Sri Lanka Institute of Information Technology

Project Proposal

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Network Tower (Site) Management System

for

Engenuity Telco Pvt Ltd

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1) Background

Figure 1.Engnuity Telco Pvt Limited logo

Engnuity Telco Pvt Limited is a telecommunications company based in Sri Lanka that offers services to mobile network operators, tower companies, and other telecom infrastructure providers. Its services include tower construction and maintenance, site acquisition, power management, network optimization, and network planning and design. In addition, Engnuity Telco provides a comprehensive suite of software solutions, such as network performance management, site management, and network analytics. The company's objective is to provide its clients with dependable, high-quality, and cost-effective telecom infrastructure solutions, enabling them to provide superior connectivity and communication services to their customers. [2]

One of the key strengths of Engenuity Telco Pvt Ltd is its commitment to delivering high-quality services that are tailored to meet the unique needs of [30] its clients. This is achieved through a team of experienced professionals who are well-versed in the latest telecommunication technologies and trends. By leveraging its expertise in tower management, network planning, and infrastructure development, Engenuity Telco Pvt Ltd has become a trusted partner for telecom operators, government agencies, and businesses across Sri Lanka.

Overall, Engenuity Telco Pvt Ltd is one of the leading telecommunications companies in Sri Lanka with a proven track record of providing high-quality services to a diverse client base. Because of its tower management, network planning, and infrastructure development expertise, the company is a trusted partner for telecom operators, government agencies, and businesses around Sri Lanka.

Figure 2:Lackshmindra Fernando, Founder, Executive ceo

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.

The goal of applying real-time monitoring in transport management is to reduce the risks to safety and security posed by the movement of personnel, equipment, and supplies. Real-time monitoring of goods, people, and vehicles is made possible by GPS tracking technology, which also provides quick position and status updates. The safety of goods, people, and equipment during transportation is improved and possible dangers are reduced thanks to this approach. It also enhances the company's reputation by guaranteeing prompt and effective delivery while lowering 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) Aim and objectives.

3.1) 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.

3.2) 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. [1]

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. [1]

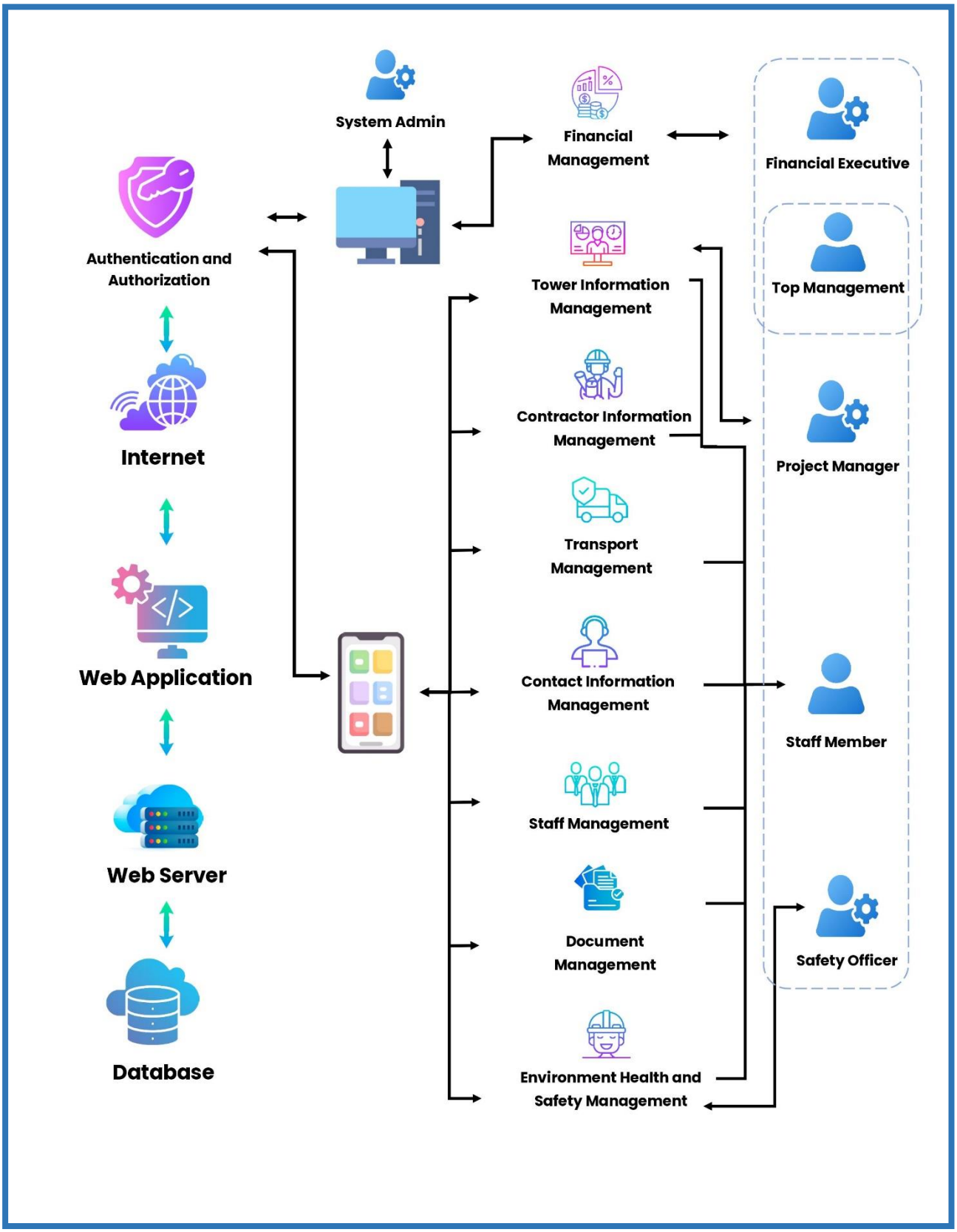
Software development: Develop the network tower site management system according to the defined design, using appropriate programming languages, frameworks, and libraries. Conduct rigorous testing to ensure that the software functions correctly and is free of bugs [1].

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. [1]

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. [1]

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]

4) System Overview



4.1) 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.

4.1.1) 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.

4.1.2) 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]

4.1.3) 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.

4.2) 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 monthly, weekly, yearly, and 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, Rollout manager, 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.

4.2.1) Functional requirements

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 weekly, monthly, annual, or 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.

4.2.2) Non-Functional requirements

Security: The system should be secure and prevent unauthorized access to financial data [12].

Reliability: The system should be reliable and available 24/7 to ensure that financial data is always accessible.[13]

Performance: The system should perform efficiently, with quick response times and minimal downtime, to ensure users can access financial data promptly.[14]

Scalability: The system should be scalable to accommodate [31] growing users and increasing financial data.[15]

Usability: The system should be easy to use, with an intuitive user interface and clear navigation, to ensure users can effortlessly search, analyze, and modify financial data.[16]

Compatibility: The system should be compatible with different browsers and operating systems to ensure users can access financial data from various devices.[17]

Maintainability: The system should be easy to maintain, with regular updates and backups, to ensure that financial data is not lost, and the system remains reliable.[18]

Data Integrity: The system should ensure data integrity by maintaining accurate financial records and preventing corruption.[19]

Auditability: The system should provide audit trails to ensure that financial data modifications are tracked and recorded.[20]

4.2.3) Technical requirements

MERN-Stack: Financial data is stored in MongoDB's database [22], while Express’s web application framework manages HTTP requests and answers [23]. The system's user interface is developed with React.js [24], while the server-side runtime environment for server-side code execution is Node.js [24].

Material UI: To create user interfaces, the Material UI React component library offers pre-made, resizable components. 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 financial management functions, including buttons, forms, dialog boxes, and tables.

Nivo: For the purpose of making data visualizations. The system provided line charts, bar charts, and pie charts among other chart types that may be used to display financial costs, income, profits, and losses. Other chart customization options provided by Nivo include color schemes, labels, and tooltips.

4.3) 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 dictions 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 and a specific date, 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.

4.3.2) Non-Functional requirements

Security: The system should be secure and prevent unauthorized access to the system. Also, there are different logins for view details and management.

Reliability: The system should be reliable and available 24/7 and should be able to recover quickly when errors and failures occoured.

Usability: The system should be easy to use and should have user friendly interface with proper navigation.

Performance: The system should be able to handle a high volume of network traffic without experiencing slowdowns or crashes. Response times for user requests should be fast.

Maintainability: The system should be easy to maintain and update. It should be designed with clear documentation and code that is easy to read and understand for anyone [32].

4.3.3) Technical requirements

MERN-Stack: Contractor information are 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.

GitHub: Developers can access a robust collection of collaboration tools for managing code

repositories on the web-based platform GitHub. It serves as a focal point for code review, collaboration, and version control.

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 farther 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.

4.4.1) 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

4.4.2) Non-Functional requirements

Data Security: The system shall ensure the security of the data stored in the system to prevent unauthorized access or modification.

System Availability: The system shall be available to users at any time.

Maintainability: The system should be easy to maintain and upgrade.

Usability: The system should be easy to use. That means each new user should be able to understand what is going on with the system.

Reliability: the system should be reliable without occurring any issues

4.4.3) Technical requirements

MERN Stack -Those entered data is stored in MongoDB's database, whileExpress.js web operation frame manages http requests and answers. The system's stoner interface is developed with React.js, while the server- side runtime terrain for Serer- side law prosecution is Node.js.

Material UI: To create user interfaces, the Material UI React component library offers pre-made, resizable components. 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 financial management functions, including buttons, forms, dialog boxes, and tables.

Nivo: This helps to visualize included data clearly, including charts and graphs. Also, it has many chart customization options provided including color schemes, labels, and tooltips.

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. Staff contact details can be obtained site- or group-wise. 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 staff'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.

The site map function makes all ongoing, pending, and forecasted site locations visible at the same time. As a result, management has created a massive capability for planning site activities.

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.

4.5.2) Non-Functional requirements

Non-functional requirements specify how a system should behave or perform rather than what it should do. Here are some examples of non-functional requirements for contact information:

Availability: The contact information should be available to authorized users 24 hours a day, seven days a week, with minimal downtime for maintenance or updates.

Security: Contact information should be securely stored, with appropriate safeguards in place to prevent unauthorized access, modification, or deletion.

Performance: The system should respond quickly to requests for contact information, with as little latency as possible.

Usability: The contact information should be presented in a clear, concise, and user-friendly format, with appropriate labeling and contextual information.

4.5.3) Technical requirements

MongoDB: MongoDB must support dynamic and flexible data model, security features, replication, and backup recovery capabilities to ensure data availability and durability.

React JS: React JS should include a library of reusable UI components, support custom styling and theming, provide a routing solution, and include testing capabilities for the unit, integration, and end-to-end testing.

GitHub: GitHub must provide users with high performance and responsiveness. It should be capable of handling large repositories and support fast code cloning and pulling.

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 3 main acters. They are staff members, rollout manager and driver. 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.

In this section has a GPS technology for find the vehicle locations. Drivers can update this section. Staff can find the location of the vehicle by connecting through google map.

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.

Updating the GPS location is one of the valuable functional requirements in the transport management system.

4.6.2) Non-Functional requirements

Software requirements that specify how a system or piece of software should behave rather than what it should do are known as non-functional requirements. Non-functional requirements are also important in a transport management system.

Performance: The transport management system should be capable of managing large amounts of data and transactions [36] without noticeably increasing latency or affecting performance.

Reliability: The transport management system must be dependable and accessible at all times, with little downtime for maintenance or upgrades and a high uptime rate.

Security: To guard against unwanted access, theft, and cyberattacks, the transport management system needs to have strong security measures in place.

Scalability: The transport management system needs to be scalable to meet the demands of the company as it develops and grows over time.

Usability: The TMS should have a user-friendly interface that makes it simple for staff to rapidly and easily access the capabilities they require.

4.6.3) Technical requirements

MongoDB: MongoDB is a high-scalability, high-performance, and flexible NoSQL document database. It is commonly utilized in contemporary online applications where it is necessary to store and quickly access massive volumes of data.

React JS, node JS, Express, mongoose: The four technologies React JS, Node JS, Express, and Mongoose are frequently used to create full-stack online applications. Each technology has a distinct function in the creation of applications, and it gives programmers a potent arsenal of resources with which to create scalable, reliable programs.

Google Maps: Google Maps is an online mapping service that offers geolocation, routing, and interactive maps. It is an effective tool for spatially displaying information and viewing data.

GitHub: Developers can access a robust collection of collaboration tools for managing code repositories on the web-based platform GitHub. It serves as a focal point for code review, collaboration, and version control.

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.

4.7.1) 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.

4.7.2) Non-Functional requirements

Examples of non-functional needs in the context of Engenuity Company could be Performance, Reliability, Security, Scalability, and Compatibility.

Performance is the system be able to handle a large number of concurrent members and provide fast response time for critical operations.

Reliable employees in the company are a very important non-functional requirement.

Security is the most valuable thing for a company. In order to safeguard sensitive data and thwart unauthorized access, the system needs to have strong authentication, authorization, and encryption mechanisms.

Scalability is the system's performance and dependability must be unaffected by growing member and data volume loads.

Compatibility is the system must have an easy- to- use interface that is intuitive and user-friendly and fits the needs of its members.

When inserting employee details and update/delete employee details, accuracy and data integrity are affected.

4.7.3) Technical requirements

MongoDB: The mongo dB is used to set up the database. The popular NoSQL database MongoDB was created to be adaptable, scalable, and simple to use. To prevent unauthorized

access to your data, MongoDB offers several security capabilities, including encryption, authentication, and authorization.

Express, Node-js and React-js are used for creating a backend application and frontend application.

A web-based platform called GitHub offers hosting for Git-based version control and Sofware development.

It offers a collaborative setting for developers to work on tasks, share code and keep track of codebase changes.GitHub is used as a project management tool.

4.8) 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.

4.8.1) 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.

4.8.2) Non-Functional requirements

Security -: The system must secure and prevent unauthorized access to documents.

Reliability -: The system must be reliable and available at all times.

Data Integrity -: The system must maintain accurate and trustworthy documents to ensure data integrity.

Maintainability -: The system should be easy to maintain using updates and backups.

Usability -: The system must be easy to use for users can easily search and modify documents.

Compatibility -: The system must be compatible with different browsers and operating systems for users can access documents from different devices.

Performance -: The system should be performed efficiently for users can access documents quickly and promptly.

4.8.3) Technical requirements

Google Drive -: Documents are stored in Google Drive. This function can't use MongoDB's database. Because client's documents are very large and don't fit in MongoDB.

MERN-Stack -: Google drive stored Document's links are 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 terrain for server-side code execution is Node.js.

5) 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 softwares. The client does not require advanced features and needs customizable specific web applications. The existing softwares 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.

6) Methodology

In this section, we are able to discover the diverse methods and various tools and technologies that we used and hope to apply 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 3-Tec icon

Gantt Chart

TASKS	Gantt Chart													
	Week 1	Week 2	Week 3	Wee k4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Requirements Gathering														
Finding Functions														
Charter Approval														
SCRUM														
Proposal														
Interface Design														
Conceptual Database														
Physical Database														
Coding and Implement														
System Testing														
Client Inspection														
Final Report														

Work Breakdown Structure

	Student ID	Name with Initials	Work Allocated
1	IT21266300	Bandara K.M.V.T	Network Tower (Site) Information Management System Can manage all tower information about TI and Civil projects. Need login to access information. All staff can access information, but only the system admin can edit information. Project managers can check out the completion steps of the civil project and update the status. Can download permission letters for every site. The system shows the completion status of the total project using the chart. System generates weekly reports about changes of data.
2	IT21266096	Bandara R.M.D.L	Finance Management Manage all financial revenue and expenses on each individual site. When login into the system user should enter the employee id and password for the enter the system. In this function system, the admin can add new revenue and expenses and update or delete revenue and expenses. Also, display revenue and expenses and calculate profits using line and pie charts. And user can search financial data using the site id and the site name
3	IT21268830	Chandrasena H.M.K.G.J.K.	Contractor Information Management Manage all contractor details and assign contractors to the project sites. Users can log in to the system and view contractor details. Only the admin can insert, update, delete contractor details, and manage those details. The project manager can search project sites using site id or site name and assign a contractor to the project sites

4	IT21298158	Kiriwaththuduwa K.C.N.	Environment and Safety Management Check whether all construction sites have full fill safety requirements that are allocated by the company. There should be valid user credentials to access the system. Actors who can access the system can insert, update, delete data. It displays safety status and only safety officers can check status and get further decisions. All users can view data and download reports. Also, all staff can search for data by using a site ID or site name.
5	IT21355882	Chamodya W.A.H.	Contact information system In the contact information system, the admin inserts the contact details of the employees site wise and has the ability to update and delete those details. All the staff can log into this system and they can read existing data and search site wise contact details to download a report to get the details.
6	IT21238444	Wimalarathna D.M.A.T.	Transport management The transport management system includes information about transport. When logging into the system, the employee id and password must be entered when logging into the system must be entered. In this function, can insert, update and delete transport details. Also, users can search for transport details and generate transport details as a report. The user of the system updates the GPS location through mobile devices.
7	IT21700156	Nanayakkara A.A.R.	Staff Management Staff management is managing the staff in the company. It is divided into document team, rollout team, revenue and commercial team, warehouse operation team and project team.

			Project manager can assign team members and system admin can insert, update, and delete information of employee details.
8	IT21220388	Senadheera W.D.N.D.	Document management system The document management function stores and manages documents for each site. It 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 who can access this function 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, and it also helps to get a better view of each of the site's work and can make good decisions for sites based on that.

7) Evaluation Method

Evaluation is a crucial component of our Network tower Management System since it allows us to analyze the final result, the system we are developing for our client, in terms of performance, effectiveness, and general quality.

We are concentrating on the evaluation of each and every scope of the system separately. As a result, we can learn more about how the system reacts to user interactions. We will ensure that the expected result is produced at all times without interfering with the system's operation.

To make this task easier to accomplish, we will break the evaluation procedure into five subcategories.

1. **Objective**
   In this section, we will assess the overall quality and performance of the system. Furthermore, we will thoroughly test the system to ensure that it meets all of the client's requirements.

2. **Method**
   In terms of method, we will execute many real-time scenarios that will change depending on the needs of the customer. Every scope and function will be tested out

here. We will collect data from the executed test cases and see how the system fared in each one. This task will involve our client, The Manager, and the Employees of the company.

3. **Scope**
   The system will be assessed as a whole web-based system. Each particular functionality will be examined and tested to ensure that it functions properly in combination with others. The various network tower Management System processes that will be tested are given below.

   - Network Tower (Site) Information Management System
   - Finance Management
   - Contractor Information Management
   - Environment health and safety management
   - Contact information system
   - Transport management
   - Staff Management
   - Document Management

4. **Timing**
   For the evaluation process, the entire system must be completed and run well as a well-integrated system.
   As a result, the system will be evaluated as "phase 1" after completion and "phase 2" following handover to the client.

5. **Output**
   Based on the results, the system will be tested, evaluated, and judged. The customer and company employees will consider the qualitative assessments and comments. Furthermore, the major criterion will be overall satisfaction.

Various technologies and tools to be used in the system evaluation.

1. Automated testing tools – Postman / Rest Client
2. Data Analytical Tools – Google analytics
3. Virtualization Tools – VirtualBox
4. User Feedback Tools – SurveyMonkey

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