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Design and Implementation of a Computerized Drug Inventory Management Information System Using ASP.NET MVC

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ARTICLE INFO	ABSTRACT
	Automation in the drug inventory distribution process is helpful to pharmacist. Pharmacy management has kept paper record in filing cabinets. Managing a very large pharmacy with records on papers will be tedious and difficult to keep track of inventories with regards to the drugs in the store, expiry date, quantity of drugs available based on the categories and their functions. A Drug Inventory Management Information System(DIMIS) is basically a computer system that can manage all the information to allow pharmacists to do their jobs faster and more effective in real time. These jobs include: dispensing of drugs, drug regulation, and the sale of these drugs. The developed methodology adopted in the implementation of the software is iterative model of system development life cycle. This method produces an early stage of model. The development of the system is based on using new technologies like AJAX, ASP.NET MVC 5, Bootstrap, HTML and CSS which make the user interface more interactive. C#.NET language was used as server language whereas as a database server Microsoft SQL server 2012 was utilized. DIMIS is able to search and check a huge number and expiration date of drug in the purchase as well as delivery records. These attributes and functions are powerful, efficient and subsequently useful in patient's safety and cost containment

1. Introduction

The increase advances in information & communication technology (ICT) beside the development of internet has highly affected the business and service delivery models of nowadays global environment[1][2]. Businesses and organizations are striving for development and enhance their operations as an endeavor to increase the productivity and quality of performance. The primary tools that required to achieve high levels of performance are information systems and technologies [3]. Drug inventory management can be time consuming and tedious task. On a daily routine, pharmacists should purchase and return back orders to the suppliers. Every morning, drug stock in each pharmacy section is also checked by pharmacists[4] [5]. All the procedures with this information are performed manually and this require time and effort. DIMIS is an E-application that make use a web-based user interface (WUI) as its user interface. Such systems would help the pharmacist to manage drugs and all the material in inventory.

Management Information Systems (MIS) is an Information System which retains at the management level. It provides the decision-making, monitoring, controlling and administrative functionalities [2]. The concept of MIS has developed over the years covering

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many different fields of the organizational utility. Recently, there has been a wide interest in the management of information using modern information technologies[6].

Many researchers' studies have been done on DIMIS in different directions and various attentions. The authors in [7] developed and modeled an Integrative computerized pharmacy inventory system for improving patient care by promoting medication dispensing accuracy which enables pharmacists to spend more time on patient care duties. In [8], Sam-david et al. designed incremental model of system development life cycle, for producing an online pharmaceutical management system. In addition, Rumi defined a notation for specifying business process behavior based on web services which considered as the glue that will link together web deployed components to form web applications [6]. In this paper, we designed and implemented a database management information system which is able to manage and archive the information in the Iraqi pharmacies environment. This system used the most advenced technologies which made the system more usable and efficient.

2.Problem identification

Unparalleled and unprecedented demands for health services that is facing our country, will increase during the next decades due to increase of population. Most of Iraqi pharmacies do not offer electronic services and the drugs' management on these pharmacies is done manually. Manual system suffers from many drawbacks in addition to time and inaccuracy. So there is a need to digitalize the request, report, store, view and retrieve the medical data in the Iraqi pharmacies environment. In this work, we will design and implement a database management information system which is able to manage and archive the information in the Iraqi pharmacies environment.

3. Drug Inventory Management Information System(DIMIS)

In pharmacy functionalities, inventory is referred to as the stock of pharmaceutical products kept and saved to meet the market demand. Inventory has been considered the most important asset in pharmacy practice, and its value keeps to raise because of the growth in variety and cost of pharmaceutical products [9]. DIMIS is a system that allows users to scan barcodes at drug dispensaries and keeps track of medication in-takes. This system has been developed to help in achieving best planning, organizing and controlling inventory that aims at minimizing the investment in inventory while balancing supply and demand, perfect financial performance and most importantly patient and employee satisfaction.

4. Proposed system

The proposed system consists of two servers (application and database server and many inventories(pharmacies) can connect to the application of the system through the URL address of the application server as shown in the figure 1. The application of system(DIMIS) consists of three section (administrator pharmacist and patient,). All are connected through wireless access point (intranet network). The drug's entering process in the inventory will be done electronically by the administrator or pharmacist, and the information about all the drugs will be stored on database servers. Administrator section would be responsible for entering the drugs, managing them, and providing the required information about them when it was needed.

5. Methodology of the study

In order to build high quality software application that satisfy the requirements requested by the user, it is essential to follow many laid down rules for software modeling. Software Development Life Cycle (SDLC) has been used as a temple that determine tasks implemented at each stage in software development. The model that has been used for this project is iterative model because it produces an early working model so that the design and functional errors can be easily discovered.

6. System requirements

Requirements gathering and analysis is the first stage for developing software application. During this stage the concentration is what to achieve by this application. Since main objective of this project is to be applied in pharmacies and drug inventories, the system's requirements are taken from pharmacists. Data had been gathered at this phase from the potential users of the system. Several meetings had been arranged with them to get information about drug's management process and what data would be needed.
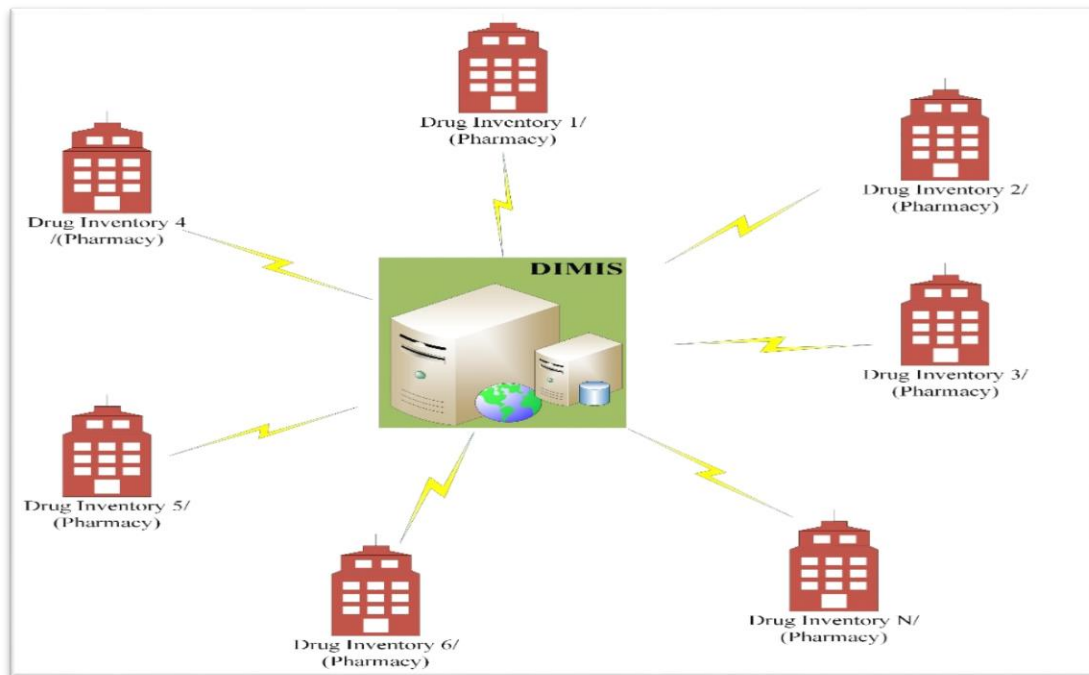
Fig. 1. Proposed System layout

7. Required tools

DIMIS is a large information system that requires some software and hardware requirements in order to be designed, programmed, implemented, and established.

A: Hardware specification
The equipment involved are:
1. Centralized computer (Server), the computer that been used is Lenovo (1.70 GHz CPU, RAM 4 GB, 64-bit OS)
2. Several computers used to access the system.

B: Software specification
For the design phase Microsoft office Visio 2013 was used. The programming on the other hand, was done by using the following: -

HTML: Hyper Text Markup Language is a client side Programming language that used in the client side to view the pages' content in the web browser.

JAVA Script: JavaScript is an object oriented dynamic language that used to provide interaction with the client and to respond to the client actions.

CSS: Cascade Styling Sheet is used for styling the HTML pages in the client side and determines how the content of the web page is displayed in the browser

JQuery: JQuery is a lightweight JavaScript library. The purpose of JQuery is to make it much easier to use JavaScript on web application.

Ajax: is techniques to create asynchronous web applications by using technologies on the client side in order to deal with the server

asynchronously (in the background) without posting back the entire page to the server.

Bootstrap: Bootstrap is a front-end framework for quickly and easy web development. The purpose of Bootstrap is to create responsive designs.

ASP .NET: Microsoft Visual Studio 2017 using ASP.NET 4.5, MVC pattern and C#.NET programming languages is a main programming language that used to construct the proposed DIMIS. As a database server Microsoft SQL server 2008 was utilized.

8. Design and development of DIMIS system

For the system to work properly and efficiently there must be a well thought-out design that determines system functions clearly. Since DIMIS application could be used by different kinds of users according to their role in the inventory or pharmacy like administrator, pharmacist, and patient. So the implementation of DIMIS application features consists of administrator section, pharmacist section and patient section and as shown in the Figure 2 that demonstrates the main structure of DIMIS system sections and the relation between the different systems and modules. As it is shown in Figure.2, this DIMIS system has three types of users.

- **Administrator/ Pharmacist**

This is the most essential module. It used by Administrator who responsible for user account management, create reports, sell drugs, import drugs and update drug's information. Figure 3 shows the Use case diagram for Administrator module.

- **Employee**

This module of the developed DIMIS is used by users who work in pharmacy and responsible for drug selling process and import medical materials in addition to user management process. Figure 4 shows the use case.

- **Patient/customer**

This module is used by Patient to select the required drugs or medical material to buy. Figure 5 shows the use case diagram for patients.

9. Database design

DIMIS System needs a well-structured database used for storing the information it needs to achieve its jobs. Relational Database is used to store the data of the proposed DIMIS using structured indexes. Many relationships are used between DIMIS tables: one-to one, one-to-many and many-to-many relationship. These relationships are established using indexes (PKs and FKs), which is the search criteria used to return the data from the database as shown in Figure 6. In each table of the proposed database, the row is called a record and column is a field. Tables of the proposed DIMIS are categorized to hold information as follows:

- pharmacy_store table includes the attributes such as ID, Barcode, Buying_Price, Selling_Price, Quntity, Expire_Date, Drugstore_Nam, Oder_Num, Oder_Date, batch_number, PharmcyID_FK, Unit_entered_by, expire_notification, ID attribute forms the PK.
- Customer orders table: includes the Customer Username, UserName_FK, PharmcyID_FK, OrderDate, Provided, disaccount. ID attribute is form the PK.
- PharmacySystemUsertable: Password, Fname, Mname, Lname, Email, Phone, Image, imageType, UserID attribute is form the PK.
- ExternalUser: includes UserName, Fnamme, MiddleName.
- MyOrderstable: Bill_Num, Bill_Date, company_Name, Payment_Date, Disaccount.
- Transaction table includes fields like OrderID, Barcode, quantity. Drug table: this table is used to hold information about available Drugs.
- Pharmacies table: includes the attributes of pharmacy like PharmacyID, pharmacyname, pharmacyLogo, pharmacylogotype.
- UserRole table: determine user's role. This table has two attributes: ID and UserRole.
- Users table: includes information related to user like UserID, UserName, Password, UserPicture, UserRoleID, UserPicturetype, FirstName.

10. Implementation

DIMIS system be implemented by the 3-tier computing model and the separation level between the tiers is high. Many advantages are provided by this modularity like that the test of modular code is easy and the fact that multiple times using of one component without rewrite the component. The development of DIMIS carried out using many new technologies like AJAX, ASP.NET, Bootstrap, and CSS which make the user interface more friendly. ASP.NET MVC model has been used because it provides a good separation for the UI, business logic, model or data. In addition to more control over the HTML, JavaScript and CSS. Furthermore, it is lightweight .C#.NET language was used as server language and IIS is used as web server whereas as a database server Microsoft SQL server 2012 was utilized.

10.1. System login user interface

This page considered as a gate from where users pass into DIMIS's subsystems. Figure 2 presents the login page of DIMIS. All users have to login to the application and depending on their accounts privilege they will be forwarded to the appropriate module.
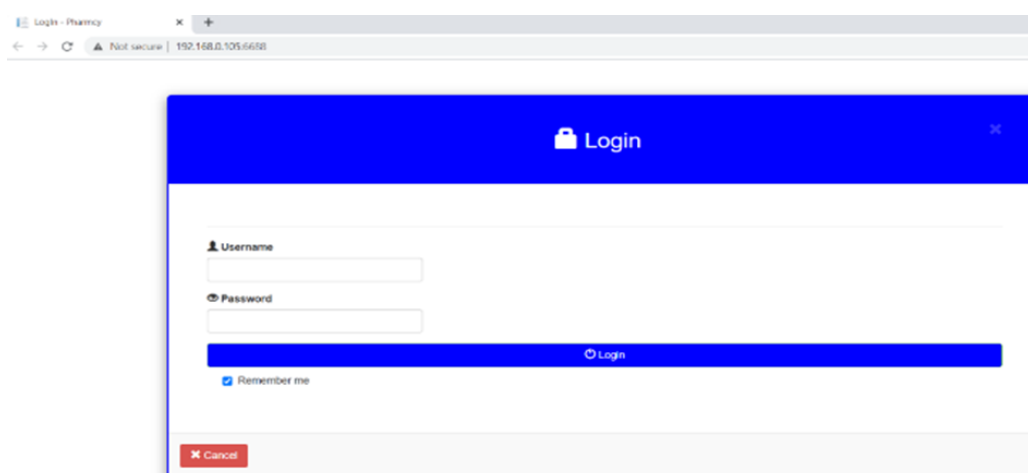
Fig 2. Login page of DIMIS

10.2-Administrator subsystem

The most substantial subsystem in DMIS. Administrator uses this subsystem in order to control the whole application. Figure 3 shows the home page for administrator subsystem from which the selected process could be done. Administrator is able to create new users to the system, account management, import materials, show the expire date for each item. The following are the functions that could be done by administrator:-

a. Administrator can create user account to users by entreing all the required data as shown in Figure 4.

b. Administrator can manage user account such as delete,update and display all the information related to an existing user as shown in Figure 5.

c. Administrator can import materials by entering all the data related to that materials to be saved in inventory as shown in Figure 6.

d. Administrator can create reports in different types either for drugs sales or for the users to show their work by displaying the total amount of drugs that has been sold by any user as shown Figure 7.
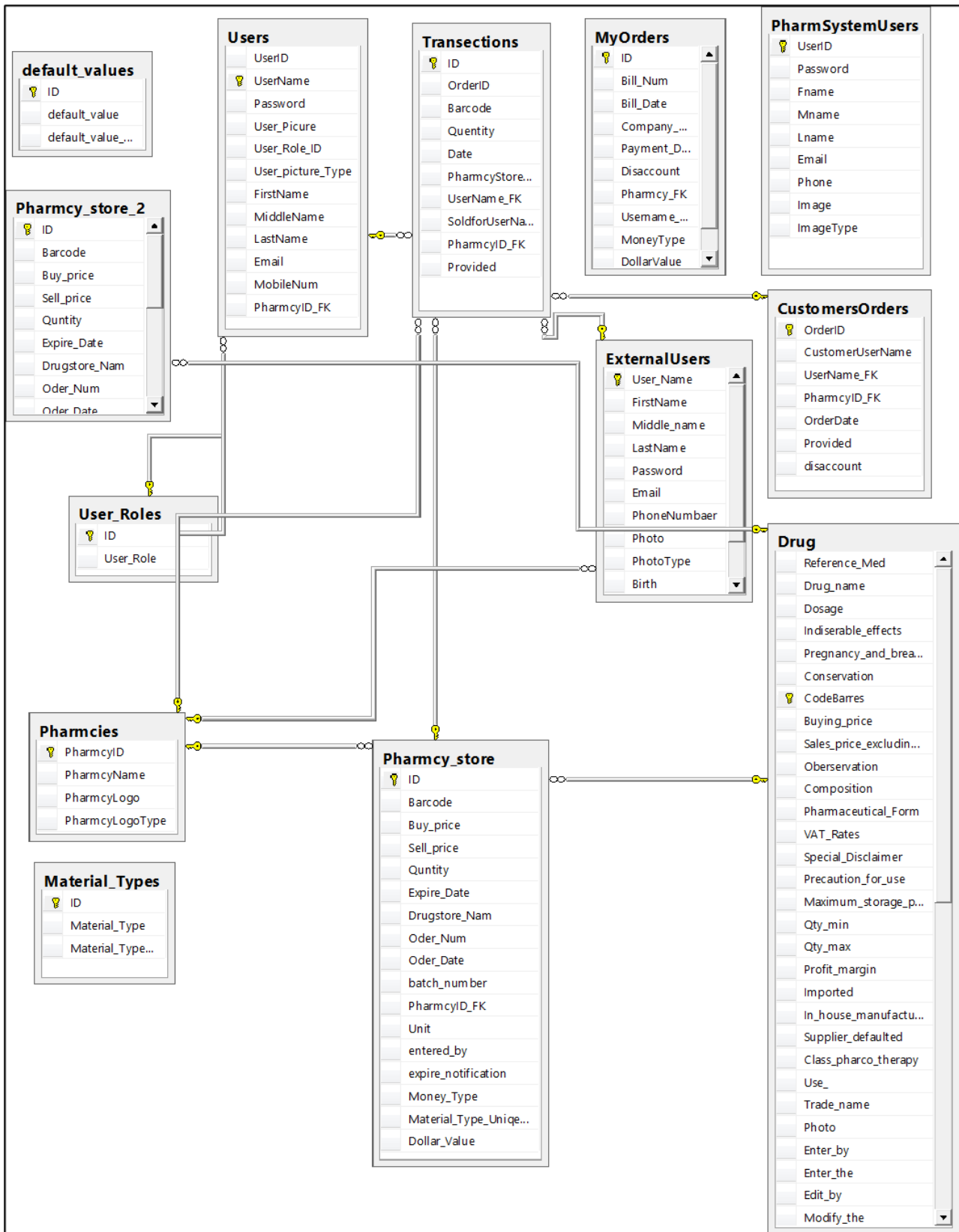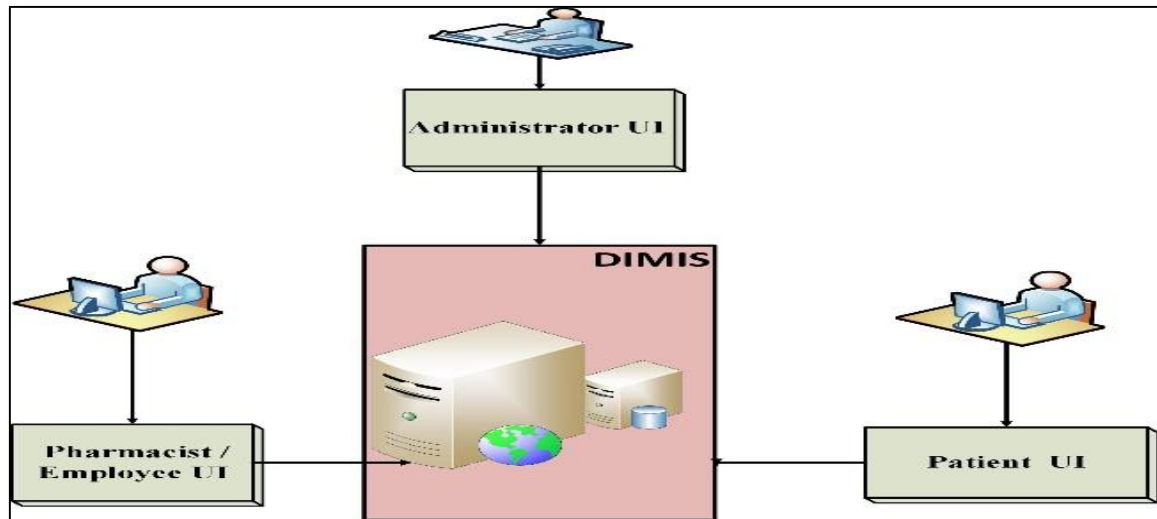
Fig 3. Database schema
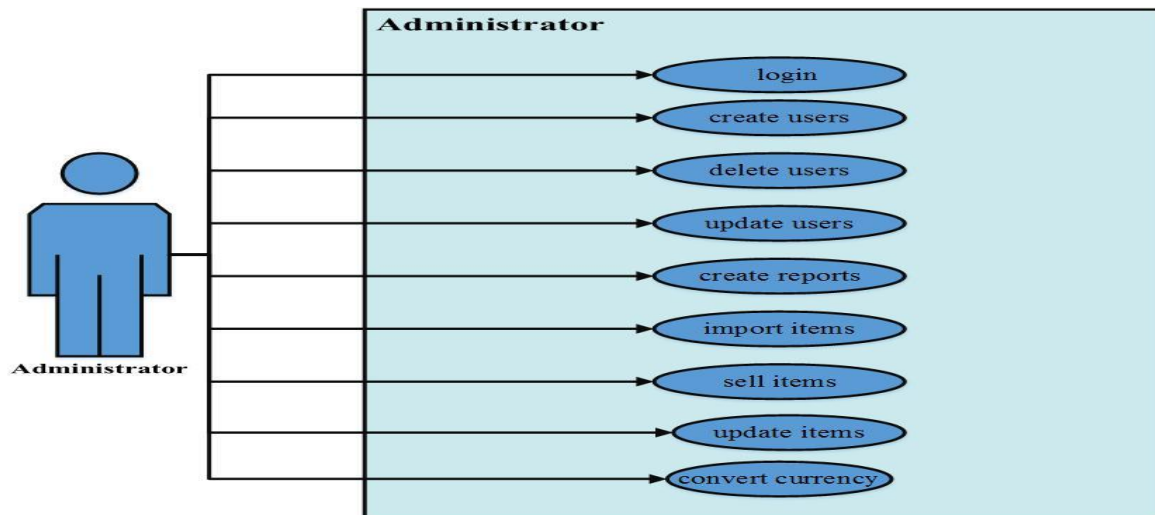
Fig 4. Main structure of DIMIS

Fig 5. Administrator module use case diagram
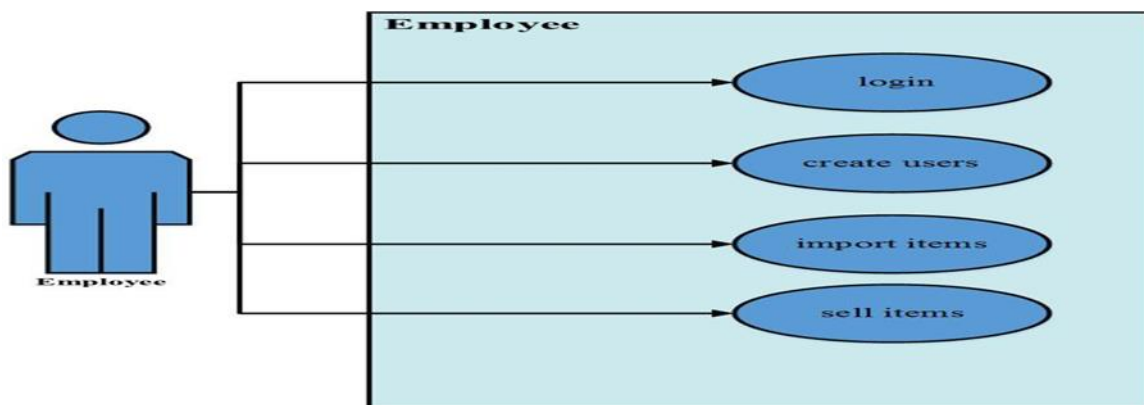
Fig 6. Employee module use case diagram
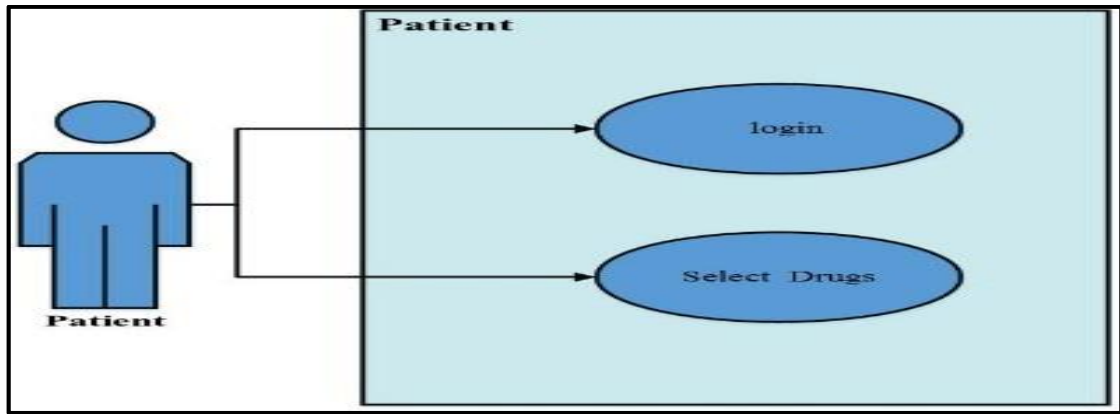
Fig 7. Patient Module Use Case Diagram

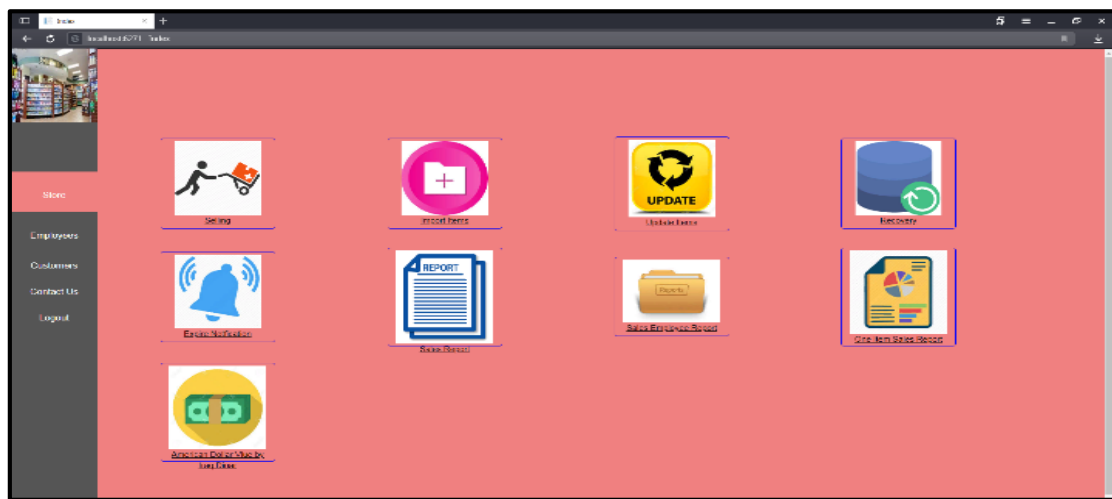**Fig 8.** Administrator home page
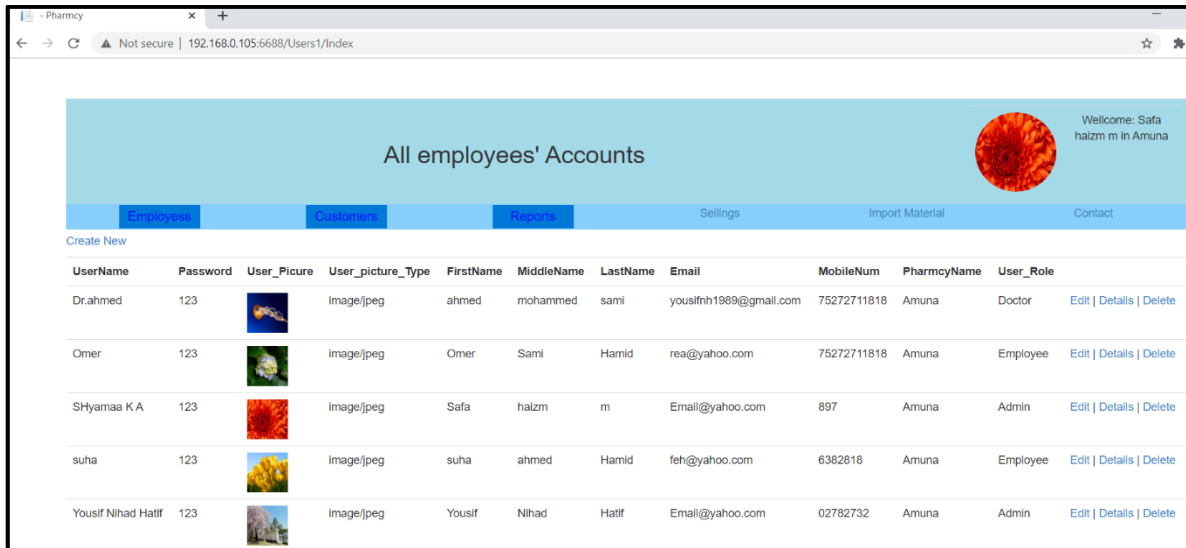

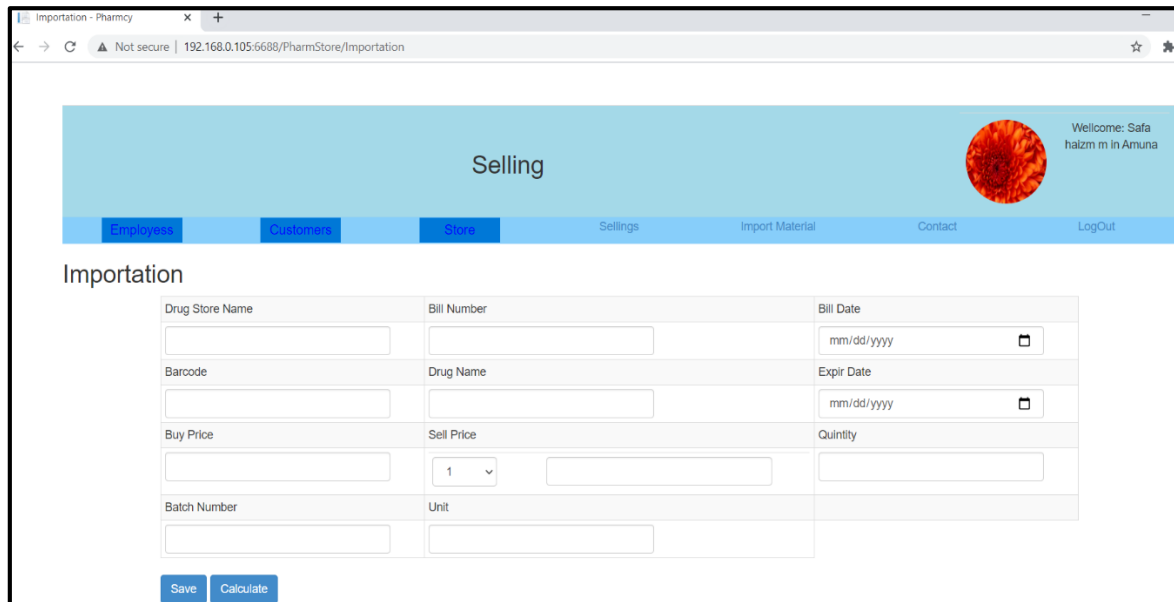**Fig 9.** Create user account

Fig 10. Manage User Account

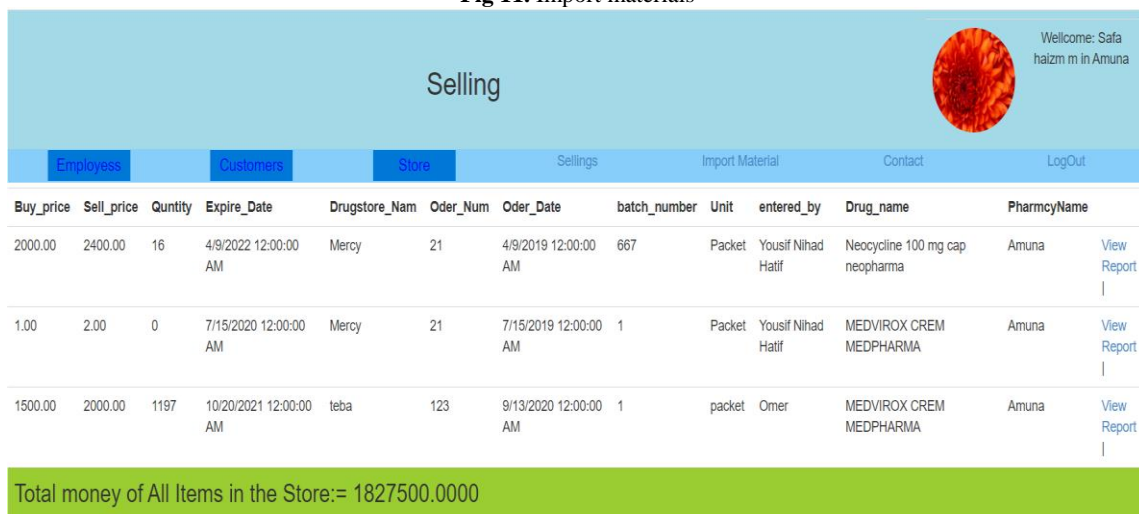**Fig 11.** Import materials

Fig 12. Create report

10.3 Employee subsystem

This component allows employee to control all the activities related to selling process as shown in Figure 13.

Fig 13. Selling form

10.4 Customer Subsystem

Physicians considered as customer when they want to supply their pharmacies with drugs from an inventory, so this component enables physicians to make their orders by selecting the required items. All the available drugs in the inventory have been listed with its related information as shown in Figure 14. The selected items would be prepared by the intended inventory then provided to customer.

Fig 14. Selling form

11. Conclusion

Inventory management process is very complicated processes that require a lot of effort in addition the time wasted on routine tasks. This paper described the design and development of DIMIS web app for managing drug inventory's issues electronically. DIMIS system is developed and implemented to handle drug inventory's issues in computerized efficient way. DIMIS system mainly designed for drug inventory and could be applicable for any

pharmacy with similar regulations. Selling and import drugs would become simpler for physicians. By information technology, strategies of inventory management and techniques of evaluating inventory management have become more accurate, more precise, and more efficient. Thus, the implemented and developed software should be utilized in pharmacies and pharmacists should be leaned and trained on dealing with such systems for managing inventory.

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