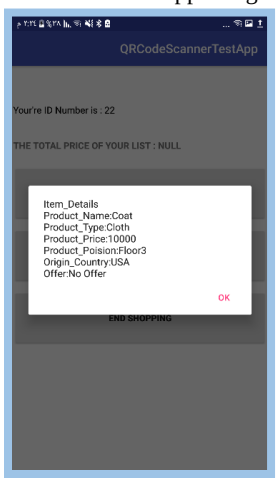


b- Run App and get ID

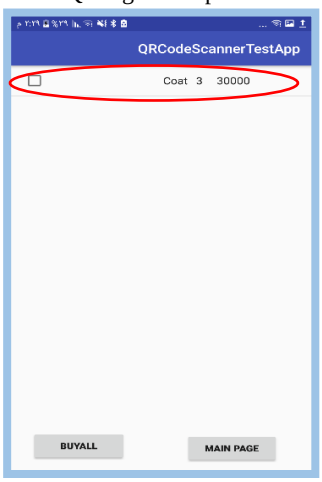
c- Scan QR tag on the product



d- Get brief information about the item

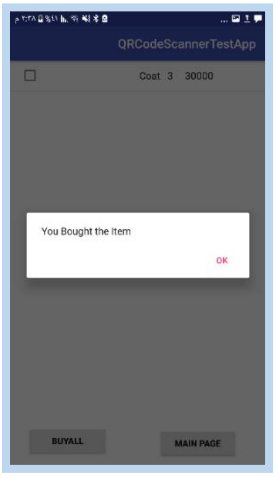


e- Get Details about the item



f- Add the item to the list

g- Decide whether deleting an item from list or buy (by cash/bank)



h- Receive notification when the item is brought

FIG. 6 PROCESSING THE DESIGNED APPLICATIONS

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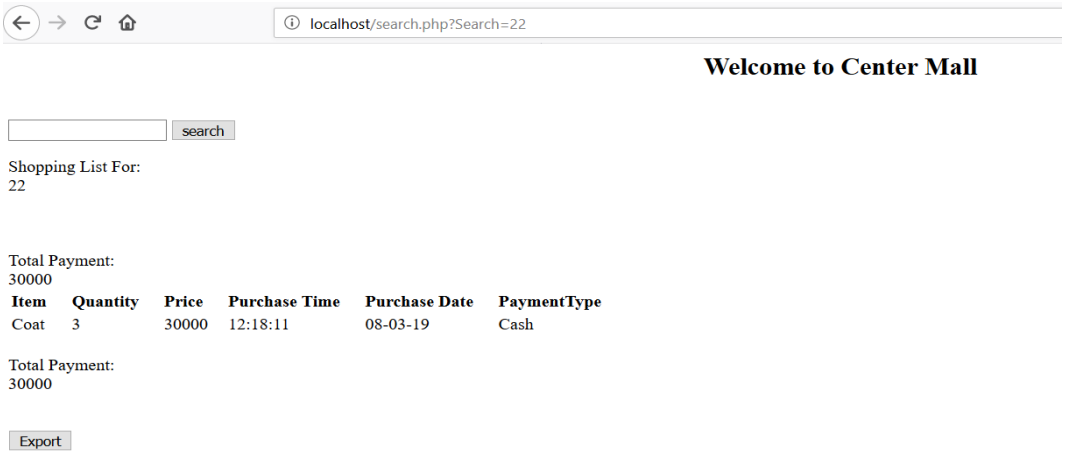

FIG. 7 CASHEIR REPORT

IV. CONCLUSION

Today, the mobile technology plays an important role in our life. It is used in many fields, such as communication, managing accounts, shopping, travelling, etc. Trading institutions, such as markets, utilized mobile devices in their field to provide service for both the customers and the institution employees as well. For trading institutions, mobile phones are used in online shopping, getting more details about products, providing effective billing system, etc. At the same time, many techniques are invented, which provide beside mobile devices easy life, saving time and cost for the society, and one of these techniques is the QR code. QR code is one of the simple and effective way to encode and decode large amount of information quickly. Therefore, this paper utilized it to implement an identity tag system that is used in indoor trade institutions and can replace the guide, so each customer has his electronic guide with him and doesn't need to spend time to wait or to spend money to get a guide. Whenever the QR tag is scanned by any smart device, it will access the institution's database and offer information (short and details) about the item on the smart device screen. The proposed system was implemented and tested in real environment in a mall and the performance of the system was as required. The proposed system can be developed in the future to get more features and options in order to be applied in other fields that need an identification system.

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