

Sri Lanka Institute of Information Technology



Project Proposal

Information Technology Project (IT2080) 2023

Group:- WD_B01_ITP_08

Network Tower (Site) Management System

for

Engenuity Telco Pvt Ltd

Submitted by:







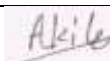
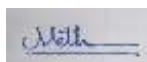
- | | |
|----------------------------|------------|
| 1. Bandara K.M.V.T | IT21266300 |
| 2. Bandara R.M.D.L | IT21266096 |
| 3. Chandrasena H.M.K.G.J.K | IT21268830 |
| 4. Kiriwaththuduwa K.C.N | IT21298158 |
| 5. Chamodya W.A.H | IT21355882 |
| 6. Wimalarathna D.M.A.T | IT21238444 |
| 7. Nanayakkara A.A.R | IT21700156 |
| 8. Senadheera W.D.N.D | IT21220388 |

May 2023

Declaration

This project report is our original work and the content is not plagiarized from any other resource. References for all the content taken from external resources are correctly cited. To the best of our knowledge, this report does not contain any material published or written by third parties, except as acknowledged in the text.

Authors:

SID	Name	Signature
IT21266300	Bnadara K.M.V.T.	
IT21266096	Bandara R.M.D.L.	
IT21268830	Chandrasena H.M.K.G.J.K.	
IT21298158	Kiriwaththuduwa K.C.N	
IT21355882	Chamodya W.A.H	
IT21238444	Wimalarathna D.M.A.T	
IT21700156	Nanayakkara A.A.R	
IT21220388	Senadheera W.D.N.D	

Date:.....19/05/2023.....

Abstract

The Network Tower Information System is a comprehensive and integrated platform designed to efficiently manage and monitor network towers in the telecommunications industry. It offers a centralized solution for tracking tower information, equipment, maintenance activities, and associated data. This web-based application offers a set of eight essential features, including a tower information system, finance management, contractor information, environment and safety management, contact information system, transport management, staff management, and document management. This web application enables the employees of Engenuity Telco (Pvt) Ltd to manage their daily tasks more easily and efficiently.

The tower information system includes information about the construction of the tower. Finance management includes everything related to financial affairs. The contractor information system contains information about contractors. Also, Environment and Safety Management contains information about the safety of employees. The contact information system contains the contact details, the transport management system contains the transport details, and the staff management includes the information about the staff and the documentation in the document management.

Engenuity Telco (Pvt) Ltd provides a user-friendly and interactive interface for members to manage their activities by utilizing a MERN stack. This web application aids in the mitigation of problems encountered in traditional management systems, resulting in considerable improvements in the company's operations.

After extensive conversations about developing a React-based web application, our team members carefully picked the capabilities to include in this web application. To construct this web application, we used the MERN stack, which comprises MongoDB, ExpressJS, ReactJS, and NodeJS. We also chose GitHub for version control, which allows for seamless collaboration and code management.

In summary, this network tower information system has made it easier for the managers and employees of Engenuity Telco (Pvt) Ltd to carry out their daily work easily and efficiently. Not only that, this web application has been made in a way that it can be easily used by avoiding the shortcomings of the previous system through the new technology.

Acknowledgement

As members of the ITP_2023_Y2_S2_G08 group, we want to express our sincere appreciation to all those who supported and guided us in successfully completing our ITP group project.

First and foremost, we extend our heartfelt gratitude to our lecturer, Mr. Buddika Harshanath, for his invaluable guidance and unwavering support throughout the project. Their expertise and insights were crucial in shaping our understanding and application of key concepts.

We would also like to thank our project evaluator, Mrs. [], for dedicating her time and effort to assess our work and provide constructive feedback. Her insights helped us identify areas for improvement and refine our approach.

We would also like to express our gratitude to Mr. Chanaka Bandara, who played a pivotal role in giving us this project. As an expert in the field and a member of the Engenuity Telco Pvt. Ltd. team, Mr. Bandara recognized our potential and entrusted us with this opportunity to gain hands-on experience in the telecommunications industry. His faith in our abilities and his support throughout the project were crucial to our success. We are grateful for his guidance and the opportunity he gave us to work on a project of such significance.

In addition, we are grateful to our parents, colleagues, and other individuals who supported and encouraged us throughout the project. Their guidance and motivation were instrumental in keeping us focused and motivated.

Finally, we want to express our deepest gratitude to our team members, who worked tirelessly throughout the semester to bring this project to fruition. Their unwavering support and commitment to our common goal were pivotal in achieving the success we enjoy today. We are proud of the work we accomplished together and the skills we acquired through this project.

Table of Contents

Declaration.....	i
Abstract.....	ii
Acknowledgement	iii
List of Tables	vi
List of Figures	vi
List of abbreviations	vii
Chapter 1 : Introduction.....	1
1. Background.....	1
1.1 Company Background.....	1
1.2 Introduction to the Web Application.....	1
2. Problem and motivation.....	2
2.1 Problem.....	2
2.2 Motivation.....	3
3. Literature review.....	4
4. Aim and objectives.	5
4.1 Aim	5
4.2 Objectives	6
5. Solution Overview	7
6. Methodology	8
7. The structure of the report.....	9
8. GitHub Repository Link :- https://github.com/SLIITITP/itp-malabe-b01-itp_wd_b01_g008.git 10	
Chapter 2. Requirements.....	11
1 Stakeholder Analysis	11
2 Requirements Analysis	12
2.1 Network Tower (Site) Information Management System.....	12

2.1.1	Functional requirements.....	13
2.3	Contractor Information Management.....	14
3	4.4) Environment health and safety management	14
4	4.4.1) Functional requirements	15
5	4.5) Contact information system.....	15
6	4.5.1) Functional requirements	16
7	4.6) Transport management	16
8	4.6.1) Functional requirements	16
9	4.7) Staff Management.....	16
	Functional requirements.....	17
	Document Management system	17
	Functional requirements.....	18
	Non-Functional requirements	18
9.1	Technical requirements	19
10	Requirements Modeling.....	20
Chapter 3. Design and Development		23
	Diagrams of components	23
	Network Tower (Site) Information Management System.....	23
10.1	Finance Management System	25
10.2	Contractor Management.....	28
10.3	Environmental Health And Safety Management System.....	30
10.4	Contact information system	32
10.5	Transport Management	34
10.6	Staff Management	36
10.7	Document Management	38
9.	processes	40
Chapter 4. Testing – Test cases and results.		42
11	Network Tower Site Information Management System	42

15.6 Transport Management System	53
Chapter 5. Evaluation and Conclusion.....	63
8) References	65
Appendix A.....	I

List of Tables

TABLE 1.1 LIST OF ABBREVIATIONS.....	VII
TABLE TEST CASE FOR ADD NEW TI SITE INFORMATION	42
TABLE TEST CASE FOR UPDATE TI SITE INFORMATION	42
TABLE TEST CASE RESULTS FOR NTSIMS	43
TABLE TEST CASE FOR ADD NEW SAFETY DATA.....	48
TABLE TEST CASE FOR UPDATE SAFETY DATA	49

List of Figures

FIGURE 1.ENGNUITY TELCO PVT LIMITED LOGO	ERROR! BOOKMARK NOT DEFINED.
FIGURE2 .LACKSHMINDRA FERNANDO, FOUNDER, EXECUTIVE CEO.....	ERROR! BOOKMARK NOT DEFINED.
FIGURE 3. SYSTEM OVERVIEW.....	ERROR! BOOKMARK NOT DEFINED.
FIGURE 4. TEC ICON	ERROR! BOOKMARK NOT DEFINED.
FIGURE 5. DIAGRAM OF NTMS	ERROR! BOOKMARK NOT DEFINED.
FIGURE 6. USECASE DIAGRAM	ERROR! BOOKMARK NOT DEFINED.
FIGURE 7. CLASS DIAGRAM	ERROR! BOOKMARK NOT DEFINED.
FIGURE 8. ER DIAGRAM	ERROR! BOOKMARK NOT DEFINED.

FIGURE 9. NTSIMS ACTIVITY DIAGRAM.....	ERROR! BOOKMARK NOT DEFINED.
FIGURE 10. FINANCE USE CASE DIAGRAM.....	ERROR! BOOKMARK NOT DEFINED.
FIGURE 11. FINANCE MANAGEMENT ACTIVITY DIAGRAM.....	ERROR! BOOKMARK NOT DEFINED.
FIGURE 12. FINANCE MANAGEMENT LOGIN ACTIVITY DIAGRAM.....	ERROR! BOOKMARK NOT DEFINED.
FIGURE 13 CONTRACTOR MANAGEMENT ACTIVITY DIAGRAM	ERROR! BOOKMARK NOT DEFINED.
FIGURE 3-114DOCUMENT ACTIVITY DIAGRAM.....	ERROR! BOOKMARK NOT DEFINED.

List of abbreviations

Table 1.1 List of abbreviations

Abbreviation	Description
Civil	Type of project
CRUD	Create, Retrieve, Update, Delete
DB	Data Base
ER	Entity Relationship
IDE	integrated development environment
JS	Java Script
MERN	MongoDB, Express, React Js, Node Js
NIC	National Identity Card
NTSIMS	Network Tower Site Information Management System
PO Amount	Purchase Order Amount
PDF	Portable Document Format
TI	Project type
UI	User Experience
UML	Unified Modeling Language
UX	User Interface

Chapter 1 : Introduction

1. Background

1.1 Company Background



Figure 1.Engnuity Telco Pvt Limited logo

Engnuity Telco Pvt Limited is a telecommunications company in Sri Lanka that provides services to mobile network operators, tower companies, and other telecom infrastructure providers. The company offers tower construction and maintenance, site acquisition, power management, network optimization, and network planning and design services, as well as a range of software solutions. Engnuity Telco is committed to providing high-quality, cost-effective telecom infrastructure solutions tailored to its clients' unique needs. The company has a team of experienced professionals and has become a trusted partner for telecom operators, government agencies, and businesses in Sri Lanka. [2]



Figure2 .Lackshmindra Fernando, Founder, Executive ceo

1.2 Introduction to the Web Application

The Network Tower Site Information Management System is built to reduce the time spent finding data. Basically, there are eight main functions for managing different types of aspects. NTSIMS is based on the internet, and users can access it anywhere they work because network tower management most of the time works in outstations.

The network tower information management system is the main function, and it's used for centralized tower information and finding site information easily. The finance management system manages site finance details and provides informative charts and overall finance status. The staff management system provides for getting staff details and assigning relevant duties. Contractor details management provides the client with a clear idea of the contractor's details site-wise. Transport management is used to manage the company's vehicles and drivers in an efficient manner. The contact information management system

is used to manage contact details related to the site. Environment, health, and safety management is used to track the equipment on the site. A document management system is used to manage site documentation.

This web application solution can be used for any other network company as well, with some simple modifications. Because in Sri Lanka, any network tower company does not use software solutions for site management.

2. Problem and motivation

2.1 Problem

Engenuity Telco Private Limited is confronted with a significant problem due to the absence of centralized information. Although the company accumulates a large amount of data regarding network tower management, this data is not saved in a central location. Instead, the company relies on its clients' systems or spreadsheets to store project information. This decentralized approach to data storage leads to inefficiencies and difficulties in managing and analyzing data.

Communication difficulties are among the key issues that the decentralized contact details(site-wise) approach causes. Since each site controls their own contact details, companies must communicate with each one to gather the necessary information. This creates excellent communication, leading to delays and miscommunication. The lack of standardized data storage also hinders the company's ability to analyze trends effectively, resulting in slower decision-making processes.

Another significant issue is the delay in obtaining permission to access project information. Since each client controls their system or spreadsheet, the company must go through a time-consuming process to gain permission to access the necessary data. This delay wastes considerable time and resources, reducing the company's efficiency and ability to provide timely services to clients.

Furthermore, the decentralized approach to data storage makes it difficult for the company to access information quickly and efficiently. They must search through multiple systems or spreadsheets to find the relevant information, leading to delays and errors. This impedes the company's ability to respond to issues promptly and provide timely services to clients.

In addition to fundamental problems, each functionality exhibits distinct Problems.

The financial management function within the company encounters a substantial predicament due to the decentralized storage of financial data in spreadsheets or clients' systems. This challenges the company to make reasonable decisions regarding its sites' revenue, expenses, profits, or losses. The absence of a centralized financial management system impedes the company's capability to enhance

profitability and financial security while also creating security vulnerabilities owing to the inadequately secured data. Consequently, a pressing need arises to establish a centralized financial management system to ensure that the company's financial data is managed efficiently and protected securely, leading to informed decision-making that enables the optimization of profitability and financial security.

Transport management is a complex task that involves the movement of equipment, supplies, and people, which can pose safety and security risks. Effective transport management requires the establishment of stringent safety and security protocols to guarantee the protection of individuals and property. Regular vehicle inspections and maintenance, ensuring drivers possess adequate qualifications and licensing, and implementing security measures such as access control and video surveillance are crucial safety measures that should be implemented. Neglecting safety and security in transport management can lead to severe consequences such as theft, damage, accidents, injuries, and unlawful activities. Therefore, it is essential to prioritize safety and security in transport management to prevent potential risks and ensure the smooth and secure movement of goods, people, and equipment. Rigorous safety and security procedures in transport management will guarantee the safety of individuals and property and enhance the company's reputation.

The absence of an effective tracking system for safety equipment across multiple sites was a significant challenge for safety officers before the development of the Environment Health and Safety Management System. The lack of proper tracking measures made it difficult to ensure employee safety and the safety of the environment. The manual process of tracking safety equipment was time-consuming, leading to delays in safety inspections and potential safety hazards. Safety officers were also unable to monitor the maintenance and replacement needs of safety equipment, leading to equipment failure and safety risks.

2.2 Motivation

In order to tackle the aforementioned problems, it is imperative for the network tower management company to adopt a centralized information system. By implementing such a system, the company can gather all project and client-related data in one place, making data management and analysis more streamlined and efficient.

A centralized information system also ensures that all data is stored in a standardized manner, leading to enhanced communication and better decision-making within the company. By having access to all relevant data in one centralized location, the company can quickly respond to any issues that arise and deliver services to clients in a timely manner. This ultimately improves the overall efficiency and reputation of the company, leading to tremendous success in the long run.

The company's financial data must be managed and protected using a centralized financial management system. This method will make it possible to make well-informed decisions, which will increase

profitability and financial stability. Financial data will be managed effectively and securely via a centralized system to protect private data from illegal access. With a centralized system, the organization can distribute resources more efficiently, prevent financial losses, and make wise decisions to increase profitability and financial stability.

monitoring in transport management aims to reduce risks to safety and security posed by the movement of personnel, equipment, and supplies. This is done by checking the location and status of goods, people, and vehicles. This approach improves the safety of goods, people, and equipment during transportation and reduces potential dangers. It also enhances the company's reputation by ensuring prompt and effective delivery while reducing the possibility of theft, damage, or other illegal acts.

The inability to track safety equipment distributed across multiple sites posed a significant risk to employee safety and the environment, increasing the likelihood of incidents and accidents. Without a reliable system, accountability and visibility into the status and maintenance of safety equipment were compromised, leading to serious consequences for individuals and organizations. However, the "Environment Health and Safety Management System" has provided a solution to this problem. By enabling safety officers to track and monitor safety equipment across multiple sites, the system ensures equipment readiness, reducing the risk of incidents and accidents. This enhanced level of safety and accountability benefits employees, the environment, and improves the company's performance and reputation.

Adopting a centralized information system is necessary for the network tower management company to address their problems related to data management, communication difficulties, and delays in accessing project information. By implementing this system, the company can improve its data management and analysis capabilities, enhance communication, and ultimately deliver better client services.

3. Literature review

Tower management systems play a vital role in maintaining and operating telecommunication towers. This literature review aims to examine and assess various solutions developed for managing network towers, with a specific emphasis on the benefits and drawbacks of each solution.[26]

One solution developed for managing telecommunication towers is the Air View Xecleate telecom tower management software. It offers centralized management, including inventory management, site maintenance, and network monitoring [27], and increases efficiency by automating many manual processes. The software can generate customizable reports. However, it is a paid software and a significant expense for smaller telecom tower operators. It is also advanced software that is not user-friendly. Therefore, it is unsuitable for our client, who requires software that users with beginner-level

knowledge of information technology can use. Hence, we developed more user-friendly and affordable software.

Another software is the Sitetracker telecom tower management software developed by SiteTracker company. It offers comprehensive features such as managing telecom towers, inventory management, and field service management [28]. The software is developed for large-scale tower operations. However, it has a steep learning curve for new users and relies heavily on technology. Any system failures or downtime could impact the ability of operators to manage their telecom towers effectively. Our client requires customizable specific web applications, and this software is unsuitable since they do not need any advanced features. Therefore, purchasing this software is not suitable.

The Inforzech tower management software is developed by Inforzech Software Pvt Ltd. The advantage of this software is that it [37] allows the creation of a customizable workflow and provides a mobile app. The system allows real-time monitoring of towers [29]. However, this software is also paid software, and our client cannot invest much money in purchasing this type of software.

Based on the literature review, the client needs more user-friendly and affordable software than the existing tower management software's. The client does not require advanced features and needs customizable specific web applications. The existing software's are expensive, not user-friendly, and has a steep learning curve for new users. Therefore, the client requires software that is more accessible and tailored to their specific needs.

4. Aim and objectives.

4.1 Aim

Developing a network tower (site) management system aims to create a software solution that enables efficient and effective management of network tower sites. This includes monitoring sites, managing employees, contractors, and environmental factors, managing finance and site documents, and tracking vehicles and drivers. The system should be scalable, empowering site staff to oversee operations with maximum efficiency and reliability, flexible and easy to use.

4.2 Objectives

Requirements gathering: Identify the requirements of the network tower site management system by consulting with site managers, network operators, and other stakeholders. Understand their needs and priorities and use them as a basis for defining the system's functionality, features, and user interface.

System design: Create a detailed design of the network tower site management system that incorporates the identified requirements. Determine the software architecture, data models, workflows, and user interface, ensuring that they are scalable, flexible, and easy to use.

Software development: Develop the network tower site management system according to the defined design, using appropriate programming languages, frameworks, and libraries. Conduct rigorous testing to ensure that the software functions correctly and is free of bugs.

Deployment and integration: Deploy the network tower site management system to the target sites and integrate it with the existing infrastructure. Configure the system to match the specific needs of each site, ensuring that it operates efficiently and effectively.

Training and support: Provide training and support to site managers and other users to ensure that they understand how to use the network tower site management system effectively. Offer ongoing technical support and maintenance to keep the system functioning at peak performance.

Continuous improvement: Continuously monitor the performance of the network tower site management system, gathering feedback from users and identifying areas for improvement. Implement updates and enhancements to the software to ensure that it remains up-to-date and meets the evolving needs of the network tower sites. [1]

5. Solution Overview

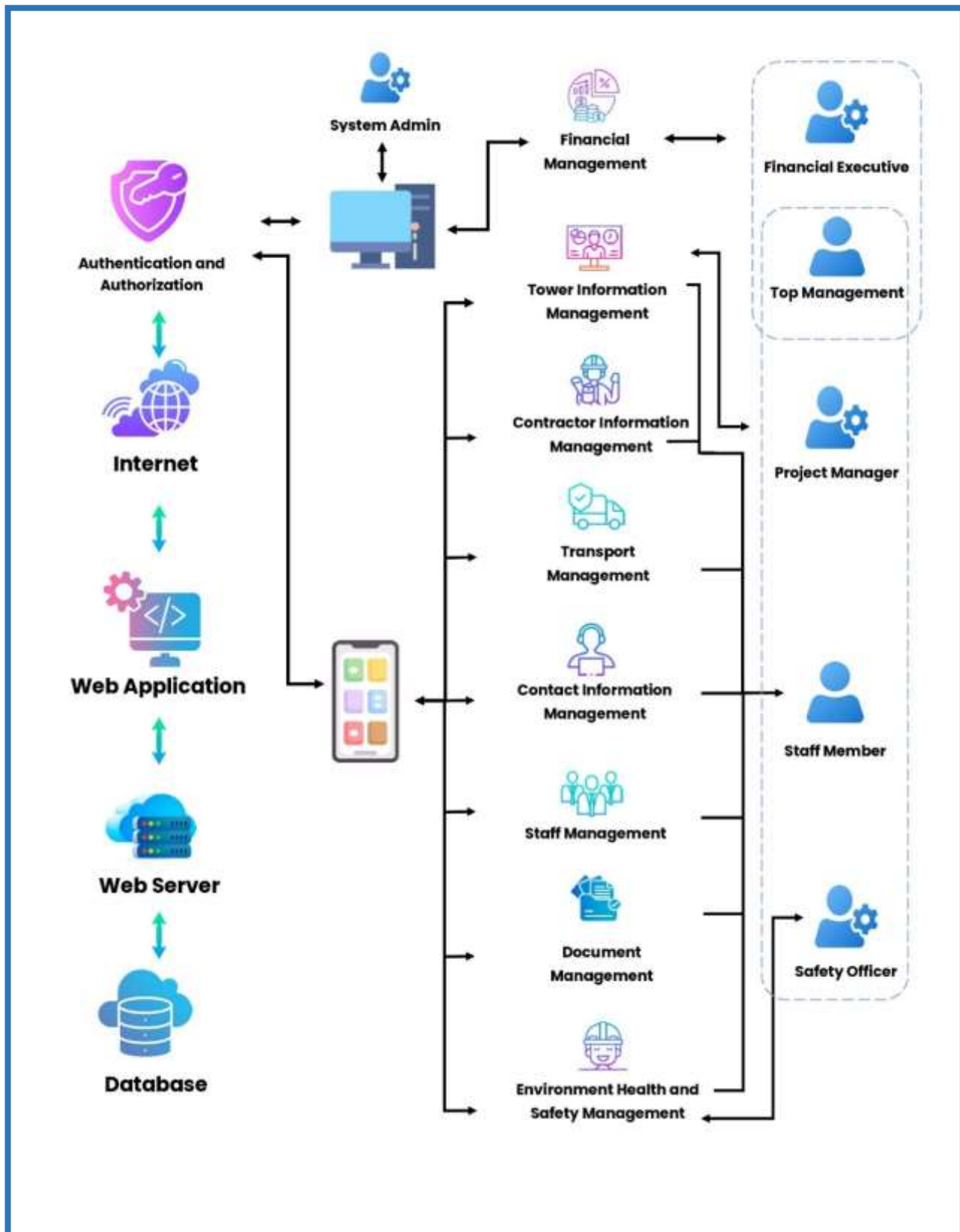


Figure 3System Overview

6. Methodology

In this section, we are able to discover the diverse methods and various tools and technologies that we used inside the software development technique of our project. In this section, our intention is to offer a top-level view of the modern nation of techniques, what the gear and technology are, and to assess how they can be used to decorate the undertaking. In this scenario here we discuss this in two parts. Those are methods, tools and technologies that are required to build the methods. We will additionally analyze the one-of-a-kind ways in which these tools can be integrated with every different to create a cohesive software development workflow. Finally, here it is possible to get a rough idea about each method and the tools and technology used and expected to be used to build those methods.

Interviews and **questionnaires** are the two main methods used to gather requirements in this project proposal. In this case, we used some key technologies and tools. It helped members to carry out their work independently and the efficiency of the system. **Unified Modeling Language (UML)** is a standardized way to visualize [38] and document software systems.[11] We can use UML to create diagrams that describe various aspects of a system, such as its structure and behavior. **draw.io** and **StarUML** are used to create UML diagrams. Also, we get aid from **Microsoft Word** for the documentation of our project. It was used to create useful documents, design, and bring a professional look to the documentation. **Microsoft PowerPoint** is used to create presentations. It was extremely useful because it contains many tools needed for our tasks.

The system is fully dependent on classes and objects. So, we use **Object Oriented Design**. Software designing tools are programs that assist in planning and visualizing software systems before they are put into use. To create design models like class diagrams and use cases, designers will also use UML and Draw.io. **Mock Flow** was utilized to implement UI/UX design in order to achieve that. It helps a cloud-based wireframe tool that enables designers to work together in real time on software and user interface prototypes. **MSPROJECT** was the software that we used to plan and manage the project as we aspect in project management process. In addition, we will use the **github** tool for time management and task management related to our project. When designing database structure, **Mongo DB** was a useful tool.

Development(implemental) is the process of realizing the design as a program. That means covert the product into a working product. We shall employ forward engineering in this situation with the aid of **Scrum** and **agile** techniques. We hope to use **Visual Studio** to develop our project because it is easy to use, and a popular integrated development environment (IDE) compared to other tools. Also, we will use **MERN** stack technology, which combines four different technologies such as MongoDB, expressjs, nodejs, react to develop the system successfully. React.js offers a dynamic and interactive frontend, Express.js is a lightweight and flexible online application framework, MongoDB offers a versatile and scalable database, and Node.js offers a quick and scalable backend. Together, they offer a solid and adaptable framework for modern web applications.

While developing software, testing the software is an unessential thing; we will mainly use the postman tool. It will help us to reduce backend errors before implementing the front end.



Figure 4-Tec icon

7. The structure of the report

The rest of the report follows a logical flow, building upon the foundation established in the first chapter. Here's an overview of the flow of the remaining chapters:

Chapter 2: Requirements

This chapter delves into the specific requirements of the project. It begins with a stakeholder analysis, identifying the key stakeholders involved. The requirements analysis section breaks down the project requirements into different modules, including the Network Tower (Site) Information Management System, Finance Management, Contractor Information Management, Environment Health and Safety Management, Contact Information System, Transport Management, Staff Management, and Document Management. Each module is discussed in detail, outlining both the functional and non-functional requirements. The chapter concludes with requirements modeling techniques.

Chapter 3: Design and Development

This chapter focuses on the design and development aspects of the project. It explores each module mentioned in the previous chapter, such as the Network Tower (Site) Information Management System, Finance Management System, Contractor Management, Environmental Health and Safety Management System, Contact Information System, Transport Management, Staff Management, and Document Management. The chapter discusses the design principles, methodologies, and techniques employed for each module, providing an understanding of how the project was implemented.

Chapter 4: Testing – Test Cases and Results

This chapter is dedicated to testing the developed system. It specifically focuses on the Network Tower Site Information Management System module. It presents the test cases that were designed to verify the functionality and performance of the system. The results of the testing phase are also provided, highlighting any issues encountered and the overall effectiveness of the system.

Chapter 5: Evaluation and Conclusion

The evaluation and conclusion chapter evaluates the implemented solution. It assesses the extent to which the project goals and objectives have been achieved. The chapter includes an evaluation of the solution's performance, effectiveness, and usability. Based on the evaluation, conclusions are drawn regarding the success of the project and its impact. This chapter may also provide recommendations for future work or improvements.

8. GitHub Repository Link :- https://github.com/SLIITITP/itp-malabe-b01-itp_wd_b01_g008.git

Chapter 2. Requirements

1 Stakeholder Analysis

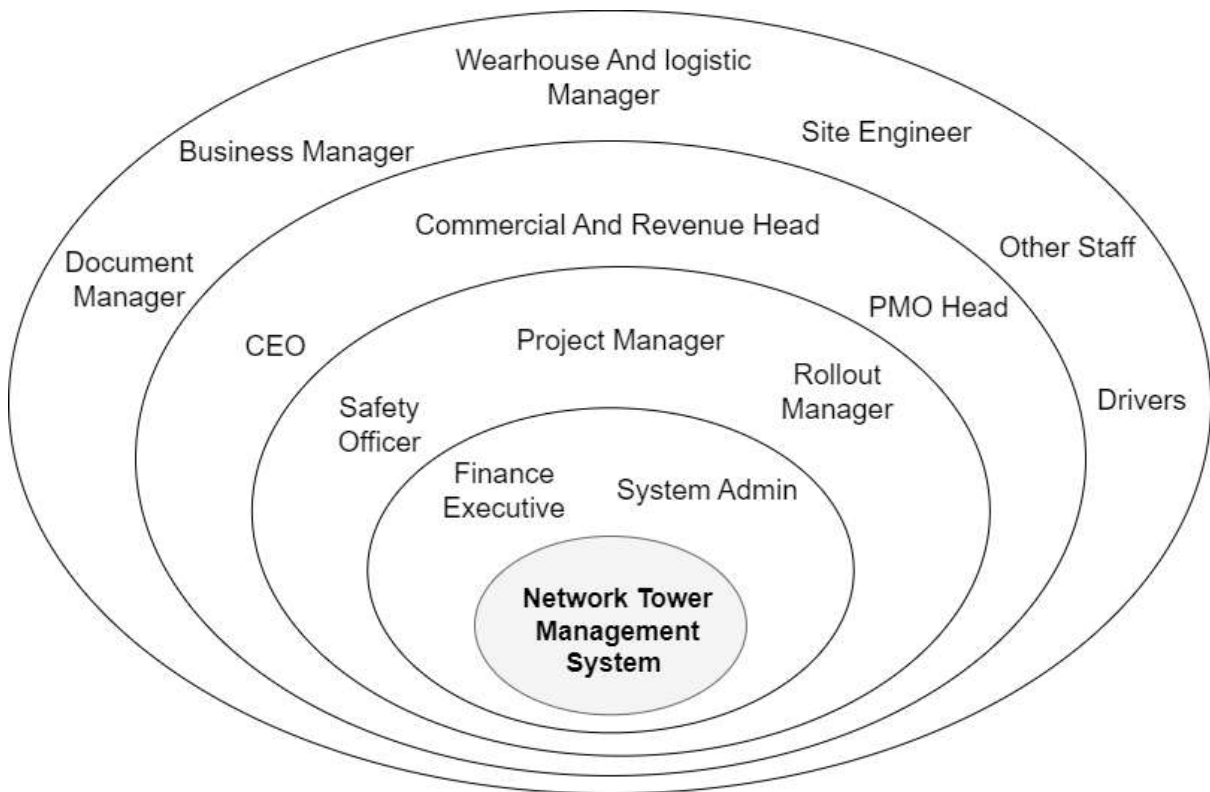


Figure 2-1 diagram of NTMS

In the network tower management system, the main stakeholders are the following users.

1)Owner: The system's profitability and success are of utmost importance to the owner of the network tower management system. They want to make that the system is effective, offers a decent return on investment, and satisfies the needs of all parties involved.

2)Management: The rollout team, project team, document team, revenue and commercial team, and warehouse operating team are all members of the management team. Each team has roles to play and stakes in the system's success. They oversee managing daily operations, making sure the system is correctly implemented, and guaranteeing that all stakeholders are pleased with the system's performance.

3)Staff: The system's usability, efficacy, and efficiency matter to the staff that run and maintain it. They want to make sure the system is user-friendly, dependable, and offers the tools they need to effectively carry out their job.

4)Admin: The system's records must be maintained by the administrator, who also makes sure that all data is correct and current. He wants to make sure that the staff can readily access and use the relevant data and that the system is user-friendly.

5)Financial Manager & Finance Executive: These participants have a monetary stake in the system's success. They oversee the system's finances, making sure they are efficient, and making sure all financial transactions are precise and open.

6)Safety Officer: The safety officer is responsible for ensuring that the network tower management system is safe for staff and clients. They want to ensure that the system meets all safety standards and regulations.

7)Contractor: Contractors who provide services or support to the system have an interest in the system's success. They want to ensure that the system is well-maintained, reliable, and meets their contractual obligations.

8)Client: The network tower management system's dependability, accessibility, and correctness are important to its users. They want to make sure that the system offers the information and resources they require to meet their needs.

2 Requirements Analysis

2.1 Network Tower (Site) Information Management System

The Network Tower (Site) Information Management System is a crucial component in the management of network towers. Comprising two primary divisions, TI and Civil, it offers essential details about ongoing projects, including completion statuses for Civil sites. While TI projects can be completed in a single day, Civil projects can require several months. The system provides comprehensive tracking capabilities for all TI and Civil projects, offering weekly and monthly reports of on-site information and status. Users can obtain permission letters through the system, while site charts and maps provide current site status updates to aid in decision-making.

The site information system is accessible to all staff members, allowing them to view site information and download permission letters. Project managers can monitor Civil sites, track the completion progress, and update status information as needed. Data manipulation capabilities are restricted to system administrators alone. Furthermore, the Tower (Site) Information System is directly connected to various other management systems, including Finance management, contractor information management, Environment Health and Safety Management, and document management.

In conclusion, the Tower (Site) Information System is an indispensable tool for managing TI and Civil projects, providing essential reporting capabilities accessible to staff members, project managers, and top management. Additionally, it is integrated with various other management systems for greater efficiency in managing network towers.

2.1.1 Functional requirements

The site information management function is a vital feature of the Network Tower (Site) Information Management System that enables all authorized users to access the system by providing valid user credentials. Users can search for sites using the site name or ID, with the system suggesting site names when the site name is used as a search parameter. Project managers can update the completion checklist of the civil site, and the system will automatically update the site's status accordingly. The system calculates the total number of completed sites, including both TI and Civil sites, and generates a pie chart on the dashboard to represent the data visually. Additionally, users can download permission letters for a given site through the system. Data manipulation capabilities are restricted to system administrators, who can add, update, or delete site data to ensure accuracy and completeness.

2.2 Finance Management

The financial management function is an integral feature of the network towers management system, facilitating the tracking and monitoring of financial data for individual sites. This function enables the system to track all revenues, expenses, profits, and losses for each site and presents the financial status of each site through financial charts on a site-wise basis. The financial management section's importance is reflected in its role in decision-making for site projects, where the financial data obtained provides critical insights into the project's financial impact on the company.

The financial management section is accessible only to specific staff members in the company, and access is restricted to top management positions, including the financial executive, Business development manager, and Project manager. While all four positions can view financial data to make informed decisions, only the financial executive is authorized to perform financial operations within the section. This restricted access ensures the confidentiality and security of financial data, making it a crucial system feature.

In summary, the financial management function in the network towers management system provides a vital tool for top management to monitor and manage the financial performance of individual sites, which positively impacts the company's overall financial performance. With the financial charts

provided, top management can make informed decisions that improve the company's financial performance.

2.2.1 Functional Requirement

The financial management function should allow users to securely log in to the system and search for site-specific financial data using the Site ID or Site name. Moreover, it should allow users to add, update, and delete financial data and analyze each site's revenues, expenses, profits, and losses. Additionally, the system should calculate profits or losses for each site separately and generate site-specific financial reports. With the help of these functional needs, the financial management function can deliver reliable and timely financial information necessary for wise decision-making.

2.3 Contractor Information Management

Contractor information management is one function of the network towers management system. Basically, this function manages contractor information of Engenuity Telco (PVT) Ltd.

The contractor information section is accessible to all the system users. Users can see contractor details, their ratings, and the number of completed project sites. For the management, there is another specific role in this function. Only system admin and project managers are authorized to manage and make decisions in this section. System Admin is the only authorized user who can manage contractor details. Project managers assign contractors to the project sites. Project managers can search sites by using siteID/Site name. If contractors are available for a given site, then only the project manager can assign those contractors to the project sites.

Furthermore, the contractor management System is directly connected to various other systems such as Environment Health and Safety Management, and document management.

4.3.1) Functional requirements

The Contractor management should allow authorized users can login to the system using their user credentials. System users can only view contractor details. There are specific logins for admin and project manager, System admin can insert, update, delete contractor details and manage those details. Project managers can search sites by using site id or site name and assign contractors to the project sites. Furthermore, users can download detailed reports about contractors.

3 4.4) Environment health and safety management

An Environment Health and Safety Management System is [33] a system designed to identify, estimate, and control hazards that may affect the health and safety of workers and the environment in a workplace.

The EHSMS is checked site wise to ensure that all construction spots are secure and safe for workers and the surrounding environment.

The main purpose of the system is to [34] identify main hazards and take measures to help accidents or incidents from occurring. The company allocates a set of safety items that help to maintain the security of workers and the environment. Each construction site must manage these safety items to ensure the overall safety of the association. There are two main actors involved in this section, the administrator, and the security officer. The administrator is responsible for directly entering site-specific data into the database. The security officer checks the safety status of each site and takes further action based on the results. However, the security officer accepts it If the point meets the safety requirements. However, the security officer declines it, If not.

The system generates a report that includes the safety status of each site, which helps to identify implicit issues and take necessary corrective conduct.

4 4.4.1) Functional requirements

Before doing any revision for the system, the system shall give a valid login interface for the admin and safety officer to access the system. Also, the system should authenticate users before allowing the data of the system.

The administrator shall be able to insert data into the database gathered from each site. The safety officer and admin shall be suitable to update data included in the database. The admin and safety Officer shall be suitable to delete data from the system. The admin and safety Officer shall be suitable to retrieve data from the system.

All staff members shall be able to view the data in the system, download generated report, search sites by sing site ID or site name.

5 4.5) Contact information system.

A contact information system is a software system designed to store, manage, and organize contact information for individuals or organizations. It allows users to store and access contact details, such as names, addresses, phone numbers, email addresses, and other relevant information.

This contact information is valuable for finding staff details and site contact details. When an issue arises, it can be resolved immediately by the person responsible. Also, reduce the time spent on this and increase the efficiency of the rollout process. The client's and the contractor's contact details can be easily obtained here. Employees can search contact details and generate information as a report. Contact

information systems have become increasingly important for maintaining communication and collaboration with others.

6 4.5.1) Functional requirements

The functional requirements of the contact information system are login, insert, update, delete, search, and generate reports. All staff members can log into this system and look up contact details by searching. Also, they can generate a contact details report of the staff who worked on the site. The admin can insert, update, and delete contact details.

7 4.6) Transport management

The transport management system is an essential tool for businesses that rely on transportation to deliver their products or services.[35] The transport management system is an especially important part of the entire system. The transport management system contains information about transport activities between sites, and all these activities are controlled by the transport management system. Under this section, there are 2 main actors. They are staff members and rollout managers. After signing up and entering the system, all staff members can view the transport details. Only the rollout manager can update, delete and insert details of the transport management system.

This includes the details of drivers, vehicle details and transport allocation details. In the driver part, the driver details include name, id, contact number, address, gender, and driver status. The vehicle part contains information such as vehicle id, vehicle model, registration number, fuel type, and vehicle status. The allocation part contains information important in transportation such as transport type, transport time, location, driver id, and vehicle id. There are 3 types of transport here. Material collection from the customer, material distribution to the sites and dismantling material return to the warehouse. All the details of drivers, vehicles and allocation have CRUD operations. Also has a search bar.

8 4.6.1) Functional requirements

Functional requirements in a transport management system are a set of features and capabilities that enable businesses to optimize their transportation operations. The main functional requirements of transport management systems are to insert, delete and update the transport details. This system has a search bar for search details. Also, it can generate the report as the details.

9 4.7) Staff Management

Technology firm Engenuity Telco (PVT) Ltd specializes in creating and implementing telecom solutions for various sectors. The business has a staff management system in place as part of its

operation to manage its personnel well. The process of monitoring and directing employees' activities within a company is referred to as staff management.

This function impact for utilize the limited human resources of the company. Key aspects of staff management include: To handle the staff properly, it is divided into several grants' teams. They are Document Team, Rollout Team, Warehouse operation Team, Revenue & Commercial Team, and Project Team.

Document creation done through document team. The progress of the site is viewed and controls the transport management through the Rollout team. Calculating the company's profit through income is done through the Revenue & Commercial Team.

Top management can monitor field staff activities and can make decisions on time.

Functional requirements

The function requirement of staff management is login, assign team members, insert employee details, Update/Delete employee details and generate monthly team allocation report.

Any member is capable of a staff management page. Moreover, there is a unique staff ID card.

The project manager can assign the team members. Here, not only new members but also the power to change the members of each team is assigned to him. The success of the business is directly impacted by this procedure; thus, it must be carried out carefully and with thorough information. Admin can insert, update, and delete staff details. Here the correct and universal information system should be included.

Document Management system

The document management system function is one of the important functions of the network towers management system. Mainly it stores and manages documents of each individual site, and also it provides a status report for site's documents on daily, monthly and site wise. The document management function reduces time waste for file searching and management can make decisions on time for sites with accurate data.

The document management section is accessible for all the system users. Users can view and download documents from the management system using site ID or site name or document ID. While all users can view and download documents, only the system admin authorized to manipulate the system. This restricted access provides security for documents in the system.

The document management function in network towers management system provides a good tool for company management to review and manage each of project site's work easily. Because of that, it also has a positive impact on company performance by making accurate decisions for sites on time and company management can review their mistakes from going over the project.

Functional requirements

The document management system function allows users to log in to the system and search site's documents using site ID or site name or document ID. The system allows users to add, update and delete documents for each project site. It also generates status reports for site's documents on daily, monthly and site wise. Report shows a summary of data like client approval pending documents, approved documents and rejected documents. It helps to get a better view of each of site's work and can make good decisions for sites based on that.

Non-Functional requirements

Security is a critical non-functional requirement for the network tower (site) information management system (NTIMS). The system should employ robust security measures to prevent unauthorized access and safeguard sensitive data. This includes secure login procedures, data encryption, and access controls. [3]

Reliability is another critical requirement for NTIMS, as the system should always be available and reliable. This can be achieved by implementing redundancy, failover mechanisms, and backups to ensure that data is not lost during a system failure. [4]

Scalability is also an essential requirement for NTIMS, and it should be able to handle a large number of users and sites. The system should be scalable and easily expanded to accommodate additional sites, users, and data. [5]

Performance is a significant concern for NTIMS, and the system should be able to process requests quickly and efficiently. This includes optimizing queries, reducing response times, and minimizing downtime. [6]

Usability is another important non-functional requirement, and the system should be user-friendly, with an intuitive interface that requires minimal training. [7]

Compatibility is also crucial for NTIMS, and the system should be compatible with various devices, operating systems, and browsers to ensure that users can access it from different platforms. [8]

Maintainability is a vital non-functional requirement, and the system should be easy to maintain and update, with clear documentation, support, and troubleshooting procedures in place. [9]

Finally, compliance is essential, and the system should adhere to relevant regulations, standards, and industry best practices, such as data protection laws and security standards. [10]

9.1 Technical requirements

MERN-Stack: Tower information is stored in MongoDB's database, while Express's web application framework manages HTTP requests and answers. The system's user interface is developed with React.js, while the server-side runtime environment for server-side code execution is Node. Js.

Material UI: The Material UI React component library offers pre-made, resizable components to create user interfaces. It is a well-liked option for creating cutting-edge, responsive user interfaces. It has a wide range of elements that may be used to construct the user interface for the system that performs tower information management, including buttons, forms, and checkboxes.

Nivo: To make data visualizations, Nivo provided charts to display site status. Other chart customization options provided include color schemes, labels, and tooltips.

10 Requirements Modeling

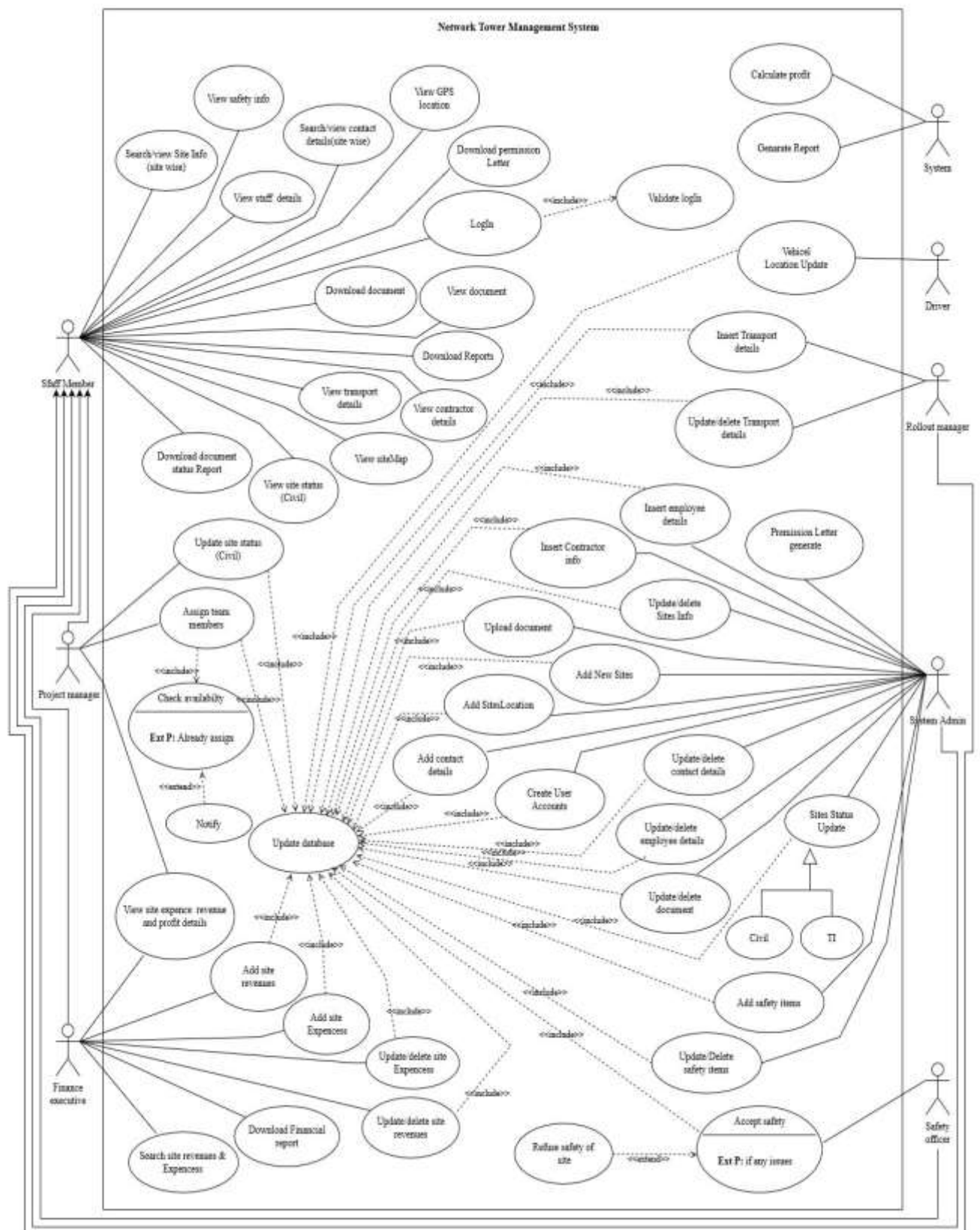


Figure 2-2 Use Case diagram

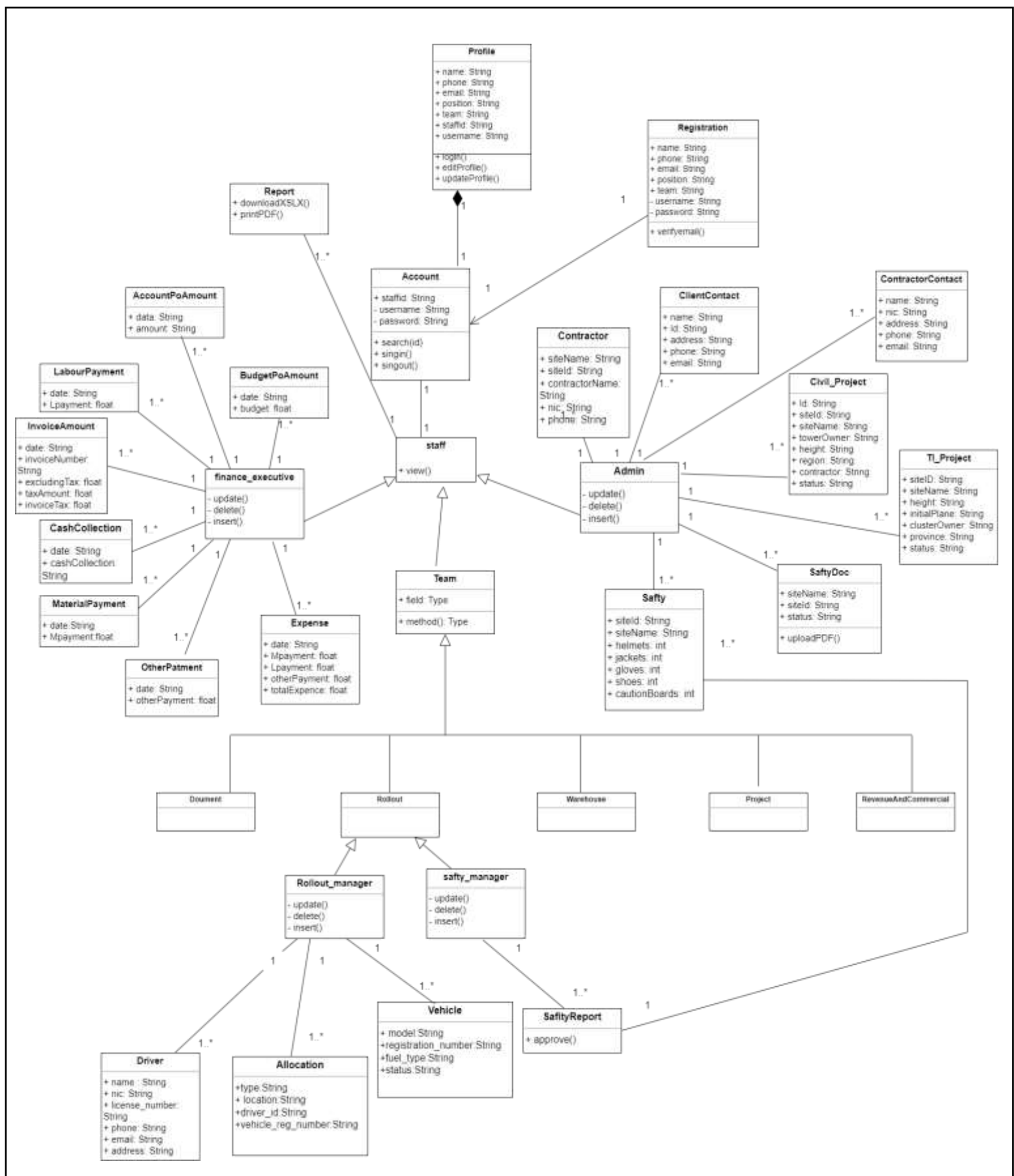


Figure 2-3Class Diagram NTMS

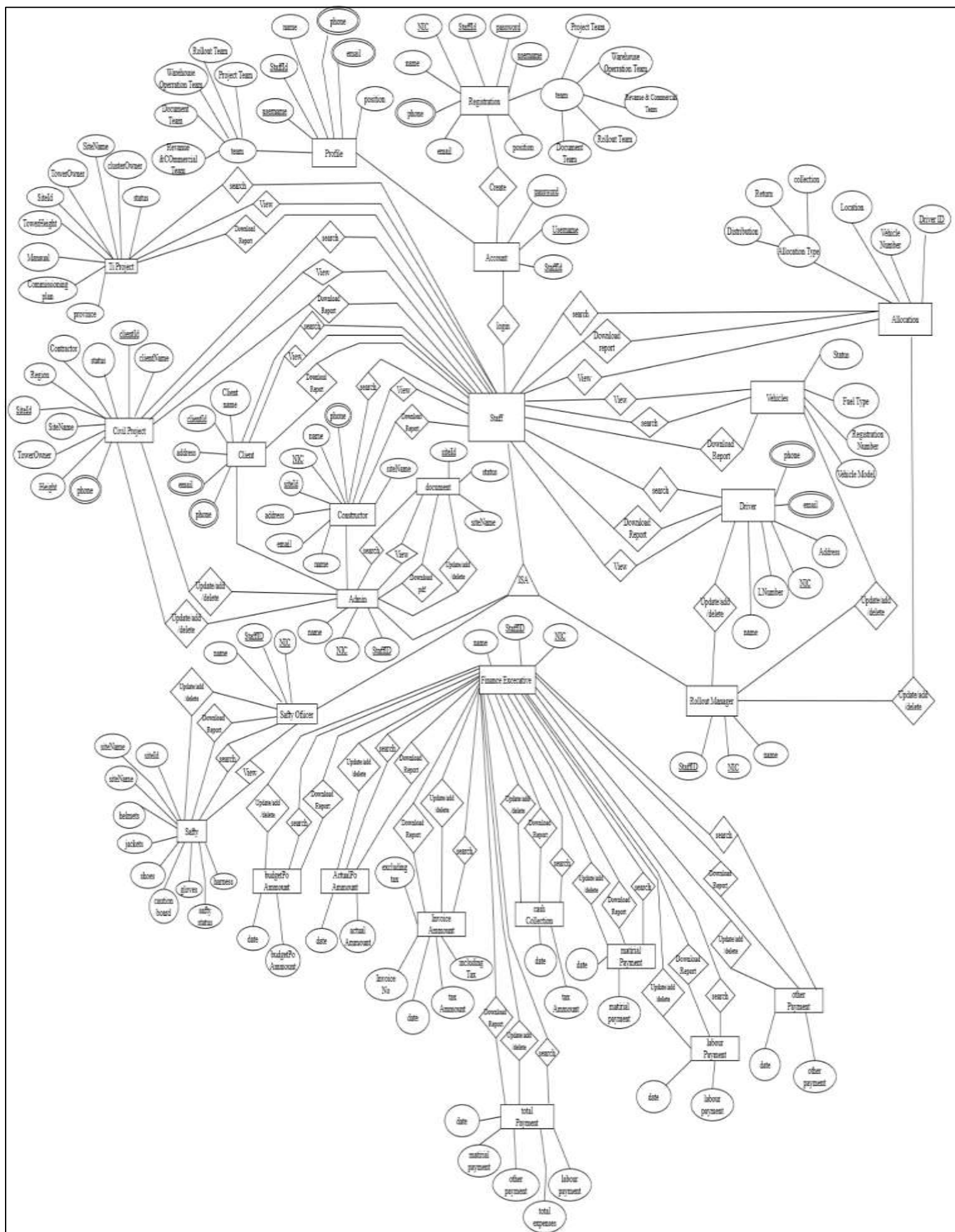


Figure2-4 5ER Diagram NTMS

Chapter 3. Design and Development

Diagrams of components workflows, databases, and development aspects.

Network Tower (Site) Information Management System

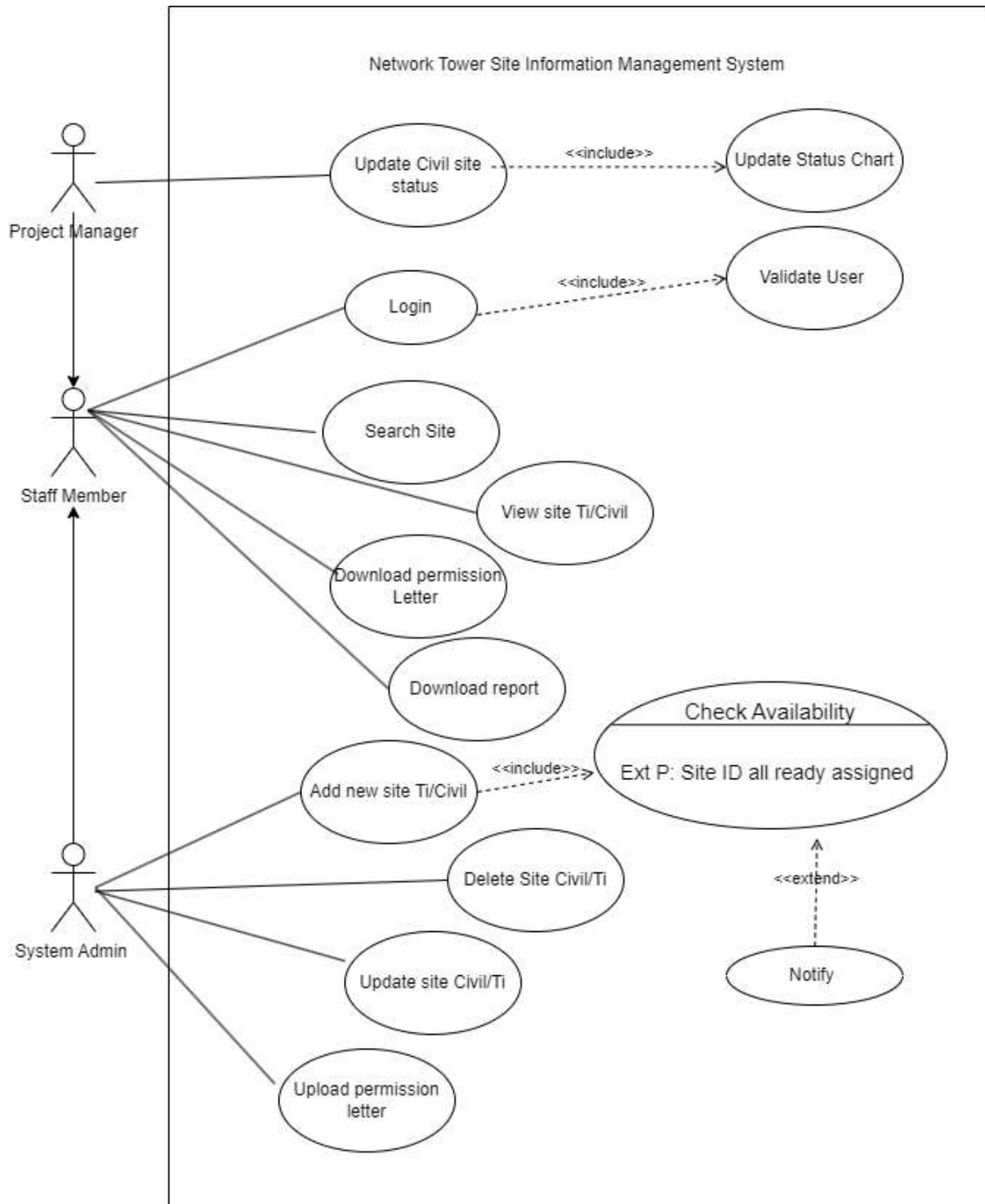


Figure3-1 6NTSIMS Use case diagram.

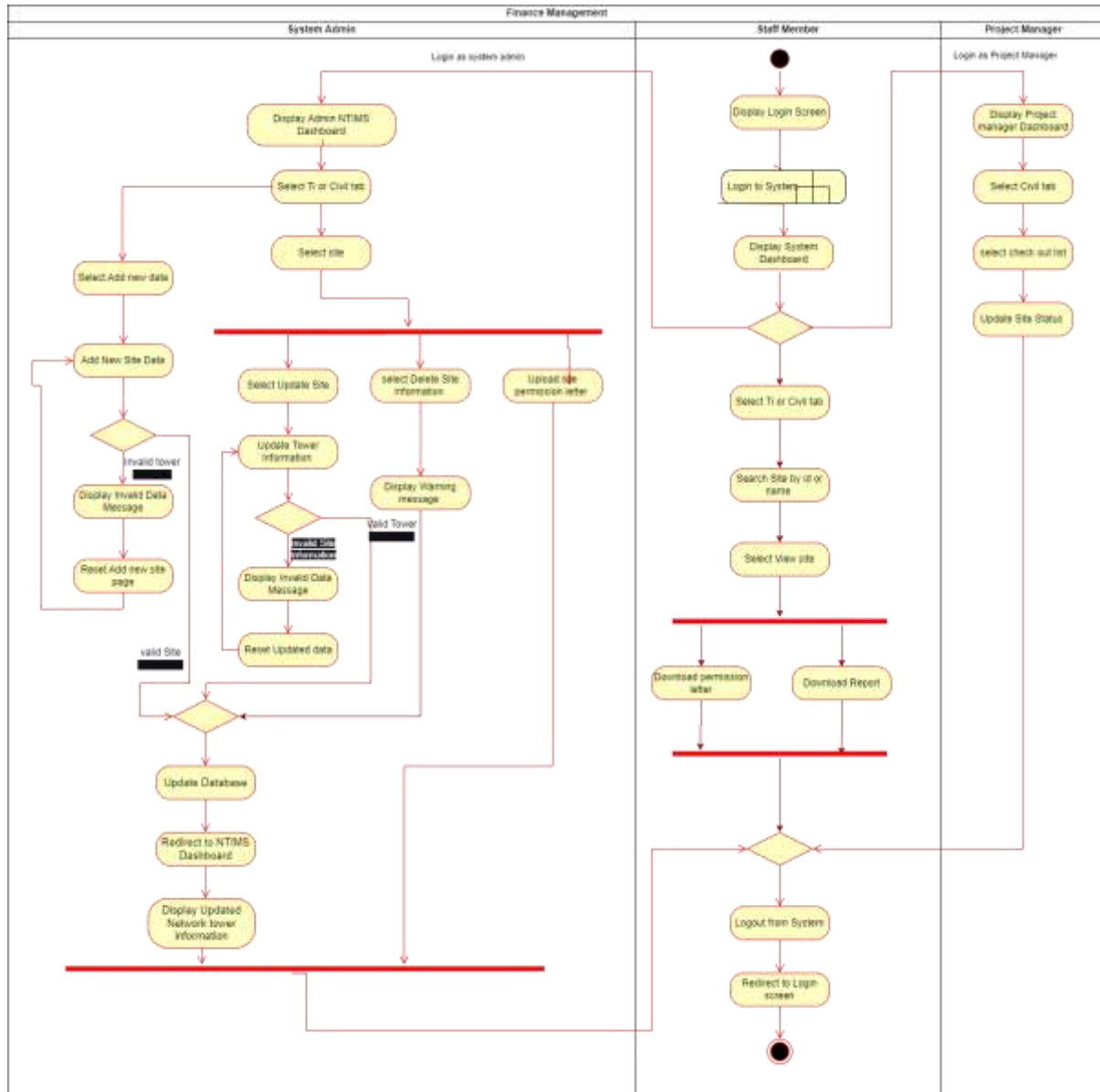


Figure3-2NTSIMS Activity diagram

10.1 Finance Management System

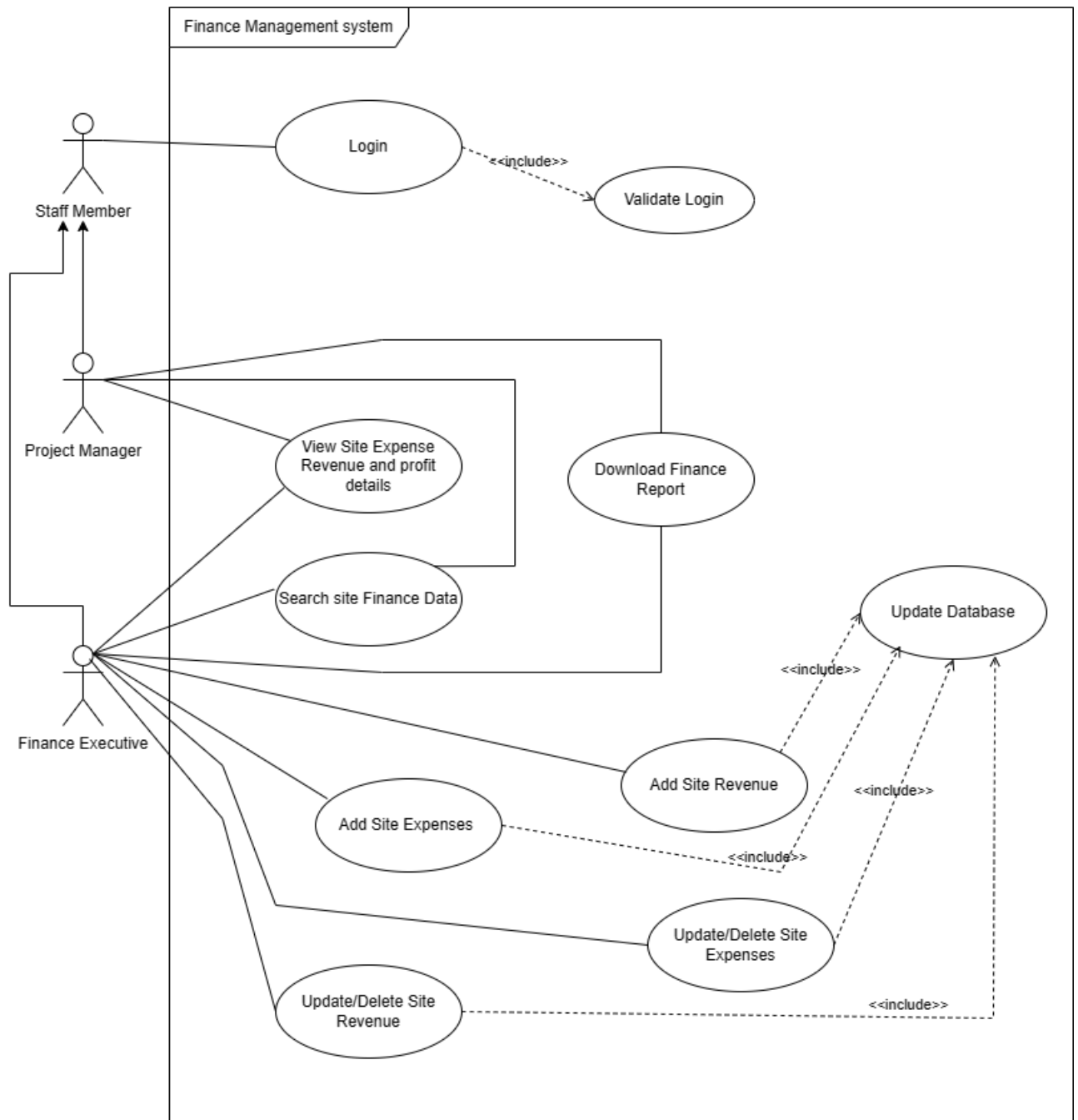


Figure 3-3 Finance Use case diagram. Figure 3

-3 Finance Use case diagram.

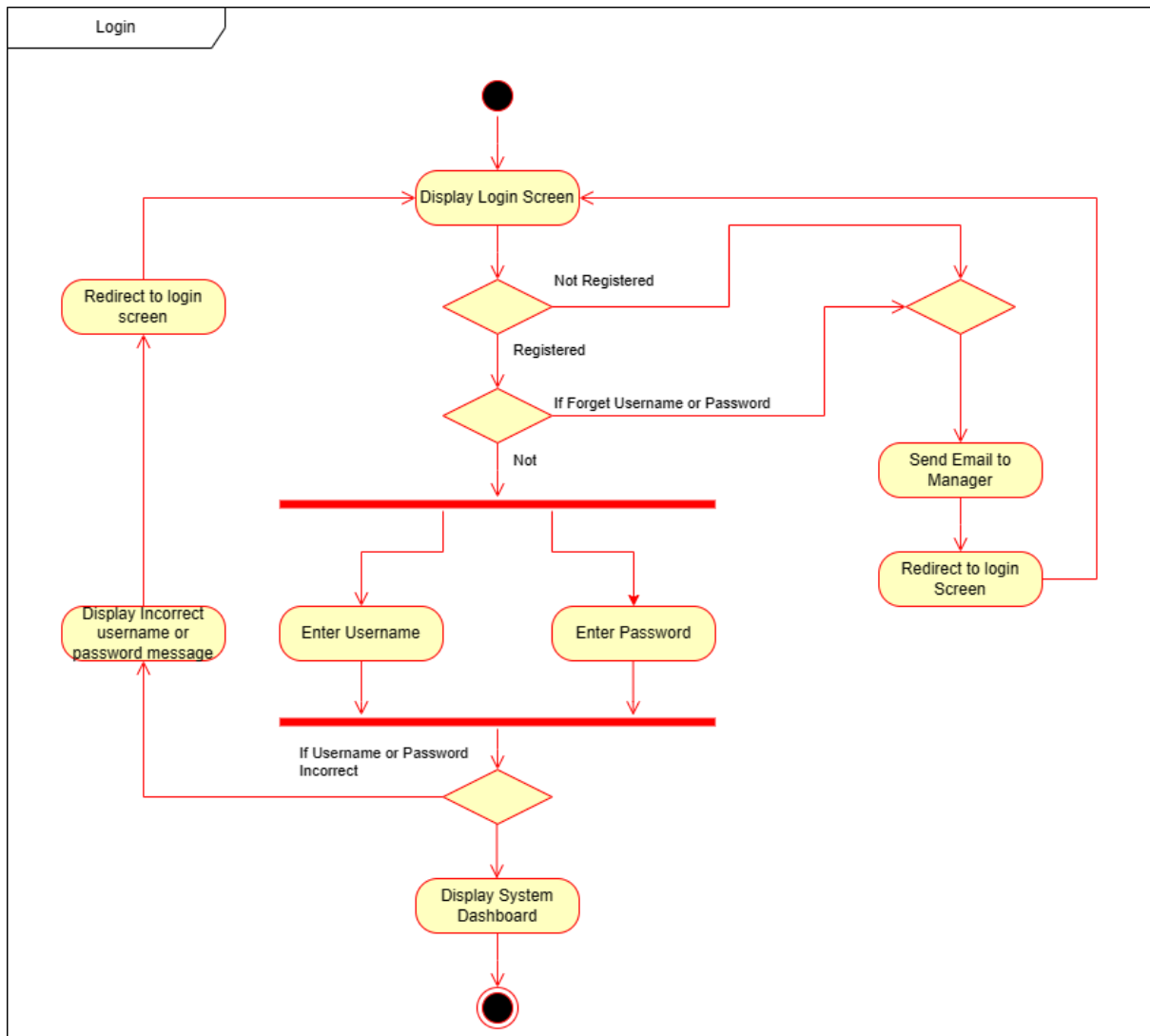


Figure3-5 Finance management login activity diagram

10.2 Contractor Management

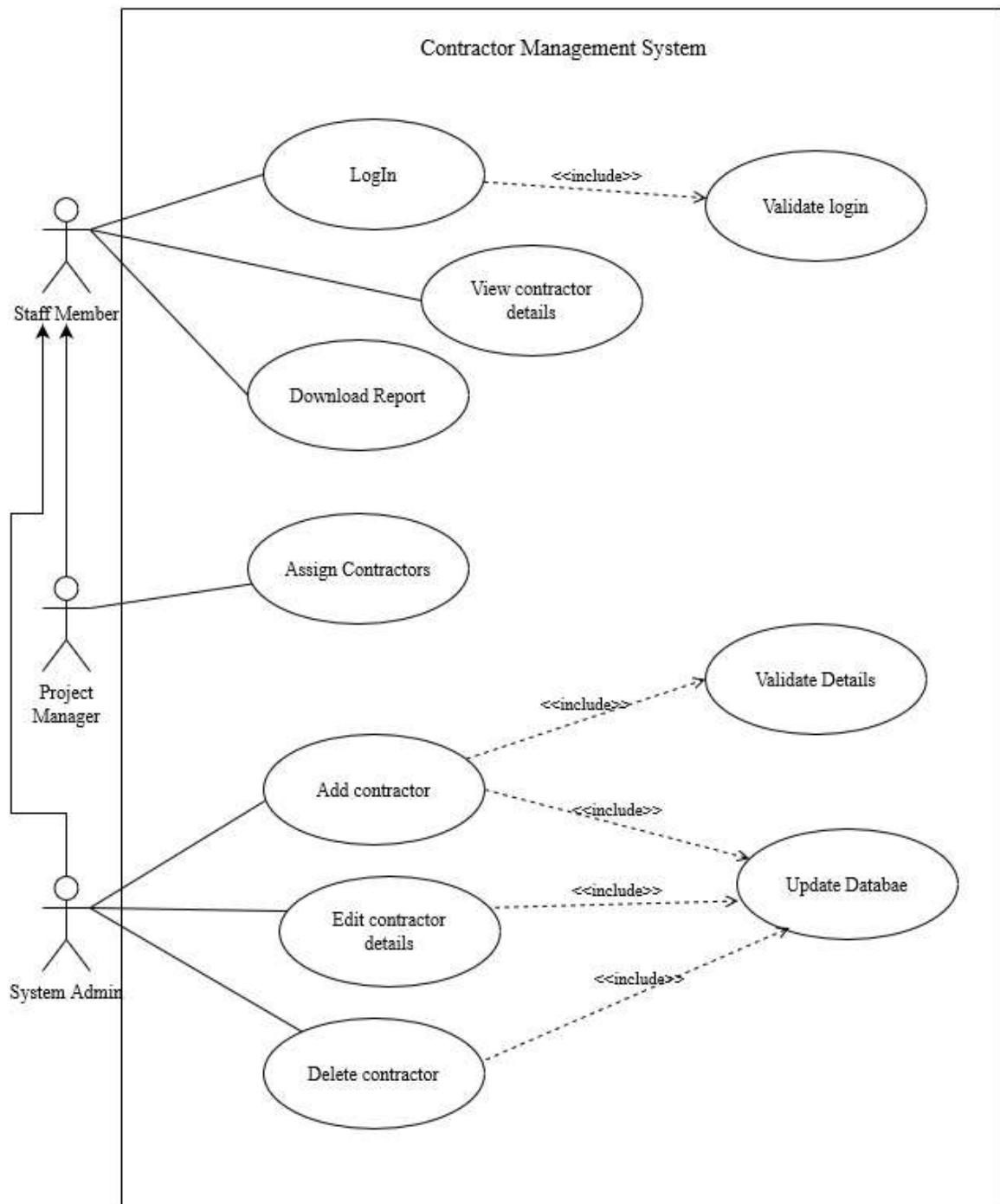


Figure 3-6 Contractor Use case diagram

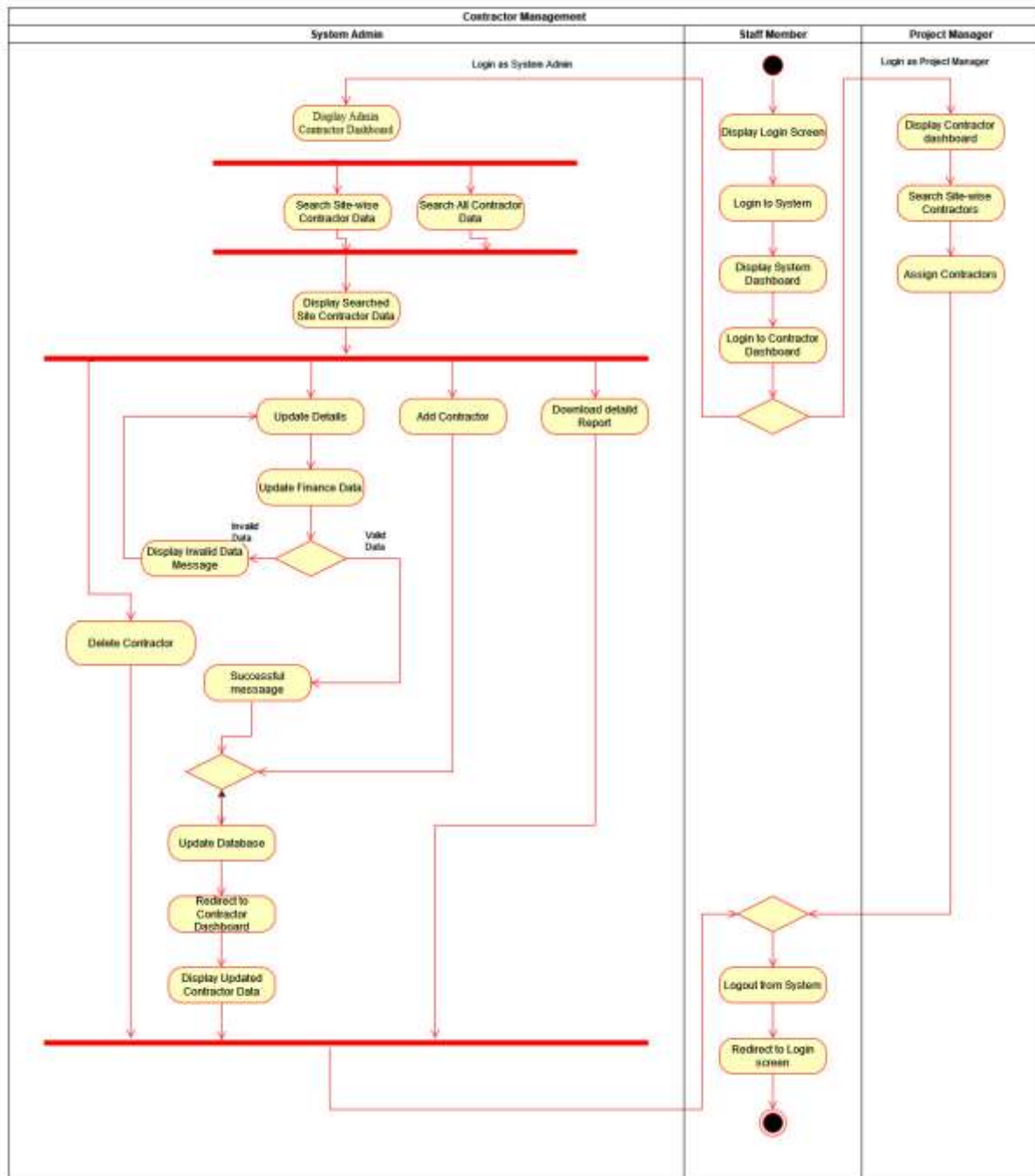


Figure 7. Contractor management Activity diagram

Figure 8 Contractor management Activity diagram

10.3 Environmental Health And Safety Management System

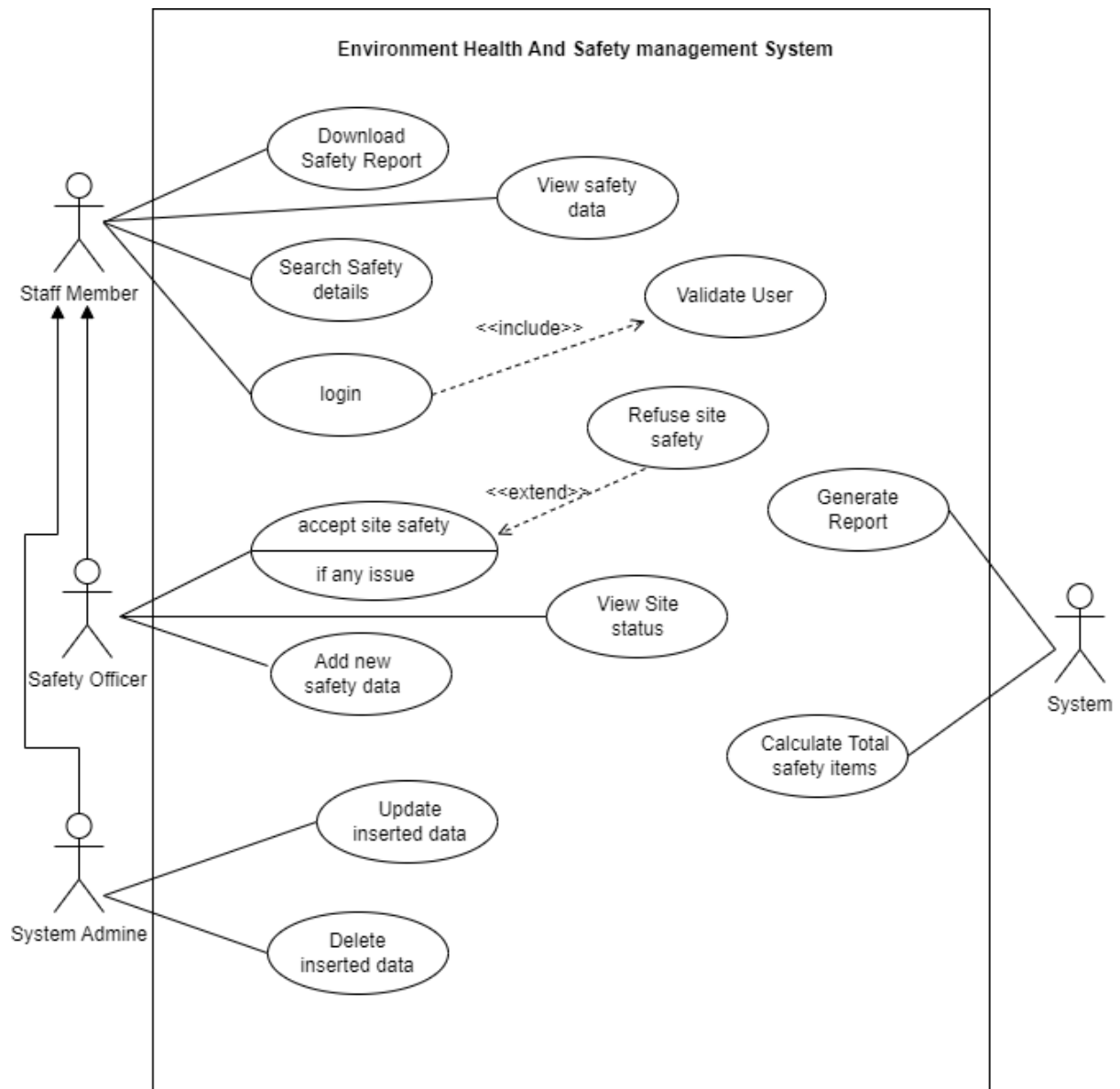


Figure 3-8 Safety use case diagram

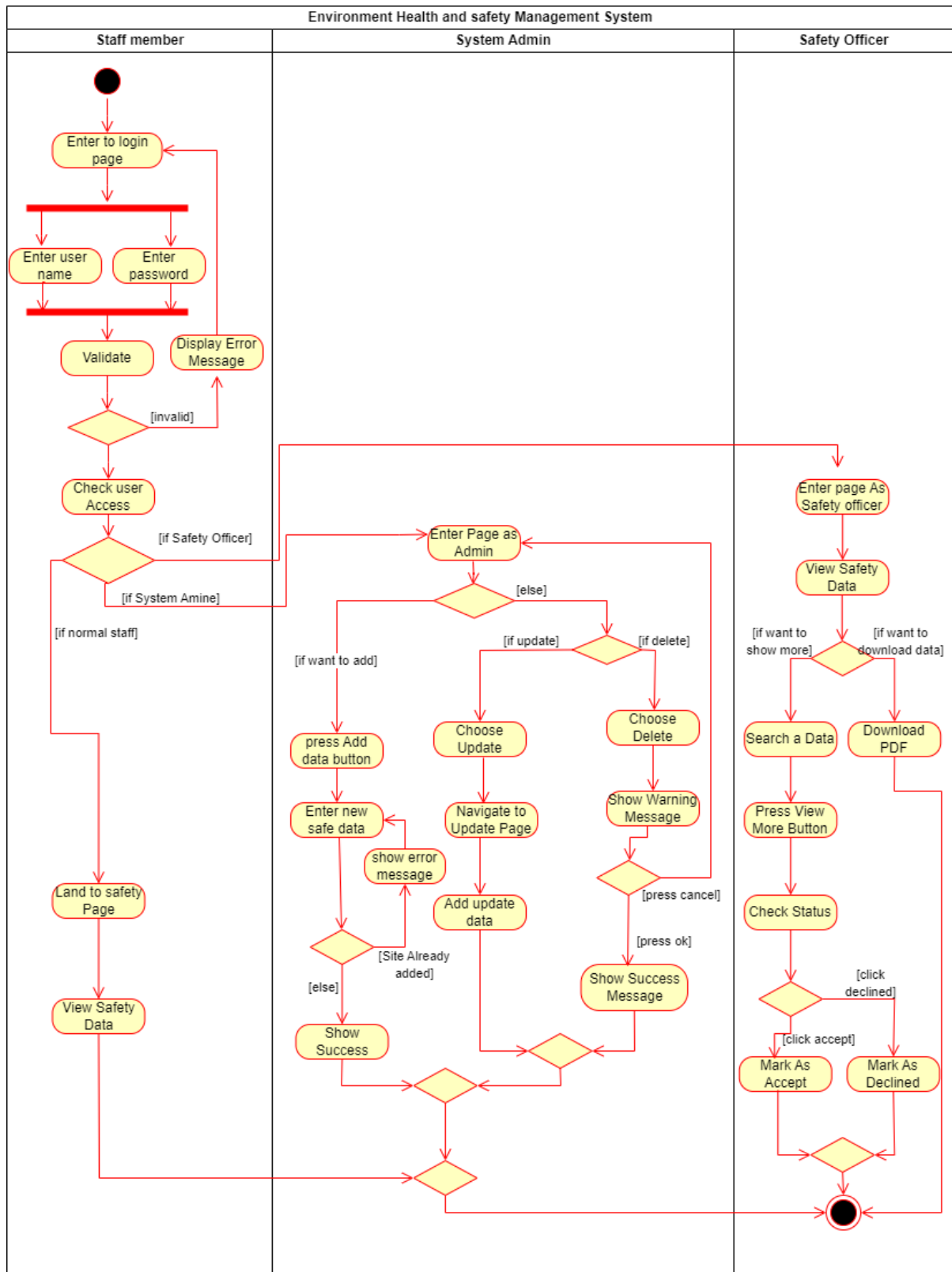


Figure 3-9 Safety Activity diagram

10.4 Contact information system

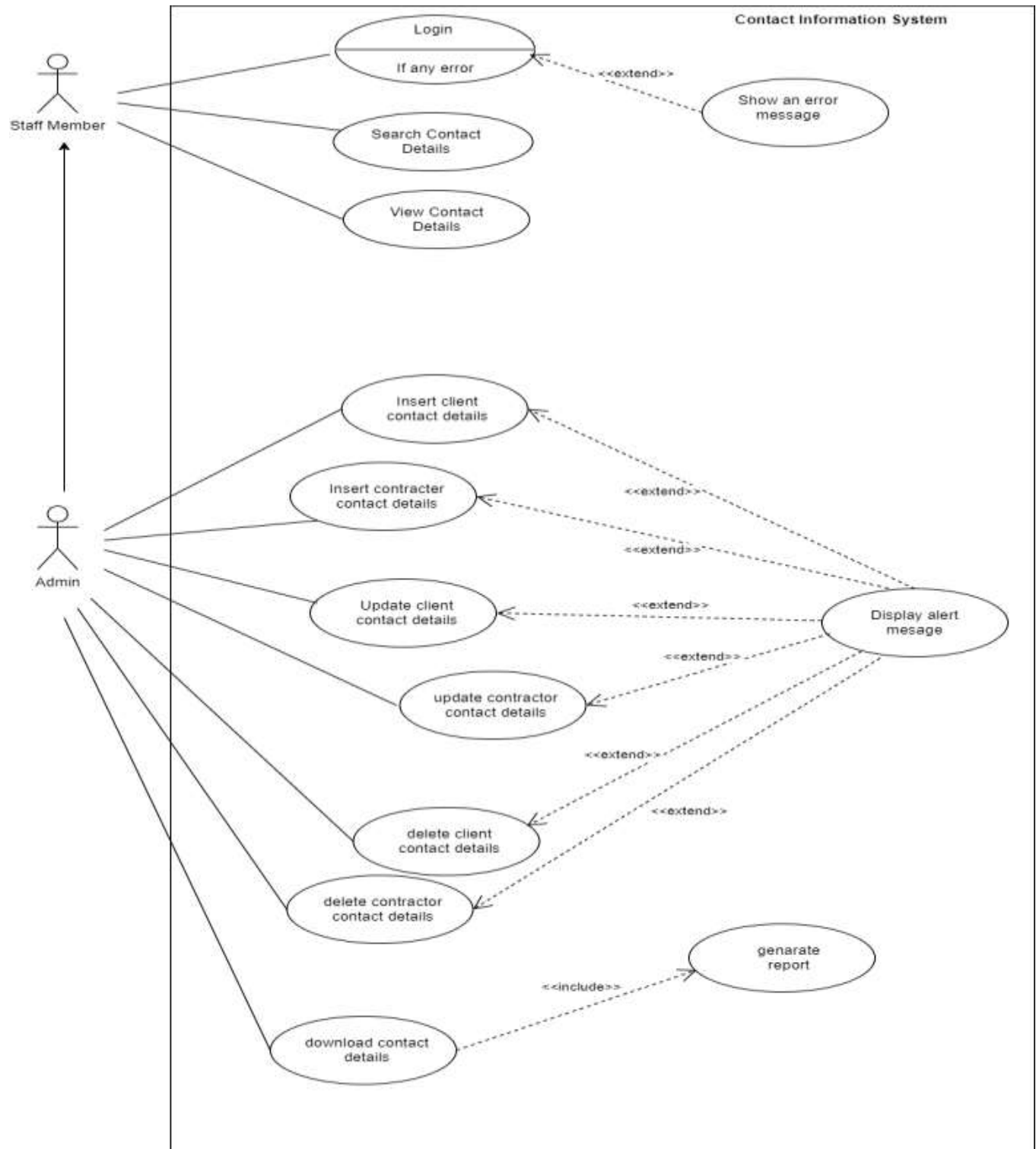


Figure 3-10 Contact use case diagram.

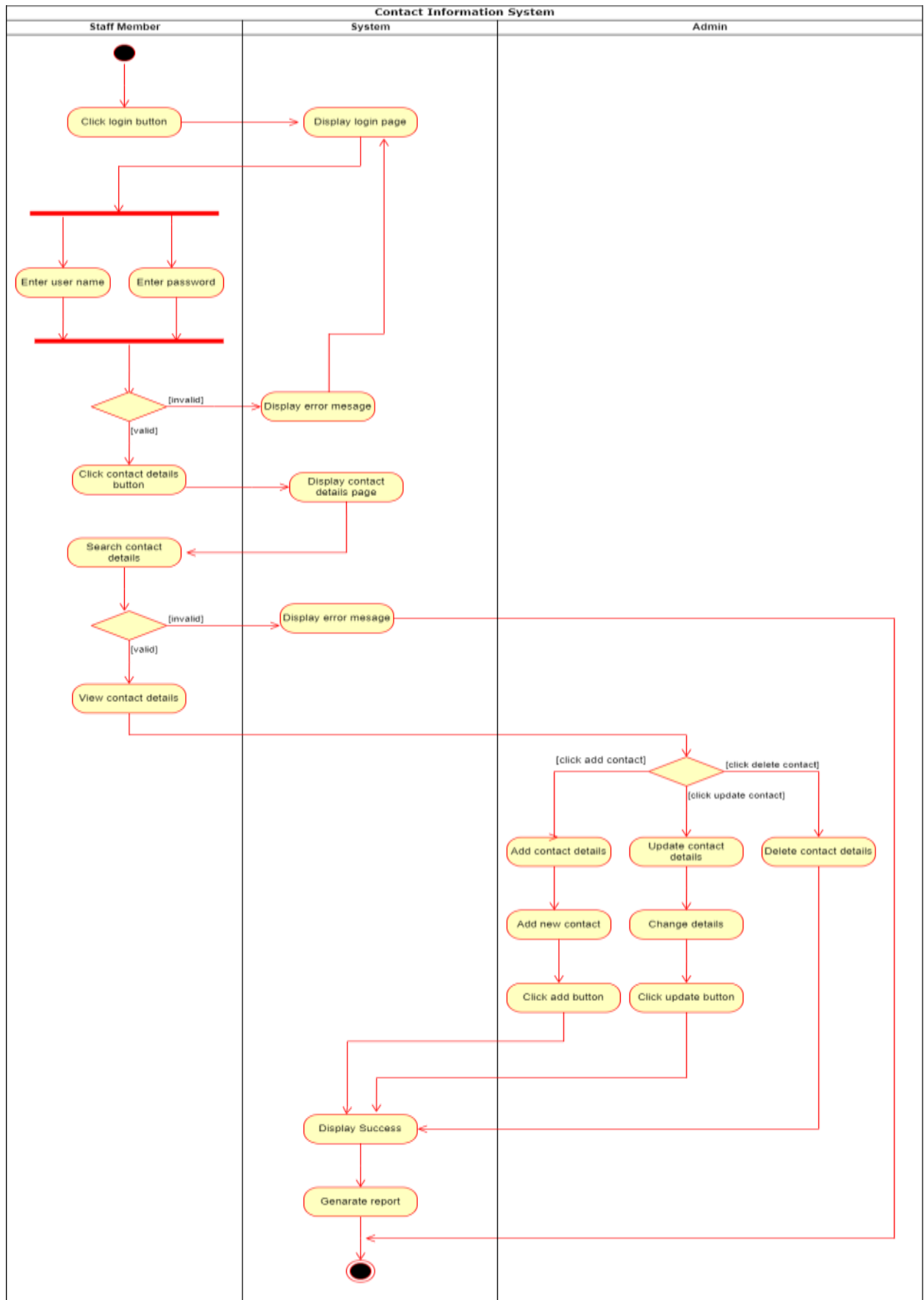


Figure 3-11 Contact Activity diagram

10.5 Transport Management

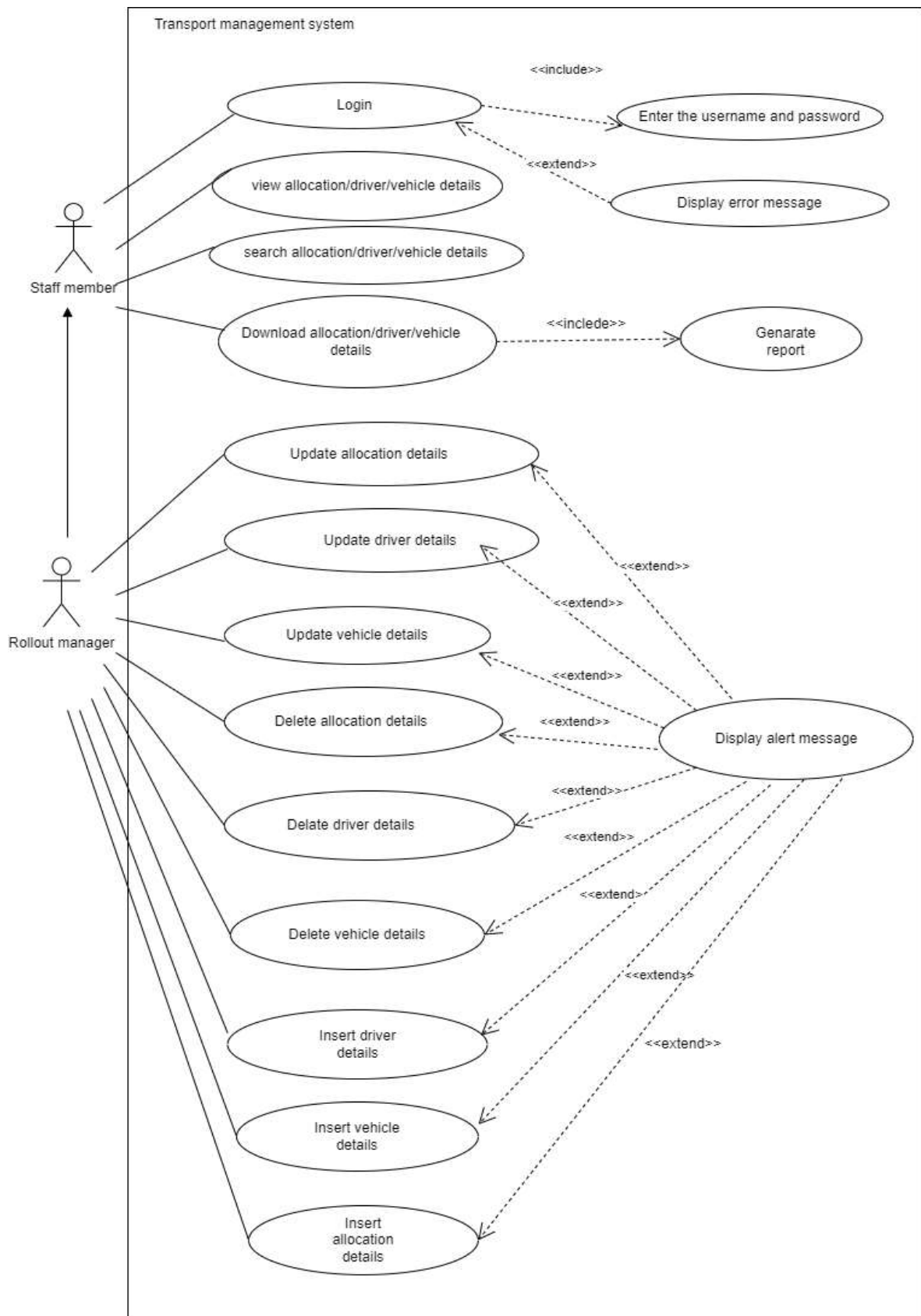


Figure 3-12 Transport use case diagram

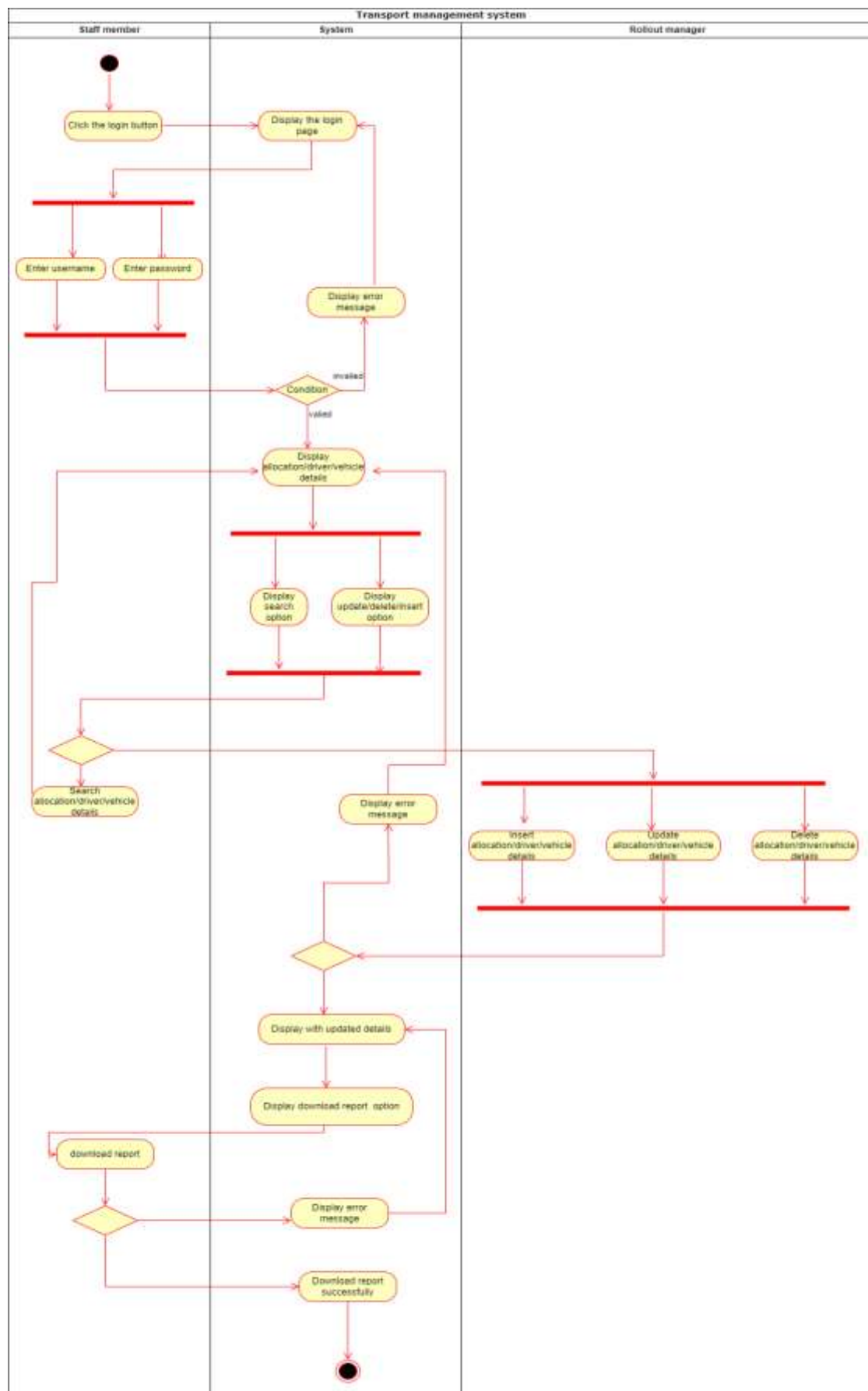


Figure 3-13Transport Activity diagram

10.6 Staff Management

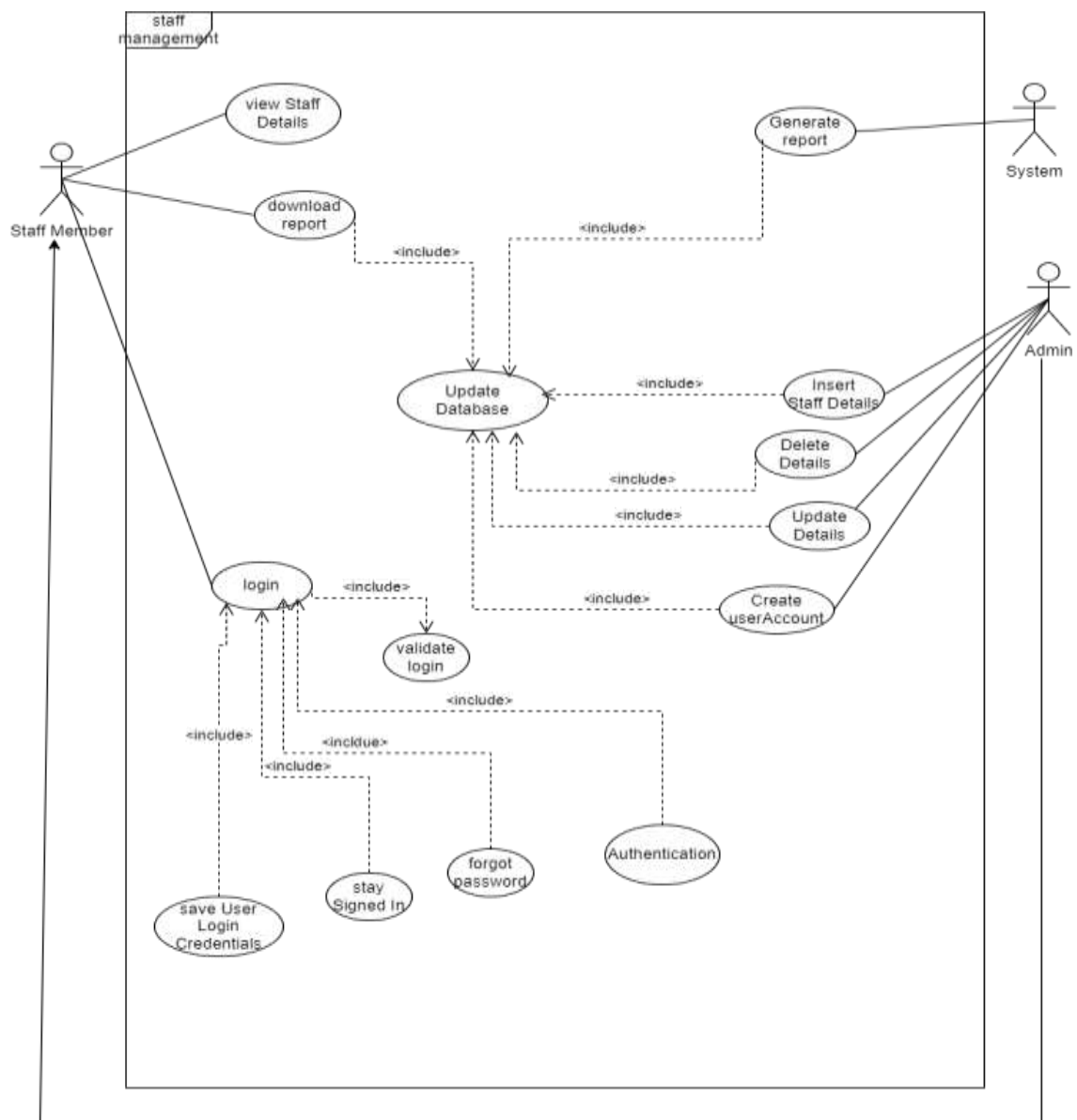


Figure 3-14 Staff use case diagram.

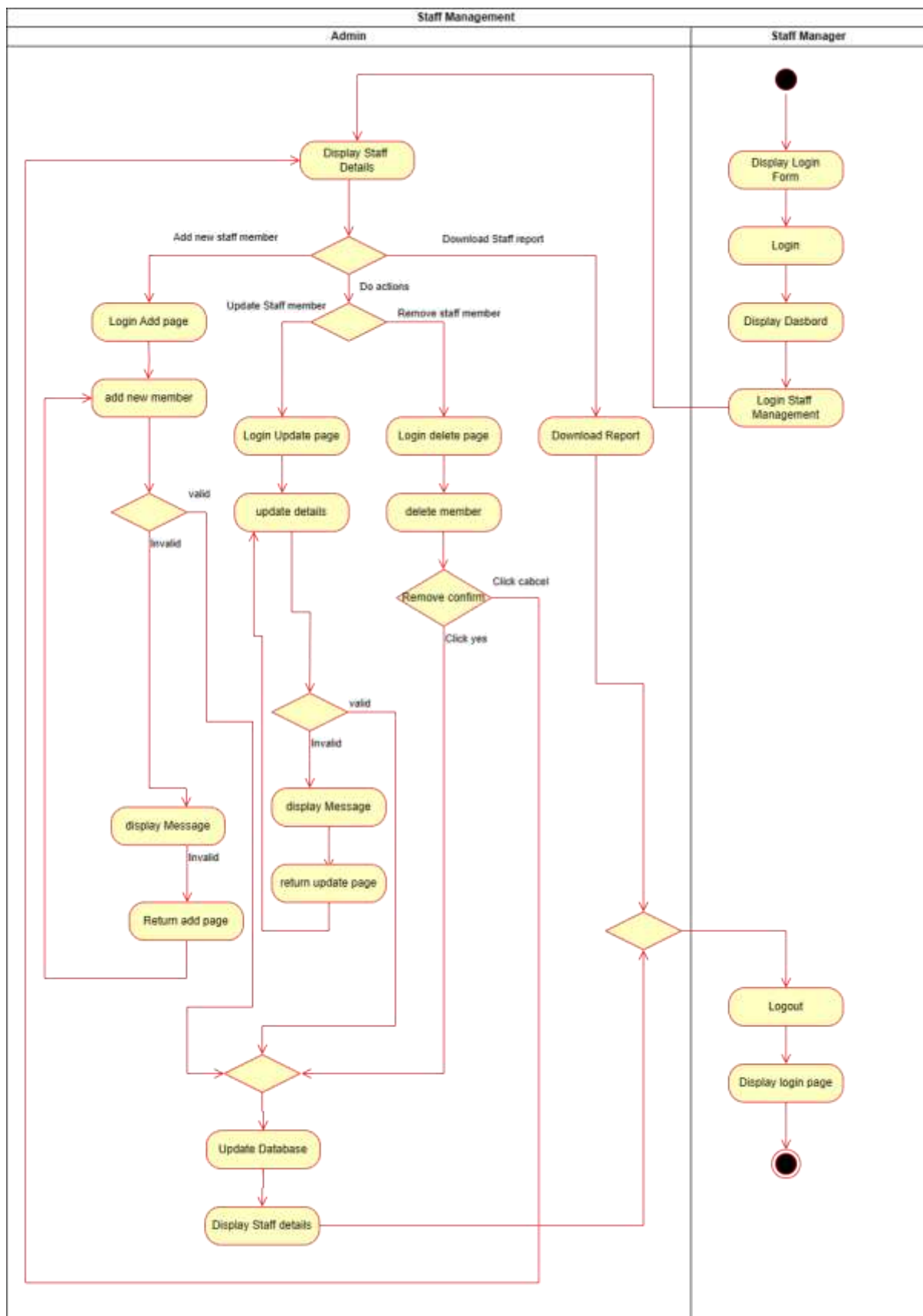


Figure 3-15 Staff Activity diagram

10.7 Document Management

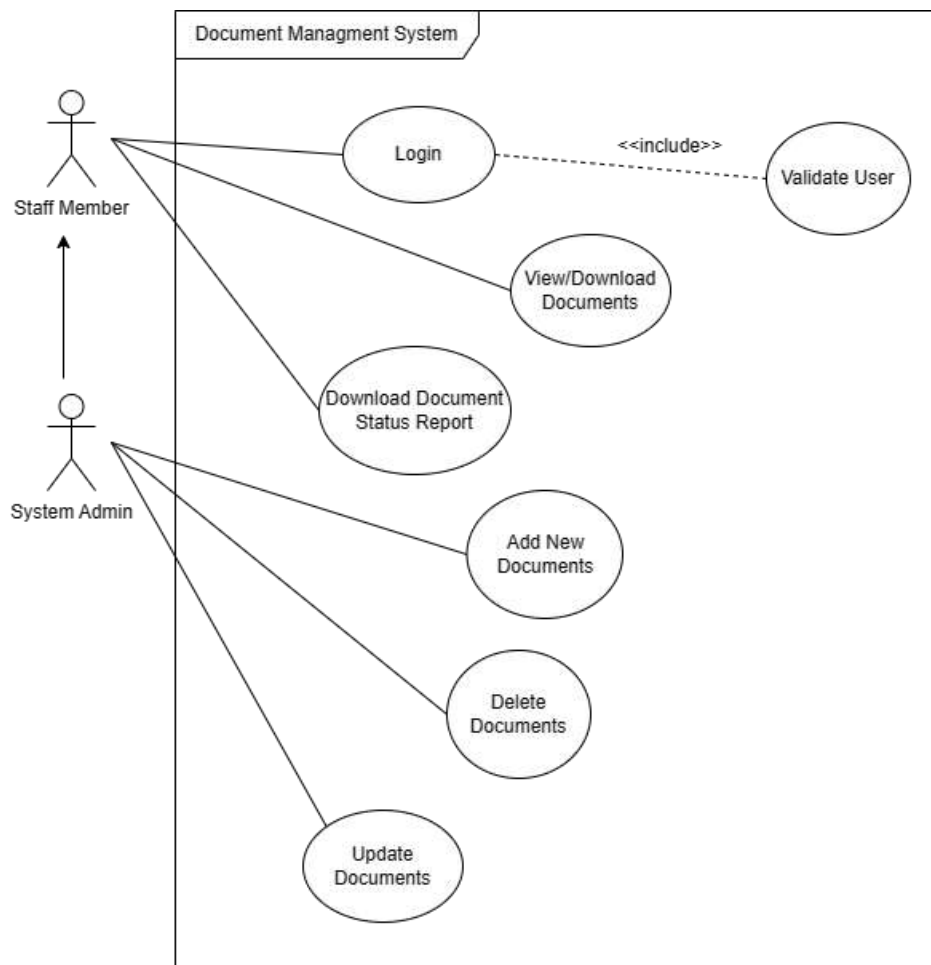


Figure 3-16 Document use case diagram.

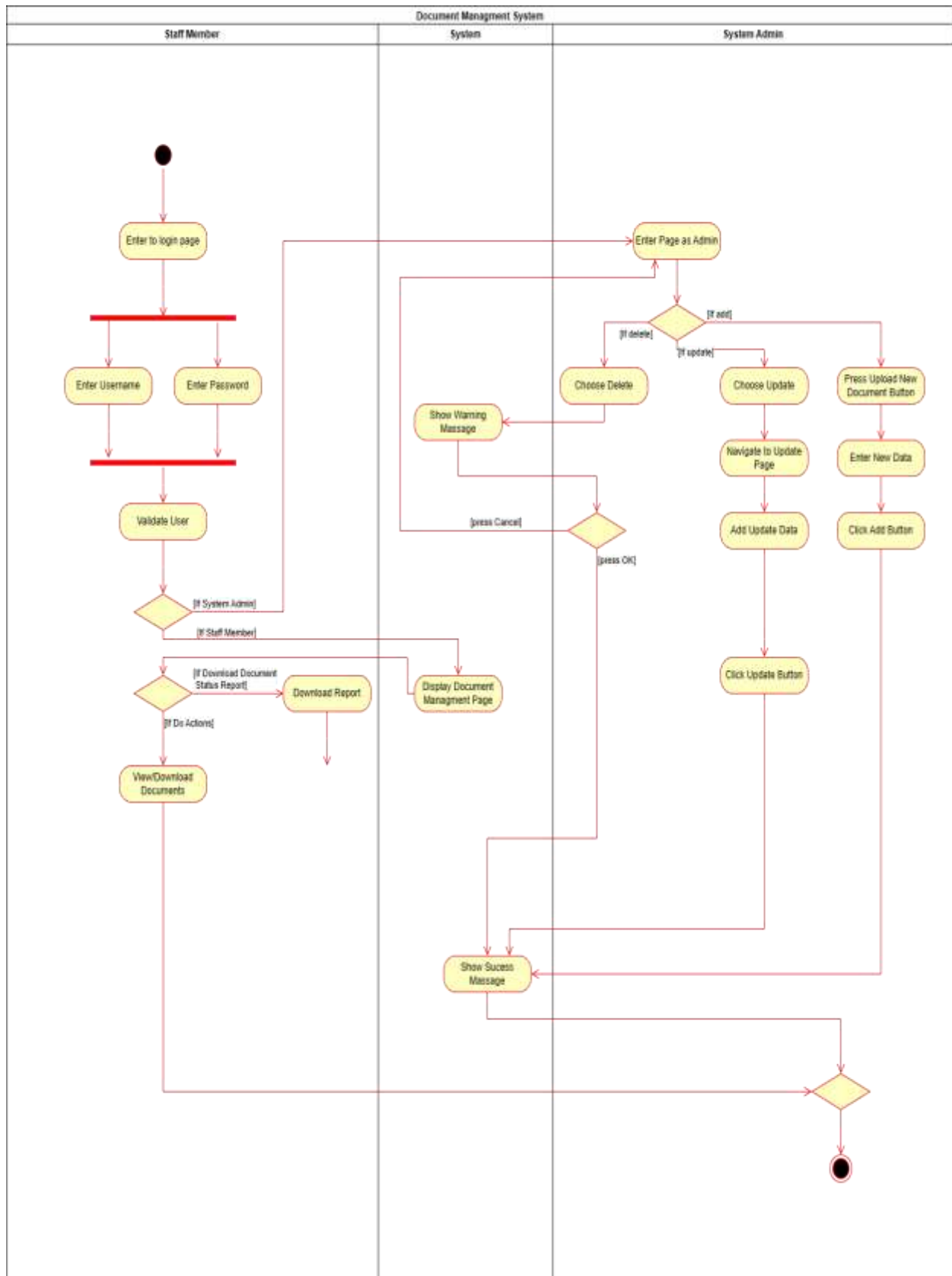


Figure 3-19 Document Activity diagram

Collection Name	Documents	Logical Data Size	Avg Document Size	Storage Size	Indexes	Index Size	Avg Index Size
actualpoamounts	10	1.71KB	175B	36KB	2	72KB	36KB
allocations	5	853B	171B	36KB	1	36KB	36KB
budgetpoamounts	15	2.71KB	181B	36KB	3	108KB	36KB
cashcollections	3	532B	178B	36KB	1	36KB	36KB
checklists	0	0B	0B	4KB	1	4KB	4KB
civilinfos	7	1.19KB	171B	36KB	1	36KB	36KB
clients	5	671B	135B	36KB	1	36KB	36KB
contactstoffs	3	495B	165B	36KB	6	216KB	36KB
contractors	3	571B	191B	36KB	1	36KB	36KB

Figure 3-17 MongoDB Database

9. Processes

A financial management system process is a group of actions and procedures used to efficiently manage the financial assets of a company. Finance executive, Project manager and Business Developer are actors in this function. Only the finance executive can add new finance data, update and delete data finance data. All three actors can access this function.

This function divided by eight part. There are Budget Po amount, Actual Po Amount, Invoice Amount, Cash Collection, Material Payment, Labor Payment, Other Payment and Total Expense. This function base on the site vise. Search the site and display the relevant site details.

Finance executive, Project manager and Business Developer can download the report. This report included various information relevant eight part.

The contact information system has entered the contact details of the people who are connected outside the organization, i.e. client and contractor. The employees working in the organization can see these contact details. Only the admin has the ability to update and delete the information.

The Environment Health and Safety Management System function is responsible for establish the safety of employees and the neighboring environment at each site. The process begins with the System Admin, who enters the count of safety outfit used at each point. The System Admin has the capability to view, update, and delete this data as he/she want. This ensures that the safety goods force is accurate and up to date.

The other one is Safety Officer and that one has access to see the data entered by the System Admin. Safety Officer can search for specific site and view any more details about each site's safety conditions and outfit operation. The Safety Officer's main task is to estimate whether each point fulfills the minimal safety requirements. However, the Safety Officer can mark it as accepted, if a point meets the minimal safety conditions. In this case, a crack mark is automatically added, indicating that the site is biddable. On the other hand, if a point doesn't meet the minimum safety conditions, the Safety

Officer can declare it as similar, and an X mark is automatically added. Both the Safety Officer and the System Admin have the capability to download a published PDF version of the data.

The transport management process within the network tower management system involves several key steps to ensure efficient allocation and reporting of transport resources. Allocation: The system allows transport management staff to view the allocation of drivers and vehicles for different tasks or routes. This includes information such as the driver assigned, the vehicle being used, and the details of the specific allocation. Driver and Vehicle Details: Transport management staff can access comprehensive information about drivers and vehicles registered in the system. This includes driver profiles with their contact details, licenses, and experience, as well as vehicle specifications, registration details, and maintenance records. Rollout Manager's Responsibilities: The rollout manager, who oversees the entire transport management process, has the authority to update or delete allocation, driver, and vehicle details as needed. This enables them to make adjustments based on changing requirements, driver availability, or vehicle availability. Staff Search Capability: Every staff member utilizing the system has the ability to search for specific transport details. They can search for information such as driver availability, vehicle availability, previous allocations, or any other relevant parameters. This search functionality assists in making informed decisions regarding transport resource allocation. Report Generation: The system provides the option for staff members to generate transport details as reports. These reports can include various information, such as allocation history, driver performance, vehicle utilization, and overall transport efficiency. By downloading these reports, staff members can analyze data and identify areas for improvement or optimization within the transport management process.

In order to efficiently manage and organize information about the staff members of a company, a staff management system procedure is used. Staff member and admin are the actors in this function. All staff members can login to the staff management page. But they can't edit these details. Only the Admin can edit this function. Such as add new member, update details, delete member and download the report.

Search the unique details can get the relevant member details. The system provides the option for staff members to generate staff details as reports.

The Document Management System function is responsible for handling and safety of documents. The System Admins have the authority to update and delete this document's data as they want. This ensures the safety of documents. Also system admins can view document. Staff members only can view or download document. All users can download documents and document's status report as PDF.

Chapter 4. Testing – Test cases and results.

11 Network Tower Site Information Management System

Table 2 Test case for add new Ti Site Information

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Add new Ti site information.	
Test case ID: Test_001	Test case designed and executed by: Reg. No- IT21266300 Name- Bandara K.M.V.T
Test Priority (High/Medium/Low):	High
Test description: Add new Ti site information as a admin of the system	
Preconditions: User must be a registered as admin.	
Test Steps: Step 1: Navigate to the NTSIMS and select Ti Site Step 2: Select add new site button. Step 3: Fill out the empty fields as requested. Step 4: Click Submit button.	
Pass-conditions: Site ID and Site name must be unique (cannot be exist before)	

Table 3 Test case for update Ti Site Information

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Add new Ti site information.	
Test case ID: Test_002	Test case designed and executed by: Reg. No- IT21266300 Name- Bandara K.M.V.T
Test Priority (High/Medium/Low):	Medium

Test description: Update Ti site information as a admin of the system
Preconditions: User must be a registered as admin.
Test Steps: <p>Step 1: Navigate to the NTSIMS and select Ti Site</p> <p>Step 2 : Find site using site ID</p> <p>Step 2: Select actions and click update button.</p> <p>Step 3: Fill out the empty fields as requested.</p> <p>Step 4: Click Update button.</p>
Pass-conditions: Com In Plan must be future date (cannot be past date)

Table 4 Test case results for NTSIMS

Test ID	Test Inputs	Expected Outputs	Actual Output	Result (Pass / Fail)	Comment
Test_001	Site ID: BAN1233 Site Name: Aiwela_1 Tower Owner: Hutch Tower Height: 70 Status: Checked Manual: 20m Com In Plan: 30/01/2024 RanClus owner: Pubudu Province: Uva	Navigate to the ti site information table and show toss message site added successfully	Navigate to the ti site information table and show toss message site added successfully	Pass	Site added successfully
Test_001	Site ID: BAN1233 Site Name: Aiwela_1 Tower Owner: Hutch Tower Height: 70 Status: Checked Manual: 20m Com In Plan: 30/01/2024 RanClus owner: Pubudu Province: Uva	Show toss message "Site Is already exist"	Navigate to the ti site information table and show toss message site added successfully	Fail	Backend validation is not working correctly

Test_001	Site ID: H1234 Site Name: Homagama Tower Owner: Hutch Tower Height: 70 Status: Checked Manual: 20m Com In Plan: 30/01/2024 RanClus owner: Pubudu Province: Uva	Show toss message "Site ID Is not valid"	Show toss message "Site ID Is not valid"	Pass	Frontend validation working as expected
Test_002	Tower Owner: Dialog Tower Height: 70 Status: Checked Manual: 20m Com In Plan: 30/01/2022 RanClus owner: Pubudu Province: Uva	Show toss message "Site Com In Plan must be future date"	Show toss message "Site Updated Successfully"	Fail	Frontend validation of Com In Plan not working as expected
Test_002	Tower Owner: Dialog Tower Height: 70 Status: Checked Manual: 20m Com In Plan: 30/12/2023 RanClus owner: Pubudu Province: Uva	Show toss message "Site Updated Successfully"	Show toss message "Site Updated Successfully"	Pass	Site updated successfully

Table 4 Test case for add new Budget PO Amount in Finance Management

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Add new Budget Po (Purchase Orders) Amount. (Finance Management)	
Test case ID: Test_003	Test case designed and executed by: Reg. No- IT21266096 Name- Bandara R.M.D. L
Test Priority (High/Medium/Low):	High

Test description: Add new Budget Po (Purchase Orders) Amount as a Finance Executive of the system.	
Preconditions: User must be a registered as Finance Executive and Login to the system.	
Test Steps: Step 1: Login to system with username and password Step 2: Navigate to the Finance Dashboard Step 3: Select Budget Po Amount tab. Step 4: Search Site using site Name or Site ID. Step 5: Click add new finance button. Step 6: Fill input fields with relevant finance data. Step 7: Submit form with finance data. Step 8: Display Budget Po Amount Data successfully added message.	
Pass-conditions: For a given date, each finance data entry should have a unique time value.	

Table 5 Test case for update Budget PO Amount in Finance Management

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Update Budget Po (Purchase Orders) Amount. (Finance Management)	
Test case ID: Test_004	Test case designed and executed by: Reg. No- IT21266096 Name- Bandara R.M.D. L
Test Priority (High/Medium/Low):	High
Test description: Update Budget Po (Purchase Orders) Amount as a Finance Executive of the system.	
Preconditions: User must be a registered as Finance Executive and Login to the system.	
Test Steps: Step 1: Login to system with username and password Step 2: Navigate to the Finance Dashboard Step 3: Select Budget Po Amount tab.	

<p>Step 4: Search Site using site Name or Site ID.</p> <p>Step 5: Click relevant data set update button.</p> <p>Step 6: Change input fields with expected finance data.</p> <p>Step 7: Submit form with updated finance data.</p> <p>Step 8: Display Budget Po Amount successfully updated message.</p>
Pass-conditions: For a given date, each finance data entry should have a unique time value.

Table 6 Test case results for finance management in NTSIMS

Test ID	Test Inputs	Expected Outputs	Actual Output	Result (Pass / Fail)	Comment
Test_003	Site ID: Com1413 Site Name: Welimada Date&Time: 20/05/2023 10.00 A.M BudgetPoAmount: 2300.40	A new Budget PO (Purchase order) amount with other data should be added	A new Budget PO amount should be added and calculate total budget po amount of the relevant site	Pass	Add new Budget Po amount successfully
Test_003	Site ID: Com1413 Site Name: Welimada Date&Time: 20/05/2023 10.00 A.M BudgetPoAmount:	A new Budget PO amount should be added and calculate total budget po amount of the relevant site	Display Error message as "Input fields cannot be empty"	Fail	Frontend validation failing to detect empty input fields
Test_004	Site ID: Com1413 Site Name: Welimada Date&Time: 19/05/2023 08.00 A.M BudgetPoAmount: 4300.40	New Date with time and Budget Po Amount should be updated successfully	New Date with time and Budget PO amount should be updated and update total Budget PO amount of the relevant site	Pass	Updated Budget Po amount Data successfully
Test_004	Site ID: Com1413 Site Name: Welimada Date&Time: 19/05/2023 08.00 A.M BudgetPoAmount: 4300.40	New Date with time and Budget PO amount should be updated and update total Budget PO amount of the relevant site	Display Error message as "Same Date with time cannot be duplicated"	Fail	Backend validation failing to reject invalid data

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Add new contractor(Contractor Management)	
Test case ID: Test_020	Test case designed and executed by: Reg. No- IT21268830 Name- Chandrasena H.M.K.G.J.K
Test Priority (High/Medium/Low):	High
Test description: Add new contractor to the system as Admin.	
Preconditions: User must be a registered as Admin and Login to the system.	
Test Steps: Step 1: Login to system with username and password Step 2: Navigate to the Contractor dashboard. Step 3: Click add contractor button. Step 4: Fill all fields. Step 5: Submit form	
Pass-conditions: NIC number must be unique and valid type.	

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Edit contractor details(Contractor Management)	
Test case ID: Test_021	Test case designed and executed by: Reg. No- IT21268830 Name- Chandrasena H.M.K.G.J.K
Test Priority (High/Medium/Low):	High
Test description: Edit contractor details and store new details to database as Admin.	
Preconditions: User must be a registered as Admin and Login to the system.	
Test Steps: Step 1: Login to system with username and password	

<p>Step 2: Navigate to the Contractor dashboard.</p> <p>Step 3: Search contractor.</p> <p>Step 4: Click edit Button.</p> <p>Step 5: Change contractor details and submit.</p>
Pass-conditions: NIC number must be unique and valid type.

Test ID	Test Inputs	Expected Outputs	Actual Output	Result (Pass / Fail)	Comment
Test_020	Site ID: BAN1233 Site Name: Aiwela_1 Name: Janith Kaushalya NIC:200132588339 Phone:0703733960	Contractor details add to database and show toast message Contractor added successfully	Contractor details add to database and show toss message Contractor added successfully	Pass	Contractor added successfully
Test_020	Site ID: BAN1233 Site Name: Aiwela_1 Name: Janith Kaushalya NIC:2001325883 Phone:0703733960	Show toast message "Enter valid NIC"	Data stored in database	Fail	Validation is not working correctly
Test_021	Site ID: BAN1233 Site Name: Aiwela_1 Name: Kaushalya NIC:200132500378 Phone:0703733960	Show toast message "Update successfully" and navigate table	Show toast message "Update successfully" and navigate table	Pass	Edit successfully
Test_021	Site ID: BAN1233 Site Name: Aiwel Name: Janith Kaushalya NIC:2001325883 Phone:0703733960	Show toss message "Site Com In Plan must be future date"	Show toss message "Updated Successfully"	Fail	Backend validation is not working correctly.

Table 5 Test case for add new Safety Data

Project ID: ITP2023_Y2_S2_B01_G08

Project Name: Network Tower(site) Management System	
Testing function: Add new Safety Data	
Test case ID: Test_0010	Test case designed and executed by: Reg. No- IT21298158 Name- Kiriwaththuduwa K.C.N
Test Priority (High/Medium/Low):	High
Test description: Add new Safety Data as an admin of the system.	
Preconditions: User must be a registered as admin.	
Test Steps: Step 1: Login to system with username and password Step 2: Navigate to the Environment Health & Safety Dashboard Step 3: Click Add New Safety Button Step 4: Add relevant data to insert form as requested. Step 5: Submit form by clicking submit button Step 6: Display Budget Po Amount successfully updated message.	
Pass-conditions: User should have an admin login.	

Table 6 Test case for update safety data

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Update Safety Data	
Test case ID: Test_0011	Test case designed and executed by: Reg. No- IT21298158 Name- Kiriwaththuduwa K.C.N
Test Priority (High/Medium/Low):	Medium
Test description: Update Safety Data as an admin of the system.	
Test Steps: Step 1: Login to system with username and password Step 2: Navigate to the Environment Health & Safety Dashboard	

Step 3: Click Action Button
Step 3: Click Update
Step 4: Navigate to Safety Update Page
Step 5: Add relevant data to update form.
Step 6: Click Submit
Pass-conditions: User should have an admin login.

Table 3 Test case for Accept/Reject site safety

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Accept Site Safety	
Test case ID: Test_0012	Test case designed and executed by: Reg. No- IT21298158 Name- Kiriwaththuduwa K.C.N
Test Priority (High/Medium/Low):	High
Test description: Accept Safety Data as the Safety Officer of the system.	
Test Steps: Step 1: Login to system with username and password Step 2: Navigate to the Environment Health & Safety Dashboard Step 3: Click Action Button Step 3: Click View More button. Step 4: Navigate to Safety Status Page Step 5: Click Accept Button	
Pass-conditions: User should have an admin login as Safety Officer.	

Table 4 Test case results for NTSIMS

Test ID	Test Inputs	Expected Outputs	Actual Output	Result (Pass / Fail)	Comment
Test_0010	Site ID: SIT01 Site Name: Jaffna	Show successful message and same	Show successful message and	Pass	Safety Data added successfully

	Safety Helmets:5 Safety Jackets:5 Safety Gloves:10 Safety Shoes:10 Safety Harness:5 Caution Boards:5	time navigate to the View Safety page	same time navigate to the View Safety page		
Test_0010	Site ID: SIT02 Site Name: Jaffna Safety Helmets:5 Safety Jackets:5 Safety Gloves:10 Safety Shoes: Safety Harness:5 Caution Boards:	Show warning message as "Some Important Data are Missing"	Show successful message and same time navigate to the View Safety page	Fail	Data Inserted. That means Front End Validation is not working correctly
Test_0010	Site ID: SIT01 Site Name: Jaffna Safety Helmets:5 Safety Jackets:5 Safety Gloves:10 Safety Shoes:10 Safety Harness:5 Caution Boards:5	Show warning message as "Site Data already Added"	Show warning message as "Site Data already Added"	Pass	Frontend validation working as expected
Test_0011	Site ID: SIT01 Site Name: Jaffna Safety Helmets:5 Safety Jackets:5 Safety Gloves:10 Safety Shoes:10 Safety Harness:10 Caution Boards:10	Show message as "Safety Data Updated Successfully"	Show message as "Safety Data Updated Successfully"	Pass	Successfully Updated pre inserted data
Test_0011	Site ID: SIT01 Site Name: Jaffna Safety Helmets:5 Safety Jackets:5 Safety Gloves:10 Safety Shoes:10 Safety Harness:0 Caution Boards:0	Show warning message "Some Important Data Are Empty"	Show warning message "Some Important Data Are Empty"	Pass	Data wouldn't be 0 So, Front end Validation Working Successfully.
Test_0012	Click 'Accept' button	Automatically add tick icon to the relevant site in View Site Page	Navigate to View Safety page & automatically add tick icon to the relevant site in View Site Page	Pass	Successfully Accept Site as safety site by Safety Officer

15.5 Contact information System

Project ID: ITP2023_Y2_S2_B01_G08

Project Name: Network Tower(site) Management System	
Testing function: Add new client contact details.	
Test case ID: Test_005	Test case designed and executed by: Reg. No- IT21355882 Name- Chamodya W.A.H
Test Priority (High/Medium/Low):	Medium
Test description: This will test if an admin can add contact details successfully	
Preconditions: User must be registered as an admin.	
Test Steps: Step 1: Admin must login to the system. Step 2 : Navigate the contact page. Step 3: Click the “Add client” button. Step 3: Fill the form according to the validation. Step 4: Click the “Add” button and add the client.	
Pass-conditions: When the client adds successfully, then a popup message will display “Add successfully”.	

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Update client contact details.	
Test case ID: Test_006	Test case designed and executed by: Reg. No- IT21355882 Name- Chamodya W.A.H
Test Priority (High/Medium/Low):	Medium
Test description: This will test if an admin can update contact details successfully	
Preconditions: User must be registered as an admin.	
Test Steps: Step 1: Admin must login to the system. Step 2 : Navigate the contact page.	

<p>Step 3: Click the “Update” button.</p> <p>Step 3: Update the form according to the validation.</p> <p>Step 4: Click the “Update” button and update the client.</p>
<p>Pass-conditions: When the client adds successfully, then a popup message will display “update successfully”.</p>

Test ID	Test Inputs	Expected Outputs	Actual Output	Result (Pass / Fail)	Comment
Test_005	ClientID: C001 Name: Rahul Phone: 0785426391 Address: Colombo Email: rahul@gmail.com	New contact details should be added.	New contact details should be added.	Pass	Add data successfully.
Test_005	ClientID: C001 Name: Rahul Phone: 0785426391 Address: Colombo Email: rahul@gmail.com	New contact details should be added	Display error message as “Input fields can’t be duplicate”.	Fail	Front end validation failing to detect empty input fields.
Test_006	ClientID: C001 Name: Rahul Phone: 0785255892 Address: Kandy Email: rahul@gmail.com	New contact data should be updated successfully.	New contact data should be updated successfully.	Pass	Update data successfully.
Test_006	ClientID: C001 Name: Rahul Phone: 0785255892 Address: Kandy Email: rahul@gmail.com	New contact data should be updated successfully.	Display error message as “Input fields can’t be empty”.	Fail	Backend validation failing to reject invalid data

15.6 Transport Management System

Project ID: ITP2023_Y2_S2_B01_G08

Project Name: Network Tower(site) Management System	
Testing function: Add new Driver details.	
Test case ID: Test_007	Test case designed and executed by: Reg. No- IT21238444 Name- Wimalarathna D.M.A.T.
Test Priority (High/Medium/Low):	High
Test description: Add new Driver details as rollout manager of the system.	
Preconditions: User must be registered as Rollout manager and login to the system.	
Test Steps: Step 1: Login to the system with username and password. Step 2: Navigate the transport dashboard. Step 3: Select the driver tab. Step 4: Select the add driver button. Step 5: Fill input field with correct data. Step 6: Submit filled data. Step 7: Display driver details added successfully by a message.	
Pass-conditions: License number and NIC must be unique.	

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Update driver details in system.	
Test case ID: Test_008	Test case designed and executed by: Reg. No- IT21238444 Name- Wimalarathna D.M.A.T.
Test Priority (High/Medium/Low):	High
Test description: Update driver details as rollout manager.	
GPreconditions: User must be registered as Rollout manager and login to the system.	
Test Steps: Step 1: Login to system with username and password Step 2: Navigate to the Transport dashboard. Step 3: Select the driver tab. Step 4: select action button. Step 5: Click the update button. Step 6: Change input fields with expected driver details.	

<p>Step 7: Submit form with updated driver details.</p> <p>Step 8: Display driver details updated successfully by a message.</p>
<p>Pass-conditions: License number and NIC must be unique.</p>

Test ID	Test Inputs	Expected Outputs	Actual Output	Result (Pass / Fail)	Comment
Test_007	Name: Nimal License Number: B300 154 NIC:895437592V Address: 154, Malabe, Kaduwela Phone:0725927503 Email: nimal@gmail.com	A new driver details should be added	A new driver details should be added	Pass	Add new driver details successfully
Test_007	Name: Kamal License Number: NIC:753448249V Address:	A new driver details should be added	Display Error message as "Input fields cannot be empty"	Fail	Frontend validation failing to detect empty input fields

	Phone:0771237654 Email: kamal@gmail.com				
Test_00 8	Name: Nimal License Number: B300 154 NIC:895437592V Address:22, Kandy Phone:0703851696 Email: nimal@gmail.com	New address and phone should be updated successfully	New address and phone should be updated successfully	Pass	Updated driver details data successfully
Test_00 7	Name: Perera License Number: B487 654 NIC: 753448249V Address: pothuhara, Kurunegala Phone:0773740847 9 Email: perera@gmail.com	A new driver details should be added	Display Error message as "Data cannot be duplicated"	Fail	Backend validation failing to reject invalid data

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Add new member details	
Test case ID: Test_00	Test case designed and executed by: Reg. No- IT21700156 Name- Nanayakkara A.A.R.
Test Priority (High/Medium/Low):	High
Test description: The admin adds the new member's data.	
Preconditions: User must be registered as admin.	
Test Steps: Step 1: Must login to the system. Step 2: click the staff management on the home page. Step 3: click the “Add new member” button. Step 4: Add member. Step5: click “submit” button in add page.	
Pass-conditions: NIC Staff Id, Email and phone must be unique (cannot be exist befo	

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Update member details	
Test case ID: Test_010	Test case designed and executed by: Reg. No- IT21700156 Name- Nanayakkara A.A.R.
Test Priority (High/Medium/Low):	High
Test description: The admin updates the new member's data.	
Preconditions: User must be registered as admin.	
Test Steps: Step 1: Must login to the system. Step 2: click the staff management on the home page. Step 3: click "Update". Step 4: Update member details. Step5: click "submit" button in update page.	
Pass-conditions: NIC Staff Id, Email and phone must be unique. (Cannot be exist before)	

Test ID	Test Inputs	Expected Outputs	Actual Output	Result (Pass / Fail)	Comment
Test_009	EmployeeName: Nuwan Staff Id:1000 Email: nuwan@gmail.com Telephone number: 563422123 NIC: 478476947V Position: Staff Team: Rollout Team	A new member should be added.	A new member should be added.	Pass	Display successful message.
Test_009	EmployeeName: Nuwan Staff Id:1000 Email: nuwan@gmail.com Telephone number: 563422123 NIC: 478476947V Position: Staff Team: Rollout Team	A new member should be added.	Display Error message as "Input fields cannot be empty"	Fail	Front end validation failing to detect empty input fields.
Test_010	EmployeeName: Nuwan Staff Id:1000 Email: nuwan@gmail.com Telephone number: 563422123 NIC: 478476947V Position: Staff Team: Rollout Team	The new member details should be updated.	The new member details should be updated.	Pass	Display successful message.
Test_010	EmployeeName: Nuwan Staff Id:1000 Email: nuwan@gmail.com Telephone number: 563422123 NIC: 478476947V Position: Staff Team: Rollout Team	The new member details should be updated.	Display Error message as "Input fields cannot be empty".	Fail	Backend validation failing to reject invalid data.

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Add new document details	
Test case ID: Test_012	Test case designed and executed by: Reg. No- IT21220388 Name- Senadheera W.D.N.D.
Test Priority (High/Medium/Low):	High
Test description: The admin adds new document's data.	
Preconditions: User must be registered as admin.	
Test Steps: Step 1: Must login to the system. Step 2: click the document management on the home page. Step 3: click the “Upload new document” button. Step 4: Upload new document. Step 5: click “Upload” button in add page.	
Pass-conditions: User must have admin login	

Project ID: ITP2023_Y2_S2_B01_G08	
Project Name: Network Tower(site) Management System	
Testing function: Update document details	
Test case ID: Test_014	Test case designed and executed by: Reg. No- IT21220388 Name- Senadheera W.D.N.D.
Test Priority (High/Medium/Low):	High
Test description: The admin updates new document's data.	
Preconditions: User must be registered as admin.	
Test Steps: Step 1: Must login to the system. Step 2: click the document management on the home page. Step 3: click the “Update” button. Step 4: Update document details. Step 5: click “Submit” button in update page.	
Pass-conditions: User must have admin login.	

Test ID	Test Inputs	Expected Outputs	Actual Output	Result (Pass / Fail)	Comment
Test_012	Site ID: C001 Site Name: Colombo Status: Pending	New document details should be added.	New contact details added.	Pass	Data added successfully.
Test_012	Site ID: C001 Site Name: Colombo Status: Pending	New document details should be added.	Display error message as "Input fields can't be duplicate".	Fail	Front end validation failing to detect empty input fields.
Test_014	Site ID: C001 Site Name: Colombo Status: Approved	New document data should be updated successfully.	New document data should be updated successfully.	Pass	Data updated successfully.
Test_014	Site ID: C001 Site Name: Colombo Status: Approved	New document data should be updated successfully.	Display error message as "Input fields can't be empty".	Fail	Backend validation failing to reject invalid data

Chapter 5. Evaluation and Conclusion

Evaluation

Evaluation is a vital part of our Network Tower Management System design. It allows us to assess the system's performance, effectiveness, and quality to ensure that it meets the client's conditions. We break down the evaluation into different orders. First, we set up objects to estimate the overall quality and performance of the system. We conduct tests to ensure that the system meets the client's conditions. Next, we use various styles to test the system in real-life scripts. We collect data from these tests to see how well the system performs. The client, the director, and the company's workers are involved in this process.

We estimate the system, examining each functionality to ensure it works well together. This includes network tower information management, finance management, contractor information management, environmental health and safety management, contact information systems, transport management, staff management, and document management. The evaluation process happens in two phases. In the first

phase, we estimate the system after completing it and integrating all its corridors. In the alternate phase, we hand over the system to the client for their evaluation. Based on the evaluation results, we assess the system and gather feedback from the client and workers. We consider their satisfaction a major criterion for evaluation.

We use different technologies and tools to estimate the system, including automated testing tools like Postman and Rest Client, data logical tools like Google Analytics, virtualization tools like VirtualBox, and user feedback tools like SurveyMonkey.

Overall, our evaluation aims to ensure the Network Tower Management System's success by meeting objectives, incorporating user feedback, and exercising innovative tools.

Lessons we learnt.

When we evaluate our project, it gave us valuable lessons for us. Significance of setting clear objectiveness, conducting testing, collaboration of each others are some of them. Clear objectiveness means that our project remains focused and aligned with customer prospects.

Comprehensive testing helps us to identify weaknesses, strengths and areas of that we must improve. The other fact is collaborating, handling and well connect with client, team members. Because they are the main roles that we engage each other's. That was the main think that we learnt from this. Without these we wouldn't complete the whole project.

Conclusion

The design of the Network Tower Management System has been an instigative trip of invention, cooperation, and success. Our evaluation process has been necessary in assessing the system's performance, effectiveness, and overall quality. Through careful testing and analysis, we've achieved the design's objectives and delivered a high-quality system that aligns with the customer's vision.

Our evaluation was organized into five crucial areas: objects, styles, compass, timing, and affair. By completely assessing the system's quality and performance, we ensured it met the customer's conditions.

By testing colorful real-life scripts, we gained precious perceptivity into how druggies interact with the system, its capabilities, and its responsiveness. Each functionality, from network tower information management to staff management, was examined to ensure flawless integration.

Timing played a pivotal role, with the system being estimated in two phases. In the first phase, we assessed the system after its completion, describing its integration and functionality as a unified reality.

In the alternate phase, the customer conducted their own evaluation, beginning their journey of perception and satisfaction. The impact of our evaluation process has been inestimable in shaping the final outgrowth of the Network Tower Management System. Through qualitative assessments and feedback from the customer and company workers, we gained a deeper understanding of their satisfaction and identified areas for enhancement. This iterative approach allowed us to upgrade the system and ensure it met the customer's expectations.

We employed innovative technologies and tools such as automated testing, data analytics, virtualization, and stoner feedback platforms to enhance our evaluation process. These tools gave precise measures, converted raw data into meaningful perceptivity, and engaged stakeholders in the evaluation trip.

In conclusion, the Network Tower Management System design has successfully delivered a high-performing, effective, and quality system. Our comprehensive evaluation process ensured the design's objectives were met. Through close collaboration with the customer and the use of slice-edge technologies, we not only met their conditions but also exceeded their prospects.

The success of this design reflects our commitment to excellence and our fidelity to furnishing innovative results. As we wrap up this chapter, we're agitated to see the Network Tower Management System thrive. It'll empower our customers with better effectiveness, streamlined operations, and a solid foundation for unborn growth.

8) References

- [1] IEEE, "IEEE Standard for Software and System Engineering," in *IEEE Standard for Software and System Engineering*, New York, NY, USA, IEEE, 2005.
- [2] e. telco, "https://www.engnuitelco.com," 2018. [Online]. Available: <https://www.engnuitelco.com/about-us/>.
- [3] Y. Zeng, Y. Huang, and D. D. Feng, "Design and Implementation of Network Security Management System Based on MVC Framework," 2018 IEEE International Conference on Cybersecurity and Computer Science (ICCCS), Hefei, China, 2018, pp. 121-125.
- [4] C. A. Gan and K. E. Chong, "Robustness and Reliability Requirements for SCADA Systems in Oil and Gas Industry," 2018 IEEE International Conference on Progress in Informatics and Computing (PIC), Singapore, 2018, pp. 1-6.

- [5] S. Lee, Y. Lee, and H. Moon, "Design and Implementation of Large-Scale Asset Management System with Scalable Architecture," 2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Macao, China, 2019, pp. 1198-1202.
- [6] H. U. Kim, T. Kwon, and K. Kim, "Performance Evaluation of Energy Management System in Smart Building Using Hybrid Modeling," 2020 IEEE International Conference on Smart Energy Systems and Technologies (SEST), Guangzhou, China, 2020, pp. 120-125.
- [7] M. Zhang, J. Hu, and J. Huang, "Design and Implementation of a User-Friendly and Customizable Mobile Health Monitoring System," 2019 IEEE International Conference on Smart Health (ICSH), Beijing, China, 2019, pp. 26-31.
- [8] D. R. Bandara, S. Seneviratne, and C. S. Wijayarathna, "A Systematic Mapping Study on Mobile Web Compatibility Testing," 2019 IEEE 21st International Conference on High Performance Computing and Communications; IEEE 17th International Conference on Smart City; IEEE 5th International Conference on Data Science and Systems (HPCC/SmartCity/DSS), Zhangjiajie, China, 2019, pp. 115
- [9] S. S. Salgado and E. J. Barreto, "Maintainability Analysis of Software Systems Using Metrics and Visualization," 2019 IEEE 27th International Conference on Program Comprehension (ICPC), Montreal, QC, Canada, 2019, pp. 221-225.
- [10] R. E. Simpson, "Meeting Cybersecurity Challenges in the Age of the Internet of Things," 2019 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), Atlanta, GA, USA, 2019, pp. 266-273.
- [11] *UML diagram tool / Microsoft Visio*, <https://www.microsoft.com/en-us/microsoft-365/visio/uml>.
- [12] J. H. Kim and C. Y. Park, "Design and implementation of a secure data management system for financial big data," *Journal of Supercomputing*, vol. 74, no. 11, pp. 5596-5612, Nov. 2018. doi: 10.1007/s11227-018-2393-6
- [13] S. H. Son and S. S. Lee, "Robustness and Reliability of Cloud Computing Systems," *IEEE Transactions on Services Computing*, vol. 6, no. 2, pp. 173-184, Apr.-Jun. 2013.
- [14] J. Dean and S. Ghemawat, "MapReduce: Simplified Data Processing on Large Clusters," *Communications of the ACM*, vol. 51, no. 1, pp. 107-113, Jan. 2008.

- [15] M. Armbrust, A. Fox, R. Griffith, A. D. Joseph, R. H. Katz, A. Konwinski, G. Lee, D. A. Patterson, A. Rabkin, I. Stoica, and M. Zaharia, "A View of Cloud Computing," *Communications of the ACM*, vol. 53, no. 4, pp. 50-58, Apr. 2010.
- [16] S. S. Kim, "A Study on the Usability of e-Learning Systems for Financial Education," *IEEE Transactions on Education*, vol. 54, no. 2, pp. 169-178, May 2011.
- [17] J. L. Whipple, J. Y. Wong, J. A. Isaacs, D. S. Katz, D. S. Katz, S. M. Saini, and S. A. Teukolsky, "Enabling High-Performance Data Analysis Through Compatible Middleware," *IEEE Internet Computing*, vol. 13, no. 5, pp. 42-50, Sep.-Oct. 2009.
- [18] T. H. Tse, "Designing Maintainable Software Systems," *IEEE Software*, vol. 30, no. 3, pp. 80-84, May/Jun. 2013
- [19] W. Zhao, W. Li, H. Li, and L. Tian, "Ensuring Data Integrity in Cloud Computing," *IEEE Internet Computing*, vol. 16, no. 5, pp. 14-22, Sep./Oct. 2012.
- [20] M. Abadi, M. Budiu, U. Erlingsson, and J. Ligatti, "Control-Flow Integrity: Principles, Implementations, and Applications," *ACM Transactions on Information and System Security*, vol. 13, no
- [21] A. Prasad, S. R. Rayaprolu, M. K. Tiwari, and N. P. Mahalik, "Cloud Based Accounting Information System," in *2015 International Conference on Computational Intelligence and Communication Networks (CICN)*, 2015, pp. 682-685. doi: 10.1109/CICN.2015.157
- [22] MongoDB, "What is MongoDB?" [Online]. Available: <https://www.mongodb.com/what-is-mongodb>.
- [23] Express, "Express - Node.js web application framework" [Online]. Available: <https://expressjs.com/>
- [24] React, "React – A JavaScript library for building user interfaces" [Online]. Available: <https://reactjs.org/>
- [25] Node.js, "Node.js" [Online]. Available: <https://nodejs.org/>
- [26] A. N. Aliasghari, H. R. Fakharzadeh, and H. Khodabandehl
- [27] AirView Xecute - Tower Management Software, AirViewXecute, accessed Feb. 25, 2023. [Online]. Available: <https://airviewxecute.com/>
- [28] Sitetracker - Tower Management Software, Sitetracker, accessed Feb. 25, 2023. [Online]. Available: <https://www.sitracker.com/>.

- [29] "Tower Management Software," Inforzech, accessed Feb. 25, 2023. [Online]. Available: <https://www.inforzech.com/tower-management-software/>
- [30] Expert Metal Fabrication Services on the Gold Coast | POSTEEZY. <https://posteezy.com/expert-metal-fabrication-services-gold-coast>
- [31]FingerprintTime Attendance Access Control System. <https://www.linkedin.com/pulse/fingerprint-time-attendance-access-control-system-ampletrails>
- [32] Schwartz, Mathew, and Philippe Dixon. "The Effect of Subject Measurement Error on Joint Kinematics in the Conventional Gait Model: Insights from the Open-Source PyCGM Tool Using High Performance Computing Methods." PLoS One, vol. 13, no. 1, Public Library of Science, Jan. 2018, p. e0189984.
- [33]Environment,HealthandSafetyManagementSystemManualAT&T.
<https://about.att.com/ecms/dam/csr/PDFs/ATT-EHS-MS-Manual.pdf>
- [34] "Uzbekistan : The System of Agricultural Digitization Has Been Introduced in Vobkent District." MENA Report, Albawaba (London) Ltd., June 2021.
- [35] The Ultimate Guide to Route Optimisation: Strategies and Techniques.<https://solbox.it/the-ultimate-guide-to-route-optimisation-strategies-and-techniques/>
- [36] Staffing - Warehouse Associate - Hiring Now at Spectraforce<https://grabjobs.co/us/job/full-time/warehousing/staffing-warehouse-associate-hiring-now-18757926>
- [37]I Will Develop A Courier Shipping Cargo Website With Tracking For You
<https://ww.nairaland.com/6162628/develop-courier-shipping-cargo-website>
- [38] UML diagram tool | Microsoft Visio. <https://www.microsoft.com/en-us/microsoft-365/visio/uml>

Appendix A

Work Breakdown Structure

	Student ID	Name with Initials	Work Allocated
1	IT21266300	Bandara K.M.V.T	Design Final document, Acknowledgment, Literature review, Non-Functional requirements (All the charts, descriptions, test cases and result of NTSIM System)
2	IT21266096	Bandara R.M.D.L.	Solution Overview, Problem and Motivation, Test cases of finance management
3	IT21268830	Chandrasena H.M.K.G.J.K.	Design
4	IT21298158	Kiriwaththuduwa K.C.N.	Methodology, Test cases of environment health and safety management system
5	IT21355882	Chamodya W.A.H.	Abstract, Class diagram, Test case of contact information system
6	IT21238444	Wimalarathna D.M.A.T.	Stakeholder analysis, class diagram, Er diagram, Test case of transport management system
7	IT21700156	Nanayakkara A.A.R.	Class diagram, Er diagram, Process, Test cases of staff management system
8	IT21220388	Senadheera W.D.N.D.	Evaluation and Conclusion, Test cases of document management system