A Medicine Stock Management System of an Agrobusiness Company Using Barcodes

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Abstract: A stock management system is a system that assists a company to manage the stock flow. In this project, a web-based medicine stock management system is designed, developed and tested to improve the medicine stock management of an agrobusiness company called Leong Hup Agrobusiness Sdn. Bhd. The current medicine stock management of the company is via manual paper recording and has caused some problems such as data recording errors. The development of the system is driven by the prototyping software process model. In this system, the barcode is used to identify the medicine making stock identification easier. Lastly, functional testing and user acceptance testing results show that the system fulfilled the requirements and satisfied the expected users. However, some future improvements can be done such as the system responsiveness can be improved to make the system creates content that adjusts smoothly to various screen sizes.

Keywords: Medicine, Stock, Inventory, Stock management system, Barcode

1.   Introduction

In Malaysia, chicken breeding is one of the biggest fields in the agriculture industry. It is not only providing chicken in the food chain supply in the country but also involves in poultry export which is contributed to the growth of the country's economy [1].

In this project, the agrobusiness company studied is Leong Hup Agrobusiness Sdn. Bhd. which owns 44 chicken farms in the whole of Malaysia. The use of medicine for the breeding of chickens is a big part of their daily operation. Therefore, proper management of their medicine stock is necessary and cannot be avoided. All the data of medicine stock checked in and checked out must be recorded daily to keep track of the stock avoiding the insufficient medicine supply if needed.

The studied chicken farm is located at Tangkak, Johor. The farm has 6 chicken cages to breed the chicken. The medicine stock is managed by the Chicken Health and Medicine Department. The staffs involved are who responsible to take care of the health of chickens every day to make sure their growth and also the veterinarian who is responsible to treat the chicken infected by the illness. They currently

manage the medicine stock via data recording in physical logbooks. As the result, there are many logbooks needed to be kept and making the whole stock management process less efficient.

Therefore, the project has the objective to design, develop, and test a medicine stock management system using a barcode to help improve the company's medicine stock management. The system users would be the department manager (administrator) and the department staff. There are 3 categories of medicine to be managed which are vaccines, vitamins, and antibiotics. The medicine is kept using different units of measurement such as vials, kilograms, bottles, and packages. Once the medicine is opened and used, it cannot be stored back.

This article is organized into five sections. The first section is the introduction to the project context. The second section describes the analysis of the related works. The third part explains the project methodology, analysis, and design for the system development. The fourth part discusses the system implementation and testing process carried out to test the developed system. Lastly, a conclusion for the article is presented in the fifth section.

2.   Related Work

A stock management system or inventory system is a software system that provides information to help manage the flow of materials in an organization [2]. The stock management system should have good stock control feature to help the organizations provide services as well as remain financially viable [3]. To investigate the features of stock management system, three medicine inventory systems are reviewed and compared with the medicine stock management system. The comparison between the 3 related systems and this project's system based on several features is summarized in Table 1.

Table 1: System Comparison

	Inventory system			
Feature	Medicine Inventory System for Central Pharmacy of Hospital	Sales and Inventory Control System for Pharmaceutical Store	Computerized Drugs Inventory System for Pharmacy	Medicine Stock Management System (proposed system)
Platform	Web-based	Desktop-based	Desktop-based	Web-based
Login	Username & password	Username, password & role	Username & password	Username & password
Manage Staff Information	No manage staff information	Admin manage staff information	No manage staff information	Admin manage staff information
Manage Inventory	Specified by medicine name	Specified by barcode	Specified by medicine name	Specified by barcode
Low Inventory Alert	Notification in system	Notification in system	Notification in system	Notification via e-mail
Medicine Expiry Alert	Notification in system	Notification in system	Notification in system	Notification via e-mail
Generate Report	Daily, monthly & yearly medicine usage	Monthly medicine usage	Daily, monthly & yearly medicine usage	Monthly medicine usage

The medicine inventory systems reviewed are Medicine Inventory System for Central Pharmacy of Hospital [4], Drug Sales and Inventory Control System for Pharmaceutical Store [5], and Computerized Drugs Inventory System for Pharmacy [6]. After reviewing the related works, the common features of the medicine inventory system have been identified. Also, some techniques and methods to control the medicine inventory better have been learned.

Compare to the related works, the developed medicine stock management system has a great advantage which is using the barcode to identify the medicine. Barcode is a machine-readable code that present in the form of numbers and pattern of parallel lines of varying width printed on a commodity and used especially for stock control [7]. By using a barcode scanner, the barcode is read by the reflection of the scanner light intensity from the bars and spaces between the bars [8]. The barcode is more reliable and accurate than manual data to track products in stock management [9].

Besides, the important notification is sent to the users via e-mail instead of notification in the system makes the users more alert to the messages.

3. Methodology

3.1 Project Planning

This project is carried out from 1 September 2021 until the end of June in the year 2022. The prototyping model [6] is used in system development in this project. Table 2 shows the activities and outcomes or deliverables for each phase during the system development life cycle for the project.

Table 2: Software Development Activities and Deliverable for Phases in Prototyping Model

Phase	Activity	Deliverable
Planning	• Identify project background, scope, objective, and schedule.	• System proposal • Gantt Chart
Analysis	• Interview stakeholder. • Gather and analyze system requirements. • Determine development tools.	• Software requirement definition • UML use case diagram • UML class diagram
Design	• Design system architecture, database, and user interface	• System architecture • Database design • User interface design
Implementation	• Coding and programming.	• System prototype
Prototype Iteration 1	• Repeat analysis, design, and implementation for improvement.	• Improved system prototype
Prototype Iteration 2	• Repeat analysis, design, and implementation for improvement.	• Finalized system prototype
Implementation and Testing	• Final system implementation • Test the developed system	• Test plans, test cases, and test results • Final system product

3.2 Requirement Analysis

The requirement analysis helps in understanding and identifying the system requirements. Table 3 and Table 4 show the system functional requirements and non-functional requirements respectively.

Table 3: Functional Requirements based on System Functional Module

Module	Description
Login Module	• The system shall allow users to log in by providing a registered username and password. • The system shall redirect the user to the respective homepage based on the user's role after successful login. • The system shall display an error message if the login failed due to an incorrect username or password entered. • The system shall allow users to log out from the system.
Manage Staff Information Module	• The system shall allow the Administrator to register the staff into the system by providing the staff information. • The system shall allow the Administrator to see all the staff information. • The system shall allow the Administrator to edit staff information and role in the system.
Manage Medicine Information Module	• The system shall allow the user to scan a barcode using a barcode scanner as input into the system. • The system shall allow the user to add new medicine information into the system. • The system shall allow the user to see and edit the medicine information. • The system shall allow user to edit and view the vaccination schedule. • The system shall recognize the medicine identified by a specific barcode accurately.
Manage Stock Module	• The system shall allow users to add new medicine information into stock. • The system shall allow users to update current medicine stock information during stock checked-in and checked-out. • The system shall keep the process history record for medicine stock checked-in and checked-out. • The system shall allow users to check the medicine stock checked-in and checked-out history records. • The system shall allow users to check and search for the current medicine stock information. • The system shall send a notification message when the medicine amount is low in stock. • The system shall send a notification message when the medicine in the stock is soon to be expired and has expired.
Generate Report	• The system shall allow the Administrator to generate and view the monthly medicine usage report.
Manage Cage Information	• The system shall allow the user to create new cage information. • The system shall allow the user to view and edit the current cage information. • The system shall allow the user to delete the cage information.

Table 4: System Non-Functional Requirements

Requirements	Description
Operational	• The system shall be able to run on any Web browser.
Performance	• The loading time required for the system shall not be more than 1 minute. • The response time for the system shall not be more than 1 minute.
Security	• The medicine information shall be secured. • The user information shall be secured.
Cultural and political	• No special cultural and political requirements are expected.

The user requirement defines the system user demands and expectations to the system functions. Table 5 shows the system user requirements.

Table 5: User Requirements

No.	User Requirements
1.	Both Administrator and department staff shall be able to enter a valid username and password to enter the system.
2.	Both Administrator and department staff shall be able to log out from the system.
3.	The Administrator shall be able to register the staff into the system by providing the staff information.
4.	The Administrator shall be able to see all the staff information.
5.	The Administrator shall be able to edit staff information and role in the system.
6.	Both Administrator and department staff shall be able to scan the barcode using a barcode scanner as input into the system.
7.	Both Administrator and department staff shall be able to add new medicine information into stock.
8.	Both Administrator and department staff shall be able to update current medicine information in the stock during stock checked in and checked out.
9.	Both Administrator and department staff shall be able to check the medicine stock checked in and checked out history records.
10.	Both Administrator and department staff shall be able to check and search for the current medicine stock information.
11.	The Administrator shall be able to receive notification messages for low amount of stock.
12.	The Administrator shall be able to receive notification messages for medicine expiry.
13.	The Administrator shall be able to generate a monthly medicine usage report.
14.	The Administrator shall be able to create, view and edit the chicken cage information

3.3   System Analysis

The structure and behaviour of the system are analyzed and presented using the UML diagrams. UML Use Case diagram defines a set of behaviours of the system as well as how the actors interact with the behaviours. Figure 1 shows the Use Case Diagram for the system.
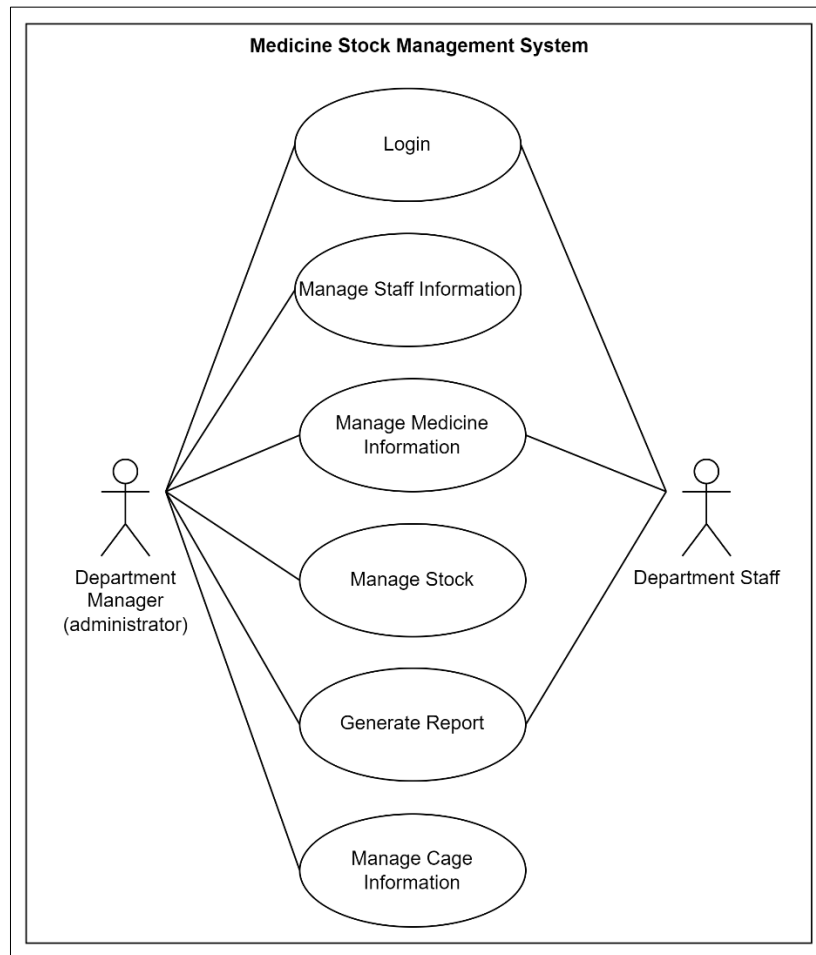

Figure 1: Use Case Diagram

From Figure 1, the use case is the action the actor can perform when interacting with the system. The actors are the users of the system who are the department manager (administrator) and the department staff.

The login use case covers the login processes such as user authentication and authorization. The manage staff information use case covers all the activities to register, view, edit and delete the staff information. This can be performed only by the Administrator.

The manage medicine information use case includes the activities in adding and editing basic medicine information such as name, measurement unit, type, and supplier. The users can also manage the schedule for chicken vaccination on different chicken cages under this use case. The cage information can be updated too.

The manage stock use case covers the processes for stock checked-in and checked-out. Barcode scanning is used to improve efficiency in the process of identifying the medicine. Lastly, the generate report use case allows only Administrator to generate the monthly medicine usage report.

The sequence diagrams for each use case are attached in appendix A.

The class diagram shows the static view of the structure of the system and how the system components interact with each other. The class diagram for the medicine stock management system is shown in Figure 2.
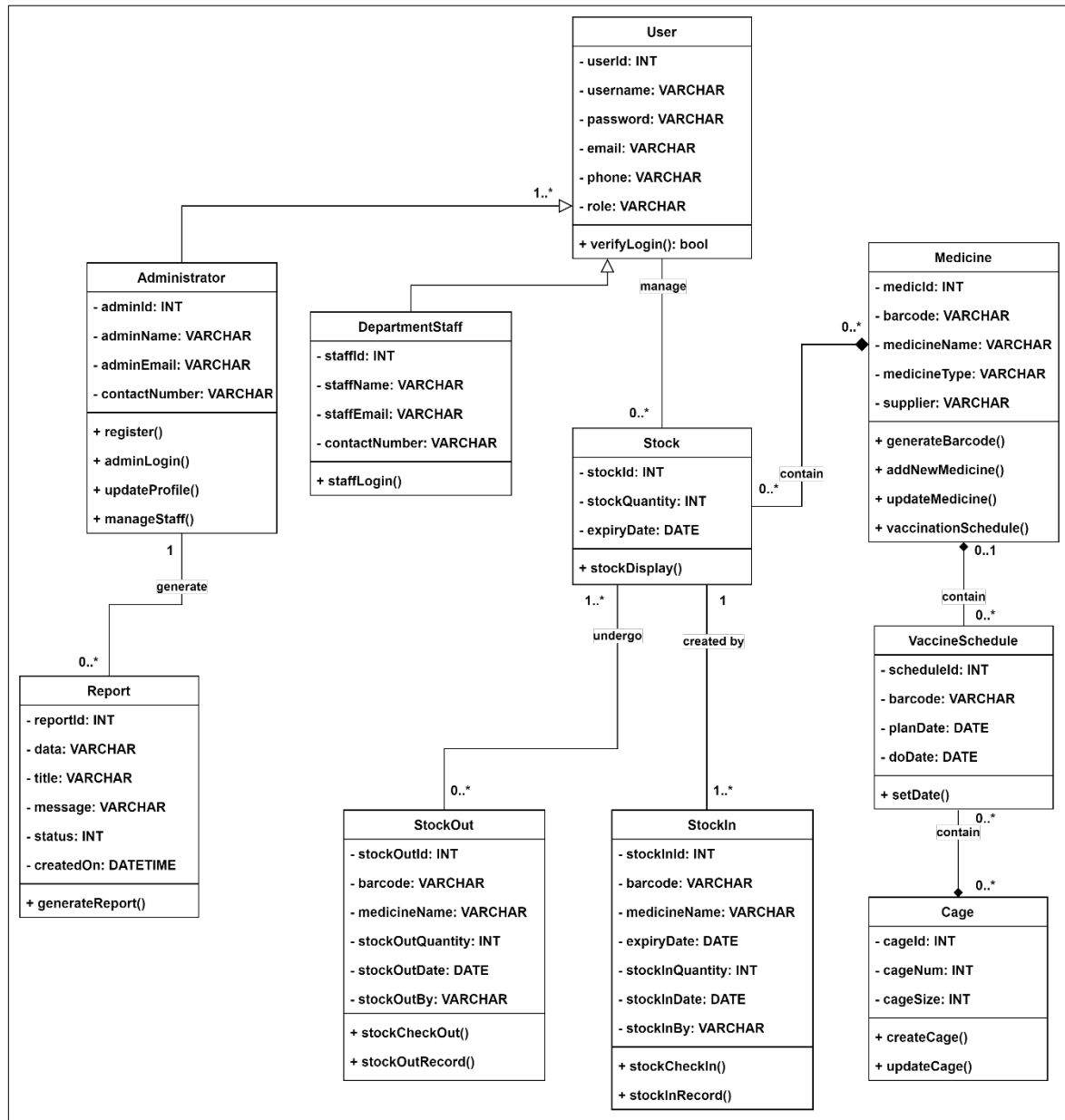

Figure 2: Class Diagram

The business model of the medicine stock management process in the case study company would be changed after the implementation of the medicine stock management system developed in this project. The to-be model in Figure 3 below shows some of the future medicine stock management processes for the studied company.
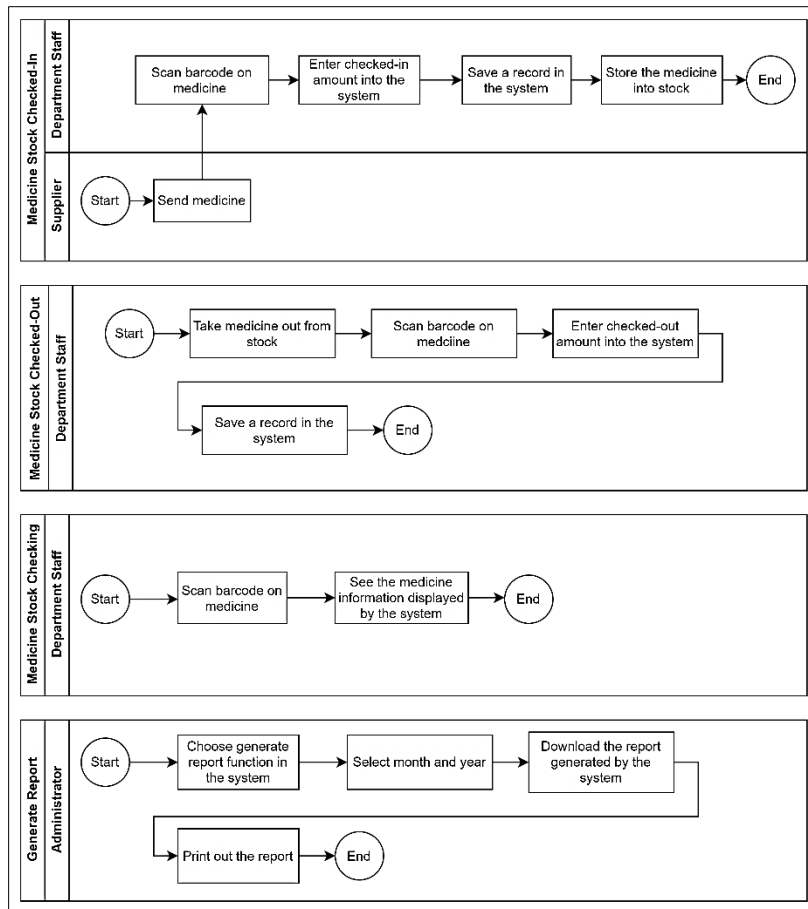
Figure 3: To-be Model

3.4 System Design

The system architecture is the whole overview of how the information system components are organized and interact with each other. The system was developed based on the client-server architecture. Figure 4 shows the system architecture for the system.
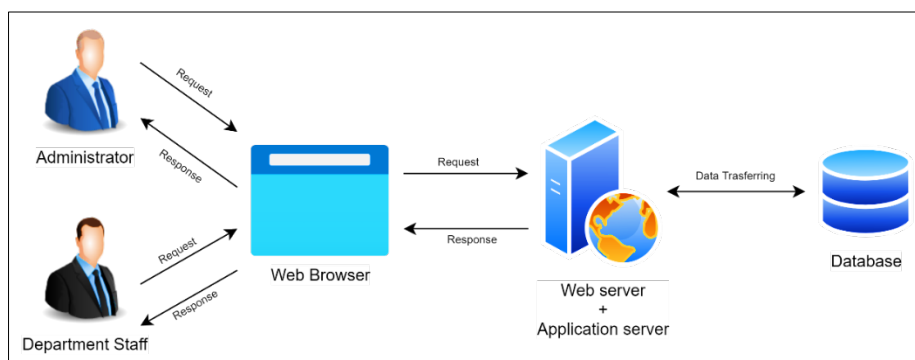
Figure 4: System Architecture

The database is designed to hold and manage the data of the system. The database schema which describes the entities that hold the different data in the database is shown.

    i.   **user**(userId, name, password, email, phone, role)

    ii.   **medicine**(medicId, barcode, name, unit, description, type, supplierId, minimumStockLevel, stockLowStatus)

    iii.   **stock**(stockId, barcode, name, type, expiryDate, unit, quantity, expired)

    iv.   stockin(stockInId, barcode, medicName, type, expiryDate, unit, stockInQty, stockInTime, stockInBy)

    v.   **stockout**(stockOutId, barcode, medicName, type, expiryDate, unit, stockOutQty, cage, stockOutTime, stockOutBy)

    vi.   **stockBalance**(balanceId, barcode, balance, date)

    vii.   **cage**(cageId, cageNum, cageSize)

    viii.   **vaccineSchedule**(scheduleId, barcode, medicName, day, planDate1, doDate1, planDate2, doDate2, planDate3, doDate3, planDate4, doDate4, planDate5, doDate5, planDate6, doDate6)

    ix.   **notification**(notifyId, message, createdOn, status)

    x.   **staffNotification**(notifyId, message, createdOn, status)

    xi.   **report**(reportId, barcode, medicName, unit, opening,input, cage1, cage2, cage3, cage4, cage5, cage6, output, balance, usagePercentage)

    xii.   **supplier**(supplierId, supplier)

    xiii.   **settings**(settingsId, expiredalert1, expiredalert2)

    xiv.   **unit**(unitId, unit, symbol)

The user interfaces of the systems are designed to give the user a good experience when using the system. Figure 5 shows an example of user interface design for the login page.
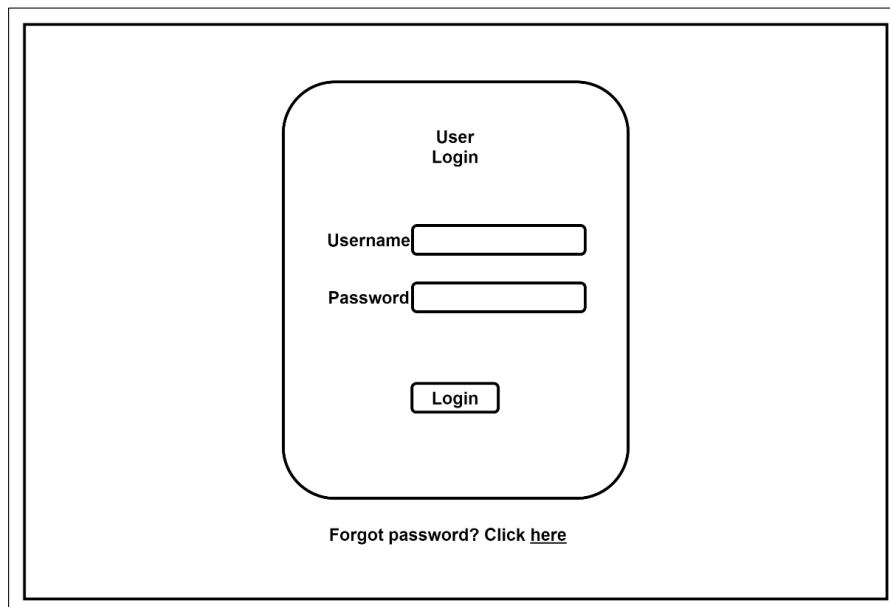

Figure 5: Login Page Interface Design

4.   Results and Discussion

4.1   Implementation

The medicine stock management system is developed as a web-based application. The front end of the system is developed using HTML, CSS, and JavaScript while the back end of the system is developed using PHP programming language. The main interfaces and their coding segments are shown and discussed.

The login module is developed for user authentication. The users have to enter a valid username and password to log in. If the username and the password are matched, the login success. Otherwise, the login failed. Figure 6 shows the user interface for the login form and Figure 7 shows the validation code segment to check if the input username and password are matched.
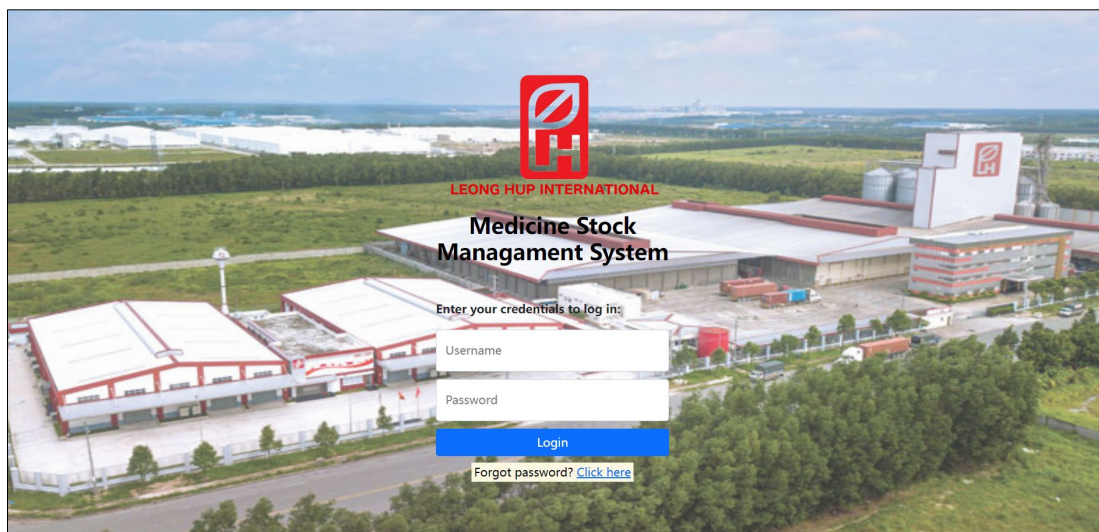
Figure 6: Login Interface

```php
if(isset($_POST['loginBtn'])){
    $username = $_POST['username'];
    $password = $_POST['password'];

    $query = $connect -> query("SELECT * FROM user WHERE name = '$username' AND password = '$password'")
            or die($connect -> error);

    $data = mysqli_fetch_assoc($query);

    $check = mysqli_num_rows($query);

    if(!$check){
        $_SESSION['errorLogin'] = 'Username & password wrong';
        header("location:login.php");
    }
}
```

Figure 7: Code Segment for Login Validation

The managing staff information module is developed for the Administrator to register, view, and edit the staff information such as the phone number, email address, and role. Figure 8 shows the user interface for the registration form and Figure 9 shows the code segment for registration process to check for redundant user.
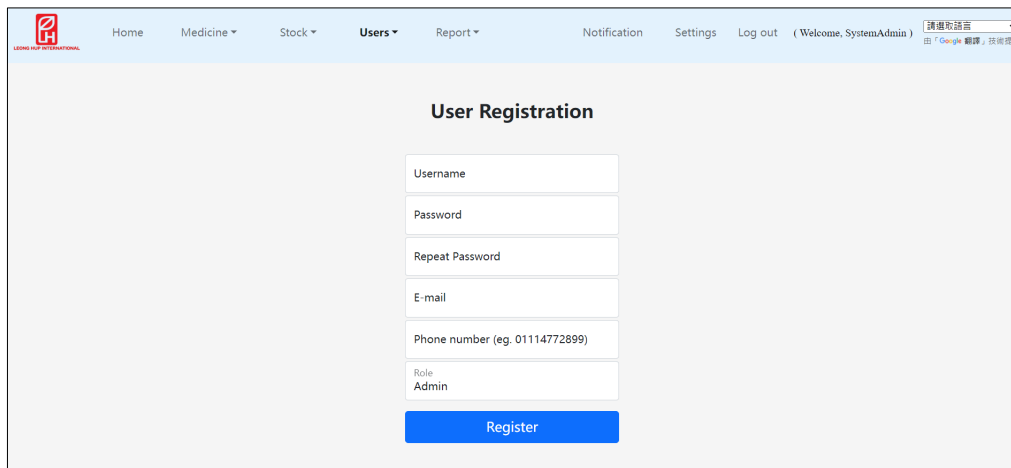
Figure 8: User Registration Interface

```php
function checkCrossUser($username, $connect){

  $sql = "SELECT * FROM user WHERE name='$username'";
  $result = $connect ->query($sql);
  if($result==false){
    return true;
  }else{
    $numRows = $result->num_rows;
    if($numRows > 0 ){
      $_SESSION['errorUsername'] = '*Username has been taken';
      return false;

    }else{
      return true;
    }
  }
}
```

Figure 9: Code Segment for User Registration Validation

To manage medicine information more effectively, the system implements the barcode as the identifier for the medicine. The users can scan the barcode label on the medicine bottle or package using barcode scanning device to retrieve the information from the database. Figure 10 shows the user interface to display the medicine information.

Figure 10: Medicine Information Management Interface

During the stock-in process, the users identify the medicine using the barcode and then enter the quantity for the medicine to be checked in and the expiry date for the medicine. The system would keep a record of the stock-in to generate the medicine usage report. Figure 11shows the user interface for stock-in process.
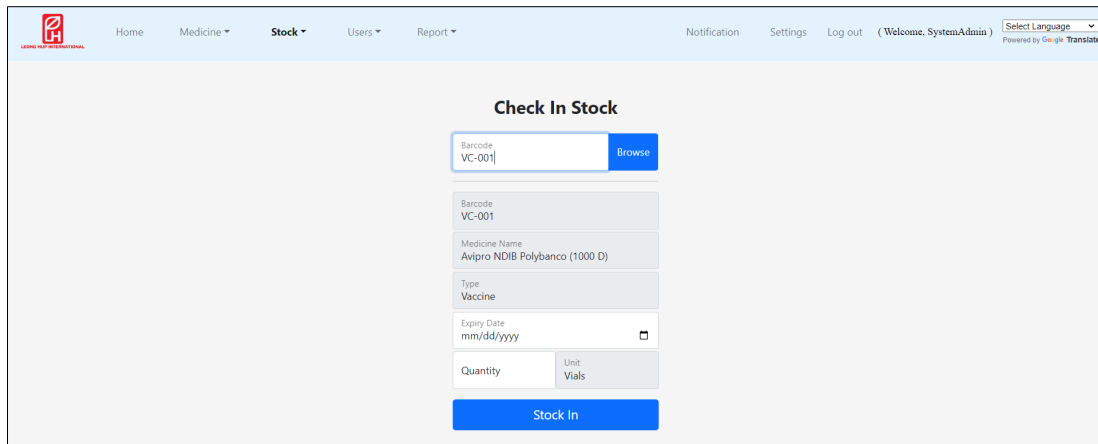

Figure 11: Stock-in Interface

During stock-out, the users scan the barcode label on the medicine and then input the quantity and the chicken cage number for the medicine to be applied. Similarly, the system would keep a record of the stock-out to generate the medicine usage report. Figure 12 shows the user interface for stock-out process.
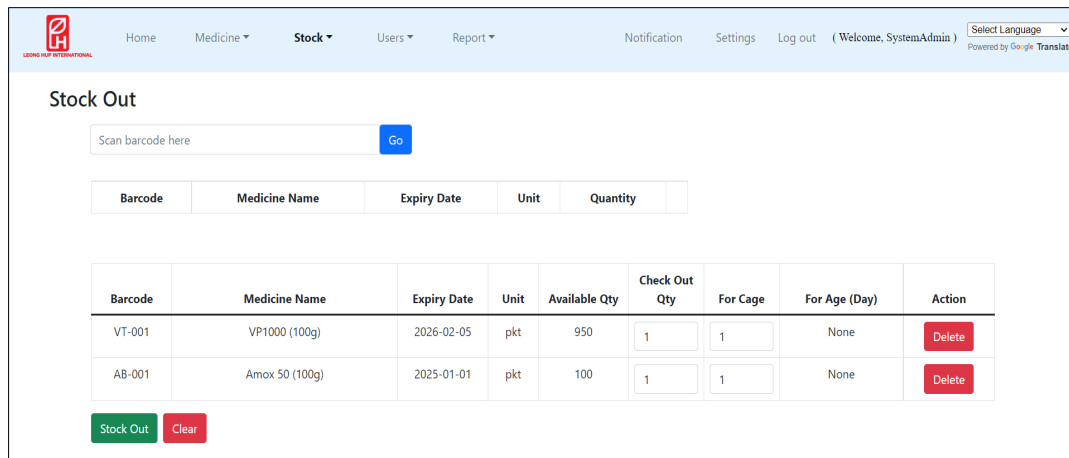

Figure 12: Stock-out Interface

Next, the Administrator is able to generate a monthly medicine usage report. The Administrator selects the month and year then the system would generate the medicine usage report for the selected time period. Figure 13 shows the user interface for the generate report module and its code segment respectively.
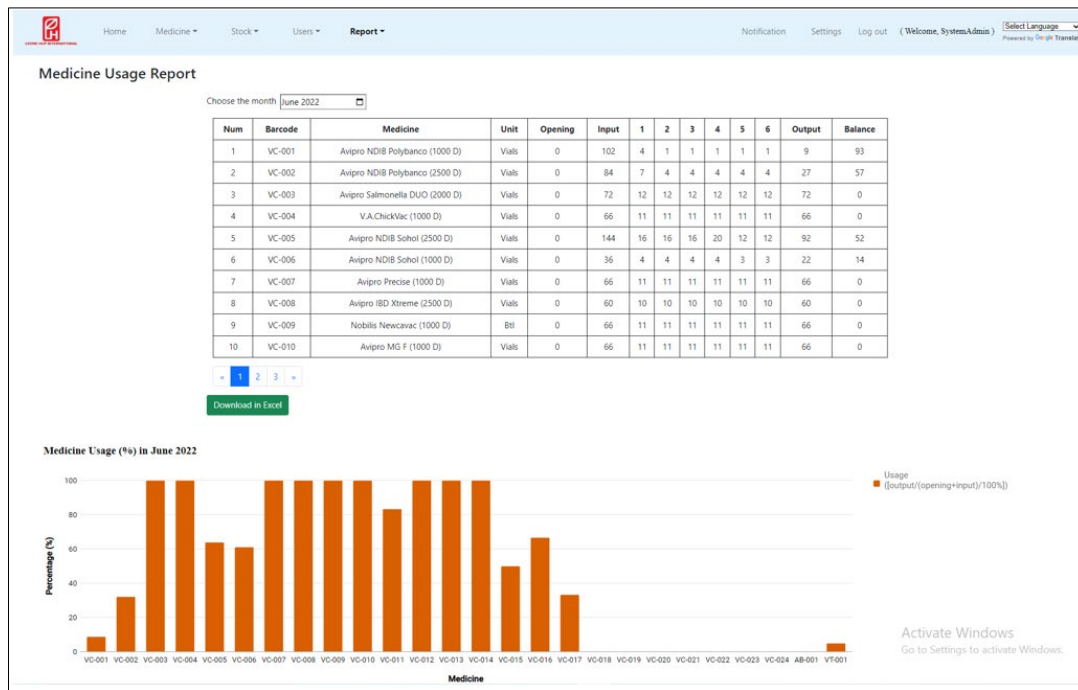
Figure 13: Generate Report Interface

Lastly, the administrator has the authority to manage the chicken cage information. The administrator can add new cage information, edit or update existing cage information, and also delete the cage information. Figure 14 shows the manage cage information interface.
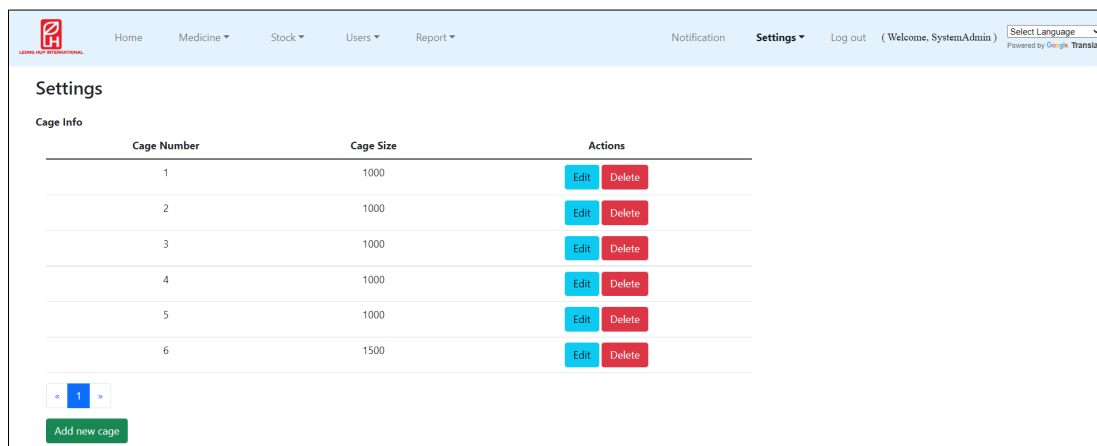

Figure 14: Manage Cage Information Interface

4.2   Testing

Two types of testing are carried out which are functionality testing and user acceptance testing. In functionality testing, the test cases are derived based on the functional requirement determined. Table 6 shows the requirement traceability matrix (RTM). It traces the system requirements and specifications. It is used especially during testing to determine whether the system requirements are met or not. This assists in testing to tracing the requirements to make sure that all requirements are being tested.

Table 6: Requirement Traceability Matrix

Software Requirement	Test Case ID	Test Case Description	Test Result (Pass / Fail)
SRS_REQ_100	TEST_100	Login	
SRS_REQ_101 SRS_REQ_102	TEST_100_001	The user enters valid username and password then the system redirects the user to the homepage based on the user role.	Pass
SRS_REQ_103	TEST_100_002	The user enters invalid username or password then the system displays an error message.	Pass
SRS_REQ_104	TEST_100_003	The user presses the log out button and the system redirects the user to the login page.	Pass
SRS_REQ_200	TEST_200	Manage Staff Information	
SRS_REQ_201	TEST_200_001	The Administrator registers the staff into the system by providing the staff information and the system save it to the database.	Pass
SRS_REQ_202	TEST_200_002	The Administrator requests to see the staff information and the system retrieves the correct data from the database and display it.	Pass
SRS_REQ_203	TEST_200_003	The Administrator edits staff information and the system updates the data into the database.	Pass
SRS_REQ_300	TEST_300	Manage Medicine Information	
SRS_REQ_302	TEST_300_301	The user adds new medicine information into the system and the auto-generates the barcode and saves the data into the database.	Pass
SRS_REQ_301 SRS_REQ_303 SRS_REQ_305	TEST_300_302	The user scans the barcode and the system retrieves the correct medicine information and display it.	Pass
SRS_REQ_301 SRS_REQ_303 SRS_REQ_305	TEST_300_303	The user edits the medicine information and the system updates the data into the database.	Pass
SRS_REQ_301 SRS_REQ_304	TEST_300_304	The user edits the vaccination schedule then the system updates the data into the database and displays the correct data.	Pass

Table 6: (cont)

Software Requirement	Test Case ID	Test Case Description	Test Result (Pass / Fail)
SRS_REQ_401	TEST_400_001	The user adds medicine information into stock by entering expiry date and quantity then the system adds the data into database.	Pass
SRS_REQ_402	TEST_400_002	The user updates stock information during stock-in and the system updates the data into database.	Pass
SRS_REQ_402	TEST_400_003	The user updates stock information during stock-out and the system updates the data into database.	Pass
SRS_REQ_405	TEST_400_006	The user requests to see the current medicine stock information then the system retrieves correct data from the database and display it.	Pass
SRS_REQ_406	TEST_400_007	The system sends a notification message when the medicine amount is low in stock.	Pass
SRS_REQ_407	TEST_400_008	The system sends a notification message when the medicine in the stock is soon to be expired and has expired.	Pass
SRS_REQ_500	TEST_500	Generate Report	
SRS_REQ_501	TEST_500_001	The Administrator selects month and year then the system generates medicine usage report in tabular form and bar graph.	Pass
SRS_REQ_600	TEST_600	Manage Cage Information	
SRS_REQ_601	TEST_600_001	The Administrator creates new cage information and the system adds it into the database.	Pass
SRS_REQ_602	TEST_600_002	The Administrator views and edits the current cage information then the system updates the data in the database.	Pass
SRS_REQ_603	TEST_600_003	The Administrator deletes the cage information and the system updates the data in the database.	Pass

Overall, 22 test cases are tested. Table 7 shows the overall test case result.

Table 7: Overall Test Case Result

Test Case ID	Total Test Cases	Total Passed
TEST_100	3	3
TEST_200	3	3
TEST_300	4	4
TEST_400	8	8
TEST_500	1	1
TEST_600	3	3
	22	22

Table 7 shows that all 19 test cases are passed. This indicates the system is able to perform the functionalities that meet system functional requirements.

Next, user acceptance testing is carried out with the expected user. The aspects being tested are the functionality of the system, usability of the system, and user interface design of the system. There is one user who tested the system as an Administrator and two users who tested the system as staff. The bar graph in Figure 15 shows the user satisfaction with the system.
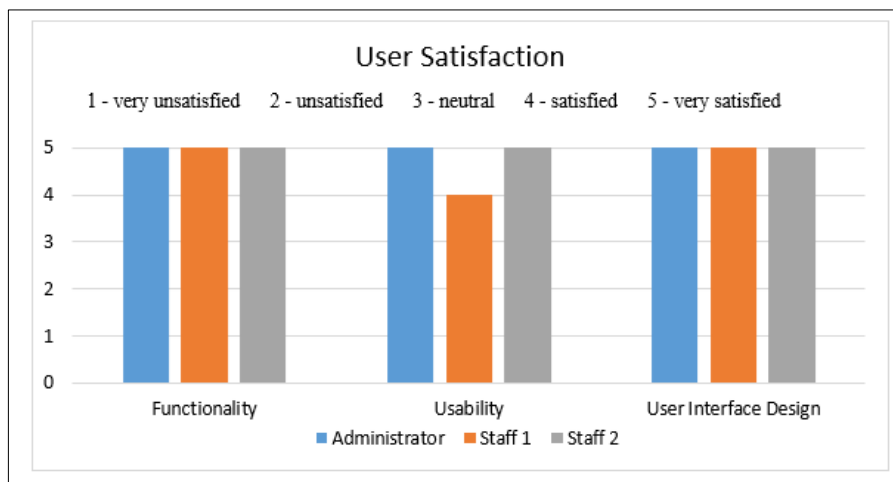

Figure 15: User Satisfaction

All the three users are very satisfied on the system functionality. The system could perform the necessary business functionalities that help improve the management of medicine stock for the company. Next, two users are very satisfied with the system usability as it is easy and simple to learn and use. One user is satisfied with the system usability and commented that it would be better if the system has the multi-language toolkit. Besides, all the three users are very satisfied with the system user interface design. The user interfaces are simple, clear, and understandable.

5.   Conclusion

The medicine stock management system developed is a web-based system application that can be accessed using any web browser. The medicines are tagged using the barcode to make the stock

identification more convenient and accurate. The functionality testing and user acceptance testing results show that the system fulfilled the requirements and satisfied the expected users. However, the system has some limitations. Since the system is a web-based application, it cannot be accessed if no internet connection. Also, the system responsiveness can be improved to make the system creates content that adjusts smoothly to various screen sizes.

Acknowledgment

Appendix A

The sequence diagrams for the use cases are shown.
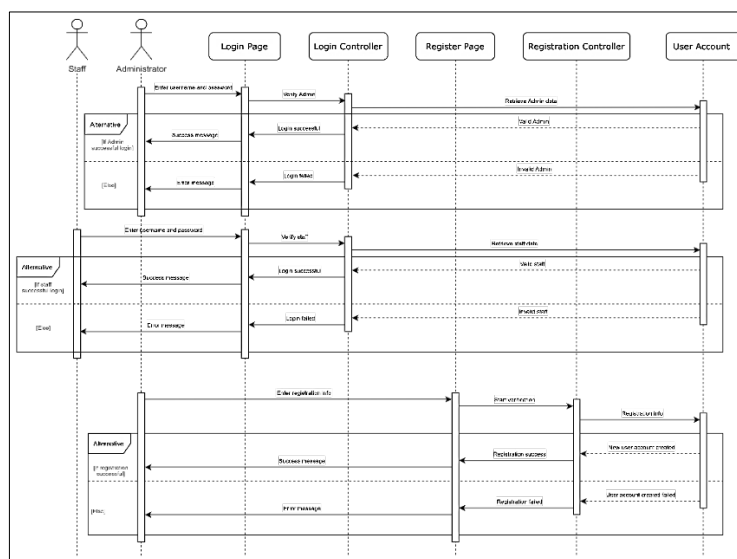
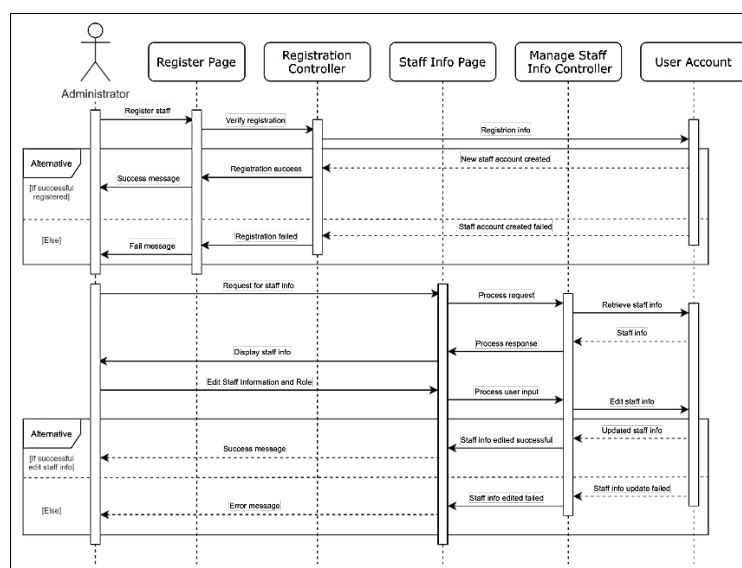**Figure 16: Login Use Case Sequence Diagram**

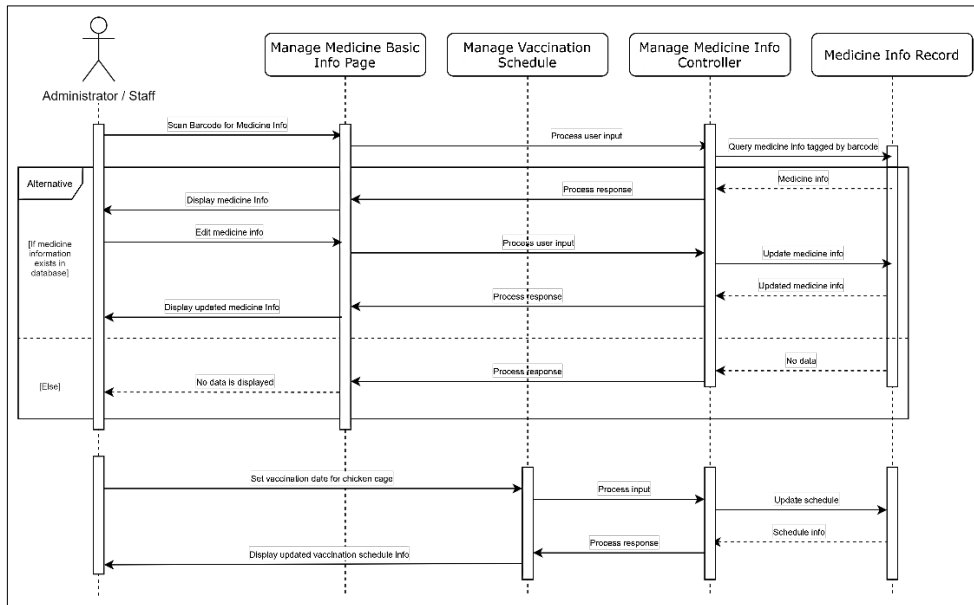**Figure 17: Manage Staff Information Use Case Sequence Diagram**

Figure 18: Manage Medicine Information Use Case Sequence Diagram
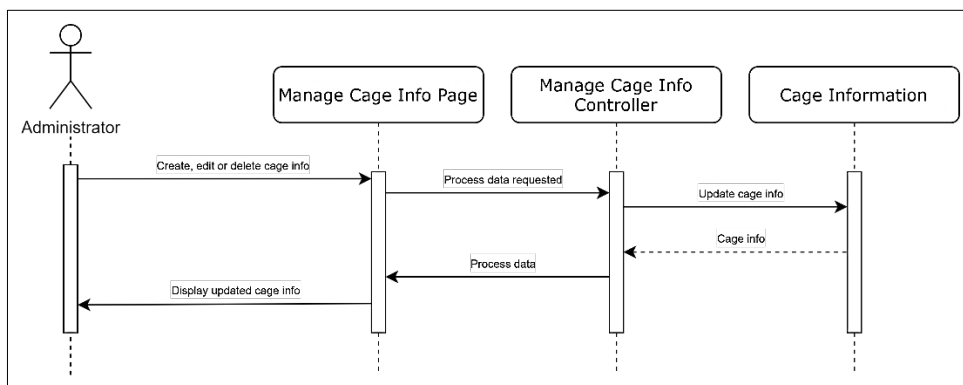

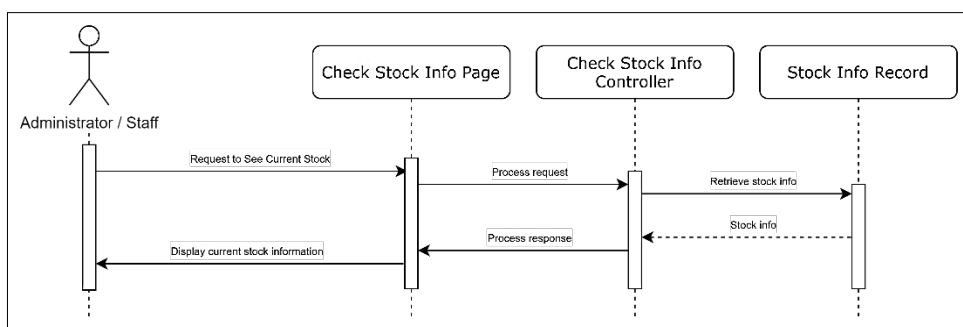**Figure 19: Manage Cage Information Use Case Sequence Diagram**

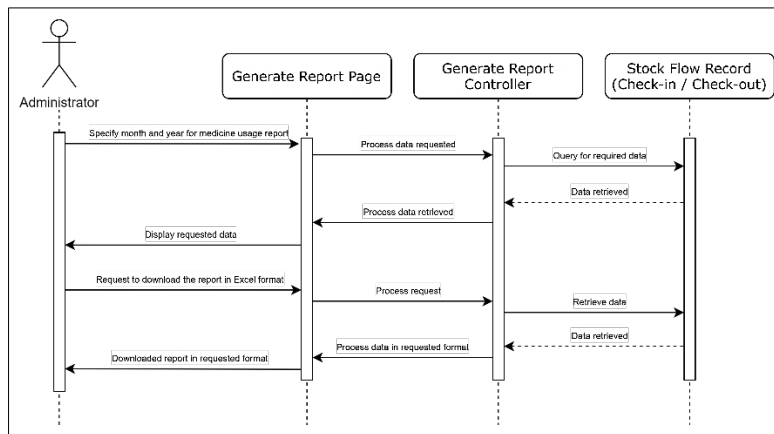**Figure 20: Manage Stock Sequence Diagram**

Figure 21: Generate Report Use Case Sequence Diagram

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