Automation of Currency Exchange Process at the Bank of Ceylon Pay Office

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Automation of Currency Exchange Process at the Bank of Ceylon Pay Office

A thesis submitted for the Degree of Master of Information Technology

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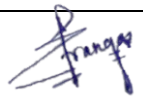	28/09/2024

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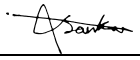
Signature			
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Abstract

This document describes the development of the web-based system which facilitates the automation of the currency exchange process at the Bank of Ceylon Pay Office in an effective way.

Bank of Ceylon Pay Office works around the clock in Departure, Arrival and Transit areas of Bandaranaike International Airport (BIA) in Sri Lanka. This fulfills local and foreign customers' currency transactions and other services. Mainly there are three different counters operating at Bandaranaike international airport as "Purchase Counters, Sales Counters, Re-Exchange Counters" and different facilities are available at each counter. The current system being used by the BOC pay office is a stand-alone software solution, which is in use for over 2 decades. There are lots of functional issues in the existing system which are handled manually by the bank staff when running day to day operations. As a beneficial solution, web-based system was developed to automate the currency exchange process at the Bank of Ceylon Pay Office.

Core concept of the developed system is to automate all the foreign currency transaction activities in the Pay Office counter with the additional features for reporting the data. System was implemented as a fully web-based application using the PHP, Java languages and the MySQL as the database storage where the users will be able to access the application through the Bank’s internal network using any user preferred browser. Therefore, with the implementation of a new system, it is expected to increase the efficiency, accuracy of the information and to improve the productivity of the staff members in the Pay Office counter.

Evaluation and testing were carried out by the selected core workers who were involved in the currency exchange counters in the BIA. Then the implemented system was demonstrated to the relevant stakeholders and the opinions and viewpoints were gathered through face-to-face interviews. Positive feedbacks received from the users have proved that the system fulfills the identified requirement and it was beneficial over the previously used manual process.

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List of Acronyms

AD	Active Directory
BOC	Bank of Ceylon
BIA	Bandaranayake International Airport
MVC	Model-View-Control
QA	Quality Assurance
UAT	User Acceptance Testing

Chapter 1 – Introduction

1.1 Project Overview

Bank of Ceylon (BOC) Pay Office is a currency exchange service, operational at Bandaranaike International Airport (BIA) in Sri Lanka. This works around the clock to fulfill local and foreign customers' currency exchange requirements in a convenient way by providing wide range of currencies, including major currencies like US dollars, Euros, British pounds, Japanese yen, and more. This provides competitive rates. (office)

In BOC Pay Office, mainly there are three different counters operating at Arrival, Departure and Transit areas while having different facilities available at each counter. The "Purchase counters" are located at the Arrival area and customers can receive local currency (LKR) against foreign currencies. Oftentimes customers at the purchase counter will be tourists or Sri Lankan citizens returning after working overseas. The "Sales counters" are located at the departure area and customers can buy foreign currencies against local currency. Potential customers at the sales counter will be Sri Lankans who travel out of the country for various purposes such as holidays, studies etc. The "Re-exchange counters" are located at Departure area as well as Transit area. Foreign passport holders can re-exchange unutilized Sri Lankan Rupees on their return and receive foreign currencies at the Re-Exchange counters. All the pay office counters primarily dealt with physical currency notes. In addition to physical currency exchange, foreign currencies can be issued by debiting the customer accounts if the customer has an account with BOC. These accounts can be Local Currency accounts as well as Foreign Currency accounts (Personal Foreign Currency accounts or Business Foreign Currency accounts).

As per the existing process, staff members are maintaining a separate stand-alone software solution namely Tellermate, to perform currency exchange transactions. This system was developed according to the requirements over 2 decades and it is currently outdated due to lack of maintenance. All the operations of this system will be carried out by a group of bank staff who are assigned to the International Division of BOC Head Office. They are handling average number of thousand transactions per day from all three counters (Purchase, Sales and ReExchange).

1.2 Motivation

Major problems and issues identified by analyzing the existing currency exchange process in the Pay Office counter at BIA are shown below.

- Existing system used for currency exchange (Tellermate) was developed by an external software according to the requirements over 2 decades. Currently this system is outdated due to lack of maintenance and cannot cater new business requirements appropriately.
- Tellermate is a stand-alone system and it has been installed on designated desktop machines at the BIA Pay Office counter. Therefore, users are unable to work with the system remotely even in some emergency situations.
- There is no connectivity between the Tellermate system and Core banking system. Therefore, users have to re-enter the transaction details performed in Tellermate system one by one manually to the core banking system which consumes lot of time. Also users are unable to retrieve customer data, account data from Core banking system and cannot validate such data with core banking system.
- There are several difficulties in reforming the Tellermate system to comply with new compliance requirements by the Central Bank of Sri Lanka and cannot capture the required data through the existing user interfaces.
- All the reports are auto generated (Hard copies) at the Day End and users have no option to select and print whatever the necessary reports only. As a result, all the printouts have to keep in physical form for audit purposes where the more paper wastage happens.
- At the end of the day, bank has to pay Annual maintenance cost (AMC) for this software as it is developed and supported from external software company.

In order to overcome above mentioned concerns and difficulties, there is a need of implementing a new software solution integrated with core banking system in the bank which will cater the Currency exchange process in the Pay Office. Therefore, with the implementation of a new system, it is expected to increase the efficiency, accuracy of the transaction information and to improve the productivity of the staff members by eliminating the unnecessary workload in the Pay Office and provide a satisfactory customer service to increase the revenue of the bank.

1.3 Objectives

Main objective of the project is to design and develop a web based Online Foreign Currency Exchange System in order to automate the current manual processes carried out by the bank staff and replace the existing outdated system while maximizing the profit gained by the bank from foreign currency exchange business.

Following are the key objectives of the proposed system:

- Enable smooth operation for 24 hour pay office counter without delaying the business operations
- Provide efficient and user-friendly interfaces to perform transactions and increase the productivity of bank staff.
- Maintain a centralized database to keep track of important data such as customer details, account details, currency exchange rate details, commission and incentive details etc.
- Handle the data and functions in a secure manner with specific authorization levels.
- Minimize the manual interventions of the employees by automating the workflows.
- Generate real-time reports which makes it easier to take management decisions by the company management.

1.4 Background of the study

The primary users of this system are the staff members assigned to the international division of the bank. Since BOC Pay office is a 24/7 business operation center, these staff members work on shift basis. Shift duration will be twenty-four (24) hours beginning at 10.00 AM and ending at 10.00 AM of the next day. Each day minimum five staff members should work as tellers and one staff member should be work as the daily manager. Daily manager is responsible for supervising the team, managing the daily activities and maintaining the physical cash in the central cash repository (Vault). Manager should assign two tellers for arrival area counters, two tellers for departure area counters and one teller for transit area counter. After the user assignment, tellers are authorized to perform transactions through respective counters. Physical cash should be handed over to the tellers as well as same amounts should be transferred through the system to each teller's working counter (Till) from the main vault in order to perform daily transactions.

After the user assignment and cash transferring process done, tellers need to upload currency exchange rates (buying and selling) to the system. For this they refer the latest rate sheet issued by the treasury division of the bank. After uploading the rates, daily manage should check the rates entered by teller and authorize it.

After rates are authorized, tellers can perform transactions. Currency Purchase transactions will be processed through arrival area counters. In foreign currency purchase transactions, foreign currencies will be credited to the purchase counter and equivalent Rupee amount (LKR) will be debited from the same counter. There are two dedicated counters for Purchase of Foreign Currency. Currency sales transactions, Currency issuing transactions and Currency withdrawal transactions will be processed through the departure area counters. In currency sales transactions, foreign currencies will be debited from sales counter and equivalent Rupee amount (LKR) amount will be credited to the same counter. In currency issuing transactions foreign currencies will be debited from sales counter and equivalent Rupee amount (LKR) amount will be debited from a customer account in real-time. In currency withdrawal transactions foreign currencies will be debited from sales counter and exact foreign currency amount will be debited from a customer foreign currency account in real-time There are two dedicated counters are operating in the departure area for facilitating above services. Re-Exchange of unexpended Sri Lankan Rupees by foreign passport holders on their return willbe processed through departure and transit area counters of the airport. Foreign currencies willbe debited from this counter and equivalent Rupee amount (LKR) amount will be credited to the same counter.

At the end of the day, each teller should balance their tills by tallying the opening balance (amount of cash received at the beginning of the day) with the transactions happened through their till. After balancing the till tellers should transfer outstanding cash balances to the main vault through the system as well as physically. The closing balance of the current date will be the opening balance of next working date.

1.5 Scope of the study

This system will consist of six major modules and below are the functional/non-functional requirements of each module.

1. User Management Module
    a. User Profile Management:

       Allow the users with administrative privileges to add/modify and manage system users. All the system users will be bank users.
    b. User Role Management:

       Allow the users with administrative privileges to add/modify and manage system roles. There are 3 distinct user roles are available as Admin, Manager and Teller
    c. User Permission Management:

       Allow the users with administrative privileges to assign user roles to users in order to control the access to each function. Admin users should assign the users for manager role and users with manager role can assign tellers for specific dates

2. Currency Rates Management Module
    a. Currency Rates Upload Management:

       Tellers in the system will be allowed to enter rates for currency purchasing, currency selling and define a ceiling value for each currency rate.
    b. Currency Rates Authorization Management:

       All the rates and ceiling values needs to be approved by the daily assigned manager of the pay office before performing any transaction in the system
    c. Currency Rates View Management:

       Provides an interface for the users to easily view daily rates with the status (New/Authorized/Rejected)
    d. Currency Rates Print Management:

       Generate a PDF format print of all the currency rates in a tabular view. This print can be obtained before authorizing the rates as well as after authorizing the rates. Rate entered user details, rate authorized user details and date time details will be available in this print.

3. Vault Management Module
    a. Vault Cash Transfer Management:

       Involves in the management of currency flow into the system, circulation within the system and flow out from the system.
    b. Till Cash Transfer Management:

       Update the currency position of each teller upon performing a transaction or transferring cash
4. Transaction Management Module
    a. Provide the facility to perform Foreign Currency Purchase, Foreign Currency Sales, Foreign Currency Re-Exchange transactions.
    b. Automatically capture customer details through scanning the passport
    c. Inquire customer details by NIC, Passport number If the customer is a BOC customer
    d. Retrieve the account details from the core banking database, If the customer is a BOC customer
    e. Calculate commission amount for Currency Sales, Re-Exchange and Issuing transactions according to the tariff provided by the Central Bank of Sri Lanka
    f. Calculate the Incentive payments for Currency purchase transactions according to the values provided by the Central Bank of Sri Lanka
    g. Auto fill default fields to minimize the time taken to perform a transaction
    h. Print two receipts (Customer Copy and Office Copy) after performing the transaction in A5 paper
5. Operations Management Module
    a. Prior Check Process Management:

       Allow the users to check any dependencies or incomplete work before executing day end process and restrict performing day end process if there are any so.
    b. Day End Process Management:

       Update the Core banking database (General Leger accounts) according to each transaction performed by all the tellers. At the endof the process, system date will be automatically set to the next working date.
    c. Daily Process Management:

       Provides an interface to view the status (success/fail) of above processes

6. Reporting Module
    a. Customized Report Management:

       Allow the users with proper user levels to generate customized reports on each module such as generate teller balancing reports at the day end and generate manager reports which will be used by the manager before performing day end.
    b. Decision Making Report Management:

       Allow the users with proper user levels to generate decision making reports such as total number of purchases, total number of sales, transactions which are done for special exchange rates etc.

1.5.1 Boundaries of the project

The excluded aspects within the scope of project development are outlined as follows:

i. Developed system will be integrated with Core Banking System since it requires to capture related customer and financial information.
ii. The web application is set to be hosted on a Virtual Server within the Bank, exclusively accessible via the intranet. Consequently, users will not have permission to access the web application through the public internet.

1.6 Feasibility study

“A feasibility study is an analysis that takes all of a project's relevant factors into account including economic, technical, legal, and scheduling considerations to ascertain the likelihood of completing the project successfully” (Kenton, 2020). (FeasibilityStudy)

Five areas mentioned below are mainly considered to evaluate the feasibility of implementing the currency exchange process at the Bank of Ceylon Pay Office

1. Technical Feasibility

   Project was developed as a Web-based application using Java as an open source server side programming language and MySQL an open-source relational database management system which are capable of delivering highly reliable solutions. The Web application was hosted in a VM server which was located in the Bank’s internal network. Considering the main technologies used for the development of the web application and the hardware used for the hosting of the application it can be concluded that the project was technically feasible.

2. Economic Feasibility

   All the technologies used for the development of the application were open-source technologies which were available for free of charge. VM Server which was used to host the application and the database was provided by the Bank. Therefore, it can be considered that the project was economically feasible since it did not bare any additional costs.

3. Security Feasibility

   The Web application is hosted on a Virtual Server in the Bank and accessible only through the intranet. Therefore, users are not allowed to access the Web application through the public internet. t. Only the port 443, the standard HTTPS Port for all the secured transactions is opened for the internal network in order to allow the access to the Web application. Considering the above facts, it can be considered that the project is Security wise feasible.

4. Schedule Feasibility

   The development of the project was expected to complete within one year time period. Project scope was developed according to the given time period and the project time line was developed accordingly. With the technical expertise and the project deadlines it can be considered that the project is schedule wise feasible.

5. Legal Feasibility

   Even though the system is integrated with Core Banking System, it is accessible only for the Bank staff. Therefore, customer information will not be exposed to any outside party through the system. Even for bank staff only the permitted information can be viewed and forbidden data will not be visible through the system. Therefore, it can be concluded that the project is legally feasible.

1.7 Structure of the dissertation

The remaining chapters of the dissertation are organized as follows;

- Chapter 1 – Introduction

  In this chapter, it mainly focuses on the introduction of the system which has been developed. It briefly mentions the problems of the current system, the solutions and the scope of the developed system.

- Chapter 2 – Background

  Second chapter describes the background of the system and the literature review about similar systems and technologies. It describes the analysis of the requirement with the different technologies and the design strategies which were used to develop the project.

- Chapter 3 – Methodology

  In this chapter, it illustrates the requirement analysis and the design of the solution and also it shows all the UML diagrams such as Deployment diagram, Component diagram, Class diagram, Sequence diagram, State Charts, Activity diagrams and the database design using the ER diagrams. Major module structures are comprehensively explained and all the test plans are described in this chapter.

- Chapter 4 – Evaluation

  Evaluation on the system with the sanction on whether the project objectives were satisfied is described in the fourth chapter. It explains the techniques that were used to analyze the data. Also mentions the failures and deficiencies in the final product with the steps taken to improve the functionalities. Suggestions for the future developments and the lessons learned are extensively stated in this chapter.

- Chapter 5 – Conclusion

  This includes the conclusion of the project which highlights the weaknesses/limitations of the used technique and solutions for them. It describes the benefits of developing the project to the Bank.

  In this chapter, it mainly focuses on the introduction of the system which has been developed. It briefly mentions the problems of the current system, the solutions and the scope of the developed system.

Chapter 2 – Background

2.1 Introduction

A detailed analysis on the requirement of the system is provided in this chapter with reviews on existing systems that are similar to the developed system. When comparing the developed system with similar systems, the chapter mainly focuses on the functionality and the technologies used in both systems. Finally, the technologies and design strategies which have used to develop the system are also mentioned.

2.2 Requirement Analysis

Requirement analysis phase includes the overall requirement of the Bank that were agreed at the initial discussions, which were held in a formal manner. These requirements have then been further developed by identifying actors, creating use-cases and identifying how the actors will interact with the system. Class diagram have also been designed, including the identification of class responsibilities and collaboration between classes. All required diagrams are included in the next chapter.

According to the information gathered through the discussion had with the staff members of the Pay Office Team, the overall summarized requirement as follows;

Main Requirement

- Automation of Currency Exchange Process at the Bank of Ceylon Pay Office

Sub Requirements (Performance)

- Increase productivity, efficiency, accuracy and data processing speed
- Avoid duplication of data entry
- Identify project bottlenecks and delays at early stage
- Reduce unnecessary printing cost

Basically, software requirements can be identified under two main categories: Functional requirements and Non-Functional requirements. Functional requirements describe the required software performance of the system while Non-Functional requirements discuss about the hardware and software requirements in developing, implementing and maintaining the system.

2.2.1 Functional Requirements

This section defines the essential functional requirements for each user role within the system, ensuring that operational processes are conducted smoothly while maintaining security, control, and efficiency at each level. The system is designed with three distinct user roles—Admin, Manager, and Teller, each with its own set of functional responsibilities. These roles enable the effective operation and management of the system while maintaining data security and organizational hierarchy.

1. Admin User Role

Administrators are responsible for overseeing the system's configuration, managing users, and handling core operational settings. The key functional requirements for the Admin role include:

1. **Manage Common Parameters:**

   Admin users should have the ability to set and modify system-wide parameters such as date, names, addresses, and telephone numbers. This ensures that the system’s configuration remains current and accurate for all users.

2. **Manage User Roles/Levels:**

   Admins can define, create, and assign different user roles or levels within the system. This includes setting permissions that determine the scope of each user's access to system features and data.

3. **Add/Remove Users:**

   The Admin user should have complete control over user profiles, allowing them to add new users to the system or deactivate and remove users as needed, ensuring proper access control.

4. **Manage Currencies:**

   Admins have the authority to add or remove currencies in the system, ensuring that the list of supported currencies remains up to date with operational needs.

5. **Add/Remove Tills:**

   Admins can create or deactivate tills (working counters) within the system, assigning them to various branches or locations to facilitate currency management.

6. **Manage Tariff Files:**

   Admins are responsible for uploading and updating tariff files, which include commission percentages for currency exchange or other financial services. This ensures that all transactions are based on the latest approved rates.

7. **Assign Users and Manage Assignments:**

   Admins can assign specific roles or responsibilities to users within the system. They can reallocate users to different branches, roles, or tasks based on operational needs.

2. Manager User Role

Managers are responsible for handling daily operations, overseeing cash management, and managing users at a higher level than tellers. The key functional requirements for the Manager role include:

1. **Add/Remove Users:**

   Managers can add new users or remove users from the system, similar to Admins, but with a more restricted scope, such as branch-level user management.

2. **User Assignments:**

   Managers can assign users to specific roles and tasks, ensuring that staff are appropriately allocated based on daily operations.

3. **Manage Main Cash Repository (Vault):**

The Manager oversees the vault, which serves as the central repository for cash. This includes transferring cash between tellers and the vault, managing vault security, and auditing vault balances.

4. **Manage Currency Exchange Rates:**

   Managers have the ability to update and manage the daily currency exchange rates, ensuring that the system reflects the most current and accurate rates for foreign exchange transactions.

5. **Authorize/Reject Transaction Cancellations:**

   Managers are authorized to approve or reject transaction cancellation requests, ensuring that only valid cancellations are processed.

6. **Cash Management:**

   Managers can perform various cash transactions such as transferring cash into and out of the main vault and accepting cash from tellers. This maintains the flow of currency within the system.

7. **Day-End Process:**

   Managers can perform the Day-End process, which includes balancing the day's transactions, generating reports, and ensuring the system is ready for the next operational day.

8. **Generate Reports:**

   Managers can generate Day-End reports, Exception reports, and other relevant operational reports to review the status of transactions and operations within the system.

3. Teller User Role

Tellers are responsible for day-to-day cash handling and customer-facing operations. Their functional requirements include:

1. **Upload Currency Exchange Rates:**

   Tellers should have the ability to upload daily currency exchange rates into the system, reflecting current market values for foreign currency transactions.

2. **Cash Handling:**

   Tellers can accept cash from the main vault, transfer cash to the vault, and make inter-cashier transfers, ensuring cash availability at their counters.

3. **Foreign Currency Exchange Transactions:**

   Tellers are responsible for executing foreign currency exchange transactions for customers using the system, with all relevant details captured in the process.

4. **Transaction Cancellations:**

   Tellers can request to cancel foreign currency exchange transactions, which are then reviewed and authorized by a Manager.

5. **Teller Balancing Reports:**

   Tellers can generate their own balancing reports to ensure that their till amounts match the transaction data captured in the system.

Additional Functional Requirements

1. **Customer Details Capture:**

   The system should automatically capture customer details by scanning their passport, minimizing manual data entry and improving accuracy. This functionality allows the system to instantly extract personal details such as name, date of birth, and nationality from the passport data.

2. **BOC Customer Details and Account Balances:**

   For customers who hold accounts with the Bank of Ceylon (BOC), the system should be integrated with the Core Banking System to automatically retrieve customer details and current account balances. This enables a more seamless and efficient process for customer service.

3. **Report Generation:**

   Both the System Manager and System Tellers should have the ability to generate required reports on demand, providing real-time insights into system operations, cash management, and transaction statuses. This ensures that management can make data-driven decisions as needed.

- Customer details should be automatically captured through scanning the passport.
- BOC Customer details and account balances should be retrieved from Core banking system
- System Manager and System Tellers should be able to generate required reports as and when required.

2.2.2 Non-Functional Requirements

- System should have user friendly graphical web pages without using heavy media content which will reduce the performance of the web application.
- In order to provide the safety and security, system shall be accessible only through the intranet.
- Multiple users should be able to work with the web application simultaneously without affecting its performance.
- System should ensure the 99.9% availability without having any downtimes.
- The system shall sustain data integrity by keeping backups of all updates to the database for every change of the records.

2.3 Review of Similar Systems

2.3.1 Thomas Cook

Thomas Cook offered currency exchange services as part of its travel and financial services. This allows customers to buy and sell foreign currencies for their travel needs. Customers could exchange their local currency for the currency of their destination country or convert any remaining foreign currency back to their local currency after their trip. (ThomasCook)

Main Features of Thomas Cook:

- Wide Range of Currencies
- Provide Competitive Exchange Rates for various currencies
- Physical Currency
- Traveler's Cheques and Prepaid Cards

Figure 1- User interface - Thomas Cook system

s

2.3.2 Currency-Fair

Currency-Fair is an online peer-to-peer currency exchange service that allows individuals and businesses to exchange currencies at competitive rates. The platform operates on a peer-to-peer model, matching users who want to buy a certain currency with those who want to sell the same currency. This unique approach often leads to better exchange rates compared to traditional banks or currency exchange services. In addition to currency exchange, Currency-Fair provides international money transfer services. Users can transfer funds to bank accounts in various countries, typically at lower fees compared to traditional banks. The platform also offers transparent and competitive pricing, displaying all fees and charges upfront. Currency-Fair's user-friendly interface and mobile app make it convenient to access and use the service from anywhere. The company prioritizes security, employing robust encryption and complying with strict regulations to safeguard users' funds and personal information. Overall, Currency-Fair offers an innovative and cost-effective solution for currency exchange and international money transfers, making it a popular choice for individuals and businesses seeking competitive rates and reliable service. (CurrencyFair)

The proposed system is only for the use of bank staff. Therefore, features like peer-to-peer model, which allow users to match their currency exchange needs with other individuals who have opposite currency requirements is not required.

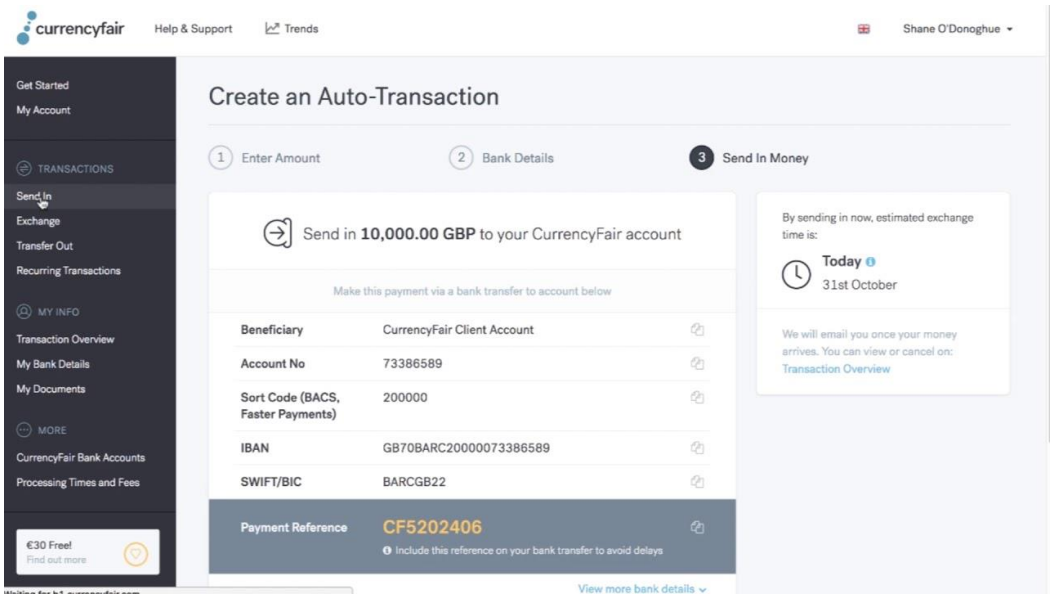

Figure 2 - User interface - Currency Fair system

2.3.3 Transfer-Wise

Transfer-Wise is an online money transfer service that allows individuals and businesses to send and receive money internationally. Founded in 2011, it is known for its transparent, cost-effective approach to currency exchange and cross-border transfers. Users create an account, provide identification, and set up transfers by entering recipient details and amounts. Transfer-Wise supports numerous currencies and countries, displaying exchange rates, fees, and recipient amounts upfront, which is particularly beneficial for larger transfers. It also offers multi-currency accounts for managing balances across different currencies. With strong security and regulatory compliance, Transfer-Wise has become a popular choice for its peer-to-peer model, competitive rates, and user-friendly platform.(TransferWise)

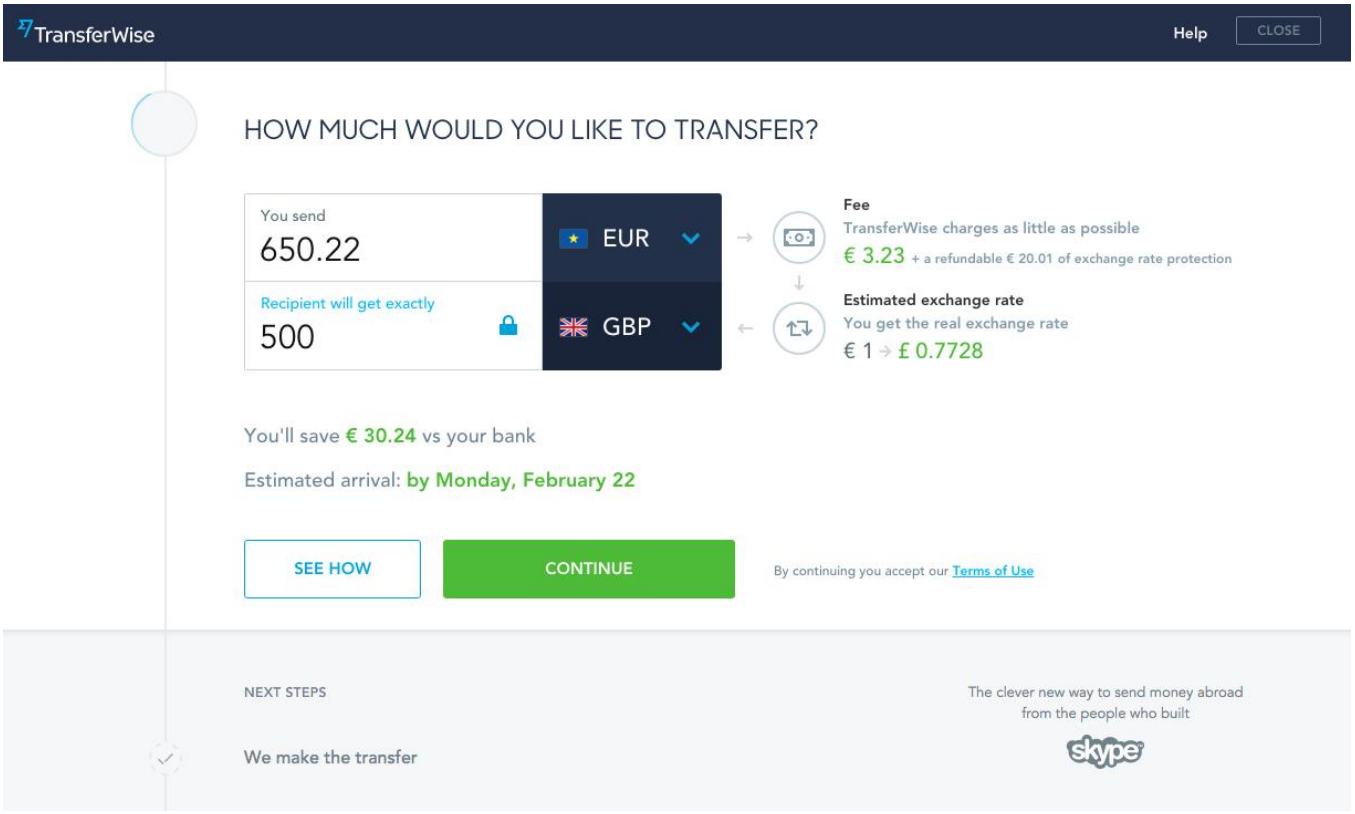

Figure 3- User interface- Transfer Wise system

2.3.4 Travelex

Travelex is a well-known global foreign exchange company that specializes in currency exchange services for travelers. Established in 1976, Travelex operates in over 70 countries, serving both retail customers and businesses. Travelex offers a range of services to cater to different customer needs. Its primary service is currency exchange, where customers can buy or sell foreign currencies at Travelex locations, both in airports and city centers. Travelex provides a wide selection of currencies, including major and exotic ones, allowing travelers to obtain the necessary currency for their destination. In addition to physical currency exchange, Travelex also offers prepaid travel cards. These cards allow users to load multiple currencies 11 onto a single card, providing convenience and security during international travel. The cards can be used for purchases and cash withdrawals, often offering competitive exchange rates and reduced fees compared to traditional debit or credit cards. Travelex also provides money transfer services, allowing customers to send money abroad or receive funds from overseas. These services can be accessed online or through Travelex locations, offering flexibility and convenience for individuals who need to transfer money internationally. Travelex is known for its extensive network of physical locations, with many branches located in airports, shopping centers, and popular tourist destinations. This accessibility makes it convenient for travelers to access their services, particularly for last-minute currency needs. In conclusion, Travelex is a prominent foreign exchange provider with a global presence, offering currency exchange, prepaid travel cards, and money transfer services. Its extensive network of locations, competitive rates, and convenient options make it a popular choice for travelers and individuals in need of foreign currency services. (Travelex)

Main Features of Travelex:

- Physical Currency Exchange
- Wide Range of Currencies
- Online Currency Exchange
- Prepaid Travel Cards

Feature	Thomas Cook	Currency-Fair	Transfer-Wise	Travelex
Service Type	Currency exchange for travelers	Peer-to-peer currency exchange, international transfers	Online international money transfers	Currency exchange for travelers
Physical Currency	Yes	No	No	Yes
Traveler's Cheques/Prepaid Cards	Yes	No	Borderless Debit Card	Prepaid Travel Cards
Online Platform	Limited	Yes, fully online	Yes, fully online	Yes (for money transfers and currency orders)
Peer-to-Peer Model	No	Yes	Yes	No
Exchange Rate	Competitive, but may vary	Competitive, peer-based rates	Mid-market exchange rates	Competitive, but varies at physical locations
Fees	Not specified	Small fee structure	Low, transparent fees	May involve fees for services such as transfers
Money Transfer Service	No	Yes	Yes	Yes
Multi-Currency Accounts	No	No	Yes	No
Global Availability	Yes, through physical branches	Yes, online	Yes, online	Yes, through physical branches
Mobile App	No	Yes	Yes	Yes, for some services
Security & Regulation	Standard	High, encrypted and regulated	High, encrypted and regulated	Standard

Table 1 - Differences of each system summarizing the key features

- **Thomas Cook** focuses on physical currency exchange with additional services like prepaid cards for travelers.
- **Currency-Fair** operates as an online peer-to-peer service offering competitive exchange rates and low fees.
- **Transfer-Wise** is known for international money transfers, offering mid-market rates and multi-currency accounts.
- **Travelex** specializes in currency exchange services with a strong presence in physical locations, including airports and tourist centers, and offers prepaid travel cards.

2.3.5 Constraints of existing systems

- Cost

As a state-owned Bank, BOC has to adhere to the financial regulations of the government where the product should be evaluated through a tender process and all the systems mentioned above require significant upfront investment, ongoing maintenance and subscription fees.

- Customizability

Workflows and processes in the existing systems cannot be used as it's with the Bank's development environment and may require significant levels of customization.

- Compatibility

Most of the software applications may not integrate seamlessly with core banking system.

- Data Integrity

Most of the solutions are cloud-based solutions. According to the bank IT security policy restrictions are there to host the sensitive data in cloud base have to host on premises.

2.4 Related Technologies

Currency Exchange System at the Bank of Ceylon Pay Office was implemented as a fully web-based application where users will be able to access it through the Bank's internal networkusing any user preferred browser (Internet Explorer, Chrome and Firefox). Different technologies and frameworks used for the development of the application are shown below.

2.4.1 Front End Development

This is the Client side of the application with the content of everything seen on the user browser screen when the web application is opened up. Responsiveness and the performance are two main objectives of the front end where user should be able to view the content without any delay and the content should appear correctly on monitors of all sizes. Front end of the application was developed using four main languages.

1. HTML (Hyper Text Markup Language)

   Used to design the front-end portion of the web pages using markup language. The markup language is used to define the text documentation within tag which defines the structure of web pages.

2. CSS (Cascading Style Sheets)

   Used to simplify the process of making web pages presentable where it allows to apply predefined styles to the web pages.

3. JavaScript

   Used to enhance the functionality of the web application allowing to handle field validations and manage dynamic content.

4. PHP

   PHP is a widely-used open-source general-purpose scripting language that is especially suited for web development and can be embedded into HTML.

2.4.2 Back End Development

This is the Sever side of the application where it stores and arranges data and focuses on how the web application should work. It was used connect the web application to the database and the other API frame works which will be used for the data processing. Back end of the application was developed using Java language in order to reuse the restful web services which have been already used by the in-house developed applications in the bank.

- Java

  Java is a class-based, object-oriented programming language that is designed to have as few implementation dependencies as possible. It is intended to let application developers write once, and run anywhere (WORA), meaning that compiled Java code can run on all platforms that support Java without the need for recompilation.

2.4.3 Database Management

DB2 is used as the database of the developed web application of the live environment as it is the main database of the bank. But for the demonstration purposes same database structure will be implemented in MySQL database and will be hostedinthe same web server, which is used to host the web application.

- DB2

  IBM Db2 is a database built on decades of expertise in bringing data governance and security, low-latency transactions and continuous availability to mission critical data,

analytics and AI-driven applications. With support for mixed transactional and analytical workloads, it provides a single place for DBAs, enterprise architects and developers to keep apps running, store and query anything and simplify development. No matter the volume or complexity of transactions, it makes applications secure, highly performant and resilient anywhere. (DB2IBM)

- MySQL

  MySQL is a freely available open-source Relational Database Management System (RDBMS) that uses Structured Query Language (SQL). “A relational database organizes data into one ormore data tables in which data types may be related to each other. SQL is a language programmers use to create, modify and extract data from the relational database (MYSQL)

2.5 Related Design Strategies

2.5.1 MVC Architecture

Model-view-controller is a software design pattern commonly used for the development of the user interfaces which divides the related program logic into three different interconnected elements. MVC provides a way to develop an application having loosely coupling between input logic, business logic and UI logic.

- Model

  Represents the data structures, mainly the classes which will be used to search, insert, delete and update the database records.
- View

  View will be the presentation layer of the web application which displays the information to the users. Therefore, view will be a web page that is visible to the user who is browsing the web application.
- Controller

  Controller is the intermediate layer between the Model and View. It includes all the data processing and validation algorithms which will be used to process the user requests.

Chapter 3 – Design Architecture

3.1 Introduction

This chapter provides a detailed analysis on the technologies, design methods and the best practices which have been used to automate the currency exchange process at the Bank of Ceylon Pay Office. It illustrates the requirement analysis and the design of the developed solution using the UML diagrams such as Use Case diagrams, sequence diagrams and class diagrams.

3.2 System Architecture

System architecture of the Web application is a framework that is contains relationships and interactions between application components, such as interfaces, middleware and databases. As per the concept of the application user will access the web application using a given URL through a general web browser like Internet Explorer or Chrome.

The figure 4 illustrates the architecture of the system

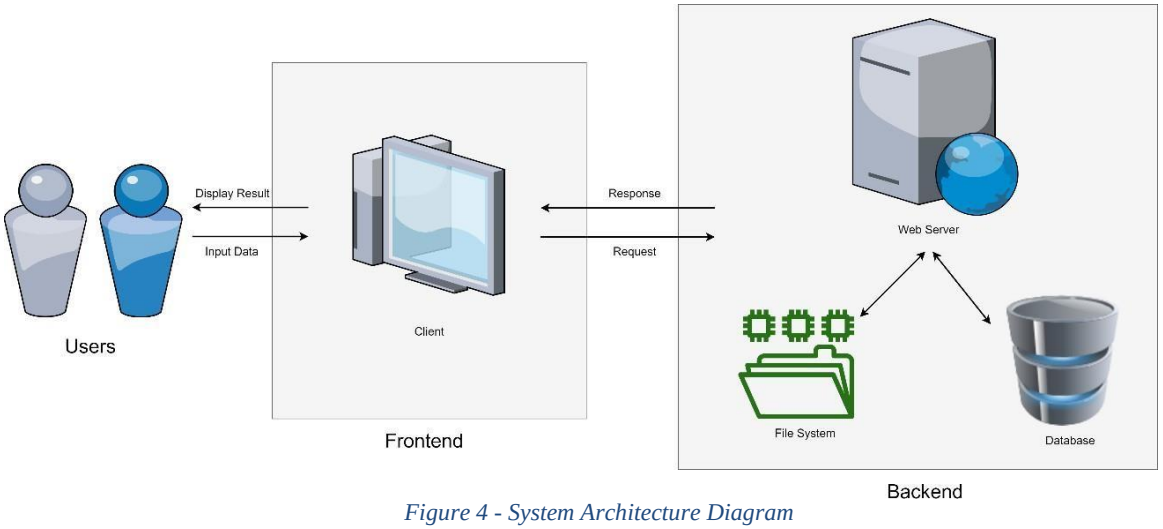

Figure 4 - System Architecture Diagram

3.3 UML Diagrams

3.3.1 Use case Diagrams

Module wise use case diagrams for the five major modules in developed system.

Use case diagram for User Management module in the developed application is shown in figure 5.

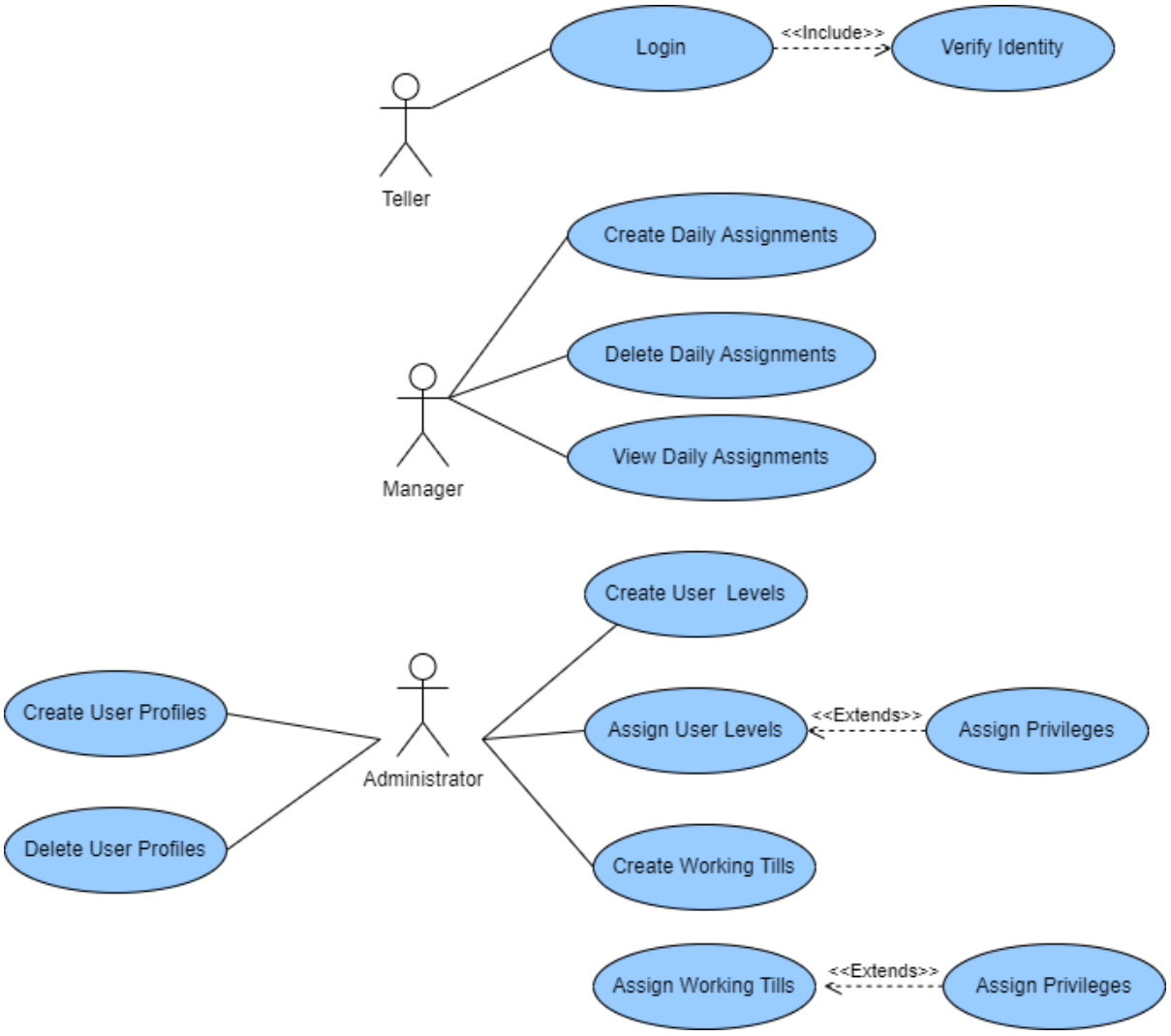

Figure 5 -Use case diagram for user management module

Use case diagram for Currency Rates management module is shown in figure 6.

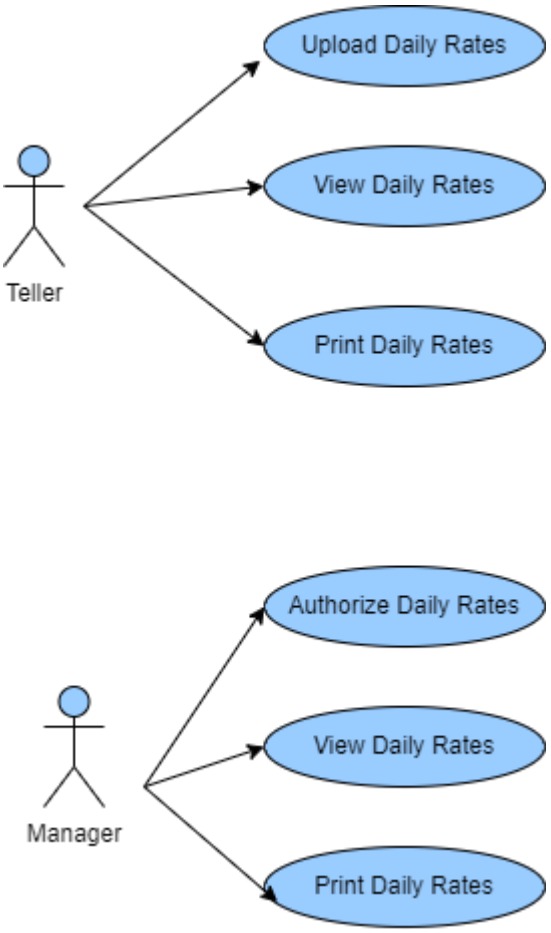

Figure 6 -Use case diagram for currency rates management module

Use case diagram for vault management module in the developed application shown in figure 7.

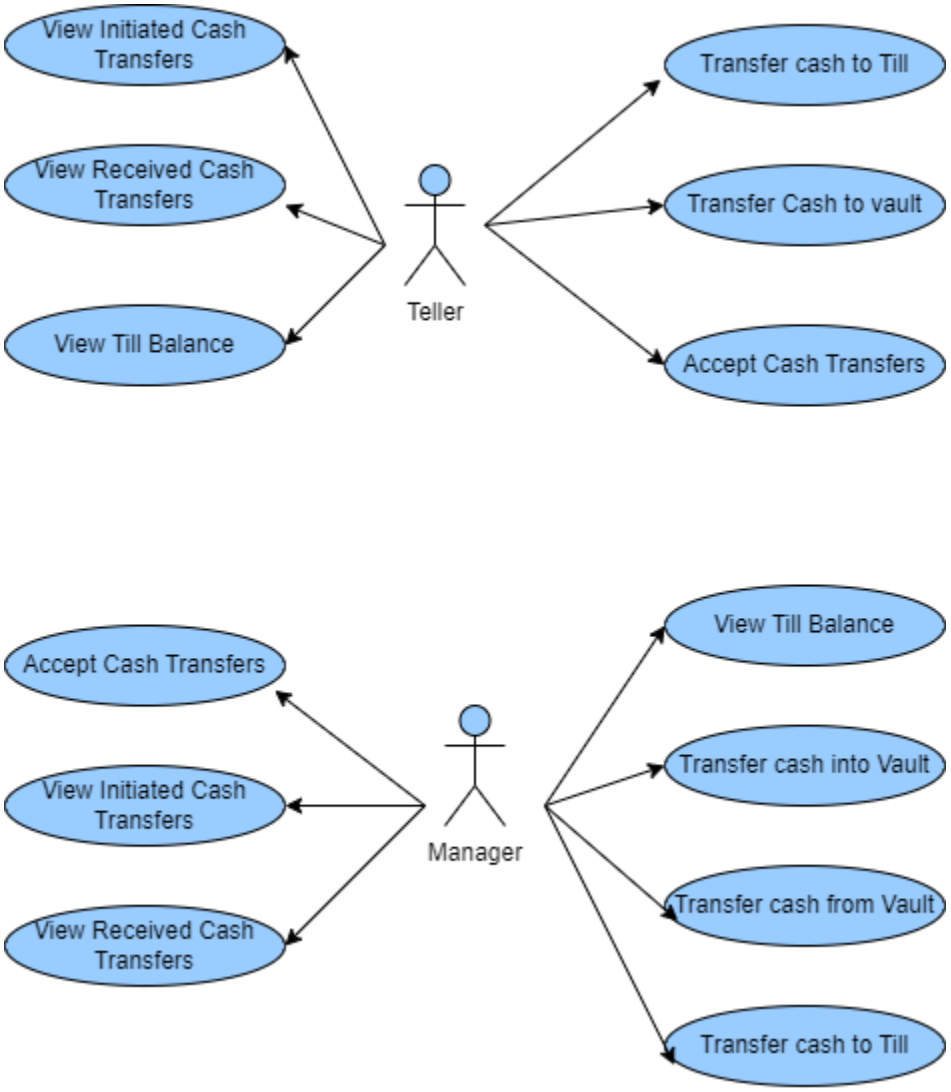

Figure 7- Use case diagram for vault management module

Use case diagram for Transaction Module is shown in figure 8

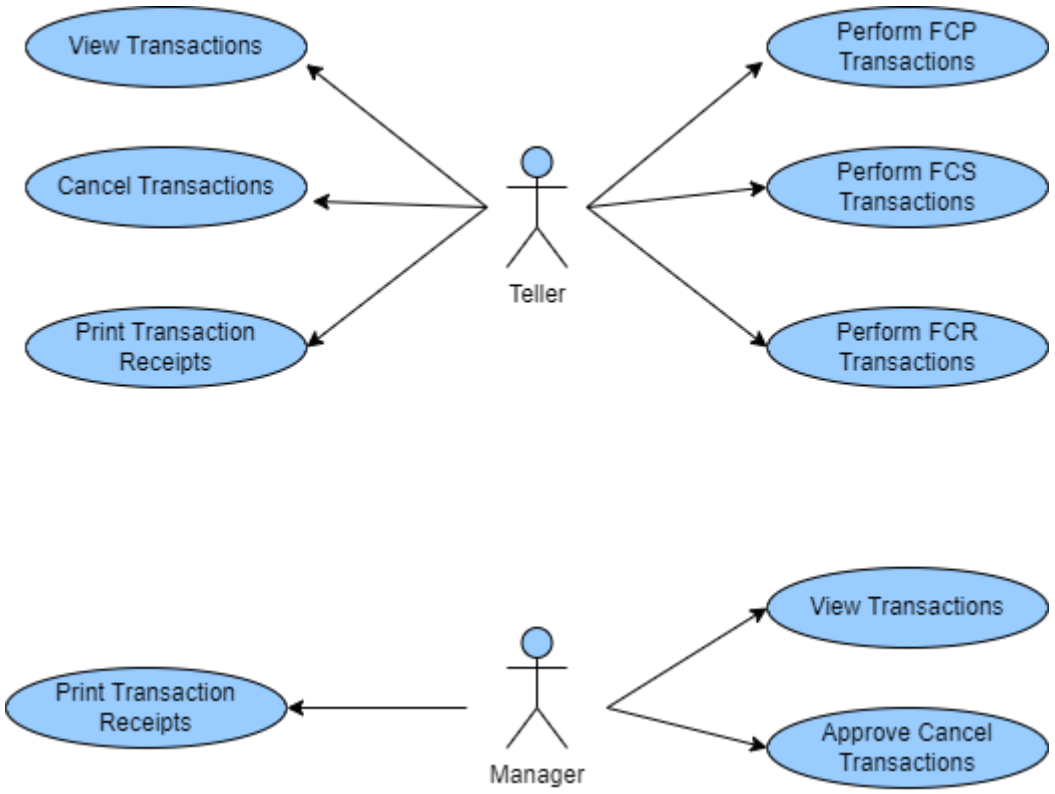

Figure 8-Use case diagram for transaction module

Use case diagram for Operations module in the developed application shown in figure 9.

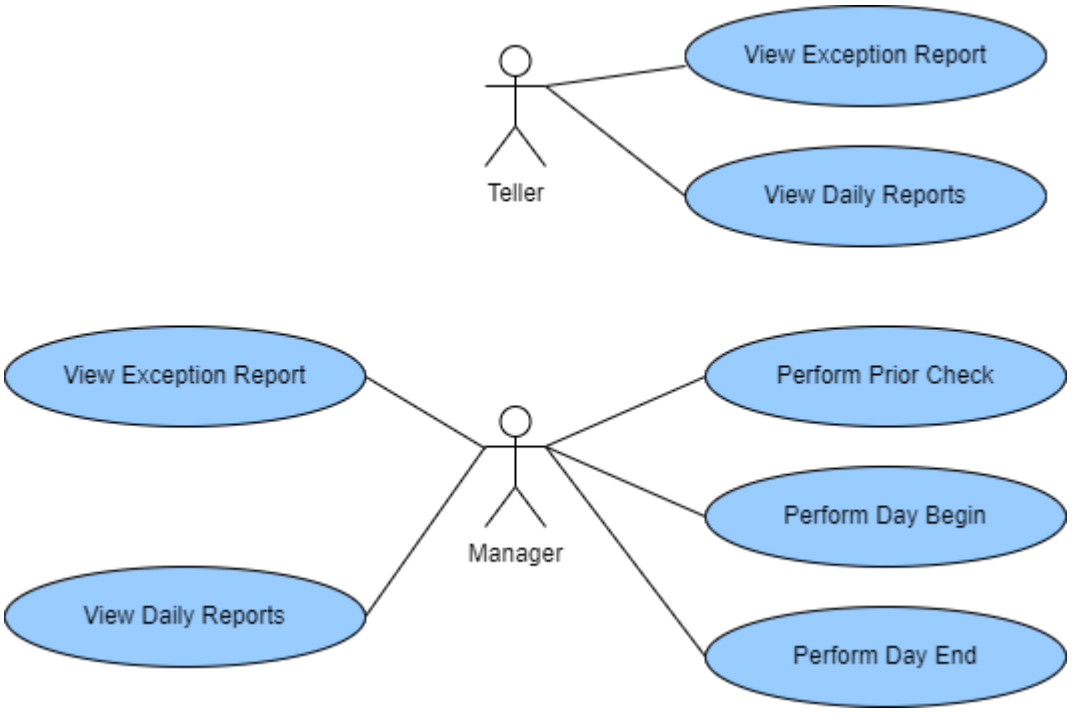

Figure 9-Use case diagram for operations module

3.3.2 Use case narrations

Use case narrations for the main use cases in the above use case diagrams are shown below.

- Use case narration for login

Use case name	Login	**Use case Type** **Business Requirements:** Prevent unauthorized access and authenticate user.
Use case id	01	
Priority	High	
Source	Web Page – Login DB Table – User, Session	
Primary Business Actor	All Users	
Other Participating Actors		
Other Interested Stakeholders		
Description	Validate the username and the password entered by the user and grant access to the web application.	
Preconditions	User already has a user account created in the web application.	
Trigger	User send request to login by pressing the login button	
Typical course of events	1) User enter the username and password 2) Click on the Login button.	
Alternative course	Error message will be displayed for the invalid username or password entered by the user.	
Post conditions	Application will create a session and redirect the user to the home page.	

Table 2 - Use case narration for login

- Use case narration for create new user profile

Use case name	Create new user	**<u>Use case Type</u>** **Business Requirements:** New user will be required to access the web application
Use case id	02	
Priority	High	
Source	Web Page – User Creation DB Table - User	
Primary Business Actor	Administrator	
Other Participating Actors		
Other Interested Stakeholders		
Description	Create user profile for the new users who will required to access the web application.	
Preconditions	User has the administrative privileges to create new user profiles.	
Trigger	User select the User Management function from the menu	
Typical course of events	1) User selects new user creation option available in the page. 2) Enter the required details of the new user. 3) Click on the save button.	
Alternative course	1) Application will display an error message if user have not entered any value for required field. 2) Application will display an error message if the users provident fund number already exists in the application. 3) Application will display a success message after creating the new user profile.	
Post conditions	Default username will be user's provident fund number and password will be the same which will be forced to change on the first login attempt.	

Table 3 - Use case narration for create new user profile

- Use case narration for create new purchase transaction

Use case name	Create new Purchase Transaction	**Use case Type** **Business Requirements:** Perform new purchase transactions in Pay Office arrival counter
Use case id	03	
Priority	High	
Source	Web Page – Create Purchase Transaction DB Table - Transactions	
Primary Business Actor	Teller	
Other Participating Actors	Customer	
Other Interested Stakeholders		
Description	Teller create a new purchase transaction in the pay office system.	
Preconditions	User has the required teller privileges to perform purchase transaction in the arrival counter.	
Trigger	Teller selects "Create New Purchase Transaction" function from the menu items.	
Typical course of events	1) Swipe the passport and capture the customer details 2) Select the currency type and enter the transaction amount 3) Save the transaction	
Alternative course	1) Application will display an error message if user have not entered any value for required field. 2) Application will display a success message after saving the transaction	
Post conditions	Transaction will be displayed for the performed teller as well as manager.	

Table 4 - Use case narration for create new purchase transaction

- Use case narration for create cash transfers

Use case name	Create Cash Transfers	**Use case Type** **Business Requirements:** Transfer cash from till to till or till to vault
Use case id	04	
Priority	High	
Source	Web Page – Create Cash Transfers DB Table – Till Log	
Primary Business Actor	Teller	
Other Participating Actors	Manager	
Other Interested Stakeholders		
Description	Teller will transfer cash from own till to another teller's till or directly to the main vault	
Preconditions	Teller has the required privileges to transfer cash.	
Trigger	Teller selects a Create Cash Transfer option from the list of menu items.	
Typical course of events	1) Enter the transfer amount for all or several currencies 2) Click Transfer Cash button. 3) A request will be sent to cash receiving party to accept the transfer	
Alternative course	System displays an error message when the transfer amount is greater than the available amount in own till.	
Post conditions	Transfer teller will get a notification mentioning that the transfer request has been sent to the receiving party successfully.	

Table 5 - Use case narration for create cash transfer

- Use case narration for upload daily rates

Use case name	Upload daily rates	**<u>Use case Type</u>** **Business Requirements:** Teller will be able to enter daily currency rates
Use case id	05	
Priority	High	
Source	Web Page – Upload Rates DB Table – Rates	
Primary Business Actor	Teller	
Other Participating Actors	Manager	
Other Interested Stakeholders		
Description	Upload new currency rates for all currencies where other users and manager can view.	
Preconditions	User have required access privileges to upload the daily currency rates.	
Trigger	User selects the Upload Daily Rates function from the menu.	
Typical course of events	1) User enter the buying rates, selling rates and ceiling values 2) User enter any remarks for uploading the rates 3) Click on the Save Rates button to save the rates.	
Alternative course	If the content of the remarks field is too long than the accepted length, error message will be displayed for the user to amend the content.	
Post conditions	Once user save the rates it will be displayed on the View Daily Rates screen.	

Table 6 - Use case narration for upload daily rates

3.3.3 Sequence Diagrams

Sequence diagrams for the main use cases in the above use case diagrams are shown below.

- Sequence diagram for login

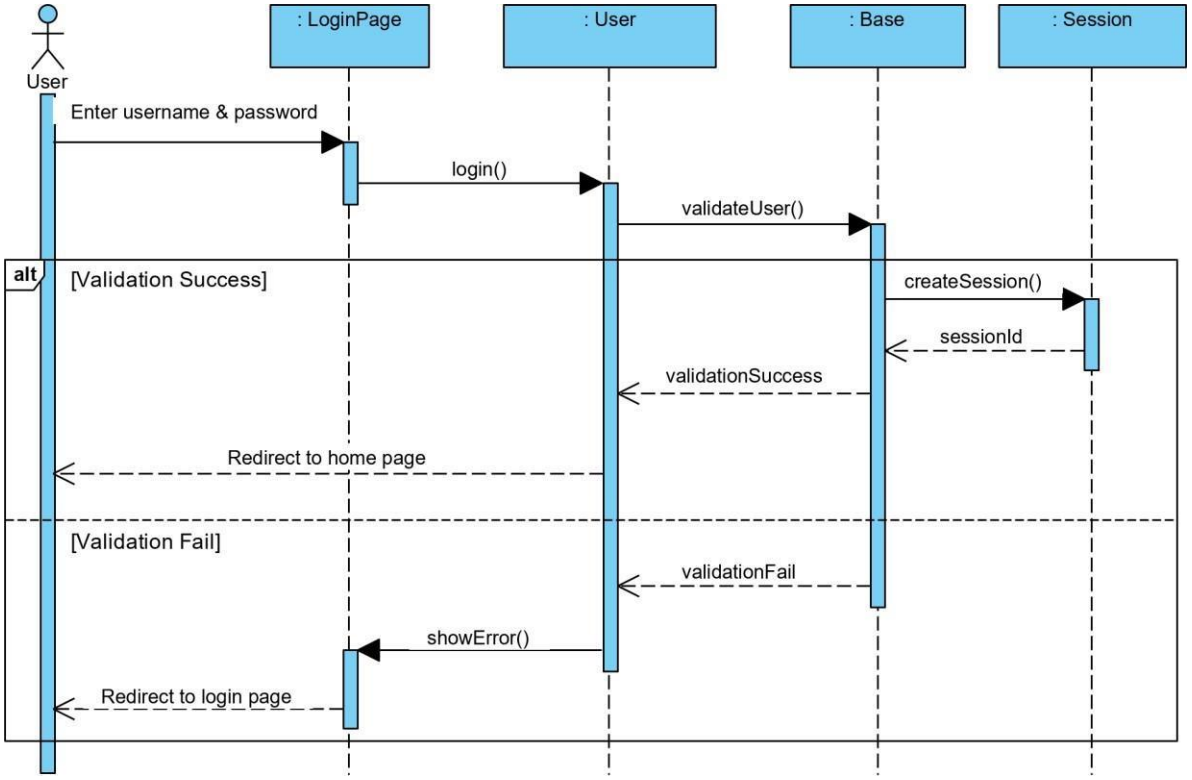

Figure 10 - Sequence diagram for login

- Sequence diagram for create new user profile

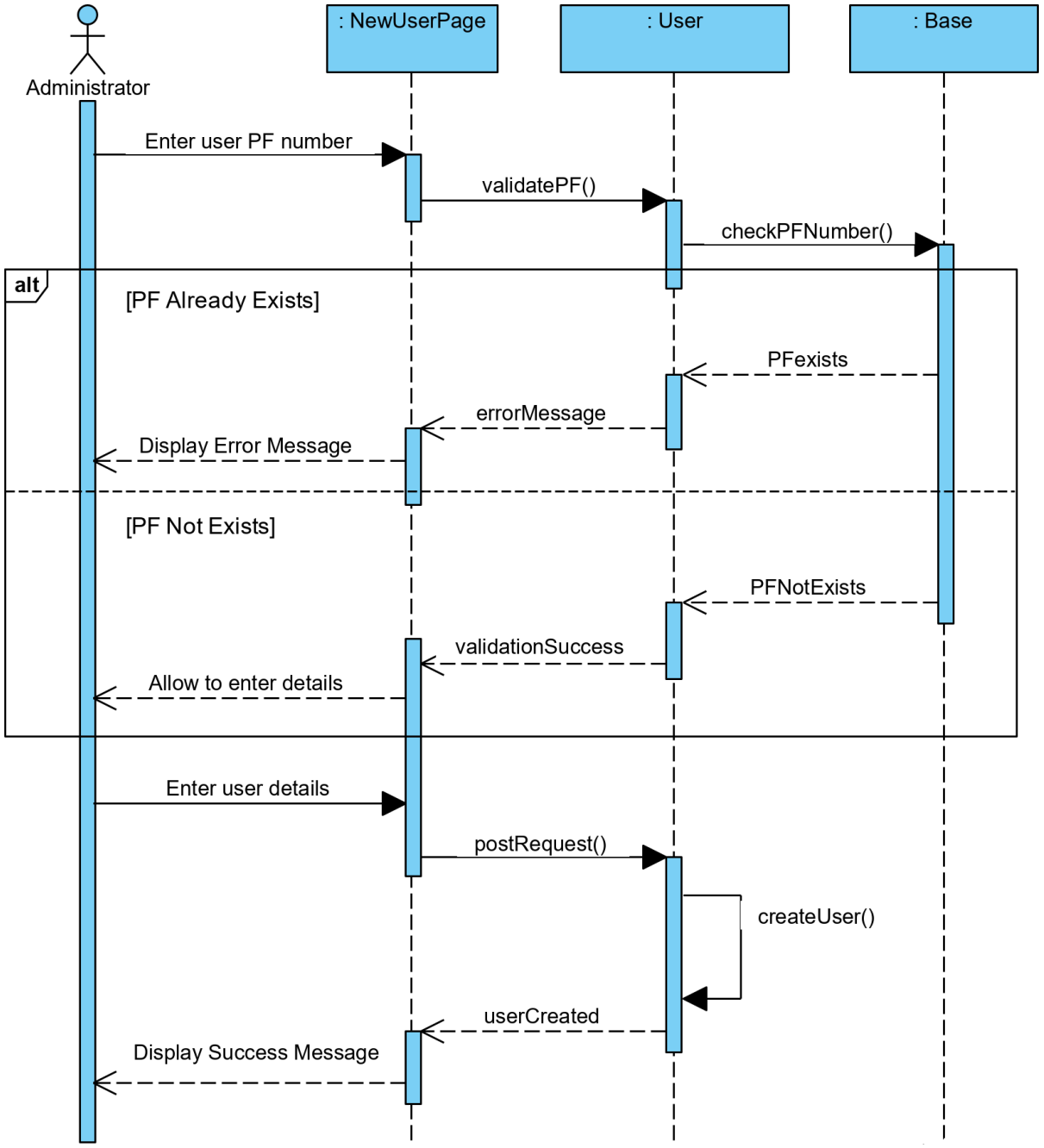

Figure 11 - Sequence diagram for create new user profile

- Sequence diagram for create new purchase transaction

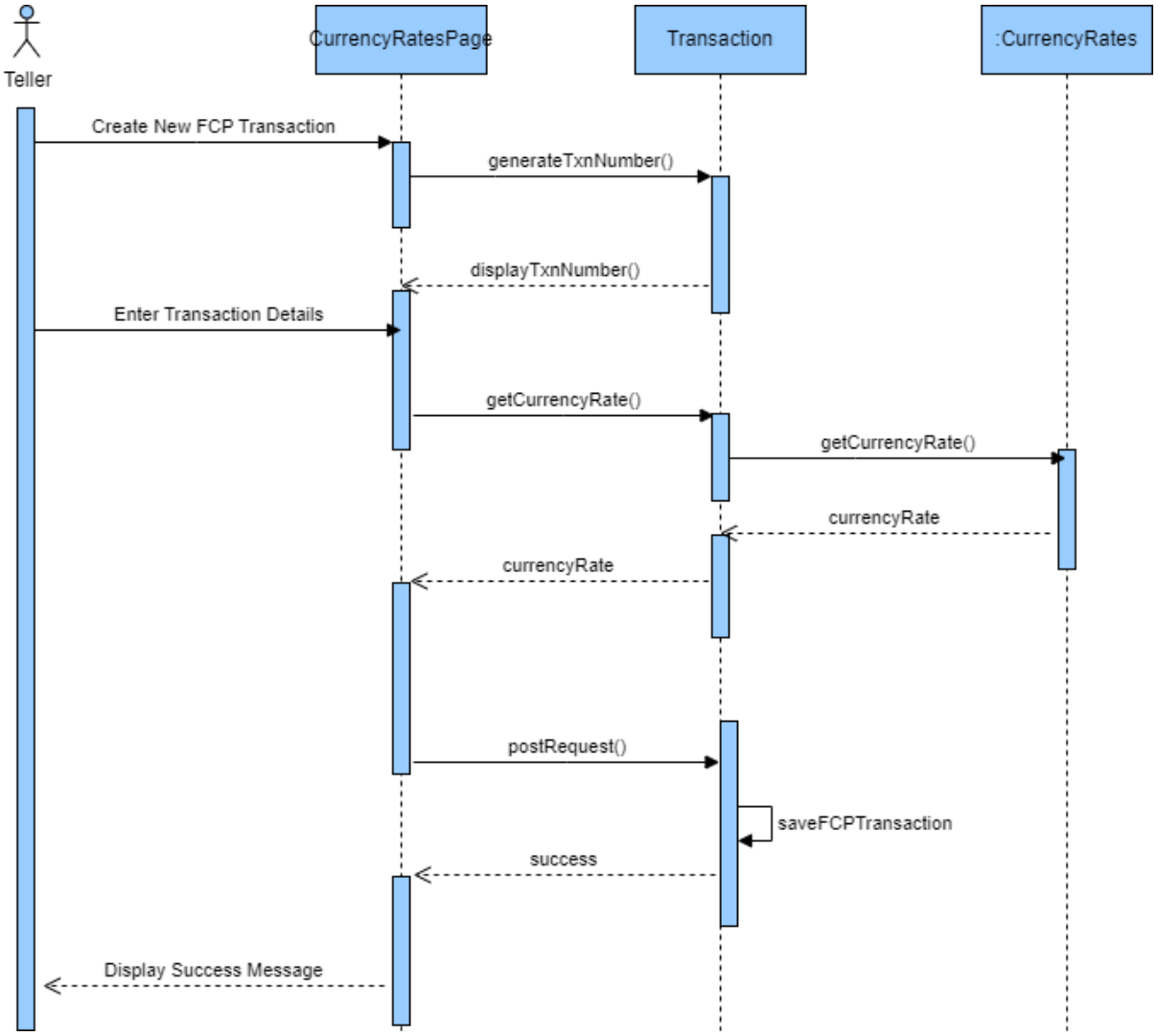

Figure 12 - Sequence diagram for create new purchase transaction

- Sequence diagram for create cash transfer

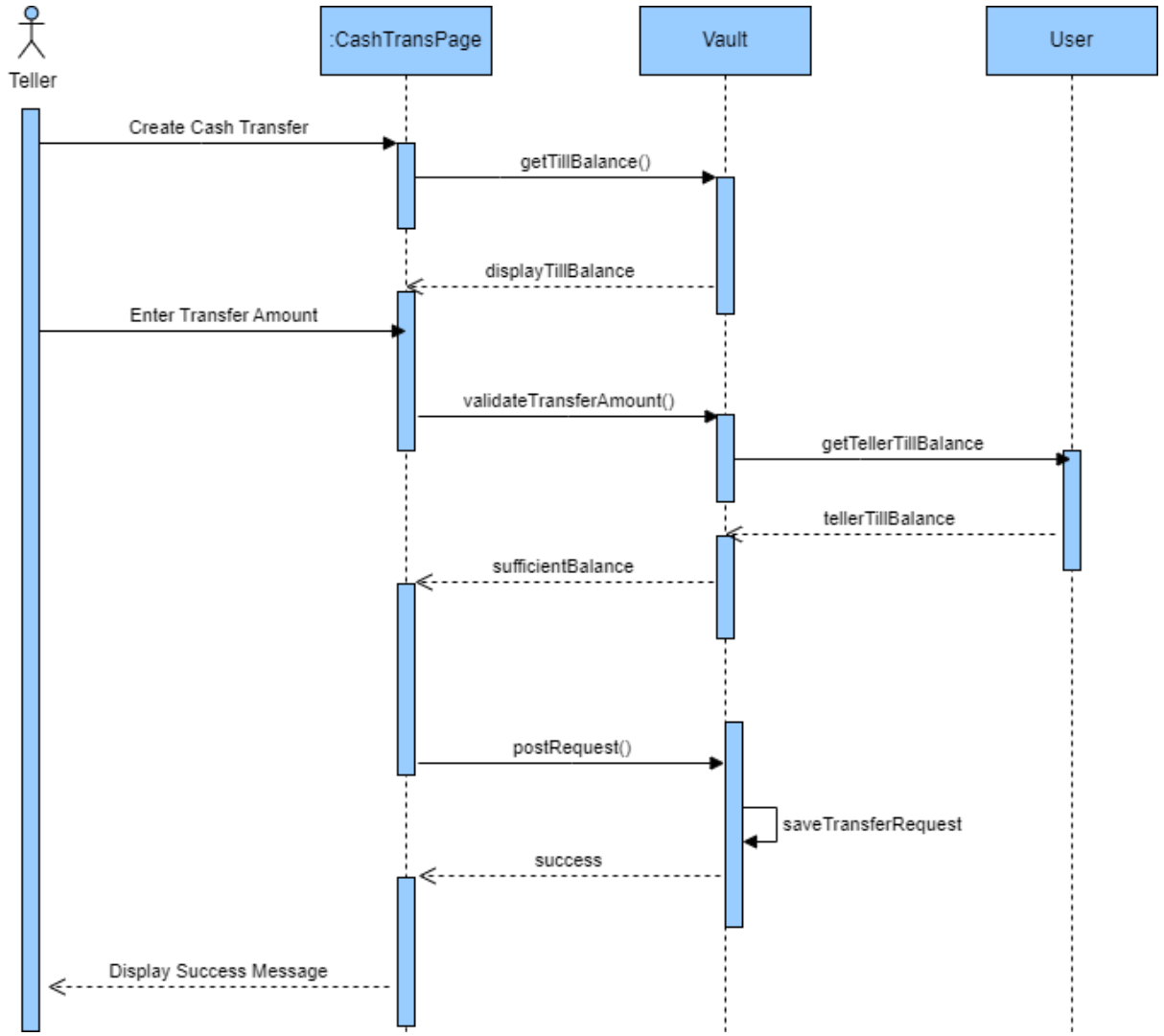

Figure 13- Sequence diagram for create cash transfer

3.3.4 Class Diagram

Class diagram for the developed web application;

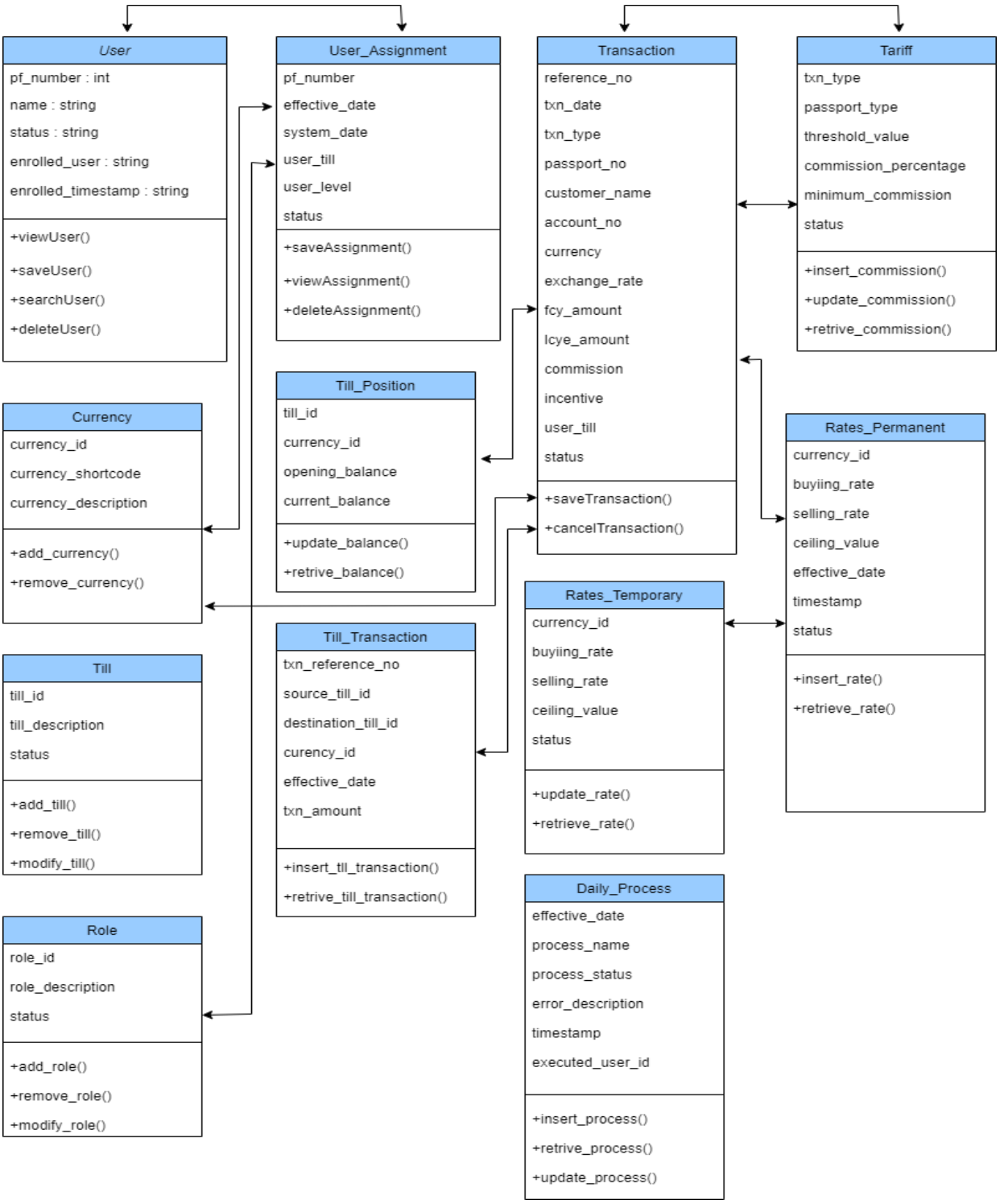

Figure 14 -Class diagram of the web application

Chapter 4 - Implementation Details

In order to automate the Currency Exchange Process at the Bank of Ceylon Pay Office, many frameworks, different technologies and third-party components have been used to enhance theuser friendliness and the comprehension of the system. This section explains the functionalities and implementation details of the main technologies and components used in the system.

Sublime text editor was used for the development of the PHP based web application and PhpMyAdmin was used for the design, creation and the maintenance of the MySQLdatabase.

4.1 Architecture of Implementation

Model-View-Controller (MVC) architecture was implemented with the use of CodeIgniter PHP based framework for frontend and RESTful web services written in Java to develop the backend.

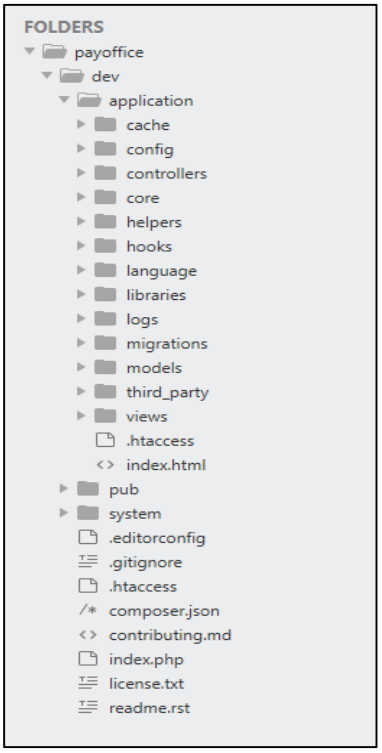

Figure 15 - Front End web application structure

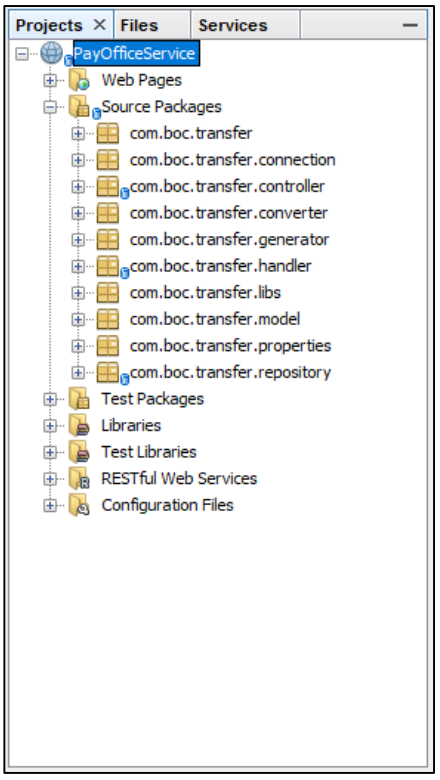

Figure 16 - Back End web services structure

Front End is developed using CodeIgniter framework which based on the Model-View-Controller development pattern and it is a fully PHP based application development used to develop dynamic web applications. Its objective is to enable the developer to develop the project faster without writing the code from the scratch. CodeIgniter provides a set of libraries for most of the commonly used tasks like accessing the database and handling user sessions. CodeIgniter framework offers enhanced security features that are required to represent the overall reliability of the developed web application.

Below figure illustrates the architecture of CodeIgniter framework (Codeignitor)

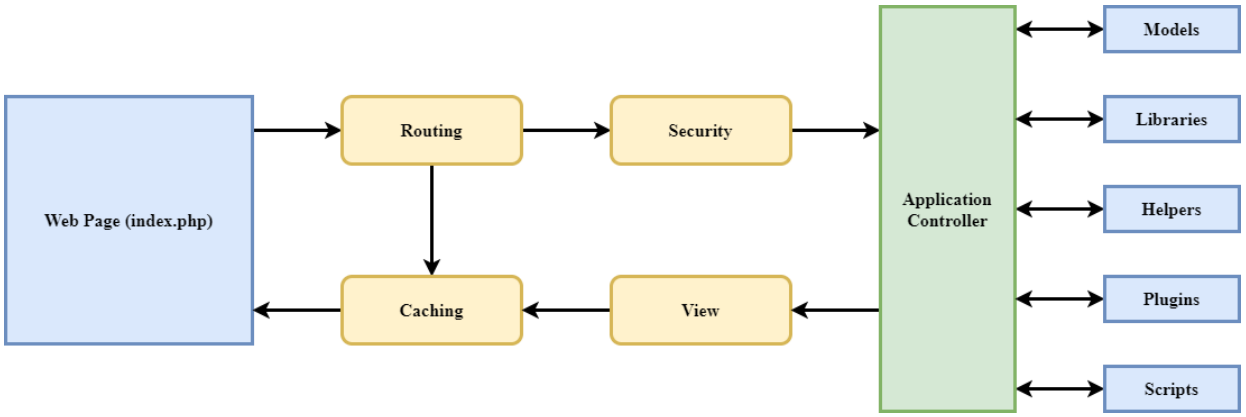

Figure 17 -CodeIgniter Architecture

Web application directory includes all the code of the developed web application including all the PHP files related to MVC architecture. Application folder includes few other folders which are described below.

- Cache

  This folder contains all the cached pages which was used to enhance the overall speed of accessing the pages through the application.

- Config

  This folder contains all the configuration files used in the application. This folder includesall the important configuration files like config.php which includes the main configuration parameters. Using the database.php file application was connected to the MySQL databaseand routes.php file which includes all the routing rules used in the application.

- Controllers

  One of the main directories in the MVC architecture which includes all the controllers ofthe application.
- Core

  This folder includes the base classes of the application.
- Helpers

  This folder includes all the helper classes of the application
- Hooks

  This folder includes the files which are used to modify the default files and methods usedby the CodeIgniter framework.
- Language

  This folder includes the files related to language.
- Libraries

  This folder includes the files of the libraries developed for the application.
- Logs

  This folder includes the files related to the log of the system.
- Models

  This folder includes the model classes designed to work with the data in the MySQLdatabase.
- Third_party

  This folder includes all the third-party plugins used in the application.Views

  This folder includes all the HTML files which used to display the pages.

System folder contains all the CodeIgniter core files which includes codes, libraries, helpers and other related system files. These libraries and helpers will be loaded in the application andwill be used without implementing it from the scratch.

Public folder contains all the CSS files, template images and the JavaScript files used for the application. Since the application has used bootstrap toolkit, all the required CSS files and JavaScript files were located in this file with the developed custom files which will be requiredfor the additional features and styles.

Java is used for the back-end development which includes inbuilt libraries and

resources that helps to create a web application with high-end functionalities and additionalfeatures. MVC architecture is used to structure the server-side code with the generated JSON as a 'view'. There are three layers of the sever side code which is to represent the MVC model. (MVCArchitecture)

- Controller
  client sends REST keyword request to server and then the server matches the requested URL to the controller action
- Handler
  Handles all the validations of the client sent requests and call the models to process the requests.
- Repository
  Model(s) for data gathering and processing. After data has been retrieved or client sent data has been processed in database it gets the result and returns back to the client in JSON.

The directory for the Back End Web service comprises the following components:

- Source Package - This directory serves as a container for the fundamental Java source code files, systematically organized within a package structure
- Libraries - Housed within the libraries folder, this section is designated for storing third-party libraries or dependencies utilized by the web service. These external libraries enhance the functionality of the service by providing additional features or capabilities. Typically, they are incorporated into the project as JAR files and managed within this directory.
- Restful Web Services - This segment encompasses sub-directories or classes that are specifically dedicated to managing HTTP methods within the RESTful web services. These classes or packages bear the responsibility of implementing HTTP methods, such as POST, which are supported by the RESTful endpoints.

The figure 18 shows a code snippet of POST web service request.

```java
@Path("usr")
public class UserController {

    Logger logger = Logger.getLogger(UserController.class.getName());


    @POST
    @Path("getSystemDate/")
    @Produces(MediaType.APPLICATION_JSON)
    @Consumes(MediaType.APPLICATION_JSON)
    public String getSystemDate(@HeaderParam("apiKey") String key) {
        logger.debug("getSystemDate");
        ApiAuthontication authontication = new ApiAuthontication();
        JSONObject jSONObject = new JSONObject();
        String systemDate = "";
        try {
            if (!authontication.isUserAuthenticated(key)) {
                jSONObject.put("errorStatus", true);
                jSONObject.put("errorMessage", "User not authenticated");
                return jSONObject.toString();
            } else {
                UserHandler handler = new UserHandler();
                systemDate = handler.getSystemDate();
            }
        } catch (Exception ex) {
            logger.warn("Error in getSystemDate", ex);
        }
        return systemDate;
    }
```

Figure 18 - POST request to Web service

4.2 Look and Feel of the web application

In order to maintain the look and feel of the web pages throughout the web application, custom build template has been used for the application without using a freely available web template.Login page used in the application is shown below.

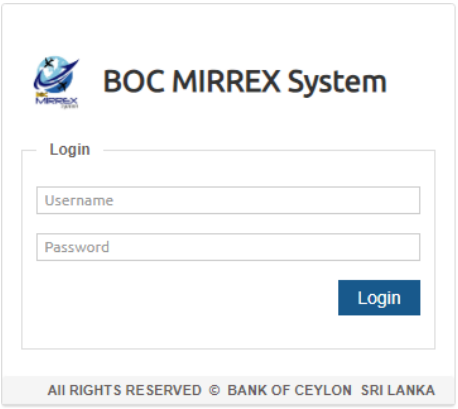

Figure 19 - Interface – Login Page

4.2.1 Success Message Model

Every success message displayed in the application includes a unique message for the easy reference of the users. Sample of the success messages displayed in the application is shown below.

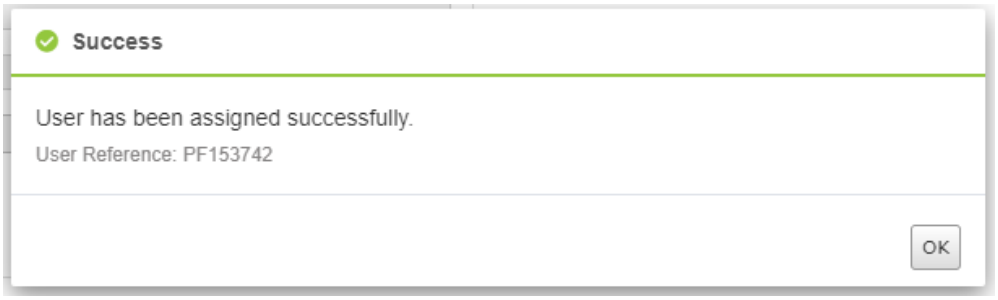

Figure 20 -Sample Success Message

4.2.2 Error Message Model

Every error message displayed in the application includes a unique error id for the easy reference of the users. Sample of the error messages displayed in the application is shown below.

Figure 21- Sample Error Message

4.2.3 Security Controls

In order to prevent unauthorized access and other security threats to the developed currency exchange system, it was essential to use security controls for the development of web-based application.

- Password Hashing

  For security reasons, it was required to store passwords in hashed format without storing itas plain text in the database. It was decided to use password_hash()

function available in the PHP without using the MD5 or SHA hashing methods which uses a weak algorithm and non-salted hashes are vulnerable to the rainbow tables and dictionary attacks. The hashresult generated from the password_hash() is more secure due to the strong hashing algorithmand also it will add a random salt to prevent rainbow tables and dictionary attacks.

- Audit Logs

  User login handle though the developed web application will be logged inthe application for the auditing purposes. As per the standard audit requirement of the Bank, below mentioned details will be captured for the user login action performed in the application.

  - User Name
  - Host Name
  - IP Address
  - Browser Name
  - Browser Version
  - Login date and time
  - Logout date and time

Chapter 5 – Testing and Evaluation

5.1 Introduction

Testing is a process used to assure the quality of the developed application and the functionality meets the customers' requirement. Also testing will be used to validate the application for the issues which will affect the performance and quality of the developed application. This chapter includes the complete testing plan for the developed web application in detail and the evaluation on the system with the confirmation on whether the project objectives were satisfied by the development.

5.2 System Testing

For the development and implementation of high-quality software application it is important have a proper testing plan in order to identify the issues and fix it before implementing the application in production environment. It was decided to do the unit testing during the development phase where all the major components have been separated from the other components and have tested for the inputs and outputs individually.

During the testing phase of waterfall model, it was decided to use the integration testing which allows to combine individual components and test it as a group. Main objective of the integration testing was to test the interfaces between the units and modules after combining it together.

Therefore, as per the test plan all the individual components and modules will be tested initially and once unit testing was completed integration testing will be started where it will be tested by integrating one by one together until all the modules are integrated.

5.2.1 Test Cases

Test cases used for testing of the developed Currency Exchange System are shown below.

1. Test Cases for Login Page

ID	Activity	Test Case Steps	Expected Result
1.1	User Log in to the system	Go to Pay Office system Log in page	Log in page should appear with User name field, Password field and Log in button
1.2	Validate login function with invalid data	Click on Login button without giving any data	Warning message should display and 'Back to login page' button will appear
		Enter only User name and click on Login button	Warning message should display and 'Back to login page' button will appear
		Enter only password and click on Login button	Warning message should display and 'Back to login page' button will appear
		Enter invalid user name or password and click on Login button	Warning message should display and 'Back to login page' button will appear
1.3	Log in to the system with manager credentials	Enter manager username, password and click on Login button	Manager's Dashboard should appear with User Management, Transactions, Vault Management, Currency rate management and Day End operations functions
1.4	Log in to the system with teller credentials	Enter teller username, password and click on Login button	Teller's Dashboard should appear with Transactions, Vault Management, Currency Rates

			Management and Day end operations functions
1.5	Log in to the system when user is not assigned to any role	Enter teller/manager username, password and click on Login button	'The signed in user is not assigned to a role for the application' message should appear
1.6	Validate 'Back to login page' button	Enter invalid data in login page and click on 'Login' button	Warning message should display and 'Back to login page' button will appear
		Click on Back to login page	System will redirect to login page and entered data will clear

Table 7 - Test cases for login

2. Test Cases for User Management Module

ID	Activity	Test Case Steps	Expected Result
2.1	Create user in the system successfully	Select 'Create User' option from User Management panel	User should be directed to Create New User form
		Select/Type User PF Number from the selection dropdown	The correct User Name should be loaded in the text field
		Press Save button	User should be successfully created in the system

2.2	Try to create a user who is already registered in the system	Select 'Create User' option from User Management panel	User should be directed to Create New User form
		Select/Type an already registered User PF Number from the selection dropdown	The correct User Name should be loaded in the text field
		Press Save Button	A warning should be displayed
2.3	Assign a user successfully	Select 'Assign User' option from User Management panel	User should be directed to Assign User form
		Fill the form and press Next button	Data fields should be disabled and Save button should be visible
		Select Save button	User should be assigned correctly
2.4	Field validation for Create User form	Try to proceed with invalid values for user name a. Empty b. Special characters/numeric/space	System should display a warning
2.5	Field validation for Assign User form	Try to proceed with invalid values a. Empty	System should display a warning
2.6	View System Users successfully	Select 'View System Users' option from User Management panel	View System Users page should be opened and system users should be displayed respectively
2.7	Delete a system user	Select 'Delete System Users' option from User Management panel	Delete System Users page should be opened and system users should be

			displayed respectively
		Delete a user using the recycle bin icon	Delete confirmation message should appear
		Press Confirm Delete button	User should be deleted successfully
2.8	View daily assignments successfully	Manager select the option from User Management panel	Assigned roles should be displayed accurately with the user details
2.9	Delete daily assignments successfully	Manager select the option from User Management panel	User should be able to delete the assigned roles as per requirement

Table 8 - Test cases for user management

5.2.2 Testing Status

Test ID	Description	Pass / Fail
1.1	User Log in to the system	Pass
1.2	Validate login function with invalid data	Pass
1.3	Log in to the system with manager credentials	Pass
1.4	Log in to the system with teller credentials	Pass
1.5	Log in to the system when user is not assigned to any role	Pass
1.6	Validate ‘Back to login page’ button	Pass
2.1	Create user in the system successfully	Pass
2.2	Try to create a user who is already registered in the system	Pass
2.3	Assign a user successfully	Pass
2.4	Field validation for Create User form	Pass
2.5	Field validation for Assign User form	Pass
2.6	View System Users successfully	Pass
2.7	Delete a system user successfully	Pass
2.8	View daily assignments successfully	Pass
2.9	Delete daily assignments successfully	Pass

Table 9 - Status of test cases

Detail test plan is mentioned in the Appendix C with all the other test cases and test results.

5.3 System Evaluation

In the software industry there are different types of methods and techniques available to evaluate the system. For the evaluation of the developed web-based system which facilitates the automation of the currency exchange process at the Bank of Ceylon Pay Office, was decided to process criteria-based assessment which is a quantitative assessment for the software system based on the terms like look and feel of the system and functionality. In order to collect the user feedback, questioner has been prepared and given to the users who have used the system for the testing purposes.

UAT environment was configured using a Virtual Server Machine in the Bank's network and shared the URL with the users who will access the system for the testing. Only the port 80 on the server was opened for the International division located at the 9th floor of the Bank of Ceylon head office building and few other business users were granted access through specific IP addresses. After allowing selected users from both IT and business teams to use the system for a time period of one week in order to get familiar with the system, evaluation form is given to 15 staff members.

Questioner was designed with multiple questions regarding the developed web application and allows users to provide rating for each question. Because of the numerical rating used for each question it will be easy to analyze data and evaluate the user rating. Questions are scaled from Strongly Disagree to Strongly Agree which are having five levels as 1 to 5.

Evaluation Form of BOC MIRREX System

Are you working in the Pay Office Counter at BIA ?	Yes	No

		Very dissatisfied	Not satisfied	Neutral	Satisfied	Very satisfied
		1	2	3	4	5
1	Attractiveness of the User Interface Design (Colors etc.)					
2	Smooth navigation through the web pages					
3	Error messages are meaningful and can be understood					
4	Learning the workflow of the system is easy					
5	Clarity of the main menu functions by it's name					
6	The system is more efficient than the manual process					
7	Usefulness of the real time reports generated by the system					
8	System is capable of providing the overall project status to stakeholders					
9	Speed and Response time of the system					
10	User Friendliness of the product					
11	Available functions in the system					
12	Quality of the content provided in the application					
13	Ability to perform intended tasks successfully					
14	Speed and Response time of the web application					
15	Use of terms throughout the system					
16	Security features provided with the login					
17	Controls used to prevent human errors while entering data					
18	Your information which will be visible for other users					
19	Visibility of the project details to the other stakeholders in the project					
20	Overall protection of your data available in the application					

Other Comments

Figure 22 - Sample Evaluation form

Sample evaluation form which was given to the users are shown in the figure 22 Printed copies of this evaluation form were given to the users who was involved in the testing process of the web application.

5.4 Analysis of the Results

	Look & Feel					Usefulness					Functionality					Security				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
User 01	4	4	5	4	5	4	4	5	4	5	4	4	4	5	5	5	5	4	5	4
User 02	5	5	5	5	5	4	4	4	5	5	4	4	5	5	5	5	5	5	4	5
User 03	4	5	5	4	4	5	5	5	4	4	5	4	4	4	5	5	4	4	5	4
User 04	4	5	5	4	4	5	5	5	5	5	5	4	4	5	4	5	4	5	4	4
User 05	4	4	5	4	5	5	5	5	4	5	5	5	4	4	3	5	5	4	5	4
User 06	5	4	5	4	4	5	5	5	5	4	5	4	5	4	4	5	4	4	5	5
User 07	4	5	5	4	5	5	4	5	5	4	5	5	5	5	5	5	5	4	4	5
User 08	5	5	5	4	5	4	5	5	4	5	5	5	5	5	5	5	5	4	5	4
User 09	5	4	5	4	4	5	5	5	5	4	5	4	5	4	5	5	4	4	5	5
User 10	5	5	5	5	4	5	5	5	5	4	5	4	4	4	5	4	4	5	5	4
User 11	4	5	5	4	4	5	5	5	4	5	5	4	4	4	5	5	4	4	5	5
User 12	5	5	5	4	5	4	4	5	4	5	4	4	4	5	5	5	5	4	5	4
User 13	4	4	5	5	5	4	4	4	5	5	4	5	5	5	5	5	4	5	4	5
User 14	5	4	5	4	4	5	5	5	4	4	5	4	4	4	5	5	4	4	5	4
User 15	5	4	5	5	4	5	5	5	5	4	5	4	4	4	4	5	5	4	4	5
	4.53	4.53	5.00	4.27	4.47	4.67	4.67	4.87	4.53	4.53	4.73	4.27	4.40	4.47	4.67	4.93	4.47	4.27	4.67	4.47
	4.56					4.65					4.51					4.56				

Table 10 - Evaluation results

After collecting the filed evaluation forms from the users, data grid has been prepared as shown with all the results given by each user for each question in order to analyze the data. The results were used to compute the mean score for the all-individual questions and individual categories as shown in the table 10.

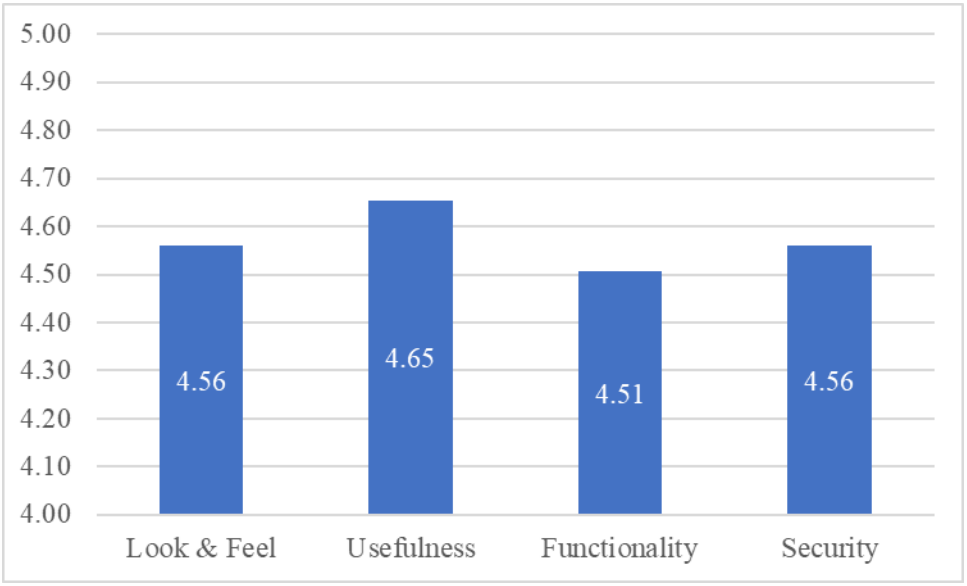

Figure 23- Graph for category wise rating

Graphical representation of the category wise mean value which was calculated based on the user evaluation are shown in the figure 23. Key highlights which were identified after analyzing the evaluation results are described below.

- Look and feel

  For the look and feel category, it has achieved 4.56 as the mean score where it gives an indication that users are satisfied with the colors used, layout of the web pages and design of the overall web application. The 3rd question which has received a rating of 5 from all the users highlights that the error messages are meaningful and clear confirming that the users are able to learn and understand the system easily

- Usefulness

  For the usefulness category it has received a rating of 4.65 as the mean score which was the highest among 4 categories. Therefore, it can be concluded that the system is useful and convenient for all the users who has involved in the UAT process.

- Functionality

  Since Functionality category has received a rating of a good 4.51 score it can be concluded that the system is able to perform the intended tasks successfully. The users are satisfied with the quality of content and the available functions of the system. It seems that the users are happy with the speed and response time of the system as well.

- Security

  As security wise, it has achieved a score of 4.56 which shows that the users are content with the security features of the system. It can be concluded that the overall protection of the data and information stored in the system is very well secured.

  Therefore, it can be concluded that the system has achieved the customer satisfaction by fulfilling the objectives of the development and system can be implemented in the production environment.

Chapter 6 – Conclusion

As stated in the first chapter, main objective of the developed project was to implement a web-based system which facilitates the automation of the currency exchange process at the Bank of Ceylon Pay Office. Therefore, when considering the successfulness of the system it mainly depends on two aspects:

1. Whether the developed solution is capable to replace the existing manual process and continue the process on a digital platform.
2. Whether the transformation of the existing process and users into the web-based system is handled successfully.

Based on the detailed analysis described in the previous chapter, it can be concluded that the developed solution was capable to replace the existing manual process since all the users who have been involved in the testing of the application has confirmed that the functionality of the developed application was sufficient to continue the existing process in digital platform.

When developing a software solution to automate a manual paper-based process to web-based system, the biggest difficulty is the transformation to the digital process because most of the users may not have the required technical knowledge to handle an online system. But the advantage of the developed web-based was that it will be mostly used by the staff members of the Pay Office counter who worked in a standalone system who are having technical skills and knowledge to work with an online system. Therefore, it can be concluded that the transformation can be successfully implemented once the system is deployed in the production environment.

Therefore, it can be determined that the development and implementation of the web-based system which facilitates the automation of the currency exchange process at the Bank of Ceylon Pay Office was successful and have achieved the objective within given tight time period.

6.1 Future Work

While the current application encompasses all the necessary functionalities, there are plans for future enhancements and the development of new features following the application's deployment in a live environment.

The application, in its present state, employs its unique authentication username and password system for user access. Recognizing the challenge users face in managing various credentials for different systems, a future enhancement involves connecting the application to the Bank's LDAP server. This integration would enable users to log in using their Active Directory (AD) credentials, streamlining the authentication process. Additionally, as part of this LDAP integration, a separate self-registration function will be implemented, allowing users to register with the system independently.

In the initial phase, both the application and the database will be hosted on a VM server in the production environment. Subsequently, the server will be replicated to a Disaster Recovery (DR) server. To ensure real-time data synchronization, a mechanism for data replication will be implemented to transfer data seamlessly from the live database to the DR database.

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Appendix A – MIS Reports

MIS Reports stands for the Management Information System reports which will be generated by the developed application automatically based on the criteria provided by the user. MIS reports will be critical for the smooth operation of the Bank since those reports will be referred by the senior management of the Bank in order to view the current status of the on-going projects. In this chapter it will demonstrate the MIS reports types and layouts used in the system with sample repots.

Administrative Reports

Administrative reports will include all the MIS reports regarding the user management and user actions handled through the system.

- List of System Users

This report was designed to get the system users list with the status. For an example if the management needs a report on list of users who are assigned to the pay office branch have to execute this report.

VIEW SYSTEM USERS — TRANSACTION DATE: 2023-11-27

Show 18 entries — Search:

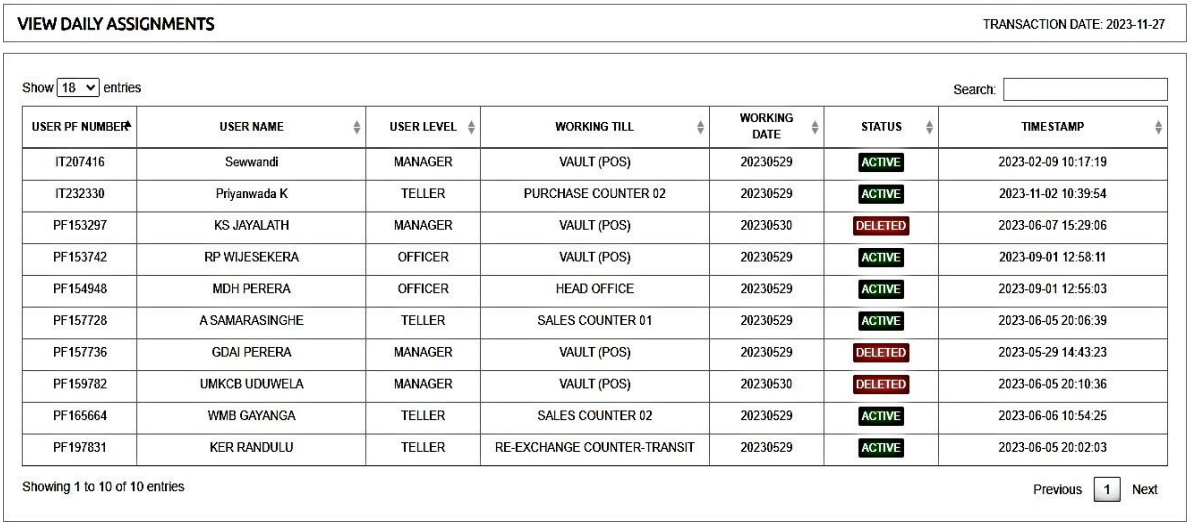
USER PF NUMBER	USER NAME	ENROLLED USER	ENROLLED DATE	STATUS
PF159849	WUD FERNANDO	PF159782	2023-01-24 09:30:41	ACTIVE
PF165664	WMB GAYANGA	PF157736	2023-01-19 09:20:31	ACTIVE
PF168288	AMAS ADHIKARI	IT207416	2023-08-22 10:57:48	ACTIVE
PF177536	GP AMBEGODA	PF159782	2023-01-24 08:33:39	ACTIVE
PF178021	WADCS WEERASINGHE	PF157736	2023-02-16 08:44:06	ACTIVE
PF196180	IS Audit	PF157736	2023-06-02 10:01:36	ACTIVE
PF197831	KER RANDULU	PF157736	2023-03-29 16:58:27	ACTIVE
PF200783	UBP PERERA	PF157736	2023-01-19 09:21:27	ACTIVE

Showing 19 to 26 of 26 entries — Previous 1 2 Next

Figure 24- List of System Users

- List of user assignments

This report was designed to get the list of daily assignments of users. Administrators will have to get a list of users who are assigned to a particular date. This user list can be generated at any time using this available report. Once user search the user status as “Active”, application will filter and show only the active daily assignments for the day.



VIEW DAILY ASSIGNMENTS — TRANSACTION DATE: 2023-11-27

Show 18 entries — Search:

USER PF NUMBER	USER NAME	USER LEVEL	WORKING TILL	WORKING DATE	STATUS	TIMESTAMP
IT207416	Sewwandi	MANAGER	VAULT (POS)	20230529	ACTIVE	2023-02-09 10:17:19
IT232330	Priyanwada K	TELLER	PURCHASE COUNTER 02	20230529	ACTIVE	2023-11-02 10:39:54
PF153297	KS JAYALATH	MANAGER	VAULT (POS)	20230530	DELETED	2023-06-07 15:29:06
PF153742	RP WIJESEKERA	OFFICER	VAULT (POS)	20230529	ACTIVE	2023-09-01 12:58:11
PF154948	MDH PERERA	OFFICER	HEAD OFFICE	20230529	ACTIVE	2023-09-01 12:55:03
PF157728	A SAMARASINGHE	TELLER	SALES COUNTER 01	20230529	ACTIVE	2023-06-05 20:06:39
PF157736	GDAI PERERA	MANAGER	VAULT (POS)	20230529	DELETED	2023-05-29 14:43:23
PF159782	UMKCB UDUWELA	MANAGER	VAULT (POS)	20230530	DELETED	2023-06-05 20:10:36
PF165664	WMB GAYANGA	TELLER	SALES COUNTER 02	20230529	ACTIVE	2023-06-06 10:54:25
PF197831	KER RANDULU	TELLER	RE-EXCHANGE COUNTER-TRANSIT	20230529	ACTIVE	2023-06-05 20:02:03

Showing 1 to 10 of 10 entries — Previous 1 Next

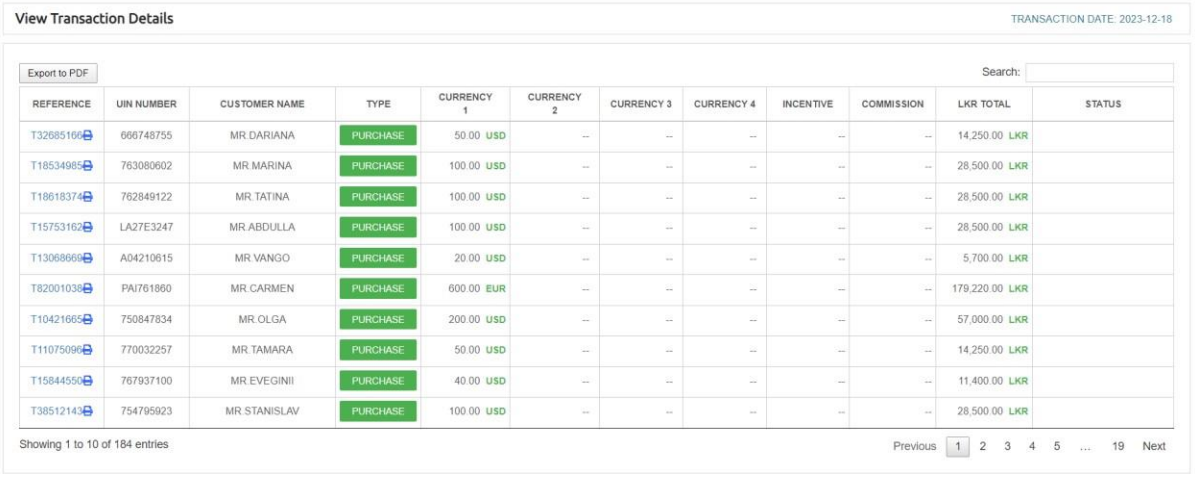
Figure 25 - List of User Assignments

Transaction Module

Transaction module consists of multiple reports which will highlight the overall and the teller wise transaction summaries of the transactions performed through pay office system. Most of the reports available in this module will be accessed by the tellers themselves and some of them are accessed by the Senior Management of the Bank.

- View Daily Transactions

Users will be able to generate a report of daily transactions performed by each user and a report of daily transactions performed by all users.



View Transaction Details — TRANSACTION DATE: 2023-12-18

Export to PDF — Search:

REFERENCE	UIN NUMBER	CUSTOMER NAME	TYPE	CURRENCY 1	CURRENCY 2	CURRENCY 3	CURRENCY 4	INCENTIVE	COMMISSION	LKR TOTAL	STATUS
T32685166	666748755	MR.DARIANA	PURCHASE	50.00 USD	--	--	--	--	--	14,250.00 LKR	
T18534985	763080602	MR.MARINA	PURCHASE	100.00 USD	--	--	--	--	--	28,500.00 LKR	
T18618374	762849122	MR.TATINA	PURCHASE	100.00 USD	--	--	--	--	--	28,500.00 LKR	
T15753162	LA27E3247	MR.ABDULLA	PURCHASE	100.00 USD	--	--	--	--	--	28,500.00 LKR	
T13068669	A04210615	MR.VANGO	PURCHASE	20.00 USD	--	--	--	--	--	5,700.00 LKR	
T82001038	PA1761860	MR.CARMEN	PURCHASE	600.00 EUR	--	--	--	--	--	179,220.00 LKR	
T10421665	750847834	MR.OLGA	PURCHASE	200.00 USD	--	--	--	--	--	57,000.00 LKR	
T11075096	770032257	MR.TAMARA	PURCHASE	50.00 USD	--	--	--	--	--	14,250.00 LKR	
T15844550	767937100	MR.EVEGINII	PURCHASE	40.00 USD	--	--	--	--	--	11,400.00 LKR	
T38512143	754795923	MR.STANISLAV	PURCHASE	100.00 USD	--	--	--	--	--	28,500.00 LKR	

Showing 1 to 10 of 184 entries — Previous 1 2 3 4 5 … 19 Next

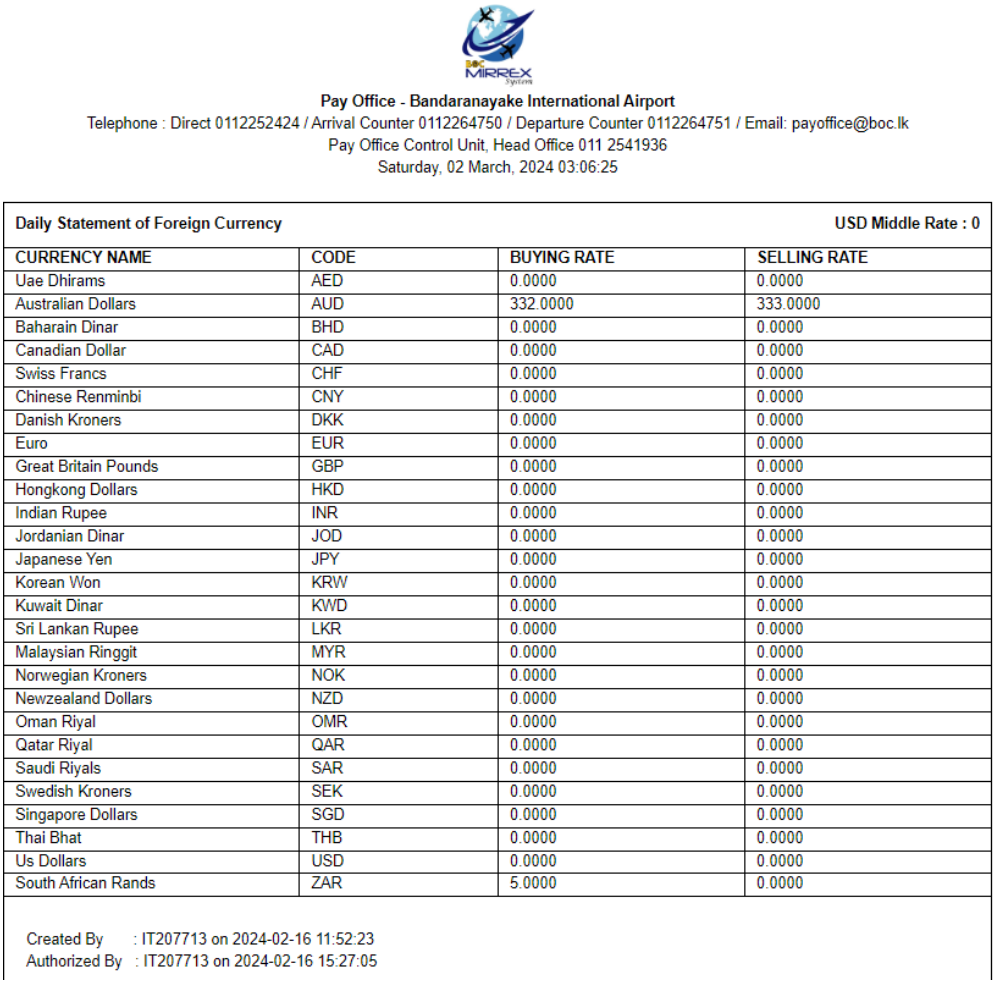
Figure 26 -Daily Transactions

7.1 Currency Rates Module Reports

Currency Rates module contains report to of multiple reports which will highlight the overall and the teller wise transaction summaries of the transactions performed through pay office system. Most of the reports available in this module will be accessed by the tellers themselves and some of them are accessed by the Senior Management of the Bank.

7.1.1 View Daily Rates

Users will be able to generate a report of daily transactions performed by each user and a report of daily transactions performed by all users.



Pay Office - Bandaranayake International Airport
Telephone : Direct 0112252424 / Arrival Counter 0112264750 / Departure Counter 0112264751 / Email: payoffice@boc.lk
Pay Office Control Unit, Head Office 011 2541936
Saturday, 02 March, 2024 03:06:25

Daily Statement of Foreign Currency — **USD Middle Rate : 0**

CURRENCY NAME	CODE	BUYING RATE	SELLING RATE
Uae Dhirams	AED	0.0000	0.0000
Australian Dollars	AUD	332.0000	333.0000
Baharain Dinar	BHD	0.0000	0.0000
Canadian Dollar	CAD	0.0000	0.0000
Swiss Francs	CHF	0.0000	0.0000
Chinese Renminbi	CNY	0.0000	0.0000
Danish Kroners	DKK	0.0000	0.0000
Euro	EUR	0.0000	0.0000
Great Britain Pounds	GBP	0.0000	0.0000
Hongkong Dollars	HKD	0.0000	0.0000
Indian Rupee	INR	0.0000	0.0000
Jordanian Dinar	JOD	0.0000	0.0000
Japanese Yen	JPY	0.0000	0.0000
Korean Won	KRW	0.0000	0.0000
Kuwait Dinar	KWD	0.0000	0.0000
Sri Lankan Rupee	LKR	0.0000	0.0000
Malaysian Ringgit	MYR	0.0000	0.0000
Norwegian Kroners	NOK	0.0000	0.0000
Newzealand Dollars	NZD	0.0000	0.0000
Oman Riyal	OMR	0.0000	0.0000
Qatar Riyal	QAR	0.0000	0.0000
Saudi Riyals	SAR	0.0000	0.0000
Swedish Kroners	SEK	0.0000	0.0000
Singapore Dollars	SGD	0.0000	0.0000
Thai Bhat	THB	0.0000	0.0000
Us Dollars	USD	0.0000	0.0000
South African Rands	ZAR	5.0000	0.0000

Created By : IT207713 on 2024-02-16 11:52:23
Authorized By : IT207713 on 2024-02-16 15:27:05

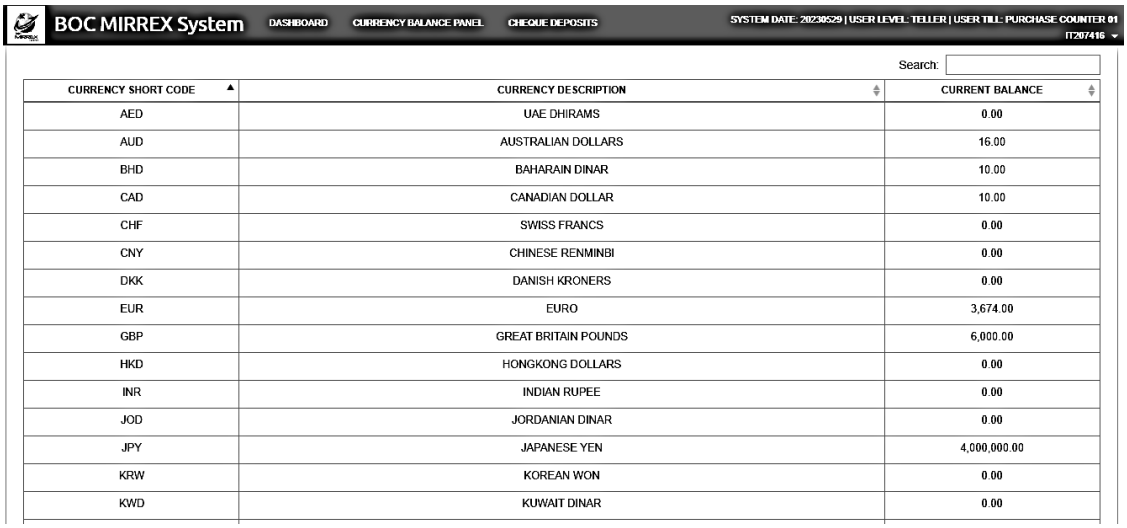
Figure 27 - Daily Currency Rates

7.2 Vault Management Module Reports

Vault management module consists of different reports which will display the cash distribution and overall cash balance of the pay office system.

7.2.1 View Vault/Till Balance

Users will be able to generate a cash balance report of the vault or any teller till at a given time

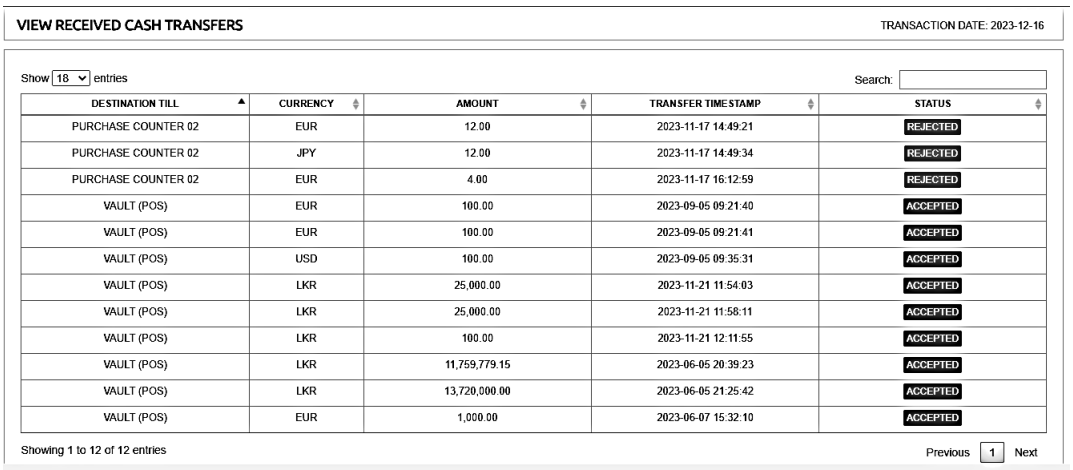


CURRENCY SHORT CODE	CURRENCY DESCRIPTION	CURRENT BALANCE
AED	UAE DHIRAMS	0.00
AUD	AUSTRALIAN DOLLARS	16.00
BHD	BAHARAIN DINAR	10.00
CAD	CANADIAN DOLLAR	10.00
CHF	SWISS FRANCS	0.00
CNY	CHINESE RENMINBI	0.00
DKK	DANISH KRONERS	0.00
EUR	EURO	3,674.00
GBP	GREAT BRITAIN POUNDS	6,000.00
HKD	HONGKONG DOLLARS	0.00
INR	INDIAN RUPEE	0.00
JOD	JORDANIAN DINAR	0.00
JPY	JAPANESE YEN	4,000,000.00
KRW	KOREAN WON	0.00
KWD	KUWAIT DINAR	0.00

Figure 28- View Vault Balance

7.2.2 View Received Cash Transfers

Users will be able to generate a report of daily transactions performed by each user and a report of daily transactions performed by all users.

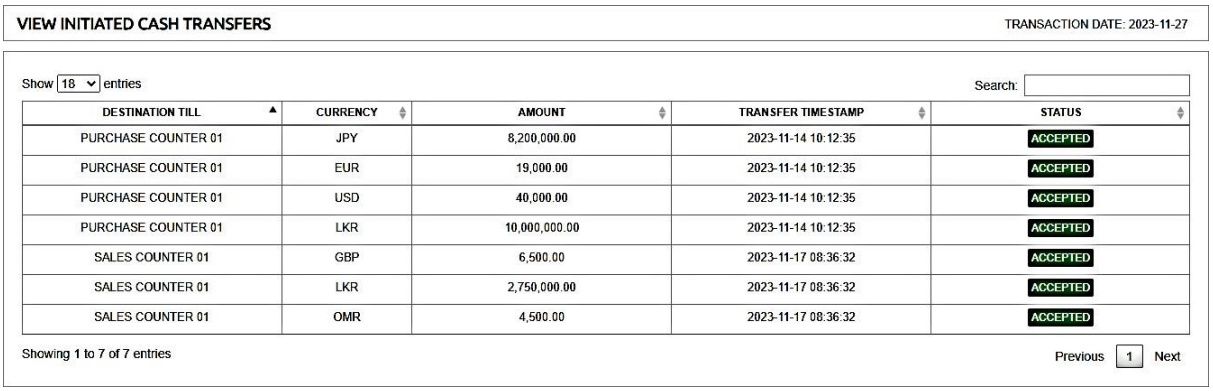


DESTINATION TILL	CURRENCY	AMOUNT	TRANSFER TIMESTAMP	STATUS
PURCHASE COUNTER 02	EUR	12.00	2023-11-17 14:49:21	REJECTED
PURCHASE COUNTER 02	JPY	12.00	2023-11-17 14:49:34	REJECTED
PURCHASE COUNTER 02	EUR	4.00	2023-11-17 16:12:59	REJECTED
VAULT (POS)	EUR	100.00	2023-09-05 09:21:40	ACCEPTED
VAULT (POS)	EUR	100.00	2023-09-05 09:21:41	ACCEPTED
VAULT (POS)	USD	100.00	2023-09-05 09:35:31	ACCEPTED
VAULT (POS)	LKR	25,000.00	2023-11-21 11:54:03	ACCEPTED
VAULT (POS)	LKR	25,000.00	2023-11-21 11:58:11	ACCEPTED
VAULT (POS)	LKR	100.00	2023-11-21 12:11:55	ACCEPTED
VAULT (POS)	LKR	11,759,779.15	2023-06-05 20:39:23	ACCEPTED
VAULT (POS)	LKR	13,720,000.00	2023-06-05 21:25:42	ACCEPTED
VAULT (POS)	EUR	1,000.00	2023-06-07 15:32:10	ACCEPTED

Figure 29 - View Received Cash Transfers

7.2.3 View Initiated Cash Transfers

Users will be able to generate a report of daily transactions performed by each user and a report of daily transactions performed by all users.



VIEW INITIATED CASH TRANSFERS — TRANSACTION DATE: 2023-11-27

Show 18 entries — Search:

DESTINATION TILL	CURRENCY	AMOUNT	TRANSFER TIMESTAMP	STATUS
PURCHASE COUNTER 01	JPY	8,200,000.00	2023-11-14 10:12:35	ACCEPTED
PURCHASE COUNTER 01	EUR	19,000.00	2023-11-14 10:12:35	ACCEPTED
PURCHASE COUNTER 01	USD	40,000.00	2023-11-14 10:12:35	ACCEPTED
PURCHASE COUNTER 01	LKR	10,000,000.00	2023-11-14 10:12:35	ACCEPTED
SALES COUNTER 01	GBP	6,500.00	2023-11-17 08:36:32	ACCEPTED
SALES COUNTER 01	LKR	2,750,000.00	2023-11-17 08:36:32	ACCEPTED
SALES COUNTER 01	OMR	4,500.00	2023-11-17 08:36:32	ACCEPTED

Showing 1 to 7 of 7 entries — Previous 1 Next

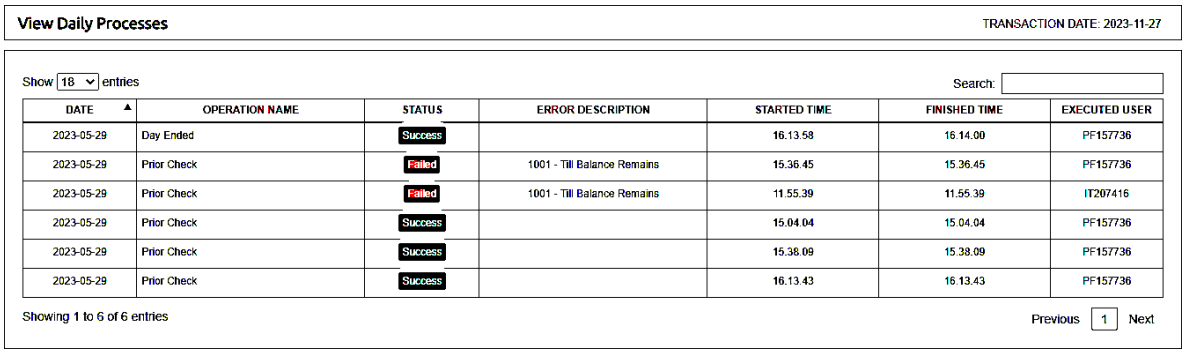
Figure 30 -View Initiated Cash Transfers

7.3 Operations Module Reports

Operations module consists of multiple reports which will highlight the overall and the teller wise transaction summaries of the transactions performed through pay office system. Most of the reports available in this module will be accessed by the tellers themselves and some of them are accessed by the Senior Management of the Bank.

7.3.1 View Daily Processes

Users will be able to generate a report of daily processes



View Daily Processes — TRANSACTION DATE: 2023-11-27

Show 18 entries — Search:

DATE	OPERATION NAME	STATUS	ERROR DESCRIPTION	STARTED TIME	FINISHED TIME	EXECUTED USER
2023-05-29	Day Ended	Success		16.13.58	16.14.00	PF157736
2023-05-29	Prior Check	Failed	1001 - Till Balance Remains	15.36.45	15.36.45	PF157736
2023-05-29	Prior Check	Failed	1001 - Till Balance Remains	11.55.39	11.55.39	IT207416
2023-05-29	Prior Check	Success		15.04.04	15.04.04	PF157736
2023-05-29	Prior Check	Success		15.38.09	15.38.09	PF157736
2023-05-29	Prior Check	Success		16.13.43	16.13.43	PF157736

Showing 1 to 6 of 6 entries — Previous 1 Next

Figure 31 - View Daily Processes

Appendix B – Testing Plan

Additional test cases used for testing of the developed system are shown below.

- Test Cases for Vault Management

ID	Activity	Test Case Steps	Expected Result
4.1	Transfer Cash into Vault	Select Transfer Cash into Vault from Vault Management panel	TRANSFER CASH INTO VAULT page should be opened listing down the currencies and their available balances
		Enter the respective amount for each currency type to transfer to Vault	Manager should be able to type amounts in the textbox
		Click on Transfer Cash into Vault	A confirmation popup should appear
		Confirm the action and press OK	Success message should appear and user should be redirected to the Dashboard
		Check Till balance	Till should be updated accordingly by adding the transferred amounts to the existing balances
4.2	Create cash transfer with sufficient source till balance	Log in to the pay office system and click on 'Create Cash Transfers'	Transfer cash page should appear which includes Currency short code, currency name, Source, till balance, Transfer Amount with 'Back' button and 'Transfer cash' button
		Enter transfer amount that need to be transferred	Entered amounts should display

		Select Destination till from drop down list	Selected till should display
		Click on ‘Transfer Cash’ button	Confirm message should display
		Click on ‘Confirm’ button	
		Click ‘Ok’ in success message	
		Click on View initiated transaction on dashboard	
		Check the status in initiated cash transfer table and View Till balance	Status should change as ‘Accepted’ and Till balance should reduce by the respective amount
4.3	Create Cash Transfer with zero till balance	Log in to the pay office system and click on ‘Create Cash Transfers’	Transfer cash page should appear which includes Currency short code, currency name, Source, Till balance, Transfer Amount with ‘Back’ button and ‘Transfer cash’ button
		Enter transfer amount where source till balance is zero	Transfer amount should display
		Select Destination till from drop down list	Selected till should display
		Click on ‘Back’ button	Should direct to Dashboard
		Click on ‘Transfer Cash’ button Then click on ‘Confirm’ button	Error message should display
4.4	View Received Cash Transfers function	Log in to the pay office system and click on ‘View received cash transfers’	Initiated transactions should display in a table which include Destination Till,

			Currency, Amount, Transfer Time Stamp and status
		Check the status after teller accepting the cash transfer	Status should display as ‘Accepted’
		Check the status after teller reject the cash transfer	Status should display as ‘Rejected’
4.5	View Till Balance function	Log in to the pay office system and click on ‘View Till Balance’	Till Balance should display in a table which include Currency Short Code, Currency Description and Current Balance fields
4.6	Reject Cash Transfers	Log in to the pay office system and click on ‘Accept Cash Transfers’	Cash Transfers should display in a table which include From Till, Currency, Amount, Transfer User, Transfer Time, Accept, Reject columns and Back, Accept All, Reject All buttons
		Click on Check box in Rejected column in order to reject selected currency	Successfully rejected message should display
		Click on ‘Ok’ button in success message	rejected currency should remove from the table
4.7	Accept Cash Transfers	Log in to the pay office system and click on ‘Accept Cash Transfers’	Cash Transfers should display in a table which include From

			Till, Currency, Amount, Transfer User, Transfer Time, Accept, Reject columns and Back, Accept All, Reject All buttons
		Click on Check box in Accepted column in order to accept selected currency.	Successful message should display
		Click on View Till balance	Accepted Currency should display in Till balance
		Click on 'View Receive cash transfers'	Accepted currency should display

Table 11 - Test cases for vault management module

Test Cases for Currency Rates Management

ID	Activity	Test Case Steps	Expected Result
5.1	Upload Daily rates	Log in to the pay office system and click on 'Upload Daily Rates'	Upload Daily Currency Rates page should appear and it includes Currency Short Code, Buying Rate, Selling Rate, Ceiling Value and CBSL indicative rates to be update. And Daily Rates Statues should display. And also 'Upload Daily Rates button' is available to upload changes.
		Change the relevant rates and click on 'Upload Daily Rates' button	Fields can't edit and Confirm Upload button and Back button will appear
		Click on 'Back' button	Redirect to the Upload Daily currency rates page and fields will get editable

		Click on Confirm Upload button	Confirmation message should appear
		Enter comment and click on Confirm button	Success message should appear
		Click on Ok button in success message	Request should appear in manager to authorize the rates. Daily Rates Status and Daily Rates Remarks should change
		Test status after authorized by manager	Rates should change and Status should change as 'Authorized'
		Test status after rejected by manager	Rates should not change and Status should change as 'Rejected'
5.2	Authorize/Reject Daily Rates	Go to Authorize/Reject Daily Rates function in Currency Rates Management panel	Authorize/Reject Daily Rates page should appear
		Click Authorize Rates	Daily rates should be authorized and status should be updated as Authorized
		Click Reject Rates and enter a reason for rejection	Daily rates should be rejected and status should be updated as Rejected with reject reason
5.3	View Daily Rates	Log in to the pay office system and click on 'View Daily Rates'	View daily rates page should appear and it includes Currency Short Code, Buying Rate, Selling Rate, Ceiling Value,Daily Rates Status and with the remark if available 'Export to excel' and 'Export to PDF' buttons should appear
		Click on 'Export to Excel' button	Excel file should download and can be viewed
		Click on 'Export to PDF' button	PDF file should download and can be viewed
5.4	Print Daily Rates	Log in to the pay office system and click on 'Print Rates' under Currency Rates Management	Currency Name, Code, Buying Rate, And selling rate before manager authorization should appear in a print window

Table 12 -Test cases for currency rates management module

Test Cases for Transaction Module

ID	Activity	Test Case Steps	Expected Result
6.1	Go to transaction pages.	Click on ‘Currency Purchase’ under ‘Transaction’ module.	Directs to Foreign Currency Purchase panel
		Click on ‘Currency Sales’ under ‘Transaction’ module.	Directs to Foreign Currency Sales panel
		Click on ‘Currency Re-Exchange’ under ‘Transaction’ module.	Directs to Foreign Currency Re-Exchange panel
6.2	Capture customer details through passport scanning	Place the cursor in the OCR captcha field and swipe the passport (foreign/local)	Capture data to the relevant fields and cursor moves to the next focus field
6.3	Empty field validation	Try to proceed without entering values	Displays ‘Required’ warning under the mandatory fields.
6.4	Check the commission	Check commission for SL passport numbers and NIC numbers by giving converted amount <10 000, =10 000 and <10 000	<= 10 000 rate is 200 >10 000 rate is 2%
		Check commission for foreign passport numbers by giving converted amount <25 000, =25 000 and <25 000	<= 25 000 rate is 500 > 25 000 rate is 2%
		Check commission for business registration numbers and Obtain from CBSL	No commission calculated.
6.5	When there is not enough balance to perform the transaction	Try to do a sales transaction when there is no enough currency	Displays an error message.

6.6	Cancel a transaction	Click on Cancel Transactions icon	Displays the teller performed transactions.
		Select a reference number to cancel	Displays the transaction details of selected transaction
		Click on 'Cancel Transaction' button	Confirmation message displays.
		Give a reason and click 'Confirm' button	If the balance is sufficient Success message will display. If not error message will display "Balance is not sufficient to cancel the transaction"
		Go to daily report and check the status	Transaction status shows as 'Pending Cancel'.
		Approve the cancellation from manager and checked the status in teller daily report	Transaction status shows as 'Cancelled'.
		Check the Till balance	Transaction amounts should get reversed and update in the till balance.

Table 13 – Test cases for transaction module

Test Cases for Operations Module

ID	Activity	Test Case Steps	Expected Result
7.1	Check Prior Check Process	Manager should go to Prior Check Process function and press PRE-CHECK button	Prior Check process should be initiated and if tellers have transferred their respective till balances to vault successfully, it should give a success message and if not an error message
7.2	Check Day End Process	Go to Day End Process Details function and press DAY END button	If Prior Check Process is not successful give a warning message to complete the prior check process successfully. If Prior Check Process is successful Day end process should be initiated

			and should give a success or error message based on its status
		Check GL account posting	Respective accounts should reflect accurately
7.3	Check View Daily Processes	Go to View Daily Processes function	Day end and prior check process details should be displayed with executed time and user details
7.4	Check Day End Reports	Go to Day end Reports function and press GENERATE REPORTS button	Day end reports should be generated
7.5	Check Exception Reports	Go to Exception Reports function	Exception report should be generated for failed transactions due to a system failure

Table 14 -Test cases for operations module

Testing Status

Test ID	Description	Pass / Fail
4.1	Transfer Cash into Vault	Pass
4.2	Create cash transfer with sufficient source till balance	Pass
4.3	Create Cash Transfer with zero till balance	Pass
4.4	View Received Cash Transfers function	Pass
4.5	View Till Balance function	Pass
4.6	Reject Cash Transfers	Pass
4.7	Accept Cash Transfers	Pass
5.1	Upload Daily rates	Pass
5.2	Authorize/Reject Daily rates	Pass
5.3	View Daily rates	Pass
5.4	Print Daily rates	Pass
6.1	Go to transaction pages	Pass
6.2	Capture customer details through passport scanning	Pass
6.3	Empty field validation	Pass
6.4	Check the commission	Pass
6.5	When there is not enough balance to perform the transaction	Pass
6.6	Cancel a transaction	Pass
7.1	Check Prior Check Process	Pass
7.2	Check Day End Process	Pass
7.3	Check View Daily Processes	Pass
7.4	Check Day End Reports	Pass
7.5	Check Exception Reports	Pass

Table 15 -Status of Test cases

Appendix C – User Manual

User manual of the developed application for the main functionalities are described in this section including the screenshots and instructions on how to use the function.

Login

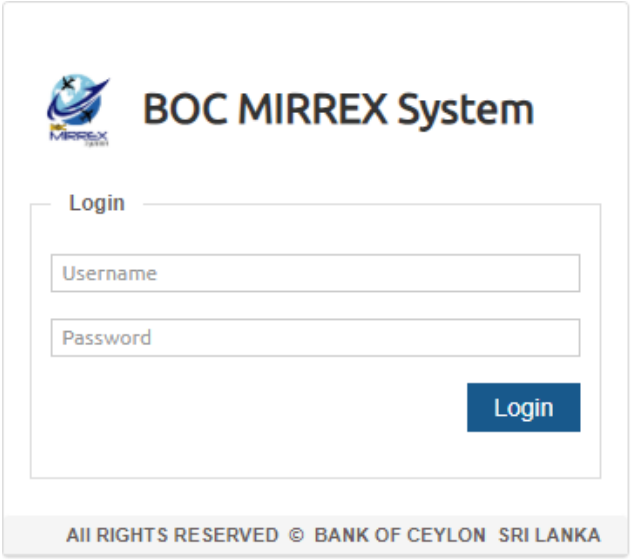


Figure 32- Initial login screen of the application

- Initial Login screen of the application shown in figure 32 and user needs to enter username and password in order to login to the web application.
- Upon the successful authentication, user will be redirected to the home page and error message will be displayed if the authentication fails.

User Management Module

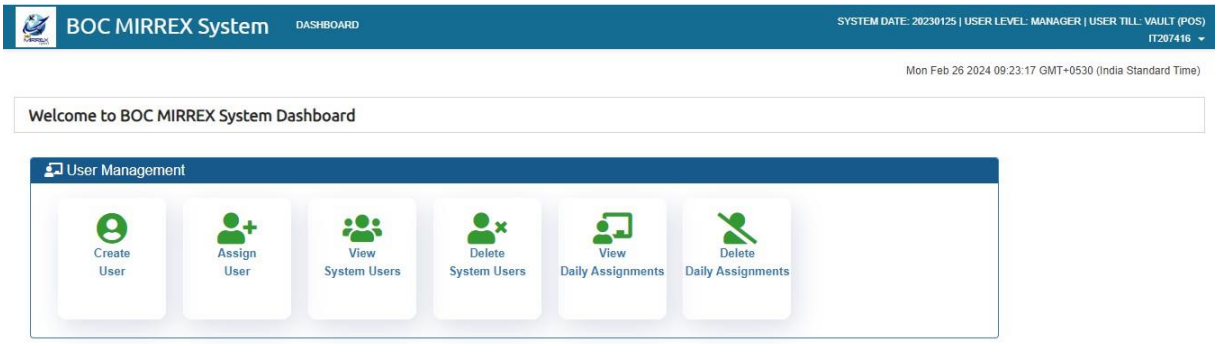


Figure 33 - User management module functions

- As shown in the figure 33, options available for user maintenance will display under the user management module.
- User Management functions will be available for the managers and admin users with the administrative privileges.
- Users are allowed to search by any column value through the search text box on top of the view user tables.

Create User

1. By clicking on the Create User button users will be allowed to add new users to the system.
2. After that have to select the user PF number from the provided drop-down list (search option available), and user name will be retrieved from database.
3. By clicking on the NEXT button input user data will be validated and SAVE Button will appear
4. By clicking on the SAVE button input user data will be saved in the system and successful message will be shown as in figure 34.

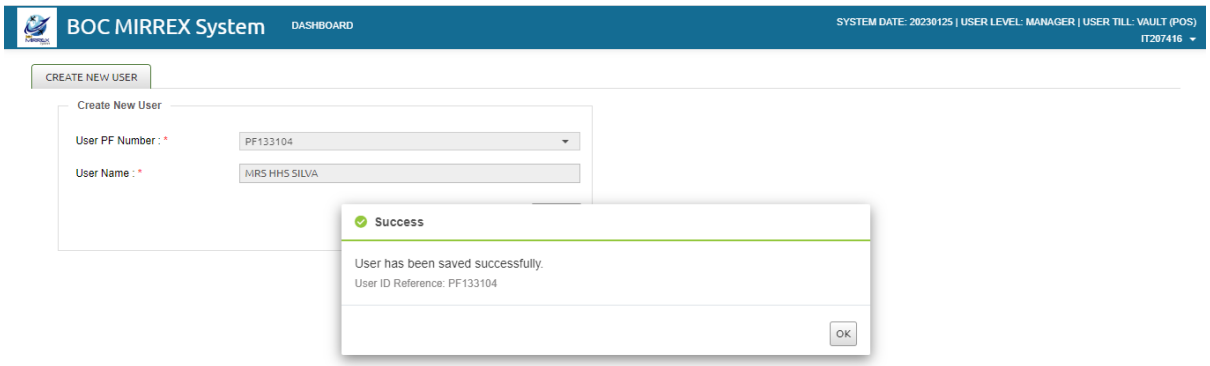


Figure 34 - Success message of new user creation

Assign User

1. By clicking on the Assign User button users will be allowed to assign users to the daily assignments in the system as shown as in figure 35.
2. Select the user PF number from the drop-down list and then select User Level and User till from respective drop-down lists.
3. Effective date to assign user has to be selected (this is set to the current date by default).
4. Next working day manager should be assigned by the current working manager. When assigning next day manager, the system allows changing the date for the assignment. (Only for the manager).

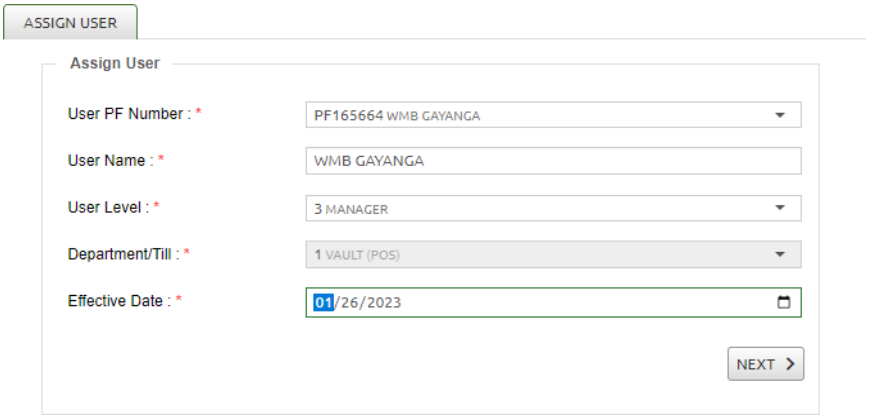


Figure 35 - Assign user screen

5. By clicking on the NEXT button input user data will be validated and SAVE Button will appear

6. As the last step, by clicking on the SAVE button input user assignment data will be saved in the system.

View System Users

1. First click on the" **View System User**" button

2. Then it will display all the users created in the system with their PF numbers, names, enrolled dates and enrolled user details in a table as shown in figure 36.

3. A search option is available to find the details of a specific user without any delay.

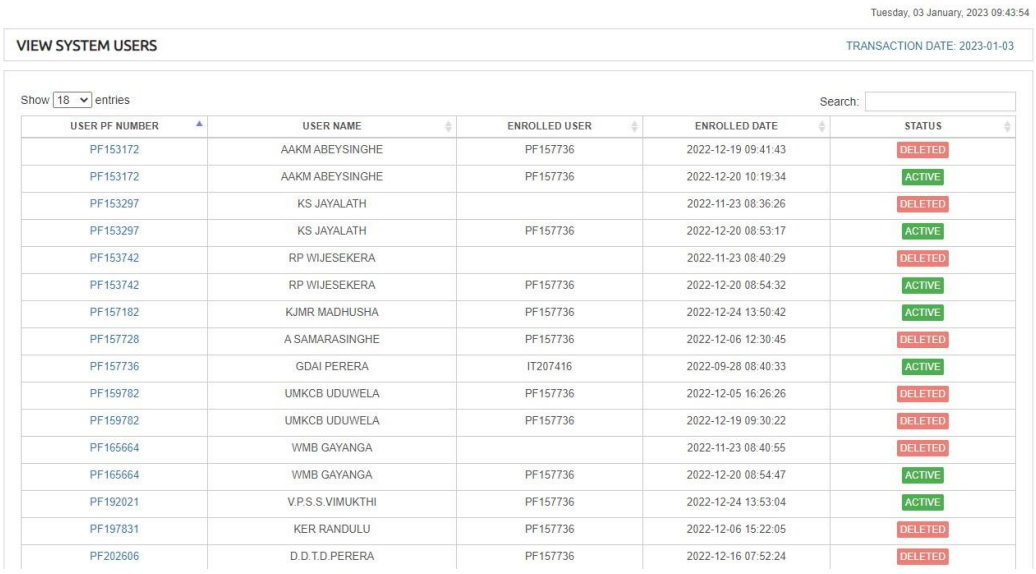


Figure 36 - View system users

Delete System Users

1. Click on the" **Delete System User**" icon

2. All the system users will be displayed in a table view as shown in figure 37.

3. Then you have to click on the respective delete icon of the user which needs to be deleted.

Figure 37 - Delete system users

View Daily Assignments

1. Click on the view "**Daily Assignment**" Icon
2. Then it will display all the assignments of the users with users' PF number, name, user level, working till, status and assigned date and time in a table as shown in figure 38.
3. You can search a specific assignment from this view and get a quick picture of the users' status.

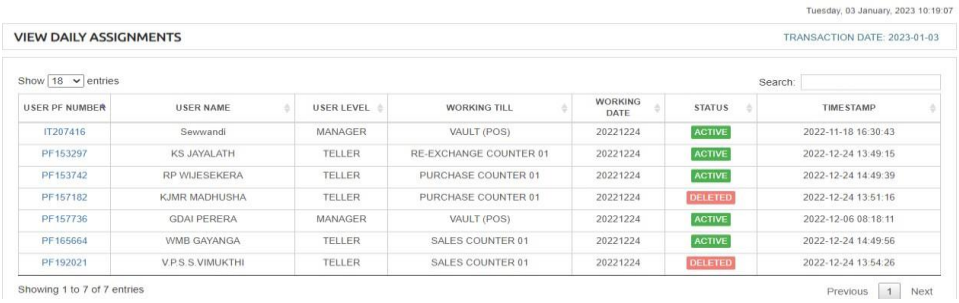


Figure 38 - Daily user assignments

Delete Daily Assignments

1. Click on the "**Delete Daily Assignment**" icon
2. Then all the user assignments will be displayed in a table view and you have to click on the respective delete icon of the assignment, which needs to be deleted.

Figure 39 - Delete user assignments

3. A confirmation screen will be displayed to confirm the deletion. Once confirmed, status of the user assignment will be changed as "DELETED" and will no longer be considered as a valid assignment. Further, deleted user assignment can be seen View Daily Assignment panel.

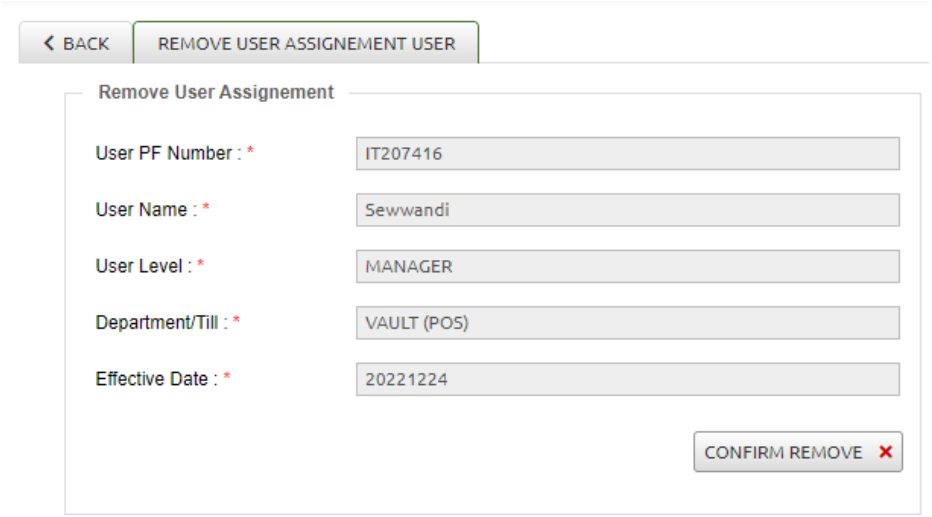
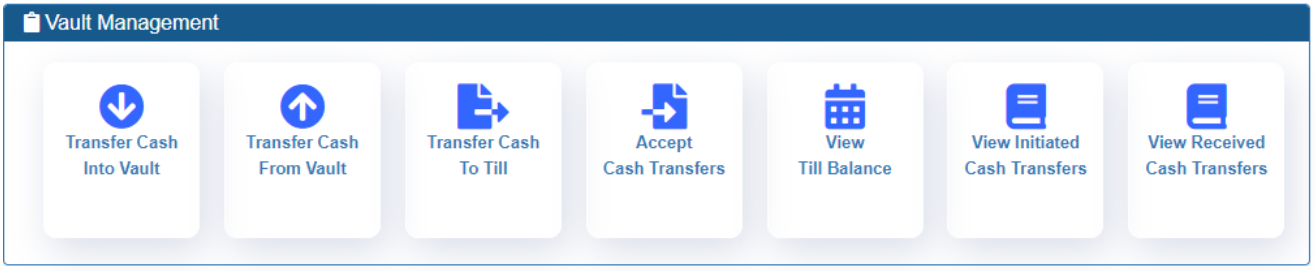


Figure 40 - Confirmation screen to delete user assignments

Vault Management Module



Transfer Cash to Vault

1. Click on the "**Transfer Cash into Vault**" icon

2. All the currencies available in the system will be listed with their respective balances in the vault as shown in figure 41.

CURRENCY SHORT CODE	CURRENCY NAME	CURRENT BALANCE	TRANSFER AMOUNT
AED	UAE DHIRAMS	870,470.00	0.00
AUD	AUSTRALIAN DOLLARS	944,415.00	0.00
BHD	BAHARAIN DINAR	1,000,050.50	0.00
CAD	CANADIAN DOLLAR	983,890.00	0.00
CHF	SWISS FRANCS	1,000,000.00	0.00
CNY	CHINESE RENMINBI	995,700.00	0.00
DKK	DANISH KRONERS	1,010,322.00	0.00
EUR	EURO	981,742.00	0.00
GBP	GREAT BRITAIN POUNDS	980,286.00	0.00
HKD	HONGKONG DOLLARS	1,003,200.00	0.00
JPY	JAPANESE YEN	1,190,000.00	0.00
KRW	KORIAN WON	1,000,000.00	0.00
KWD	KUWAIT DINAR	997,909.00	0.00
LKR	SRI LANKAN RUPEE	1,875,512,676.69	0.00

Figure 41 - Currency balances in vault

3. Enter transfer amounts for one or more currency types and click **TRANSFER CASH INTO VAULT** button.

4. Confirmation message will be popped up to confirm the action. Once confirmed, transfer amounts for each currency will be added to the current balance of the respective currency

Transfer Cash from Vault

1. Click on the "**Transfer Cash from Vault**" icon
2. All the currencies available in the system will be listed with their respective balances in the vault.
3. Enter transfer amounts for one or more currency types and click **TRANSFER CASH FROM VAULT** button.

4. Confirmation message will be popped up to confirm the action as shown in figure 42.

5. Type transfer remark and confirm, then transfer amounts for each currency will be added to the current balance of the respective currency.

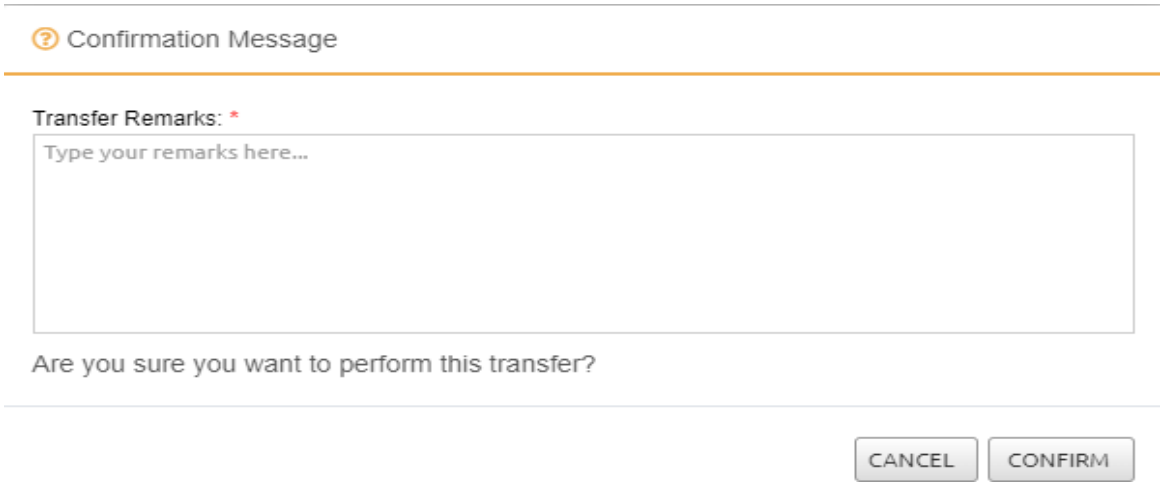


Figure 42 - Confirmation screen to transfer cash from vault

Transfer Cash to Till

1. First click on the "**Transfer Cash to till**" icon.
2. Then, all the currencies available in the system will be listed here with their respective balances in the vault.

CURRENCY SHORT CODE	CURRENCY NAME	SOURCE TILL BALANCE	TRANSFER AMOUNT
AED	UAE DHIRAMS	870,470.00	0.00
AUD	AUSTRALIAN DOLLARS	944,415.00	0.00
BHD	BAHARAIN DINAR	1,000,050.50	0.00
CAD	CANADIAN DOLLAR	983,890.00	0.00
CHF	SWISS FRANCS	1,000,000.00	0.00
CNY	CHINESE RENMINBI	995,700.00	0.00
DKK	DANISH KRONERS	1,010,322.00	0.00
EUR	EURO	981,742.00	0.00
GBP	GREAT BRITAIN POUNDS	980,286.00	0.00
HKD	HONGKONG DOLLARS	1,003,200.00	0.00
JPY	JAPANESE YEN	1,190,000.00	0.00
KRW	KORIAN WON	1,000,000.00	0.00
KWD	KUWAIT DINAR	997,909.00	0.00
LKR	SRI LANKAN RUPEE	1,875,512,676.69	0.00

Figure 43 - Transfer cash from vault to till

3. Select the destination till (which cannot be the same as the user's current working till) where the cash should be transferred to, and click **TRANSFER CASH** button.
4. Then a confirmation message will be popped up to confirm the action.
5. Finally, click on the confirm button to perform the action.
6. The system does not allow to do transfers if the till balance is not sufficient with transferring amount. The error message popup and the correct transfer amount have to enter again.

Accept Cash Transfers

1. First click on the "**Accept Cash transfer**" icon **Error! Reference source not found.**

2. Then click on the **ACCEPT** check box to accept the transfer or **REJECT** check box to reject the transfer on the provided table

3. If you accept the transfer, respective currency amount will be added to user's working till and be deducted from the sending teller's till. (In manager's view it shows as deducted from the vault).
4. In case, you reject the transfer, both sender's and receiver's working tills will remain same without any change. (The currency amount will not be added to your working till and will not be deducted from the sending teller's till).
5. After each acceptance or rejection, respective transfer entry will be removed from the list shown in **Accept Cash Transfer** table view.
6. A user can accept all the currencies at once rather than selecting currencies one by one.

View till Balance

1. First click on the "**View till Balance**" icon
2. Then you will be able to view balance of the till currently assigned to you. This view includes currency short code, currency description and current balance of each currency.

View Initiate Cash Transfer

1. First click on the "**View Initiate Cash Transfer**" icon **(Error! Reference source not found.**
2. Then you will be able to view Initiated Cash Transfer details including Destination till, currency, Amount, Transfer Time stamp and status.

View Received cash transfer

1. First click on the "**View Initiate Cash Transfer**" icon.
2. Then you will able to view received Cash transfer details in a table.

Create cash transfers

1. First you have to click on the "**Create Cash Transfer**" icon (can use this function to transfer currency amounts from your working till to another teller's working till)

2. Then you have to enter the amount to be transferred.

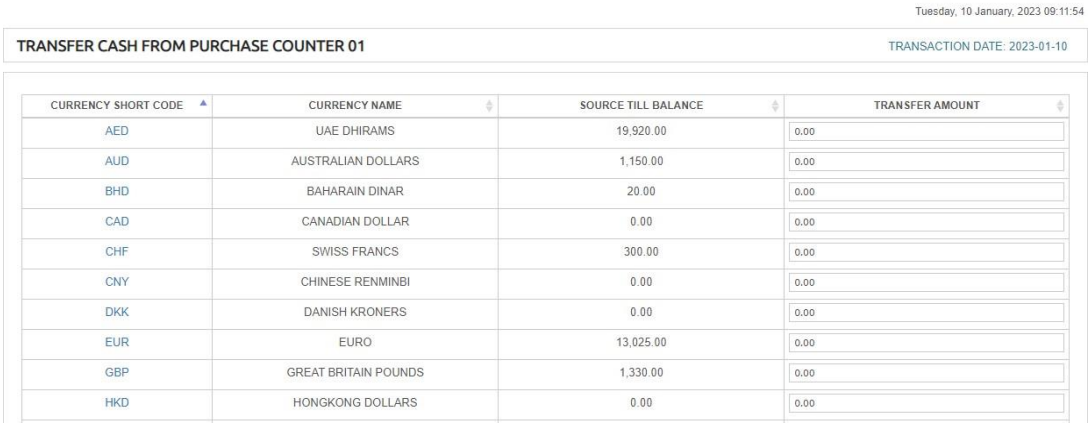


Figure 44 - Create Cash Transfers

3. After entering the transfer amounts for one or more currency types, you have to select the destination till (which cannot be the same as your own current working till) where the cash should be transferred to.

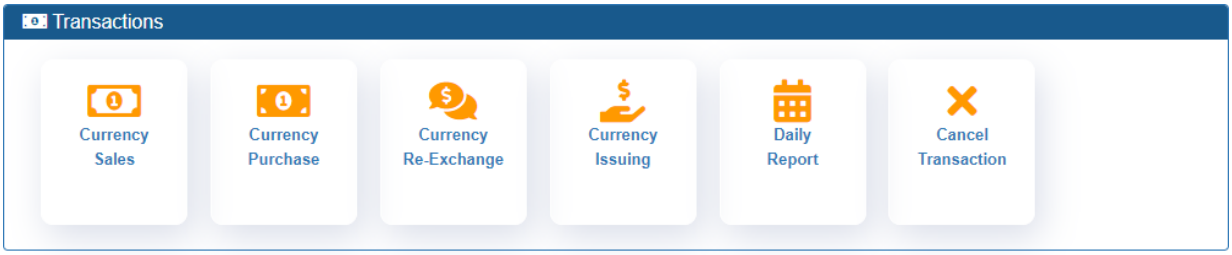
4. Then click on the **TRANSFER CASH** button.

5. A confirmation message will be popped up to confirm the action.

6. Then click on the "**Confirm**" button.

7. Once confirmed, transfer amounts for each currency will be added to the current balance of respective currency.

Transaction Module



Create Transaction

1. First you have to click on the "**Currency Sales**" icon
2. Then you have to swipe the passport (cursor should be placed in OCR Captcha field) and system will automatically fill out the following fields under the customer details section.

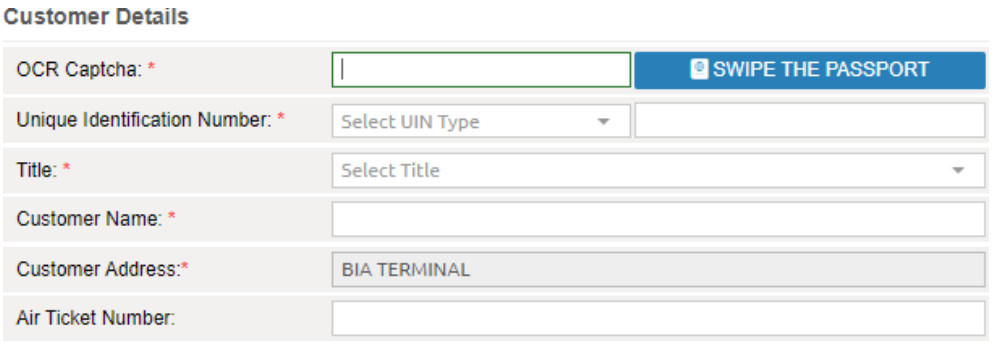


Figure 45 - Create Transaction screen – Customer details

3. Then you can change default values if required, from the provided drop-down lists.
4. All the fields under counter party/beneficiary details section are auto-filled with default values.
5. Then you can change those values if required, from the provided drop-down lists.
6. If the passport does not swipe correctly, user can enter the relevant passport details manually.
7. All the details related to the payments are captured in Payment details section and you can change required details.

8. Click on the “currency calculator” button. (Currency Calculator can be used when necessary to get the foreign currency amount for a fixed LKR amount).

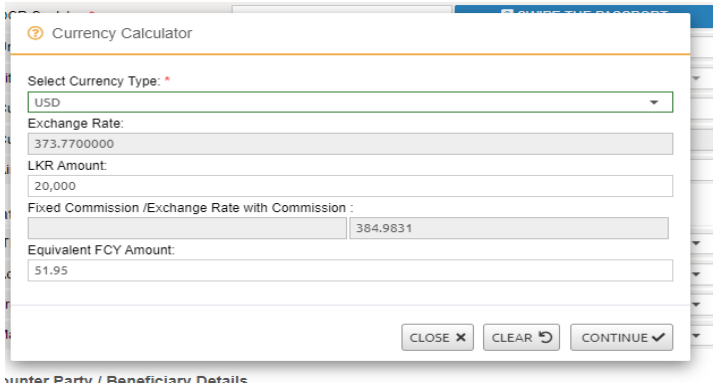


Figure 46 - Create Transaction screen – Currency Calculator

9. Select the currency type from the provided drop down menu under the Payment Details.
10. Currency rate will be retrieved from the database.
11. Enter the transaction amount and then the LKR amount and commission amount and Total LKR amount with commission will be calculated automatically.

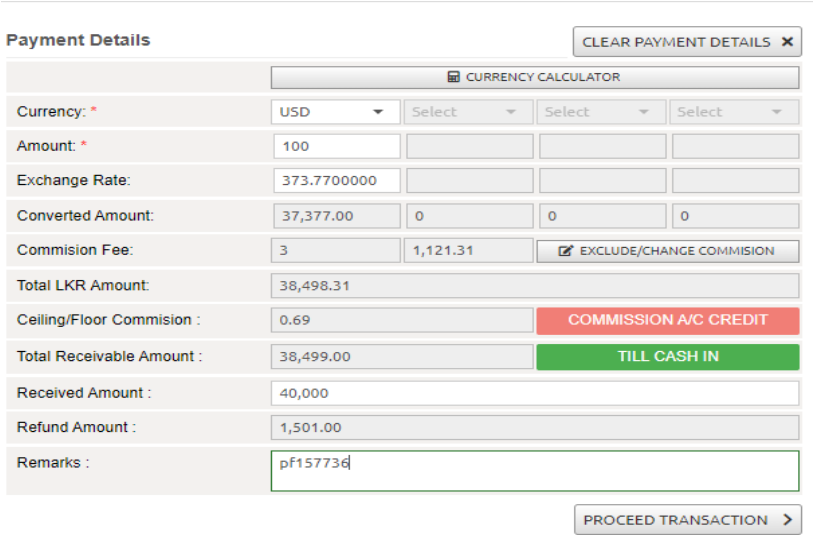


Figure 47 - Create Sales Transaction screen – Payment Details

12. To Change commission fee, click on the “**COMMISSION A/C CREDIT**” button.
13. Then you can select BOC Staff or Special forces using provided radio buttons.

Commission percentages are as follows

- ✓ BOC Staff - Zero Commission
- ✓ Special Forces - 1%
- ✓ Regular Customers - 3%

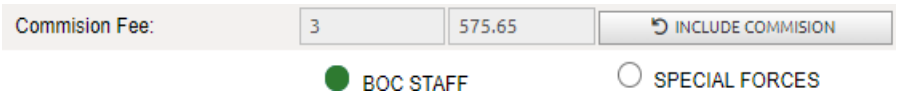


Figure 48 - Create Transaction screen – Change Commission

14. In Foreign currency purchase transaction, user can select up to four currency types in a single transaction

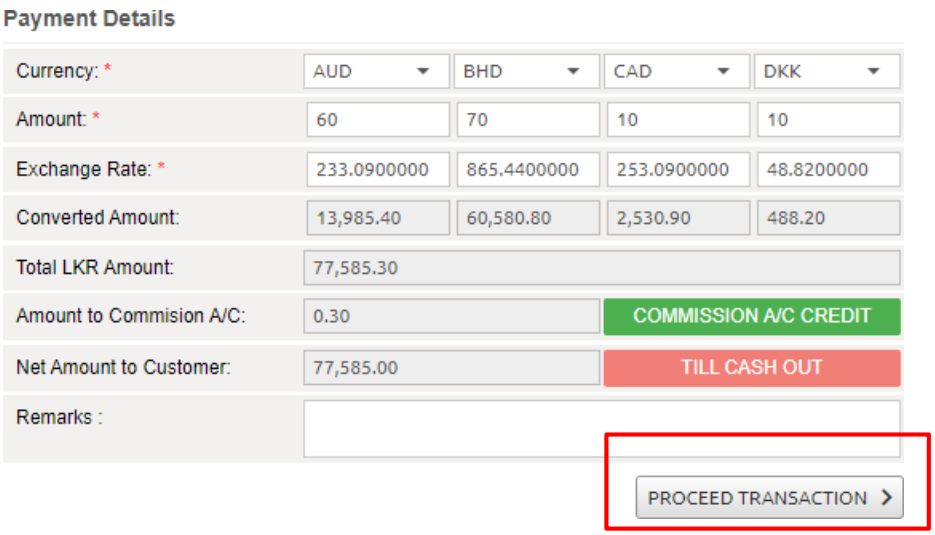


Figure 49 - Create Purchase Transaction screen – Payment Details

15. You can add a remark before proceeding with the transaction.
16. As the last step teller has to click on the **PROCEED TRANSACTION** button and then click on the **SAVE TRANSACTION** button to save the transaction in system.
17. After that, you can print the receipt for the saved transaction.
18. After the generation of the print the details are cleared and routes back to existing panel

Cancel transaction

1. Teller can click on "**Cancel transaction**" icon
2. The desired transaction to cancel can be searched using Reference UIN No, Customer Name Type or currency, displaying in cancel transaction panel.
3. Click on the reference number to navigate to cancellation interface.
4. Search option is provided for easy lookup.
5. If you expect to deny the transaction, teller can click **BACK** icon.
6. If you want to cancel transaction click "**Cancel Transaction**".
7. Enter the reason for the cancellation in "**Confirmation Message**"

Pay Office - Bandaranayake International Airport

Telephone : Direct 0112252424 / Arrival Counter 0112264750 / Departure Counter 0112264751 / Email: payoffice@boc.lk

Pay Office Control Unit, Head Office 011 2541936

Cancel Currency Sell Transaction

Reference Number	T99006326
Customer Name	MS.PRIYA
NIC/ Passport/ Company Reg. No.	255522525
Air Ticket No	0
Transaction Created Details	Created by IT207713 at 2024-02-22 10:28:42

Currency	Amount	Exchange Rate	Sub Total (LKR)
AUD	10.00	333.0000000	3,330.00
		Commision Fee (44.00%)	1465.20
		Total LKR	**4,796.00**
		Rounding Off	**0.80**
		Net Amount to Customer	**4,796.00**

BACK CANCEL TRANSACTION

Figure 50 - Cancel Transaction screen – Teller

8. Then Cancelled transaction will be sent for manager approval.
9. The cancellation will not be effected until the approval of the manager.
10. Once the cancellation is approved, teller can view the cancellation on daily report panel.

Pay Office - Bandaranayake International Airport
Telephone : Direct 0112252424 / Arrival Counter 0112264750 / Departure Counter 0112264751 / Email: payoffice@boc.lk
Pay Office Control Unit, Head Office 011 2541936

Cancel Currency Sell Transaction

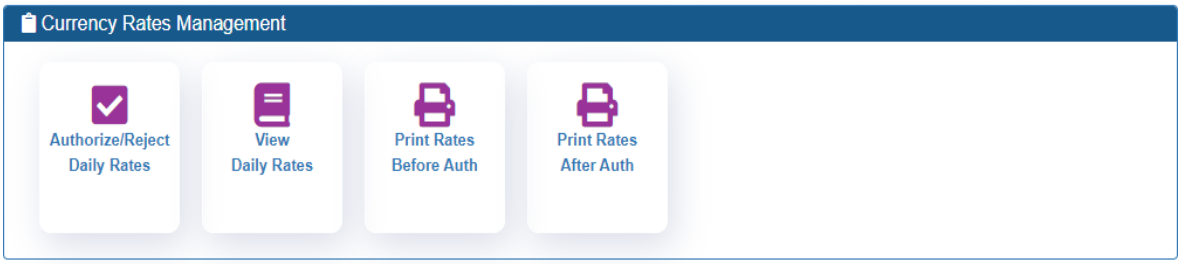
Reference Number :	T82499563
Customer Name :	MR.THAMALI SHANIKA
NIC/ Passport/ Company Reg. No.	898503925V
Air Ticket No	0
Transaction Created Details :	Created by IT207713 at 2024-02-19 10:55:29
Transaction Cancelled Details :	Cancelled by IT207416 at 2024-03-02 14:58:52 due to wrong

Currency	Amount	Exchange Rate	Sub Total (LKR)
AUD	10.00	333.0000000	3,330.00
		Commision Fee (44.00%)	1465.20
		Total LKR	**4,796.00**
		Rounding Off	**0.80**
		Net Amount to Customer	**4,796.00**

BACK | REJECT CANCELLATION | APPROVE CANCELLATION

Figure 51 - Cancel Transaction screen – Manager

Currency Rates Management Module

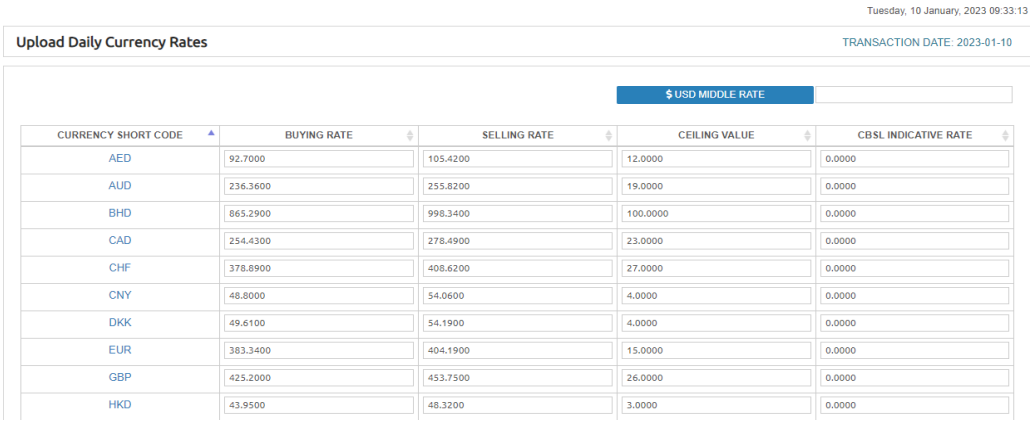


Upload Daily Rates

1. Click on the "**Upload Daily Rates**" icon. Then Respective previous values will be loaded to the Upload daily rates interface**.**

2. Edit the rates if necessary and save to the system by clicking **"UPLOAD DAILY RATES** "button.

3. When the action is confirmed, entered rates will be saved to a temporary file in the system database with the status NEW



CURRENCY SHORT CODE	BUYING RATE	SELLING RATE	CEILING VALUE	CBSL INDICATIVE RATE
AED	92.7000	105.4200	12.0000	0.0000
AUD	236.3600	255.8200	19.0000	0.0000
BHD	865.2900	998.3400	100.0000	0.0000
CAD	254.4300	278.4900	23.0000	0.0000
CHF	378.8900	408.6200	27.0000	0.0000
CNY	48.8000	54.0600	4.0000	0.0000
DKK	49.6100	54.1900	4.0000	0.0000
EUR	383.3400	404.1900	15.0000	0.0000
GBP	425.2000	453.7500	26.0000	0.0000
HKD	43.9500	48.3200	3.0000	0.0000

Figure 52 - Upload Currency rates screen

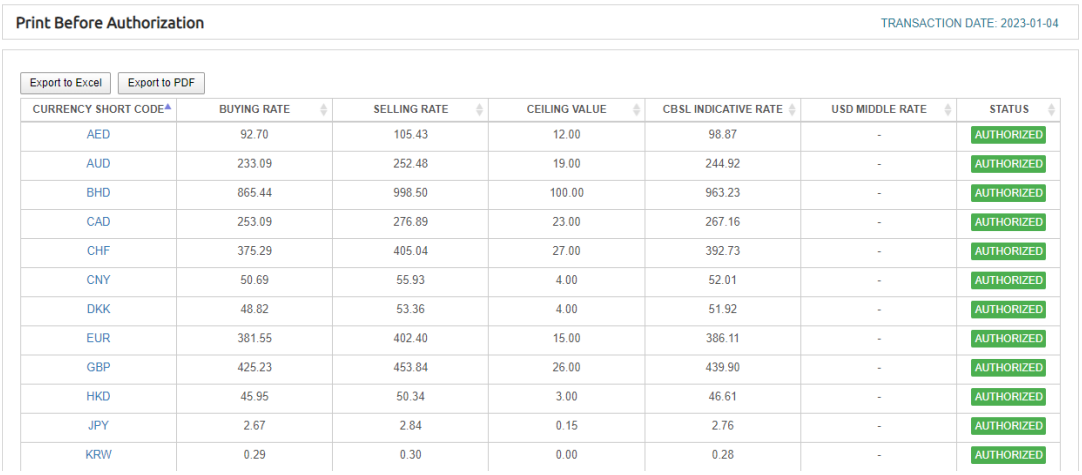
Authorize/Reject Daily Rates

1. Click on" **Authorize/Reject Daily Rates**" icon, then authorize daily currency rate table will be displayed.
2. Manager cannot edit the rate values but can reject the rates if required.
3. To Authorize rate, click on **AUTHORIZED RATE** button.
4. To Reject rate click on **REJECT RATES** button.

   When rejecting, reason for rejection should be provided, which will be handy to spot the error.
5. Confirmation messages will be popped up for both authorization and rejection.
6. After confirmation, status of the temporary rates file will be changed as AUTHORIZED or REJECTED. At the same time, rates will be saved to a permanent file in the system database with the date, user, host, IP and timestamp.

View Daily Rates

1. Click on the "**View Daily Rates**" icon , then you will be able view daily currency rates fetched from temporary file with the status (**AUTHORIZED/REJECTED/NEW**).
2. Displayed list of rates can be exported to PDF and Excel file formats using Export to Excel or Export to PDF buttons.



CURRENCY SHORT CODE	BUYING RATE	SELLING RATE	CEILING VALUE	CBSL INDICATIVE RATE	USD MIDDLE RATE	STATUS
AED	92.70	105.43	12.00	98.87	-	AUTHORIZED
AUD	233.09	252.48	19.00	244.92	-	AUTHORIZED
BHD	865.44	998.50	100.00	963.23	-	AUTHORIZED
CAD	253.09	276.89	23.00	267.16	-	AUTHORIZED
CHF	375.29	405.04	27.00	392.73	-	AUTHORIZED
CNY	50.69	55.93	4.00	52.01	-	AUTHORIZED
DKK	48.82	53.36	4.00	51.92	-	AUTHORIZED
EUR	381.55	402.40	15.00	386.11	-	AUTHORIZED
GBP	425.23	453.84	26.00	439.90	-	AUTHORIZED
HKD	45.95	50.34	3.00	46.61	-	AUTHORIZED
JPY	2.67	2.84	0.15	2.76	-	AUTHORIZED
KRW	0.29	0.30	0.00	0.28	-	AUTHORIZED

Figure 53 - View Daily Rates screen

Print Daily Rates

1. Click on the **Print Daily Rates i**con and then print preview will be displayed in a new tab.
2. To print the report, click on print button.

Pay Office - Bandaranayake International Airport
Telephone : Direct 0112252424 / Arrival Counter 0112264750 / Departure Counter 0112264751 / Email: payoffice@boc.lk
Pay Office Control Unit, Head Office 011 2541936
Saturday, 02 March, 2024 03:06:25

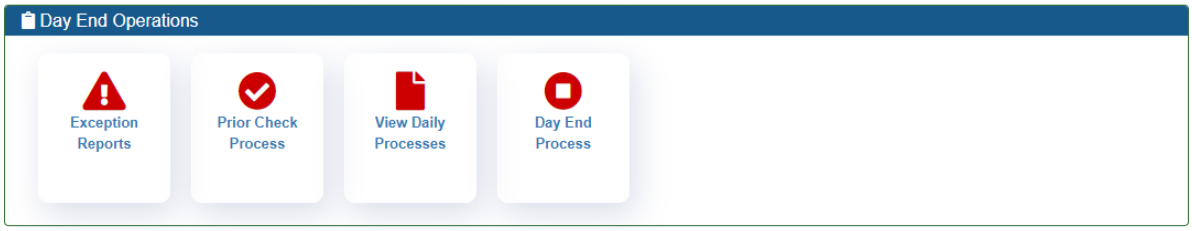
Daily Statement of Foreign Currency — **USD Middle Rate : 0**

CURRENCY NAME	CODE	BUYING RATE	SELLING RATE
Uae Dhirams	AED	0.0000	0.0000
Australian Dollars	AUD	332.0000	333.0000
Baharain Dinar	BHD	0.0000	0.0000
Canadian Dollar	CAD	0.0000	0.0000
Swiss Francs	CHF	0.0000	0.0000
Chinese Renminbi	CNY	0.0000	0.0000
Danish Kroners	DKK	0.0000	0.0000
Euro	EUR	0.0000	0.0000
Great Britain Pounds	GBP	0.0000	0.0000
Hongkong Dollars	HKD	0.0000	0.0000
Indian Rupee	INR	0.0000	0.0000
Jordanian Dinar	JOD	0.0000	0.0000
Japanese Yen	JPY	0.0000	0.0000
Korean Won	KRW	0.0000	0.0000
Kuwait Dinar	KWD	0.0000	0.0000
Sri Lankan Rupee	LKR	0.0000	0.0000
Malaysian Ringgit	MYR	0.0000	0.0000
Norwegian Kroners	NOK	0.0000	0.0000
Newzealand Dollars	NZD	0.0000	0.0000
Oman Riyal	OMR	0.0000	0.0000
Qatar Riyal	QAR	0.0000	0.0000
Saudi Riyals	SAR	0.0000	0.0000
Swedish Kroners	SEK	0.0000	0.0000
Singapore Dollars	SGD	0.0000	0.0000
Thai Bhat	THB	0.0000	0.0000
Us Dollars	USD	0.0000	0.0000
South African Rands	ZAR	5.0000	0.0000

Created By : IT207713 on 2024-02-16 11:52:23
Authorized By : IT207713 on 2024-02-16 15:27:05

Figure 54 - Print Daily Rates screen

Operations Module



Prior Check Process

1. Click on "**Prior Check Process**" icon.
2. Then Prior check process details will be displayed.
3. Then click on **PRE CHECK** button.

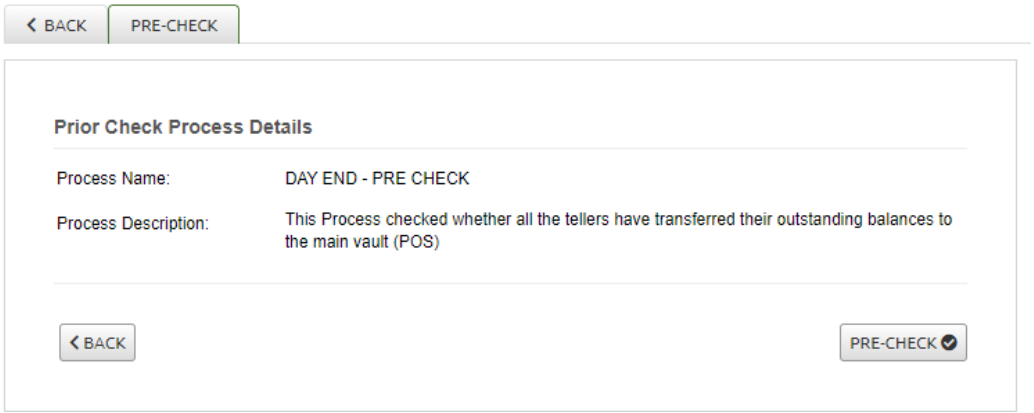


Figure 55 - Pre-Check operation screen

3. Then a confirmation message will be popped up to confirm the action.
4. Next you have to click on the Confirm button.
5. Once confirmed, process status will be changed as STARTED. During the pre-check process, teller tills are being checked to verify if all the tellers have transferred their outstanding balances to the main vault (POS).

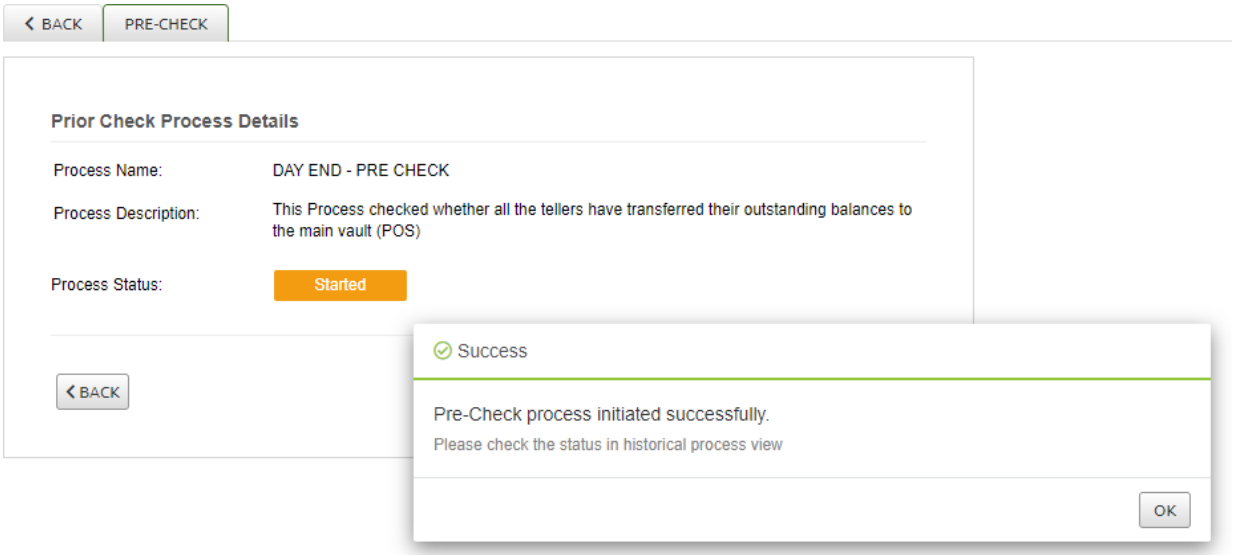


Figure 56 - Pre-Check operation screen - success

6. If not, pre check process will get failed and generate an error message. It is advisable to perform the prior check until it is successfully completed.
7. Pre-Check process is mandatory.

View Daily Processes

1. First you have to click on the "**View Daily Processes**" icon.

2. Then This will list down all types of above operations performed by the user with the executed date, executed time, executed user, status and error description.

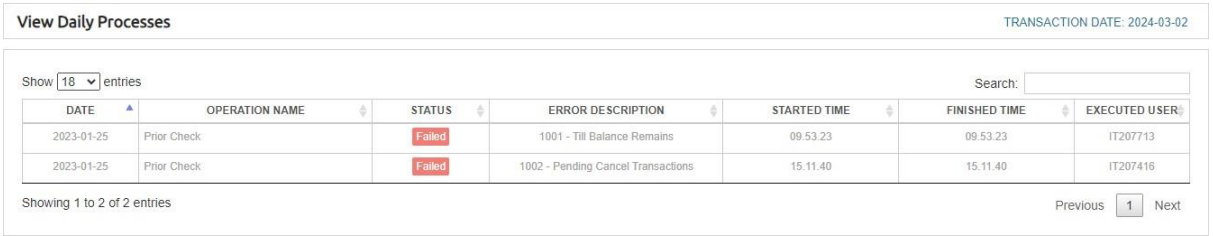


Figure 57 - View Daily processes

Day End Process

1. First you have to click on the "**Day End Process**" icon.
2. System will check for the remaining balances in the teller tills and generate an error message if the prior check had not been successfully completed before executing the DAY END process.

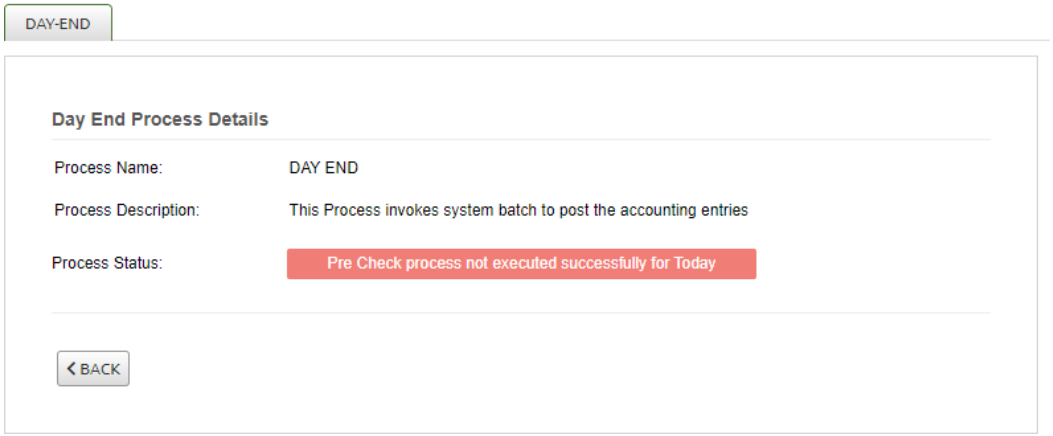


Figure 58 - Day End operation screen

3. Therefore, all the balances remaining in teller tills should be transferred to the main vault (POS) before EOD. When the manager clicks on DAY END button,
4. Then a confirmation message will be popped up to confirm the action. Once confirmed, process status will be changed as STARTED.
5. During the day end process, system batch will be executed to post the accounting entries. When the day end function is completed, process status will be changed as COMPLETED.