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A Simulation of Mobile-Based Bank Teller Application for Managing Waiting Time of Customers

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Abstract: In business decision-making, the queuing system is one of the options employed to satisfy the demands of a particular service system for resource needs. The queuing theory has been used successfully by various business service industries. There are many types of queuing systems that can predict waiting times and queue lengths. The First In First Out (FIFO) algorithm works like the queue principle, where the first customer to arrive is served first. To mitigate the negative effects of waiting, service managers have implemented various solutions, such as informing customers of the wait length, reducing waiting time, and offering entertainment options like television during the wait. Service operations managers continually strive to reduce customer waiting times to enhance customer satisfaction, which can be achieved through real waiting time reduction or improvement in the customer waiting for the experience. This study presents a simulation of a mobile-based bank teller application for managing customer wait times. The application is built using back-end and cloud computing and is based on a FIFO algorithm. It has been shown that the proposed system is efficient and contributes to the real workflow process.

Keywords: Mobile, Waiting Time, Customer Queue Management, Workflow, Bank Teller Application, Scheduling, Resource Management, Teller Utilization, Customer Satisfaction

Introduction

Nowadays, customers are restricted by time than previously. In an extremely aggressive world, the need, expectation, and pressure to accomplish further in a smaller time are doubtful to reduce. Service suppliers perceive the quality that customers expected time they see wasted while viewing the service delivery. A waiting consumer in line for service is probably a lost one.

Service operations managers continuously try to reduce the waiting time of customers through the delivery of services to accomplish customer satisfaction. Corporations beyond a range of activities initiated several superficial service aspects to the service package experience of their clients to reduce waiting times for clients (Sheu *et al*., 2003).

In many industries, innovative technologies present further opportunities to enhance customer service and service processes. For example, the airline e-ticketing practice of making a massive effect on buying tickets like the check-in processes in airports. more examples comprise telephone communication switching systems, supermarket's self-service checkout and optical scanners to checkout, in restaurants wireless orders from waiters to kitchen, collecting copy machines, transportation auto-toll booths, financial services electronic funds transfer and electronic systems to check-in or check-out in the hotels, etc., (Sheu *et al*., 2003).

About waiting time, to increase customer satisfaction, there are two ways. First real waiting time reduction, the second customer's waiting for experience enhancement (Wu *et al*., 2013). However, decreasing the actual time is the most favorable to the customers (El-Bakry and Mastorakis, 2008; 2009; El-Bakry, 2010a-c; El-Bakry and Zhao; 2006; 2005; El-Bakry, 2002a-b; El-Bakry and Hamada, 2008; El-Bakry, 2001; Adel *et al*., 2014; Kareem *et al*., 2022), so this study presents a mobile-based bank teller application to solve this problem.

Many researchers investigated the waiting time problem. Some researchers represented the waiting time of customers in a queue system in general. Other researchers represent some applicable queue management systems. While other researchers introduced mobile-based systems to manage customer queues in banks.

Hapsari *et al*. (2016) developed a management information system to register veterinary hospital patients utilizing the first-out procedure. Hapsari *et al*. (2016) created the information system as a web-based form since the system registration was developed for other sub-systems integration, there are billing, pharmacy, and medical record systems that require many peripherals at distinct spaces in a single site. Furthermore, the system is as well hospitals need to manage an electronic system to be accessed outside of the hospital, for instance, medical records of hospitalized patients could be charged by doctors wherever they are, through their own devices. Under each patient's queue number, patient services are conducted sequentially (Hapsari *et al*., 2016).

The test results showed software quality that satisfies the least need for the system registration with a total vote were 75.28%. Though a pure FIFO algorithm was used for system registration however the real hospital queue system implementation is more complicated than a basic FIFO, thus more algorithms are needed to agree with the patient registration system queue (Hapsari *et al*., 2016).

Muhammad *et al*. (2014) examined the patterns of behavior of students on arrival at a university over the observation process. They introduced time and measuring queuing system standards and apply to student affairs in universities as a case study. The service waiting time could have a passive impact and produce a passive acuity about the university. Managers reported the subject of waiting in lines as essential for the firm's success. However, it is supposed in banks serve consumers on a FIFO method, but a few consumers try to cut the line by giving an urgent excuse. Consequently, to balance the negative effects of waiting, service managers developed various options such as notifying consumers about the wait length, reducing waiting time, and offering several entertainment sorts such as television throughout the waiting time. Though, it is not easy to inspire consumer satisfaction even with the extensive range of available methods (2).

Muhammad *et al*. (2014) employed the observation technique for research purposes in their study. A direct investigation method was applied to monitor staff and students for a week to obtain the service rate, arrival rate, arrival pattern, and the queue system in practice. They found that students at various universities indicated that over 70% of university students were angry and unsatisfied with student affairs services (2).

Uddin *et al*. (2016) introduced an automatic queue management system to efficiently assist service providers with customer management. Their proposed system helped the service provider managers to facilitate the flow management of customers. They utilized the system to organize queuing systems to analyze the queue status and take decisions about a first-served customer. Their study was conducted using two inquiries. Firstly, what adjacent could be utilized to create an automated queue management system? Secondly, which parameters could accomplish queue system optimum performance (Uddin *et al*., 2016).

They utilized several queuing procedures and employed them in bank systems to help average waiting time and customers. Their proposed system scenario was for the client to select needed services from service-A, service-B, or service-C and pick up an admission note. The note contains information such as retail or organizational name, time, date, service selected, and token number. The client continues to the counter when his token number is shown on the screen. Consequently, clients can relax and have a great customer service understanding as a substitute for worrying about their places in line performance (Uddin *et al*., 2016).

Alam (2018) introduced the integration of mobile-based queuing systems. They analyzed and designed and created a system model to integrate most queuing services utilizing the First In First Out (FIFO) technique. By installing the system users could sign up for different service sites. The system was designed to fulfill communication and information requirements using the SDLC structure. Information requirements are such as estimated service time and queue position. Therefore, users could sign up for a service and wait for it from everywhere with no time wasting. They designed a queuing application model to be employed as a mobile-based application (Alam, 2018).

Abadi *et al*. (2021) introduced a customer management experience in the mobile banking industry for Dubai commercial banks. Explorative qualitative and quantitative approaches were used. They collected data using grounded theory (qualitative phase) and cross-sectional survey method (quantitative phase). Using grounded theory, people involved in academic experts and specialists (management field professors) were chosen using the snowball sampling method. Data was collected using a semi-structured interview. Data collection attained theoretical data dissemination in the twenty-fifth interview. The coding results using the qualitative phase introduced the identification of 24 axial codes, 170 open codes, and seven selected codes involving communicative, behavioral, physical, sensory, motivational, cognitive, and value ones. The cross-sectional survey method, people involved 100,000 users for services of mobile banking. Assuming the unavailability of people variation, they used Morgan and Krejcie table to verify the size of the sample calculated at 384 persons. They confirmed the qualitative findings with data analysis in the quantitative phase using Adjusted Goodness of Fit (AGFI), the Goodness of Fit (GFI),

chi-square (x_2), and Root Mean Squared Error of Approximation (RMSEA) indicators (Abadi *et al*., 2021).

Sharma *et al*. (2016) introduced the main developments in the banking industry and created a relationship between traditional banking systems and mobile technology. They discussed in detail the main benefits presented and the major difficulties that challenged mobile banking implementation. Moreover, they examined the integration of new technologies like big data and cloud computing in the context of the banking industry. They introduced practical and theoretical consequences for decision-makers and researchers from a developing country, by investigating several dimensions of mobile banking adoption (Sharma and Al-Muharrami, 2018).

Chaimaa *et al*. (2021) introduced an overview of the concepts, challenges, and solutions of E-banking. They represented the several benefits that E-banking offers for both customers and banks. E-banking enables customers to access account information and electronically perform banking transactions anywhere at any time. Moreover, E-banking saves customers time as they need not physically exist at the location of the bank. E-banking minimizes operational costs by reducing waiting times, staffing resources needed and physical facilities in branches leading to increase sales performance. They also represented the E-banking challenges like; accessibility concerns, difficulty to use for new technology users, authentication process time, availability concerns, and security concerns (Chaimaa *et al*., 2021).

Jeevan (2015) investigated a customer implementation method of a new electronic payment service and the factors affecting mobile banking implementation in India. ICICI Bank utilized iMobile applications that offer several technology services for customers. ICICI Bank's mobile banking application can be downloaded on a mobile phone. With iMobile, customers can pay utility bills, transfer funds, check their account balance, book movie tickets recharge their mobile phone, broadband, DTH connection, etc. The iMobile app for the Windows platform is compatible with Windows 8 or higher. Banks technology changes the systems and functions with the easy usage of banking fund transactions and payment of bills safely and easily. It makes the customer take their privacy in banking activities with the help of innovative Technological solutions. Innovative technologies are upgraded each second towards the changes in customer characteristics and requirements for effective solutions in the business. Therefore, it will improve the entire system. The upgrade technologies give easy, secure, safe, and more benefits to organizations (Jeevan, 2015). This literature could be summarized in Table 1.

Table 1: A summary of the literature review

Reference	Idea	Advantages	Disadvantages	Domain
Hapsari *et al*. (2016)	Veterinary hospital patient registration	First in first out algorithm	Real hospital queue system implementation is more complicated over a basic FIFO	Veterinary hospital
Muhammad *et al*. (2014)	Patterns behavior of students arrival in a university	First-come-first-served, providing different kinds of entertainment	Some customers cut the line	between student affairs in of universities
Uddin *et al*. (2016)	Automatic queue management system	Organize queuing systems to analyze the queue status and take decisions about first-served customer	Customers should go to bank and select required services and gets an acknowledgment receipt then waits for his token the number displayed on the screen	Banks queuing system
Alam (2018)	Integration of mobile based queuing systems	Mobile-based applications, first come first serve, people can register in various service places		Bank, clinics, and other services
Abadi *et al*. (2021)	Customer management experience in mobile banking industry	Qualitative and quantitative approaches were used.	The approach was conducted on commercial banks in Dubai only	Dubai commercial banks the customers
Sharma *et al*. (2016)	The main developments in the banking industry and created a relationship between traditional banking systems and mobile technology	Discussed the main presented major difficulties challenged mobile banking implementation		Mobile banking
Chaimaa *et al*. (2021)	Concepts, challenges, and solutions of E-banking	Several benefits that E-banking presents customers and banks	E-banking challenges; accessibility concerns, difficulty to use for new technology users, authentication process time, availability concerns and security concerns	E-banking
Jeevan (2015)	Consumer adoption model of a new electronic payment service	iMobile applications which give several technology services for customers	Applied only for the ICICI Bank	ICICI bank

Materials

The main materials for developing the proposed application are Flutter development using dart, laravel development framework using PHP script language, MySQL data storage and front scripting including HTML, JavaScript and CSS. The software runs a web server, and android mobile.

Methods

The proposed mobile-based bank teller application was designed using back-end development tools. The backend of an application is responsible for performance, database interactions, business logic, and calculations. Most of the code which is needed to build an application work is executed on the backend. The code is executed on a server different from the client. The majority of application code is written on the backend, it must be simple to recognize and work with. Most backend languages such as Python and Ruby have standard techniques to make writing and reading code enjoyable and efficient (Filipova *et al.*, 2018).

The application was developed using the Software Development Life Cycle (SDLC) as it is the most standard system development approach. The data is uploaded to the cloud. Cloud computing is defined as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources like services, applications, storage, servers, and networks) which are rapidly provisioned and unrestricted with minimal management determination or service provider collaboration" (Sharma *et al.*, 2016).

Many mechanisms like Priority Queuing (PQ), First Come First Served (FCFS) and Weighted-Fair Queuing (WFQ) are used for managing the Quality of Service (QoS) (Kaunser and Kansal, 2016). In this study, the proposed system uses the First In First Out (FIFO) mechanism to handle all user requests.

The Proposed Mobile-Based Bank Teller Application

It is found that the waiting queuing process is time wasted and tiring because registration, waiting time and all process are executed at the same place continuously without delay time. To reduce wasting time, we designed a mobile-based bank teller application.

The Entity Relationship Diagram (ERD) explains the content and related data model in a database through the form of attributes, entities, and entities relationship. ERD is required to create a model of data structures and relationships for every data. Figure 1 shows the ERD of the bank teller application introducing the relationship between the customer and his orders from what branch. The use case diagram is utilized to demonstrate the functions of a system. The highlighted function in this diagram is what the system makes (Fig. 2).

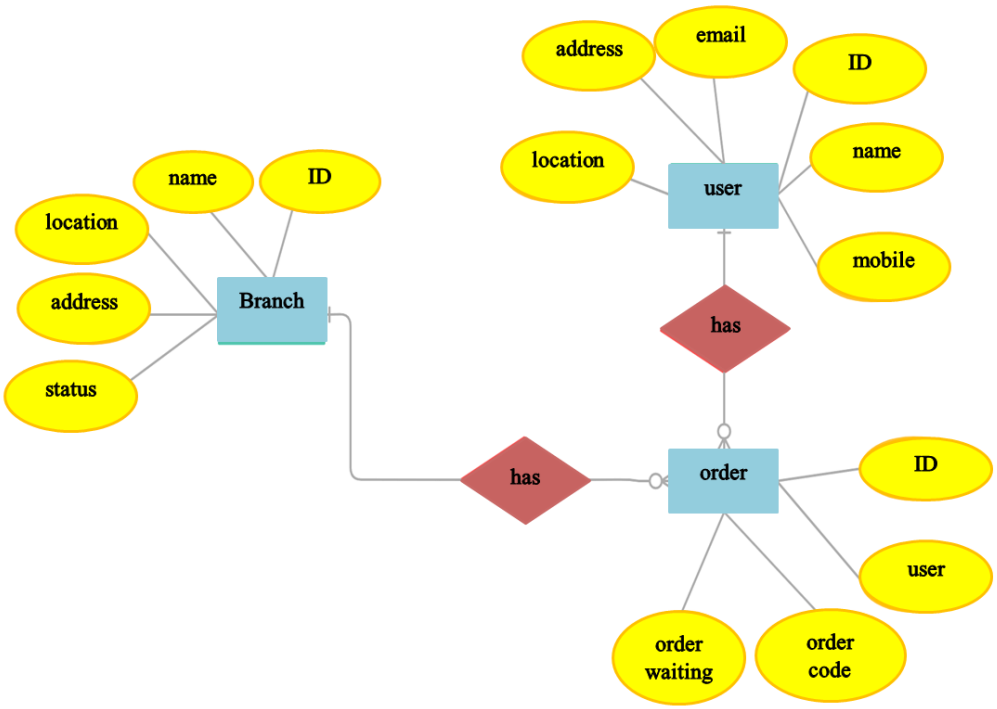

Fig. 1: The ERD of the bank teller application

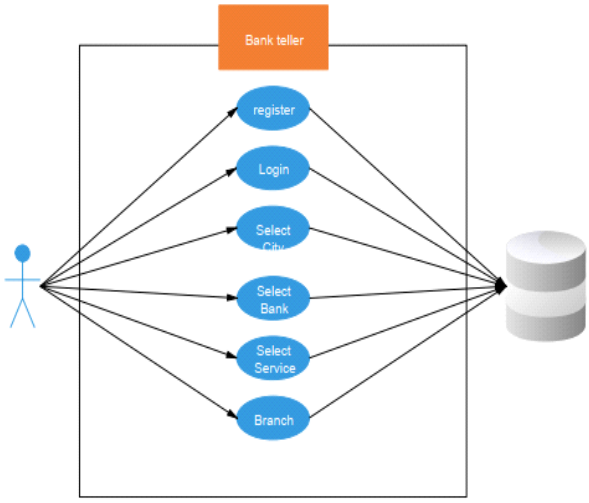

Fig. 2: The use case diagram of the bank teller application

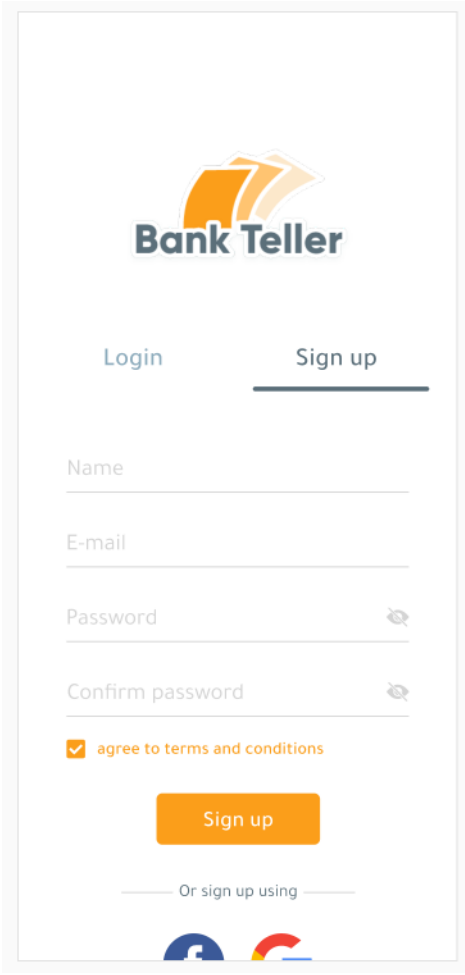

Fig. 3: Sign up screen; the user can register as a new user providing a user name, email, and password; the user is asked to enter the password twice for confirmation, and accepts the terms and conditions to sign up. The user can sign up using his facebook or google account

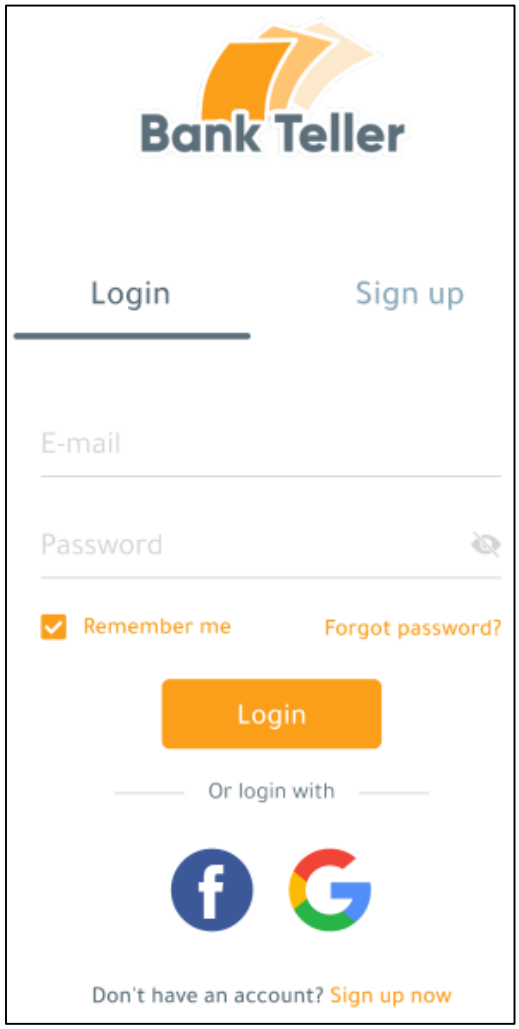

Fig. 4: Login screen; the user can log in using the user's name and password and can make the application remember these data for further use. Also, the user can log in to the application using his Facebook or google account

The system interface design is shown in Fig. 3-11. Figure 3 shows the signup window; in the signup tab the user can register as a new user providing a username, email, and password; the user is asked to enter the password twice for confirmation and accepts the terms and conditions to sign up. Also, the user can sign up using his Facebook or Google account. Figure 4, the user can log in using the user's name and password and can make the application remember these data for further use. Moreover, the user can log in to the application using his Facebook or Google account. If the user forgot his password, he can change it from this screen and the application shows another screen (Fig. 5) asking him to provide the email to send a four digits code. The user uses these for digits to reset the password in the reset password screen (Fig. 6).

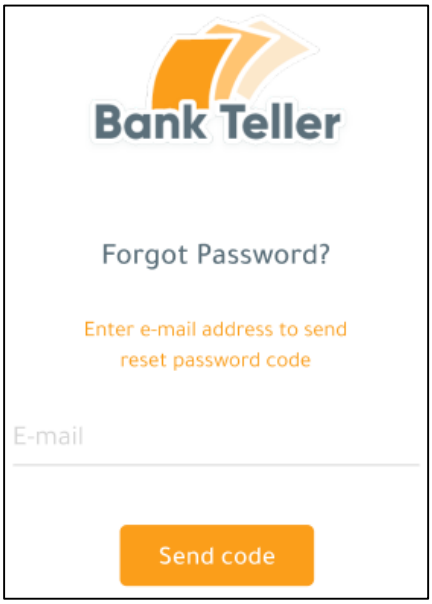

Fig. 5: Forgot password screen; if the user forgot his password, he can change it from this screen and the application shows another screen asking him to provide the email to send a 4-digit code to be used to create a new password

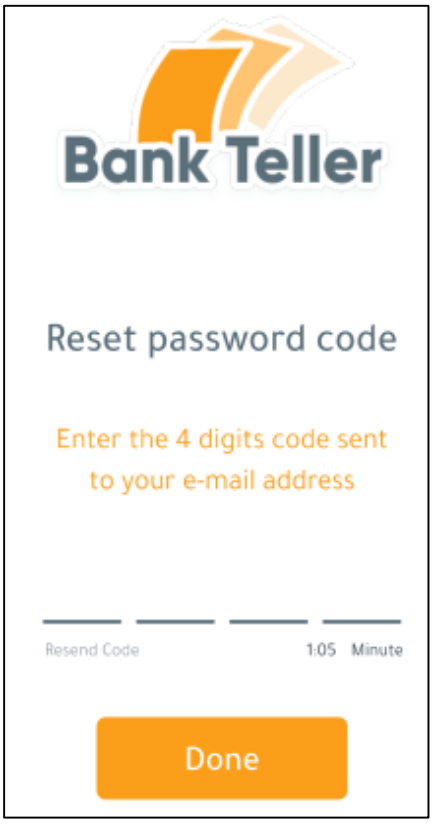

Fig. 6: Reset password screen; the user uses the four digits to reset the password

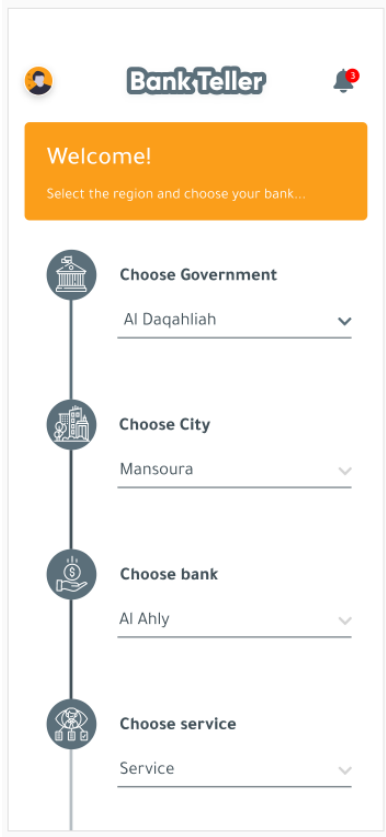

Fig. 7: On the main window screen, the user chooses the government, then chooses the city, after that he chooses the bank then the service

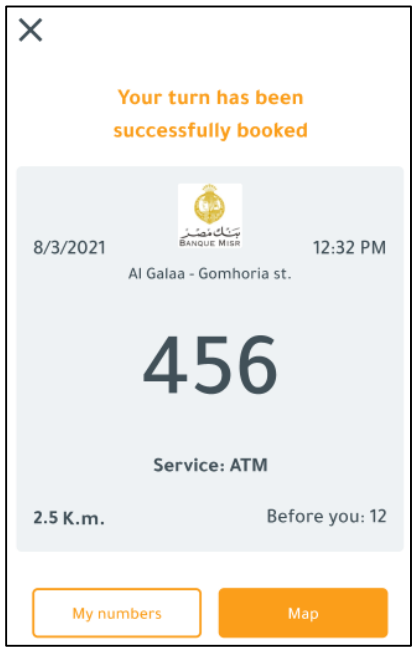

Fig. 8: The token number screen; showing the service type, the waiting queue before him, and the distance between the customer and the nearest branch in which he will be served

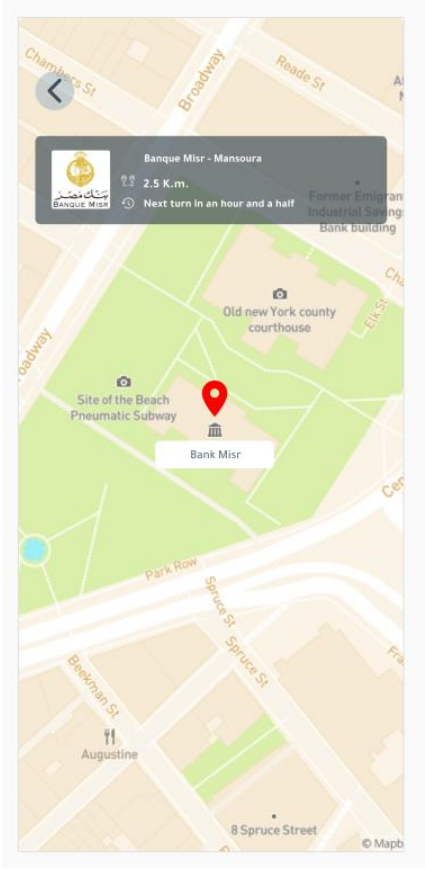

Fig. 9: The map identifying the branch location to take the best way to arrive at the branch

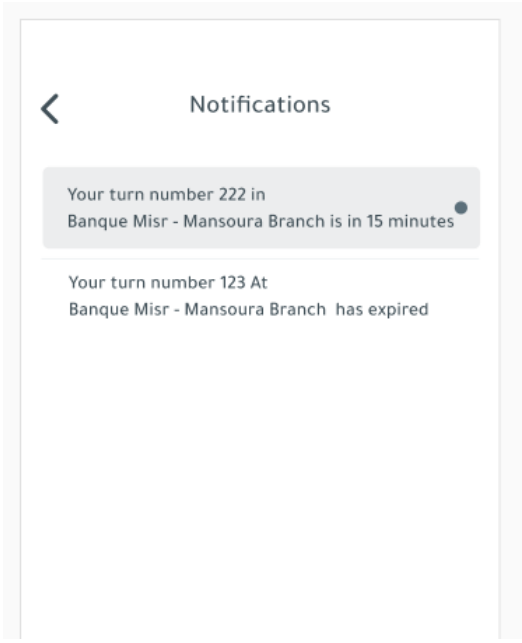

Fig. 10: The notification screen; shows notifications about the services that was ordered by the user

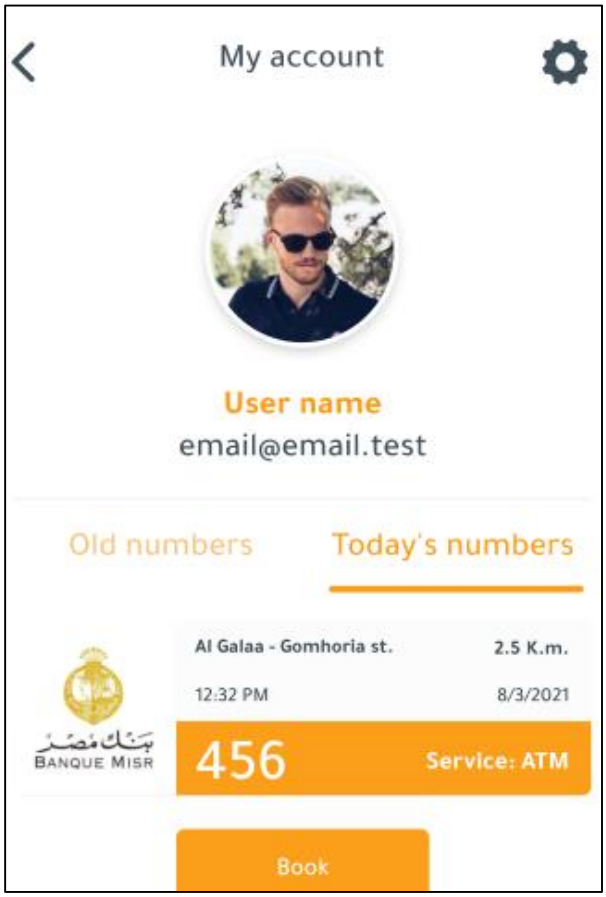

Fig. 11: My account window, shows the user data with today's numbers and he can also view his old numbers

Once the user login to the application, the main window appears in which the user chooses the government, then chooses the city, and after that, he chooses the bank then the service (Fig. 7). After that, a screen appears showing his token number, his service type, the waiting queue before him and the distance between the customer and the nearest branch in which he will be served (Fig. 8). Also on this screen, you can view the map to the bank branch to take the best way to arrive at that branch (Fig. 9). The my-numbers button in the screen in Fig. (8) navigates to another screen that shows notifications about the services that were ordered by the user (Fig. 10).

Also, from the main window, if the user pressed on my account, a new screen appears showing the user data with today's numbers and he can also view his old numbers (Fig. 10).

The application was designed to work during work time so that if a user tried to book a service before or after work time, the system refuses to do that. If a problem appears to the user, he can contact the system administrator using the contact us button providing his name, email, subject, and the message.

Results and Discussion

The proposed mobile-based bank teller application was designed and implemented to be appropriate for bank customers to manage queue time waiting for all bank services. However, the simulated application isn't yet conducted completely by customers or bank systems but employed by simulation when this application was created. Moreover, the purpose of this study is to create queuing management system with the capability to integrate all bank services queuing systems in one mobile application that can contain the number of queuing positions, time estimation of the service, and places of queuing branches.

Figure 12 represents a map showing the status of the customers for the QNB Mit Ghamr branch on 26 September 2021 at 10:00 am showing that some customers are in the bank branch represented with grey color and some other customers are on way to the branch represented with yellow color, some other customers are away from the branch represented with purple color and the other customers are who have finished the required service. This information is collected every two hours during the same day for data analysis for each bank branch. Table 2 represents all data collected on 26 September 2021 at 10:00 am for QNB bank branches included in the system.

Figure 13 a chart represents all data collected on 26 September 2021 at 10:00 am for each branch of the QNB included in the system.

The main advantage of this application is the ability to integrate all booking processes of all bank services in one single application without the necessity to go to the bank branch to take a role and wait in the bank branch to be serviced and this leads to save time instead of wasting it in the branch. Another advantage of this application is that application searches for the nearest branch for the customer and if the nearest branch is fully completed it searches for the next nearest available branch and books a number for the customer.

One important result of this application is saving customers and bank time. Traditionally the customer must go to the bank branch, take a number and wait for his role in the branch. In many bank branches, the average time is about two hours from the arrival time until the time to be serviced. But using this application the user goes to the branch at the exact time to start the service, saving two hours of his time. This means less traffic in the bank branch and more health.

Many benefits are expected because of this application such as it could be a key to developing queuing systems with the economical budget for national or private banks to develop queuing systems. Also, integrating all bank services in one single mobile application can improve services to customers.

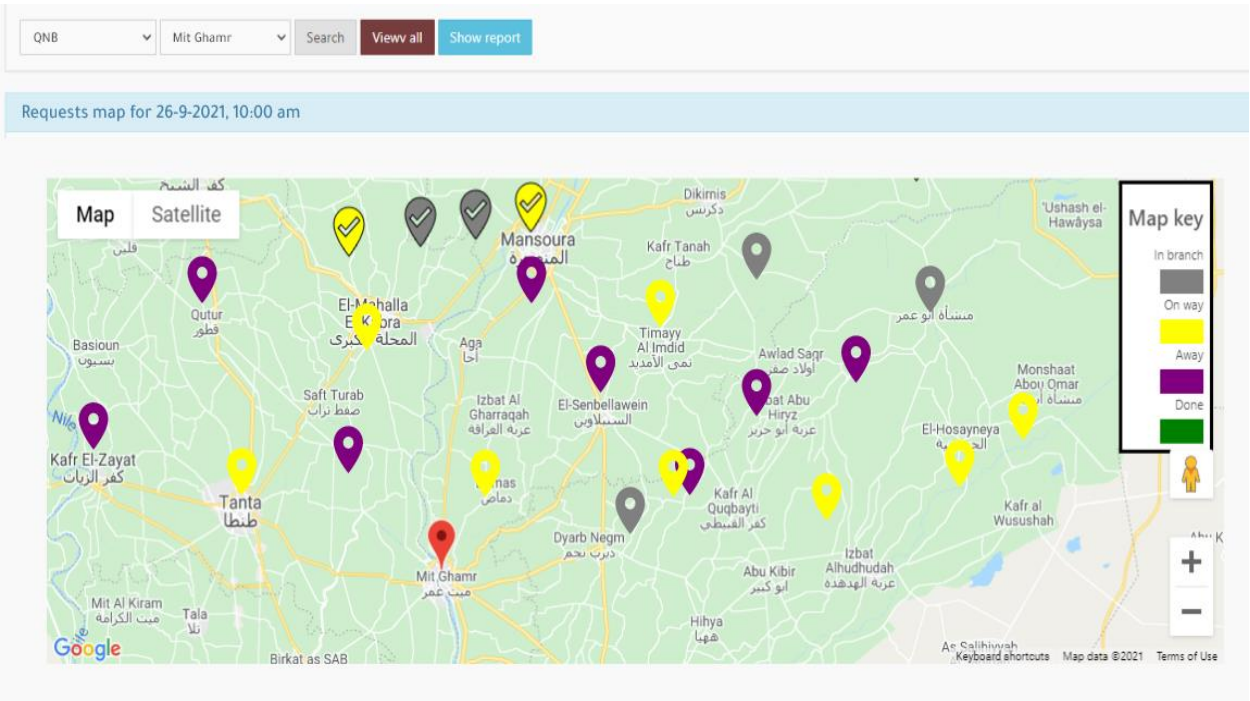

Fig. 12: A map showing the status of the customers for the QNB Mit Ghamr branch on 26 September 2021 at 10:00 am

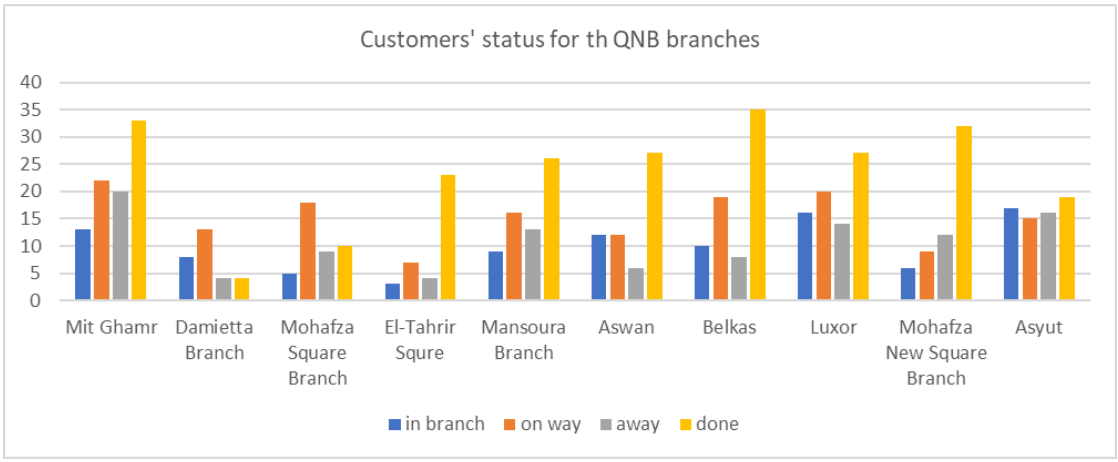

Fig. 13: Data for QNB bank branches included in the system on 26 September 2021 at 10:00 am

Table 2: Collected data for QNB bank branches included in the system on 26 September 2021 at 10:00 am

Bank name	Branch	IN branch	On way	Away	Done	Total
QNB	Mit Ghamr	13	22	20	33	88
QNB	Damietta branch	8	13	4	4	60
QNB	Mohafza square branch	5	18	9	10	42
QNB	El-Tahrir square	3	7	4	23	37
QNB	Mansoura branch	9	16	13	26	64
QNB	Aswan	12	12	6	27	57
QNB	Belkas	10	19	8	35	72
QNB	Luxor	16	20	14	27	67
QNB	Mohafza new square branch	6	9	12	32	64
QNB	Asyut	17	15	16	19	57

Conclusion

This study introduced a mobile-based bank teller application that is designed and implemented to be suitable for bank clients to manage queue time waiting for all bank services. As queuing theory was used with success by different categories of business service industries. Furthermore, there are many kinds of queuing systems that might estimate the expectations of waiting time and queue length. However, the proposed system is a simulation of a bank teller system to save wasting time for customers' service queues, but we are looking forward to implementing this system in the real world. The proposed system proved that the efficiency of the proposed system is helpful and contributes to the workflow of the real workflow process. Also, this application could be enhanced to be appropriate for many other services in government organizations and private companies or associations.

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Author's Contributions

All authors equally contributed in this study.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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