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Development of Smart Tag for Resource Management

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Abstract
The integration of Radio Frequency Identification (RFID) and wireless tag technologies with Building Information Modeling (BIM) presents a transformative approach to construction management. RFID enables real-time monitoring of individuals, tools, and materials within construction sites, addressing challenges such as tool misplacement and inefficient resource tracking. BIM, as a digital representation of physical spaces, provides a platform for visualizing and managing construction activities. When combined, these technologies create a hybrid model capable of overseeing manpower procurement, material transportation, and equipment utilization both during and after delivery. RFID applications extend to worker attendance and location tracking, enhancing project scheduling and safety management. This study explores the technological requirements for integrating RFID and BIM, reviews existing hybrid model implementations, and analyzes case studies to assess current practices. Furthermore, it discusses potential future applications and their implications for efficiency, safety, and productivity in construction management.

Keywords: *Radio Frequency Identification (RFID, Building Information Modeling (BIM)*

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I. INTRODUCTION

Theft at construction sites poses a significant challenge for businesses, particularly in remote regions where assets must remain on-site for extended periods. After-hours theft is a major concern, contributing to annual financial losses of approximately $1 billion in the U.S. construction industry, as reported by the National Equipment Registry. Effective management requires addressing security difficulties and implementing best practices in safety and loss prevention. While builders risk insurance offers coverage for stolen items, compensation often falls short of covering the broader secondary consequences such as project delays, increased costs, and operational disruptions. Thus, theft remains a critical issue demanding proactive strategies to safeguard assets and minimize financial and operational impacts.

1.1.1 Impact of Theft on Construction Site

Construction site theft presents significant challenges for contractors, particularly in balancing project deadlines with financial recovery. In many cases, contractors must purchase replacement materials out of pocket and later seek reimbursement through builders' risk insurance. While this expedites project continuity, insurance payments are often delayed for weeks or months, straining contractors' cash flow. Such financial burdens can hinder business growth, force reliance on credit lines, and generate ongoing interest expenses. Although builders' insurance provides coverage, it rarely mitigates the broader consequences of theft, including operational disruptions and hidden costs. Ultimately, theft of tools, specialty materials, or appliances imposes substantial direct and indirect expenses, underscoring the need for stronger preventive measures and financial safeguards in construction management.

1.1.2 Insurance Occurrences

Contractors often maintain insurance coverage to safeguard against construction site theft, yet many are reluctant to file claims due to potential increases in future premium rates. While submitting a claim is logical when high-value or rented items are stolen, smaller losses—such as a $2,000 appliance—may not justify the long-term financial impact of higher premiums. In such cases,

contractors may opt to personally absorb the replacement costs to protect their revenue streams. This highlights the complex trade-off between utilizing builders' risk insurance and managing financial stability, underscoring the need for strategic decision-making in theft-related incidents.

1.1.3 **Scheduling Delays**

Theft at construction sites significantly disrupts project schedules, as most stolen items are essential for ongoing work. While some materials can be quickly replaced from local suppliers, specialized products, large appliances, and machinery often require reordering, leading to delays that may span days, weeks, or even months. Such interruptions jeopardize project timelines and can halt construction progress entirely until replacements arrive. Consequently, theft not only imposes financial losses but also creates severe scheduling setbacks, underscoring the critical need for effective asset protection and theft prevention strategies in construction management.

1.1.4 **Restricted Cash Flow**

Timely project completion and financial recovery are critical concerns for contractors facing construction site theft. To maintain schedules, contractors often purchase replacement materials with personal funds before filing insurance claims. Although this expedites delivery, reimbursement from insurers may take weeks or months, creating temporary financial strain. Overspending on replacements can reduce cash flow, hinder workforce expansion, and limit organizational growth. In cases of severe liquidity shortages, contractors may resort to credit lines, incurring additional interest expenses. Thus, while builders' risk insurance provides eventual compensation, the interim financial burden highlights the broader economic repercussions of theft on construction projects.

1.1.5 **Higher Costs**

Accurate cost estimation in construction projects requires awareness of fluctuating market conditions that affect material and equipment prices. While the agreed contract payment covers services and anticipated expenses, theft introduces uncertainty, as replacement costs may exceed original estimates. Contractors are often compelled to purchase stolen items immediately to maintain project continuity, regardless of whether insurance reimbursement reflects fair market value or arrives on time. This exposes them to financial risk, particularly when market prices shift unexpectedly. Consequently, construction site theft not only disrupts schedules but also undermines financial stability, emphasizing the importance of proactive risk management and cost control strategies.

1.1.6 **Slower Payments**

Theft at construction sites can lead to severe financial repercussions, with delayed payments being among the most critical consequences. When essential equipment is stolen, project milestones may be missed, preventing contractors from receiving scheduled progress fees. This disruption places significant strain on cash flow, limiting the contractor's ability to compensate subcontractors for completed work. Such financial instability can escalate into disputes, potentially resulting in mechanics liens on the property or legal action. Thus, construction site theft not only causes direct material losses but also triggers cascading financial and legal challenges that threaten project continuity and organizational stability.

1.1.7 **Prevention of Thefts on The Construction Site by Using RFID**

Radio Frequency Identification (RFID) technology enables wireless communication between tags and readers, offering a practical solution for asset tracking, access control, and inventory management. RFID tags, composed of a microchip and antenna encased in metal or plastic, store and transmit data such as identification numbers, product details, and location information. They are available in passive forms, which rely on reader-provided energy, and active forms, which contain their own power source for longer-range transmission. On construction sites, RFID technology can be strategically applied to prevent theft by monitoring equipment, tracking materials, and controlling site access. By providing real-time visibility and secure asset management, RFID offers an effective approach to reducing losses and enhancing operational efficiency in the construction industry.

1.2 **Different Methods to use RFID in Construction Industry**

RFID (Radio Frequency Identification) technology offers a versatile and effective solution for enhancing security at construction sites. By enabling asset tracking, RFID tags allow contractors to monitor and locate tools, equipment, and supplies, thereby reducing theft and improving inventory control. RFID-based access systems ensure that only authorized personnel can enter the site, minimizing unauthorized access. Real-time tracking of individuals and items further aids in detecting abnormal behaviors and alerting security personnel to potential theft. Additionally, RFID tags can identify tampering attempts, triggering immediate notifications to safeguard valuable assets. When properly installed and regularly maintained, RFID systems provide significant benefits, including reduced theft, improved operational efficiency, and strengthened site security

II. PROBLEM STATEMENT

2.1 Aim

To assess and manage equipment inventory and human resource based on which scheduling of project is predicted.

2.2 Objectives

- To conduct extensive literature survey for examining the past studies
- To identify and collect relevant and useful resources for the RFID prototype
- To optimize the best suited resources for the research
- To develop working prototype for the automated RFID scheduling system
- To compare and validate prototype with existing models
- Scope of present investigation
- Human Resource tracking
- Equipment tracking
- User interface for management of said resources
- Provide vital user/safety manuals
- Progress tracking on site with smart tags
- Feedback system for creating equipment and employee database

2.3 Method and Methodology

Table 2.3.1 method and methodologies

Objective No	Statement of the objective	Method/Methodologies	Resource utilized
1	To study the literature review	Assembling of related literature papers directed by the literature survey.	Journals, thesis, articles, reports.
2	Choosing best RFID tags for your application	Using the bandwidth of RFID tags for our Range	RFID tags,RFID scanners.
3	Optimizing QR code scans	Development of QR codes for which real time monitoring of construction activity & human resource can be done.	QR code, QR code scanners, Netbean,
4	Developing the working prototype	On site RFID installation, Hardware EFID data storage, Access through application & upload of MSP & updating of MSP	Android studio, Real Time monitoring application, real time monitoring website
5	Comparing & Validating the proto type with existing model & real time project	Cost estimation of resource used food proto type, REIF tags, user interface software JAVA & Arduino, App making	Cost estimation based on the project

2.4 Methodology

Radio Frequency Identification (RFID) technology uses radio waves to identify and track items, offering wide applications in asset management, inventory control, and supply chain monitoring. Implementing RFID requires a structured approach: defining the specific use case, identifying system components such as tags, readers, and supporting software, and selecting the appropriate frequency—low (LF), high (HF), or ultra-high (UHF)—based on operational needs. System architecture must then be designed, including reader placement and data management strategies. Rigorous testing ensures functionality before deployment, while ongoing maintenance, software updates, and component replacements are essential for sustained performance. A methodical implementation process enhances the likelihood of success, enabling organizations to fully realize the efficiency and security benefits of RFID technology.

III. PROBLEM SOLVING

3.1. Introduction

RFID technology enables the identification and monitoring of objects through the use of radio signals. When it is necessary to track assets or items, RFID tags are attached to them, and an RFID reader is employed to identify the unique number assigned to the tag. In this article, we will extensively explore the functioning of RFID technology.

3.1.1 RFID Tags

RFID bands are small electronic devices equipped with a transmitter and a microchip. The item or object that requires supervision has the label attached to it. RFID tags are available in diverse sizes and shapes and can either be passive or active. The RFID scanner supplies the energy needed to power passive RFID tags, which do not have batteries. Active RFID devices are capable of transmitting signals over greater distances compared to passive tags due to being powered.

3.1.2 Working of RFID Tags

The working of RFID tags can be divided into three main steps: Tagging, Reading, and Data Collection. Tagging: Assets that need to be monitored are given RFID tags to affix to them. The position, condition, and upkeep history of the object are all connected to the tag's special identifying number.

Reading: RFID scanners are strategically positioned at places of entrance and departure, warehouses, and loading docks. The RFID reader emits a signal that is picked up by the receiver of the RFID tag whenever the marked object comes into range of the reader. The microchip in the tag is powered by the reader's signal, and it communicates the tag's distinctive identifying number to the reader.

3.2 Types of RFID Tags

Depending on their source of electricity, RFID bands can be divided into three categories: passive (also known as inactive), active (also known as active), and battery-assisted passive (BAP).

Passive RFID tags: These tags depend on the energy transferred from the RFID reader to fuel them and send data because they lack a power source. In supply chain and inventory management apps, passive RFID tags are frequently more compact and less costly than active tags. Active RFID tags: These tags have a power source built into them, enabling them to transmit data over greater distances and in more difficult conditions. For asset monitoring and other situations where real-time tracking is required, active RFID bands are frequently used. Semi-passive RFID tags: These tags have a tiny battery to charge the RFID chip, but they depend on the power of the RFID reader to interact with the reader. Semi-passive tags are frequently employed in applications that call for greater scan rates or lengthier read ranges than those that call for passive tags.

UHF RFID tags are capable of being detected from a distance of a few meters and operate within the ultra-high frequency range of 860 to 960 MHz. The application of UHF RFID tags is extensive in the field of logistics and supply chain management. High frequency (HF) RFID tags: These tags, which work at a frequency of 13.56 MHz, are frequently used in apps for asset monitoring and access control. NFC tags: These tags, which work at a frequency of 13.56 MHz, are frequently used in contactless payment methods, transit tracking, and other scenarios in which data must be sent over short distances. Depending on their intended use and context, RFID bands can take on a variety of shapes. Typical types of RFID bands include: Inlays: These RFID devices can be affixed to goods, containers, or assets and are incorporated in labels or adhesive materials. Hard tags Made of

sturdy, impermeable material, these tags can be fastened to goods or assets with nails, bolts, or glue, Wristbands Access control, event administration, and healthcare apps frequently use RFID wristbands and Cards Access control, identity, and payment systems frequently use RFID cards.

Bandwidth of RFID Tags:

RFID tag range is the separation between the tag and the scanner at which the tag can be reliably read. This is referred to as the bandwidth of RFID tags. The sort of tag, how frequently it operates, and the setting in which it is used are some of the variables that can affect an RFID tag's range.

Here are some typical values for various RFID tag types:

Passive RFID tags: When paired with a 900 MHz RFID scanner, these tags usually have a range of up to 10 metres (33 feet). However, in settings with a lot of metal or other elements that can interfere with the RFID signal, the range can be greatly decreased.

Active RFID tags can receive data from up to 100 metres (328 feet) away, which is a greater reading range than inactive RFID tags. Active tags can send a stronger signal and be detected over greater distances because they are fuelled by a battery.

UHF RFID tags: Depending on the reader's strength and the setting in which the tag is being used, UHF tags can be read at distances of up to 10 metres (33 feet) or more. In supply chain and logistics applications where long read ranges are required, UHF tags are frequently used.

HF RFID tags: HF tags are appropriate for applications like access control and asset monitoring because they usually have a range of up to 1 metre (3.3 feet).

NFC tags: NFC tags have a very limited reading range and can only be read from a few centimetres away. This qualifies them for uses like contactless payment methods, registration for public transit, and other situations where data must be sent over brief distances.

It is of utmost importance to keep in mind that the range of an RFID device can be affected by environmental factors, such as the presence of metal or other materials that may disrupt the signal. The range can also be affected by factors such as the power of the RFID scanner, the positioning of the device, and other elements. In order to ensure reliable performance, it is essential to fully evaluate the specific requirements of the RFID application and choose the appropriate type of tag and reader.

Working model:

An actual illustration of how RFID technology functions is an RFID functioning model. An RFID tag, an RFID reader, and a software programme that gathers and stores data from the RFID tag typically make up the model. An RFID system's fundamental operating principle is as follows: An asset or thing that needs to be monitored is given an RFID tag. The device has an antenna and a microchip, allowing it to interact with an RFID scanner. Strategic sites, such as entrance and departure spots, warehouses, and cargo docks, are equipped with RFID readers.

The reader transmits the tag's special identifying number to a central computer, which records information about the whereabouts and motion of the tagged objects in real time.

The working model typically consists of the following components:

RFID Tag: An RFID tag is a tiny electrical gadget with a transmitter and a microchip. The asset or thing that needs to be monitored has the tag affixed to it. RFID Reader: An RFID reader is a gadget that communicates with RFID tags by sending out radio frequency signals. The scanner gathers the special identifying number from the tag and transmits it to the main database. Software Application: Information from RFID bands is gathered and stored using software applications. Real-time tracking of the whereabouts and motion of the objects with tags is possible using the programmed.

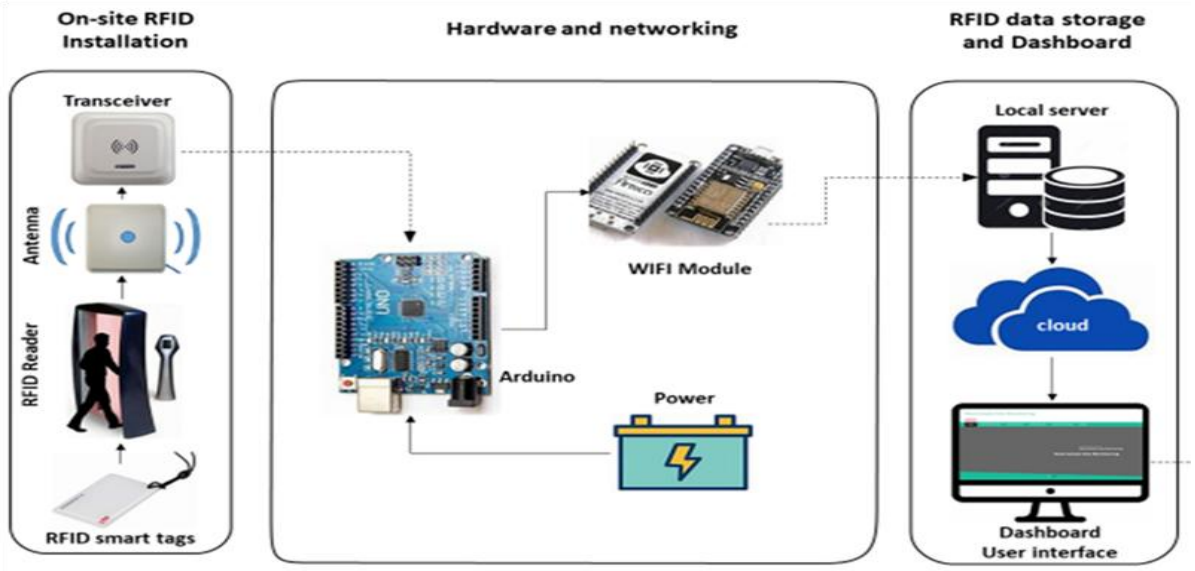


Fig 3.1 Shows the RFID working model

To demonstrate how the RFID working model works as shown in figure 1, the following steps can be taken:

Add an RFID tag to a asset, such as a piece of machinery, now Position an RFID scanner close to the marked object. Switch on the RFID scanner and start the programme then Bring the marked object into the RFID reader's detection area. The antenna of the RFID device receives a signal from the scanner, the tag then powers its microprocessor with energy from the reader's signal, and the chip then transmits the tag's special identifying number to the reader. The reader transmits the tag's distinctive identifying number to the central.

Computer, which records information about the tagged item's mobility and position in real time. The software programme shows the information gathered from the RFID tag, such as the item's position and activity. Finally, an RFID functional model is a great tool for explaining how RFID technology operates. Visualizing the procedure and comprehending the various elements of an RFID system is helpful. The approach can be applied to a variety of sectors, including retail, healthcare, and logistics, to enhance asset monitoring and inventory control. The figure 3.3 depicts a typical working of a RFID scanning system.

Prototype:

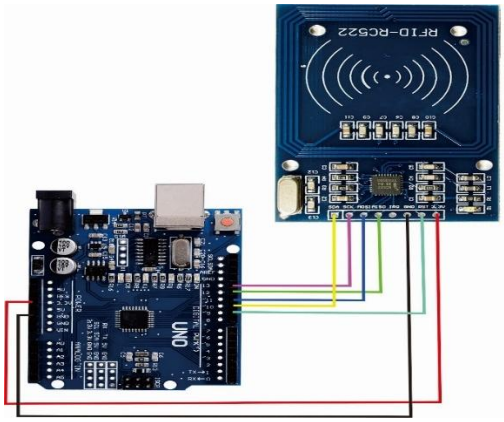
Arduino:

The widely used open-source electronics platform Arduino offers a quick and inexpensive way to build interactive projects, including those that incorporate RFID tags. The following steps are necessary for Arduino to function with RFID tags:

Using an RFID reader with an Arduino: The Arduino board must first be connected to an RFID reader module. An antenna and a control card that interacts with the Arduino board via the serial port typically make up an RFID scanner module. The Arduino board's RX and TX ports are used to make the contacts.

Adding an RFID Library: The following action is to add an RFID library to the Arduino IDE. (Integrated Development Environment). The code required to receive and handle the data from the RFID reader module is present in the library.

Writing the code: After installing the RFID library, the next step is to create the code to receive the data from the RFID tags. To initialize the RFID reader module, read the tag data, and transmit the data to a computer or other output device, the code usually makes use of the library's functions.



Arduino	RFID-RC522
SDA	10
SCK	13
MOSI	11
MISO	12
GND	GND
RST	9
3.3V	3.3V

Fig 3.2 Shows the RFID reader with an Arduino

System testing: occurs after the code has been written, and one way to test the system is by placing an RFID tag in the line of sight of the RFID reader module. The RFID reader module will read the data from the tags and transmit it to the Arduino board. Afterwards, the Arduino chip will handle the data and transmit it to the output device.

The capacity of the Arduino board to receive data from the RFID reader module and process it using software is the foundation for how Arduino works with RFID bands. When an RFID tag is in the RFID scanner module's range, a signal is sent to the Arduino device. The Arduino board then receives the tag data and applies the programme code to it to handle it. By offering pre-written methods that can be used to initialise the reader, receive the tag data, and process the data, the RFID library makes it easier to interface the RFID reader module with the Arduino board.

Arduino offers a straightforward and reasonably priced method for developing engaging tasks with RFID tags. The Arduino board can be quickly connected to the RFID reader module, and the RFID library makes it easier to receive and handle tag data. Access control systems, inventory management, and asset monitoring are just a few of the uses for Arduino with RFID devices.

The Wi-Fi module:

To allow digital contact and distant tracking of RFID tag data, a Wi-Fi module can be used with RFID tags. Compared to conventional wired systems, using a Wi-Fi module with RFID tags offers more freedom, scaling, and real-time data transfer. A Wi-Fi module for RFID bands can be used for a variety of purposes, including asset monitoring, inventory control, and security systems.

The working of a Wi-Fi module with RFID tags involves the following steps:

An RFID scanner module is used to receive the information from the RFID tag. The Wi-Fi module, which the reader module is connected to, transmits the data to a distant server or cloud-based platform.

Wi-Fi Module: Wireless communication between the RFID reader module and the remote server is handled by the Wi-Fi module. The reader module sends data to the module, which then transmits it over a Wi-Fi network.

Remote Server: The data sent by the Wi-Fi module is received by the remote server, which then saves it in a database. Based on the information from the RFID tags, the server can also analyse the data and produce reports or warnings.

User Interface: To show the RFID tag data in real-time, a user interface can be created. An internet browser or a mobile device can be used to view the UI.. There are many advantages to using an RFID chip and Wi-Fi module. Data from RFID tags can now be remotely monitored and viewed from any location in the world. Additionally, real-time data transfer makes it possible to react quickly to problems like theft, low inventory, or device malfunction. Scalability is another benefit of using a cloud-based platform, allowing the system to manage large volumes of data and serve numerous people.

In conclusion, the use of an RFID tag and Wi-Fi module offers a scalable and versatile option for security systems, inventory management, and asset monitoring. Real-time data transfer, remote tracking, and quick problem resolution are all made possible by the system. The system can be readily customised to suit unique user needs and linked with current RFID infrastructure.

Antenna:

An Antenna transmits and receives radio frequency information, an antenna is an essential part of how RFID device's function. The radio frequency impulses that power the RFID device and transport the data it contains are sent and received by the antenna. The following actions are necessary for the RFID tag antenna to function

Powering the RFID Tag, or 1. The radio frequency impulses that the reader sends out charge the RFID tag. The antenna on the RFID tag receives a signal that is sent out by the reader. The RFID device is powered by the antenna, which transforms the radio frequency information into electrical energy.

Data can be transferred from the device to an RFID reader when they are in close proximity. The antenna of the RFID tag detects the signal transmitted by the scanner when they are in close proximity. Afterwards, the RFID tag`s transmitter converts the signal into electrical energy, facilitating the operation of the tag and transmitting the captured information back to the scanner.

Interpreting the information, the reader receives and analyses the data forwarded by the RFID tag. The information can be transmitted to a computer, another output device, or shown on a scanner's screen. There are various types of antennas that can be used with RFID tags, including patch, circular, and linear antennas. The application, frequency range, and size and shape of the RFID tag all influence the type of antenna that is used. The read range and dependability of the RFID device are significantly influenced by the antenna design. In conclusion, radio frequency impulses are transmitted and received in order for the RFID tag receiver to function. The antenna's job is to transform radio frequency signals into electrical energy, which powers the RFID tag and powers data transmission. The application and the layout of the RFID tag determine the type of antenna to be used. The read range is greatly influenced by the antenna.

Microsoft project:

The construction business can plan and handle construction tasks using the project management software tool known as Microsoft Project. Project managers can plan duties, allocate personnel, monitor progress, and handle budgets using the software's platform. Microsoft Project is primarily used in building for the following reasons:

Planning: A thorough project plan with all the tasks, resources, and dependencies needed for a construction project can be made using Microsoft Project. Gantt charts, which are used to visualise the project timetable and pinpoint crucial routes, can be made using the software's creation tools.

Resource Management: Using Microsoft Project, project managers can allocate resources, such as manpower, supplies, and equipment, to particular tasks in the project schedule. Tools for monitoring resource availability, utilisation, and expenses are provided by the programme.

Budget Management: A building project budget can be created using Microsoft Project, and expenditures can be tracked against the budget. The programme offers tools for estimating costs, keeping track of expenditures, and producing project cost reports.

Collaboration: Project teams can work together on the project plan and monitor success in real-time using Microsoft Project. The programme offers resources for information exchange, job distribution, and team member communication.

Risk Management: The construction project's risks can be found and managed using Microsoft Project. The programme offers resources for making risk management plans, determining how risks affect the project, and building backup plans. There are numerous advantages to using Microsoft Project in the building industry. It allows project managers to schedule and oversee building projects more effectively, cut down on delays, and enhance project results. The software also allows better project team collaboration by giving real-time insight into the status of ongoing projects.

Construction project planning and management can be done with the help of Microsoft Project, a potent instrument. Project managers can plan duties, allocate personnel, monitor progress, and handle budgets using the software's platform. The use of Microsoft Project in the building industry has a number of advantages, including better project results, fewer project delays, and increased teamwork.

Equipment Description:
Backhoe: In the project, the backhoe is used for the excavation works before the foundation. To clear the site and load the trucks with waste or the excavated materials
Transit mixer: To mix the concrete properly with the proper ratios of the materials.
Conveyor trucks: Conveyor trucks are used to convey the materials from the storage to the site or from the manufacturer to the construction site.
Concrete pump: This equipment is used to pump the concrete from the lower heights to the upper heights. Since it will be difficult to carry the mixed concrete or the material to the upper floors manually, the pumps will be helpful to transfer the concrete directly to the heights which make it easy and construction faster.
Bar cutting machine: This equipment is used for cutting steel bars for reinforcement.
Description of project: Total duration of the project is 404 days. The RFID tags are given to the equipment and human resources. In this project, the RFID tags are given to the Backhoe, Transit mixer, Bar cutting machine, and Conveying trucks. The RFIDs are linked with the schedule which also carries the details of each piece of equipment and the total working hours are tracked along with the change in the schedule if any delay occurs.

Integration of Microsoft Project and RFID Technology:
Microsoft Project and RFID technology can work together to create a potent resource management system for the building sector. While Microsoft Project can be used to handle the distribution of these resources to various jobs in the building project, RFID technology can be used to monitor the movement of resources, such as supplies and tools.
Ways that RFID and Microsoft Project can be used together for resource management in construction:
Resource tracking: On a construction site, RFID technology can be used to monitor the movement of resources. To monitor the movement of these resources, RFID tags can be affixed to supplies, equipment, and tools, and readers can be positioned throughout different environments. Microsoft Project can incorporate this information to give real-time insight into the position and availability of resources.
Resource Allocation: Microsoft Project can be used to control how resources are distributed among the various jobs involved in a building project. Project administrators can see the availability of resources and allocate them to particular duties as required by integrating RFID data with the project schedule. By doing so, resource disputes can be avoided and effective resource use can be guaranteed.
Inventory Control: RFID technology can be used to monitor the supplies of tools and materials on a building site. To provide real-time visibility into inventory amounts and to help ensure that supplies and tools are available when required, this data can be integrated with Microsoft Project.
Time tracking: It can be done using RFID technology to keep track of the amount of time employees spend on specific tasks. Project managers have the ability to track the progress of tasks in real-time and make changes to the project plan as needed by merging this information with Microsoft Project. For resource administration in building, combining RFID and Microsoft Project can have several advantages. It can aid in enhancing productivity, cutting down on wastage, and better utilising resources. By giving real-time visibility into resource availability and allocation, it can also aid in preventing delays and cost overruns.
Describe the requirements for resource tracking using RFID tags and Microsoft Project, as well as the project's scope. When choosing RFID tags and technology for resource monitoring, make sure Microsoft Project is interoperable with them. Set up the tools and RFID devices required for acquiring and analysing RFID data then Create a Microsoft Project plan with duties, deadlines, and resource needs, Label resources with RFID tags and set up RFID readers to gather information on resource mobility and position. Employ a data administration programme or application to integrate RFID data with Microsoft Project. Track resource availability, assign resources to jobs, and control inventory levels using the integrated data. To make sure the project stays on track and within budget, constantly monitor and update the RFID and Microsoft Project integration.
This is an outline of the basic procedures for combining RFID tags with Microsoft Project for resource management in the building industry. The particulars of the merging procedure will rely on the software and RFID technology being utilised.
When RFID and Microsoft Project are used together, material administration in the construction business may be greatly improved. Project managers can follow the movement of resources, assign them to particular duties, control inventory levels, and monitor progress in real-time by integrating RFID data with the project schedule. This could increase efficiency, decrease waste, and better utilise resources in building initiatives.

Benefits of RFID in Construction:
RFID technology has numerous benefits in the construction industry. Some of the benefits are as follows:
Improved asset tracking is possible thanks to RFID technology, which offers real-time data on the whereabouts and motion of assets on a building site. This lessens the possibility of asset loss or larceny and enhances asset monitoring.

Improved Inventory Management: RFID technology offers precise and up-to-date information about the stock on a building site. This lessens the possibility of stock-outs and overstocking and helps to better inventory management.
Increased Safety: RFID technology can be used to keep track of how employees and tools are moving around a building site. As a result, there are fewer chances of mishaps and injuries, which improves safety.
Increased Efficiency: By giving real-time information about the position and movement of assets, RFID technology contributes to increased efficiency of building site activities. By doing so, output is increased and delay is decreased.
Cost Savings: By enhancing asset management, inventory management, and lowering the risk of asset theft or loss, RFID technology serves to lower costs in building.

User interface:
Making a system that enables users to access real-time information about the building process is part of designing a user interface for tracking construction sites. When creating the user experience, keep the following things in mind:
Dashboard: A dashboard shows statistics from a construction location visually. It should be built to present important information in a straightforward, succinct, and aesthetically pleasing manner. A map of the building location, deadlines, plans, and other pertinent information should all be included on the dashboard.
Real-time updates: The user UI needs to give development process information in real-time. When something significant occurs, like a timetable modification or a delay, it should be intended to provide alerts and notifications.
Mobile responsiveness: The user experience needs to be created with mobile users in mind. Stakeholders will be able to access information at any time and from any location thanks to this. Integration with other systems: To give a comprehensive view of the building site, the user interface should combine with other systems like project management software and contact tools.
User access control: Depending on the user's position, the user interface is be made to offer various degrees of access control. As a result, stakeholders will only have access to the data that pertains to them.
Data visualization: The user interface needs to be created so that data is presented in an understandable manner. Utilizing diagrams, charts, and other instruments for data visualization may be necessary.
User input: The user interface should be created to enable user comments. The system can be improved using this input to make sure that it satisfies the requirements of the stakeholders.

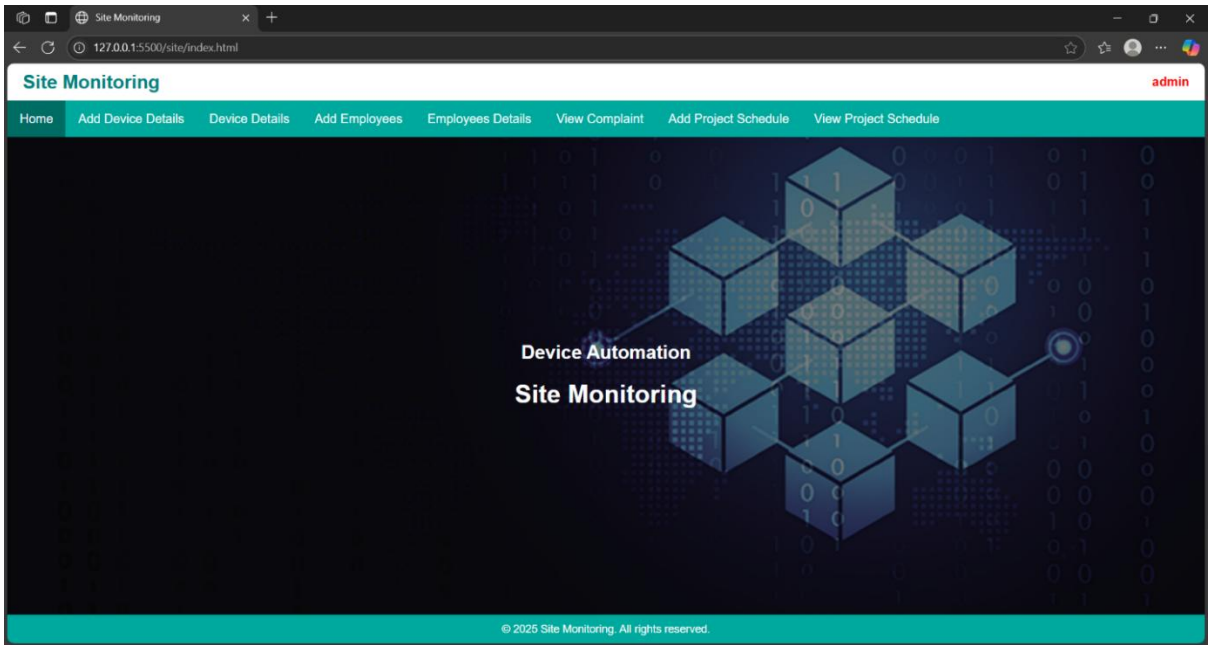


Fig 3.3 Shows The landing page of the website

In this fig. 3.3 shows The landing page of the website can be seen we have created a website, through which we can access the site monitoring. This can be controlled by site supervisor only & we can access it through a mobile application we have created it is also and displayed in the bellow pictures.

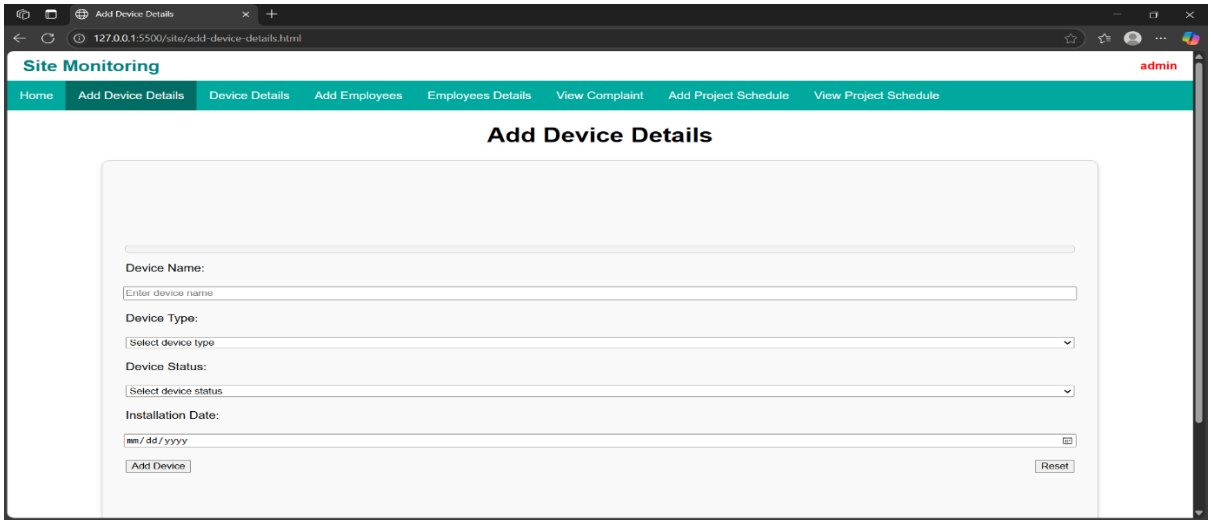


Fig 3.4 Shows The landing page of the website

In the fig. 3.4 This is how the fields can be added & activity can be assigned and updated. This can only be accessed by the authorized handles, but cannot be handled by any unauthorized persons. The access can be a password protected and also an authorized access and also be controlled by the head of the construction site.

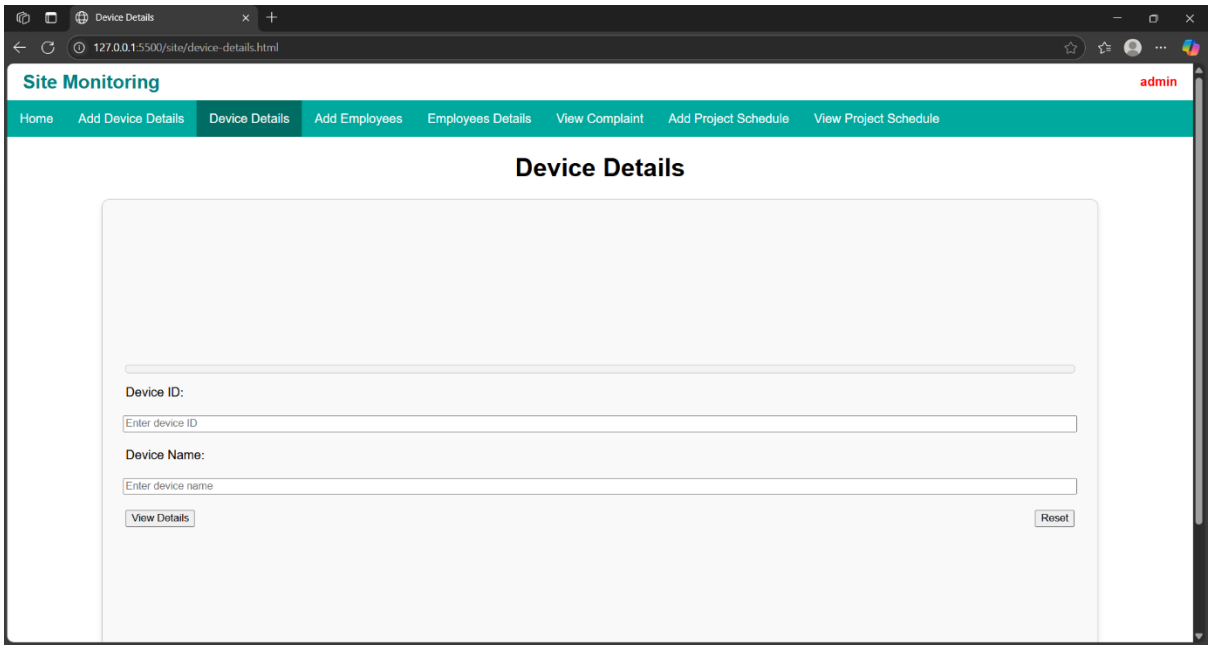


Fig 3.5 Shows The landing page of the website

In the fig. 3.5 This is how an activity can be assigned. This is directly connected to project scheduling. The activity once assigned can be added and can be deleted but the activity can be linked to a mobile app which can be easily accessible through which can be accessed and assigned the data can be manipulated in the mobile application also.

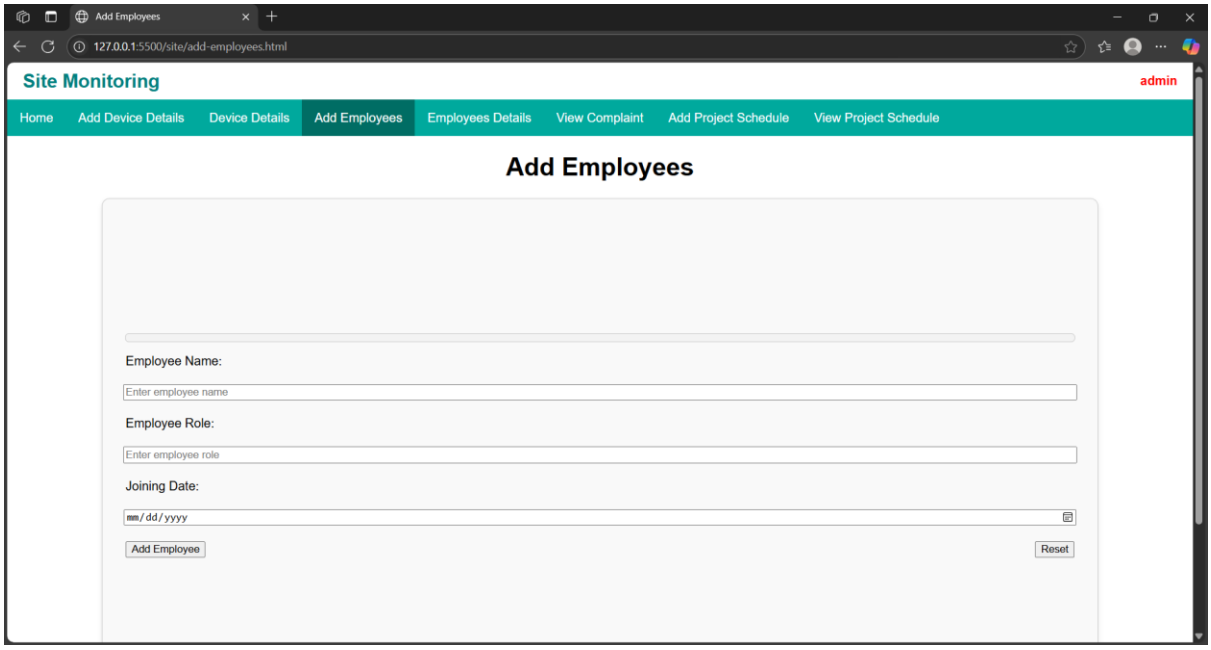


Fig 3.6 Shows The landing page of the website

In this fig 3.6 This is how the Employees fields can be added and how the data can be entered. The activity can be added only by the site supervisor. And also, can be manipulated only by the higher authorities and can be reviewed by the higher authorities.
In this fig. 3.7 The above picture describes how the employee details can be updated here itself. The data regarding the labours or staff members can be traced here, the previous work data which he or her worked can also be updated.

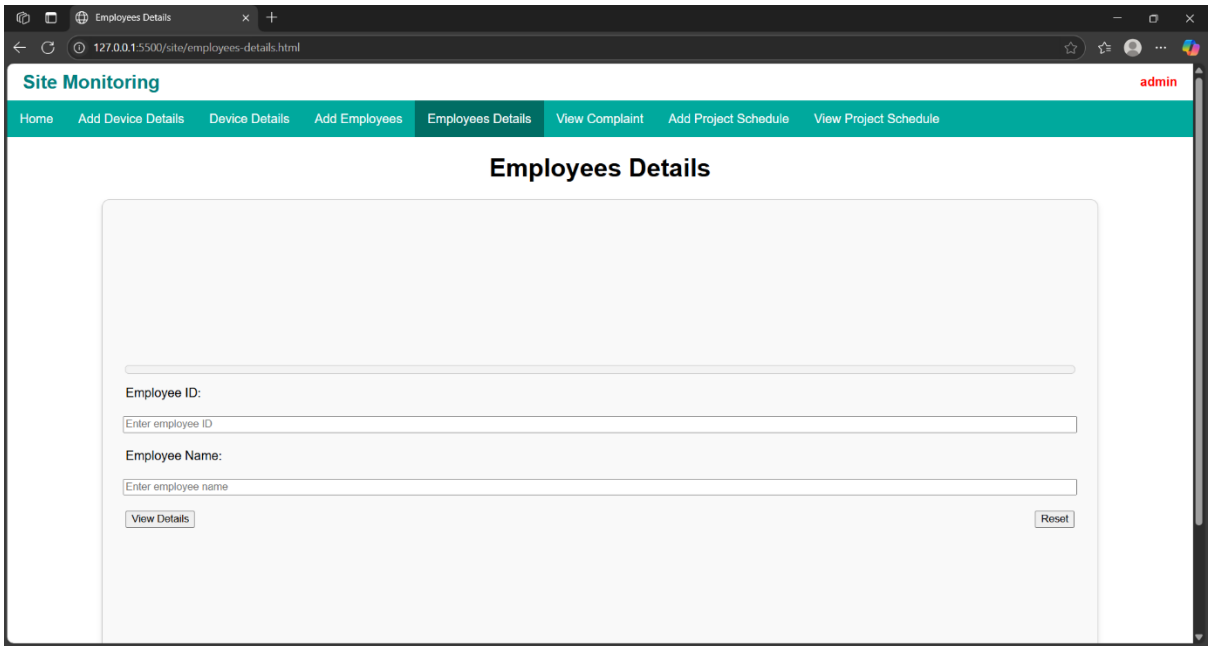


Fig 3.7 Shows The landing page of the website

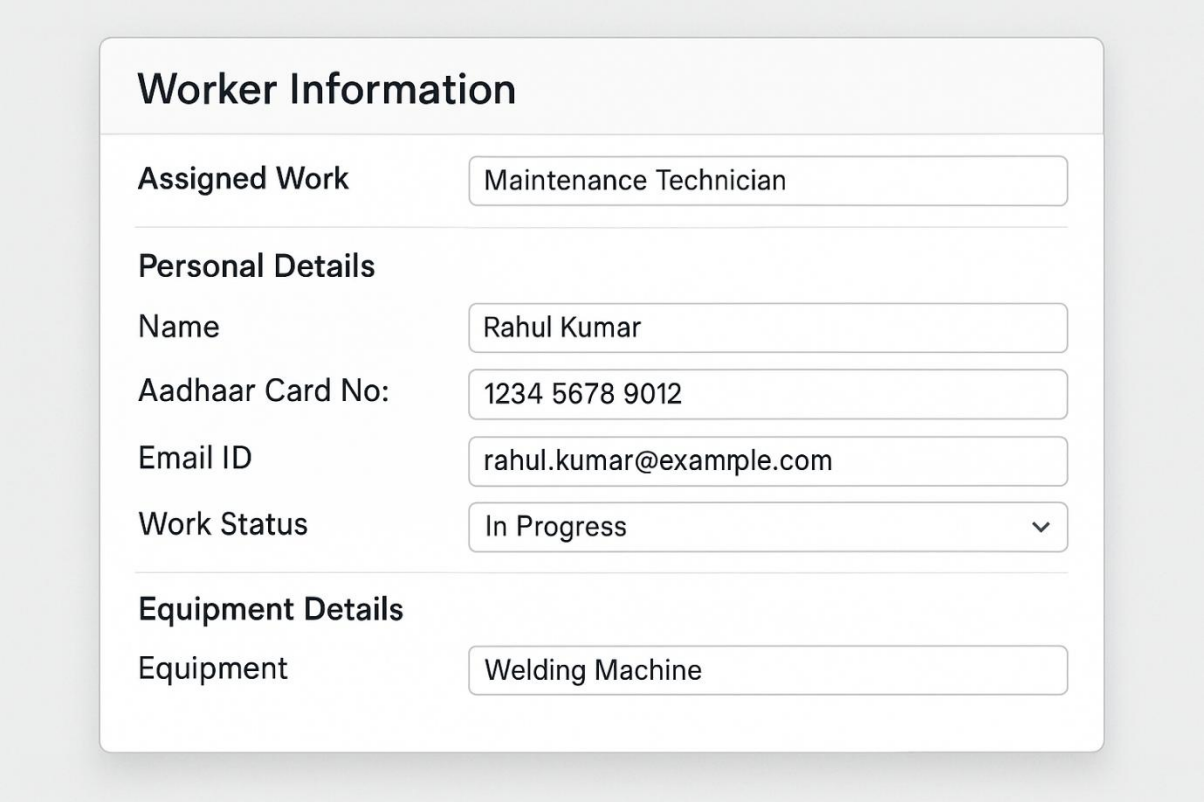


Fig 3.8 Shows The workers data is entered and all the details regarding his assigned work

In the fig. 3.8 The workers data is entered and all the details regarding his assigned work and the details of his personal data like the (Aadhaar card no), (email id) and the work updating can also be reviewed there itself and also, the equipment details of the equipment's which is handled by that particular person.

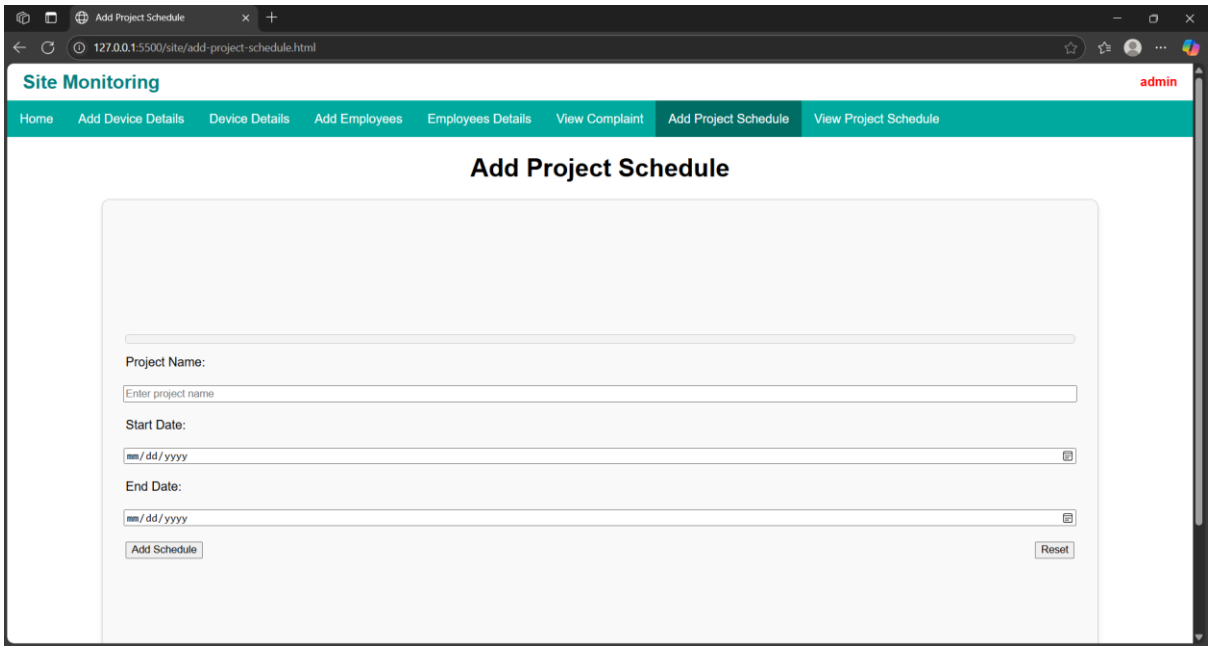


Fig 3.9 Shows The activity details can be seen here the activity details are directly updated

In the fig. 3.9 The activity details can be seen here the activity details are directly updated & connected to project scheduling. The activity details are directly updated if the assigned days of the work are delayed or completed on time irrespective of activity.

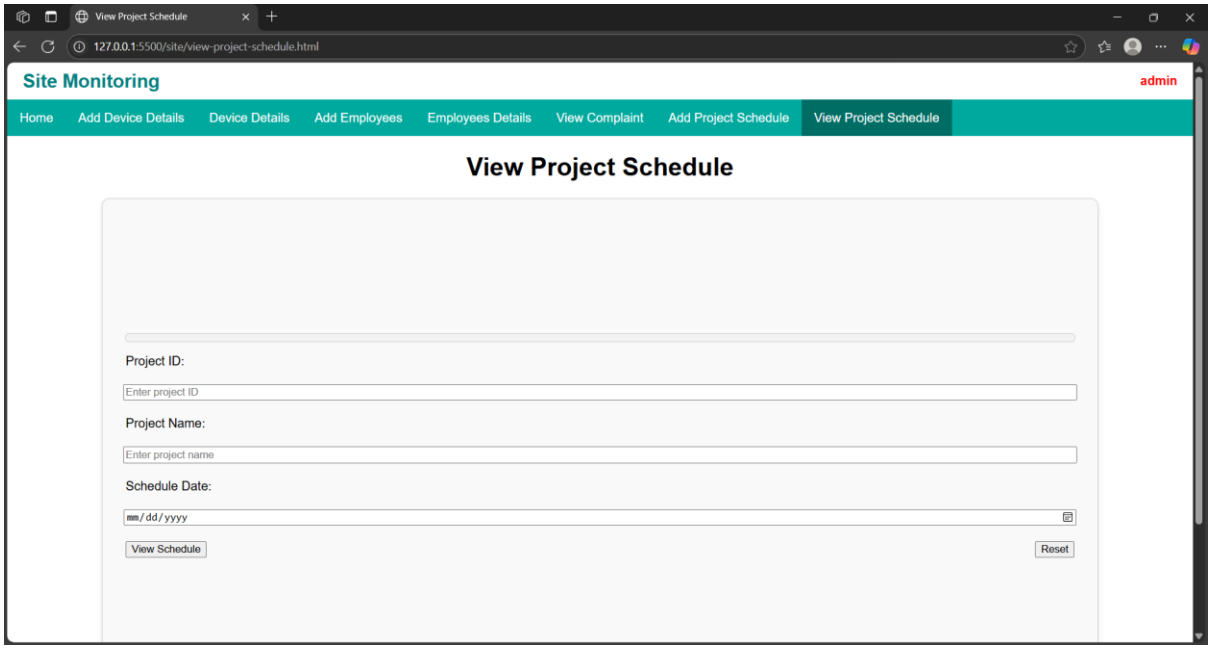


Fig 3.10 Shows The days assigned for each activity can be updated and can be easily monitored through the app and website

In the figure 3.10 The days assigned for each activity can be updated and can be easily monitored through the app and website. The duration for the activities can be updated through the application or the website itself like when the QR code is scanned the activity can be updated through that itself.

In this fig. 3.11 The app name is “SITE MONITORING”. This is the mobile applications login page or the landing page. This is only designed for android device. The data about the app and also the data related to it is secured in systems files for now but for the further development’s we can use cloud services can be used to store the data irrespective of mobile app and website data.

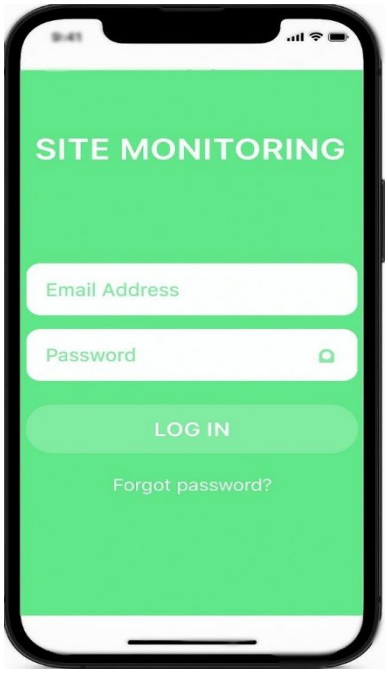


Fig 3.11 Shows The app name is “SITE MONITORING”

Fig 3.12 Shows The user interface of the mobile application through which we can have a QR code scanned access of the QR code.

In the fig. 3.12, This is the user interface of the mobile application through which we can have a QR code scanned access of the QR code which is given to individual staff member and also for the labours. The mobile app can be accessed by anyone who is the regarding person who is assigned to. We can get the data regarding the activity which has already done and also the activity which will be carrying out in the following days or the activity which will be happening currently. And also, the labours details can also be identified through the mobile app and also the scheduling details can also be monitored here.

In this project we concentrated more about the equipment's lost or misplace or the theft, here we also added the field in which we can add the description or the details of the staff and labours working in the site also what work he is carrying out and also the equipment and also the ongoing activity can be tracked also the project scheduling can also be manipulated and also can be updated on the one go.

We are using a RFID scanner which are installed in the entry and exit points at the construction site and also at the inventory/store in the site, here each labour and the equipment will have individual „QR" code which is scannable. Using this we can get the details of the labours staff and also the equipment's which the person is handling if there is any misplace of any equipment it can be easily identified by the „QR" code scanner and also be updated through the website and also in the app which is for this project we have took 5 no of "RFID" tags and also a "RFID" scanner and we have made a prototype of the whole project which can be worked under real time the duration for the whole completion of the project was 3 months.

3.3 Software Destination

Java is a language that operates using the principles of objects and classes, indicating that it is object-oriented. This feature is perfect for creating intricate, extensive applications. It is a language that enforces strong typing, requiring declaration of variables and functions with specific data types before they can be used. Java's platform independence is one of its main characteristics. The Java programming language can be executed on any computer system as long as it has a Java Virtual Machine (JVM) installed. This implies that a Java program created for one operating system, like Windows, can be compiled and executed on a different operating system, such as Linux or macOS, without needing any changes to the code.

Java has strong security measures in place, including sandboxing and automatic memory management, that make it a highly secure programming language. This feature is perfect for creating software that needs a strong level of safety, such as banking and financial applications.

Java is utilized across a broad spectrum of applications, encompassing web development as well as enterprise software. It is commonly used for creating applications for desktops, mobile devices, and the internet. Furthermore, it is employed in the creation of embedded systems, gaming software, and scientific applications.

Navicat is a user-friendly software that provides a visual interface for managing and controlling databases effectively. It has the capability to handle various database management systems like MySQL, Oracle, PostgreSQL, SQL Server, and SQLite.

Navicat provides a user-friendly interface that allows users to easily create, modify, and delete database objects such as tables, views, procedures, and triggers. It also supports data import and export, allowing users to transfer data between different database systems. Some of the key features of Navicat include a visual query builder, data synchronization, backup and restore functionality, and database design and modelling tools. It also supports

advanced features such as data visualization, SQL debugging, and remote server management.

Navicat is used by a wide range of professionals, including database administrators, software developers, and data analysts. It is particularly useful for managing large, complex databases that contain a significant amount of data.

Navicat is available for Windows, macOS, and Linux, and it offers both a free trial and a paid version with additional features. The paid version offers more advanced functionality, such as data modelling and database design tools, advanced data synchronization, and data backup and restore functionality.

Net Beans is a freely available integrated development environment (IDE) used mainly for creating Java software applications. It also facilitates programming in diverse languages like HTML, CSS, JavaScript, and PHP. It offers a complete range of software development tools that encompass code editing, debugging, testing, and profiling. NetBeans offers several functionalities such as an interface that is easy to navigate, a GUI builder that allows users to drag and drop elements, tools for generating code, options for making improvements to existing code, integration with version control systems, and the ability to work with various programming languages. It additionally possesses a substantial group of developers who contribute plugins and extensions to improve its functionality. NetBeans is widely used in the software development industry for developing desktop, web, and mobile applications. It has gained popularity among developers due to its ease of use, versatility, and cross-platform compatibility.

Arduino is a freely available platform utilized for the construction and coding of electronic gadgets. It includes hardware and software parts, such as a microcontroller board, a programming language, and a development environment. The Arduino board is a compact and customizable device that has the capability to manage

different electronic elements like sensors, motors, and lights. This text explains that it includes a microcontroller, which is a tiny computer chip that has the capability to be programmed in order to manage these components depending on inputs specified by the user.

The Arduino development environment offers an uncomplicated and user-friendly platform for writing and uploading code to the Arduino board. Arduino uses a simplified version of C++ as its programming language, which allows beginners to easily understand and utilize it. Arduino is used in various fields such as robotics, home automation, and Internet of Things gadgets. For instance, Arduino can be utilized for constructing a robot that can be operated from a distance, or for designing a home automation setup that can activate and deactivate

lights and appliances according to user-set prompts.

Arduino is also employed in the field of education, specifically in the realm of STEM (Science, Technology, Engineering, and Math) education. It offers a simple and convenient method for students to gain knowledge in programming and electronics.

In general, Arduino is a flexible and easy-to-use platform that enables the creation of various electronic devices. Its ease and availability make it perfect for individuals at any level, be it novices or experts, and its open-source characteristic results in a thriving community of developers actively involved in its continuous growth and enhancement.

C++ is a programming language that was created in the 1980s to build upon the existing C programming language, providing a higher level of functionality and versatility. This language is highly versatile and capable, with extensive usage in creating a variety of applications such as operating systems, video games, and financial software. C++ stands out with its ability to support object-oriented programming (OOP). C++ permits the formation of classes and objects, which bundle data and functions into reusable and modular elements. This feature makes it perfect for creating software systems that are extensive and intricate.

C++ is recognized for its excellent speed and efficiency, making it a suitable choice for applications like real time systems, embedded systems, and high-performance computing that demand superior performance. C++ is extensively utilized in the software development sector to create various types of applications, such as operating systems, device drivers, game engines, desktop applications, and server-side applications. It is also widely utilized in creating financial programs, such as trading platforms and systems for managing risks.

C++ is an compiled programming language where the source code is converted into computer executable machine code. Therefore, the computer can directly understand and run it. This provides it with a competitive edge compared to interpreted languages like Python and JavaScript.

In general, C++ is a highly adaptable and robust programming language that is extensively utilized in various industries for a diverse set of applications in software development. Its ability to perform well, adapt easily, and use object-oriented programming make it an excellent option for creating intricate and high-performing software systems.

3.4 Specifications of the On-Site Installation Equipment

3.4.1 Ultra-long-range tag

Functions:

Extraordinarily long distance of operation.
Exclusively designed for efficient energy usage and providing a longer duration of operation.
A permanent ID consisting of 4 bytes.
In the active mode of operation, only reading is allowed.
The PVC plastic covering is designed to withstand high tension and is waterproof with an IP67 rating.

3.4.2. RF Parameters

The frequency of operation is between 2.4 and 2.48 gigahertz.
The power that is produced is 10 decibels of power.

3.4.3 Basic Parameters

The fundamental identification is composed of four bytes.
Active operating mode is the current mode of operation.
Signal Interval: Every 500 milliseconds per time period (which can be adjusted to fit individual preferences).
Battery Life: The duration of the battery's optimal functionality spans for 6 years, depending on the mode of operation and the power output associated with it.
Reading Range: 0-1500 meters (Testing conducted in an open environment during active operation mode).

3.4.4 Mechanical & Electrical performance

The measurements of the object are 4.7 inches in length, 2.0 inches in width, and 0.6 inches in height. Mass: 82 grams.
The temperature range in which the system can operate is from minus 40 degrees Celsius to plus 60 degrees Celsius.
The temperature range for storage is between -60℃ and +80℃.
The humidity range is 5% to 95% without condensation.
The IP rating is IP67.
Shock Resistance: Can withstand vibrations ranging from 10 to 2000Hz, with a magnitude of 20mm displacement and 15g force, in three directions.

3.5 Battery Powered Tags

The passive RFID tag from Battery powered Tags functions in the 2.45 GHz frequency range. It can be attached to clothing or affixed to a vehicle's windshield. Battery operated tags are extensively employed in managing and tracking personnel in schools and companies, as well as for locating objects, identifying vehicles automatically, managing parking, and collecting
toll fees. Battery-operated tags will transmit signals through the air using a specific protocol format. A specially designed active reader will then analyse the protocol to determine the movement of the tag in relation to time. The Active Reader can communicate with Tags at a distance of more than 80 meters.

3.5.1 Functions:

Exclusively designed for low energy usage, resulting in a longer operational duration. A basic ID that remains constant and is composed of four bytes. Passive operating model allows users to write in the bank. The outer covering of PVC plastic is durable, resistant to high pressures, and has a waterproof rating of IP67.

3.5.2 RF Parameters of Battery Powered Tag

Frequency of operation: 2.4 to 2.48 gigahertz.
The power output is -6dBm.

3.5.3 Mechanical & Electrical Performance of Battery Powered Tags

The measurements are 3.3 inches long, 1.4 inches wide, and 0.2 inches high.
The weight of the object is 22 grams.
The acceptable temperature range for operation is -40 degrees Celsius to +60 degrees Celsius.
The temperature range for storage is -60 degrees Celsius to +80 degrees Celsius.
The range for humidity is between 5% and 95% without the occurrence of condensation.
The IP Rating is IP67.
Shock resistance of 10 to 2000Hz with a displacement of 20mm and an acceleration of 15g in triaxial configuration.

3.6 LF-ACTIVE WAKE TAG

3.6.1 Introduction:

The LF and active Wake-up tag is activated by a 125KHz LF signal and transmits its tag ID at a frequency of 2.45GHz to the reader. The LF and active Wake-up tag is suitable for managing personnel in corporations and schools, checking and identifying vehicles, managing parking lots, and implementing electronic toll collection on highways, among other uses. Active RFID tags have the capability to generate power for an internal clock, allowing for the precise synchronization of time and date with every sensor reading or event recorded. Due to the need for long-distance communication, the ability to monitor an area is limited to using
Active RFID technology.

3.6.2 Functions:

The low-power consumption of this device allows for a longer duration of use.
Support for a basic ID that is 4 bytes long permanently
Awake through the activation of a signal with a frequency of 125KHz.
The outer layer of the material is made of PVC plastic, which is resistant to damage and has a high level of tensile strength. It is also waterproof with an IP67 rating.

3.6.3 RF Parameter

The frequency at which it operates is 2.4-2.48GHz with a 125KHz option.
Output Power: 0 decibels relative to 1 milliwatt .
Rise and shine Sensitivity level: 100 microvolts RMS

3.6.4 Basic Parameters

ID: Fundamental identifier consisting of 4 bytes.
Wireless mode is stimulating and involves actively transmitting signals.
Signal Range: 0 to 8 meters when using the SZ-E221B exciter in an open area.
Battery Life: The battery can last for up to 6 years depending on the operating mode and output power.
The text can be paraphrased as follows: The reading distance is 0-200 meters when using the SZ-F526 and testing in an open environment.

3.6.5 Mechanical & Electrical performance

The measurements are 87mm in length, 55mm in width, and 4.7mm in height.
Weight: 22 grams.
The temperature range in which it can operate is from -40℃ to +60℃.
The range of acceptable temperatures for storage is between -60℃ and +80℃.
The humidity range is between 5% and 95% without condensation.
The IP rating of the device is IP67.
Shock Resistance: Able to withstand vibrations ranging from 10 to 2000Hz, with an amplitude of 20mm and a force of 15g, in all three axes simultaneously.

3.7 Long Range Active Reader

The capability to automatically track RFID badges is facilitated by the 433 MHz active RFID badge reader, which is equipped with two external antennas. The directional antennas included in this device can determine the direction in which the RFID badge is moving, allowing for localization between two adjacent identification zones. This technology is frequently employed as a contactless method to control access, keeping track of the whereabouts of staff members in different sectors like construction and manufacturing.

3.8 Technical Features

Active RFID double readers can be defined as devices capable of reading and detecting active RFID signals. The interfaces of RS232, RS485, and RS422 are available with the option for IP connectivity. Detecting traffic moving in both directions and managing the entrances and exits. Alternative Power Source: 12 volts of direct current or 230 volts of alternating current. There are two sockets for antennas, labelled A and B.
Long-distance: capable of reaching distances up to 328.083 feet. The text can be paraphrased as: The distance can be adjusted to 100 meters and the frequency can be set to either 433 or 868 MHz. The configuration can be done either through RS232 or by using the internal LCD panel, which has a size of 2*16 characters. The dimensions of the ABS white housing are 7.086 inches in length, 3.543 inches in width, and 7.165 inches in height (180 mm in length, 90 mm in width, and 182 mm in height).
A program that enables the setup, display, and saving of RFID data packages. RFID readers equipped with various interfaces such as RS-232, RS-485, Ethernet, Wi-Fi, or USB connections. Utilizes the MCHD command codes. This software is compatible with Windows XP and any newer version.

3.9 RFID Reader Access Control Autonomous or Centralized Sensor

The active RFID reader at 433 MHz ensures access control by operating at either 433 MHz or 868 MHz frequency. It also includes a built-in relay that allows for direct control of the accessories. The recipient is able to work with

both RS-485 and RS-422 connections and has an extended coverage area of up to 328.083 feet. The radius of 100 meters. The Wiegand output, which is compatible with most access controllers, allows for hands-free access control and monitoring. The active RFID reader operating at 433 MHz has the capability to monitor the humidity and temperature in various types of buildings within industries like manufacturing, among others.

3.10 Technical Features

Active RFID reader operating at a frequency of 433 MHz. The interface options are RS232, RS485, and USB. Access control protocols include Wiegand 26bits, as well as Data and Clock components. "Operating independently, the system includes one internal relay that is activated through a dry contact." Long-distance: up to 328.083 feet. The software allows for adjustment of the open field to a distance of 100 meters. The dimensions of 3.740 × 2.125 × 1.377 inches (95 × 54 × 35 mm) make it a waterproof device with an IP65 rating. BNC connector for the antenna / Gland connector for the antenna. Software used for configuring electronic warfare systems. ERW modifies the range of detection for the badge. ERW constantly shows the received data frames. ERW monitors and evaluates levels of RF noise in real-time

IV. CONCLUSIONS AND SCOPE OF FUTURE WORK

4.1 Conclusion

1. The website has been created to monitor the daily work status of that particular project from the scheduled date of work.
2. Without progress tracking it is impossible to summarize whether the project is on schedule and within budget.
3. Single source for better data consistency i.e. all the documentation in one single platform making effective monitoring and controlling process.
4. It ensures that every team member is well-informed about the project's status, enhancing the efficiency of communication within the team.
5. JSP and HTML programming language is been used to create a database of the website.
6. AWS account is created to run the application in the Cloud.
7. 'N' Number of resources can be added, to allocate the resource to the particular sequence of work.
8. All the specimens were immersed in 3%Hcl, 3%NaCl and 3%Na2So4 gives gain in the weight of the specimens as a result of the reduction in the compressive strength of treated CFRC with varying immersion period.
9. To ascertain the mineralogical and microstructure of the treated CFRC, tests using the scanning electron microscope (SEM), energy dispersive X-ray analyzer (EDAX), and X-ray diffraction (XRD) were carried out. This SEM outcome demonstrates that the matrix's and fibers' connection is was achieved but there is formation of void space around the fibres which is to be minimized with any other treatment. The minerals present and magnifications of the composite were examined through EDAX and XRd which was tabulated in chapter 4.2.8 and 4.2.9.

4.2 Scope for Future Work

1. Integration with IoT and AI Future research can explore the integration of RFID technology with the Internet of Things (IoT) and Artificial Intelligence (AI) to enhance real-time monitoring and predictive analytics. AI algorithms could analyse RFID data to predict equipment failures, optimize resource allocation, and improve theft prevention strategies.
2. Advanced Data Analytics Implementing advanced data analytics tools to process the vast amounts of data collected by RFID systems could provide deeper insights into construction site operations. This could include trend analysis, anomaly detection, and automated reporting for better decision-making.
3. Cloud-Based Solutions Expanding the current system to a fully cloud-based platform would allow for seamless data access and collaboration across multiple construction sites. Cloud storage could also enhance data security and scalability.
4. Mobile Application Enhancements Future iterations of the mobile application could include features like augmented reality (AR) for equipment tracking, voice commands for hands-free operation, and offline functionality for remote areas with limited connectivity.
5. Energy-Efficient RFID Tags Research could focus on developing RFID tags with even lower power consumption or energy-harvesting capabilities to extend battery life further, reducing maintenance needs and costs.
6. Blockchain for Security Incorporating blockchain technology could enhance the security and transparency of RFID data, ensuring tamper-proof records of equipment and material movements, which would be particularly useful for insurance and audit purposes.

7. Multi-Technology Integration Combining RFID with other technologies like GPS, Bluetooth Low Energy (BLE), or Ultra-Wideband (UWB) could improve tracking accuracy, especially in complex or indoor construction environments.
8. Automated Scheduling Adjustments Future systems could automatically adjust project schedules based on real-time RFID data, accounting for delays or accelerations in equipment and labour availability without manual intervention.
9. Sustainability Tracking RFID technology could be used to monitor the environmental impact of construction activities, such as tracking material waste, carbon footprint, and energy usage, contributing to sustainable construction practices.
10. Global Standardization Developing global standards for RFID implementation in construction could facilitate wider adoption, interoperability between systems, and consistency in data reporting across the industry.
11. User Training and Adoption Future work could include creating comprehensive training programs and user manuals to ensure smooth adoption of RFID technology by construction workers and managers, addressing any resistance to new technology.
12. Cost-Benefit Analysis Conducting detailed cost-benefit analyses for RFID implementations in various construction scenarios could help organizations justify investments and optimize their use of the technology.

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