Inventory Management System for Household and Commercial use with QR Code

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Abstract— In recent years, the advancement of technology has provided a lot of convenience to our daily life. It is unsurprising to say that we are depending on technology at every moment of our daily life especially for the younger generation. Even some of the businesses are fully dependent on technology to operate their daily business such as online shopping platforms. For the time being, many software systems developed for attempting to meet the demands from different users. Then, inventory management systems have been developed to ease the processes of tracking inventory and restock inventory on time. But, most of the existing inventory management systems are mostly designed based on the needs of big organizations that have huge amounts of inventory flow. Eventually, there are almost no suitable inventory management systems for household and small commercial users. Therefore, this project aims to develop an inventory management system with QR Code and some basic features that is suitable to meet the demands of households and commercial users. The QR Code technology has been chosen to cope with this project due to its conveniences and ease of access.

Index Terms— Inventory Management System, QR-Code Technology, Household Use, Commercial Use.

I. INTRODUCTION

QR Codes technology has been chosen to cope with this project as it is easier to use and cheaper to get. According to research, the infrastructure costs of implementation QR Codes are considered as low [1]. This is because QR Codes can be scanned through using mobile devices where almost everyone has equipped in the current digital world.

A. Usefulness of Inventory Management System

At first, the inventory management system was used as a simple system that tracks the quantities of goods and products among a warehouse [2]. Soon, it becomes more complex even now it can integrate with the accounting system which used to calculate the costs [2]. Besides, a good inventory management system should be able to help keeping the latest update of the available stock records [3]. It should be able to reduce human error through minimizing manual documentation using the availability of labelling and the software of the inventory management system.

B. History of Inventory Management System

Back in the early days, the inventory management system does not occur before the industrial revolution. All the merchants required to note manually about the buying transactions and keep checking manually on which items were being sold and the total of items were left on a long day [7]. However, this method of estimating stocks is always not so accurate and even slows down business processes. In 1930, the team at Harvard University created the first modern check-out system [5]. The check-out system used punch cards which linked with items on the catalog [5]. The information would be passed to the storeroom once the system read the punch cards. Besides, the item would be taken right to the customer [5]. This system also able to generate transaction records and managing those inventories as an automated system [5]. However, it is very expensive to implement this system. According to the Barcode Direct website (2017), in the late 1940s and early 1950s, the forerunner modern bar-coding system was developed to meet the demands of a better inventory management system. It involved with a reader and ultraviolet light-sensitive ink for labelling the items used for selling [7]. However, this system was too large and not supported by the computing power at that time. In the late 1960s, the laser technology has been developed to create fast, small and cheap scanners and the first barcode was created which also known as Universal Product Code (UPC) [7]. The first item scanned by the barcode was a 10-pack Juicy Fruit gum on 26 June 1974 in the Marsh supermarket of Troy, Ohio [7]. In the 1980s and 1990s, the implementation of more advanced software with hardware has made the inventory tracking more well-organized [7]. The system working in a circular process which includes tracking, monitoring and reordering [7]. In the 2000s, the Radio-frequency Identification (RFID) technology was widely implemented as a modern inventory management system in the retail stores, factories and warehouses until today [7]. RFID transmits product information using a microchip [7]. The information including serial numbers, product types or manufacturers. One of the benefits of the RFID tag was it does not require to be in direct sight which means any angles also can read the stored information [7]. Other than that, when comparing with barcode, RFID is able to store more information. Nowadays, Barcode and RFID are widely used in the current inventory management system where barcode used to store data and RFID used to prevent the products from being stealing. Yet, both of them need a specific reader in order to function.

C. Development of QR Codes

In 1994, the Denso Wave created the first QR Code in order to assist the process of manufacturing [6]. It was named as Quick Response code because it was designed for fast speed decoding [6].In 1960, QR Codes was developed in Japan during its high economic growth period [4]. There are many items that are selling in the supermarkets and require cashiers to key in manually for the purpose of checkout [4]. This would lead to carpal tunnel syndrome where it is a common situation that causes numbness, pain or tingling in hand and arm [4]. In 1997, the Association for Automatic Identification and Mobility (AIM) standards have approved the QR Codes to be implemented in the automatic identification industry [4]. In the 1999s, the QR Codes was accepted by the Japan Industrial Standard as a standardized 2D code [4]. In 2000, the QR Codes was approved by the International Organization for Standardization (ISO) [4]. Now, the use of QR Codes was

separated widely. In 2004, the micro QR Code was approved by Japanese Industrial Standards (JIS) standard. It was developed in order to meet the desire for smaller codes [4]. In 2008, iQR Codes was developed and FrameQR was developed in 2014 [4].

D.   Implementation of QR Code Technology

The QR Codes technology is now widely adapted in the education management area. In Russia, the Volgograd State University was development an QR-quests application to improve its existing educational process [6]. The application was used as an innovation way teaching method and learning methods that obtain interactivity for current modern education management [6]. The QR application offers some interactive augmented reality games such as quest clues and riddles which come up with some questions that require students to find the correct answers accordingly [6]. This allows the direct connect between students and teachers to build interaction among themselves and students are able to gain the skills of teamwork, finding solution and increase their critical thinking skills. In Turkey, the QR Codes technology was developed into their healthcare system where they developed a QR Code Identity Tag system that integrating with healthcare field [8].

The QR Code tag was assigned to each person uniquely where patients are required to wear the bracelets with QR Code Identity [8]. The detailed information about the QR Codes Identity holder such as personal information, medical record, allergies, current medications can be obtained by scanning their identity tags as it will direct to the webpage of the QR Code Identity Tag system. In order to responds with medical identification alert system, the hospital has notified everyone to carry the QR Code Identity tag along with them while in the hospital area regardless with the necklace, bracelet or identification card. The QR Codes technology even implemented into the parking spaces management system [9]. In India, there was a Reservation-based Smart Parking System (RSPS) has been designed to locate and reserve the empty parking spaces [9]. The users would be generated with a unique QR Code tag before they entering the parking area. And, the system is able to track and manage the available parking space and guide the users to the nearest empty slot. With this, the parking spaces management could be facilitated and eliminated the crowding traffics of the parking processes.

E.   Problem with RFID

Requires External Reader. Today, most of the inventory management system using RFID technology and barcode technology, but there are still many drawbacks with RFID technology. The most common issue with RFID technology is the tags are not able to be read by using mobile devices as the RFID tags require an external scanner to scan [10]. Therefore, this clearly shown that it is not convenient for home users as they need to bring along the specific RFID reader to read the stored information. When compared with QR Codes, the advancement of technology allowed QR Codes tags accessed using the camera of any mobile devices. Consequently, using QR Codes technology in the inventory management system could simplify practicing processes for users among the range of home users to mid-size company users. Once the inventory management system is supported by using QR Codes technology, the users could experience the ease of accessibility.

High Implementation Costs. It is not cheap for implementing the RFID inventory management system as RFID tags require external readers to read [10]. Whereas the external readers are not commonly brought and could be a waste for household users as they do not use the scanner as frequent compared to industrial use. Thus, the high cost of acquiring the scanners do not justify the use of RFID technology in household use. The cost of implementing the inventory management system could be lower when it comes to QR Codes technology as it does not require any external reader. And, users can print the QR Code tags on their own.

Require Program to Transmit Data. The RFID inventory management system requires a program to transmit data between the RFID tags and the RFID readers as the external reader is used to scan the RFID tags. It means that the program will connect with the RFID reader to collect the scanned data and access to the stored information. The process of inventory management could be simplified since the QR Code tags can be scanned directly by using mobile devices. These tags are used to store unique information such as price, manufacturer, and product origin and so on. Hence, by scanning the QR Code tags, the users can easily access with the stored information.

Scanning Issues. RFID tags having scanning issues as well. The tags might not be functioning well if there are any distractions from metal or water [10]. Furthermore, RFID technology might face some tag or reader collision wherever there is overlapping information caused by both of the readers and tags as placed close together [11]. When compared with QR Codes technology, it would not occur any interference as it is focusing on one tag at a time. Besides, the RFID tags would become unusable when it spoiled, yet, the QR Codes still can be reprinted if it was destroyed.

Tags Collision and Unable to Remove. The RFID tags inside a product are usually hidden or embedded where it is not able to be removed. Therefore, this might cause a collision if users wish to add extra tags for personal use. Additionally, the removal of the RFID tag will cause it to be deactivated [12]. It means that the RFID tag must be permanently stored at the specified position. Therefore, users are not able to change the position of RFID tags. When the QR Codes technology implemented in the inventory management system, all of these could be solved. Users can add the QR Codes tag anywhere without worrying about the interference. Other than that, users can always change the position of the QR Code tags whenever they want. This due to the QR Codes tag is printed and pasted by themselves based on their preferences.

Standardization. The RFID technology used in inventory management might be incompatible depending on warehouses or countries [13]. This is due to the RFID tags are not controlled by any authority which makes its standards of storing information to be different based on regions. The international standard of QR Codes has been approved in June 2020 [14]. This means that the QR Codes technology implemented in inventory management might not occur any differentiate.

II. LITERATURE REVIEW

Due to globalization, the marketplace has new opportunities and challenges towards the industry which allows businesses to meet more customers [3]. Eventually, this could also increase

the need of demanding a reliable inventory management system (IMS) to help in their [3]. Technology becomes the most effective tool for managers to keep tracking accurate records where the ways of managing stocks become essential in determining a business to success or failure [3]. Therefore, the QR Code technology could be considered as an important enhancement to the inventory management system as it can store much more information and can be generated and printed easily. Most of the application relies on QR Code technology as it simplifies technological base where it is easy to access due to not requiring special tags or readers. Besides, printing QR Code does not require a specialized printer and can be printed easily on any surface regardless of paper or plastic labels. Moreover, every mobile device can be used to access QR Code tag as long as it is equipped with camera features and has an active internet connection. Furthermore, compared to RFID technology, accessing QR Code tag requires close proximity where there is low chance to access an undesired code.

A. *QR Code Technology in Medical Field*

In Turkey, the case study by Vassilya Uzun and Sami Bilgin has developed a QR Code Identity Tag system that integrates with their healthcare system [8]. The system provides an in- hospital patient identification system and the QR Code based medical identification alerts [8]. Therefore, everyone in the medical system is assigned with a unique QR Code tag bracelet or necklace that must be carried as an Identity Card within the hospital grounds [8]. The QR Code tag connects to the QR Code Identity website where it stores all the detailed information such as personal information, medical record, allergies, current medication. The system allows authorized personnel such as paramedics, firefighters and police to access that detailed information to improve the accuracy of medical treatment [8]. In California, the ICEid developed ICEid Tags and ICEid QR Code stickers that stores medical information such as medical history and allergies in case of emergency [8]. Those tags are plastic and waterproof which means users can attach to their clothes and wash by machine or stick to their helmet, bicycle or motorbike. Besides, the study also shows childIDcode has developed identification stickers for children to prevent the risk of wandering without adult's notice, it is the custom-printed waterproof QR Code sticker that can be placed on clothing or backpacks [8]. This sticker can be a good option for children as some of them might not be able to adapt with identification bracelets that need to be worn all the time. In Turkey, the QR Code technology has been used to track medical devices as well. The medical devices such as Vaporizer (VAP) are used to integrate with anesthesia devices that can be used in the operating room [15]. All the anesthetic gases that are transferred to the patient must be controlled, therefore, the QR Code technology was developed to track the Vaporizer (VAP) in a more convenient way [15]. Besides, the QR Code tag allows the Vaporizer (VAP) to be more easily tracked by the sales team as the stored information on the QR Code tag including device belongings, manufacturing date, location, responsible person and so on. With this technology, the medical devices of the hospital could be tracked accurately and reported to the head office on a monthly basis. Also, the GPS Coordinates of devices could help in reducing missing devices during the transferring process and the QR Code tag helps to monitor the performance of the salesperson. In brief, QR Code technology is suitable to be developed in the medical field as everyone can access the QR Code tag if there are any emergencies as it does not require any additional reader. When an accident happens, any passerby can save one's life on time by accessing the QR Code and checking for medical history. Similarly, this can ensure the use of appropriate medication and prevent errors and undesired misused medication at the step of various healthcare provisions [15][16][17][18][19].

B. *QR Code Technology in Education Sector*

Nowadays, the QR Code technology has been widely adapted into library management systems in order to create a simple and smart solution for managing huge resources of the library. With the help of QR Code technology, students are able to issue, return and manage books by using the library's application and librarians are able to check incoming or outgoing books, contact students and manage books [16]. Thus, this system could simplify the library managing processes while keeping track of all records. At the same time, users are able to access the library resources more easily. The QR Code technology library management system is able to be minimized to no employee assistance due to its ease of use. Eventually, this would reduce operating costs of the library as it does not require much employee to operate. Gradually, the university has started to rely on QR Code technology for taking attendance. The smart attendance system is implemented with QR Code technology to speed up the process of manually taking attendance [17]. This is due to manually attendances taking is actually every time-consuming as instructors require to check attendees one by one. The system is developed by implementing a webcam to a computer and students are required to scan their QR Code which is embedded on their student card when they attend the class [17]. With this system, the instructors are able to save time on taking attendance and focus on valuable teaching. Also, instructors can monitor the performance of their students by using this system to track latecomers and absentees [7][8][20][21][22][23].

In short, this shows that the education sector would slowly adapt into QR Code technology. It is reliable to utilize the functions of QR Code technology in education sectors since it requires huge human resources to operate. The traditional ways of managing the education sector is not efficient enough since it is depending on human resources and does not rely much on technology. In fact, the traditional management method should be replaced with the QR Code technology management method which could help in effective managing and decreasing human workload.

C. *QR Code Technology in Retail Sector*

In recent years, the QR Code technology has also been extensively used in the retail sector. One of the areas that are popular using QR Code is the ATM system. The QR Code is used as an authentication for users to make their transaction or withdrawal [18]. This QR Code is used like the OTP which means users can set up their transaction using their mobile banking application when they are queuing for the ATM machine. Once done setting up, the QR Code would be generated and the transaction is still yet to be completed. They are still required to scan the generated QR Code to the ATM machine in order to complete the transaction. Thus, this study shows that the QR Code authentication method is more secure and able to enhance customer satisfaction because users no longer need to fear their PIN being seen by others [24][25][26].

Besides, this could fasten the transaction process and reduce the waiting time for ATM machines when the QR Code is being used as an authentication method. In India, the bus system has integrated with QR Code technology as their government wants to improve their public transport [18]. This system is able to track the bus with the QR Codes that are placed at the bus stop [18]. A smartphone will be placed in the bus where it can trigger the GPS feature and locate the location of the bus [18]. Therefore, users are able to view the bus routes, bus current location and estimated arrival time by scanning the QR Code. Besides, this bus system is generating QR Code e-ticket and it will send email or SMS to notify passengers if there are any delays. In the end, this system can improve the whole bus system process and help to save time by eliminating queuing, save resources by using e- ticket. Even it is more efficient as passengers can estimate the arrival time.

In brief, the QR Code technology could improve the customer satisfactions on the retail sectors due to its ease of use. This QR Code technology is able to speed up the overall transaction processes and provide a more secure transaction method. Every QR Code is being generated uniquely and in complicated forms which means there would be less chances for QR Code being stolen. Thus, the implementation of QR Code technology could be considered as secure since it is able to guarantee its security and has been widely used in making transactions such as payment authentication methods. Besides, the e-ticket features could help to save resources by not printing out tickets or receipts that can be only used for once [8][9][27].

III. PROPOSED SYSTEM

This section explain in brief about the proposed system and the diagrams that shows how the system interacts with users and the process for every activity. It is shown with use case diagram and activity diagram.

Fig. 1. Use Case of the System

1. Use Case of the System

The above use case diagram shows the overall roles of users in the system. The member will automatically become the master of the group once he/she added another user to the group where he/she main role is adding member to the group. Meanwhile, every user is the member for the system
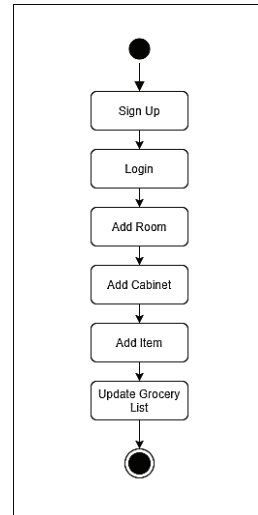

Fig. 2. Activity Diagram of Overall System Process

2. Overall Process

All of the users are required to sign up for an account before they are allowed to use the system. The system will direct the users to the login page once users have successfully signed up. As soon as users logged in, the homepage will be shown to preview the existing room or else, add room button will be shown if users do not have any room. Then, users can add room, add cabinet and add item. The added item will be automatically previewed at the grocery list unless users have defined not to preview it.

3.   Add Room, Cabinet, Item Process

Fig. 3. Activity Diagram for Add Room/Cabinet/Item

The activity diagram shows the flow of room, cabinet and item. Firstly, users require to login to the system whenever they want to check their rooms, cabinets or items. Once users logged in, they will be able to reach the homepage that showing the existing room created by their group member or themselves. By accessing the room, users can check the room details such as room name, image, date created, remark, owner, category and cabinet created previously. Yet, if users do not own any room, they can create a new room. After checking the room, the users can access to their existing cabinet that has been created previously. By accessing the cabinet, users can view the cabinet information such as cabinet name, image, date created, remark, location, owner, QR Code and stored items. At the same time, users can check or scan the QR Code for that particular cabinet. However, users can create new cabinet if there are no available cabinet for them to access. The same goes to item, users can access the existing item that created by themselves or their group member previously. By accessing the item, users can get the item details such as item name, image, date created, quantity, unit, remark, location, restock level, owner and QR Code. Meanwhile, the QR Code is available for users to check or scan to reach the particular item. Still, users can create new item if there are no any existing item. The process will be ended after users done with their actions.
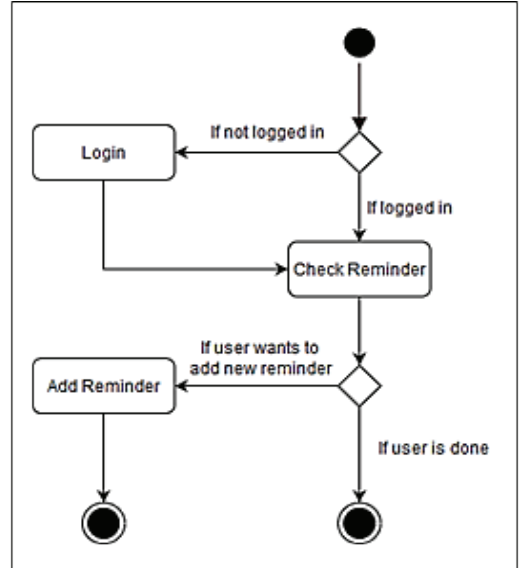
4.   Reminder Process

Fig. 4. Activity Diagram to show the Reminder Process

In order to check the reminder, users are required to login their account first. If the user is not logged in, he/she will be directed to the login page as the reminder page needs authentication to be accessed. Once the user is logged in, he/she will be able to check the reminder. Then, the user can choose whether he/she wants to add a new reminder. If he/she does not want to add a new reminder, the process will be ended. If yes, the process will be ended after a new reminder is created.
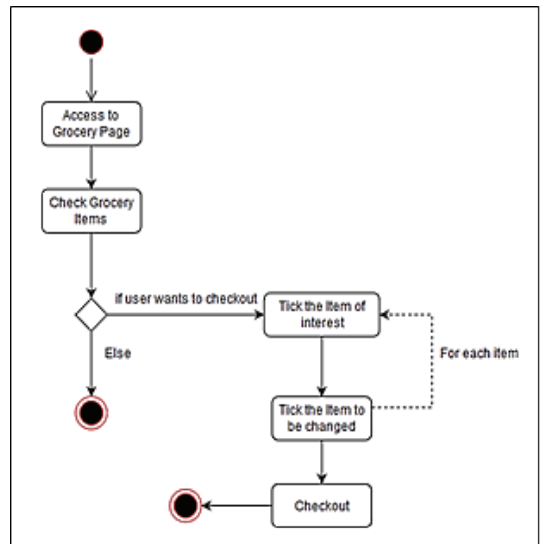
5.   Grocery Process

Fig. 5. Activity Diagram to show the Grocery Process

First, users need to access to the grocery list page in order to check for their grocery items. Yet, if no item needs to be check out, the process will be end. Meanwhile, if users want to check out their items, they need to select the correct amount for each item and tick the checkbox beside the item. Then, those selected items would be done checkout after clicking the checkout button.

IV. CONCLUSION

This paper proposes an inventory management systems by using QR code to ease the processes of tracking inventory and restock inventory on time. The QR Code technology has been chosen to cope with this project due to its conveniences and ease of access. This paper also presents the design of the proposed system by depicting the use case diagram and activity diagram.

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