IT Service Management System for People's Leasing & Finance PLC

A dissertation submitted for the Degree of Master of Information Technology

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Abstract

People's Leasing & Finance PLC is a well reputed financial company in Sri Lanka, which is a subsidiary of People's bank. Mainly, The Company focuses on various financial needs of the customers to provide the best service to them. Hence, the financial field is highly competitive, it is necessary to provide value-added services to attract new customers as well as to retain their existing customers. Further, efficient process and procedures need to be established. In order to achieve the requirement, the company has expanded with introducing many branches and resources. Thus, In the IT perspective, the IT department has faced many issues in handling this heavy workload. Further, there are lots of manual works in IT process and procedures which are very time-consuming.

In order to address those issues in the IT Department, IT Service Management System was introduced. The main objective of this project work is to enhance the services provided by the IT department. Maintaining company asset register, streamlining asset issuing and returning process are some of the key functions of the Asset Management module. Further, the issues raised in the asset repairing process will be addressed from the service desk module. Clear visibility of the repairing process can be improved through this system process. Vendor management module includes all the vendor information, vendor rating, and vendor agreement management. The log information regarding DB log, CCTV log can be managed through the log monitoring section. Furthermore, the system was developed with user-friendly interfaces which are easy to use and easy to learn. The dashboard of the system is very informative and clearly displays the status of each ticket. Further, pending approvals and notifications also presented to the user very clearly. In addition, Security, Reliability, and Maintainability are some of the features which need to be considered during the implementation of the project. Further, all the process and procedures in the system were developed to cater to the requirements of ISO 27001:2013 information security standard. The system is implemented as a web-based system using the MEAN Stack which is a JavaScript-based framework. Mongo DB is used for the database of the project. After implementing the project, testing was carried out in different testing levels. At the completion of the project testing, the system was deployed into the live environment that can be used by all staff of People's Leasing. Afterward, the user evaluation process was carried out to evaluate the system to get the user feedbacks and improvements. Most of the users were satisfied with the system and few improvements were suggested to enhance the system.

Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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This is to certify that this thesis is based on the work of Ms. L.D.J.K. Chathurangani under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

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List of Abbreviations

IT – Information Technology

ICT – Information & Communication Technology

SLA – Service Level Agreements

PLC – People's Leasing & Finance PLC

ISO – International Organization for Standardization

ITSM – Information Technology Service Management System

ITIL - Information Technology Infrastructure Library

PMF – Process Maturity Framework

COBIT – Control Objectives for Information and Related Technology

CMMI – Capability Maturity Model Integration

MVC –Model View Controller

AMS – Asset Management System

ISACA – Information Systems Audit and Control Association

ISMS - Information Security Management System

PMI – Project Management Institute

MEAN – Mongo DB, Express, Angular and Nodejs

Chapter 1. Introduction

People's Leasing & Finance PLC is one of the leading finance company in Sri Lanka, which provides many financial facilities to the customers. It is a subsidiary of the People's Bank, and there are more than 100 branches island-wide to support the customers who are in various financial requirements. It provides many financial products such as Loans, Deposits, Margin Trading, Factoring, and Islamic finance other than its core product of Leasing. Further, its five subsidiaries mainly including People's Insurance PLC, People's Micro Finance Ltd, and People's Leasing Fleet Management Ltd, also provide several specialized financial needs to their customers. However, all IT-related operations of these subsidiaries are controlled by one ICT department.

1.1. Motivation

Although in 1996, its commercial operations were commenced with just three employees, currently more than 3000 employees are working in the branches located in Whole Island. The company is growing day by day with the introduction of new products. Therefore, the workload expected from the IT division also has been increased due to the expansion of the company. ICT department should be responsible for all the IT support services required by the branches to do their business related work smoothly. Mainly, IT support services include software support and hardware support. All software and core system tasks are handled by the software division and all hardware tasks such as hardware items management, software licenses, network, server monitoring, SLA management, and log monitoring are handled by the hardware division. Further, as a top financial company in Sri Lanka, Information security is essential in the day to day operations. Therefore, PLC is certified as an ISO 27001:2013 standard [1] certified company to provide the best service to its customers in information security point of view. Since the PLC ICT department handles all these responsibilities, currently they have faced many problems due to the expansion of the company. The ICT department is unable to cater to the heavy workload for IT support services required by the branches as well as Head office.

It is very difficult to maintain the IT Asset Register since it is a manual process which updates on Excel sheets by the IT Officers. Hence, Duplicate/missing assets and inaccurate asset details can be resulted because of the current manual process. Further, there is no proper tracking of

ICT department information assets. Thus, it is difficult to find the track of records such as maintenances or part replacements about each item. There is no any repairing procedure for branch/department assets. Hence, several assets have been misplaced during courier, and also some users send IT equipment to head office without informing the fault of the item. The time taken for repairs is also high due to the unavailability of an appropriate procedure. Currently, Quotations and payments for asset maintenance are kept in files. Therefore, it is difficult to find those quotations and payment details at a later day. Not only that, There is a huge number of telephone calls from branches/ departments regarding repairs and other IT-related operations. Therefore, the existing staff in the hardware help desk is not enough to provide better service to branch users. As an ISO 27001 certified company, process and procedures are need to be established to cater to the requirements of ISO 27001: 2013 Information Security Management System Standard. According to the standard, it is necessary to maintain a proper procedure for asset management. Log monitoring is another major security requirement for ISO 27001:2013 standard. However, still, the company has no any appropriate procedure to monitor logs such as CCTV, DB and etc. Currently, they are updated manually in logbooks, and most of the time, they are not up to date. Further, it is challenging to identify the renewals of the vendor agreements since the vendor details and vendor agreements are recorded manually. Also, there is no any vendor evaluation procedure to take decisions about the vendor agreement renewals.

In order to address the above problems, the management has decided to go for a computerized system to reduce the manual process and handle the workload in the Hardware Division. Additionally, it is hoped to develop the system according to the procedures in the ISO 27001:2013 Information Security standard because it would be much helpful in the ISO 27001 periodical audits. By considering all these requirements, it is hoped to develop an IT Service Management System for People's Leasing & Finance PLC.

1.2. Aims and Objectives

The main objective of the proposed solution is to provide IT services more efficiently as well as more effectively to the internal users to do their business-related operations easily. Some of the key objectives of the IT Service Management System (ITSM) can be summarized as follows.

1. Establish a proper procedure for tracking of ICT department information assets.

2. Provide better service to the internal users for their smooth operation.

3. Improve the accuracy of the asset register and easy maintenance of the asset register.

4. Provide a proper procedure for repairing IT equipment.

5. Reduce help desk calls and workload of the IT staff by automation of the process.

6. Cater to the requirements of ISO 27001: 2013 Information Security Management System Standard. [1]

7. Maintain vendor agreements and renewals.

8. Systematize log monitoring process.

1.3. Scope

The proposed IT Service Management System mainly focuses on four areas in the IT services. It consists of ICT Asset Management, ICT Hardware Help Desk, Vendor Management, and Log Monitoring.

In Asset Management perspective, it is hoped to handle and maintain all the IT assets in the company. The proper procedure needs to be established for registering assets and tracking asset movements. Further, ICT asset related reports generation will be expected in this module. In the Hardware Helpdesk module, it is projected to provide proper tracking of repairing equipment which is sending from branch/departments. Since the branch users send the equipment for repairs, they will be able to see the status of the equipment through this system without contacting the Hardware Helpdesk. The entire equipment repairing process, including ticket generation, inspection, repairing, and payment need to be coved in this section.

It is hoped to develop an automated procedure for managing all the IT vendors of the company through the Vendor Management module. There are many Service Level agreements and vendor agreements which need to renew on time. Therefore, renewal notifications for SLA agreements and vendor rating evaluation are essential to be addressed in this section. According to the ISO 27001: 2013 standard log monitoring is another control that is useful for information security. Thus, the entire log monitoring process is projected to automate in the Log Monitoring Section.

1.4. Dissertation Outline

This dissertation consists of six main chapters, followed by Reference and Appendix. Chapter 1 is the Introduction chapter, which describes the problem, motivation, objectives, and scope of the project. Chapter 2 describes the background study of the project and the current procedure of the company. Further, it includes the reviews and the features of similar systems and how they are useful to the proposed system. Chapter 3 is the Analysis and Design. This chapter contains the requirement gathering, functional and non-functional requirements and the design of the system. Chapter 4, which is the Implementation chapter, consists of hardware and software requirements and all its implementation methods, which were used to develop the system. Chapter 5 is the Evaluation chapter, which contains a critical evaluation of the system discussing whether the project objectives are satisfied. Chapter 6 is the Conclusion chapter. It identifies any deficiencies in the final system and future improvements of the project.

Chapter 2. Background

This chapter provides some background information to the current status of the company process and procedures regarding the IT Service Management perspective. The information obtained by reviewing the similar systems also presented in this chapter. First, the introduction to the IT Service Management concept can be illustrated as follows.

2.1. Background Study

IT Service Management refers to all activities involved in implementing, managing, and delivering IT services to meet the needs of an organization. Mainly, it focuses on IT services that are helpful to carry out the business related operations smoothly. There are several industry-recognized IT Service Management (ITSM) frameworks and maturity models to improve service management functions and processes.

Information Technology Infrastructure Library (ITIL) is the most widely used framework for IT service management in the world. It was developed as an initiative by UK Cabinet Office and currently owned by Axelos, a joined venture between Capita and the UK Cabinet Office. In the 1980s, The framework was developed and the most recent update to Version 3 was published in 2011. Currently, ITIL has become the effective standard in IT Service Management. Service Strategy, Service Design, Service Transition, Service Operation, and Continual Service Improvement are the five stages of the ITIL framework. [2]

COBIT (Control Objectives for Information and Related Technology), CMMI (Capability Maturity Model Integration), and ISO (International Organization for Standardization) practices are some of the other ITSM frameworks which are frequently used. According to Wikipedia, COBIT is a good practice framework created by international professional association ISACA (Information Systems Audit and Control Association) for IT management and IT governance. [3] As compared to ITIL, COBIT provides IT governance and practices while ITIL provides guidance for service management. CMMI model is mainly focused on IT Service management with the software development, maintenance perspective. Further, ISO/IEC 20000 is the international standard for ITSM that is measure how well ITSM practices are being adopted. It defines requirements for planning, establishing, implementing, operating, monitoring, reviewing, maintaining and improving the ITSM. ISO 9001 focuses on quality management systems while ISO 27001 focus on IT security.

2.2. Current Process

In People's Leasing and Finance PLC, currently, there is no any systemized procedure for IT service management. All the service management tasks are carried out manually. The officers maintain manual excel sheets for recording all the asset details, warranty periods, asset repairing details, vendor and SLA (Service Level Agreement) details, log details and etc. Therefore, many errors and mistakes were found in this manual process. Not only that, it needs more effort and time to handle this process.

Further, as a financial company, PLC is responsible for maintaining a high information security standard when compared to the other organizations. Hence, People's Leasing has been moved to follow the ISO 27001 information security standard. Therefore, all the IT services are carried out according to that standard and procedures.

2.3. ISO 27001 Information Security Standard

ISO/IEC 27001 is an information security standard which is a part of the ISO/IEC 27000 family of standards. Its latest version was published in 2013. Further, it is the best standard for providing requirements for an information security management system (ISMS). ISMS offers a systematic approach to managing sensitive company information as well as the risk assessment process. This certification is very important for a company to reassure their customers and clients whether the company is following the certification controls. Therefore, they feel that their sensitive information is secure in the ISO 27001 certified company than which it is not.

The standard covers 14 security control clauses containing a total of 114 controls. The following Figure 2.1 illustrates the clauses in the ISO 27001:2013 standard. Asset Management is one of the significant control which is under clause 8 of the ISO/IEC 27002:2013. [1]. According to clause 8, all information assets of the company should be inventoried and maintained. An asset can be Hardware, Software, Information, Infrastructure, People, or Suppliers of the company. Further, there should be an Asset Owner for each and every asset of the company. Asset Classification also should be done to identify the confidentiality level of each information asset. Additionally, clear labeling procedure for each asset is also expected in this standard. Further, as per the Standard, Handling of assets, Disposal of assets, and Asset transferring also should be done in secure procedure.

Figure 2.1 - Controls of ISO 27001:2013 Standard [4]

For Operations Security, which is mentioned under Clause 12 of the standard, it is required to maintain and monitor the logs which can identify actions of the users, errors, events and etc. By reviewing the logs daily, it is able to detect the unusual behaviors of the systems. It will help in the incident management of the company. Supplier Relationships is another essential clause which is under Clause 15. Process and procedures should be established to manage IT outsources and other external suppliers of the company. Vendor contracts or agreements should be renewed on time, and Service delivery of them should be continuously monitored.

2.4. Review of Similar Systems

There are many applications developed to manage IT Services of a company. However, they all have some similarities and dissimilarities that should be taken into consideration. This section will illustrate some leading applications and project works that were carried out regarding IT Service Management.

2.4.1. Information Technology Service Management (ITSM) Implementation Methodology Based on Information Technology Infrastructure Library Ver.3 (ITIL V3)

This covers the concept of IT Infrastructure Library Version 3 (ITIL) and how to implement it in order to increase the efficiency of any Egyptian IT corporate and to help the corporate employees to do their work easily and its clients to feel the quality of services provided to them. ITSM systems were implemented in three Egyptian companies called ASCOM, DP World, and Nile.Com. Here, ITIL V3 was considered as the framework for developing the ITSM system, and mainly, it focused on Incident Management, Problem Management, and Change Management process.

After implementing the ITSM system, ITIL process Maturity Framework (ITIL PMF) was used to measure the improvement of the implemented process. With the evaluation results of the PMF levels before and after the implementation of three companies, it was clearly stated that there was an improvement in the efficiency of the IT processes. As the next step, they are going to develop software for Service Desk, including many ITIL V3 processes using a web portal. [5]

2.4.2. Experience with an IT Asset Management System

Asset Management System (AMS) is a tool to support the management and maintenance of the assets. It was introduced by DESY, and as the first release in 2002, it was implemented only for software license management. Then, it was improved to an inventory of IT equipment like computers, printers, monitors, and switches. Further, it was used for asset tracking of IT equipment. [6] AMS system has three main goals which are implemented as logical modules.

1. Software License Management which can be used to record details of the used and available licenses on windows computers.

2. Procurement of standard resources to reduce the processing time and needed human resources for the delivery of IT equipment.

3. Common central repository to track and configure all IT devices within one information system.

2.4.3. Samanage

Samanage is a cloud-based IT service desk and asset management software for IT and enterprise service management. It was established in 2007 by Doron Gordon, and after a three-year development and testing period, in 2010, it was first delivered an IT Asset Management Solution to the market. Later in 2011, Samanage was extended to the service desk functions [7]. The service desk includes a self-service portal, service catalog, knowledge base, and SLA management tool.

It was developed to comply with the IT Service Management framework - The Information Technology Infrastructure Library (ITIL). Samanage collects IT Asset data and provides reports to the users. Further, user service requests can be submitted online, and users can be able to track those requests in the IT Service Desk [8]. Some of the main features of Samanage are IT Asset Management, Service Desk Management through ticketing, Service Level Management, Dashboards, Reporting, Incident Management, Change Management, and Problem Management.

2.4.4. ServiceDesk Plus

ServiceDesk Plus [9] is ITIL based help desk software with Asset management and Project management capabilities. It is easy to use and helps IT support teams to deliver the best service to the end users with reduced cost and complexity. IT asset and Inventory management, Asset tracking, Software License management, Purchase order tracking, Incident management, Change management, Service Level Agreements, Help desk services, and Problem management are some of the features offered by ServiceDesk Plus.

2.4.5. JIRA Service Desk

JIRA Service Desk [10] is another IT Service management software which provides most of the service functions needed for a service request, incident, problem, and change management. Since JIRA Service Desk is capable of integrating with JIRA software, IT and development teams can work better together. Therefore, the users can connect service desk tickets to JIRA software issues and get to the root cause of problems before they escalate. The main features of the JIRA Service Desk are Incident Management, Problem Management, Change Management, ITIL certified Service Desk, SLA Management, and JIRA Software Integration.

2.4.6. SolarWinds Web Help Desk

SolarWinds Web Help Desk [11] is Ticketing and IT Asset Management Software. It is mainly designed to improve the service of help desk management. This solution includes Ticket Management, Asset Management, Change Management, and Knowledgebase capabilities. Some of the key features in the above solution are Automate Ticketing Management, Manage SLAs, IT Asset Management, and Change Management.

2.5.   Comparison and Contrast with Similar Systems

The comparison and contrast of the above discussed similar systems can be summarized as the following Table 2.2 - Comparison and Contrast with Similar Systems.

Table 2.1 - Similar Systems Numbering

System 1	Information Technology Service Management (ITSM) Implementation Methodology Based on Information Technology Infrastructure Library Ver.3 (ITIL V3)
System 2	IT Asset Management System
System 3	Samanage
System 4	ServiceDesk Plus
System 5	JIRA Service Desk
System 6	SolarWinds Web Help Desk
System 7	Proposed ITSM System

Table 2.2 - Comparison and Contrast with Similar Systems

	System 1	System 2	System 3	System 4	System 5	System 6	System 7
Asset Management		✔	✔	✔		✔	✔
Asset Tracking		✔		✔		✔	✔
Software License Management		✔		✔			✔

Help Desk/ Service Desk			✔	✔	✔	✔	✔
Incident Management	✔		✔	✔	✔		
Change Management	✔		✔	✔	✔	✔	
Problem Management	✔		✔	✔	✔		
Service Level Agreements			✔	✔	✔	✔	✔
Purchase Order Tracking	✔			✔			✔
ITIL Framework				✔	✔		
Dashboard & Reporting			✔	✔			✔

Chapter 3. Analysis and Design

After reviewing the similar systems, the next step is to analyze the requirements of the proposed system. According to the analysis, It is required to design the system. Hence, all the details of the system analysis and design that are used to make this project complete as well as working are discussed in this chapter.

3.1.   Requirement Gathering

Requirements are a necessary part of any software project, which is the foundation of the entire project. Therefore, as the initial stage of the project workflow, requirements were captured through the investigation of the current procedures and the user views. Requirement gathering is an essential phase in the project because the misleading information and requirements can cause many problems and failures at the later stages of the project. The main approaches that can be used for requirement gathering process include documentation, interviews, observations, and questionnaires.

3.1.1.   Fact Finding Techniques

Several fact-finding techniques were used to capture the requirements of the proposed system. Several meetings were carried out with the Hardware Division officers, ISO Team members, and other related officers of the IT department. In those meetings, it was able to get the idea about the current process and its problems. Further, the suggestions they expect to the new system and how they comply with the ISO standards were also discussed. Several meetings had to be taken to capture the initial requirements of the system and clarify them since there were conflicting requirements with some officers and ISO procedures. Few branch users were contacted through the telephone and handled some interviews about the current status of the IT Services, IT Equipment maintenance, and repairing process. Also, the opinion of each interviewee was taken by asking whether it is helpful to them if the company moves those services to a computerized system.

The questionnaire is another fact-finding method used to capture the requirements of a large set of the user group. Hence, Printed sheets containing several questions were handed over to the branch users as well as head office users. Another set of question set was handed over to the Hardware Division staff, who is the main target user group of the system. The questionnaire

distributed to the branch users and Hardware Division Staff can be referred to under Appendix A. By analyzing the results of the questionnaire, it was able to capture the current process and the work flow related to the IT Services of the company.

Observing the working environment and document reviews are another major resource to gather the requirements. Hence, it was able to clarify the requirements that were captured in the meeting sessions more practically. Further, the requirements could be easily captured through documents such as manual maintained excel sheets, Vendor agreements, Log books, Audit findings, and ISO documents.

3.1.2. Problems and Proposed Solutions

After the requirement capturing process, the issues of the current system were identified, and solutions for those problems were proposed. Table 3.1 illustrates the problems and the solutions for each problem.

Table 3.1- Problems of the current system and proposed solutions

Problem	Proposed Solution
Difficult to maintain the IT Asset Register since still, it is a manual process which updates on Excel sheets by the IT Officers.	The system should be able to enter the IT assets details and maintain them.
Duplicate/missing assets and inaccurate asset details	Each asset should have a unique asset code and barcode that cannot enter duplicate assets into the system.
Difficult to find the track of records such as maintenance or part replacement of assets	The system should be able to update the maintenance or part replacement of each asset.
No any repairing procedure for branch/department assets. Several assets have been misplaced during courier.	It is required to establish a procedure to send assets to IT after generating a ticket through the system.
Time taken for repairs is high and no any feedback about the status of the repairs.	Each ticket should follow and update the status of the asset repairing process

Quotations and payments for the asset maintenance are kept in files. Therefore, it is difficult to find those quotations and payment details at a later day.	The system should be able to attach the quotations and other payment details.
A vast number of telephone calls from branches/ departments regarding repairs. Therefore, the existing staff in the hardware help desk is not enough.	The system should provide a screen to view the status of the repairing items by the branch/department users.
Proper process and procedures need to be established to cater to the requirements of the ISO 27001:2013 standard.	The system should be developed according to the ISO 27001:2013 standard.
Difficult to identify renewals of the vendor agreements since the vendor details and vendor agreements are recorded manually.	The system should be able to capture the details of the vendor agreements and give notifications on vendor renewals.
Since log monitoring is done manually in logbooks, most of the time, they are not up to date.	The system should be able to enter the log details and update them accordingly.

3.2. Requirement Analysis

Requirement Analysis is the process of studying and clarifying the conflicting or ambiguous requirements which were captured in the requirement gathering stage. It includes analyzing, documenting, validating, and managing software or system requirements. Mainly, system requirements include the Functional and Non Functional requirements of the system. Hence, Following Functional and Non Functional Requirements were identified in the ITSM system.

3.2.1. Functional Requirements

The key functional requirements which were captured in the requirement gathering stage can be summarized as below.

- **Asset Management**

IT Officers should be able to register new assets and modifying the existing assets. It is hoped to develop the ICT Asset Register with asset barcoding and labeling procedure. Further, According to the ISO 27001 standard, asset categorization and asset ownership should be entered in the asset registration process. Reports on the asset register will be able to generate in the annual ICT asset verification process. Further, it is hoped to develop asset wise audit trail to view the log details of the asset modifications. Asset warranty period tracking is another function that needs to be developed in the system.

Temporary/ Permanent asset issuing and the returning process should be automated to enter the details about the asset issuing and returning. Then, the automated declaration has to be printed when issuing assets to other parties. Damage/ misplace asset tracking and asset disposal procedure also should be able to automate. Further, users can be able to generate ICT asset related reports.

- **ICT Hardware Help Desk**

Any registered user can be able to submit tickets for repairing IT equipment of the branch/department. It is hoped to introduce a systematic procedure to repair IT equipment and to track the history of the repaired IT equipment. Users should be able to view the current status of the repairing item.

There are two ways of repairing items. Either it can be sent to the vendor if the item has a warranty or it can be repaired in-house by the Hardware officers. It is expected to automate these two procedures through this module. Further, gate pass can be generated for asset movements such as sending equipment from branch to IT, IT to vendor and etc. Quotation details, quotation approvals, and payment details of each ticket can be captured by entering the details into the system.

- **Vendor Management**

IT Officer can enter the IT vendor details and contract agreements. There should be notifications on renewals of Vendor agreements and Service Level Agreements. Vendor rating evaluation is another feature of this module.

- **Log Monitoring**

IT Officer can be able to enter the log details into the system and update the ICT log register. Further, the system can be able to generate log reports to identify the unusual behaviors of the logs.

- **Report Generation**

It is able to generate various reports concerning the four main modules of the ITSM system. ICT Asset Register Report, Ticket detail reports, gate pass reports, and vendor rating report are some of the reports that can be generated in the Report Generation module.

- **Administration**

This module consists of the supporting functions of the system. For Asset Management module, Make, Model, Asset Locations, Branches, Asset Category, and Asset Types have to be entered into the system. IT Officers can enter or update those details from this module. Further, Automatic Asset Code Generator is another function of this module.

- **User Registration and Login**

IT officers can register the employees and create logins for the users. Then the registered user will be able to login into the system by entering his/her username and password. Registered users can reset their password if they know their current password. Otherwise, the IT Officers can reset the user passwords.

- **Access Control**

IT Officers will be able to create job roles and access menus for each job role. Further, they can assign each user to the job roles from this module.

3.2.2. Non Functional Requirements

Non-functional requirements are the requirements which are not directly concerned with the specific functions delivered by the system. They may relate to emergent system properties such as reliability, response time, user-friendliness, availability and etc. The main non-functional requirements that were captured are as follows.

- **Reliability**

Reliability can be referred to as the ability of a component or system to function under specified conditions for a stated time period. Reliability is related to the Availability of the system and the Failure Rate of the system. Hence, to make the ITSM system more reliable, there should be high availability of the system and fast recovery time in case of a failure.

- **Usability**

Usability is another essential requirement of the system. It defines how difficult the system to learn and operate to the users. It can be achieved in several ways, such as user-friendly interfaces to the ITSM system. Users should be able to use the system easily without any doubts. Further, the flow of the activities should be memorable when the users return to the system after a period of not using it. Also, system messages should be very clear and understandable. Usability helps to improve the efficiency of the ITSM system also.

- **Security**

Security ensures that the system is protected from the unauthorized access to the system as well as its stored data. ITSM system should have a secure database connection to its stored data and secure logins with passwords. Further, different access levels for different user roles.

- **Performance**

Performance measures the responsiveness of the system to various user interactions. Poor performance can lead to negative user experience. Therefore, the system should have a fast processing time.

- **Maintainability**

In Software Engineering, Software Maintenance is very essential. Hence, the system should have the ability to change and modify at any time without much effort. To meet the new requirements or to correct bugs of the system, good maintainability in the system is important.

3.3. System Design

System design is the process of defining architecture, modules, interfaces, and data for the system according to the identified requirements of the system. Simply, it is the process of transforming the user requirements into a suitable form which help the developers to implement the system. After identifying the system users as well as functional requirements of the system, the overall system architecture of the ITSM system was designed as following Figure 3.1 below.
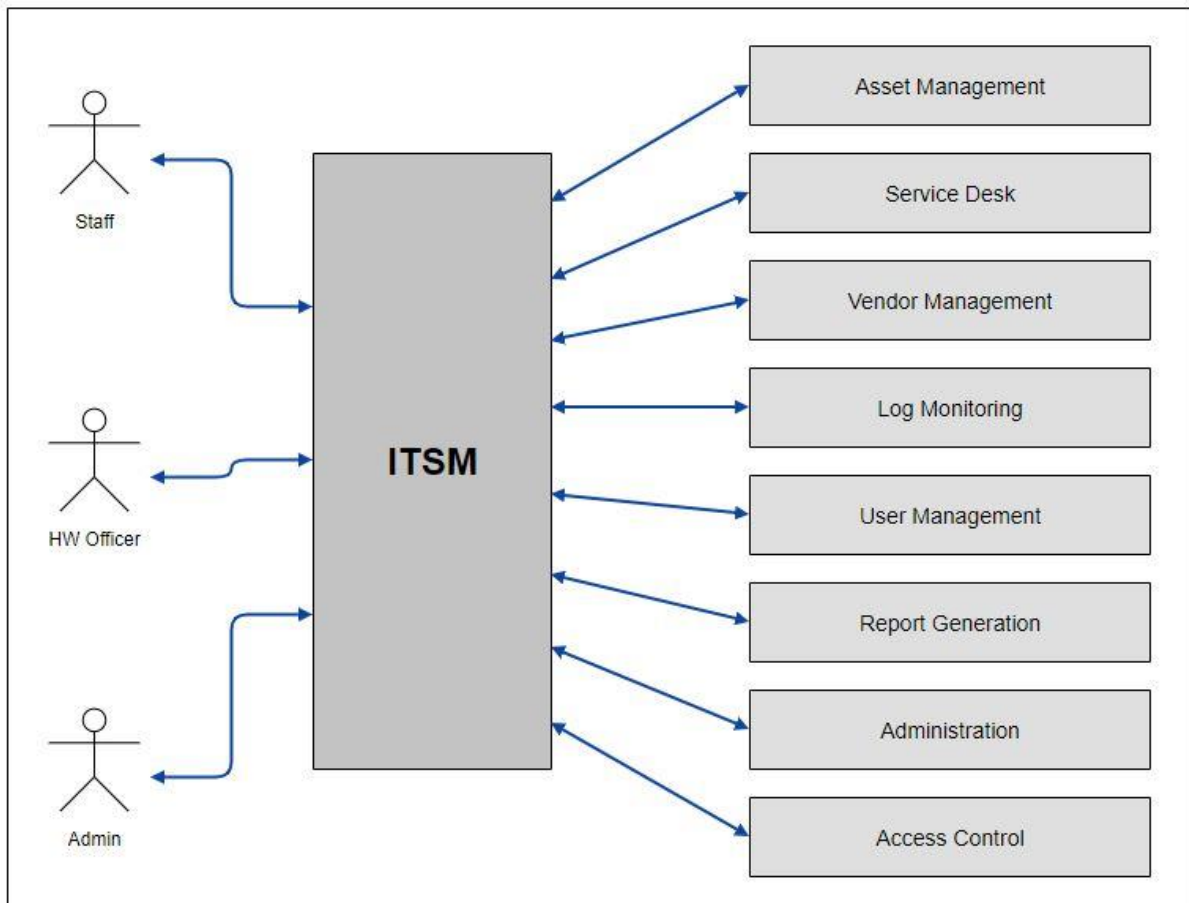

Figure 3.1 – Overall System Architecture of ITSM

Afterward, the process and workflow of the system were designed according to the functional requirements that were captured at the earlier stage. The workflow of the Service Desk module can be summarized as the following Figure 3.2.
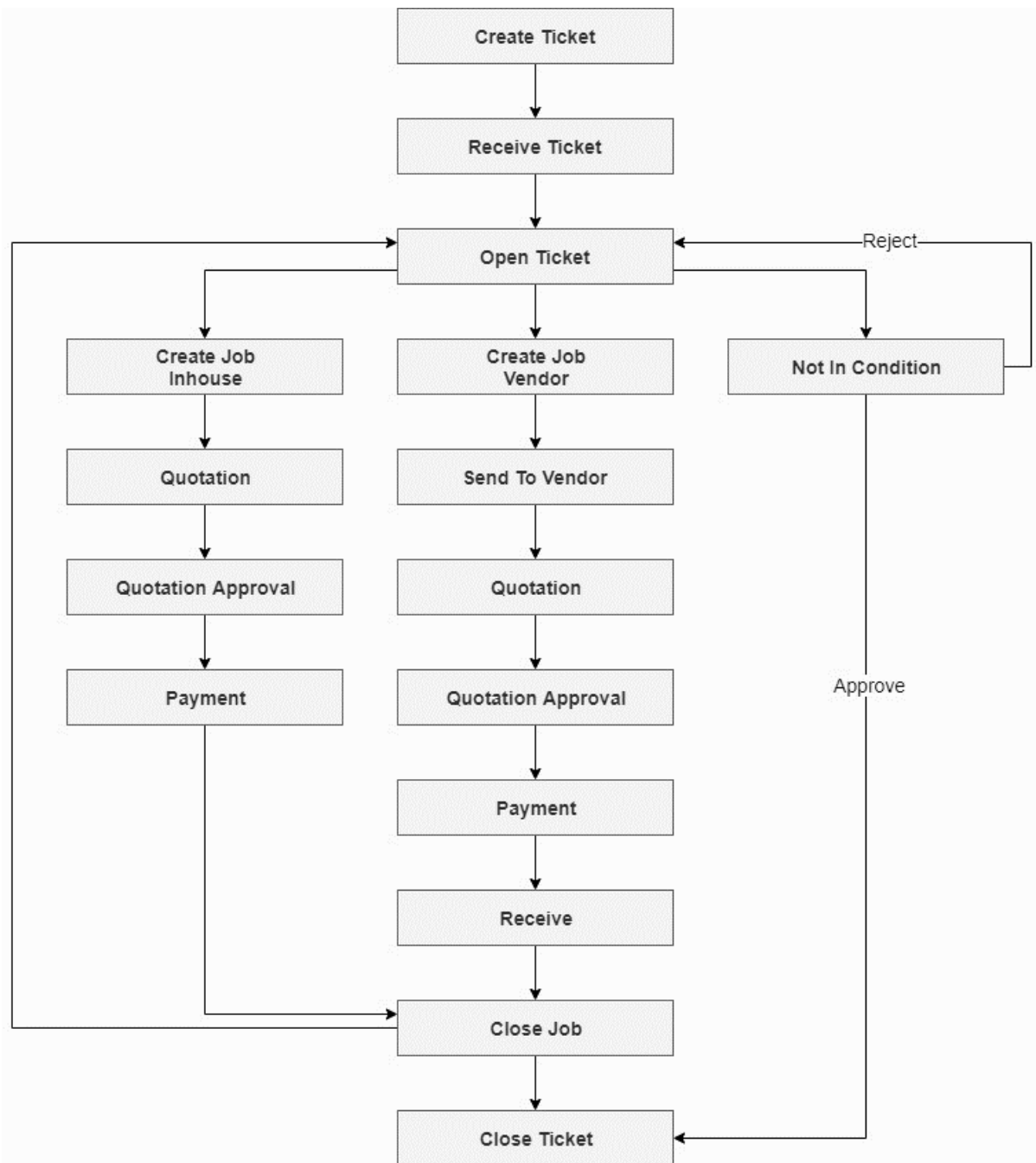
Figure 3.2 – Work Flow of the Service Desk Module

Afterward, Use case diagram was drawn to visualize them more clearly and more understandable way.

3.3.1.   Use Case Diagram for the System

The Use Case diagram of the ITSM system can be shown as the following Figure 3.3. This summarizes the system functionalities which are related to each user group of the system.
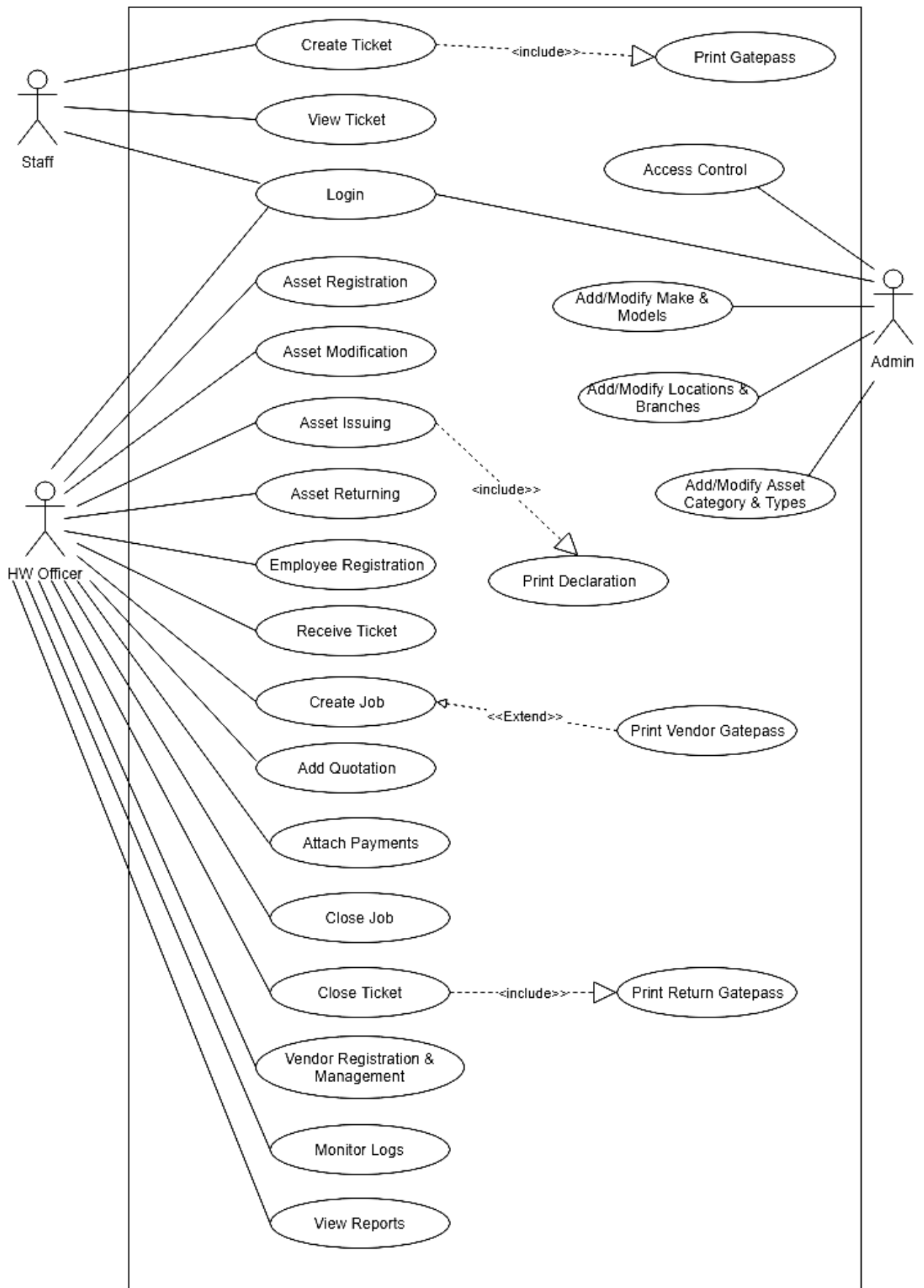
Figure 3.3 – Use Case Diagram for the ITSM System

3.3.2. Class Diagram for the System

In Software Engineering, Class diagram is used to describe the structure of the system by showing the system classes, their attributes, methods, and the relationships among the objects. Following Figure 3.4 shows the class diagram for the ITSM System.
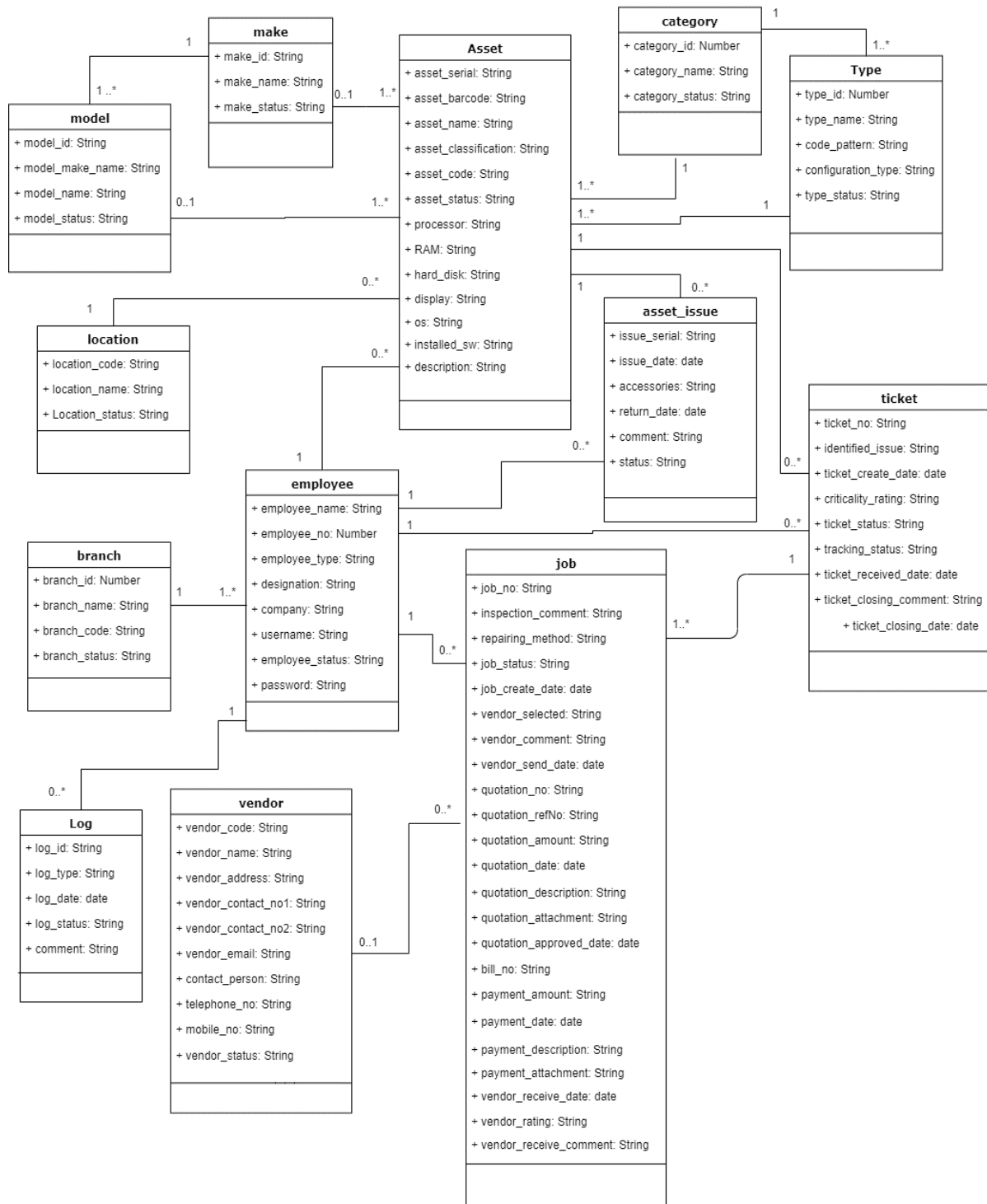
Figure 3.4 – Class Diagram for the ITSM System

3.4. Database Design

Database Design involves the classifying data and identifying the relationships among them. A well-designed database improves the performance of the system and easy to maintain. The Diagram under Figure 3.5 shows the Database Design for the ITSM System.
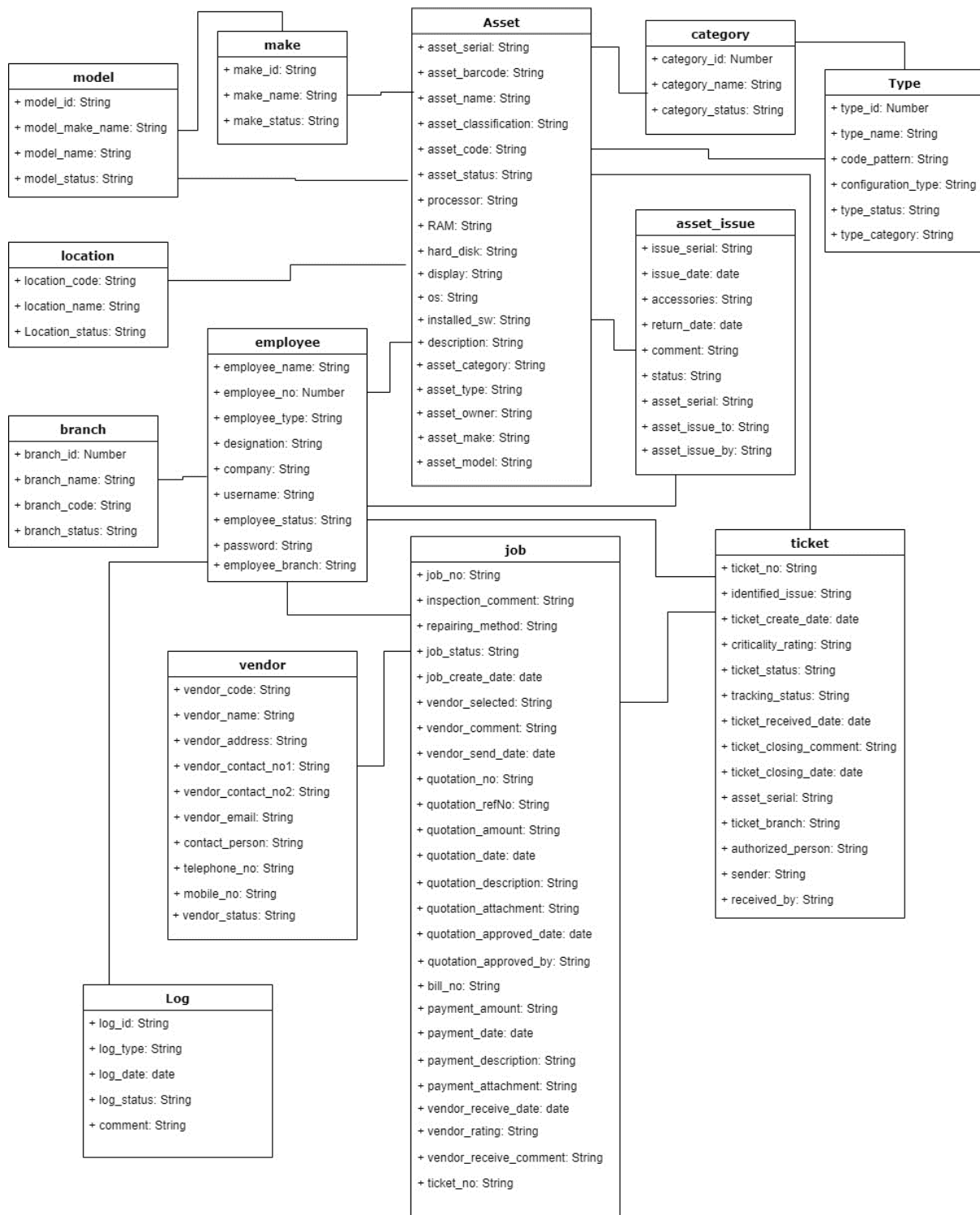
Figure 3.5 – Database Design Diagram for ITSM

3.5. Interface Design

Wireframes or Mockups can be used to design the interfaces of the system. When compared to Wireframes, Mockups provides more visual details such as colors and typography, which gives the observer a more realistic impression of how the end product will look. Mockup for the Asset Registration Screen in the ITSM system is as shown in the following Figure 3.6.

Figure 3.6 – Mockup for Asset Registration Screen

Further, some primary interfaces of the ITSM system are included in Appendix B.

Chapter 4. Implementation

After designing the system, the next phase is to implement the system. In this stage, the system design is translated into the source code, and all the components of the system are developed. Before starting the coding, it is necessary to select suitable programming language according to the requirements and design of the system. This chapter describes all the implementation details of the system, including programming languages, architecture, and some user interfaces of the system. As the first step, it was decided to implement the ITSM system using MEAN Stack, which is free and open source JavaScript framework.

4.1.   Hardware and Software Specification

The system was developed under the following Hardware and Software Requirements.

Hardware Requirements

Intel Core i7 2.20GHz, 6GB RAM, 500GB Hard Disk

Software Requirements

Front end Framework: Angular: 7.1.4, Bootstrap 4

Back end run-time Framework: Node: 10.14.1

Back end web Framework: Express

Database: MongoDB version v4.0.4, Robo 3T -1.2 as Mongo DB GUI tool

Code Editor: Visual Studio Code

4.2.   Architecture

The system was developed using MEAN Stack, which is the JavaScript-based technology using for web developments. MEAN is a short form for MongoDB, ExpressJS, AngularJS, and NodeJS.

4.2.1. Architecture of MEAN Stack

MEAN Stack is very simple and easy to use for both back end and front end of the application. The key benefit of the MEAN stack is that it lets the developer to write the complete code in JavaScript from client to server. Also, it supports the MVC architecture. The Working environment of the MEAN Stack architecture is as shown in the following Figure 4.1.
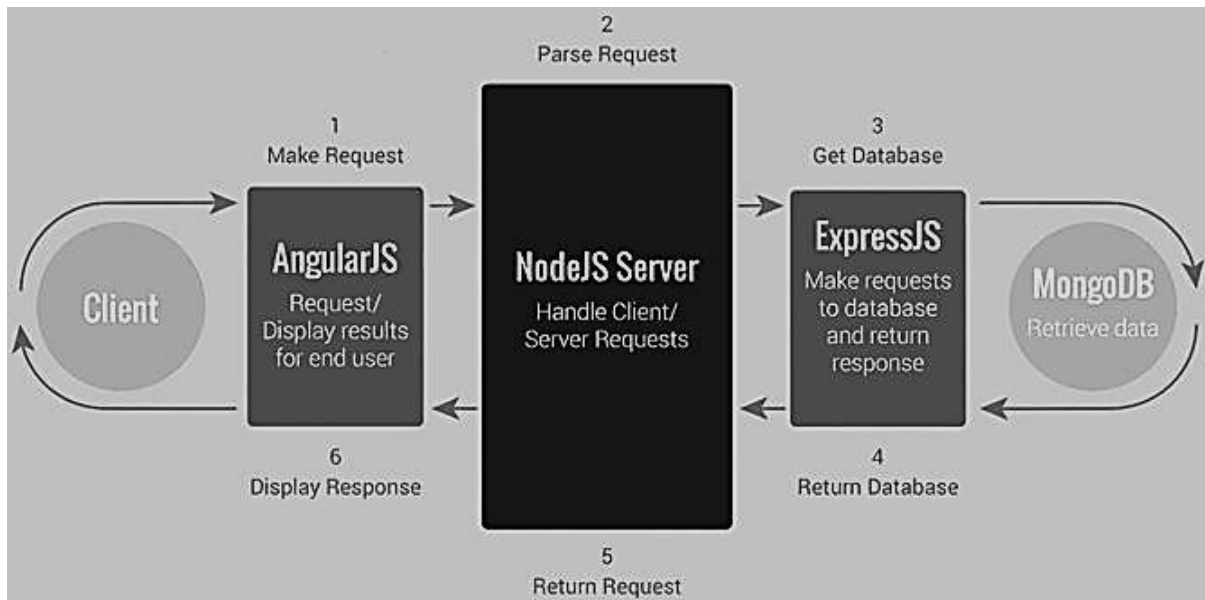

Figure 4.1 - MEAN Stack Architecture [12]

When a client makes a request, it is firstly processed by AngularJS, which is the client side language in JavaScript. Then, the request enters into phase 2, which is NodeJS. It is the server side language in JavaScript. After that, the request comes into phase 3, which is ExpressJS. It makes the request to the database. At that point, MongoDB Retrieve the data and return the response to the ExpressJS. Afterward, ExpressJS return response to the NodeJS and NodeJS return it to the AngularJS to display the result.

4.2.2. AngularJS

AngularJS can be defined as a structural framework for developing dynamic web applications. In Angular, it is able to use HTML as the template language to express the application components clearly. Further, AngularJS data binding and dependency injection eliminate much of the code currently have to write. It provides the developer's options to write the client-side applications in MVC framework. Hence, ITSM System was developed using the MVC architecture of Angular, which represents Model View Controller in software design patterns.

The model is used for managing the data of the application. It reacts to the request from the view, and it also reacts to instructions from the controller to update itself. The view is the presentation of data in a particular format, triggered by a controller's decision to present the data. They are script-based templating systems and very easy to integrate with AJAX technology. The controller is used to respond to the user input and performs interactions on the data model objects. Once the controller receives the input, it validates it and then performs the business operation that modifies the state of the data model.

MVC architecture of the AngularJS is illustrated in Figure 4.2 - MVC Architecture of AngularJS.
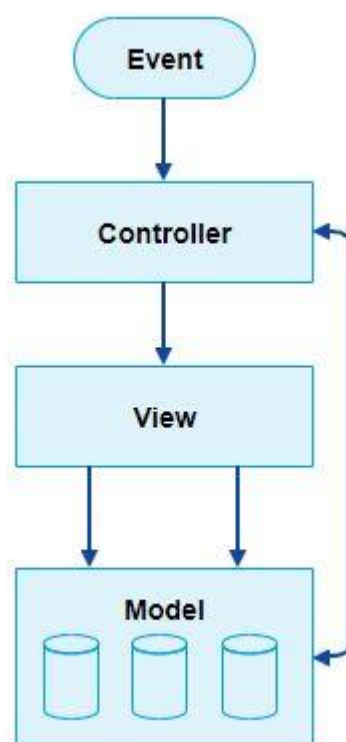
Figure 4.2 - MVC Architecture of AngularJS [12]

4.2.3. NodeJS

NodeJs is an open source JavaScript framework that uses asynchronous events to process multiple connections simultaneously. It is built on Google Chrome's V8 JavaScript Engine. Therefore, NodeJs library is very fast in code execution. Further, NodeJs uses a single threaded model with event looping. Hence, the same program can provide service to a much larger number of requests than traditional servers like Apache HTTP server.

4.2.4. Express

Express is a web application framework for NodeJs. When a user sends a request to through AngularJS, that request is firstly accessed by the NodeJS threading then it is sent to the ExpressJS to Create, Read, Update and Delete the API for the request. ExpressJS host the website for the NodeJS. After CRUD the API data is retrieved from the MongoDB and then send it to the user. The Architecture of ExpressJS is shown in Figure 4.3 – Architecture of ExpressJS
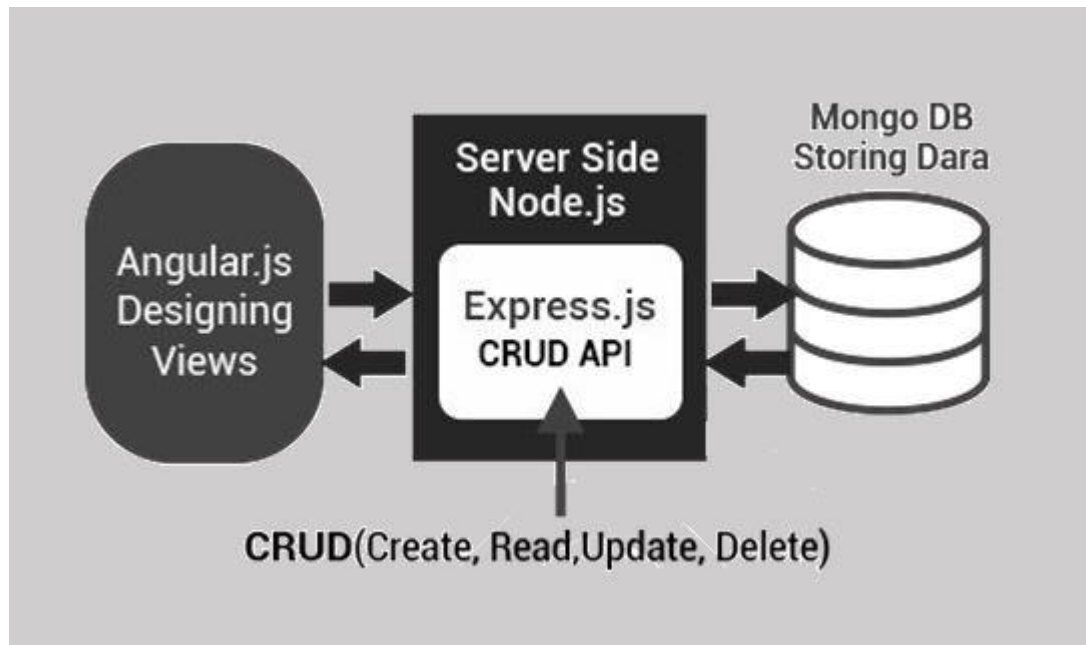

Figure 4.3 – Architecture of ExpressJS [12]

4.2.5. Mongo DB

Mongo DB is a free and open- source, a document-oriented database which is classified as NoSQL database. It uses JSON like documents with schemas. Further, it is able to add a field to the database without reloading the entire table, and also it supports multi-dimensional data types like other documents and arrays. Since Mongo DB is known as a fast and flexible data model, it has the ability to manage large amounts of data without compromising on data access.

4.3. User Interfaces

In this section, it is hoped to describe some of the main interfaces of the ITSM system and its functionalities.

4.3.1. User Login

In order to use the ITSM system, the user has to login into the system using the correct username and password. Therefore, this is the first interface of the system which controls the access to the ITSM system. The wrong username or password will give error message while preventing unauthorized access into the system.

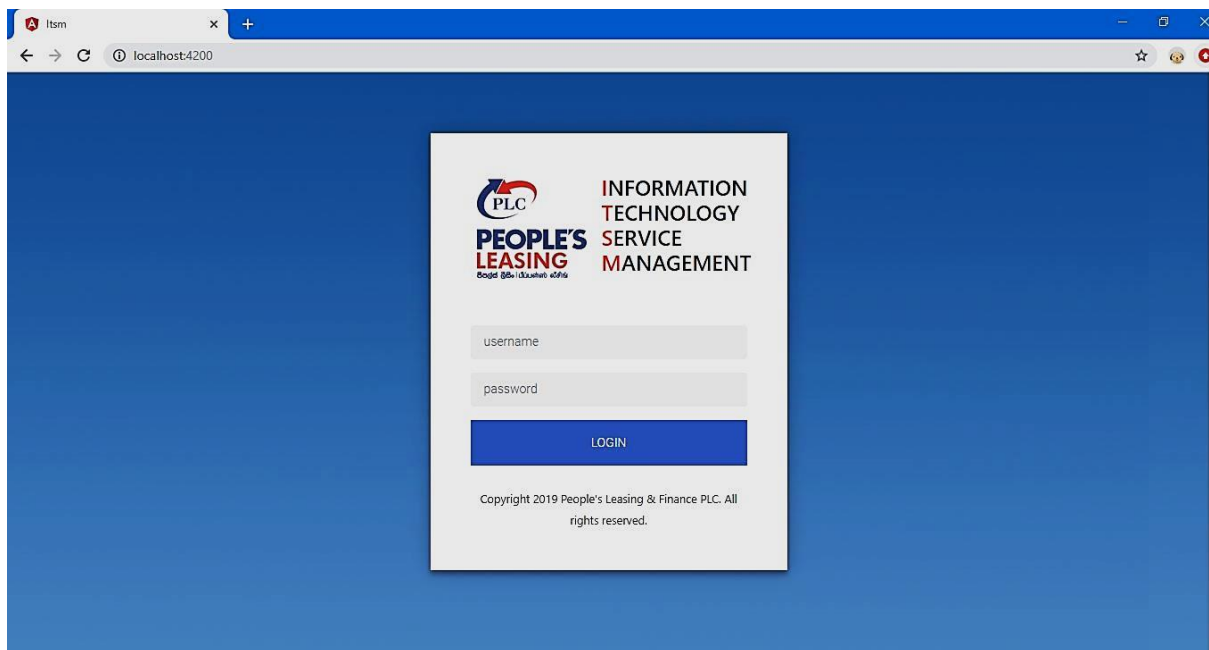Following Figure shows the User Login Interface of the ITSM system.

Figure 4.4 – User Login Interface

4.3.2. Asset Registration

In the Asset Management Module, the main user interface is the Asset Registration. The user will be able to add a new asset to the company asset register through this interface. The Asset Registration Main screen can be shown as the following Figure 4.5 – Asset Registration Main Screen.

Figure 4.5 – Asset Registration Main Screen

Further, one of the key features of this screen is the dependencies among the form input fields. According to the 'Asset Category' which user selects, 'Asset Type' dropdown list values are changing. After the selection of 'Asset Type', the Asset Code will be generated automatically according to the selected Asset Category and Asset Type. Asset Code is a system generated code that can uniquely identify each asset in the asset inventory. Following Figure shows how the screen will be changed after the selection of Asset Category and Asset Type.

Figure 4.6 – Asset Registration Screen after selection of Asset Category and Type

As per the above screen, after selection 'IT Hardware' as Asset Category and 'Laptops as Asset Type, several fields related to asset location, owner and configuration detail will be added to

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the existing asset registration form. According to Control 8: Asset Management [1] in ISO 27001:2013 standard, it is compulsory to maintain an asset inventory with their ownership of assets. Further, every asset should be labeled and classified. Therefore, the Asset registration user interface was developed in order to capture those ISO standard requirements.

4.3.3. Generate New Ticket

Service Desk module consists of the asset repairing process of the company. First, the user has to generate a new ticket using the following Figure 4.7 – Ticket Generation Screen. In this interface, the new ticket number will be displayed, and the user has to enter the asset serial. Then, the asset details relevant to that asset serial will be displayed on the right-hand side of the screen. Next, the form details have to be entered with an authorized person. When the user enters the correct employee number to the authorized person field, it will display the employee details of the entered employee number. Therefore, the user will be able to verify whether the entered officer is correct or not before generating the ticket.

Figure 4.7 – Ticket Generation Screen

After generating the ticket, it will direct to the page as shown in the following Figure 4.8 – Gate pass Printing Screen

Figure 4.8 – Gate pass Printing Screen

It is able to be familiar with all the functionalities of the ITSM system through the user manual attached in Appendix C.

4.4. Coding

Visual Studio Code was used as the source code editor to implement the system because of its simplicity and ease of use. Further, VS Code includes enriched built-in support for Node.Js development with JavaScript and TypeScript. Also, it provides great tooling for web technologies such as HTML and CSS. The Screenshot of the VS Code editor is shown under Figure 4.9 – Screenshot of Visual Studio Code Editor
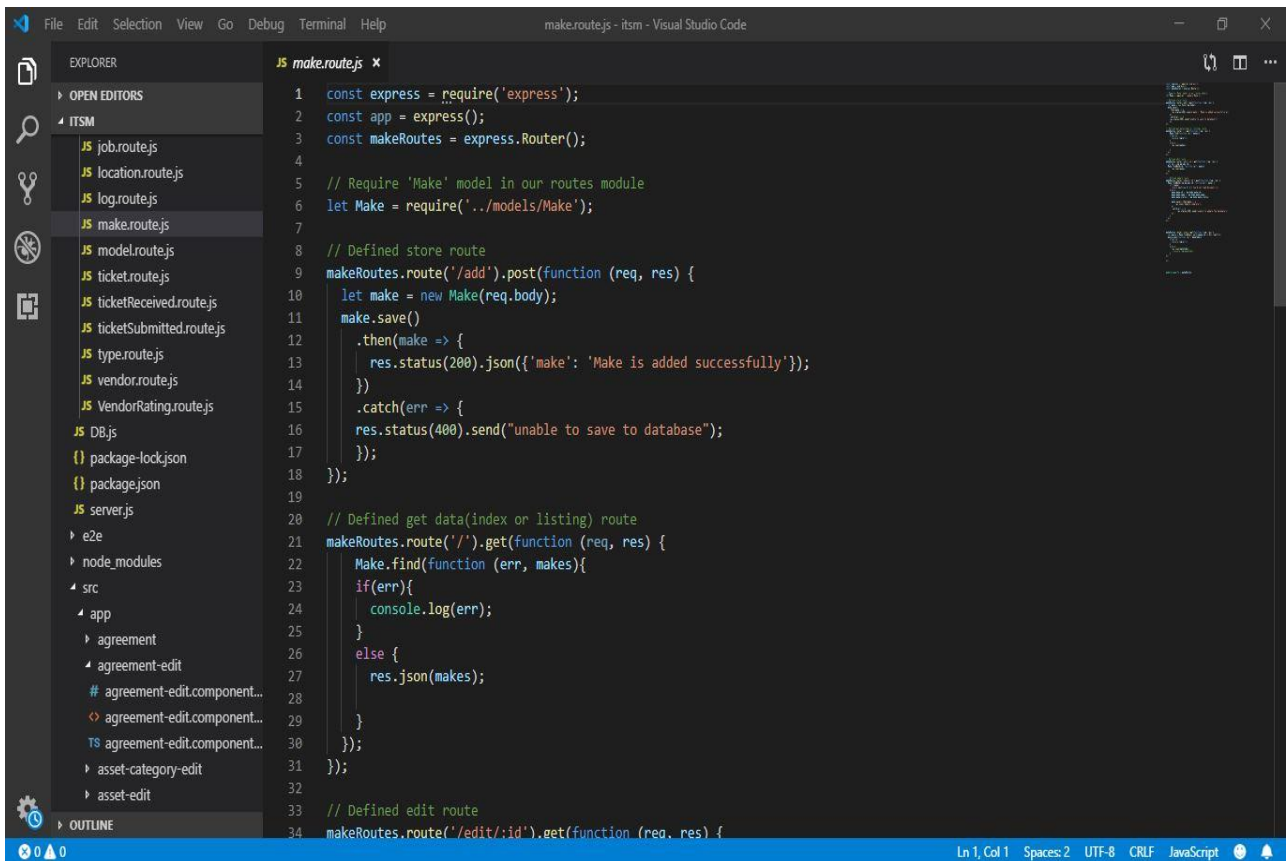
Figure 4.9 – Screenshot of Visual Studio Code Editor

Following code segment in the service file 'asset.service.ts' was used to add new asset to the 'asset' collection.

```
addAsset(asset_category, asset_type, asset_code, asset_make, asset_model, asset_serial,
asset_barcode, asset_description, asset_classification, asset_location, asset_owner_IT,
asset_branch, asset_owner_branch,  asset_company, asset_status) {
  const obj = {
    asset_category: asset_category,
    asset_type: asset_type,
    asset_code: asset_code,
    asset_make: asset_make,
    asset_model: asset_model,
    asset_serial: asset_serial,
    asset_barcode: asset_barcode,
    asset_description: asset_description,
    asset_classification: asset_classification,
    asset_location: asset_location,
    asset_owner_IT: asset_owner_IT,
    asset_branch: asset_branch,
    asset_owner_branch: asset_owner_branch,
    asset_company: asset_company,
    asset_status: asset_status
```

```
  };
  console.log(obj);
  this.http.post(`${this.uri}/add`, obj)
    .subscribe(res => console.log('Done'));
}
```

The above source code segment then routes to the following function in the 'asset.route.js' file to add the new asset object into the database.

```
assetRoutes.route('/add').post(function (req, res) {
 let asset = new Asset(req.body);
 asset.save()
  .then(asset => {
   res.status(200).json({'asset': 'Asset is added successfully'});
  })
  .catch(err => {
  res.status(400).send("unable to save to database");
  });
});
```

4.5. Robo 3T

To visualize the Mongo database, Robo 3T GUI tool was used. It is an open source tool which can display the database collections and their documents as object or table structure. A Screenshot of the Robo 3T tool can be shown as under Figure 4.10 – Screenshot of Robo 3T Mongo DB GUI tool
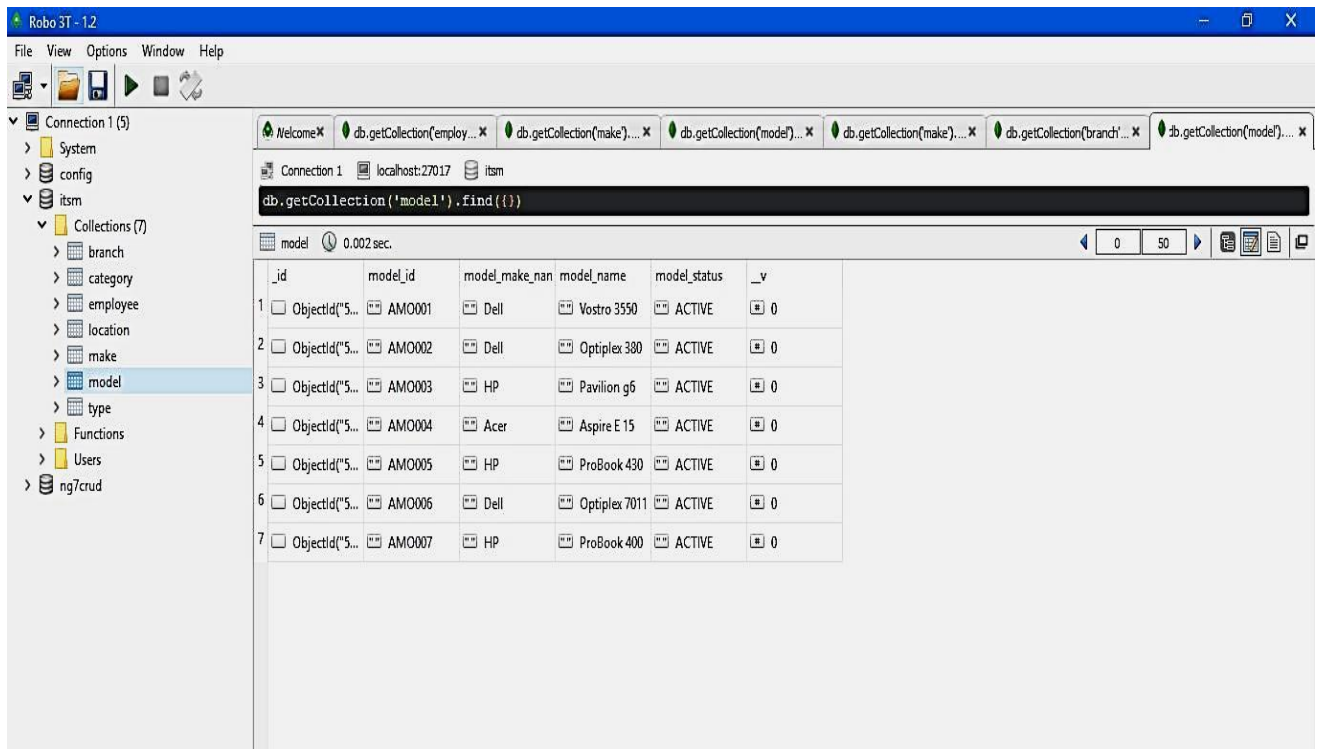
Figure 4.10 – Screenshot of Robo 3T Mongo DB GUI tool

Chapter 5. Evaluation and Testing

After implementing the ITSM system, the next phase was to test and evaluate the system to check whether it meets the specified requirements. Simply, Software Testing can be defined as an activity to check whether the actual results match with the expected results. Hence, it is able to ensure that the system is defect free. Further, software testing helps to identify errors, gaps, or missing requirements contrary to the actual requirements. Therefore, it is hoped to discuss the testing strategies and user evaluation methods that were used in the system.

In software testing, the process of Verification and Validation is very important. It may also be referred to as software quality control. According to Boehm, Verification ensures that whether we are building the product right while Validation ensures whether we are building the right product.

5.1.   Testing Approaches

There are two testing approaches which were used to test the system.

1. Black Box Testing

2. White Box Testing

5.1.1. Black Box Testing

Black Box Testing is a high-level testing approach which was used to focus on the behavior of the system. Its main focus is on the validation of the functional requirements of the system. In this method, testing is done without looking at the internal code structure, implementation details, and knowledge of the internal paths of the system. Here, the testing is based entirely on the system requirements and specifications. Thus, testing is done by considering the inputs and outputs of the system without bothering about internal knowledge of the system.

5.1.2. White Box Testing

In White Box testing, the internal structure of the system, design, and coding is tested. Mainly, this testing involves the testing of the software code regarding the internal security issues, the flow of specific inputs through the code, the functionality of conditional loops and etc. Here, the testing can be done at different testing levels such as system, integration, and unit.

5.2. Testing Levels

Testing can be done in different stages of the software development life cycle. There are many testing levels which help to check the behavior and software testing. Some of the testing levels which were used to test the ITSM system can be described as follows.

5.2.1. Unit Testing

Unit testing is the level of testing where the individual units/components of the system are tested. In this stage, all the individual components of the ITSM system is tested and validated to check whether they perform as designed. This helps to identify a majority of bugs at the earlier stage of the software development life cycle. Hence, it is able to fix the identified bugs very quickly.

5.2.2. Integration Testing

After the Unit Testing, the next phase is the Integration Testing. In this stage, individually tested modules were combined into one group and carried out the testing. The modules that have been unit tested were grouped into larger aggregates, and test plan was applied to those aggregates. Integration testing ensures that the software modules work together appropriately when integrated with one another. Also, it leads to the good quality and performance of the system.

5.2.3. System Testing

As the next step, system testing was carried out to test the system as a whole. Once all the components were integrated, the system was tested as a whole to check whether it meets the specified requirements as well as quality standards. In system testing, the knowledge of the internal code is not required, and it is mainly focused on the functional and non-functional requirements of the system.

5.2.4. Acceptance Testing

Acceptance Testing is the level of software testing where the system is checked for the acceptability. The main focus of this type of testing is to evaluate the compliance of the system with specified requirements and check whether it is acceptable for delivery to the end users.

5.3. Test Plan and Test Cases

According to the Software Testing Life Cycle, It is necessary to prepare a test plan first. Test Plan covers all the major activities regarding the testing of the project such as testing environment, testing schedule, deliverables and etc. Then, test cases are written for each scenario of the system. Simply, the test case is a specification of the inputs, execution conditions, testing procedure, and expected results that developed for a particular test scenario in order to verify compliance against a specific requirement. Table 5.1 illustrate a sample test case written for the Login scenario of the ITSM system.

Table 5.1 – Test Case for Login

Test Case ID	1					
Test Case Name	Login					
Test No	Test Unit / Controls Description	Prerequisite	Input or Selected Data	Expected Result	Actual Result	Status (Pass, Fail,N/A)
1_1	Login with correct username and password	Load the login page	Username: Jani, Password: jani@123	Login into the system and redirect to the user dashboard	Logged in to the system and directed to the dashboard	Pass
1_2	Log in with the wrong username	Load the login page	Username: Admin, Password: jani@123	Give message 'Username or Password is Incorrect.'	Gave message 'Username or Password is Incorrect.'	Pass
1_3	Log in with the wrong password	Load the login page	Username: Jani, Password: 123	Give message 'Username or Password is Incorrect.'	Gave message 'Username or Password is Incorrect.'	Pass
1_4	Login with empty username	Load the login page	Username: empty	Give message 'Username is required.'	Gave message 'Username is required.'	Pass
1_5	Login with an empty password	Load the login page	Password: empty	Give message 'Password is required.'	Gave message 'Password is required.'	

5.4. User Evaluation

After the testing stage, the ITSM system was deployed to the live environment, which can be accessible by the branch users as well as head office users. Then, it is necessary to evaluate the system with user feedback and suggestions. Therefore, it was decided to carry out a user evaluation survey to identify the system improvements, system weak points and etc. Hence, after two weeks of the live deployment, User Evaluation Questionnaire was distributed among 200 users covering all branches, head office, all subsidiaries, and ICT Staff to collect the user feedback. Following is the User Evaluation Questionnaire, which was circulated.

User Evaluation Questionnaire

IT Service Management System(ITSM)

We would like you to dedicate a few minutes to complete this survey. It will help us to improve our IT Support Services.

Thank you!

PLC ICT Team

Please tick '✓' the most appropriate response	Very Good	Good	Fair	Poor	Very Poor
System Quality					
1. Ease of Use					
2. System Performance					
3. Accuracy of Information					
4. Response Time					
User Interface					
1. User Friendliness					
2. Meaningful Error Messages					
3. Quality of Help Messages					
4. Ese of Use					
5. Usefulness of Colors					

System Operations					
1. Workflow alignment					
2. Makes job Easier					
3. Usefulness in decision making					
Training					
1. Ease of Learning					
2. The usefulness of User Manual					
3. Clarity of Documentation					
Comments					

The results of the user evaluation questionnaire can be summarized as the following Table 5.2 – Summarized results of User Evaluation Questionnaire. Further, some users have given several suggestions to improve the ITSM system. Some of the suggestions were deployed to the system, and some were kept for future enhancements.

Table 5.2 – Summarized results of User Evaluation Questionnaire

	Very Good (%)	Good (%)	Fair (%)	Poor (%)	Very Poor (%)
System Quality					
1. Ease of Use	77.5	14	8.5	0	0
2. System Performance	73	22.5	4.5	0	0
3. Accuracy of Information	66.5	26	7.5	0	0
4. Response Time	70	22	8	0	0
User Interface					
1. User Friendliness	64.5	28	7.5	0	0
2. Meaningful Error Messages	74	19.5	6.5	0	0
3. Quality of Help Messages	66.5	26.5	7	0	0
4. Ease of Use	82.5	13.5	4	0	0
5. Usefulness of Colors	69	24.5	6.5	0	0
System Operations					
1. Workflow alignment	69.5	21.5	9	0	0

2. Makes job Easier	68	19.5	12.5	0	0
3. Usefulness in decision making	84.5	12.5	3	0	0
Training					
1. Ease of Learning	71	23.5	5.5	0	0
2. Usefulness of User Manual	66	31.5	2.5	0	0
3. Clarity of Documentation	67.5	25.5	7	0	0

In order to analyze the results of the user evaluation, Bar graph was plotted as shown in the following Figure 5.1.
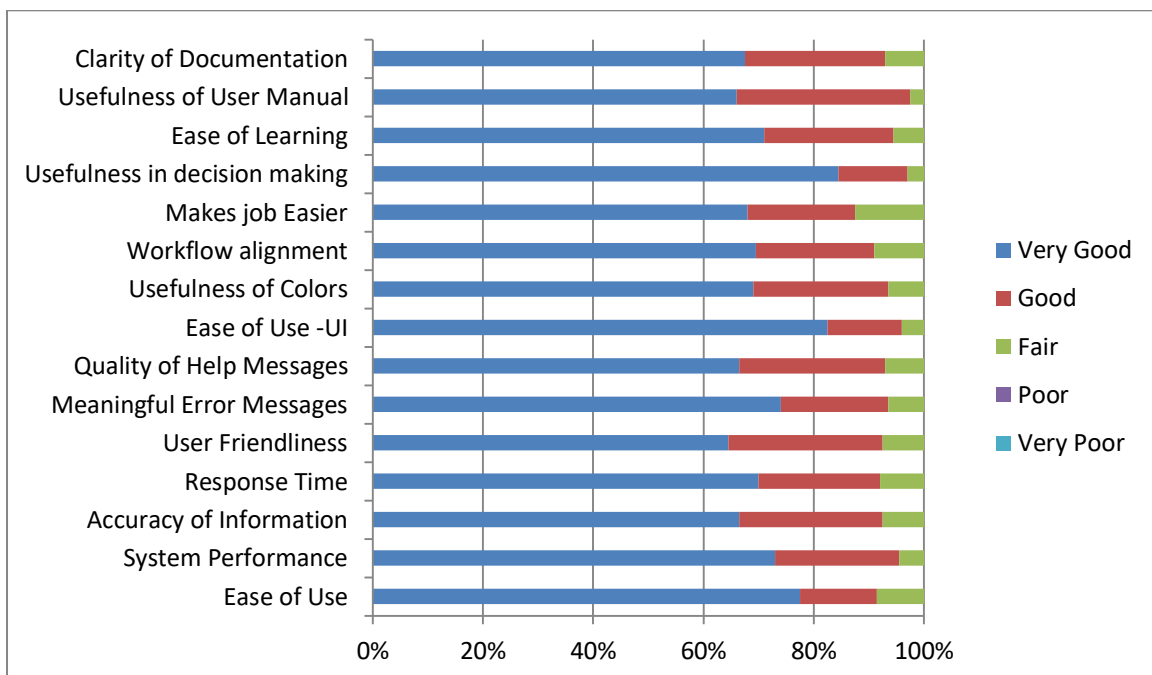
Figure 5.1 - Results summary of the User Evaluation as a bar Chart

According to the above Figure 5.1, more than 60% of the users were very satisfied with the new ITSM system by commenting with 'Very Good'. Further, more than 80% of the population have marked that the system is good and satisfied with the system. Only a few users have commented that the system is fair. However, no one is commented that the system is poor or very poor. Therefore, as per the results of the evaluation, most of the users have satisfied with the ITSM system, and some of them have suggested a few improvements such as new reports and dashboard figures which want to enhance the system.

Chapter 6. Conclusion

The ultimate objective of the ITSM system is to provide better service to the internal users to carry out their business-related operations smoothly. Using this system, currently, branch users can be able to get their IT related services very efficiently without any delays. Further, visibility is also high in the ticket management process. Moreover, IT staff can be able to do their jobs according to the system process very efficiently without getting any stress. The reports generated by the ITSM system are also useful in decision making as well as in audit purpose.

6.1.   Critical Evaluation

ITSM is a web-based system proposed to overcome the current issues in the working process and IT services. It streamlines the day to day IT service process and procedures. The project began with the requirement gathering through various techniques such as meetings, questionnaire and etc. Here, similar systems and their features were also taken into consideration. After that, the functional requirements and non-functional requirements of the system were identified by the analysis of the gathered requirements.

Then, the system was designed with four major modules: Asset Management, ICT Hardware Helpdesk, Vendor Management, and Log Monitoring. Afterward, the system was implemented using MEAN Stack, and testing was done at different levels of the system development process. Further, the system has different access levels to each user group. Report generation is another key feature in this system. Now, several reports can be generated through the system, which is very helpful in decision making. Also, they are accurate and up to date. Further, the major significance of this system is its all the process and procedures were according to the ISO 27001:2013 Information Security Standard. Therefore, all the workflow of the system is practically secured and periodically audited by the internal as well as external auditors.

Finally, a survey was carried out to evaluate the ITSM system in the user perspective. According to the results of the survey, the users satisfied with the new system, and it is useful for them to carry out their operations smoothly.

6.2.   Problems Encountered

There were some problems which were encountered through different phases of the system. In the requirement gathering stage, it needed to conduct several meetings to get the right requirements and to clarify some unclear requirements. Different users came up with conflicting requirements. Therefore, it was necessary to clarify them with the users while fulfilling the user requirements. Earlier, there was no procedure to follow up the IT services in the company. Therefore, the process and procedures were needed to be established according to the ISO 27001 standard.

The system was developed using MEAN Stack with latest versions. Since it is a new technology, the major problem encountered in the development stage was the lack of knowledge regarding the development tools and the coding language. Therefore, it was required to have some extra effort to study and explore various implementation scenarios while developing the system. Online tutorial, videos, and books were used to capture the essential knowledge required to develop the system.

After deploying the system to the live, some traditional users had the resilience to change into the new system. However, it was able to change that attitude from the users through several training sessions as well as user-friendliness of the system.

6.3. Future Enhancements

The ITSM system was developed according to the essential IT services captured within the company. Therefore, this system can be further developed by adding more modules into the existing system. As the next phase, Incident Management and Change Management are the two main modules which can be developed into the system. Further, several reports need to be included in the report generation section according to the user requirements.

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APPENDIX A: Questionnaire for Branch Users
People's Leasing & Finance Plc

IT Service Management Questionnaire

We would like you to dedicate a few minutes to complete this survey. It will help us to improve our IT Support Services.

Thank you!

PLC ICT Team

Please tick '✓' the most appropriate response

1. **Branch Grade** …………………………………………………………………….

2. **District of the branch** ……………………...

3. **How long have you work in the company** …………………………………………

4. **How does the IT help desk officers attend to the troubleshooting process to fix a fault of IT equipment?**

	Over the Telephone
	By taking Remote Control of the equipment
	By visiting the equipment
	By Email
	By sending equipment to the Head Office
	Other, Please Specify ………………………………………………………

5. **How do you send IT equipment to the Head Office for repairing purpose?**

	By Hand
	By Courier
	Other, Please Specify ………………………………………………………

6. **How can you know the status of the repairing process of equipment?**

   | | Over the Telephone |
   | | By Email |

	By visiting the IT department
	Through web page
	Other, Please Specify ……………………………………………………

7. How often do you want to contact the IT department per one repair?

	Never
	Rarely
	Sometimes
	Most of the Time
	Always

	Never	Rarely	Sometimes	Most of the Time	Always
8. How often do you send IT Equipment to the Head Office?					
9. Do you inform the IT department before sending the equipment to the Head Office?					
10. How often do you want to contact the IT department per one repair?					

	Very Satisfied	Satisfied	Average	Dissatisfied	Very dissatisfied
11. Are you satisfied with the security of the IT equipment while sending to the IT department?					
12. Are you satisfied with the current procedure of IT equipment repairing process?					
13. How satisfied with the amount of time taken for the repairing process in the IT department?					
14. How can you rate the quality of the IT equipment repairing process?					
15. How can you rate the service of the user calls regarding the IT equipment repairs?					

16. What is your opinion about a computerized system to IT equipment repairing process?

☐	Extremely Important
☐	Very Important
☐	Moderately Important
☐	Slightly Important
☐	Not at all Important

17. Please share any additional comments about your experience or suggestions on how we can better improve our Services.

```



```

Questionnaire for Hardware Division Staff
People's Leasing & Finance Plc

IT Service Management Questionnaire

We would like you to dedicate a few minutes to complete this survey. It will help us to improve our IT Support Services.

Thank you!

PLC ICT Team

Please tick '✓' the most appropriate response

1. **Designation** ………………………………………………………………….

2. **How long have you work in the company** …………………………………………………

3. **How do you attend to the troubleshooting process to fix a fault of IT equipment?**

☐	Over the Telephone
☐	By taking Remote Control of the equipment
☐	By visiting the equipment
☐	By Email
☐	After receiving equipment to the Head Office
☐	Other, Please Specify …………………………………………………

4. **How do you receive IT equipment to the Head Office for repairing purpose?**

☐	By Hand
☐	By Courier
☐	Other, Please Specify …………………………………………………

5. **How do you inform the status of the repairing process of equipment to the user?**

☐	Over the Telephone
☐	By Email
☐	By meeting the user

☐	Through web page				
☐	Other, Please Specify …………………………………………………				

6. How often do you receive telephone calls per one repair?

☐ Never

☐ Rarely

☐ Sometimes

☐ Most of the Time

☐ Always

	Never	Rarely	Sometimes	Most of the Time	Always
7. How often do you receive IT Equipment to the Head Office?					
8. Do they inform the IT department before sending the equipment to the Head Office?					
9. How often do you contact the user per one repair?					
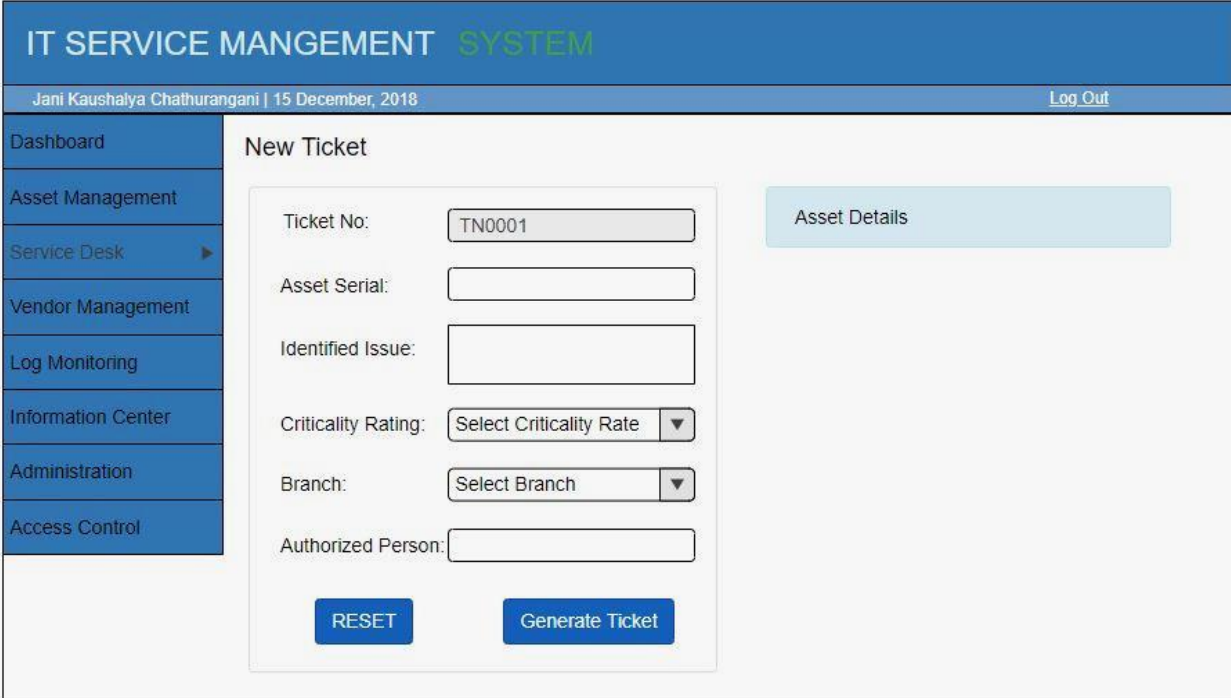
	Very Satisfied	Satisfied	Average	Dissatisfied	Very dissatisfied
10. Are you satisfied with the security of the IT equipment while sending to the IT department?					
11. Are you satisfied with the current procedure of IT equipment repairing process?					
12. How satisfied with the amount of time taken for the repairing process in the IT department?					
13. How can you rate the quality of the IT equipment repairing process?					
14. How can you rate the service of the user calls regarding the IT equipment repairs?					

15. What is your opinion about a computerized system to IT equipment repairing process?

☐	Extremely Important
☐	Very Important
☐	Moderately Important
☐	Slightly Important
☐	Not at all Important

16. Please share any additional comments about your experience or suggestions on how we can better improve our Services.

APPENDIX B: Mockup Interfaces

Figure B.1 – Mockup interface for New Ticket Screen

APPENDIX C: System Documentation

This document describes the technical requirements and installation procedure of the IT Service Management System.

Software Requirements

Angular: 7.1.4, Bootstrap 4

Node: 10.14.1

Express

MongoDB version v4.0.4, Robo 3T -1.2 as Mongo DB GUI tool

Google Chrome

System Launching

1st Step: Start MongoDB Server

Open Command Prompt and start Mongo DB Server using the following command.

>> mongod

2nd Step: Start Nodemon Server

Open Command Prompt. Go to the following path and type the following command to start the Nodemon Server.

>> projectFolder\api\nodemon server

3rd Step: Start Angular Development Server

Open Command Prompt and go to the project folder. Then, Start the server using the following command.

>> projectFolder\ng serve

4th Step: Go to URL

Open 'Google Chrome' Browser and go to the URL 'http://localhost:4200/'

APPENDIX D: User Manual

System Overview

IT Service Management (ITSM) is a web-based solution to automate the IT Services and procedures in order to provide better service to internal users. The company Asset Management process, IT Service Desk process, Vendor Management, and Log Monitoring process can be able to handle from the ITSM system.

User Login

To log in to the system, first, open the browser and go to the URL http://localhost:4200/. It will direct to the login page of the ITSM system, which is shown under Figure D.1. The registered users can be able to login into the system entering the correct username and password.
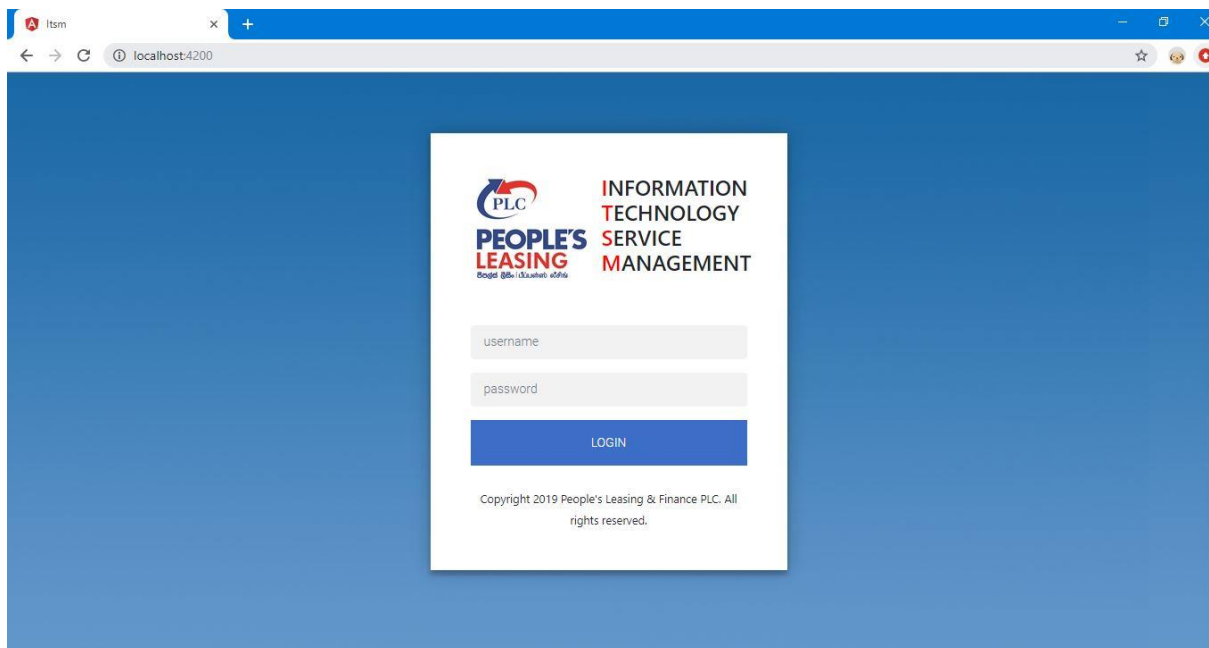
Figure D.1 – ITSM User Login Page

System Menu

Once the user logging into the system, Dashboard of the logged in user will appear, which is the main interface of the ITSM. It indicates the name of the login user and the current time, as shown under Figure D.2.

Figure D.2 – logged in user name and time

Further, the navigation menu will appear to the user, as shown under the following Figure D.3. The navigation menu will change according to the user access level of the logged in user. Following Figure D.3 shows the navigation menu relevant to the administrator role of the system, which is having all the access to the menu items.

Four main menu items are indicating the main modules of the system, which are Asset Management, Service Desk, Vendor Management, and Log Monitoring. Further, other menu items are used as supporting modules as well as informative modules.
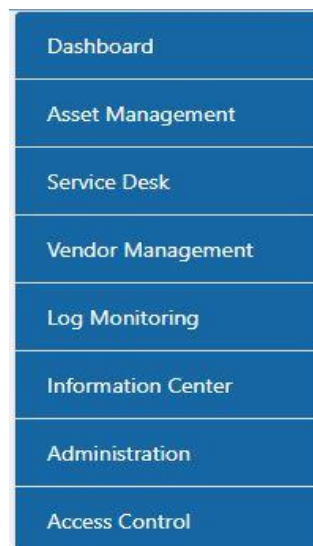
Figure D.3 – Navigation Menu

Asset Management Module

Asset Management module handles all the information regarding the assets of the company. The module mainly consists of Asset Registration, Asset Modification, Employee Registration, and Asset Issuing process.
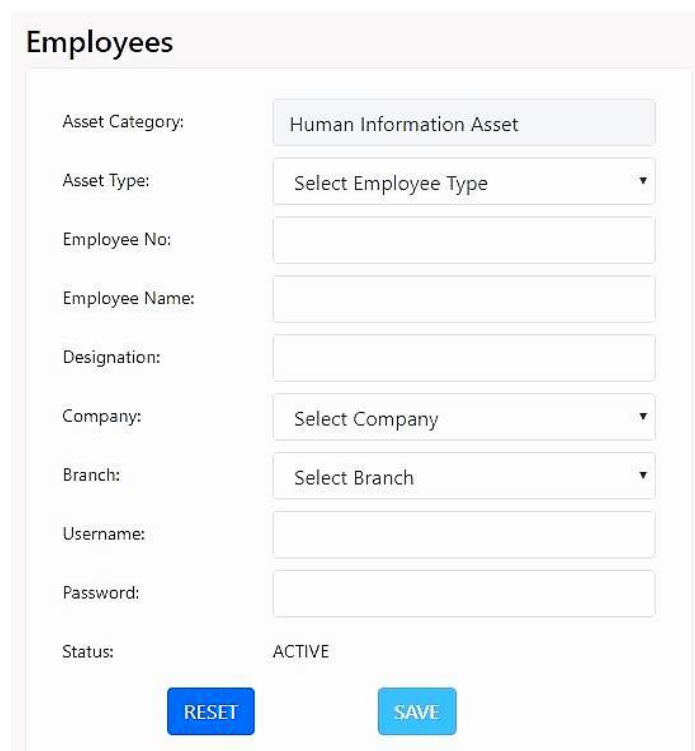
User Registration

Any user can be able to register in the ITSM system by sending a request email through the Branch Manager/ Department Head to the IT department. Then, the requested user is registered,

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and the user account is created in the system by IT Officer through the interface under Figure D.4.

Asset Management → Employees

In the process of registration, the username and the password also need to be given. Afterward, Username and the password will be informed to the user by an email. Then, User can be able to login into the system by entering the correct credentials.

Figure D.4 – Employee Registration

Employee Search

There is an employee search facility on the right side of the same page, as shown in the following Figure D.5.

Figure D.5 – Employee Search Screen

Employee Detail Update

By clicking the "EDIT" button on the Employee Search screen as shown under Figure D.5, it will be redirected to the page which can be editable as shown in the below Figure D.6.

Figure D.6 – Employee Edit Screen

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Password Reset

Password reset option is also available in the above employee editing screen. If the user forgets his/her current password, User has to send email to the IT department to reset the password and then IT Officer can be able to reset the password using the following steps.

Step 1: Asset Management → Employees

Step 2: Enter Employee Number in the search box
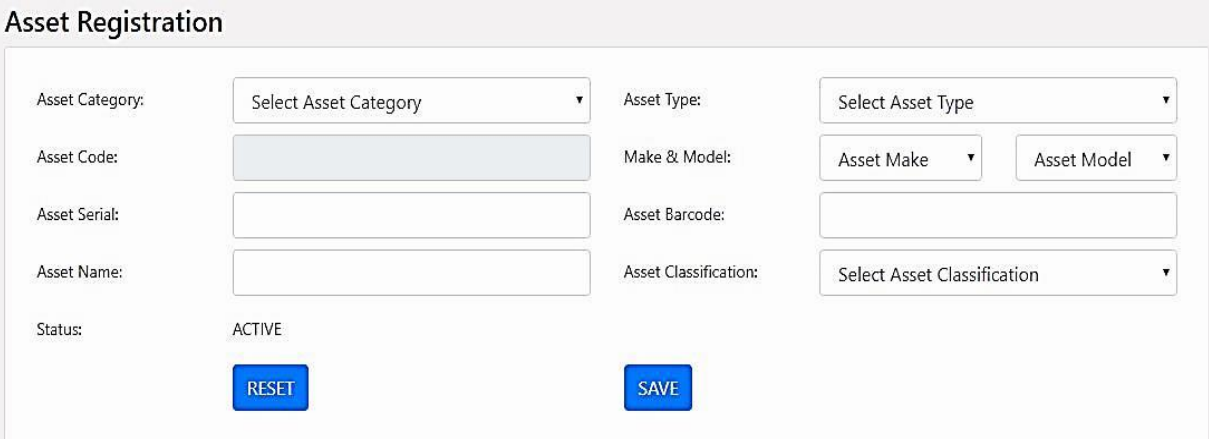
Step 3: Once Employee details display, Click 'EDIT' button as shown in Figure D.5

Step 4: Then, it redirects to the Employee Edit screen as shown under Figure D.6

Step 5: Enter New password and Click 'SAVE' to change the password

Asset Registration

Asset Registration can be done under the 'New Asset' menu item, which is under the Asset Management Module. Following Figure D.7 shows how the initial Asset Registration screen will look like. Once the 'Asset Category' and 'Asset Type' is selected, the Asset Code will be generated automatically and displayed in the screen, as shown below Figure D.8. Further, According to the selected category and type, form fields will be displayed, and the user has to enter the relevant fields into the form. After clicking 'Save', the Asset is successfully added to the Asset Register.

Figure D.7 – Asset Registration Initial Screen

Figure D.8 – Asset Registration Screen after selecting Asset Category and Type

Service Desk Module

Service Desk Module covers all the process and procedures regarding the asset repairing process. The ticketing system is used to track this asset repairing process.

New Ticket

Under the Service Desk module, the first option is "New Ticket". Any registered user can be able to generate a ticket by entering the details, as shown in the following Figure D.9.

Figure D.9 – Generate New Ticket

Here, Ticket No is an auto-generated field which indicates each ticket uniquely. Then, the user has to enter the asset serial of the asset which needs to be repaired. Once after entering the correct asset serial, the details relevant to that asset will be displayed at the right side of the page, as shown in the above figure D.9. Then, the user has to mention the issue of the IT equipment in the identified issue field. By selecting the criticality rating, IT division can speed up their repairing process according to that selected category. Further, it is required to select the branch and authorized person for the ticket. When the user enters an employee number of the authorized person, the employee name, designation, and the branch/department will be displayed as shown in above figure D.9. Then, the user has to generate a ticket by clicking the button 'Generate Ticket'.

Afterward, the user will direct to the following page under Figure D.10 with the details of the generated ticket. Then, the user can print the gate pass for the ticket by clicking the button 'Print Gatepass'. After that, the user has to send the equipment to the IT department along with the printed gate pass.

Figure D.10 – Gate pass print

Ticket Submitted

After generating the ticket, it will be displayed in the Submit Ticket List of the Hardware Officers as shown under Figure D.11 below.

Ticket Submitted

#	Ticket No	Asset Serial	Sending Branch	Sender	Sending Date	View
1	TN0079	WS67YH2	Head Office	000004	2019-05-02T07:26:35.889Z	View
2	TN0096	HN84KAY	Negombo Branch	000006	2019-05-11T08:30:32.911Z	View
3	TN0097	ASW57HV6	Negombo Branch	000006	2019-05-11T09:02:56.701Z	View

Figure D.11 – Ticket Submit List

Once the equipment is received to the IT department, the relevant Hardware officer will view the ticket by clicking the 'View' link, as shown in the above Figure D.11. Then it will redirect to the page under Figure D.12. Afterward, the officer can be able to check the details of the ticket and mark the ticket status as 'IT_Received' by clicking the button 'Receive Ticket'. Then, the ticket will be moved into the Received Ticket list.

Ticket No : TN0097 || Gatepass No: GP000106

Asset Details

Asset Serial	ASW57HV6	Asset Barcode	cgfgffh
Asset Type	Laptops	Asset Code	PLC/ICT/IHW/LAP/003
Asset Make	Dell	Asset Model	Vostro 3550

Ticket Details

Sending Branch	Negombo Branch	Criticality Rating	Medium
Sender	Sumudu Gamage Second Officer Negombo Branch	Authorized By	Nalin Weerakkody Branch Manager Negombo Branch
Ticket Submit Date	2019-05-11	Ticket Status	IT_Submitted
Identified Issue	Laptop runs only few minutes when it is power unplugged		

Receive Ticket

Figure D.12 – Receive Ticket Screen

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Ticket Received

All the received tickets will be appeared in the 'Ticket Received' list as shown under Figure D.13.

Figure D.13 – Received Ticket List

IT Officers will be able to view the details of the received tickets by clicking the 'View' button, as shown in the above Figure D.13. Then, it will route to the following page under Figure D.14 to create a new job for the ticket.

Figure D.14 – Create Job Screen

By considering the ticket details and issue of the asset, the IT officer should enter the inspection comment and select the repairing method. Repairing methods can be Inhouse,

Vendor, or Not In Condition. If the selected repairing method is vendor or inhouse, the officer has to create a new job by clicking the button 'Create Job' as shown under Figure D.14 above.

Figure D.15 – After Selection of Not In Condition

If the asset cannot be repaired, then, the officer has to select the repairing method as 'Not In Condition'. In that scenario, the ticket has to be sent for approvals, as shown in Figure D.15 above.
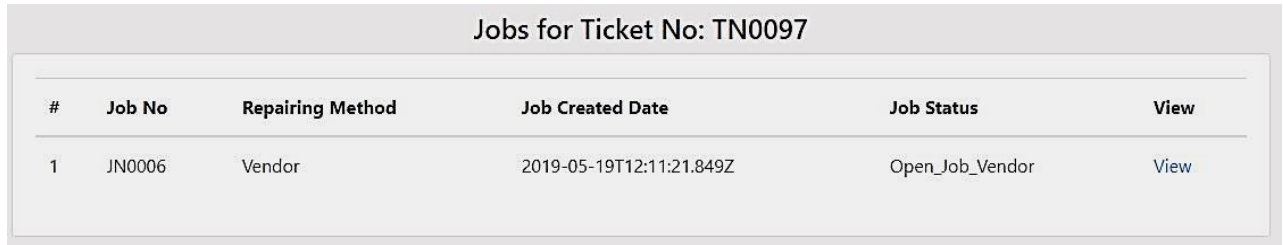
Ticket Opened

After the creation of the new job, it will move into the 'Ticket Opened' List. All the tickets which are currently in Open state can be viewed from the Ticket Opened submodule with the ticket status of each ticket. Ticket Open List Screen can be shown as the following Figure D.16.

By clicking the 'View' button, it is able to view all the jobs which are related to the selected ticket as shown under Figure D.17.

Jobs for Ticket No: TN0097

#	Job No	Repairing Method	Job Created Date	Job Status	View
1	JN0006	Vendor	2019-05-19T12:11:21.849Z	Open_Job_Vendor	View

Figure D.17 – Jobs related to the selected Ticket

To process the job or to view the job details, the officer has to click the 'View' link of the required job. Then, it will redirect to the following page under Figure D.18 if the repairing method is 'Vendor'. By selecting the vendor tab, it is able to select the vendor which the asset needs to be sent for repair. Further, the officer needs to enter the vendor comment and click the 'Send' button to mark the asset as 'sent to vendor'.

Ticket No: TN0097 || Job No: JN0006

Vendor   Quotation   Approval   Payment   Receive

Vendor Information

Vendor Name: Select Vendor ▼

Vendor Comment:

Send

Figure D.18 – Vendor Selection Screen

Then, vendor quotation details need to be entered into the system by the following screen under Figure D.19, as mentioned below.

Figure D.19 – Quotation Entering Screen

Quotation No is an auto-generated code which is unique to identify the quotation. Reference No is the numbering in the vendor quotation, which is the reference of the vendor. Then, the quotation amount date and description need to be entered into the system. Further, the officers can be able to attach the vendor quotations into the system as pdf, jpg, or doc format. It will help for future references.

After entering the quotation details, quotation needs to be approved by the Authorized person of the IT department. Then, the officer needs to enter the approval details into the system by the following screen, as shown under Figure D.20.

Figure D.20 – Approval Screen

The next step is to complete the payment section relevant to the approved quotation, as shown under the following Figure D.21. Officer has to enter the bill no, payment amount, payment

date, and payment description into the system. Also, it is able to attach the payment bill as a pdf, jpg, or doc file.

Figure D.21 – Payment Screen

Afterward, when the asset is returned from the vendor, the officer needs to be marked the asset as received using the Figure D.22 below. Further, received date, vendor rating and comments have to be entered into the system before marking asset as received.

Figure D.22 – Received from vendor

After marking the receive status, the job will automatically be closed. Then, the officer will be able to close the entire ticket or to create a new job if necessary.

If the job type is selected as 'Inhouse' the equipment is repaired at the company by the IT officers. In this scenario, the process path will be quotation, quotation approval, and payment only. If 'Not In Condition' is selected, then the request is submitted for approvals from the Hardware division manager. If manager, approves the request, the ticket will be closed otherwise, again the ticket will be moved into 'Ticket Opened' list.

Administration Module

Administration module includes many supporting screens for feeding data into the ITSM system. Each screen of the administration module can be illustrated as below.

Make & Model

The following screenshot under Figure D.23 illustrates the Make and Model Screen in the ITSM system. In order to enter the make and model types of assets, the same screen can be used.

Asset Make By

At the top half of the page, new Asset Make data can be entered into the system as well as can be viewed the entered data. Asset Make ID is an auto-generated code which is unique. Then, the user has to enter the make name at the 'Make Name' field. When entering the new make name, always its status is 'ACTIVE'. After clicking the button 'SAVE', the new make type can be added to the system.

Further, any make type which is added to the system can be viewed by the 'Search Asset Make' section at the top right side of the page. Not only that, details of the entered asset make types can be edited using the link 'Edit'. Then it will route to the page under Figure D.24. User can be able to edit the name of the make type as well as active/inactive the make type in the system.

Figure D.23 – Make & Model Screen

Figure D.24 – Asset Make By Edit Page

In order to enter the new Model to the system, the bottom half of the page under Figure D.23 can be used. Here also, the Asset Model ID is an auto-generated code which indicated the next unique Model code of the system. Then, the user has to select the Make Name from the list. If the required 'Make Name' is not in the list, it is necessary to add the 'Make Name' into the system as discussed earlier. Afterward, the user can enter the asset model name and save the data into the system.

The existing model details also can be view/ Edit from the list appeared on the right-hand side of the web page. Once the user clicks 'Edit', it will be directed to the editing page as shown under Figure D.25, and the user will be able to update the details.

Figure D.25 – Asset Model Edit Page

Asset Code Generator

Asset code can be generated using this module by entering an asset category, and asset type into the system using the screen under Figure D.26.

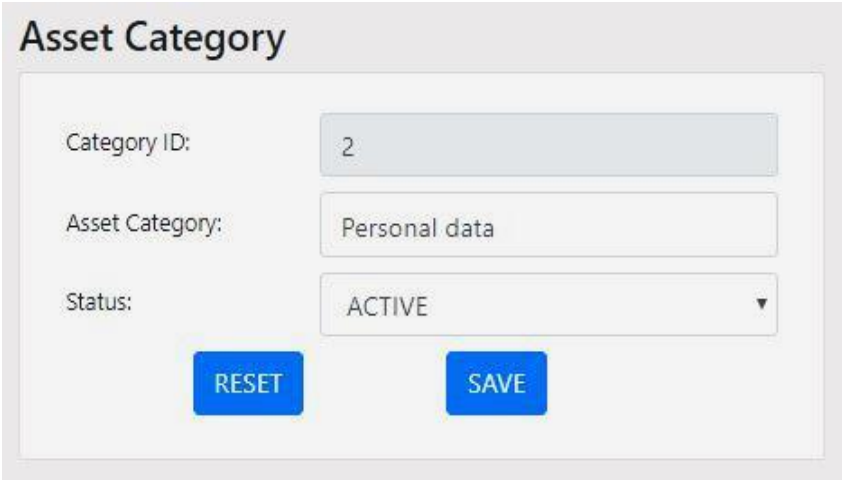Figure D.26 – Asset Code Generator Screen

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Asset Category

As shown in the above Figure, Category ID is auto-generated from the system, which indicates the next available Category ID. Then, the user has to enter the Asset Category name and save the details by clicking the 'SAVE' button.

Asset Type

Asset Type also can be added to the system using the same page as presented under Figure D.26. Here, Asset Type ID is an auto-generated field which indicates the next Asset Type ID. Then, the user can select the Asset Category, which belongs to the new asset type. If the required asset category is not in the list, the user has to add that asset category first from the asset category section. Afterward, the new Asset Type name has to be entered into the 'Asset Type' field. At that point, the Asset Code Pattern needs to be entered into the system to generate the asset code of the assets. Then, it is required to select the configuration type and click 'SAVE' to add a new asset type into the system.

Further, the fields in the Asset Registration screen will be displayed according to the configuration type that the user selected here. Asset Code will be generated according to the Asset Code Pattern, which entered here.

Existing Asset Category and Asset Type can be view/ Edit from the list appeared on the right-hand side of the web page. Once the user clicks 'Edit', it will be directed to the editing page, and you can update the details as presented under Figure D.27 and Figure D.28.

Figure D.27 – Asset Category Edit Screen

Figure D.28 – Asset Type Edit Screen

Asset Location

ICT Asset locations and branches can be entered into the system by this section, as shown under Figure D.29.
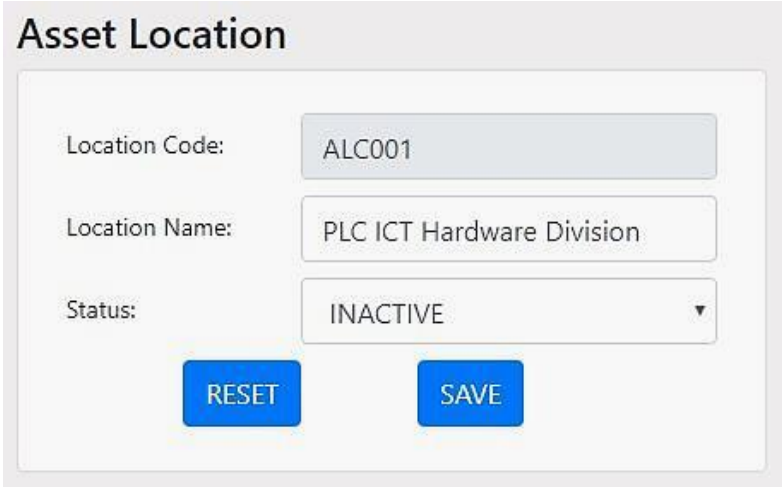

Figure D.29 – Asset Location Screen

ICT Location

ICT Location section can be used to enter only the locations of the ICT department. Each location has a unique location code to identify them. Therefore, as seen under above Figure D.29, Location code will auto-generated by the system. Then, the user can be able to enter the location name and save the details.

Branch Location

This is the place to add branches into the system. Branch ID is an auto-generated number which is used to identify the next available unique Branch number. User has to enter the Branch Name and Branch code into the relevant fields. When entering data, always status is ACTIVE'. Afterward, by clicking the button 'SAVE' branch will be added to the database.

Furthermore, the current ICT locations and branch details can be view/ Edit from the list appeared on the right-hand side of the web page. Once the user clicks 'Edit', it will be directed to the editing page, and the user can update the details as presented under Figure D.30 and Figure D.31.

Figure D.30 – Asset Location Edit Screen

Figure D.31 – Branch Location Edit Screen

Vendor Management Module

All the vendor related activities are carried out from this module.

New Vendor

The officers will be able to add new vendors into the system using the following Figure, as shown below.

Figure D.32 – Add New Vendor Screen

Vendor Code is an auto-generated code that can identify the vendor uniquely. Then, vendor name, address, vendor contact No 1 and vendor Email is compulsory to enter to register a new vendor. Otherwise, it gives error messages indicating that the fields cannot be empty, as shown in the following Figure D.33. If there is a contact person to represent the vendor, his/her details also can be entered into the system, as shown in the above figure.

Figure D.33 – Vendor registration showing compulsory fields

Log Monitoring

In this section, it is able to manage all the log details such as DB logs, CCTV logs and etc. Log entering, viewing the log details are the main functions of this module. Lod entering screen can be displayed as below Figure D.34. First, the user has to select the log type which needs to be entered. Then, by entering the other details, and click 'SAVE' button will add the log details into the database.

Figure D.34 – Log Entering Screen

Dashboard

The dashboard of the system displays all the ticket details such as submitted, received, Opened, and Closed tickets. Also, there is a pie chart that indicates the asset type wise open tickets. Further, the pending approvals and recent activities can also be viewed through the dashboard of the system. The screenshot of the dashboard is shown in Figure D.35.
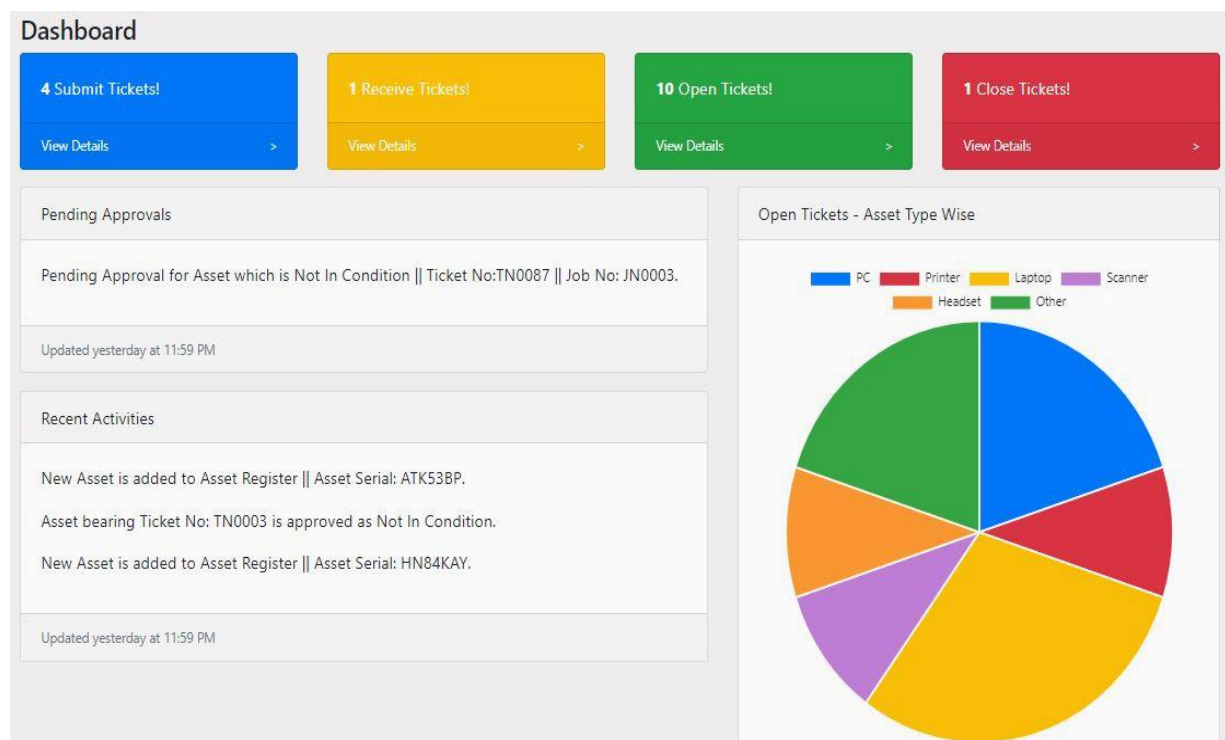
Figure D.35 – Dashboard of ITSM

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Information Center

Information Center will be available to the users to get all the information regarding the assets, tickets, vendors and etc. All the reports can be generated through this module.

System Exit

User can be able to log out from the system by clicking the 'Log Out' link, as shown in the following Figure D.36. Then, the user will log out from the system, and it will direct the user back to the login page.

IT SERVICE MANAGEMENT SYSTEM

Jani Chathurangani | Monday, May 20, 2019, 10:01 AM   Log Out

Figure D.36 – System Log Out

APPENDIX E: Test Cases

Table E.1 – Test Case for Asset Registration

Test Case ID	2					
Test Case Name	Asset Registration					
Test No	Test Unit / Controls Description	Prerequisite	Input or Selected Data	Expected Result	Actual Result	Status (Pass, Fail,N/A)
2_1	Change Asset Type dropdown list according to the Asset Category selected	Go to Asset Management->New Asset and Load Asset Registration page	Select Asset Category 'IT Hardware'	Display Asset Type drop-down list according to 'IT Hardware'	Asset Types, according to the 'IT Hardware' were displayed.	Pass
2_2	Control for empty fields	Go to Asset Management->New Asset and Load Asset Registration page	Asset Serial: empty	Give message 'Asset Serial is required'	Gave message 'Asset Serial is required'	Pass
2_3	Auto-generated Asset Code	Go to Asset Management->New Asset and Load Asset Registration page. Select Asset Category and Type	Asset Category: Branch Hardware, Asset Type: 'PC'	Asset Code in the un-editable text field should be displayed as 'PLC/ICT/BHW/PC/001'	'PLC/ICT/BHW/PC/001' was displayed in the un-editable Asset Code field	Pass
2_4	Display fields according to the selected Asset Category	Go to Asset Management->New Asset and Load Asset Registration page	Asset Category: IT Hardware	Asset Location and Asset Owner fields should be added into the form.	Asset Location and Asset Owner fields were added to the form	Pass

| 2_5 | Successful asset registration | Go to Asset Management->New Asset and Load Asset Registration page | Fill all the mandatory field in the form and Click 'SAVE' button | Display message 'New Asset is Successfully Registered' and redirect to the 'New Asset' page | Displayed message 'New Asset is Successfully Registered' and redirected to the 'New Asset' page | Pass |

Table E.2 – Test Case for Asset Make

Test Case ID	3					
Test Case Name	**Asset Make**					
Test No	**Test Unit / Controls Description**	**Prerequisite**	**Input or Selected Data**	**Expected Result**	**Actual Result**	**Status (Pass, Fail,N/A)**
3_1	Auto generated Make ID	Go to Administration -> Make & Model	None	Asset Make ID which is a read-only field in the Asset Make By section need to be displayed as next Make ID 'AMA002'	'AMA002' was displayed in the Asset Make ID field	Pass
3_2	Control for empty fields	Go to Administration -> Make & Model	Make Name: empty	Give message 'Make Name is required.'	Gave message 'Make Name is required.'	Pass
3_3	Successful Entering of new Asset Make	Go to Administration -> Make & Model	Enter Asset Make By Name to the field of 'Asset Make Name' and Click 'Save'	Display message 'New Make Name is added' and redirect to the Make & Model page.	Displayed the message 'New Make Name is added' and redirected to the Make & Model page.	Pass
3_4	Get Make data into the Make & Model	Go to Administration -> Make &	None	All Make details in the database need to be	All Make details in the database were	Pass

				displayed as a table with its ID, Make Name and Status.	displayed as a table with its ID, Make Name and Status.	
page
3_5	Test for pagination	Go to Administration -> Make & Model and view Asset Make Search Section	Change pagination tabs by clicking each tab.	Display five Make data records at a time when changing the pagination tabs.	Five Make data records were displayed at a time when changing the pagination tabs.	Pass
3_6	Test for edit page	Go to Administration -> Make & Model and view Asset Make Search Section	Click 'Edit' link relevant to Make ID 'AMA002'.	Direct to the Asset Make by Edit page and display the existing data for the selected Asset Make ID.	Directed to the Asset Make by Edit page and displayed the existing data for the selected Asset Make ID.	Pass
3_7	Test for data the updation in Asset Make	Go to Administration -> Make & Model -> Search Asset Make and Click 'Edit' for 'AMA002'	Select Status as 'INACTIVE'	Give message 'Make Details are successfully updated.'	Gave message 'Make Details are successfully updated.'	Pass

Table E.3 – Test Case for Asset Model

Test Case ID	4					
Test Case Name	Asset Model					
Test No	Test Unit / Controls Description	Prerequisite	Input or Selected Data	Expected Result	Actual Result	Status (Pass, Fail,N/A)
4_1	Auto-generated Model ID	Go to Administration -> Make &	None	Asset Model ID which is a read-only field in the	'AMO008' was displayed in the Asset	Pass

		Model		Asset Model section need to be displayed as next Model ID 'AMO008'	Model ID field	
4_2	Control for empty fields	Go to Administration -> Make & Model	Model Name: empty	Give message 'Model Name is required.'	Gave message 'Model Name is required.'	Pass
4_3	Test for 'Make Name' drop-down list	Go to Administration -> Make & Model	None	All active asset Make Names should be displayed in the drop-down list of 'Make Name' in the Model section.	Displayed all active Asset Make names in the drop-down list of 'Make Name' in the Model section.	Pass
4_4	Successful Entering of new Asset Model	Go to Administration -> Make & Model	Enter Asset Make Name, Model Name and Click 'Save'	Display message 'New Model Name is added' and redirect to the Make & Model page.	Displayed the message 'New Model Name is added' and redirected to the Make & Model page.	Pass
4_5	Get Model data into the Make & Model page	Go to Administration -> Make & Model and view Asset Model Search Section	None	All Model details in the database need to be displayed as a table.	All Model details in the database were displayed as a table.	Pass
4_6	Test for edit page	Go to Administration -> Make & Model and view Asset Model Search Section	Click 'Edit' link relevant to Model ID 'AMO002'.	Direct to the Asset Model Edit page and display the existing data for the selected Asset Model ID.	Directed to the Asset Model Edit page and displayed the existing data for the selected Asset Model ID.	Pass
4_7	Test for data the updation in	Go to Administration ->	Select Status as 'INACTIVE'	Give message 'Model Details are	Gave message 'Model	Pass

| | Asset Model | Make & Model -> Search Asset Model and Click 'Edit' for 'AMO002' | | successfully updated.' | Details are successfully updated.' | |

Table E.4 – Test Case for Ticket Generation

Test Case ID	5					
Test Case Name	**Ticket Generation**					
Test No	**Test Unit / Controls Description**	**Prerequisite**	**Input or Selected Data**	**Expected Result**	**Actual Result**	**Status (Pass, Fail,N/ A)**
5_1	Auto-generated Ticket No	Go to Service Desk -> New Ticket	None	Next Available Ticket No 'TN0004' should be displayed in the uneditable Ticket No field.	'TN0004' was displayed in the uneditable Ticket No field.	Pass
5_2	Control for empty fields	Go to Service Desk -> New Ticket	Identified Issue: empty	Give message 'Identified Issue is required.'	Gave message 'Identified Issue is required.'	Pass
5_3	Test for asset serial	Go to Service Desk -> New Ticket	Asset Serial: WS64TZ9	Display asset details related to the entered asset serial at the right side of the page	Displayed asset details related to the entered asset serial at the right side of the page	Pass
5_4	Test for displaying authorized person details	Go to Service Desk -> New Ticket	Authorized Person: 000002	Employee name, designation, and branch related to the given employee number should be displayed.	Employee name, designation, and branch related to the given employee number was displayed.	Pass

5_5	Successful generation of ticket	Go to Service Desk -> New Ticket	Enter mandatory fields and Click 'Generate Ticket'	Display message 'New Ticket is generated Successfully' and redirect to the page showing ticket details.	Message 'New Ticket is generated Successfully' was displayed and redirected to the ticket details page.	Pass