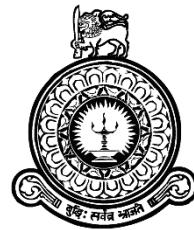


**MEDICAL AND LABORATORY EQUIPMENT
PROCUREMENT MANAGEMENT SYSTEM
FOR
THE NATIONAL HOSPITAL KANDY**

S. B. W. M. R. C. J. UDURAWANA

April 2020



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April 2020



This dissertation is submitted in partial fulfillment of the requirement of the

Degree of Bachelor of Information Technology (external) of the

University of Colombo School of Computing

Declaration

DECLARATION

I certify that this dissertation does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any university and to the best of my knowledge and belief, it does not contain any material previously published or written by another person or myself except where due reference is made in the text. I also here by give consent for my dissertation, if accepted, to be made available for photocopying and for interlibrary loans, and for the title and abstract to be made available to outside organizations.



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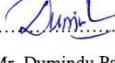
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Date: 28.11.2019.....

Abstract

The General Hospital (Teaching) Kandy, situated in the country's breathtaking central region is acclaimed as the second-largest tertiary care public sector medical institution in Sri Lanka. With the vision "To be the safest tertiary care hospital in Sri Lanka", the hospital provides specialized health care services primarily to the Central Province. This progressive hospital which consists of 78 wards, 13 Special Units, 10 Intensive Care Units, 24 Operating Theatres established a Planning Unit, which is the prime user of my project, in 2013 to meet all the planning needs of the hospital. As to the client, currently, the procurement process handled by the planning unit is a file-based manual system that is operating with different shortcomings. Plenty of time consuming to get approvals from the superior management, to record and relocate numerous data regarding to a procurement, monetary losses due to miss use of money by double dealing workers, storing of the much needed information files or the documents and etc. were identified to be as the main deficiencies of the current system; which will be briefly cited later in this document.

To address the current shortcomings and the client's requirements, the "Equipment Procurement Management System" (EPMS) with an e-Tendering website was designed under ten key modules mainly including a request/complain handling and progress monitoring module, sourcing and contract management module and a report generation module. To develop the designed system, the latest software practices and technologies are using. Since the system is a web-based system, PHP is mainly used for server-side scripting. For the client-side scripting Java Scripts, jQuery and AJAX is been used. HTML is going to blend with CSS and Bootstrap for the Front-end and for the system to be more user-friendly. Apache webserver with MySQL has been chosen to host the system. VS Code 2015 has been used as the coding tool.

The system was tested in-house as well as in the client environment. Then the system was implemented in the client environment and presently, the system is ideally performing very well fulfilling its obligations, addressing the requirements effectively while helping out in everyday activities.

Acknowledgment

I would like to take this opportunity to convey my sincere gratitude to numerous individuals for the guidance and encouragement given in aiding me with this endeavor to provide successful means of an end to this software development project.

Moreover, as a matter of first importance, I would like to stretch out my heartiest appreciation to the BIT coordinator, the Project Evaluation Board and the University of Colombo School of Computing for giving us this precious opportunity to develop an industry-level software system as a part of a world perceived degree program.

Secondly, my parents who have been with me throughout and for encouraging me with all the supportive guidance must be cited here, and my sincere thanks are offered to them with all means of gratitude.

I am as most grateful to Miss. Damayanthi Ramalingam, Managing Director, Senior Lecturer iSeeQ (Pvt) Ltd, Kandy, for standing with me all throughout the project as my supervisor and for her commitment to empowering proposals, directing me in the right track. Also, not to forget, Mr. Dumindu Pahalawatta, Senior Systems Engineer at London Stock Exchange Group, for his kind guidance throughout the development of this project.

The staff and the lecture panel of iSeeQ (Pvt) Ltd, Kandy and ESOFT Metro Campus Kandy for providing all means of support and academic knowledge since the initial stage of my degree programme.

My appreciations and thankfulness should be granted to Dr. P. M. P. Gunasinghe and Dr. Anjana Senevirathne, of General Hospital (Teaching) Kandy, lately The National Hospital Kandy, the staff at the planning unit for giving me this chance to build a system and for likewise enriching me with all the vital data for the system while yielding their own valuable time.

Finally, I want to be much appreciative for each and every individual who has helped me and is not mentioned here, for their various supports and directions.

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List of Acronyms

AJAX	– Asynchronous JavaScript and XML
BME	– Bio-Medical Engineer
CSS	– Cascading Style Sheet
EPMS	– Equipment Procurement Management System
HTML	– Hypertext Markup Language
MO	– Medical Officer
MOIC	– Medical Officer In-Charge
NRP	– Non-Refundable Payment
PHP	– Php Hypertext Preprocessor
PU	– Planning Unit
RUP	– Rational Unified Process
TEC	– Technical Evaluation Committee
UML	– Unified Modeling Language
VS	– Visual Studio

Chapter 1: Introduction

1.1 Introduction to Healthcare

Sri Lanka has one of the foremost effective health systems among developing nations. The country holds an outstanding position in South Asia, collectively of the developing nations to provide universal health. Public sector healthcare is universally accessible for the entire population and is sort entirely freed from charge. The health system in the state is enriched by a mixture of Allopathic, Ayurveda, Unani and alternative systems of drugs. Of those systems, allopathic medicine has become dominant and is catering to the majority of the health desires of society. Figure 1.1 depicts the number of hospitals and their bed strengths in Sri Lanka as at 2018 January.

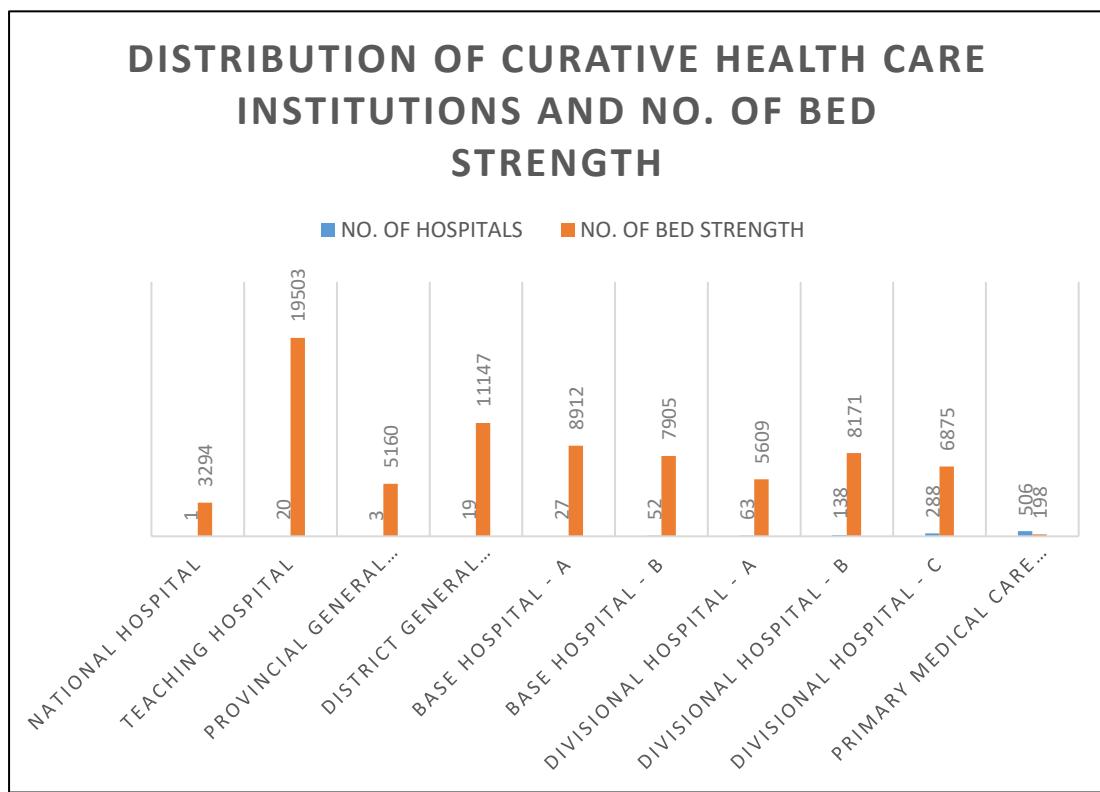


Figure 1.1: Distribution of Curative Health Care Institutions and No. of Bed Strength

According to the Ministry of Health, Nutrition & Indigenous Medicine, as of 2018/01/01, there are 1118 curative healthcare institutions in Sri Lanka. [1] Among them, General Hospital Kandy being a Teaching Hospital holds an outstanding position in the Sri Lankan healthcare system.

The General Hospital (Teaching) Kandy is that the second-largest tertiary care public sector health facility center in Sri Lanka, established and Administered under the scope of the Ministry of Healthcare and Nutrition. The hospital which was firstly established in Deyyannevela as a smallpox hospital in around 1861 was later expanded to become the General Hospital Kandy. Recently, the hospital was upgraded as The National Hospital Kandy which extent to a range of 58,409 acres. This hospital provides specialized health care services primarily to the Central Province that consists of Kandy, Matale, and Nuwara-Eliya districts. Individuals from all other provinces except Western and Southern are coming to seek expert care from the General Hospital (Teaching) Kandy, as there aren't any extremely specialized units in most of the remote areas within the country. [2]

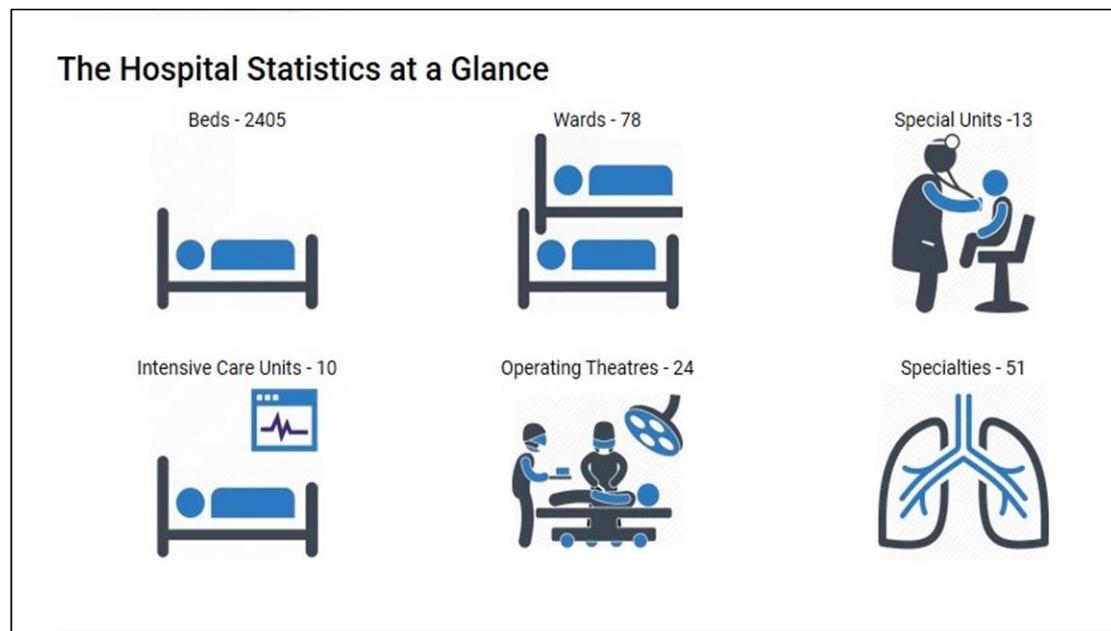


Figure 1.2: Current Status of the Hospital

As in the figure 1.2 national hospital Kandy has 78 wards and 13 Special Units for inpatient services. It also has 10 Intensive Care Units and 24 Operating Theatres. Out-Patient Service, Specialized Clinic Services and Emergency Treatment Units are also within the Hospital. In addition to that Chemical, Microbiology, Histological and Pathological Investigations, X-Rays, USS, CT, MRI, Exercise ECG, Physiotherapy and Pharmacies services are also available within the hospital premises. [2]

As of 2017 Hospital is privileged with a staff over 5000 staff members dedicated to provide a patient centered service to a large volume of clients. Hospital has recorded 224,917 inpatient admissions, treated over 82793 clinic patients through 51 types of specialty clinics and services to over 379,401 outpatients in the year 2017. [2] Figure 1.3 is about the number of patient admissions of the hospital in past years.

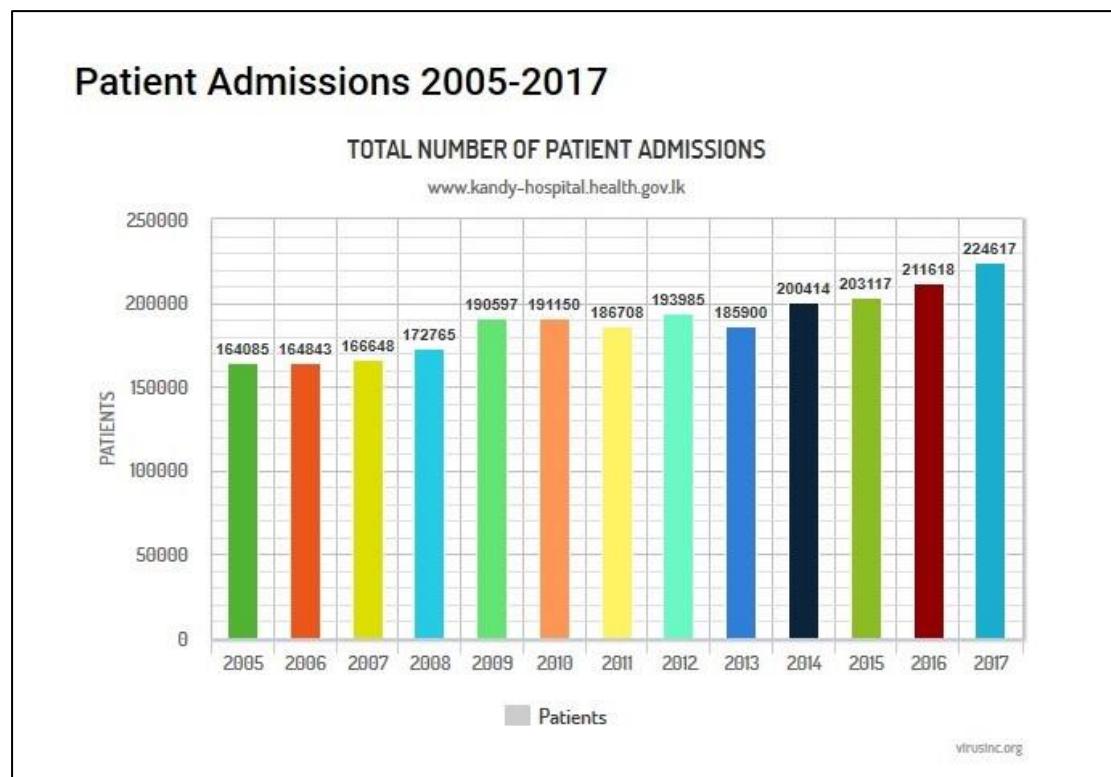


Figure 1.3: Total Number of Patient Admissions over the past years

The PU of the hospital was established within the year 2013. Throughout the last half-dozen years, it has grown up to meet the planning desires of the hospital. Planning and evaluation of medical instrumentality want, Planning and observance of hospital building constructions, assisting decision-making process for the superior management, Coordination of other planning activities are the services chiefly rendered by the PU.

With the fast aging lifetime of the rapid demanding world, the absence of information technology is creating an enormous influence on the efficiency of the hospital services. Therefore, maintaining a web-based EPMS results in smoothening the process of purchasing equipment; which can benefit the planning Unit in numerous ways.

1.2 The motivation for the Project

The PU of General Hospital (Teaching) Kandy mainly focus on Planning and evaluation of Medical and Laboratory equipment needs. Here, acquisition of the requested/needed Medical and Laboratory equipment is presently handled in a file-based manual system that is operating with different shortcomings.

Since the present system is a manual method, it costs plenty of time to get approval from the superior management to purchase urgent equipment even; which will have an effect on the efficiency of the hospital services and sometimes for the patient's lives.

The manual system they presently using is little time consuming as it is predicated on a variety of handwritten registers for recording data. Also, the responsible officers have to face numerous difficulties when re-locating the already purchased equipment details, who involved in purchasing the respective equipment and etc. during the audits and in decision making for further purchases.

Since most of the equipment within the Hospital premises value a huge amount of money, monetary losses might cause in case of misuse of money by a double-dealing worker. Therefore, the process is required to be an unequivocal one which will facilitate the operating staff to manage and handle all these related details simply and ethically.

As a BIT undergraduate at the University of Colombo School of Computing, in order to successfully complete the degree program, implementing a Software Development Project is by far the most vital individual piece of work. In searching for a potential project, I found this above-mentioned drawback within the General Hospital (Teaching) Kandy would benefit me in showcasing the knowledge I have gathered throughout the degree program practically and to contribute my knowledge to smoothen the procurement process of the hospital, increasing the efficiency of the hospital services.

1.3 Objectives and Scope of the Proposed System

The main objective of this project is to implement a reliable and fully-functional web-based procurement management system to increase the productivity of the procurement process and to overcome their current drawbacks. Also, to incorporate sophisticated Information and Communication Technology (ICT) related aspects of this process appropriately.

- Introduce mechanisms to smoothen the process of requesting equipment and manage related documents.
 - Consultants at the Wards/ Units will be able to request needed Medical or Laboratory Equipment instantly and generate related documents.
 - Facility to make complaints regarding the received equipment due to various reasons such as faults.
- Maintain the prevailing procurement procedures and approved workflow management of the hospital via the new system.
 - Maintain procurement policies followed by hospital management.
 - The director of the Hospital will be able to monitor and visualize the whole process.
 - Approve or reject requested orders on as per procedures.
 - Perceive the reports/statistics or relevant information in various forms for decision making.
- Enables the staff to secure and manage purchased equipment details and all the procurement related data for future reference.
- The proposed system will allow the user to notify the relevant parties regarding the order status and different other requests/messages from the top management and the lower-level employees.

- Ensure proper sourcing and supplier contract takes place which saves time and money. Manually compiling and comparing supplier proposals can be time consuming and ineffective. Therefore,
 - Evaluate supplier bids based on predetermined factors such as price, quality, and value-allowing to arrive at the best possible selection based on the unique business requirements.
 - A secure, searchable contract repository with complete tracking and audit history enables users to quickly locate whenever they need.
 - Automated renewal management capabilities give procurement professionals early notification of expiring contracts.
 - Analytics identify contract deviations from defined standards. Auditable workflows enforce document approvals.
- Aid in management decision making the process.
 - Users will be able to generate statistics and relevant information in various forms such as graphs, reports, charts, dashboards whenever needed.
- Provides admin with the ability to create new users with different access privilege levels as well as to block or restrict existing users and to update their user privileges, to manage Reviews, and to manage account settings.

1.4 Structure of the Dissertation

The dissertation includes six main chapters including the introduction chapter. Following describes the main chapters of the dissertation.

Chapter 02 – Analysis

This chapter describes the requirement gathering techniques used during the project. The current systems working mechanism and its drawbacks are also described here. Functional and Non-functional requirements of the proposed system are described followed by the Literature review on a similar existing system.

Chapter 03 – Design

This chapter describes the software designing strategies, alternative solutions for the developing system and UI design, database design of the proposed system.

Chapter 04 – Implementation

This chapter describes the implementation of the developed project. The chapter consists of major code segments and other reusable code segments used in development.

Chapter 05 – Evaluation

This chapter explains how the system has been tested and describes the testing methods used. Various test methods, test results and changes made are pointed out.

Chapter 06 – Conclusion

This chapter includes the lessons learned by developing this system, recommendations and future improvements of the system.

Chapter 2: Analysis

The most important phase in the software development lifecycle is the requirement gathering and analysis phase; as this is where we begin to understand the client's expectations from the project. Analysis refers to the breaking of the whole project into minor segments with the intent of gaining insights into the parts/ sections, functions & process of the current system and the requirement gathering techniques used.

The functional and non-functional requirements of the proposed system and about the similar existing systems are elucidated here. The basic process of analysis involves three steps:

1. Understand the existing system (the as-is system).
2. Identify improvements.
3. Define requirements for the new system (the to-be system).

2.1 Requirement Gathering Techniques

Requirement gathering is the first and foremost step in the software development life cycle. Requirements analysis, also called requirements engineering, is the process of determining user expectations for a new or modified product. These features, called requirements, must be quantifiable, relevant and detailed. Business analysts and subject experts are responsible for gathering the requirements of the user. This process is needed to be done accurately as only the clear requirements can lead to the best design. If not proper and adequate requirement gathering is performed it can lead to a waste of time, loss of opportunity and/or unnecessary overhead.

When it comes to requirement gathering techniques, there are several different requirement gathering techniques that facilitate this process and capture the exact and exhaustive requirements. Some of the commonly used requirement gathering techniques include;

- FAST technique – Facilitated Application Specification Technique
- VORD – Viewpoint oriented requirement definition
- Ethnography – Observational technique
- Brainstorming

- Scenario and Documentation Analysis
- Reverse engineering
- Questionnaire

These techniques can differ from one project to another. In this project, requirements were gathered mainly using Interviews. Numerous face-to-face interviews; both structured and unstructured were conducted with the prime users of the system. Starting with unstructured interviews with the MOIC to solicit an understanding of the current working environment/system and requirements followed by a structured interview using questionnaires etc. to clarify those that gathered. During the interview session, it was identified that the different users had different interpretations of what the system was required to perform.

Therefore, as a secondary method of fact-finding, VORD and Ethnography methods were conducted involving the different users of the system. Different users had different viewpoints. Different viewpoints on the same problem were an aid when viewing the problem in different ways. Thus, using observations on the existing system and the users, the study of users in their natural habitat and identifying new requirements of the system as well as verifying requirements obtained from the interview sessions were covered.

Finally, Scenarios and Documentation analysis (sampling and documentation) were used to identify how each requirement was being carried out on the current system and to get a better understanding of the complex areas of the system. When studying the existing system, various existing documentation, forms, and files were thoroughly analyzed and numerous facts from existing documentation were collected which were unspoken by the users.

During the study process, the cooperation of various levels of the staff immensely supported in understanding the system to a greater extent.

2.2 Current System and the Process

Currently in General Hospital (Teaching) Kandy, there's no such a system running on and all the works were handled in a file-based manual system except for one excel sheet which stores only the dates related to procurement.

The process is, whenever there's a need for medical or laboratory equipment to a unit/ward, the relevant consultant who employed in that particular ward/unit sends a letter requesting the equipment to the Director of the hospital. Director, if the request is approved as per his decisions, send the authorized request letter to the MOIC (PU).

Then MOIC forwards the received letter from the Director to the Ministry depending on the type of the purchase (Direct purchase / Indirect purchase) However, both; indirect purchases after receiving the approval from the ministry and the direct purchases are subjected to a specification where TEC is formed and relevant ID's for the procurement is generated and forward a file containing all the details (items requested, specification details and etc.) to the Chief Accountant.

Chief Accountant, after receiving that file publishes a tender notice on paper magazines (tender open/ tender close). After closing the tender, the chief accountant creates a “tender file” which includes all the details about the bidders who bid for that particular tender. And forward that file to both MOIC and BME for the evaluation process. There, they involve with the TEC and chooses the most suitable bidder just by comparing the compulsory documents provided by the bidders and their prices. And creates “Final report of TEC” which is also another document file, which includes the details of the bidder which all the members in the TEC agreed on. That report is then forwarded to the Chief Accountant. All these activities are handled manually in the current system.

Chief Accountant then places an order, contacting with the Bidder chosen. There he signs a contract/maintenance agreement with the supplier. Usually, payments are made after receiving the order. (advance payment of 10% - 20% are rarely paid depending on the bidder's wish).

Order, when received after 8-12 weeks' time the order purchased, is sent to the surgical pharmacist who manages the Inventory. From here, the process of the

procurement system is over. Figure 2.1 shows the use case diagram for the existing system.

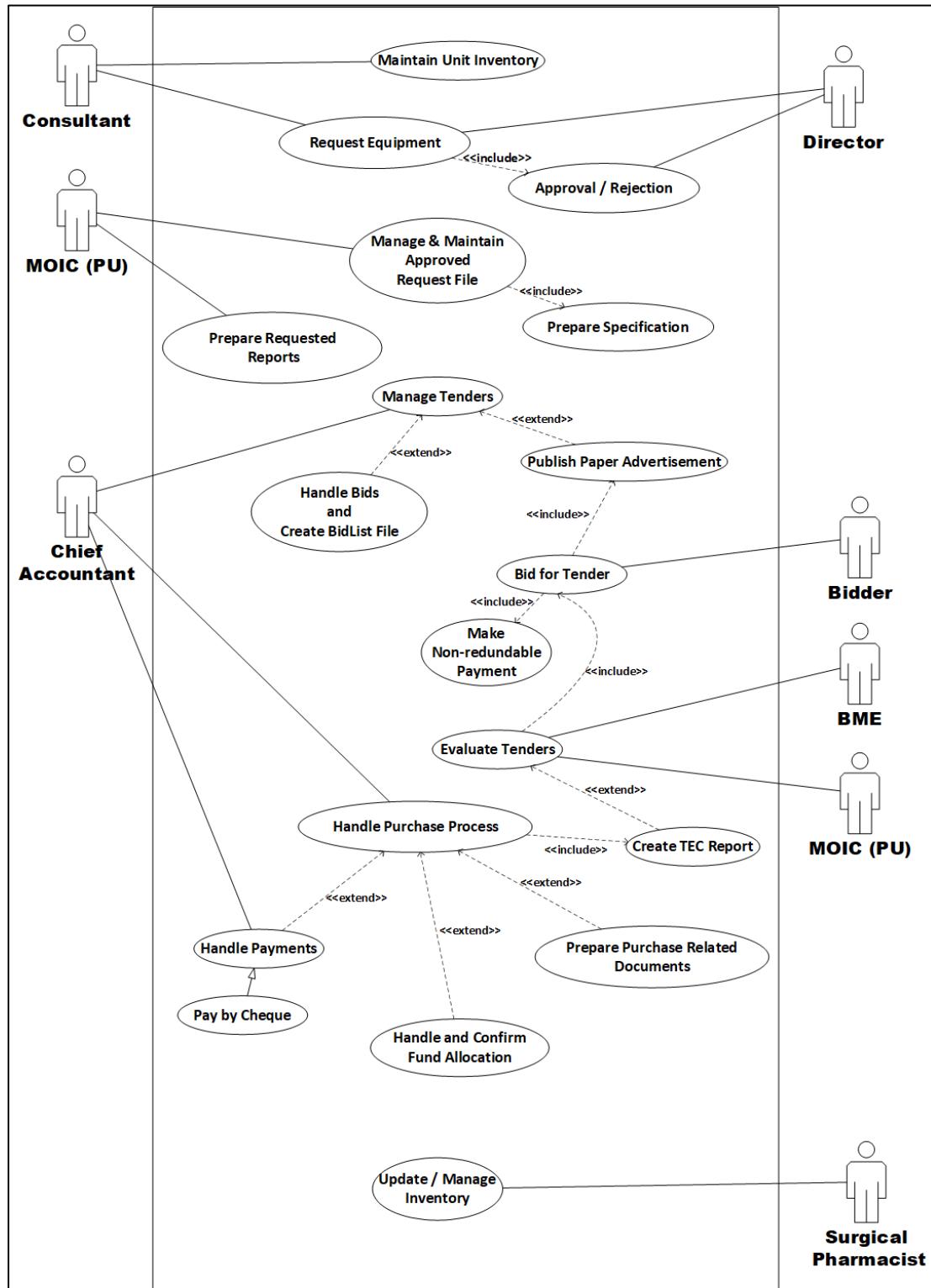


Figure 2.1: Use Case Diagram of the Existing System.

2.3 Drawbacks of the Existing System

The current system followed by the Kandy General Hospital is a manual system that has created a massive inefficiency to hospital services. The following drawbacks were identified in the current system during the analysis of the problem domain.

- It costs plenty of time to get approval from the superior management to purchase urgent equipment even; which will have an effect on the efficiency of the hospital services and sometimes for the patient's lives.
- Consumes time as the current system is predicated on a variety of handwritten registers for recording data.
- Hard time re-locating the already purchased equipment details, who involved in purchasing the respective equipment and etc. during the audits and in decision making for further purchases.
- Monetary losses might cause in case of misuse of money by a double-dealing worker.
- Inability to visualize the requested order's current status.
- All the confidential files and documents are currently been circulated between the users by the hand of the minor staff. Due to this, sometimes the users may need to wait for those workers to be free; which causes some delay and slowness in the process.
- Files containing the details about the previous procurements get damaged with the time or in case of a sudden natural disaster. So, recovering the data is impossible in such a situation.

2.4 Functional and Non-Functional Requirements

2.4.1 Functional Requirements of the System

“The functional requirements for a system describe what the system should do. These requirements depend on the type of software being developed, the expected users of the software, and the general approach taken by the organization when writing requirements.” [3]

Admin portal - The system has to provide the admin with the ability to create new users with different access levels as well as to remove or freeze existing users and update their privileges.

User and login management - A user login management is required to provide user authentication and authorization.

Laboratory and Medical Equipment Management - System has to provide the users with the ability to manage all the details about the medical and laboratory equipment, it's purchased history and all info related to the acquisition of that particular equipment.

Request/Complaint Handling and Progress Monitoring - The system should allow the users to monitor the progress of the procurement process of a requested item. Also, he/she should be able to make complaints if needed. All these have to be managed by the system so that, it can be used as an aid in the management decision making the process.

Vendor Management, Sourcing and Contract Management - The system has to provide the users with the ability to manage details about the vendors who bid for a tender, and all the sourcing and contracts signed with the vendors, as it will be an aid in when calling for tender meetings and in evaluation process in future acquisitions.

Order Management and Payment Management - The system should be capable of managing the approved orders and its payments appropriately.

Notification and Communication - This allows the users with the ability to communicate with the different users through a live chat in the system. And

this will also notify the users when a new request of an item is received and its approval related details etc. through emails and Online alerts.

Report Generation Module with Dashboard - The system will allow the users to Perceive the reports/statistics or relevant information in various forms for decision making.

2.4.2 Non-Functional Requirements of the System

“Non-functional requirements, as the name suggests, are requirements that are not directly concerned with the specific services delivered by the system to its users. They may relate to emergent system properties such as reliability, response time, and store occupancy.” [3]

Availability

The system should be available to all its users at all times without any problems, disregarding location, time or any kind of system failure.

Dependability and Security

The system should not cause any harm to the usual day today activities of the hospital or economic damage in the event of system failure. Also the unauthorized / malicious users should not be able to access the system or damage the system.

Accuracy and Consistency

The system should be updated accurately and consistently, as the superior management should be able to make decisions using reports generated.

Acceptability and High user-friendliness

The system should be acceptable to the type of users for which it is designed to. i.e., the developed system must be understandable and easily usable to both technically savvy and non-savvy people. It should be simple, elegant and user-friendly.

Efficiency and Performance

The system should not make unnecessary use of system resources. Also, the responsiveness and processing time should take not more than the usual time as in the manual system. Users should not be left long to get a work done.

Maintainability

The system should be capable of evolving to meet the changing needs of the customer with the changing business environment. It should be written in such a way where a different person could easily understand and proceed with the necessary modifications.

Extensibility

The system should be capable of having new functionalities without or minimally affecting the system's internal structure and the data flow. (Recompiling or changing the original source code is unnecessary.)

2.5 Similar Systems and the Literature Review.

Procurement is the process of finding, agreeing on terms, and acquiring goods, services or works from an external source. Often via a tendering or competitive bidding process. The process is used to ensure the buyer receives goods, services or works at the best possible price when aspects such as quality, quantity, time and location are compared. [4]

The primary concept of procurement is that advanced planning, scheduling, and group buying will result in cost savings, more efficient business operation, and therefore increased profitability. A procurement system is used to manage this process, providing turnaround time for invoices, tracking of total spending by commodity type, as well as financial commitments and cash flow management. The complete implementation of a procurement system usually results in significant changes to the existing business process. There are two primary types of procurement systems: electronic procurement and standard procurement. Both types of systems are widely available.

Figure 2.2 and figure 2.3 below defines the general steps of the procurement process.

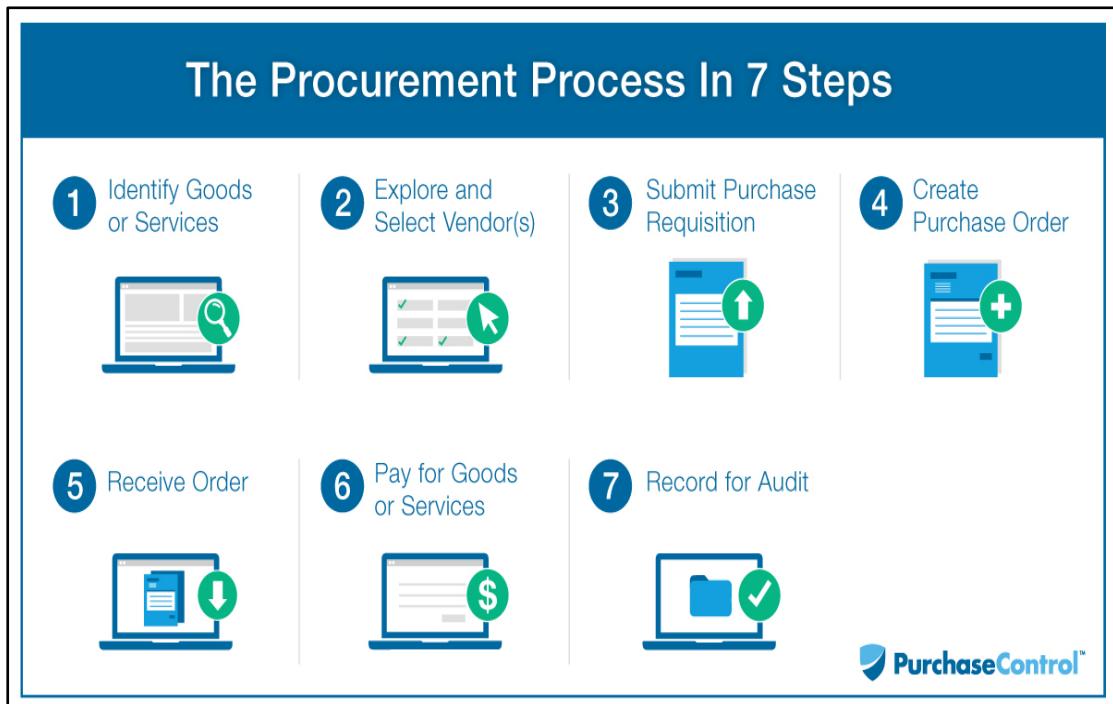


Figure 2.2: General Steps in a Procurement Process

An electronic procurement system is also known as e-procurement. This term is used to describe software that allows purchasers to access the supplier's catalogs via the Internet, as well as accepting electronic invoices. The purchasers select their materials, indicate the accounts to be charged for the purchase, and create purchase orders in the accounting system. All the procurement related activity is completed in the electronic system reducing paperwork and increasing efficiency. It can manage the entire procure to pay cycle, i.e. send inquiries (RFQ, RFP, etc.), float tenders, compare bids, do e-Auctions, set up internal workflows for the internal procurement approvals, generate PO, manage material delivery, make payments.

A standard procurement system is fully integrated with the accounting software package used by the organization. All purchasing activity is tracked and managed through this module, allowing the firm to control spending and track opportunities for greater savings. Reports, analysis, and internal controls are all built into this type of software and are designed around best practices. The implementation of a procurement system is one of the easiest ways to improve operational efficiency.



Figure 2.3: Procure-to-Pay Cycle

Managing procurement well will add value to the business practices and save both time and money. It is important to get some insight into the system that is to be developed and the easiest way to do this is by reviewing some similar existing systems. Therefore, some highly reputed similar systems were studied before starting the development of the system. A brief description of the systems that were studied is given below.

2.5.1 Literature Review

Promena e-Sourcing - Promena sourcing module helps you to create RFx events and both forward and reverse e-auctions. You can identify, select and collaborate with best vendors to see bottom-line effect with huge savings opportunities and operational efficiency. [5] Dashboard of the “Promena e-Sourcing” is shown in the figure 2.4

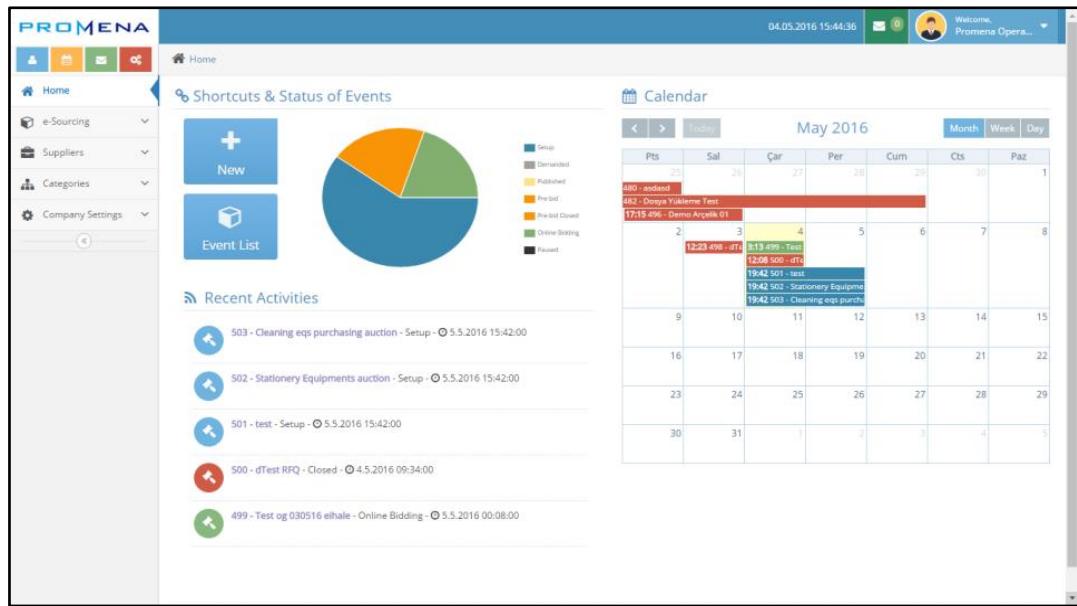


Figure 2.4: Dashboard of Promena e-Sourcing

Gatekeeper - A simple to use, powerful, AI-driven cloud-based Procurement solution. Manage Suppliers and Contracts, receive automated alerts of key dates, monitor risk, manage workload and store files and messages - all in one place - company-wide. Gatekeeper's suite of reporting, collaboration, and alert tools make Supplier and Contract management easy and effective. [6]

Figure 2.5 depicts the dashboard of “Gatekeeper”

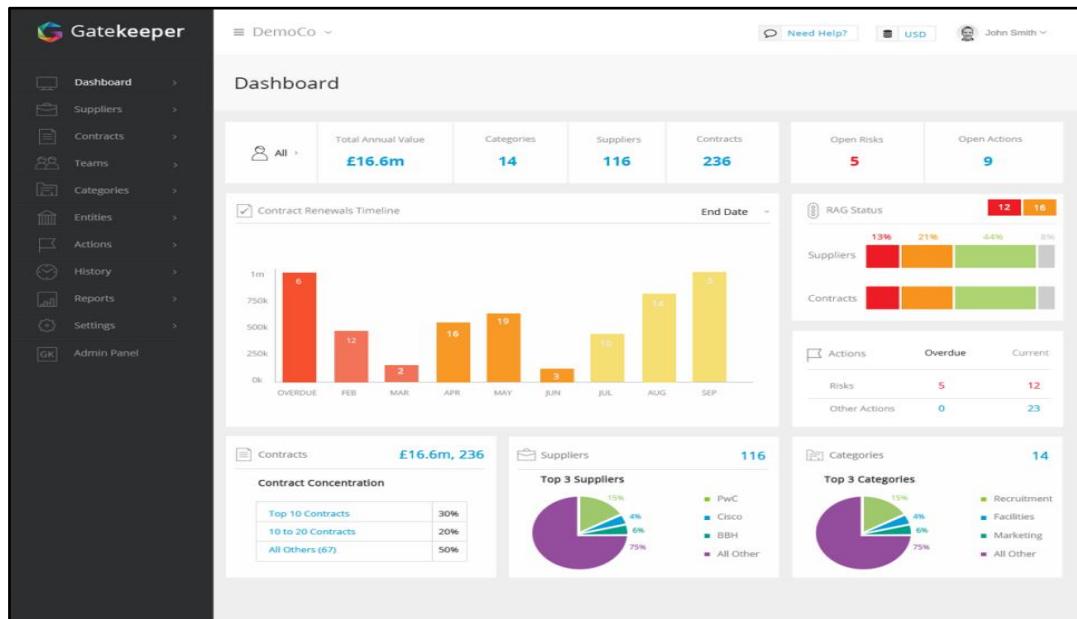


Figure 2.5: Dashboard of Gatekeeper

Procurify - Procurify is the go-to spend management solution for mid-sized companies. Across the world, hundreds of companies use Procurify to track, control and analyze their spending. With its comprehensive workflow and user-friendly interface, Purchasing, Procurement, and Finance teams have been able to implement Procurify across departments and teams and create a better Spend Culture. [6] Figure 2.6 is the dashboard of “Procurify”

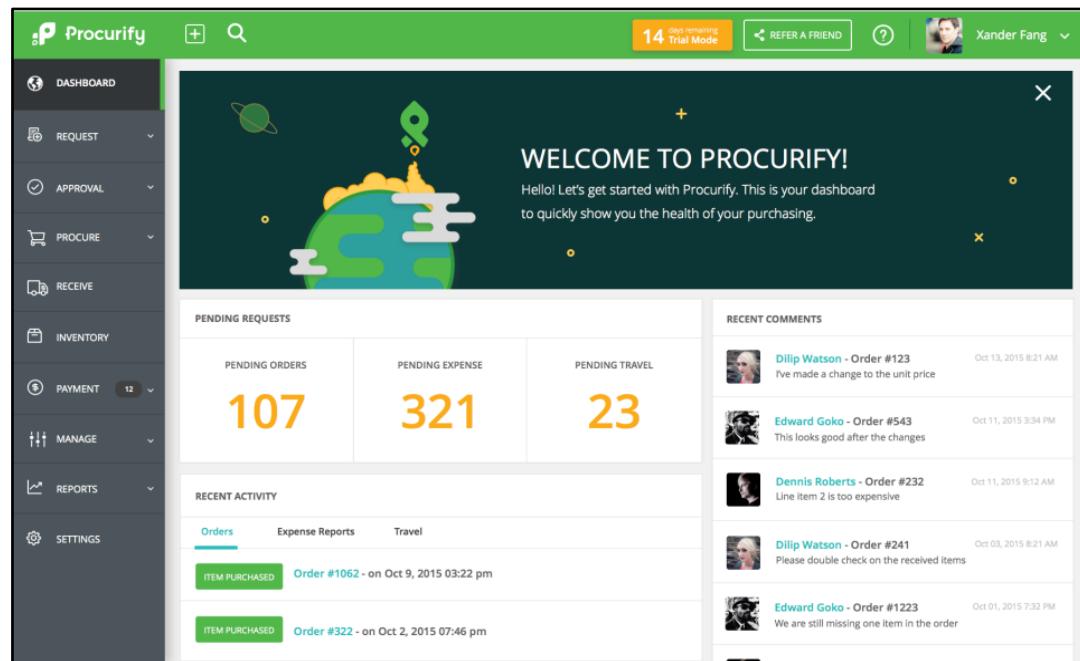


Figure 2.6: Order Status Page of Procurify

2.6 Comparison of Similar Systems with the Proposed System

Features	Promena e-Sourcing	Gatekeeper	Procurify	Proposed System
Catalog Management	YES	NO	YES	YES
Contract Management	NO	YES	NO	YES
Order Management	YES	NO	YES	YES
Requisition Management	YES	NO	YES	YES
Sourcing Management	YES	YES	YES	YES
Supplier Management	YES	YES	YES	YES
e-Tendering	NO	NO	NO	YES

Table 2.1: Feature Analysis

2.7 Process Model for the Proposed System.

The software development process model, also known as a Software Life-cycle model is the process by which an organization develops software. Usually, development organizations have their own working process that evolves for how it gets software development done, depending on the aims and goals of the project. When considering the aims and goals of the project, Rational Unified Process (RUP) was selected as the process model.

RUP is a modern generic process model that has been derived from work on the UML and the associated Unified Software Development Process. It basically is a phased model that identifies four discrete phases in the software process. (Figure 2.6)

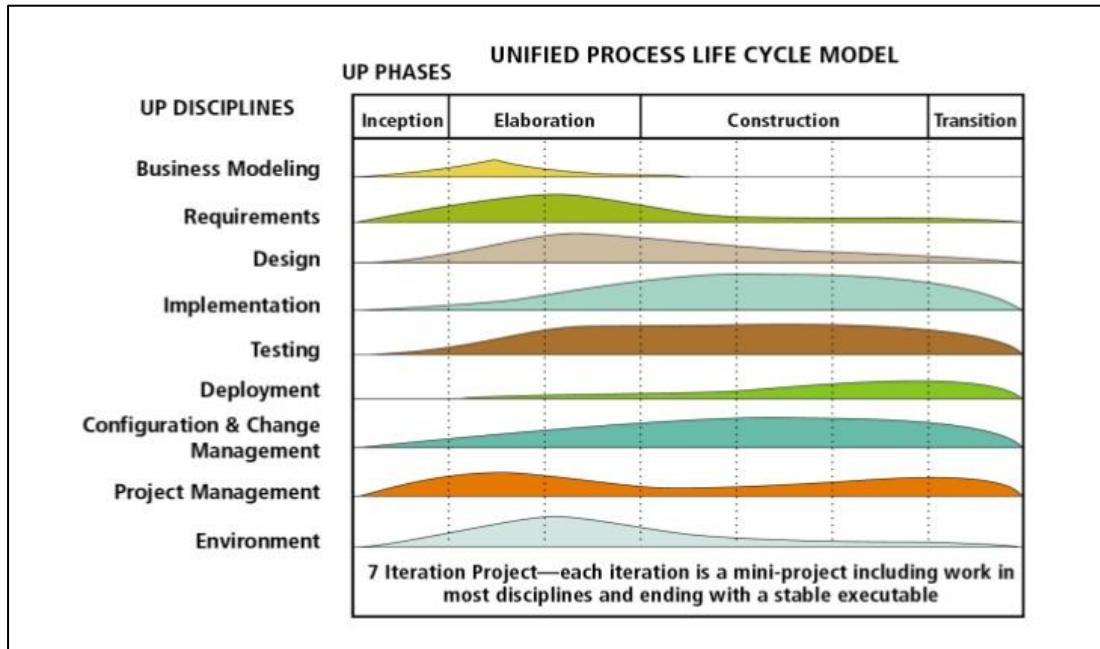


Figure 2.7: Rational Unified Process Model

- **Inception phase** - “The goal of the inception phase is to establish a business case for the system. You should identify all external that will interact with the system and define these interactions. You then use this information to assess the contribution that the system makes to the business. If this contribution is minor, then the project may be canceled after this phase.” [3]

- **Elaboration phase-** “The purpose of the elaboration phase is to analyze the problem domain, establish a sound architectural foundation, develop the project plan, and eliminate the highest risk elements of the project. To accomplish these objectives, you must have the “mile wide and inch deep” view of the system. Architectural decisions have to be made with an understanding of the whole system: its scope, major functionality and nonfunctional requirements such as performance requirements.” [7]
- **Construction phase-** “During the construction phase the majority of the development work is completed, all applications components and features are integrated and end-to-end testing is executed.” [8]
- **Transition phase-** “Easier thought of as deployment, the transition phase is when the finished product is finally released and delivered to customers. However, the transition phase is more than just the process of deployment; it must also handle all post-release support, bug fixes, patches, and so forth.” [9]

2.7.1 Why Choose the Rational Unified Process,

- Reduced risk as the issues are discovered early in the process.
- Integration is performed throughout the development life cycle; therefore, less time is needed for the integration process.
- Reuse of components is addressed in RUP; therefore, the development time is less.

Chapter 3: Design

The design phase decides how the system will operate in terms of the hardware, software, and network infrastructure that will be in place; the user interface, forms, and reports that will be used; and the specific programs, databases, and files that will be needed.

3.1 Alternative Solutions for the System.

The ultimate goal of the PU of Kandy General hospital is to enhance the system efficiency and the process is required to be an unequivocal one which will facilitate the operating staff to manage and handle all these related details simply and ethically. The management has several alternative solutions to contrast and compare. Some of the key solutions are shown described in the Table 3.1.

	Continue with the Current System	Use a Commercial Software	Use a free Software Package
Description	The whole process is handled and maintained in a file based manual system.	Commercially available systems are designed for a specific task which cause user to do little or no modification.	Free software is software that can be freely used, modified and redistributed. Which means users can improve and change the software as per their needs.
Drawback	Lack of data integrity, data redundancy and inconsistency. Slow and inefficient Error prone	Expensive All the user requirements are not addressed. Availability of unused/ unwanted features. Lack of security concern.	No proper documentation. Not user friendly Not trustworthy Low user support

Table 3.1: Alternative solutions for the System

3.2 The system as a Web-based Solution.

Web-based software is a system that can be used over the internet with a web browser. It does not require installation by CDs, downloading any other software, or worrying about upgrades as they often run inside a web browser. Besides this developing system's requirements are clearly fit into this web-based solution. Beneath are the core benefits of using a Web-Based System.

- Cost-effective development

Only the application needed to be tested on different web browsers as the users access the system via web-browsers.

- Accessible anywhere

Since the Internet has no physical limitations, users can access the system from where ever they are with an Internet Connection deprived of walking into the office.

- Easily Customizable

User interfaces of the System are easily customizable as to the user groups without any struggle.

- Device-independent

Any sort of new version or an upgrade is needed to be installed only on the host server, hence easier installation and maintenance.

- Increased Security

Web-based applications are usually deployed on dedicated servers, which are constantly monitored by experienced server administrators. This is far more effective than monitoring every single-user computer as in the standalone applications.

3.3 Equipment Procurement Management System Design

Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Systems design could be seen as the application of systems theory to product development. EPMS contains basic computer-based system functions under ten (10) key modules.

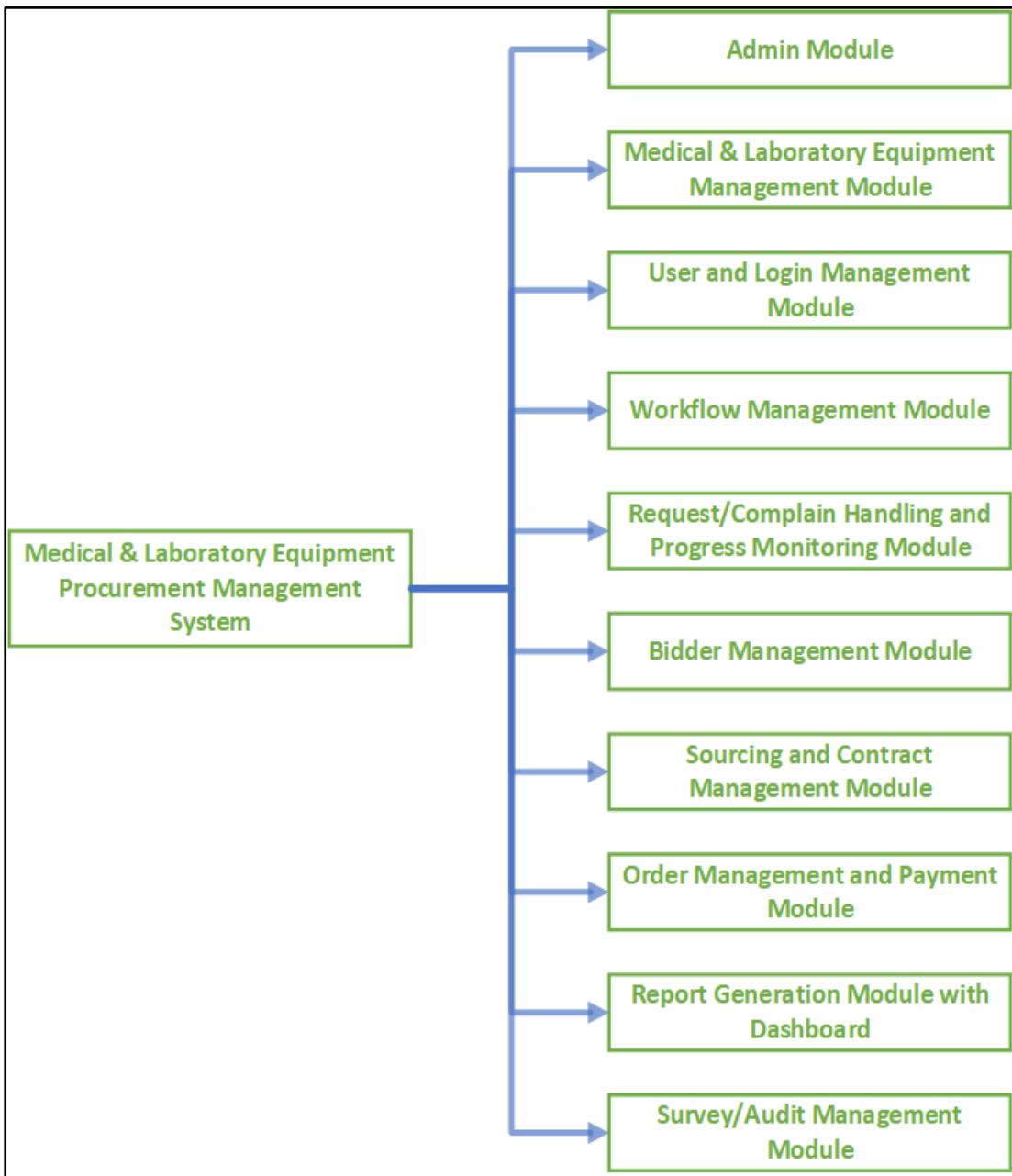


Figure 3.1: Modules of Developing System

3.3.1 High-Level Use Case Diagram for the Developing System

“A use case depicts a set of activities performed to produce some output result. Each use case describes how an external user triggers an event to which the system must respond.” [10]

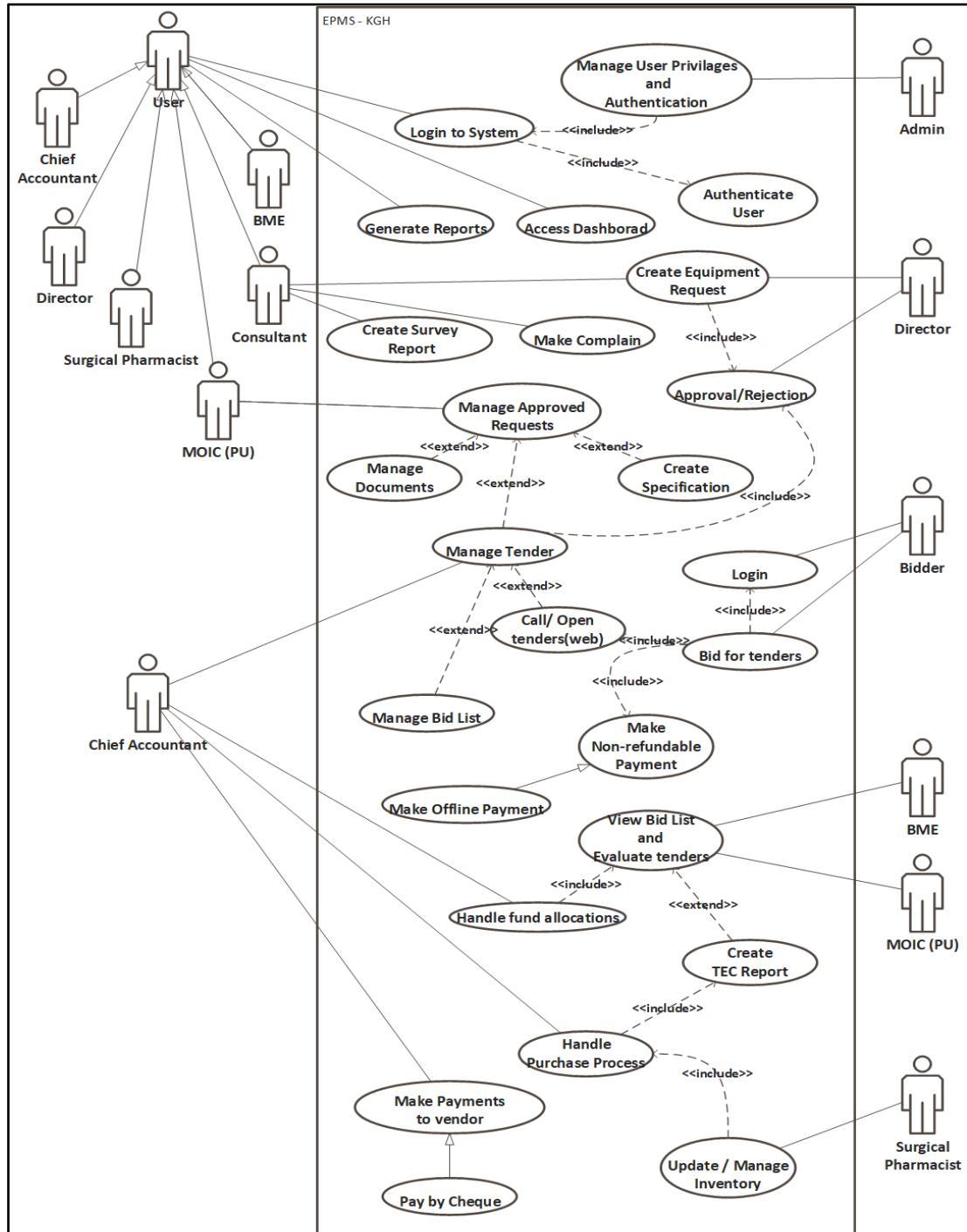


Figure 3.2: High-Level Use Case Diagram for the Proposed System.

3.3.2 Class Diagram for the Developing System

“Class diagrams are used when developing an object-oriented system model to show the classes in a system and the associations between these classes. Loosely, an object class can be thought of as a general definition of one kind of system object. An association is a link between classes that indicates that there is a relationship between these classes. Consequently, each class may have to have some knowledge of its associated class.” [3] Figure 3.3 is the class diagram for the designed system.

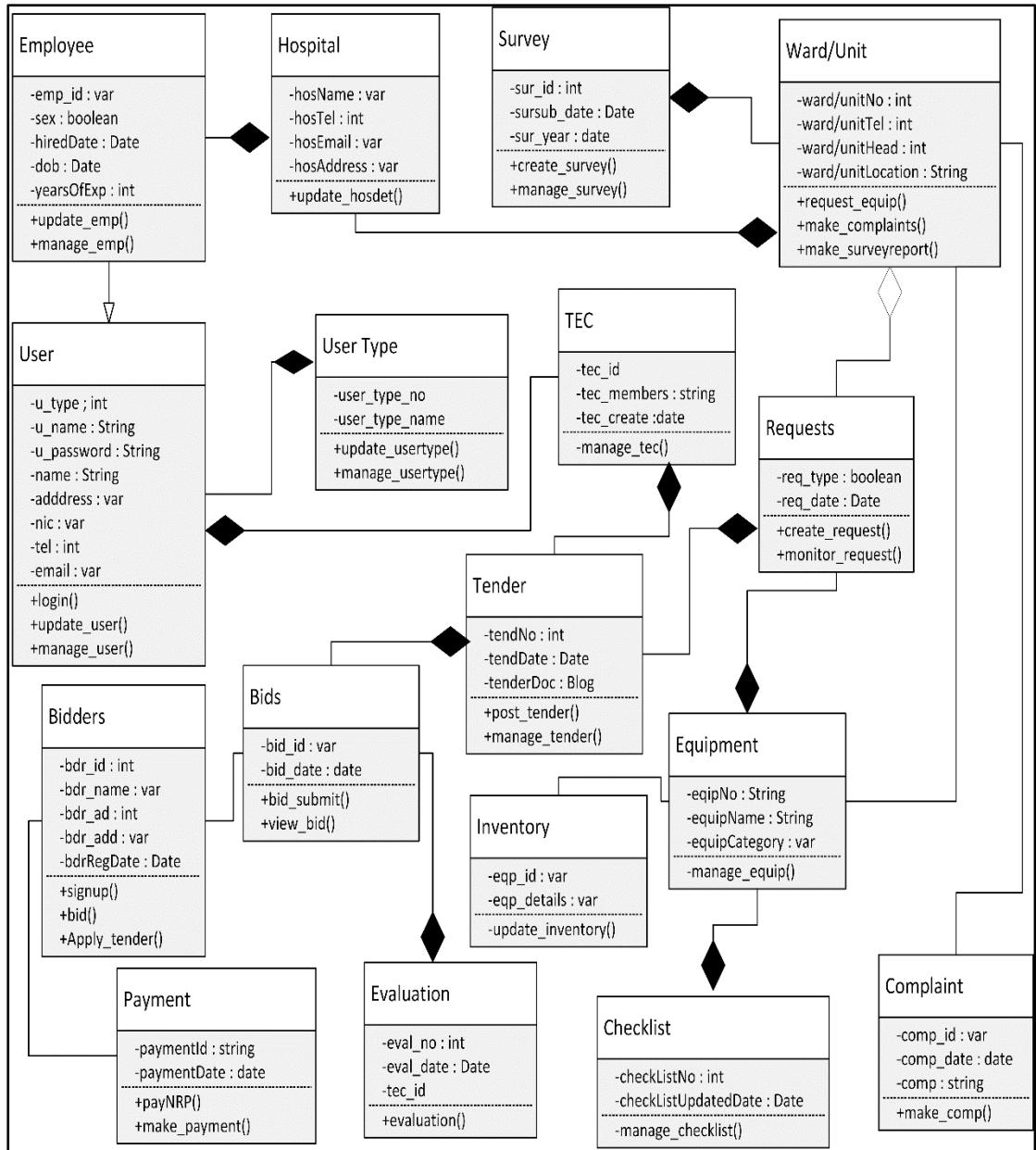


Figure 3.3: Class Diagram for the Developing System

3.3.3 EER for the Developing System

An entity-relationship model also called an entity-relationship (ER) diagram, is a graphical representation of entities and their relationships to each other, typically used in computing in regard to the organization of data within databases or information systems. Expanded version of ER diagram is Enhanced entity-relationship (EER) diagram. EER models are helpful tools for designing databases with high-level models. With their enhanced features, you can plan databases more thoroughly by delving into the properties and constraints with more precision. [11] Enhanced Entity Relationship diagram of the designed system is shown in the Figure 3.4.

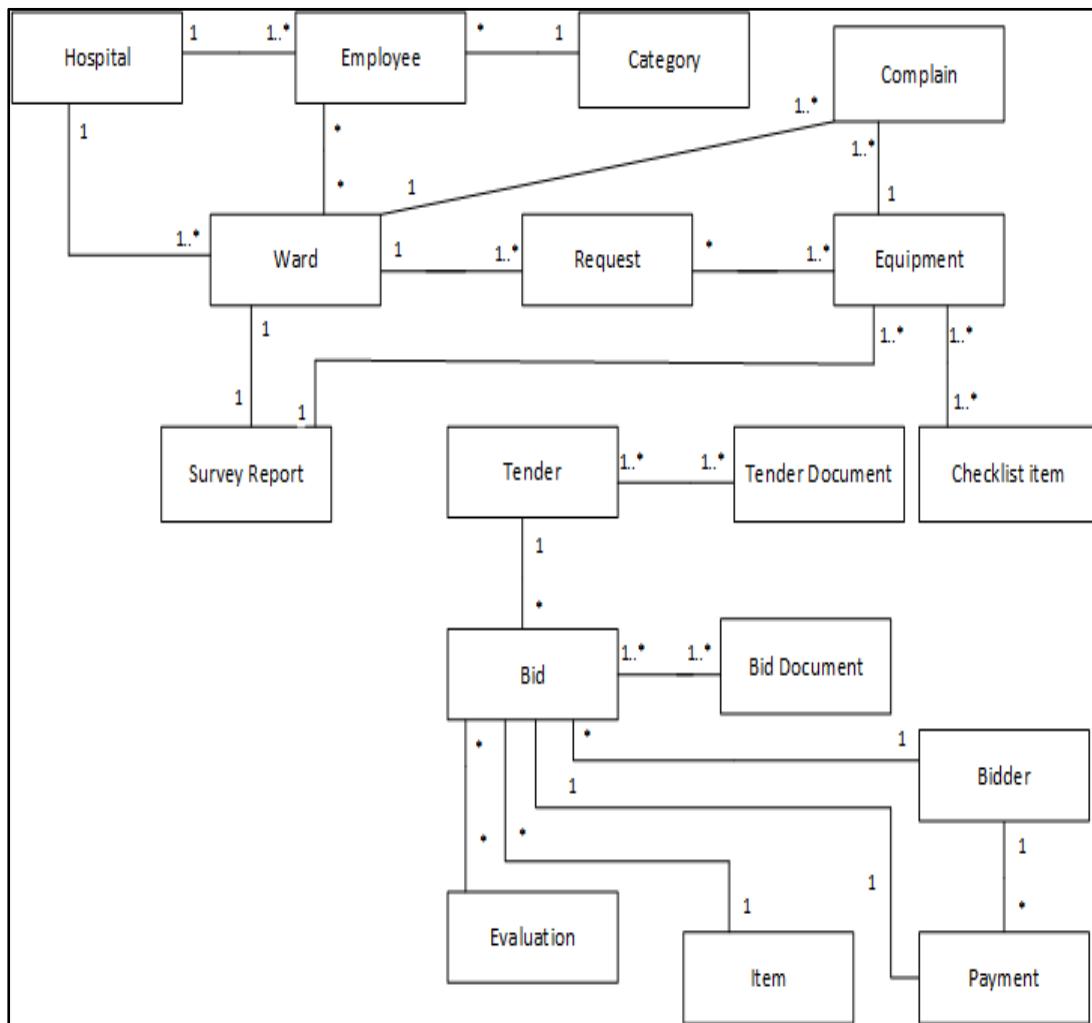


Figure 3.4 : EER Diagram of the Developing System

3.3.4 Sequence Diagram for the Developing System

“Sequence diagrams in the UML are primarily used to model the interactions between the actors and the objects in a system and the interactions between the objects themselves. The UML has a rich syntax for sequence diagrams, which allows many different kinds of interaction to be modeled” [3] Sequence diagram for the Request Handling Module is shown in the Figure 3.5.

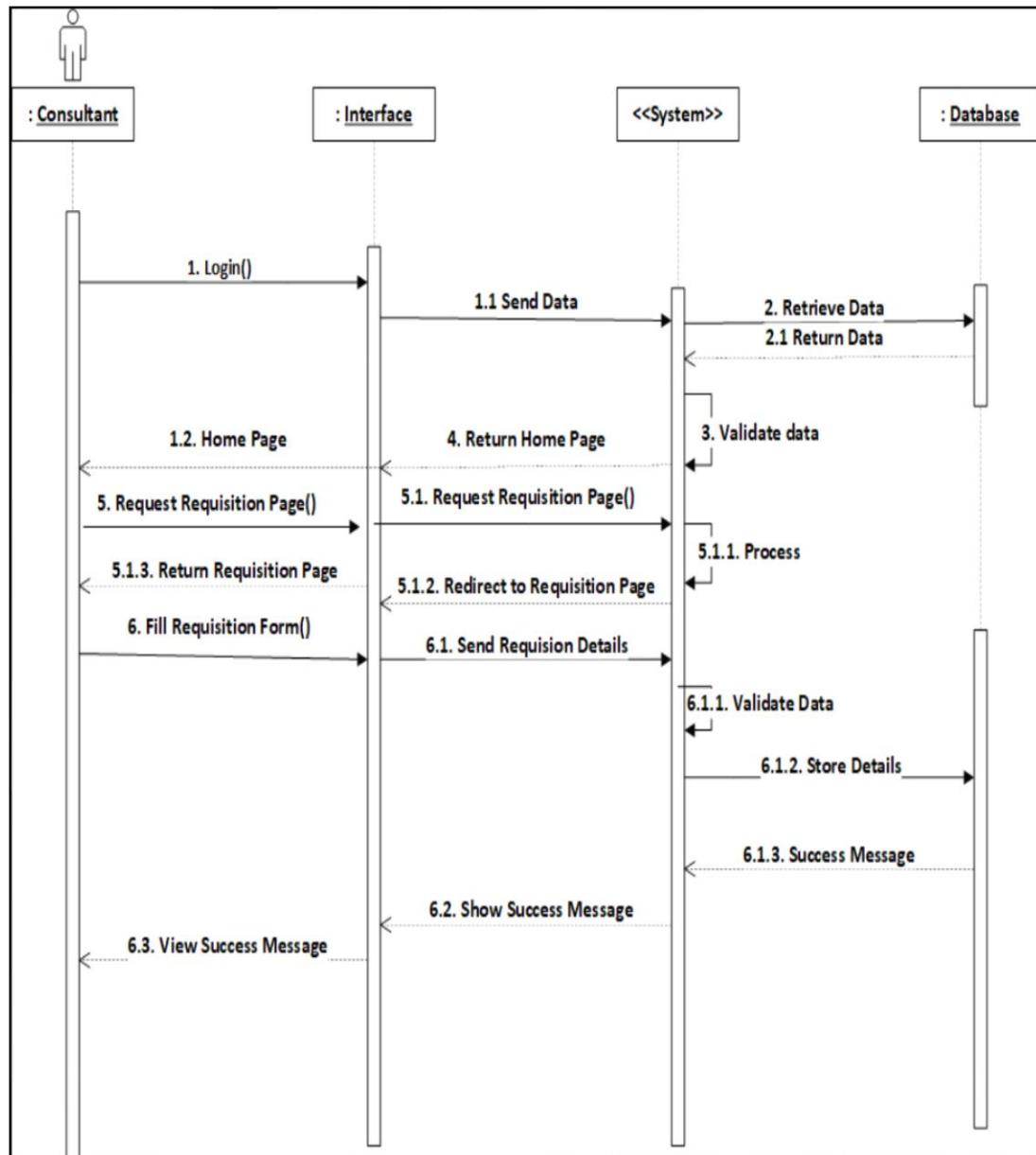


Figure 3.5: Sequence Diagram for the Request Handling Module

3.3.5 Activity Diagram for the Developing System

“Activity diagrams are intended to show the activities that make up a system process and the flow of control from one activity to another.” [3] Activity diagram for the Request Handling module is shown in the Figure 3.6.

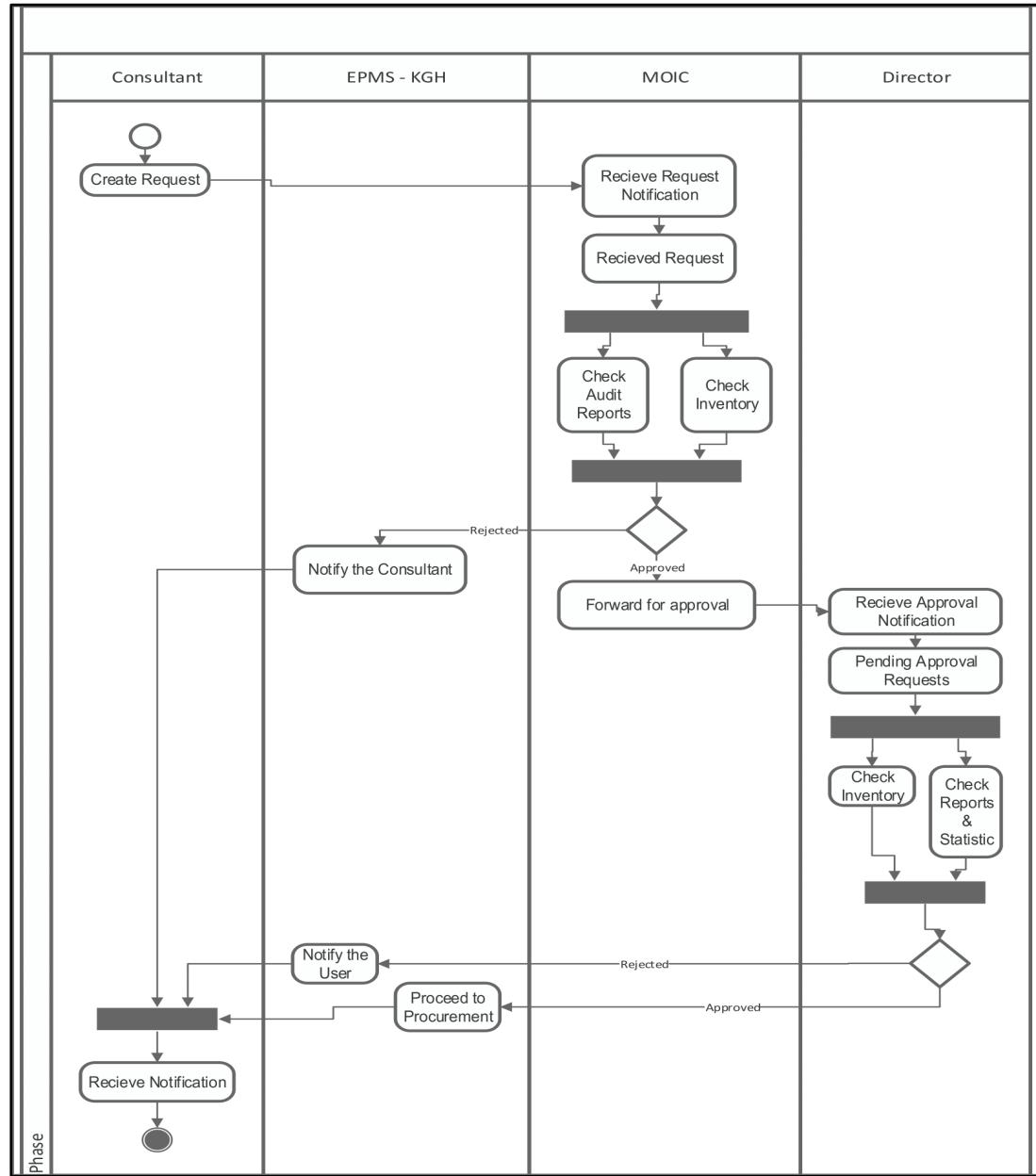


Figure 3.6: Activity Diagram for the Request Handling Module

3.4 User Interface Design

The user interface design defines the way in which the users will interact with the system and the nature of the inputs and outputs that the system accepts and produces. The user interface includes three fundamental parts. The first is the navigation mechanism, the way in which the user gives instructions to the system and tells it what to do (e.g., buttons, menus). The second is the input mechanism, the way in which the system captures information (e.g., forms for adding new customers). The third is the output mechanism, the way in which the system provides information to the user or to other systems (e.g., reports, Web pages).

3.4.1 Login Interface

Authorizing the system users is an essential feature in any system. Providing the system with a login interface gives the best and the easiest solution. Only the entitled users are able to access the relevant functionalities of the system. Figure 3.7 shows a rough sketch of a login interface designed for the system at the beginning of the construction phase.

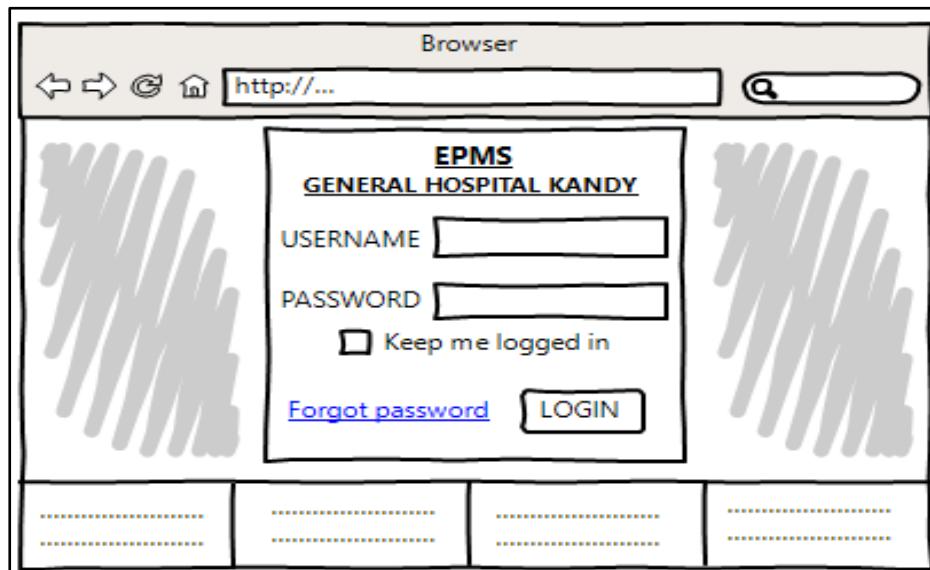


Figure 3.7: Login Interface Sketch

3.4.2 Admin Dashboard

Following depicts a sketch of the admin dashboard which visualize the admin with different statistics and charts etc. A side menu has been introduced to navigate through the system. Rough sketch of a designed Admin dashboard is shown in Figure 3.8.

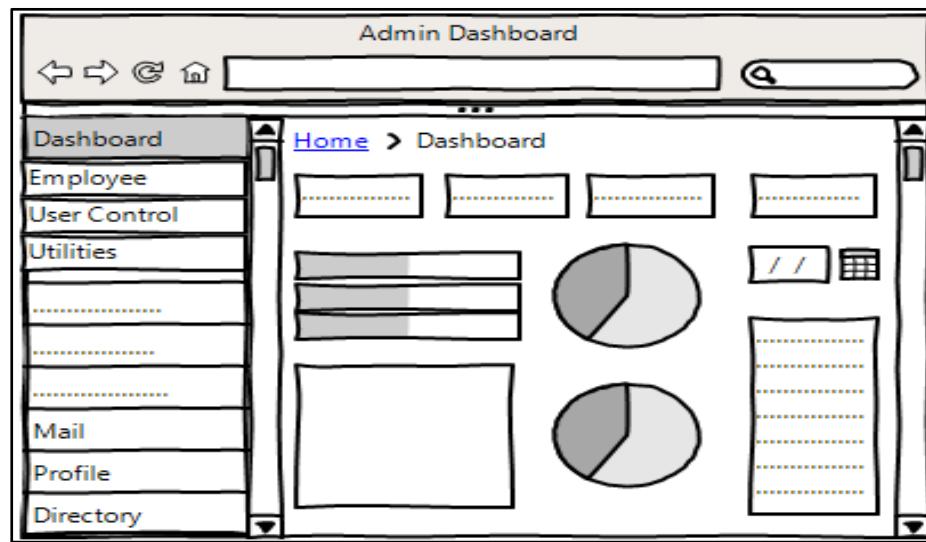


Figure 3.8: Admin Dashboard

3.4.3 Equipment Registration Form

This allows the users to add equipment details to the system. It will help to evaluate the equipment individually. Figure 3.9 is a designed Equipment Registration form.

The figure shows a wireframe of an 'Equipment Registration Form' titled 'EPMS - KGH'. The header includes back, forward, search, and refresh icons. The breadcrumb navigation shows 'Home > Equipment Add Equipment'. The main form is titled 'Step 01 - Basic Details' and contains fields for 'Equipment Name' (with a dropdown arrow), 'No.' (with a dropdown arrow), and 'Category' (with a dropdown arrow). A 'Next >' button is located to the right of the category field. Below this is a table titled 'Equipment' with columns 'Equipment', 'Equip No', 'Status', and 'Actions'. The table contains three rows: 'Incubator' (Equip No EQ002, Status, Actions 'Edit View'), 'EQ003' (Equip No EQ003, Status, Actions 'Edit View'), and 'EQ004' (Equip No EQ004, Status, Actions 'Edit View').

Figure 3.9: Equipment Registration Form

Chapter 4: Implementation

4.1 Introduction

The main focus of the Implementation phase, which is a key stage in SDLC is to translate the design model, which was developed in the earlier stage, into a complete operable system using the necessary tools and techniques. Merely, this is the stage where we take actions to follow the preliminary thinking in order to make it actually happen. As stated by R. Pressman, in his book “Software Engineering A Practitioner’s Approach” it says that during implementation, “Models are translated into source code” [12]

The system was built on the grounds of coding with appropriate comments and ensuring readability, understandability to ease future maintenance and updates.

4.2 Implementation Environment

The implementation environment can be divided into two categories.

4.2.1 Hardware Environment

EPMS was developed on a computer consisting of the following configurations

- **Intel(R) Core (TM) i7-7500U CPU @ 2.70GHz**
- **8 GB Ram**
- **1TB Hard Disk**

4.2.2 Software Environment

- **Operating System – Windows 10 Enterprise 64-bit**
- **PHP Version 5.6.23**
- **MySQL 5.0.11**
- **Apache 2.4.17**

4.3 System Development Tools and Technologies Used

The development of a project involves the use of software along with the use of several technologies and also the use of many other different tools. EPMS was developed with the aid of both commercial and open-source software. Listed below are the main software and technologies used.

- **XAMPP 3.2.1** - A software package that was an aid to install and config PHP, Apache and MySQL.
- **PHP** - This is a server-side scripting language that is freely available, PHP was used to develop the logic of system functions.
- **MySQL (Structured Query Language)** - Widely available open-source software which was used to handle a database of the system.
- **HTML (HyperText Markup Language)** - It is a simple language that allows one to structure the system clearly and concisely. HTML was used to develop the user interfaces of the system.
- **CSS (Cascading Style Sheet)** - CSS was used to stylize the system making it appealing to users.
- **JavaScript** - Client-side scripting was done using JavaScript as some codes are required to run only on the client's computer.
- **jQuery** - A JavaScript library that was an aid to add reusable components when developing the system.
- **Ajax** - A JavaScript-based technology that was used to update the system components on a webpage without refreshing it.
- **Microsoft Visio 2013** - Most of the diagrams were designed by this software.
- **Visual Studio Code** - Visual Studio Code is a source code editor developed by Microsoft for Windows, Linux, and macOS. It includes support for debugging, embedded Git control and GitHub, syntax highlighting, intelligent code completion, snippets, and code refactoring.

4.4 Reusable Components

Reusable components were utilized to develop the system effectively as well as more interactively. The following reusable components were utilized to improve unwavering quality and the adequacy of the development.

➤ Bootstrap

- Bootstrap makes front-end web development faster and easier.
- Limitless, a new professional admin template, based on the Bootstrap framework. Limitless is a powerful and super flexible tool, which suits best for any kind of web application. [13]

➤ Typeahead search

- A method for progressively searching for and filtering through text. It is also sometimes known as autocomplete, incremental search, search-as-you-type, inline search, instant search, and word wheeling.

➤ JQuery Validate Plugin

- This allows to validate user inputs using pre-defined validations rules as well as custom validation rules.

➤ PHPMailer

- PHPMailer is a code library to send emails easily and safely via PHP code from a web server.

➤ Datatable Extension Button

- A JavaScript library that used to retrieve data from the database and exposes the data in frontend efficiently without writing a whole lot of code.
- This facilitates options such as,
 - Export to PDF
 - Export to Excel
 - Export to CSV
 - Copy to Clipboard

➤ Date Picker / Date Range Picker

4.5 Implementation Architecture of the System.

EPMS is a web-based system and therefore requires a server for it to be hosted. It requires two different servers, one for the e-tender site and another database server for the Database. This ensures high levels of security as well as better performance. The Bidders can use the internet to access the system and bid for tenders. Designed implementation architecture for the system is shown in Figure 4.1.

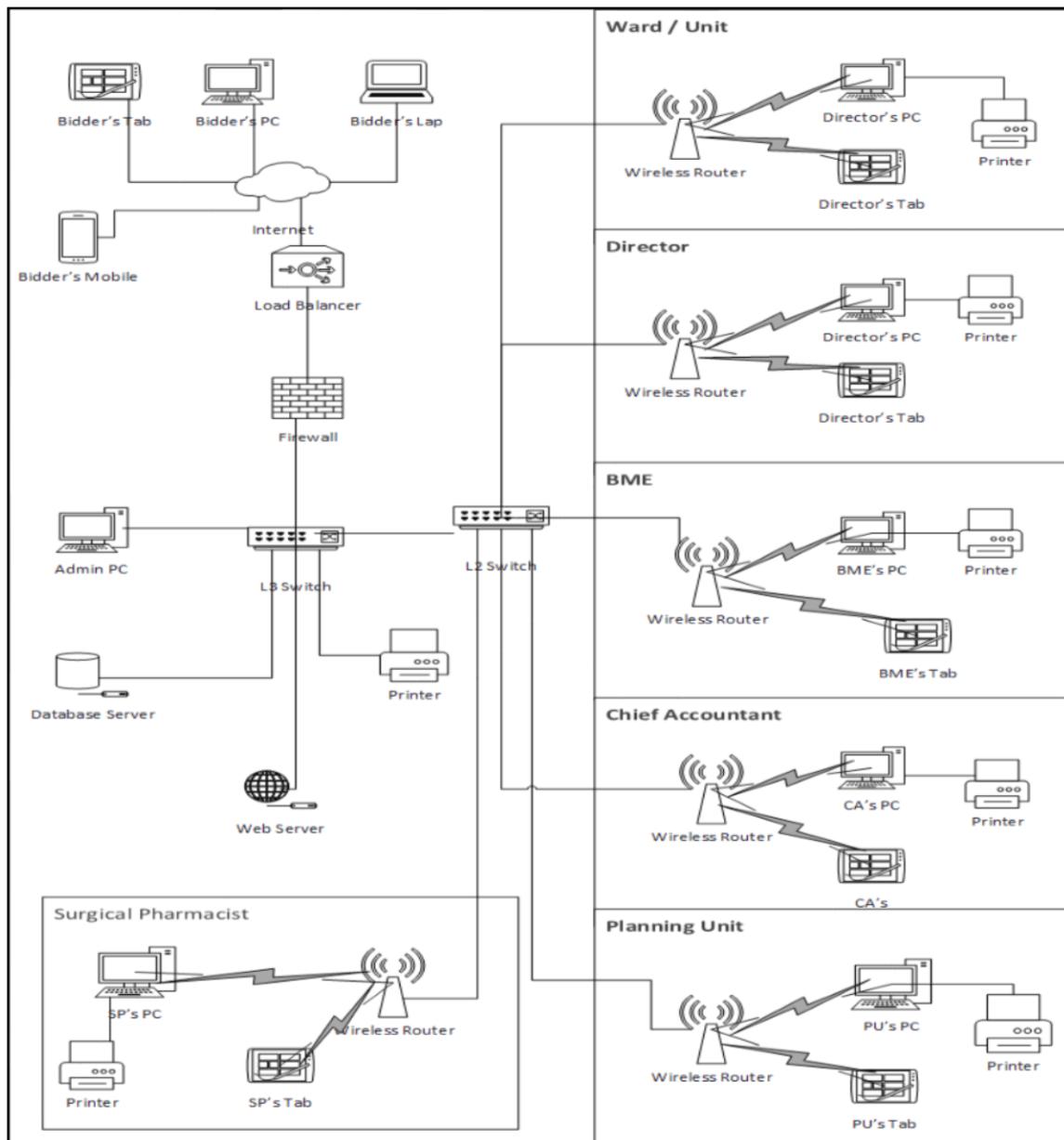


Figure 4.1: Implementation Architecture of the System

4.6 Major Code Segments

Given beneath are some of the major code snippets from a couple of important modules that were used to develop the system.

4.6.1 Database Connection

A database is the main component of the system which comprised all the collections of data and information that has a regular structure and is organized in such a way that a computer can easily find the desired information. All the collected data are organized into rows, columns and tables. Also, it is indexed to make it easier to find relevant information. Whenever a piece of new information is added, these data get updated, expanded and deleted. Seeing all these facts, the database of the EPMS was developed using the MySQL database.

```
<?php
//database connection class
class Connection {
    private $server;
    private $username;
    private $password;
    private $db;
    //constructor method of Connection class
    public function Connection () {
        $this->server = "localhost";
        $this->username = "root";
        $this->password = "";
        $this->db = "nhk_epms";
    }
    function db_con(){
        $con = new mysqli($this->server,$this->username,$this-
>password,$this->db);
        if($con->connect_errno) {
            echo("Connection error: ");
            echo($con->connect_errno);
            echo(" ". $con->connect_error);
            exit;
        }
        return $con; //return connection object
    }
}
?>
```

4.6.2 Login Controller

Following depicts the code segment for the login controller, which is a key feature in any sort of a system. It should ensure security and accessibility of the system to the users. Here, when the user enters username and the password in the relevant fields of the login interface, system once verified with the database, checks for the user status of that particular user and if it is “1” (active), a session is created and directs the user to the page as per the user type.

```
<?php
    session_start();
    require_once("class_dbconnection.php");

    $uname=$_POST["uname"];
    $pass=$_POST["pass"];
    //echo($uname);
    $obj=new Connection ();
    $con=$obj->db_con();
    $sql="SELECT * FROM epms_users WHERE User_username='".$uname."'";
    $result=$con->query($sql);
    if($con->errno) {
        echo ("SQL Error".$con->error);
        exit;
    }
    $nor=$result->num_rows;
    //echo($nor);
    if($nor>0) {
        $rec=$result->fetch_assoc();
        $pass=md5($pass);
        if($pass==$rec["User_password"]) {
            if($rec["User_status"]=="1") {
                $_SESSION["user"]["uname"]=$uname;
                $_SESSION["user"]["uid"]=$rec["User_sn"];
                $_SESSION["user"]["utype"]=$rec["User_type_name"];
                echo ("3");
            }
            else {
                echo ("2");
            }
        }
        else {
            echo ("1");
        }
    }
    else {
        echo ("1");
    }
    $con->close ();
?>
```

Routing process of the users as per their user type is done by the code segment shown below.

```
<?php
    session_start();
    if(!isset($_SESSION["user"]))
    {
        header("Location:../index.php");
    }
    $utype=$_SESSION["user"]["utype"];

    if($utype=="Admin")
    {
        header("Location:../Admin/dashboard.php");
    }
    else if($utype=="Consultant")
    {
        header("Location:../Consultant/dashboardcon.php");
    }
    else if($utype=="MOIC")
    {
        header("Location:../MOIC/dashboardmoic.php");
    }
    else if($utype=="Director")
    {
        header("Location:../Director/dashboarddir.php");
    }
    else if($utype=="Chief Accountant")
    {
        header("Location:../Chief_Accountant/dashboardchef.php");
    }
    else if($utype=="Surgical Pharmacist")
    {
        header("Location:../Surgical_Pharmacist/dashboardsurg.php");
    }
?>
```

4.6.3 Function to add data into Database

Following code snippet shows the function used in the system to add employees in to the system. Hence the system holds vast amount of valuable data records of whoever involved with system is need to be recorded in the system for any future reference. Beneath is the function used to save the data of the employees creating a unique ID to identify each employee separately and save in the database. Similarly, same sort of way is used changing the fields, variables, function name and etc. for all the other occasions wherever a form is needed to be saved to the database.

```
//save form
$("#save").click(function(){
    sendData = new FormData($("#empcrtfrm")[0]);
    $.ajax({
        method: "POST",
        url: "./DBhandle/employee_create_con.php?code=save",
        data: sendData,
        processData: false,
        contentType: false
    }).done(function (msg) {
        getdatatotable();
        $("#initials").val("");
        $("#fname").val("");
        $("#morf").val("");
        $("#salutation").val("");
        $("#dob").val("");
        $("#nic").val("");
        $("#address").val("");
        $("#email").val("");
        $("#home_tel").val("");
        $("#mob_tel").val("");
        $("#djoin").val("");
        $("#workid").val("");
        $("#jtitle").val("");
        $("#unit").val("");
        $("#ward").val("");
    });

    preventDefault();
})
});
```

By clicking the save button, using jQuery, inputs are collected and passed to the employee controller page with the type. The employee controller page checks the type and calls the relevant method to assign values to the variables and execute the query to return the result.

```

$ sql = "INSERT INTO `epms_employee`(`Emp_id`, `Emp_nwi`, `Emp_name`, `Emp_gender`, `Emp_salutation`, `Emp_dob`, `Emp_nic`, `Emp_add`, `Emp_email`, `Emp_tel_home`, `Emp_tel_mobile`, `Emp_join_date`, `Emp_job_role`, `Emp_workid`, `Emp_assigned_unit`, `Emp_assigned_ward`)

VALUES('$new.empid','$namewi','$namefull','$gender','$salute','$bdate','$nationalid'
,'$Address', '$mail', '$Hphone', '$Mphone', '$jdate', '$jtitle', '$workingid', '$Unit', '$Ward')";

$result = mysqli_query($conn, $sql);

if (!$result) {
    echo mysqli_error($conn);
}
else{
    echo "success";
}
}

```

4.6.4 Function to retrieve data to a table and dropdowns from the Database

Beneath is the Ajax request sent to retrieve the data from the database to the tables and dropdowns in the frontend. All the retrievals of data from database to the frontend is handled in a similar way, throughout the system.

```

function mydatatable(){

    $('#empmangtb').DataTable();
}

$(document).ready(function () {
    mydatatable();

    $.ajax({
        method: "POST",
        url: "../DBhandle/employee_create_con.php?code=get_data",
        processData: false,
        contentType: false
    })
    .done(function (data) {
        $('#empmangtb').DataTable().destroy();
        $('#empmangtb tbody').empty();
        $('#empmangtb tbody').append(data);
        mydatatable();
    });
});

```

The employee controller page checks the type and calls the relevant method to assign values to the variables and execute the query to return the result.

```
<?php
if(isset($_GET["code"])){
    $code=$_GET["code"];
    switch($code){
        case "get_data":
            getdata();
            break;
    }
}
//get data to the table from the database
function getdata(){
    $servername = "localhost";
    $username = "root";
    $password = "";
    $db = "nhk_epms";

    // Create connection
    $conn = mysqli_connect($servername, $username, $password, $db);
    // Check connection
    if (!$conn) {
        die("Connection failed: " . mysqli_connect_error());
    }
    $sql = "select * from `epms_employee`";
    $result = mysqli_query($conn, $sql);
    if (mysqli_num_rows($result) > 0) {
        // output data of each row
        while($row = mysqli_fetch_assoc($result)) {
            echo
                "<tr><td>" . $row["Emp_id"] . "</td><td>" . $row["Emp_workid"] . "</td>
                <td>" . $row["Emp_name"] . "</td><td>" . $row["Emp_job_role"] . "</td>
                <td>" . $row["Emp_assigned_unit"] . "</td><td>" . $row["Emp_assigned_war
                d"] . "</td><td>" . $row["Emp_join_date"] . "</td>
                <td>
                    <ul class='icons-list'>
                        <li><a><i class='icon-pencil7'></i></a></li>
                        <li><a><i class='icon-trash'></i></a></li>
                    </ul>
                </td>
            </tr>";
        }
    } else {
        echo "0 results";
    }
}

?>
```

Retrieval of data to a dropdown / Select search box is done in a similar method. Following is the code snippet used to retrieve data from a table in the database to a dropdown in the form.

```
//get data
$(document).ready(function () {

    //to select box
    //unit name
    $.ajax({
        method: "POST",
        url: "../DBhandle/employee_create_con.php?code=get_unitselect_data",
        processData: false,
        contentType: false
    })
    .done(function (data) {
        $("#unit").append(data);
    });
});
```

```
<?php
if(isset($_GET["code"])){
    $code=$_GET["code"];
    switch($code){

        case "get_unitselect_data":
            get_unitselect_data();
            break;
    }
}
//get unit list to the unit select box
function get_unitselect_data(){
    $servername = "localhost";
    $username = "root";
    $password = "";
    $db = "nhk_epms";

    // Create connection
    $conn = mysqli_connect($servername, $username, $password, $db);
    // Check connection
    if (!$conn) {
        die("Connection failed: " . mysqli_connect_error());
    }

    $sql = "select * from `epms_unit`";

    $result = mysqli_query($conn, $sql);
```

```

if (mysqli_num_rows($result) > 0) {
    // output data of each row
    while($row = mysqli_fetch_assoc($result)) {
        echo "<option>" . $row["Unit_name"] . "</option>";
    }
} else {
    echo "0 results";
}
?>

```

4.6.5 Code Segment to generated Requested Equipment ID

Employee id, Unit/Ward id, Procurement id, Tec id and etc. in the system are generated in a similar way.

```

//create req_eqp id
$sql2 ="SELECT Req_equip_id FROM epms_req_equip ORDER BY Req_eqp_sn D
ESC LIMIT 1 ";
$result2=mysqli_query($conn,$sql2);

$rowcount=mysqli_num_rows($result2);

if ($rowcount>0) {
    $row = mysqli_fetch_assoc($result2);
    $last_id2 = $row["Req_equip_id"];
}

$requeqp_number = substr($last_id2,7,13);
$newrequeqp_number = str_pad(intval($requeqp_number) + 1, strlen($requeqp_number),'0', STR_PAD_LEFT);
$new_reqeqpid = "REQEQP-".$newrequeqp_number;
?>

```

4.6.6 Code Segment of document checklist count and switch color on bid approval.

Just as in the following code block, a count of the submitted documents is converted to a percentage after dividing the count by the total number of documents.

```

$sql = "SELECT * FROM `epms_bids` AS b , `epms_preliminaryeval` AS p ,
`epms_tenders` AS t WHERE b.`Bid_id` = p.`Bid_id` AND b.`Procurement_id` = t.`P
rocurement_id`";

$result = mysqli_query($conn, $sql);

if (mysqli_num_rows($result) > 0) {
    // output data of each row
    while($row = mysqli_fetch_assoc($result)) {

        $precent = ($row["Count"]/22)*100;
        $tender_sn = $row["Tender_sn"];

        $status = $row["Bid_status"];
        $clr = "";

        switch($status){
            case "Approved":
                $clr = "#65eb89";
                break;
            case "Rejected":
                $clr = "#d67272";
                break;
        }
        echo "<tr style='background-color: ".$clr."><td>" . $row["Procurement_id"] . "</td>
<td>" . $row["Bidder_id"] . "</td>
<td>" . $row["Procure_title"] . "</td>
<td>" . $row["Quantity"] . "</td>
<td>" . $row["Unit_price"] . "</td>
<td><a href='../../EPMS/Bid_Documents/$tender_sn.pdf'>DOC </a></td>
<td>
<div class='progress'>
<div class='progress-bar progress-bar-
info' style='width: ".$precent."%;'></div>
</div>
</td>
<td>
<button onclick='modalpop(" . $row["Bids_sn"] . ")' class='btn btn-default btn-
sm'>EVALUATE</button>
</td>

</tr>";
    }
} else {
    echo "0 results";
}

}

```

Chapter 5: Evaluation

5.1 Introduction

This chapter examines whether the software solution that has been created meets with all the client's requirements and standards before it is put into use. Also, it determines the quality and effectiveness of the designed instructions as well as the final product. Based on prepared sets of test cases, the system has been tested under numerous conditions and the errors found were eliminated before it reaches the client.

According to Glenford J. Myers, in his book “The Art of Software Testing”, “Software testing is a process, or a series of processes, designed to make sure computer code does what it was designed to do and that it does not do anything unintended. The software should be predictable and consistent, offering no surprises to users” [14]

5.2 System Test Plan

Here, the code blocks of the developed system units were tested separately in advance and then, the integration of the tested units and the system as a whole were checked for any sort of drawbacks. The modules of the system need to be faultless in order for the system to function well and effectively as a whole.

Therefore, as the final step of this testing phase, the completed system was deployed in the real environment, which the system is going to be used. Thus, the real users of the system are set to the testing of user experience and accomplishment of the user requirements. This is mainly concerned with the deployment of the development system.

“Deployment in this context focuses on the delivery of a software increment and the acquisition of feedback from end-users” [15]

“A test plan is a document describing the scope, approach, objectives, resources, and schedule of a software testing effort. It identifies the items to be tested, items not be tested, who will do the testing, the test approach followed, what will be the pass/fail criteria, training needs for team, the testing schedule etc.” [16]

5.3 System Test Cases

Test cases are critical for testing and checking functionalities of a system. A test case is comprising of test number, test description, steps, and expected result. Test cases having a place with some major functions of the implemented systems are depicted underneath.

5.3.1 Test Cases for User Login

Test No.	Test Description	Precondition	Steps	Expected Result
1	Authenticate Login Details	Must be in the User Login Page	Enter the correct username & password. Click "Login" Button	Login into the system.
2	Authenticate Login Details	Must be in the User Login Page	Enter the correct username & incorrect password. Click "Login" Button	Show an error message. "Invalid USERNAME or PASSWORD!"
3	Authenticate Login Details	Must be in the User Login Page	Enter incorrect username & correct password. Click "Login" Button	Show an error message. "Invalid USERNAME or PASSWORD!"
4	Authenticate Login Details	Must be in the User Login Page	Enter incorrect username & password. Click "Login" Button	Show an error message. "Invalid USERNAME or PASSWORD!"
5	Authenticate Login Details	Must be in the User Login Page	Click "Login" Button with empty fields.	Show an error message. "Please enter both username and password"

Table 5.1: Test Case for User Login

5.3.2 Test Cases for Employee Creation and Manage Employee

Test No.	Test Description	Precondition	Steps	Expected Result
1	Invalid Employee Working ID	Must be logged in to the employee registration form as an authorized user.	Enter a Working ID, fill the fields and Click Next Button	Display a message "Please enter a valid working ID"
2	Invalid NIC	Must be logged in to the employee registration form as an authorized user.	Enter a NIC, fill the fields and click Next Button.	Display a message "Please enter a valid NIC"
3	Click Next / Submit button without filling a field.	Must be logged in to the employee registration form as an authorized user.	Enter fewer details Click Next / Submit Button	Display Error Message "This is a required field!"
4	Enter already used Email Address	Must be logged in to the employee registration form as an authorized user.	Enter email address Click Submit Button	Show Error Message "Email is already in use!"
5	Invalid Contact Number	Must be logged in to the employee registration form as an authorized user.	Enter the contact number. Click Submit Button	Show Error Message "The input value must be 10 characters!"
6	All Valid Information	Must be logged in to the employee registration as an authorized user.	Enter all valid data. Click Submit button	Display Message "Added Successfully!"
7	Search user by ID/Name/Nic	Must be logged in to the employee table page as an authorized user.	Enter ID, Name or Nic in the search bar	Display Particular Employee information.
8	View an Employee	Must be logged in to the employee table page as an authorized user.	Select an Employee. Click View Button	Display Particular Employee Information

Table 5.2: Test Cases for Employee Registration and Manage Employee

5.3.3 Test Cases for User Creation and Manage

Test No.	Test Description	Precondition	Steps	Expected Result
1	Invalid Employee ID	Must be logged in as an authorized user, in the Add New User Form.	Enter an Employee ID, fill the fields and Click Submit form Button.	Display a message "Please enter valid Employee ID"
2	Empty User Status/Type Field	Must be logged in as an authorized user, in the Add New User Form.	Click the Submit form button with empty fields.	Display an error message "This is a required field!"
3	Enter an Invalid Date	Must be logged in as an authorized user, in the Add New User Form.	Enter a past/future date. Click Next / Submit Button.	Display Error Message "Please enter a valid date!"
4	Enter All Valid Data	Must be logged in as an authorized user, in the Add New User Form.	Enter valid data in all fields. Click Submit Button	Show Error Message "User created successfully"
5	View User	Must be logged in as an authorized user, in the User List Table.	Click View Button	Pop-up a modal with user data
6	Update User	Must be logged in as an authorized user, in the User List Table.	Click Update Button on the specific user's row.	Load the user on to the Create New User Form
7	Update All Valid Data	Must be Login as an authorized user. Required user must be loaded to the form. Must be in the Create New User Form.	Enter all valid data. Click Submit form Button	Display a message "Updated Successfully!!"

8	Update Invalid Data	<p>Must be Login as an authorized user.</p> <p>Required user must be loaded to the form.</p> <p>Must be in the Create New User Form</p>	<p>Insert Invalid data.</p> <p>Click Submit Form Button</p>	Display an error message “Please Insert Valid Data”
---	---------------------	---	---	---

Table 5.3: Test Cases for User Creation and Management

5.3.4 Test Cases for Equipment Request Module

Test No.	Test Description	Precondition	Steps	Expected Results
1	Request an Equipment	Must be logged in as an authenticated user. Must be in the confirmation step of the Request an Equipment Form.	<p>Enter all valid data</p> <p>Click Save Button.</p>	Display a message “Added Successfully”
2	Request an Equipment	Must be logged in as an authenticated user. Must be in the confirmation step of the Request an Equipment Form.	<p>Enter invalid data.</p> <p>Click Save Button.</p>	Display an error message “Please insert valid data”
3	Request an Equipment	Must be logged in as an authenticated user. Must be in the confirmation step of the Request an Equipment Form.	<p>Enter all valid data.</p> <p>Click Send for Approval.</p> <p>Click Save Button.</p>	Display a message “Added Successfully”
4	Request an Equipment	Must be logged in as an authenticated user. Must be in the confirmation step of the Request an Equipment Form.	<p>Enter invalid data.</p> <p>Click Send for Approval.</p> <p>Click Save Button.</p>	Display an error message “Please insert valid data”

5	Request an Equipment	Must be logged in as an authenticated user. Must be in the equipment details step of the Request an Equipment Form.	Empty Equipment Name Field. Click Add Button	Display an error message “This is a required field”
6	Request an Equipment	Must be logged in as an authenticated user. Must be in the equipment details step of the Request an Equipment Form.	Empty Quantity Field. Click Add Button	Display an error message “This is a required field”
7	Request an Equipment	Must be logged in as an authenticated user. Must be in the equipment details step of the Request an Equipment Form.	Empty Equipment List table. Click Next Button.	Display an error message “Please insert valid data”
8	Request an Equipment	Must be logged in as an authenticated user. Must be in the equipment details step of the Request an Equipment Form.	Enter all valid data Click Next Button.	Proceed to the Confirmation step.
9	Request an Equipment	Must be logged in as an authenticated user. Must be in the Requisition details step of the Request an Equipment Form.	Enter all valid data Click Next Button.	Proceed to Equipment Details step.

10	Request an Equipment	Must be logged in as an authenticated user. Must be in the Requisition details step of the Request an Equipment Form.	Enter all details with an invalid Date. Click Next Button	Display an error message “Please insert a valid date”
11	Request an Equipment	Must be logged in as an authenticated user. Must be in the Requisition details step of the Request an Equipment Form.	Empty Fields. Click Next Button	Display an error message “This is a required field”

Table 5.4: Test Cases for Equipment Request Module

5.3.5 Test Cases for Yearly Survey.

Test No.	Test Description	Precondition	Steps	Expected Result
1	Submit Annual Survey Report	Must be Login as an authorized user. Must be in the Survey Details step of the Yearly Survey Form.	Enter all valid data. Click Next Button	Proceed to Equipment Details step.
2	Submit Annual Survey Report	Must be Login as an authorized user. Must be in the Survey Details step of the Yearly Survey Form.	Enter invalid data. Click Next Button	Display an error message “Please insert valid data”

3	Submit Annual Survey Report	Must be Login as an authorized user. Must be in the Survey Details step of the Yearly Survey Form.	Empty Fields. Click Next Button	Display an error message “This is a required field”
4	Submit Annual Survey Report	Must be Login as an authorized user. Must be in the Equipment Details step of the Yearly Survey Form.	Empty Equipment Details table. Click Next Button.	Display an error message “Please insert valid data”
5	Submit Annual Survey Report	Must be Login as an authorized user. Must be in the Equipment Details step of the Yearly Survey Form.	Empty Fields. Click Add Button	Display an error message “This is a required field”
6	Submit Annual Survey Report	Must be Login as an authorized user. Must be in the Equipment Details step of the Yearly Survey Form.	Enter All valid Data. Click Add Button	Display a message “Updated Successfully”
7	Submit Annual Survey Report	Must be Login as an authorized user. Must be in the Equipment Details step of the Yearly Survey Form.	Enter All valid Data. Fill the Table Click Next Button	Proceed to the confirmation step
8	Submit Annual Survey Report	Must be Login as an authorized user. Must be in the Confirmation step of the Yearly Survey Form.	Click Submit Button	Display a message “Added Successfully”

Table 5.5: Test Cases for Yearly Survey

5.3.6 Common Test Cases

Test No.	Test Description	Precondition	Steps	Expected Result
1	Greet User	Must provide valid credentials and logged in	Log in to the system	Display greetings with username
2	Clear Fields	Must be logged in and in a particular form	Click Clear / Refresh Button	Clear all the fields
3	Change User Password	Must be Logged in	Click Change Password Button Click Submit Button	Display Message "Updated Successfully!"
4	Logout	Must be Logged in	Click Logout Button	Logout user and redirect to the index page.
5	Menus and Sub Menus	N/A	Click on menus and sub menus	Display relevant sub menus /load relevant pages
6	Check for different Browsers	Must be connected to the Internet	Try to access via different browsers	Perfectly works in all browsers
7	Restricted file access through URL (not login)	Must be connected to the Internet	Enter URL and click	Redirect to the login page

Table 5.6: Common Test Cases

5.4 User Acceptance

After successfully implementing the “Equipment Procurement Management System”, it was deployed in a user environment and tried by the MOIC and a couple of other staff individuals at the planning unit to ensure that the system’s functionalities meet the organization's requirements. Acceptance testing was done in two stages,

- Alpha testing – The users tried the system with dummy data to get a rough idea about the new system and to get used to it.
- Beta testing – The users try the system with real data and monitored it for any problems or errors that might occur in real-time use.

The MOIC has tried the system as the administrator of the system and a couple of staff members at the planning unit additionally have tried the system with their significant privileges by login as specific users of the system. Finally, a questioner was given to few staff individuals including the MOIC of the planning unit to get the user feedback more precisely.

For this, a standard questionnaire that was published by J. Lewis is used and to evaluate the system. Figure 5.1 was designed using the feedback on the “overall satisfaction of the system” section in the ‘user feedback form 2’ (Figure 5.3)

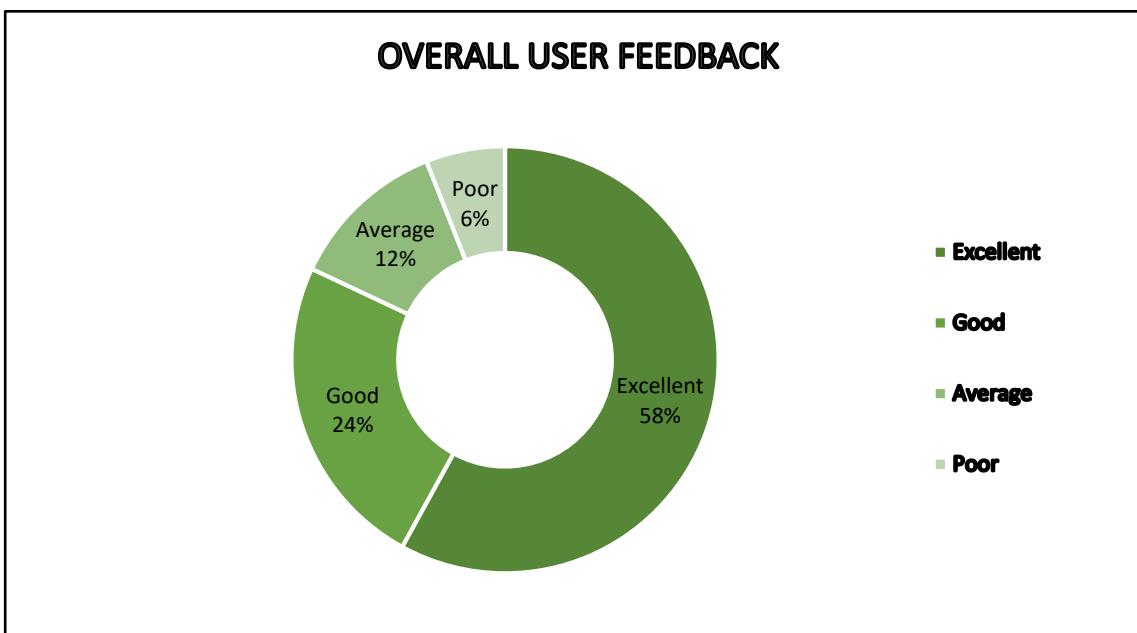


Figure 5.1: Overall User Feedback Chart

Collected feedback from the users and client acceptance certification for the system is attached in Appendix F and Appendix G respectively.

Beneath is the questioner used to get user feedback from the client environment.

User Feedback for Medical and Laboratory Equipment Procurement Management System						
	Test Measure	Strongly Disagree		Strongly Agree		
		1	2	3	4	5
1	Overall, I am satisfied with how easy it is to use this system.					
2	It was simple to use this system.					
3	I was able to complete the tasks and scenarios quickly using this system.					
4	I was able to effectively complete the tasks and scenarios using this system.					
5	I felt comfortable using this system.					
6	It was easy to learn to use this system.					
7	I believe I could become productive using this system.					
8	The system gives error messages that clearly told how to identify problems.					
9	Error messages, warning messages provided with this system was clear.					
10	It was easy to search the information I needed.					
11	It was easy to enter information to the system.					
12	The information was effective in helping me complete the tasks and scenarios.					
13	The interface of this system was simple to understand.					
14	I liked using the interface of this system.					
15	This system has all the functions and capabilities I expect it to have.					
16	Overall, I am satisfied with this system.					

Name: - Date: -

Designation: -

Signature: -

Figure 5.2: User feedback form 01

Module wise user feedback form

	Test Measure	Strongly Disagree		Strongly Agree		
		1	2	3	4	5
1	Admin Module					
2	Notification & Communication Module					
3	Laboratory & Medical Equipment Management Module					
4	User and Login Management Module					
5	Workflow Management Module					
6	Request/ Complain Handling and Progress Monitoring Module					
7	Vendor Management Module					
8	Sourcing and Contract Management Module					
9	Order Management and Payment Module					
10	Report Generation Module with Dashboard					

Overall Satisfaction of the System

(Please tick your satisfaction level about the system)

Excellent	<input type="checkbox"/>
Good	<input type="checkbox"/>
Average	<input type="checkbox"/>
Poor	<input type="checkbox"/>

Remarks

Figure 5.3: User feedback form 02

Chapter 6: Conclusion

6.1 Critical Evaluation of the Project

The management of the PU has discovered numerous issues and constraints with the file-based manual system which they were utilized for the procurement of medical instrumentality wants of the hospital. Hence the management has chosen to develop with the present technology for having better coordination with all the users involved in the process, including both internal and external stakeholders. The new system, Web-based Equipment Procurement Management System was produced to conquer all those issues they were having.

Since the beginning of the project, every requirement was accumulated utilizing meetups with the client, discussions and observing the client environment and the files they were using. In the analysis phase, all the functional and non-functional requirements were identified and documented. From all that collected, a workflow was designed at the designing stage with the needed diagrams and interfaces, etc. However, a couple of changes were made as per the client's suggestions.

The most critical function of all the functions is the workflow management module of the system. Due to the criticality of the module, the designed workflow had to be thoroughly evaluated and tested with the presence of the client to avoid any inconsistencies.

During the development stage, numerous testing was done and after collection of feedbacks, the entire system's usefulness was tested and the client concluded that the system is sufficient enough to satisfy the client's requirements and desires.

6.2 Lessons Learnt

As a student who is following this course of study, this was a brilliant chance to be concerned in the software developing field. It had been giving the chance to utilize theories and strategies in certifiable circumstances which were learned in several semesters of the degree program. Although various issues were encountered some way or another they were overcome and it allowed to figure out how to defeat those issues by meeting the supervisor and referring more other knowledge sources such as the internet, lecturers and past pupils.

In this way, it really gave the prospect to own a superior understanding of how to confront various types of issues when building up a system.

Likewise, it allowed us to induce a thorough understanding and gain skills in using varied forms of programming languages and database systems which aids in building up software systems. Practically involving in developing gave more opportunity to get hands-on programming skills and knowledge in using various algorithms and other programming techniques. Managing the client gave the comprehension of the way to impart and manage a real client and it has demonstrated that communication is a critical part of software developing field. Besides, it allowed to boost the collection and organizing information with facts and figures for decision making by composing every report associated with this project.

6.3 Future Enhancements of the Project

Software development is not a procedure which stops with the deployment of the system, it requires future changes and to stay aware of the modern trends as they advance, a couple of improvements that can be completed later has been proposed below,

- Integrate a real payment gateway to handle online transactions.

An online payment facility will be established for the bidders to pay the Non-refundable payment. So that they can download the Bid Document instantly after paying the relevant amount

- Expand the System to Jointly run with an Asset Tracking and Maintenance Management System.
- Build an SMS notification gateway to notify bidders.
- Implement the Equipment Procurement Management System in all the hospitals in the island and upgrade the “Medi-Tenders”, e-tendering portal as a place where all the tender notices of every hospital are made available to the bidders.
- Give a user access to the Ministry of Health, so that the ministry approval process become more efficient and faster.

References

- [1] "MINISTRY OF HEALTH, NUTRITION & INDIGENOUS MEDICINE," [Online]. Available: http://www.health.gov.lk/moh_final/english/others.php?pid=111. [Accessed 08 04 2019].
- [2] "National Hospital Kandy," [Online]. Available: <http://www.kandy-hospital.health.gov.lk/about-us/current-status.html>.
- [3] I. Sommerviller, Software Engineering, 9th ed., Boston: Addison-Wesley, 2011.
- [4] "Procurement," En.wikipedia.org, 2019. [Online]. Available: <https://en.wikipedia.org/wiki/Procurement>. [Accessed 27 05 2019].
- [5] "Promena," [Online]. Available: <https://www.promena.net/solutions/e-sourcing>. [Accessed 26 05 2019].
- [6] "Capterra," [Online]. Available: <https://www.capterra.com/procurement-software/>. [Accessed 23 05 2019].
- [7] "ibm," [Online]. Available: https://www.ibm.com/developerworks/rational/library/content/03July/1000/1251/1251_bespactices_TP026B.pdf. [Accessed 05 December 2019].
- [8] "SolutionIQ," [Online]. Available: <https://www.solutionsiq.com/agile-glossary/rational-unified-process/>. [Accessed 05 December 2019].
- [9] "Airbrake," [Online]. Available: <https://airbrake.io/blog/sdlc/rational-unified-process>. [Accessed 05 December 2019].
- [10] J. L. Whitten and L. D. Bentley, System Analysis and Design Methods, 7th ed., Boston: McGraw-Hill/Irwin, 2007.
- [11] "Cacoo," 09 05 2018. [Online]. Available: <https://cacoo.com/blog/er-diagrams-vs-eer-diagrams-whats-the-difference/>. [Accessed 19 02 2020].

- [12] R. S. Pressman, "Software Engineering" in A Practitioner's Approach, Seventh ed., New York: McGraw- Hill Higher Education, 2010.
- [13] "themeforest.net," [Online]. Available: https://themeforest.net/item/limitless-responsive-web-application-kit/13080328?gclid=EAIaIQobChMI1bHI0cbq5QIVhiQrCh2OqgIUEAAVASAAEgIKSPD_BwE. [Accessed 14 November 2019].
- [14] G. J. Myers, "The Art of Software Testing," Second Edition ed., Hoboken, New Jersey: John Wiley & Sons, Inc., 2004.
- [15] A. Dennis, B. H. Wixom and R. M. Roth., Systems analysis and design, 5th ed., United States of America: John Wiley & Sons, 2012.
- [16] "Software Testing Mentor," [Online]. Available: <https://www.softwaretestingmentor.com/what-is-testplan/>. [Accessed September 2019].

Appendix A – System Documentation

This section consists of the technical documentation necessary for the real users of the system to carry out further improvements on EPMS as well as details of minimum hardware & software requirements needed and detailed, step-by-step guidance to deploy the software in the site. The following steps lead the user to successfully install the Equipment Procurement Management System.

Step 1 - Make sure that your computer fulfills the following hardware and software requirements.

Hardware Requirements

Hardware	Minimum Requirement
Processor	Intel Pentium 3.0GHz or higher
Memory	1 GB Memory Capacity
Hard Disk	80GB Capacity
Display Resolution	Any Resolution as preferred by the user
Printer	LaserJet Printer or Inkjet Printer
Internet	512kbps broadband Internet connection

Table A.1: Hardware Requirements

Software Requirements

Software	Minimum Requirement
Operating System	Windows XP, Windows 7,8 or 10
XAMPP	Version 3.0 or higher / or separately installed Apache 2.4.25 / MySQL 5.0.11 / PHP 5.4.30 / phpMyAdmin 4.6.5.2
Web Browser	Google Chrome / Mozilla Firefox / Opera (Latest Versions)
Code Editor	Adobe Dreamweaver CS6 or any other code editors (Needed for the developer)
Graphics Editor	Adobe Photoshop CS6
PDF Reader	Adobe Reader/Adobe Acrobat/Foxit Reader

Table A.2: Software Requirements

Step 02 – Install XAMPP

- Download XAMPP from <https://www.apachefriends.org/index.html> and install it in C:\xampp directory.



Figure A.1: Xampp Control Panel

Step 3 - Install a Web Browser

- Download Google Chrome from <https://www.google.com/chrome/browser/desktop/> and install.
- Download Mozilla Firefox from <https://www.mozilla.org/en-US/firefox/new/> and install.

Step 4 - Copy System Files

- Copy folder “apps” into the web servers root folder. (C: /xampp/htdocs by default).

Step 5 - Import Database

- Run web browser and type <http://localhost/phpmyadmin/> in the URL section and enter username and password. (if you added)
- Make a new database and name it as “nhk_epms”, then click the “Go” button and then click the “Import” tab (Figure A-2) in the navigation list. Then select

“nhk_epms.sql” file by browsing the CD. Then click “Go” button to import the database.

Importing into the database "epms_kgh"

File to import:

File may be compressed (gzip, zip) or uncompressed.
A compressed file's name must end in **.[format].[compression]**. Example: **.sql.zip**

Browse your computer: No file chosen (Max: 2,048KiB)
You may also drag and drop a file on any page.

Character set of the file: ▾

Figure A.2: Database Import Interface

Step 6 - Launching the System.

- Open the web browser and type <http://localhost/EPMS/> and press the enter button or click go button to launch the system.

To understand how to use the system, please refer to Appendix C – User documentation section.

Appendix B – Design Documentation

This appendix is deliberate to provide detailed design information of the “Medical & Laboratory Equipment Procurement Management System” along with the necessary diagrams and narrations.

Use Case Diagrams and Narratives

Detailed use case diagrams for the major modules of the system are beneath.

User Login Management

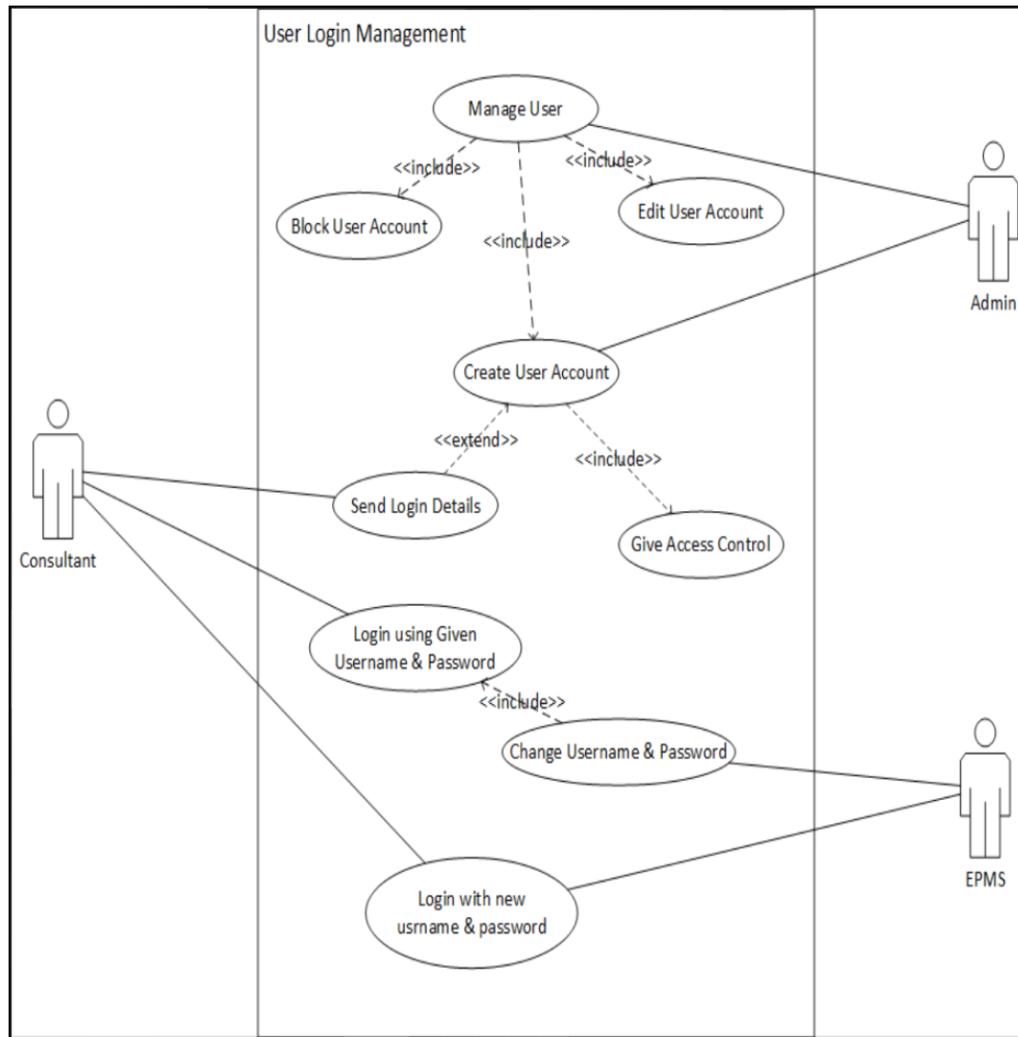


Figure B.1: Use case Diagram for User Login

Use Case	Log in to the System
Actors	Consultant, System
Description	Consultant login to the System
Pre-Conditions	
<ul style="list-style-type: none"> • The employee should be a registered employee. • The consultant should receive an email including login details. 	
Flow of Events	
<ul style="list-style-type: none"> • Collect the Username & Password from the email. • Select the user login menu. • Insert the Username & Password & click Login 	
Post Condition	
<ul style="list-style-type: none"> • If entered correct login details, <ul style="list-style-type: none"> ◦ Pop-up successful message and an alert to change username & password. ◦ Pop-up successful message and direct to the dashboard. 	

Table B.1: Use Case Narrative for User Login

Use Case	Create a New User Account
Actors	Admin, System
Description	Create a new User
Pre-Conditions	
<ul style="list-style-type: none"> • Admin has to log into the system. • The employee should not already be a user. 	
Flow of Events	
<ul style="list-style-type: none"> • Click the create user menu. • Select the Employee ID • Select the user type and click save button 	
Post Condition	
<ul style="list-style-type: none"> • Pop-up a successful message • Send login details via email to the employee 	

Table B.2: Use Case Narrative for Create New User Account

Equipment Request Management

This is one of the main modules in the system. The Consultant has the ability to request the needed equipment directly from the director via the system. Then the director can approve/reject the request so that the MOIC can proceed with the procurement process as per the workflow.

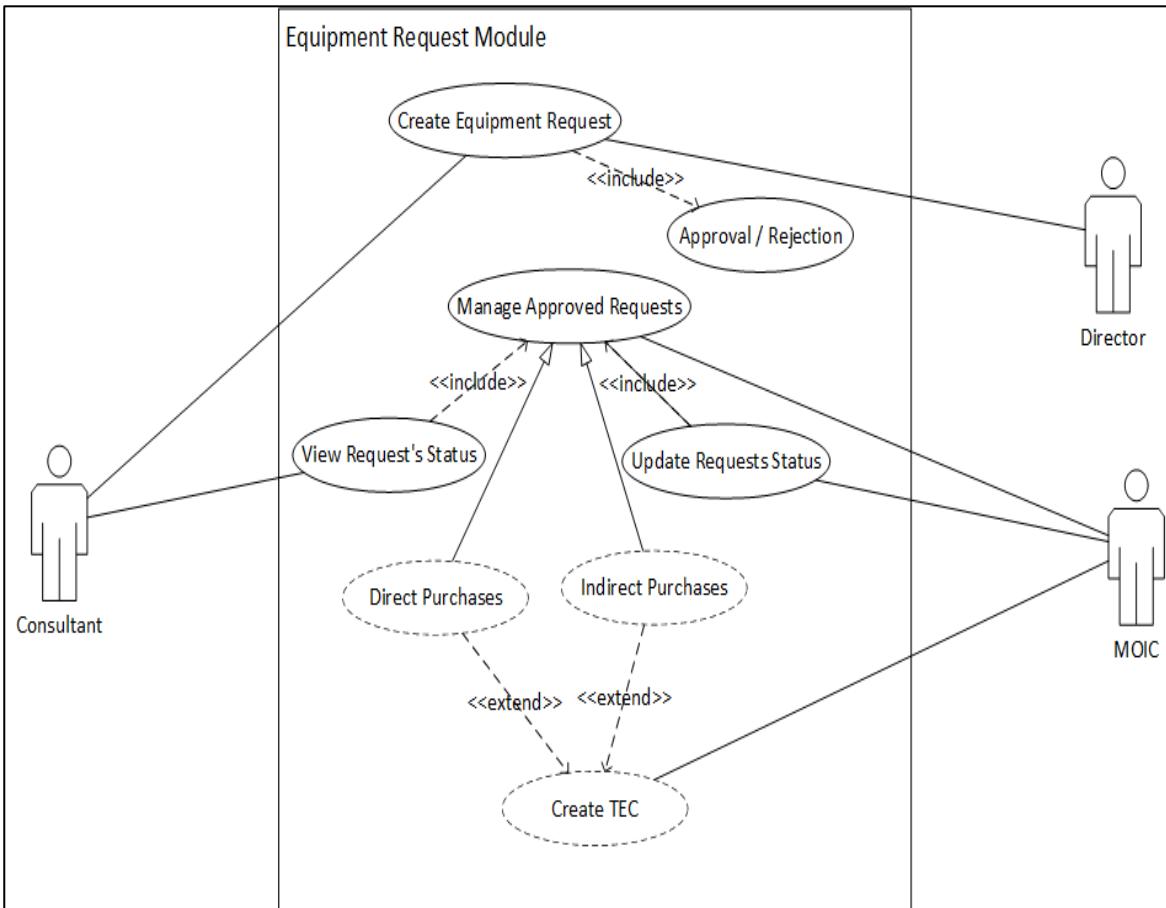


Figure B.2: Use Case Diagram for Request Equipment

Use Case	Create Equipment Requisition
Actors	Consultant, Director
Description	Consultant request an Equipment
Pre-Conditions	
<ul style="list-style-type: none"> The consultant has to log in to the system as an authorized individual to make a request. 	

Flow of Events
<ul style="list-style-type: none"> • Click the create requisition menu. • Fill all the fields correctly • Click send for approval button • Click save button
Post Condition
<ul style="list-style-type: none"> • Pop-up a successful message • Send request details to the Director automatically updating the new requisition table

Table B.3: Use Case Narrative for Create Equipment Requisition

Use Case	Approval for equipment requests
Actors	Director, System
Description	Approve / Reject Equipment Request
Pre-Conditions	
<ul style="list-style-type: none"> • Director has to log into the system. • New requests have to be present in the table. 	
Flow of Events	
<ul style="list-style-type: none"> • Select new Requisitions menu • Click a requisition • Select accept/reject equipment in the request. • Click save button 	
Post Condition	
<ul style="list-style-type: none"> • Pop-up a successful message • Notify the specific consultant that the request is accepted/rejected. • Approved equipment list should be sent to the planning unit (Primal approved requisitions menu) 	

Table B.4: Use Case Narrative for Approval for Equipment Requests

Use Case	Create Technical Evaluation Committee
Actors	MOIC, System
Description	Create a TEC for approved equipment
Pre-Conditions	
<ul style="list-style-type: none"> • MOIC has to log into the system. • Specific Equipment has to be approved for proceeding by director/ministry • TEC members should be registered employees in the system • Specification code should be created 	
Flow of Events	
<ul style="list-style-type: none"> • Select the approved equipment. • Click create TEC button. • Add necessary details and Submit 	
Post Condition	
<ul style="list-style-type: none"> • Pop-up a successful message • Update the TEC List 	

Table B.5: Use Case Narrative for Create TEC

Yearly Survey Submission

Here the consultant / Unit or Ward's head is able to submit the yearly audit report regarding the equipment currently allocated to his/her unit/ward.

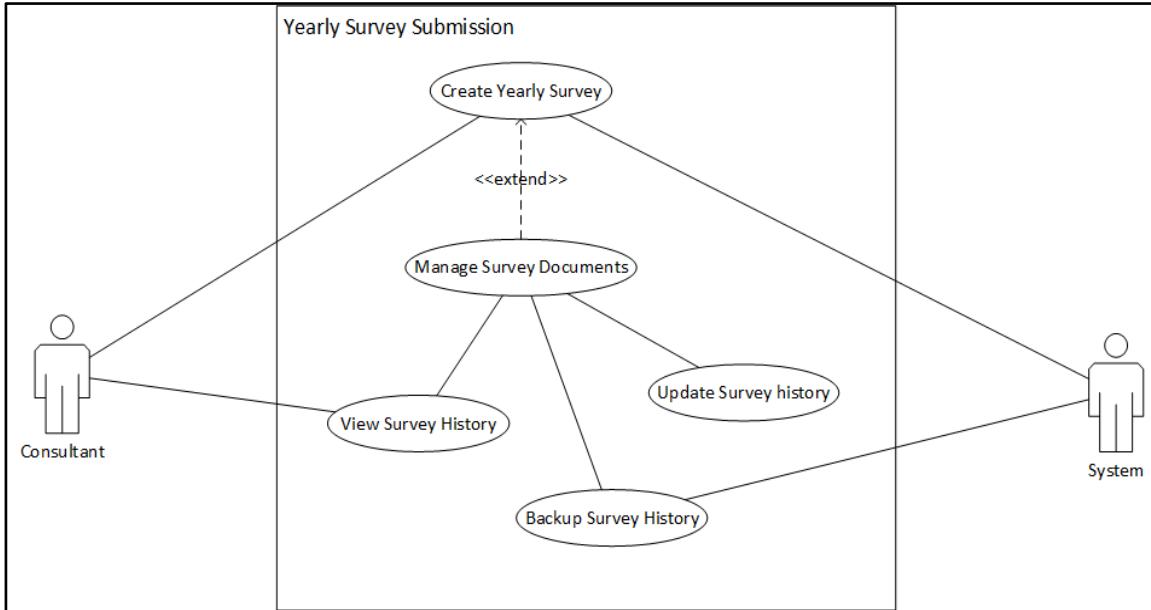


Figure B.3: Use Case for Yearly Survey Submission

Use Case	Create a Yearly Survey
Actors	Consultant, System
Description	Create and submit an annual survey report
Pre-Conditions	
<ul style="list-style-type: none"> • The consultant has to log into the system. • Should be a unit/ward in charge. 	
Flow of Events	
<ul style="list-style-type: none"> • Select Yearly survey menu • Update all necessary data. • Click Submit Button 	
Post Condition	
<ul style="list-style-type: none"> • Pop-up a successful message • Update the Ward/Unit Survey History 	

Table B.6: Use Case Narrative for Create a Yearly Survey

Activity Diagram

The following diagram shows the activity of the tender creation process when creating a new tender post by the chief accountant.

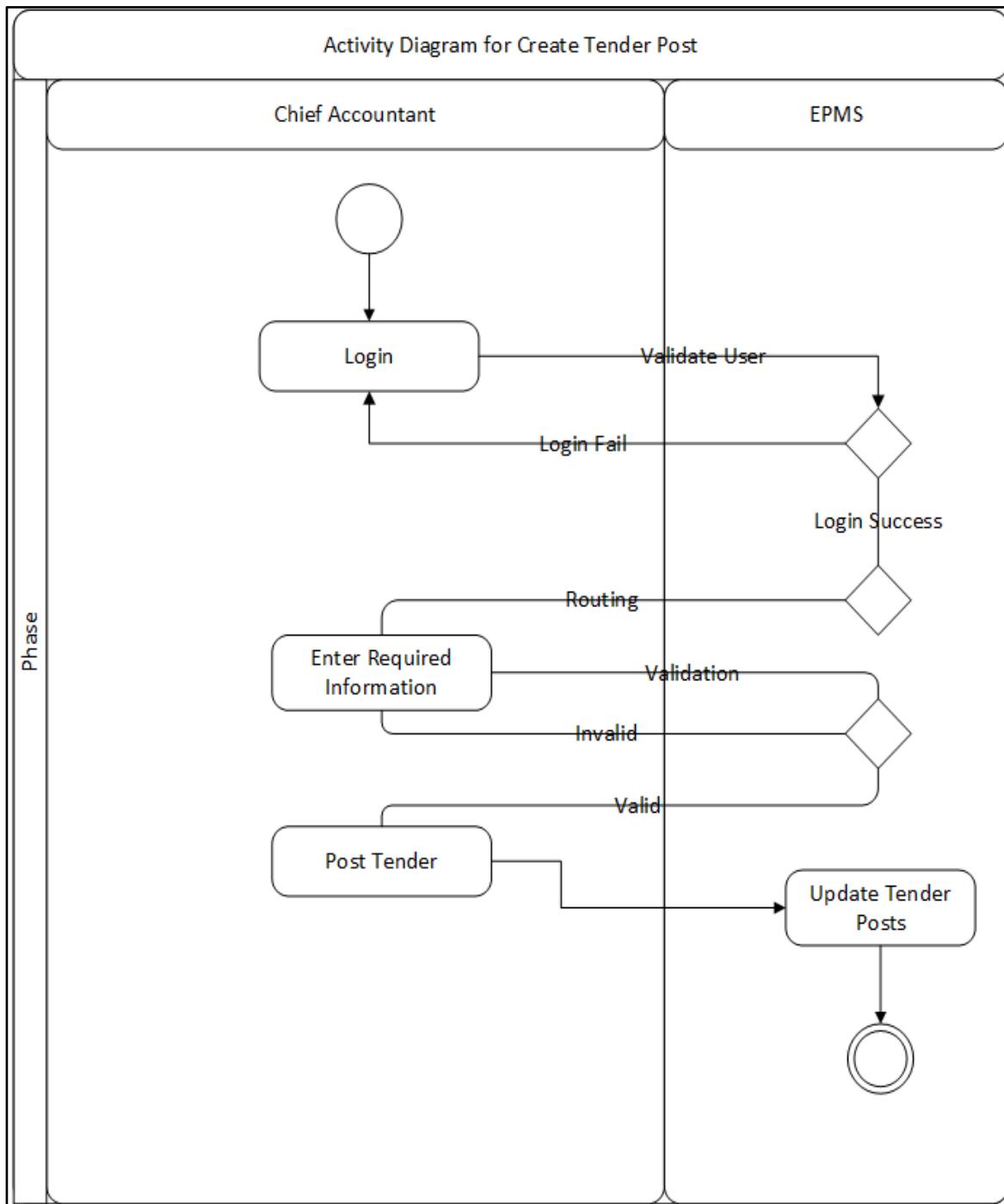


Figure B.4: Activity diagram for creating tender post

The workflow of the EPMS

The diagram on the Figure B.5 depicts the workflow of the EPMS.

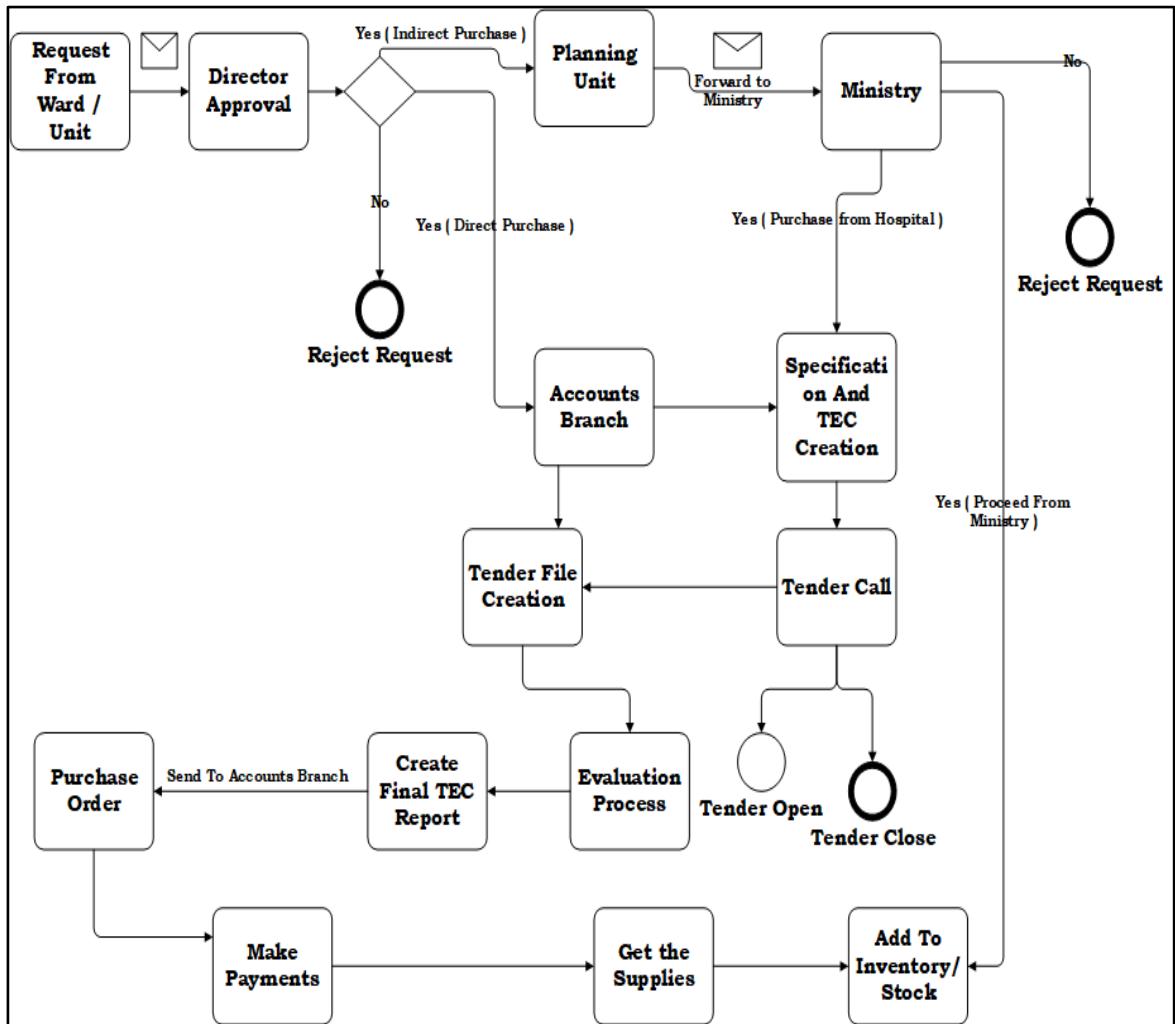


Figure B.5: Workflow diagram of the EPMS

Appendix C – User Documentation

The initial users of EPMS need to have some idea about how the system works. The User documentation was created to aid potential users on a step by step guide on how to work with the system as well as give them an overview of the overall system.

User Login and Sign Up

Internal users can access the Login to EPMS by visiting the URL <https://localhost/EPMS/index.php> through a web browser. With valid credentials, a user gets access to the particular dashboard by considering their user group. If the credentials are invalid or user account is disabled, the user cannot access the system and system shows the warning message according.

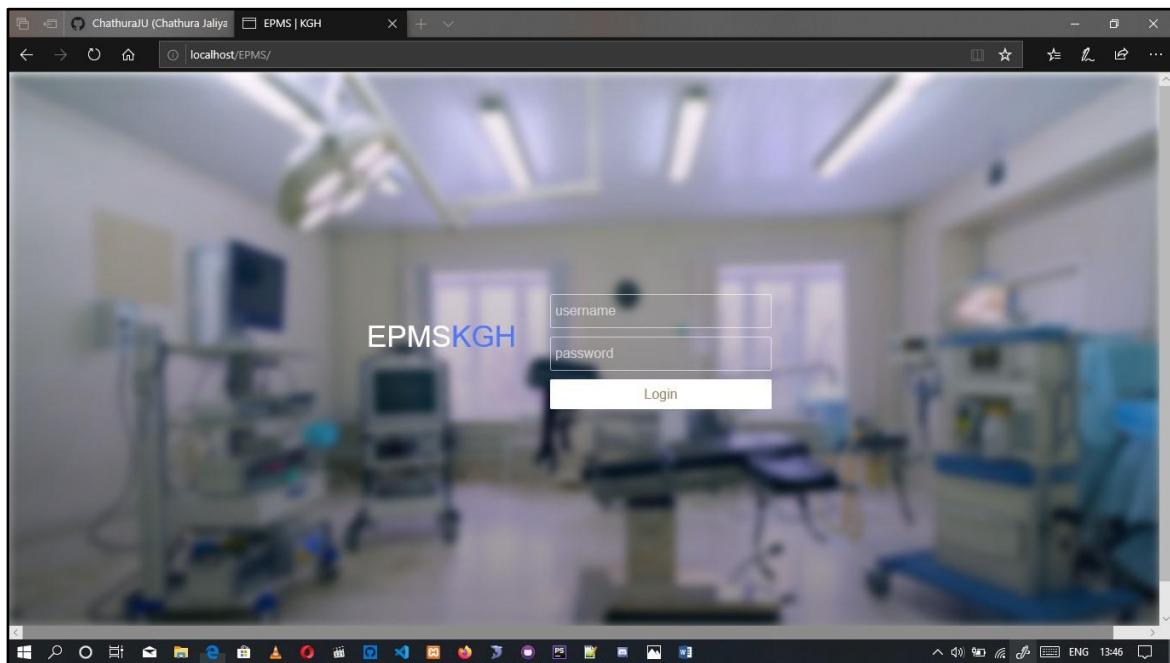


Figure C.1: User Login Interface of EPMS

Similarly, External users (Bidders) can access the Medi-tenders thru the URL <http://localhost/Medicio/> and by clicking the REGISTER button, you can sign up for Medi-Tenders. After the admin contact you with the username, password, bidder can login to the system via the SIGN IN button.

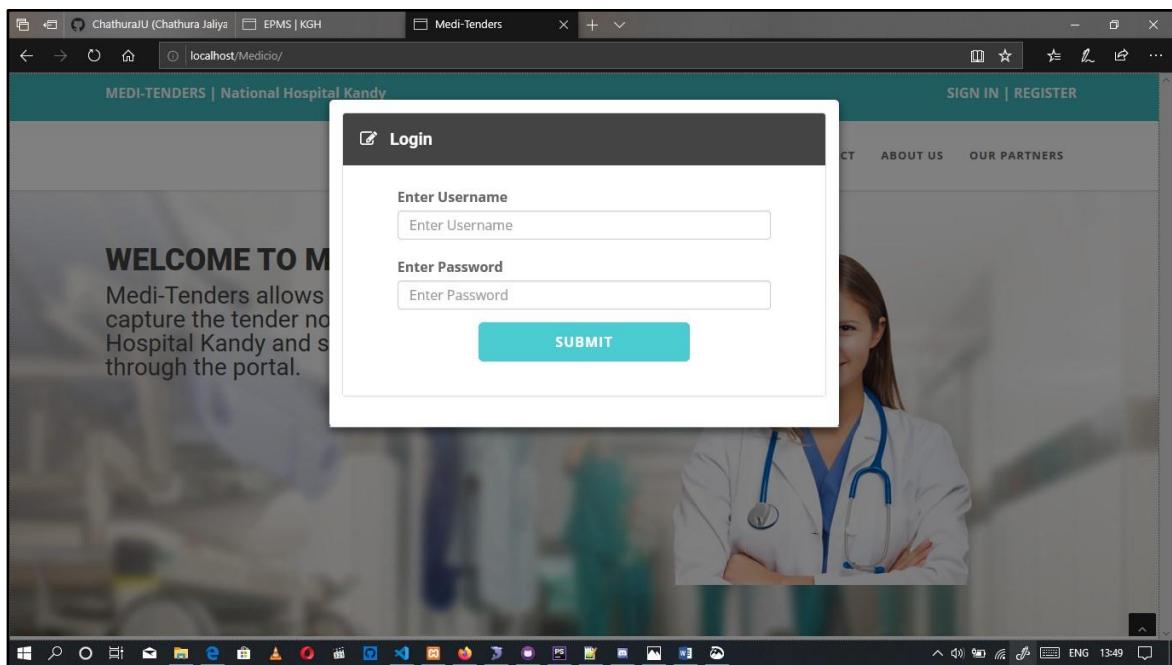


Figure C.2: User Login for Medi-Tenders

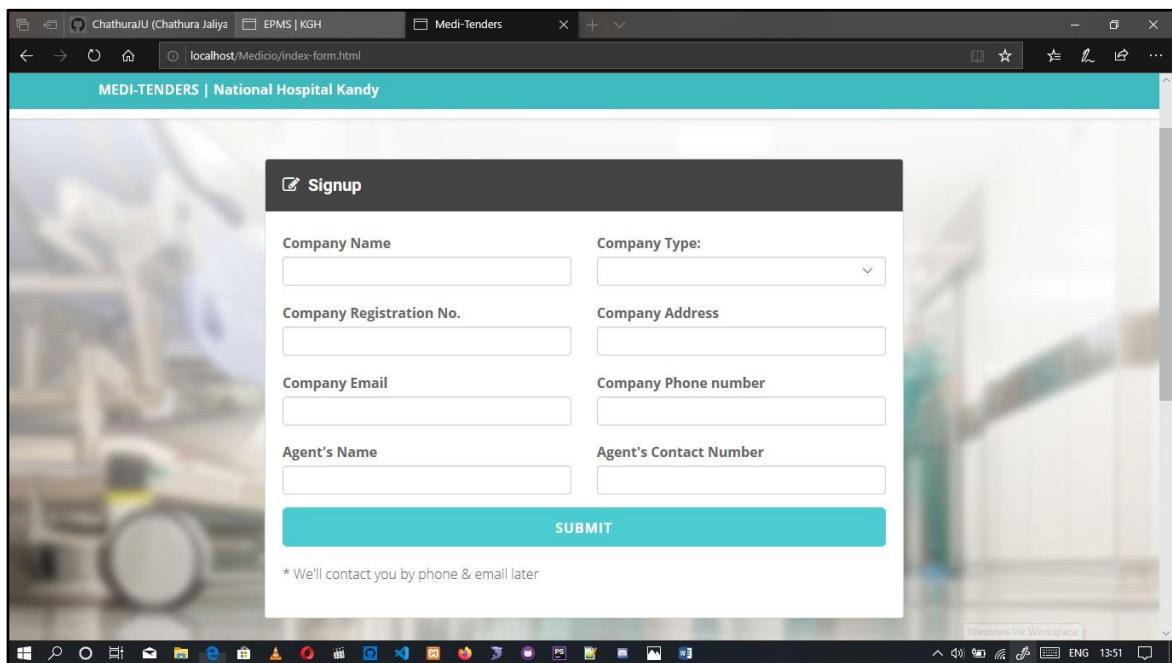


Figure C.3: User Signup for Medi-Tenders.

Navigation

Navigation through the system can be done by using the side navigation panel. By clicking on the name of the menu you want, that specific menu can be reached.

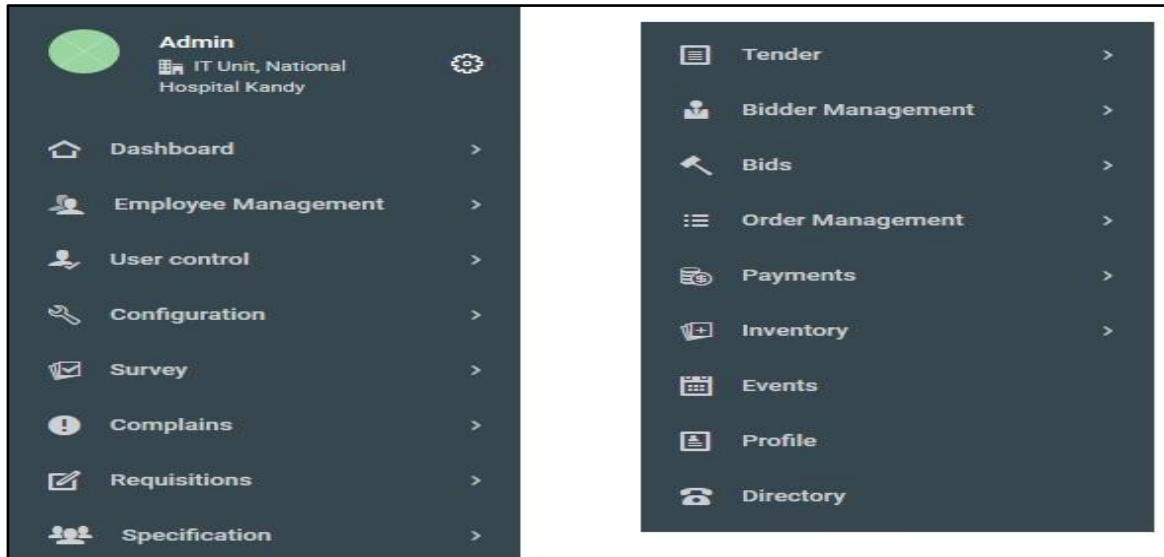


Figure C.4: Navigation bar of EPMS

Add / Manage New Employee Form Interface

The image shows a screenshot of the 'Add New Employee' form. The form is divided into two main sections: 'Personal data' and 'Job Data'. In the 'Personal data' section, there are fields for 'Name With Initials' (containing 'C J Udurawana'), 'Full Name' (containing 'John Doe'), 'Gender' (with 'Male' selected), 'Date of Birth' (set to 'Wednesday, 4th of June, 2014'), 'Address' (containing '58/1 Peradeniya rd, Kandy'), 'Email address' (containing 'your@email.com'), 'Home Phone No.' (containing '+94-81-2256-978'), and 'Mobile Phone No.' (containing '+94-71-6865-623'). In the 'Job Data' section, there is a dropdown field for 'Salutation' with the placeholder 'Choose a Salutation...'. At the bottom right of the form, there is a blue 'Next >' button with a red oval highlighting it. The background shows the EPMS navigation bar and a Windows taskbar at the bottom.

Figure C.5: Step 01 - Add New Employee.

Figure C.6: Step 02 - Submit Employee Registration Form

Employees are the main stakeholders of the system. The following interface can be used to add new employees to the system and manage existing employees in the system. Next/Back buttons in the form will let the user travel over the wizard and in the final step, save button will be available for the users to save and create the user. Button in the Action column of the Manage Employee table will let you direct to the update/delete of a particular employee.

Employee ID	Employee Work ID	Employee Name	Unit	Ward	Job Title	Join Date	Actions
KGH-00009	H-124688	Abdul Wahid Mohamed Wazil		Ward 10	Nephrologist	5 September 2016	
KGH-00023	H-122455	Saman Kularathna		Ward 03	General Physician	16th January, 2014	
KGH-00022	H-122224	Lalith Gunawardhane		Ward 02	General Physician	16th January, 2014	
KGH-00021	H-156856	Nimal Perera		Ward 01	General Physician	16th January, 2014	
KGH-00001	H-156982	Dushantha Madagedara	Respiratory Unit		Consultant Respiratory Physician	30 October, 2018	

Figure C.7: Manage Employee Table

Create Equipment Requisition Form Interface

Consultants can use this interface to create and submit the equipment request to the Director. By filling the equipment details as in the Figure C.8 and clicking on the “Add” button, the user can add the needed equipment for the request list. Then by clicking on the “Save” button, the request can be submitted to the director for the approval.

EPMS | KGH

localhost/EPMS/Admin/req_create.php

Employee Management

User control

Configuration

Survey

Complains

Requisitions

Create Requisitions

All Requisitions

Primal Approved Requisitions

Primal Rejected Requisitions

Pending Direct Procurements

Pending Ministry Approvals

Update Ministry Approvals

Ministry Rejected Requisitions

Ministry Approved Requisitions

Specification

Tender

Requisition Details

Equipment Details

Requisition ID : Pending

Request Type : * Annual Request

Request Date : * 2020-03-02

Employee ID : * KGH-00003

Unit : * IT Unit

Ward : *

Next →

Figure C.8: Step 01 - Equipment requisition form interface.

Employee Management

User control

Configuration

Survey

Complains

Requisitions

Create Requisitions

All Requisitions

Primal Approved Requisitions

Primal Rejected Requisitions

Pending Direct Procurements

Pending Ministry Approvals

Update Ministry Approvals

Ministry Rejected Requisitions

Ministry Approved Requisitions

Specification

Tender

Bidder Management

Bids

Request An Equipment

Requisition Details

Equipment Details

Equipment : * Bio Chemistry Analyzer

Quantity : 2

Priority : * Low

Reason : Not enough

Add

Equipment List

Equipment	Quantity	Priority	Reason	Action
Bio Chemistry Analyzer	2	Low	Not enough	

Back Save

Figure C.9: Step 02 - Equipment requisition form interface.

Requisition Primal Approval Interface

This can be reached by navigating thru Requisition → New Requisitions → Proceed. This directs to the particular requisition's detail page. From there, clicking the Button in the Action column of the table will direct you to the Primal Approval Interface. By selecting approved/rejected from the combo box, Director can grant his approval for the request, and select the type of the purchase (Direct/ Indirect)' if the equipment is approved to purchase.

The screenshot shows a web browser window titled 'ChathuraJU (Chathura Jalya) EPMS | KGH Medi-Tenders'. The left sidebar has a tree view with nodes like 'Employee Management', 'User control', 'Configuration', 'Survey', 'Complaints', 'Step 01', 'Requisitions' (highlighted with a red circle), 'Step 02', 'Create Requisitions', 'All Requisitions' (highlighted with a red circle), 'Requisitioned Equipment List', 'Primal Approved Requisitions', 'Primal Rejected Requisitions', 'Pending Direct Procurements', 'Pending Ministry Approvals', and 'Update Ministry Approvals'. The main content area is titled 'New Requisitions' and lists ten requisitions with columns for Requisition ID, Requisition Date, Unit, Ward, and 'Proceed for Approval' (with a 'PROCEED' button). A red circle highlights the 'PROCEED' button for Requisition ID REQ-000001. A red box labeled 'Step 03' is drawn around the 'PROCEED' button.

Figure C.10: Step 01 - Path to Requisition Approval Interface.

The screenshot shows a modal dialog titled 'Requisition Approval' over a dark background. The dialog has sections for 'BASIC DETAILS' and 'PRIMAL APPROVAL DETAILS'. Under 'PRIMAL APPROVAL DETAILS', it shows 'Director Name : Dr. Sanath Gurusinghe', 'Primal Approval Date : Try me...', 'Primal Approval : Pending' (with a dropdown menu containing 'Approved' and 'Rejected'), and 'Procurement Type : Direct/Indirect'. A red circle highlights the 'Approved' option in the dropdown. A red box labeled 'Step 01' is drawn around the dropdown. A red circle highlights the 'Save changes' button at the bottom right. A red box labeled 'Step 02' is drawn around the 'Save changes' button.

Figure C.11: Requisition Approve / Reject Interface.

Pending Ministry Approval Interface

When approved, the equipment will filter in to 02 tables Direct Purchases and Indirect Purchases. Sum of the requested quantities of the equipment are calculated and directed to Pending Direct Purchases and Pending Ministry Approval Page. Pending Direct Purchases then will Direct that specific equipment to Specifications where the TEC committee and Procurement ID is Generated. Pending Ministry Approval Page will allow the user to get a print of the letter to be sent to the ministry. Generated Letter is attached in Appendix D.

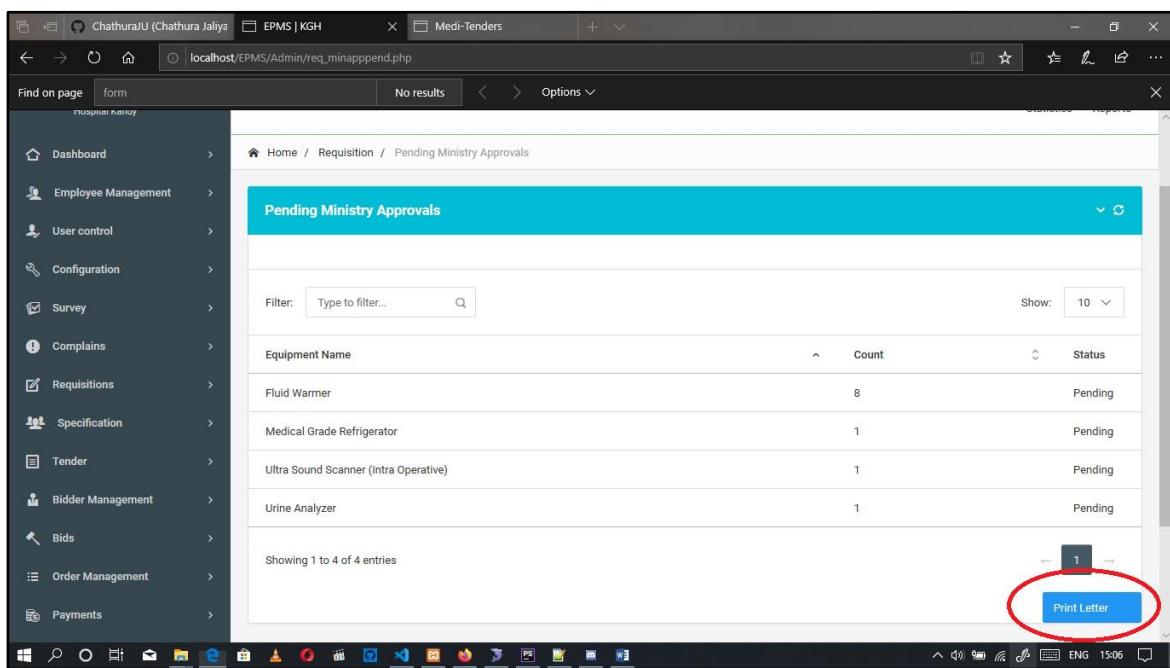


Figure C.12: Interface to Generate the Letter to be Send to the Ministry.

After approval from the Ministry is returned, Thru Update Ministry Approval Page, user can update the details and then, those which approved are filtered to Ministry Approved Requisitions page which directs it to the specifications.

Create Technical Evaluation Committee Interface.

Click over the Name of the employee needed to be added to the TEC and submit. Procurement ID and TEC ID will generate automatically.

The screenshot shows a web-based application interface titled 'Technical Evaluation Committee Form'. On the left is a dark sidebar menu with various administrative options like 'Dashboard', 'Employee Management', 'User control', etc. The main panel has a header 'SPECIFICATION' and a breadcrumb path 'Home / Specification / Create TEC'. Below this is a form section with two tabs: 'Procurement Details' and 'Technical Evaluation Committee'. Under 'Procurement Details', there are fields for 'Procurement ID' (containing 'Pending...') and 'Tec ID' (containing 'Pending...'). Under 'Technical Evaluation Committee', there is a field for 'Equipment Name' and another for 'Quantity'. At the bottom right of the form area, there is a blue button labeled 'Next' with a red circle around it, indicating the next step in the process. The status bar at the bottom shows 'Step 01'.

Figure C.13: Step 01 - Create Technical Evaluation Committee.

The screenshot shows the same application interface as Figure C.13, but now in Step 02. The main panel displays a note: 'NOTE : Please select a TEC of 05 including Director from the Employee list below.' Below this is a search interface with two filter boxes and two lists of names. The left list contains 'Dilshan Wahala', 'Dilsha Nayanamadhu Liyanage', 'Sunethra B. Athauda', 'Chandani Udagedara', and 'Chandana Jayathi Wijekoon'. The right list contains 'Dushantha Madagedara' and 'Chathura Jaliya Udurawana'. At the bottom right of the interface, there is a blue 'Save' button with a checkmark, which is also circled in red. The status bar at the bottom shows 'Step 02'.

Figure C.14: Step 02 - Create Technical Evaluation Committee.

Tender Creation Interface

Fill the relevant details, upload the Bid Document and then click SUBMIT FORM button.

The screenshot shows the 'Create a Tender' page. On the left is a sidebar with a dark theme containing links like Dashboard, Employee Management, User control, Configuration, Survey, Complains, Requisitions, Specification, Tender (selected), Create Tender, Post Tender, Bidder Management, and Bids. The main area has a teal header 'Create a Tender'. It contains several input fields: 'Procurement ID' with a dropdown placeholder 'Select the Procurement ID..', 'Equipment Name' and 'Quantity', 'Title of the Procurement' and 'Nature of the Procurement', 'Non Refundable Payment' with a dropdown 'LKR', 'Bid Collection Date (Opening Date)' with a placeholder 'Try me...', 'Bid Collection Date (Closing Date)' with a placeholder 'Select a date', and a file input field 'Bid Document (General Document)' with a 'Browse' button and a red 'Upload Bid Document Here' link. At the bottom right is a blue 'Submit form' button with a red circle around it.

Figure C.15: Create a Tender Interface.

Fund Allocation and Payment handling Interface

Fill all the fields in step 01 and click next to update the cheque details. Insert the cheque number in the relevant field and upload a scanned copy of the cheque received.

The screenshot shows the 'Make Payments' page. The sidebar is identical to Figure C.15. The main area has a teal header 'Make Payments' with three circular steps: 1. Fund Allocation Details, 2. Cheque Details, and 3. Payment Details. Step 1 is active, showing a green icon of a clipboard with a plus sign. It contains fields for 'Procurement ID', 'Equipment Name.', 'Quantity', 'Price' (with a dropdown 'LKR'), and 'Funding Entity'. At the bottom right of this section is a red 'Step 01' label and a blue 'Next' button with a red circle around it. Step 2 and Step 3 are shown as empty sections with their respective icons.

Figure C.16: Step 01 – Update fund Allocation.

Next button will direct to the next step where the payment conclusion is handled. Fill all the fields and upload a scanned copy of the Invoice. Add any other remarks if needed and click SUBMIT button to finish.

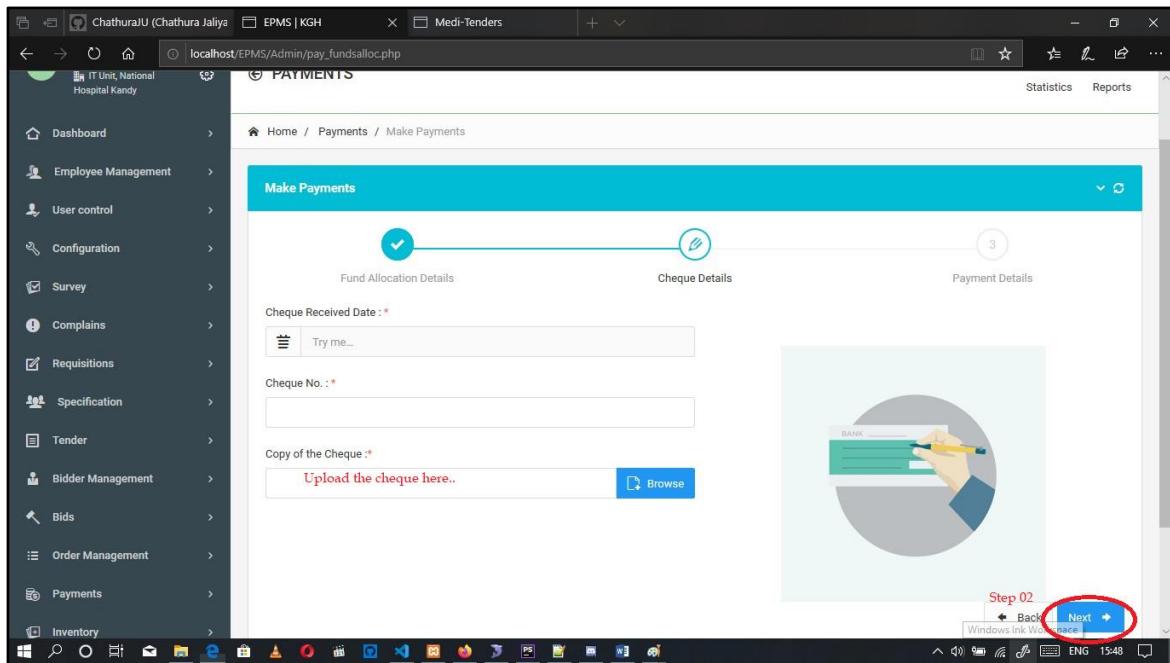


Figure C.17: Step 02 - Upload cheque details.

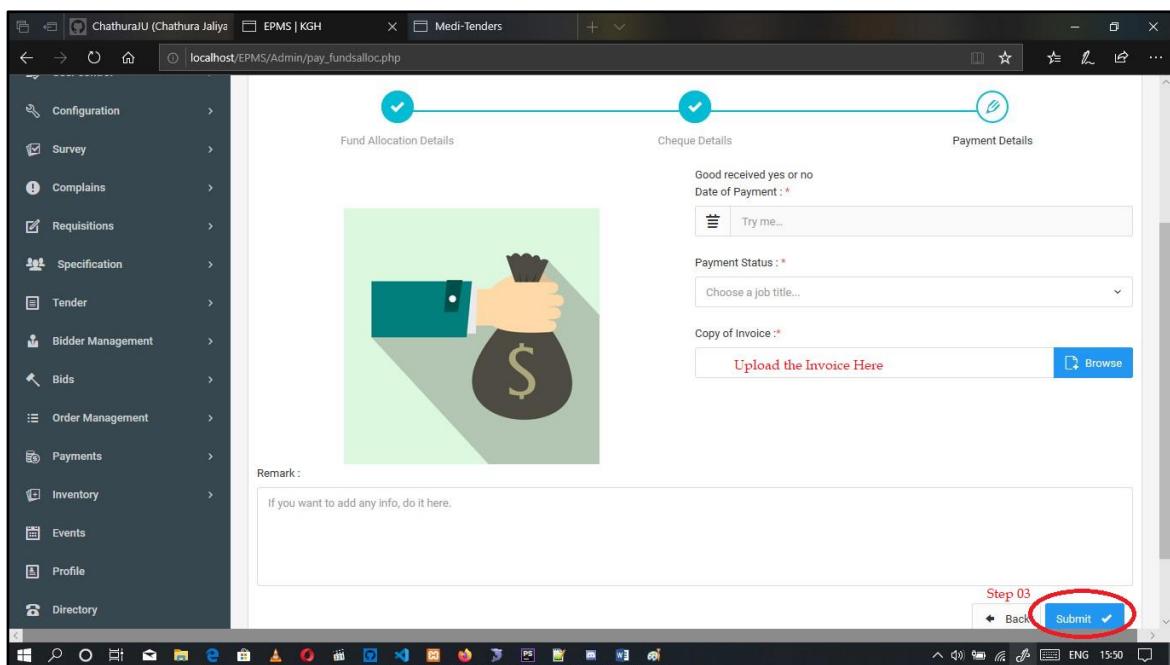


Figure C.18: Upload invoice and submit.

Inventory Manage Interface

Once the equipment purchased and received, user can update the equipment details to the inventory thru this interface.

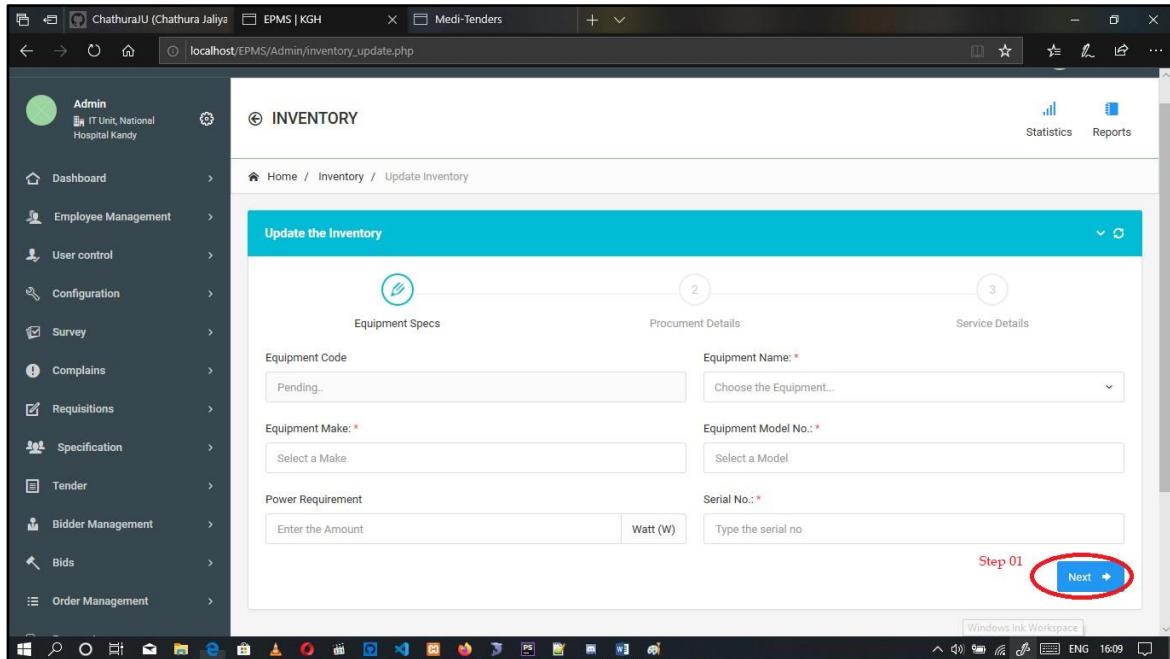


Figure C.19: Step 01 - Update the Inventory.

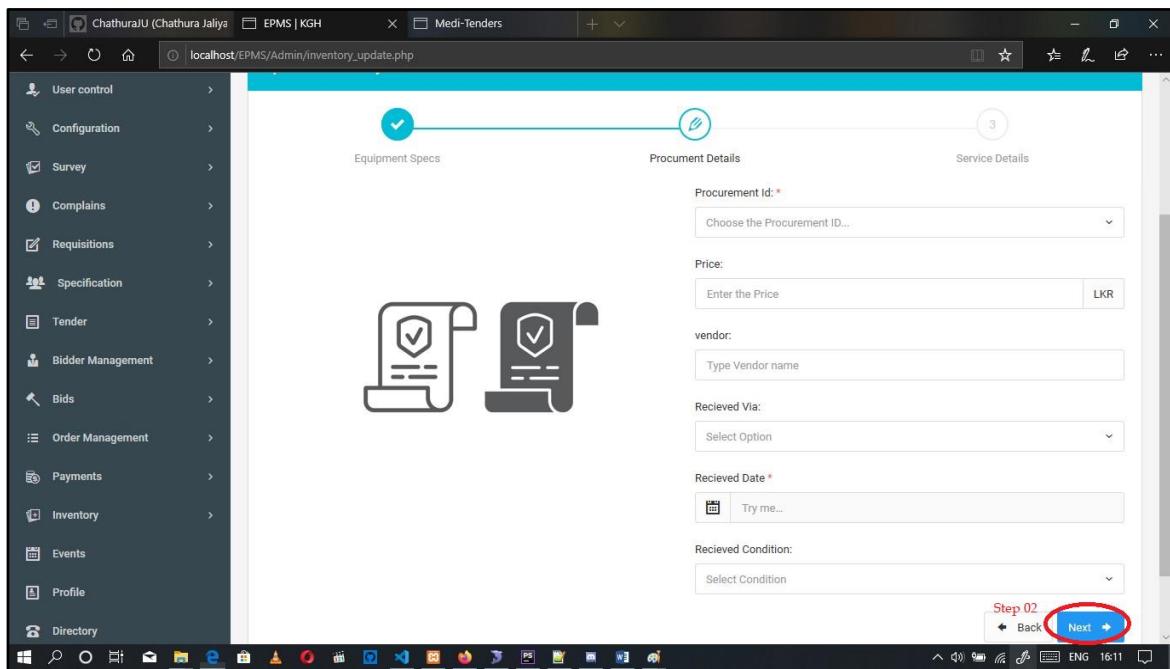


Figure C.20: Step 02 - Update the Inventory.

Fill all the fields and click NEXT button to proceed and at the final step, upload the Service Agreement, add any other additional information and click SUBMIT to save the data.

The screenshot shows the 'Update the Inventory' page within the EPMS Admin interface. The left sidebar lists various administrative modules. The main area is titled 'Update the Inventory' and contains three tabs: 'Equipment Specs' (with a wrench icon), 'Procurement Details' (with a checkmark icon), and 'Service Details' (with a gear icon). Under 'Equipment Specs', there are fields for 'Warranty Period (In Months)' and 'Preventive Period (In Months)'. Under 'Service Details', there is a field for 'Maintenance Service Provider'. At the bottom, there is a section for 'Additional Details About The Equipment' with a large text input field. A 'Browse' button is available for attaching a service agreement. A 'Submit' button is located at the bottom right, circled in red. The status bar at the bottom indicates 'Step 03' and shows system icons like battery level and network status.

Figure C.21: Step 03 - Update the Inventory.

Complain creation and handling Interface

The screenshot displays the 'Complain creation and handling Interface'. The left sidebar contains a navigation menu with items like Employee Management, User control, Configuration, Survey, Complains, Requisitions, Specification, Tender, Bidder Management, Bids, Order Management, Payments, Inventory, Events, Profile, and Directory. The main area is divided into two sections: 'Make a Complain' (top) and 'Complain List' (bottom). The 'Make a Complain' section features a form with fields: 'Employee ID :*' (input field), 'Equipment Code :*' (input field), 'Date of Complain :*' (date input field with placeholder 'Try me...'), and a large text area for 'Complain'. A 'submit form' button is at the bottom right. The 'Complain List' section shows a table with columns: Complain ID, Employee ID, Equipment Code, Date, Complain, and Actions. Two rows are listed: 'COM-1' and 'COM-2'. The 'Actions' column contains edit icons for each row.

Figure C.22: Complain creation and handling interface.

Home page of the Medi-Tenders

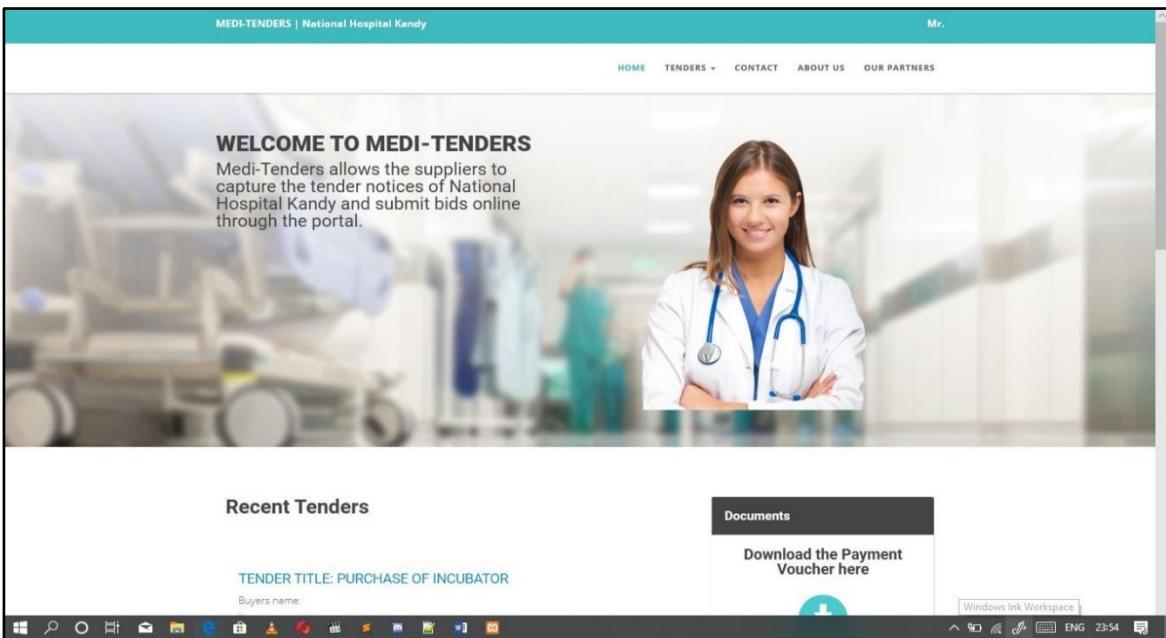


Figure C.23: Home page of the Medi- Tenders

Tender Notice Page

Here, user can visualize the tender notices and apply for it by clicking APPLY button. Also, the NRF payment voucher can be download by clicking the download image.

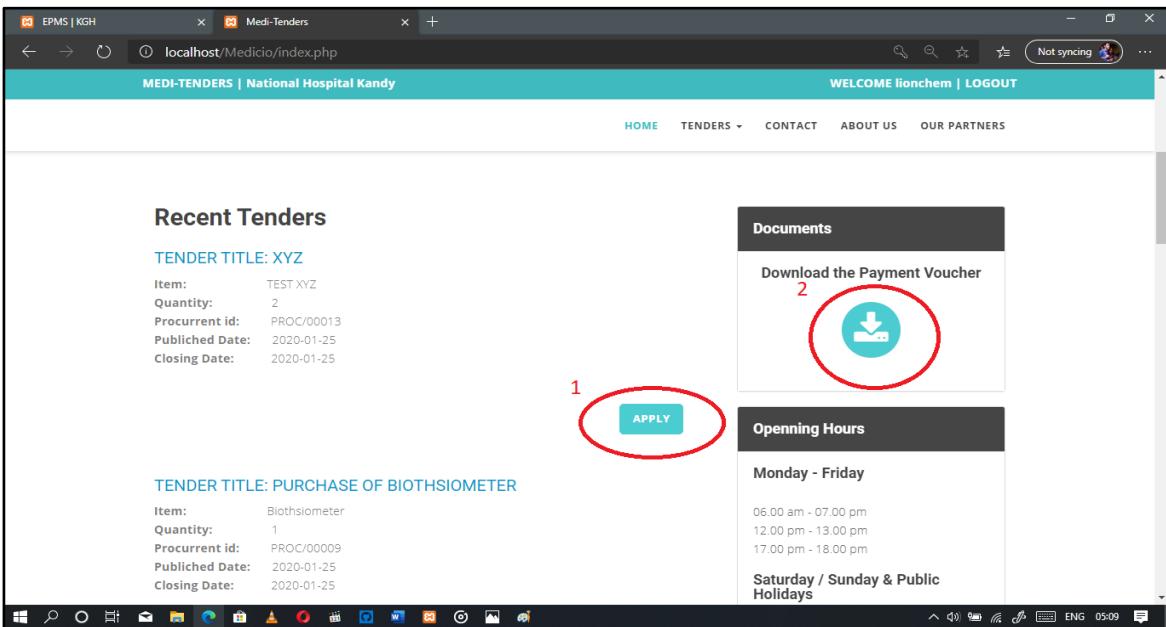


Figure C.24: Tender notice interface.

By uploading the Hospital copy of the payment voucher, registered bidders can apply for a Tender, once it approved by the hospital, user can bid for the tender by self-evaluating the fields, and uploading the filled bid document.

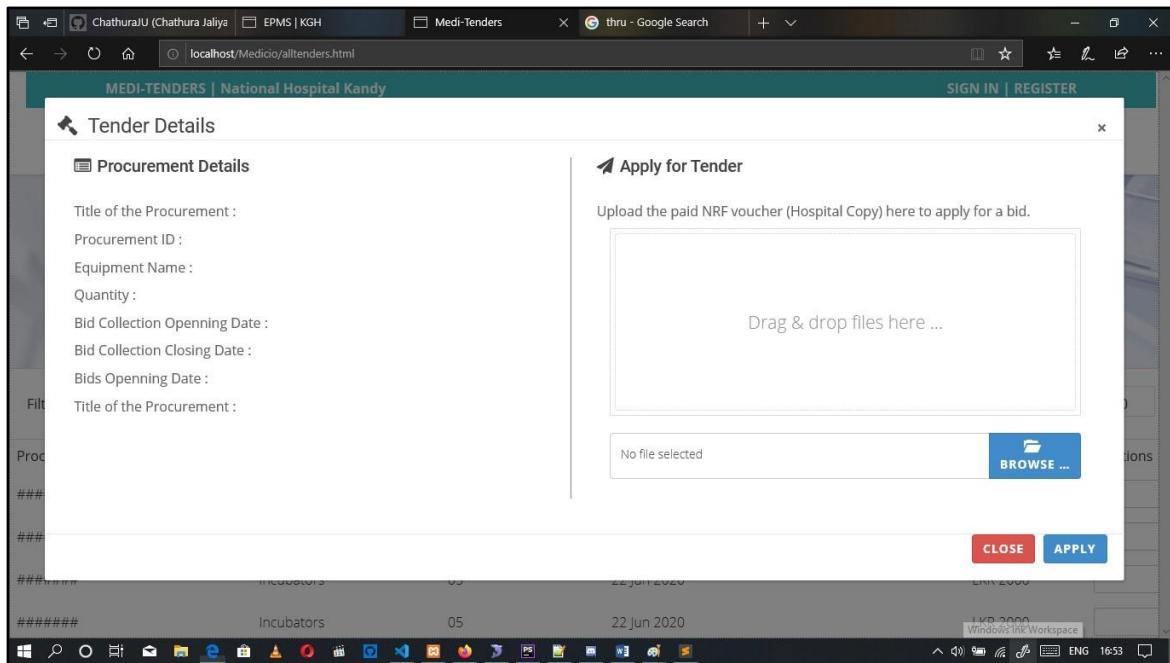


Figure C.25: Apply for a tender.

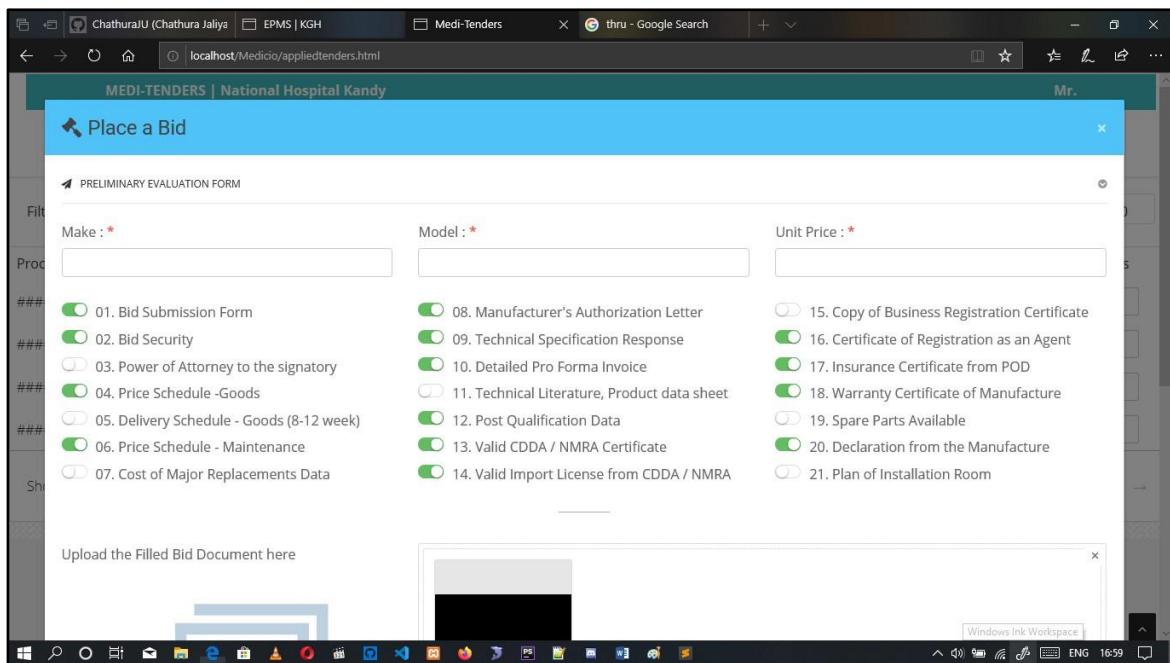


Figure C.26: Step 01 - Self-evaluation of document list.

Drop the file on the uploader, mark the declaration and click apply button to submit your bid. Unless mark the declaration, use cannot submit the Bid.

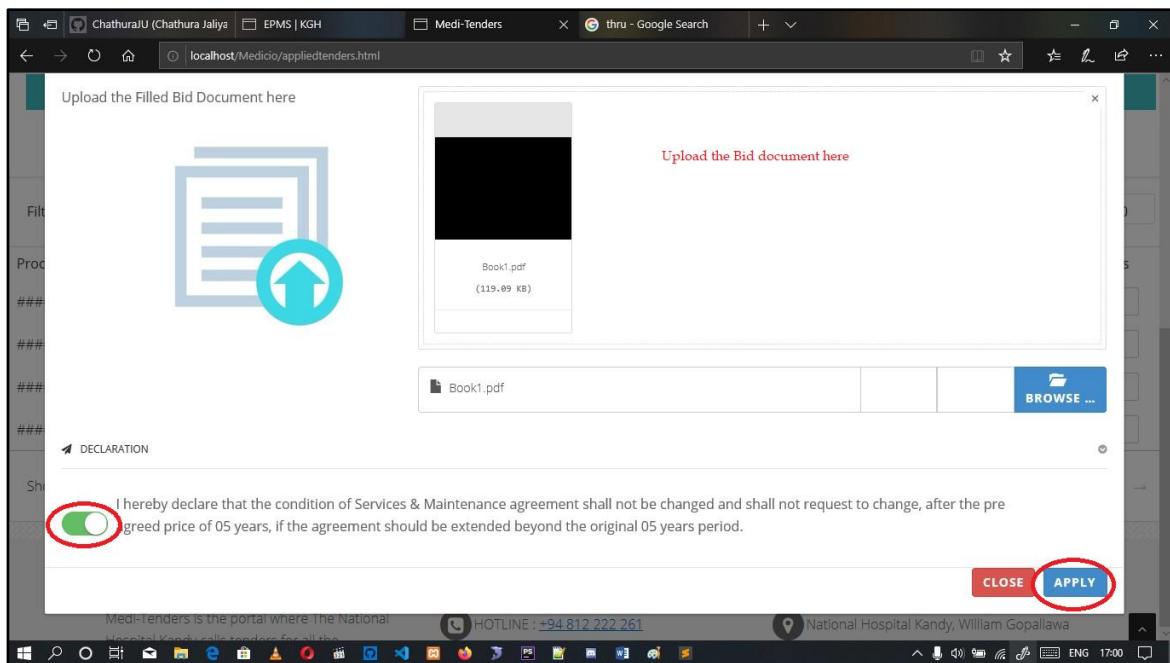


Figure C.27: Step 02 - Bid for the tender.

Appendix D – Management Reports

Ministry Approval Letter

This gives the sum of requested equipment which are approved by the director to be purchased from indirect purchase process.

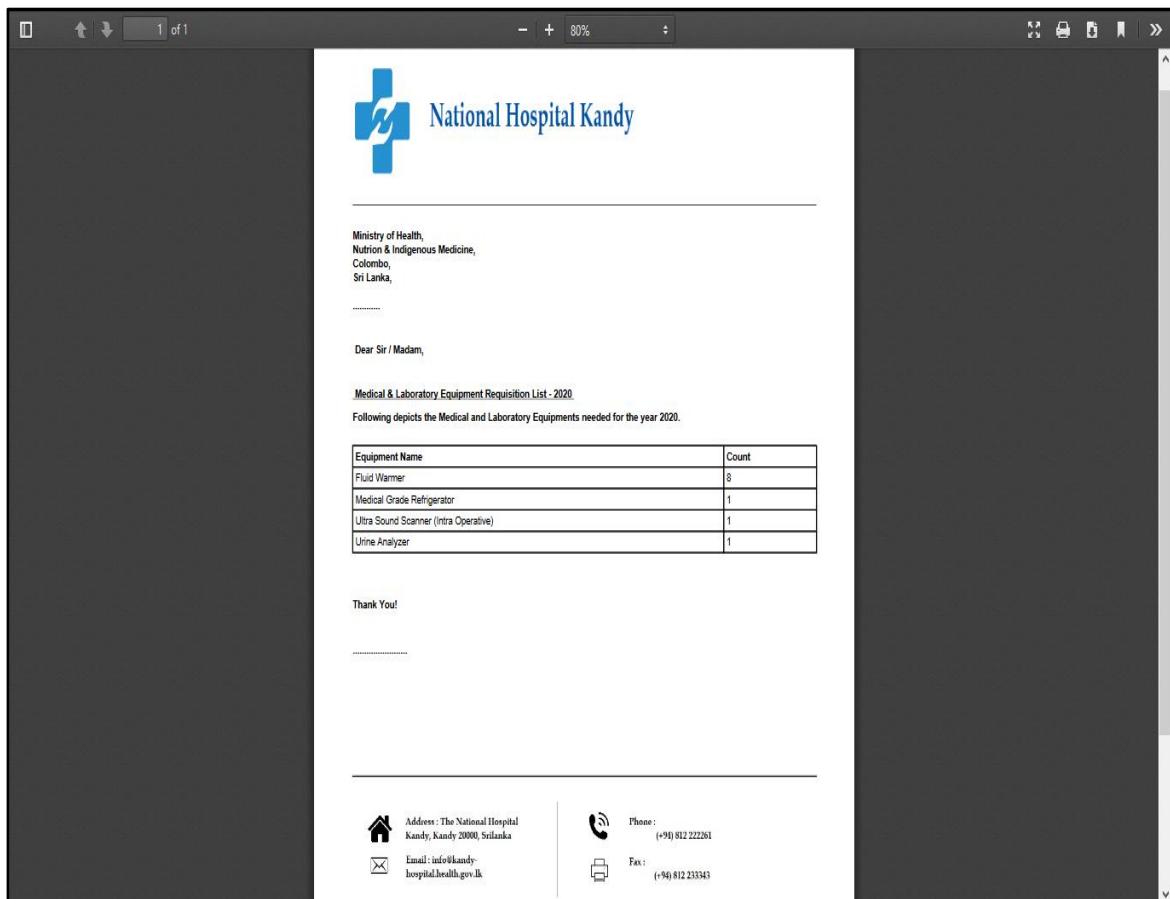


Figure D.1: Letter to be send to the Ministry.

Requisition List

Requisition List gives all the equipment requests made by the Consultants of each unit/ward. Also, it shows the date of which the requests are made and if the request is approved by the Director.

Requisition ID	Requisition Date	Unit	Ward	Primal Approval
REQ-000013	30 Nov 2019	None	WD 44	Pending
REQ-000012	27 Nov 2019	Respiratory Unit	None	Pending
REQ-000010	26 Nov 2019	Cardiology Unit	None	Pending
REQ-000007	24 Nov 2019	Radiology Unit	None	Approved
REQ-000005	24 Nov 2019	Skin Clinic	None	Rejected
REQ-000003	23 Nov 2019	KT OT	None	Approved
REQ-000002	22 Nov 2019	Eye Clinic	None	Rejected
REQ-000001	22 Nov 2019	None	Wd 03	Approved

Figure D.2: Equipment Requisition List.

Annual Survey Report

This shows an annual survey report submitted by a specific unit. It includes all the details like who submit the survey, when it was submitted, and the unit/ward name. It also depicts the details of the equipment assigned to that specific unit/ward.

The screenshot shows a web page titled "report.php" with a header "1/1". At the top is the logo of National Hospital Kandy, featuring a stylized blue cross-like symbol. Below the logo is the text "National Hospital Kandy". A horizontal line separates this from the main content area. The content area starts with a section titled "ANNUAL SURVEY REPORT". Below this is a table with the following data:

Survey ID	Employee ID	Unit	Ward	Year	Submission Date
SURV000058	KGH-000002	None	WD 05	2019	25/11/2019

Below the table is a section titled "Equipment Details" containing another table:

Equipment Name	Make	Model	Serial No.	Present Status	Date of Installation	Remarks
Incubator	SSS	ret	2894567891	In-Use	25/11/2017	N/A
Incubator	SSX	ret	5487921548	In-Use	15/11/2017	N/A
Medical Grade Refrigerator	CEG	uREC	5487216987	In-Use	04/01/2015	Repair on-going
Auto Transfusion System	CEG	xREF	3256187991	In-Use	25/08/2018	N/A
Fluid Warmer	XERFD	pREFT	1485789245	In-Use	17/03/2018	N/A

On the right side of the page, there are three circular icons with symbols: a gear, a plus sign, and a minus sign. Below these icons is the text "Activate Windows" and "Go to Settings to activate Windows".

Figure D.3: Annual Survey Report.

Primal Approved Equipment List

This shows the details of the requested types of equipment which are primarily approved to proceed in the procurement by the Director. It includes the type of purchase it is assigned to purchase, approval date and the details of the approver.

The screenshot shows a web page titled "report.php" with a header "1 / 1". The main content area features the National Hospital Kandy logo (a blue cross with a stylized "N" inside) and the text "National Hospital Kandy". Below this is a table titled "Primal Approved Equipment List - 28/11/2019". The table has columns: Primal Approved Equipment ID, Requisition ID, Director Name, Employee ID, Primal Approved Date, and Procurement Type. The data in the table is as follows:

Primal Approved Equipment ID	Requisition ID	Director Name	Employee ID	Primal Approved Date	Procurement Type
PAPP-REQ-000011-01	REQ-000011	Dr. Sanath Gurusinghe	KGH-000083	05.02.2019	Direct Purchase
PAPP-REQ-000005-01	REQ-000005	Dr. Sanath Gurusinghe	KGH-000083	04.02.2019	In-direct Purchase
PAPP-REQ-000003-07	REQ-000003	Dr. Sanath Gurusinghe	KGH-000083	01.02.2019	Direct Purchase
PAPP-REQ-000003-08	REQ-000003	Dr. Sanath Gurusinghe	KGH-000083	01.02.2019	Direct Purchase
PAPP-REQ-00000-09	REQ-000003	Dr. Sanath Gurusinghe	KGH-000083	01.02.2019	In-direct Purchase

On the right side of the page, there are three circular buttons with icons: a double arrow (zoom), a plus sign (+), and a minus sign (-). Below these buttons, the text "Activate Windows" and "Go to Settings to activate Windows." is displayed.

Figure D.4: Primal Approved Equipment List.

Ministry Rejected Equipment List

This is the list where it shows the details of the requested equipment which are approved by the director to purchase using indirect purchases but rejected by the ministry. This depicts the Ministry's approval date and that specific document's name for future reference.

The screenshot shows a web browser window with the title 'report.php' at the top left and '1/1' at the top right. The main content area displays the 'National Hospital Kandy' logo, which consists of a blue stylized cross-like shape followed by the text 'National Hospital Kandy'. Below the logo is a horizontal line. Underneath the line, the text 'Ministry Rejected Equipment List - 28/11/2019' is centered. A table follows, with columns labeled 'Primal Approved Equipment ID', 'Requisition Equipment no.', 'Ministry Approval Document ID', and 'Ministry Approval Date'. The table contains five rows of data. At the bottom right of the content area, there is a message: 'Activate Windows Go to Settings to activate Windows.' Below the browser window are three circular control buttons: a zoom-in button (+), a plus sign (+), and a minus sign (-).

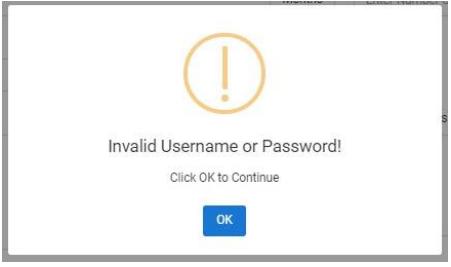
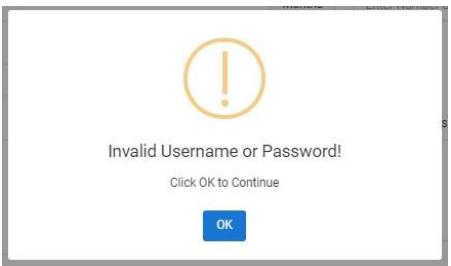
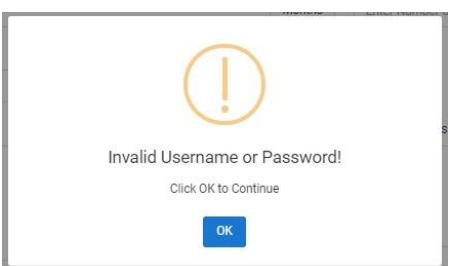
Primal Approved Equipment ID	Requisition Equipment no.	Ministry Approval Document ID	Ministry Approval Date
PAPP-REQ-000013-01	REQ-000013-01	MAD_09/11/2019.pdf	29/11/2019
PAPP-REQ-000007-01	REQ-000007-01	MAD_09/11/2019.pdf	29/11/2019
PAPP-REQ-000006-03	REQ-000006-03	MAD_09/11/2019.pdf	29/11/2019
PAPP-REQ-000003-04	REQ-000003-04	MAD_09/11/2019.pdf	29/11/2019
PAPP-REQ-000001-07	REQ-000001-07	MAD_09/11/2019.pdf	29/11/2019

Figure D.5: Ministry Rejected Equipment List.

Appendix E – Test Results

This section depicts the test results of the test cases described in the evaluation chapter.

Test Results for User Login

Test No.	Steps	Expected Result	Status
1	Enter the correct username & password. Click "Login" Button	Login into the system.	✓
2	Enter the correct username & incorrect password. Click "Login" Button		✓
3	Enter incorrect username & correct password. Click "Login" Button		✓
4	Enter incorrect username & password. Click "Login" Button		✓

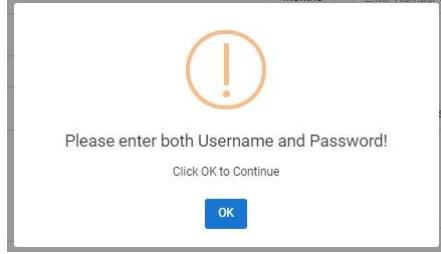
5	Click "Login" Button with empty fields.		
---	---	--	---

Table E.1: Test Results for User Login.

Test Results for Employee Registration and Employee Management

Test No.	Steps	Expected Result	Status
1	Enter a Working ID, fill the fields and Click Next Button	Please insert a valid working ID !	
2	Enter a NIC, fill the fields, Click Next Button.	Please enter a valid NIC !	
3	Enter fewer details Click Next / Submit Button	This field is required !	
4	Enter email address Click Submit button	This email is already in use !	
5	Enter the contact number. Click Submit button	The input value must be 10 characters !	

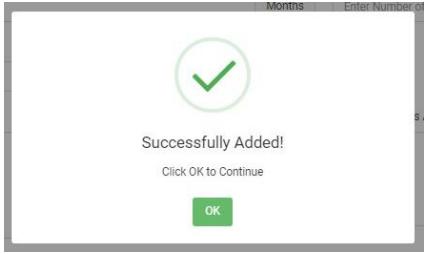
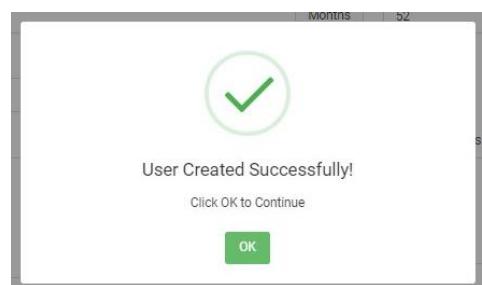
6	Enter all valid data. Click Submit button		
---	--	--	---

Table E.2: Test results for Employee Registration and Management.

Test Results for User Creation and Manage

Test No.	Steps	Expected Result	Status
1	Enter an Employee ID, fill the fields and Click Submit form Button.	Please enter a valid Employee ID !	
2	Click the Submit form button with empty fields.	This field is required !	
3	Enter a past/future date. Click Next / Submit Button.	Please insert a valid date !	
4	Enter valid data in all fields. Click Submit Button		

5	Click View Button	Pop-up a modal with user data	
6	Click Update Button on the specific user's row.	Load the user on to the Create New User Form	
7	Enter all valid data. Click Submit form Button		
8	Insert Invalid data. Click Submit Form Button		

Table E.3: Test Results for User Creation and Manage

Test Results for Equipment Requisition Module

Test No.	Steps	Expected Results	Status
1	Enter all valid data Click Save Button.		
2	Enter invalid data. Click Save Button.		

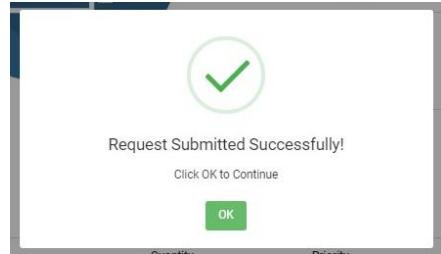
3	Enter all valid data. Click Send for Approval. Click Save Button.		✓
4	Enter invalid data. Click Send for Approval. Click Save Button.	Please insert valid data !	✓
5	Empty Equipment Name Field. Click Add Button	This field is required !	✓
6	Empty Quantity Field. Click Add Button	This field is required !	✓
7	Empty Equipment List table. Click Next Button.	Please insert valid data !	✓
8	Enter all valid data Click Next Button.	Proceed to the Confirmation step.	✓
9	Enter all valid data Click Next Button.	Proceed to Equipment Details step.	✓
10	Enter all details with an invalid Date. Click Next Button	Please insert valid data !	✓
11	Empty Fields. Click Next Button	This field is required !	✓

Table E.4: Test Result for Equipment Requisition Module.

Test Results for Yearly Survey Submission

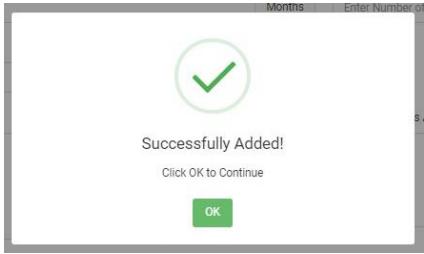
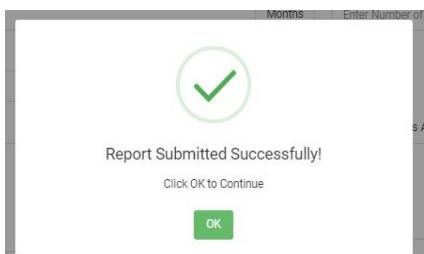
Test No.	Steps	Expected Result	Status
1	Enter all valid data. Click Next Button	Proceed to Equipment Details step.	✓
2	Enter invalid data. Click Next Button	Please insert valid data !	✓
3	Empty Fields. Click Next Button	This field is required !	✓
4	Empty Equipment Details table. Click Next Button.	Please insert valid data !	✓
5	Empty Fields. Click Add Button	This field is required !	✓
6	Enter All valid Data. Click Add Button		✓
8	Click Submit Button		✓

Table E.5: Test Results for Yearly Survey Submission.

Appendix F – User Feedback Forms

Beneath is the feedback form which was filled and given by a Medical Officer at the Planning Unit.

	Test Measure	Strongly Disagree					Strongly Agree	
		1	2	3	4	5		
1	Overall, I am satisfied with how easy it is to use this system.				✓			
2	It was simple to use this system.				✓			
3	I was able to complete the tasks and scenarios quickly using this system.				✓			
4	I was able to effectively complete the tasks and scenarios using this system.				✓			
5	I felt comfortable using this system.					✓		
6	It was easy to learn to use this system.					✓		
7	I believe I could become productive using this system.				✓			
8	The system gives error messages that clearly told how to identify problems.				✓			
9	Error messages, warning messages provided with this system was clear.			✓				
10	It was easy to search the information I needed.				✓			
11	It was easy to enter information to the system.					✓		
12	The information was effective in helping me complete the tasks and scenarios.					✓		
13	The interface of this system was simple to understand.					✓		
14	I liked using the interface of this system.				✓			
15	This system has all the functions and capabilities I expect it to have.					✓		
16	Overall, I am satisfied with this system.				✓			

Name: - Dr. W. D. P. Ranasinghe..... Date: - 29 - 11 - 2019.....

Designation: - Medical Officer - PU

Signature: - 

Figure F.1: User feedback from the MO at Planning Unit

Beneath is the feedback summary in user type wise as per the feedbacks collected from the real users of the system.

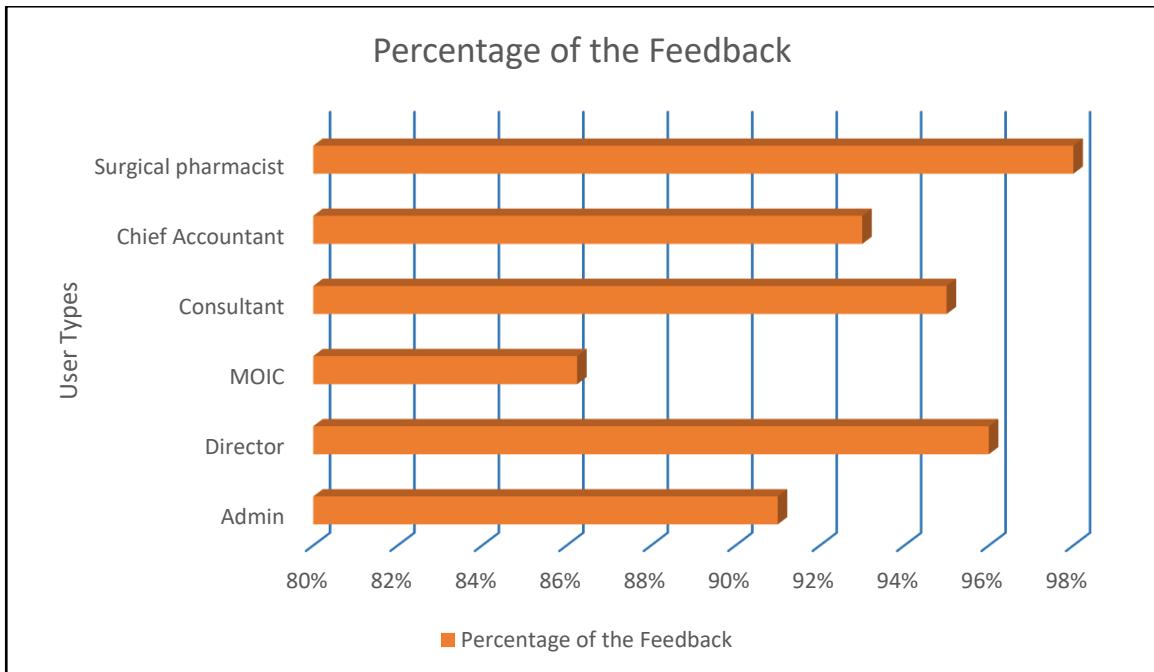


Figure F.2: User feedback as per the user type wise.

Calculation used to get the values for the graph on Figure F.2 is shown below.

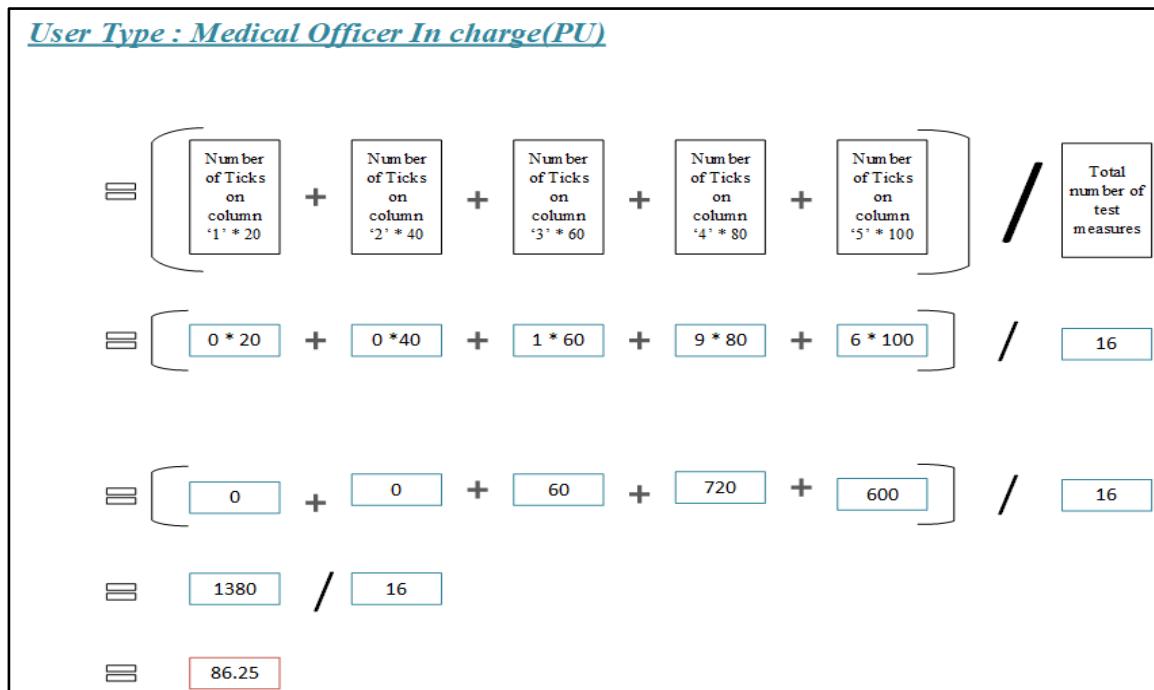
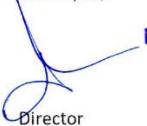


Figure F.3: User feedback value calculation.

Appendix G – Client Certification

 	<p>ජාතික රෝහල - මහනුවර දෙශීය බෙවත්තියේ සාලාල - කඩ්පැ NATIONAL HOSPITAL - KANDY</p> <table><tr><td>ජාතික මහනුවර හෝස්පිෂල</td><td>+94 81 2 244 888</td><td>උපාය තොගවත්කන්</td><td>+94 81 2233343</td><td>ඊමේල් මිලිනාංසුල</td><td>info@nhk.health.gov.lk</td></tr><tr><td>ඡායා පොදුව</td><td>My No.</td><td>උපාය තොගවත්කන්</td><td>Your No.</td><td>දිනය තිකුත්</td><td>Date</td></tr><tr><td>අභ්‍යන්තර ත්‍රිත්වය</td><td>AI/Tc/2019</td><td></td><td></td><td>05 .02.2020</td><td></td></tr></table>			ජාතික මහනුවර හෝස්පිෂල	+94 81 2 244 888	උපාය තොගවත්කන්	+94 81 2233343	ඊමේල් මිලිනාංසුල	info@nhk.health.gov.lk	ඡායා පොදුව	My No.	උපාය තොගවත්කන්	Your No.	දිනය තිකුත්	Date	අභ්‍යන්තර ත්‍රිත්වය	AI/Tc/2019			05 .02.2020	
ජාතික මහනුවර හෝස්පිෂල	+94 81 2 244 888	උපාය තොගවත්කන්	+94 81 2233343	ඊමේල් මිලිනාංසුල	info@nhk.health.gov.lk																
ඡායා පොදුව	My No.	උපාය තොගවත්කන්	Your No.	දිනය තිකුත්	Date																
අභ්‍යන්තර ත්‍රිත්වය	AI/Tc/2019			05 .02.2020																	
<p>Project Examination Board (BIT), External Degrees Centre, University of Colombo School of Computing, No. 35, Reid Avenue, Colombo 07, Sri Lanka</p>																					
<p>Dear Sir/Madam,</p>																					
<p>LETTER OF CERTIFICATION</p>																					
<p>This is to certify that Mr. S. B. M. R. C. J. Udurawana who is reading for his bachelor's degree at University of Colombo School of Computing has been very successful in developing the system "Medical and Laboratory Equipment Procurement Management System" for the Planning Unit of the National Hospital Kandy to enhance the efficiency and productivity of the hospital premises.</p>																					
<p>I'm pleased to inform that he spent lot of time with us to understand the requirements. The newly developed system has successfully met its specified requirements and will be more effective with the future enhancements.</p>																					
<p>Thank you,</p>																					
<p> Dr. ERASHA FERNANDO DEPUTY DIRECTOR National Hospital Kandy</p>																					
<p>දෙශීය මහනුවර හෝසිපිල නිවේදිත සභාර්ථක පෙරේල වෙත පෙනීම සම්බුද්ධීය ත්‍රිත්වය අනුමත කළ ඇති දෙපාර්තමේන්තුව සාලාලයාක එක්ස්ප්‍රෝල Vision - To be the safest tertiary care hospital in Sri Lanka</p>																					
<p> NHK NATIONAL HOSPITAL KANDY</p>																					
																					

Glossary

AJAX (Asynchronous JavaScript and XML)-is a group of interrelated web development methods used on the client-side to create interactive web applications. It is the art of exchanging data with a server, and update parts of a web page without reloading the whole page.

Authentication - is the process of determining whether someone or something is, in fact, who or what it is declared to be

Authorization - is the process of giving someone permission to do or have something.

CSS (Cascading Style Sheet) - is a style sheet language used to describe the presentation semantics (the look and formatting) of a document written in a mark-up language.

HTML (Hypertext Mark-up Language) - is the predominant mark-up language for web pages. HTML is the basic building blocks of web pages, which has collaborated with XML conventions.

JavaScript- is a prototype-based, object-oriented client-side scripting language that is dynamic. It is also considered a functional programming language.

jQuery - is a cross-browser JavaScript library designed to simplify the client-side scripting of HTML.

PHP (PHP Hyper-text Pre-processor) – Is a server-side scripting language.

SQL (Structured Query Language) - is a database computer declarative language designed for managing data in relational database management systems (RDBMS).

UML (Unified Modeling Language) - is a standardized general-purpose modeling language in the field of object-oriented engineering. This includes a set of graphic notation techniques to create visual models of object-oriented software-intensive systems.

Web Browser - is a software that allows the user to access WWW.

XAMPP – Open source Bundled software package. Include Apache, PHP, MYSQL, and Perl.

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