MITR Term Project Report

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Executive Summary

Socotec US, a leading provider of technical advisory services specializing in testing, inspection, and certification, has a team of four hundred experts dedicated to supporting construction and infrastructure projects throughout the entire asset lifecycle. With numerous offices in major cities across the country, Socotec is known for its well-established in-house team capable of managing multiple high-profile projects simultaneously; Socotec emphasizes impartiality as a trusted third-party, providing unbiased solutions. Anthony Traniello, the Director of Information Technology, served as the primary contact for the project.

Within the past few years, Socotec has experienced rapid growth. As a result, the company's already overburdened IT team struggled to monitor employee software and hardware assignments accurately and consistently. This resulted in significant and unnecessary annual expenditures – unused software licenses were being renewed and untracked hardware was being replaced unnecessarily. The absence of a centralized database for license assignment information across various enterprise software forced team members to rely on numerous different software admin portals. This led to inefficiencies in workflow and communication between team members, as well as discrepancies in employee license assignments. Manual methods of tracking employee hardware distribution through spreadsheets created similar inefficiencies and discrepancies, prompting the need for a streamlined, centralized system.

As Socotec continues to expand, they need more viable solutions for IT resource management. Currently, the company employs approximately five hundred total employees – four hundred industry experts and over a hundred support staff – and expects to quadruple its workforce within the next decade. The Socotec IT Dashboard application enhances productivity of the IT and Administrative teams and streamlines their workflow for the management of IT resources on a national scale. The project was designed to address the company needs of managing employee license information through tools that allow the querying and manipulation of the database and accomplishes this through a simple interface for viewing active and inactive resources across all software and hardware providers. This creates value in two ways: IT and Admin teams members spend less time on resource management, and less cost will be incurred from excess licenses renewal or unaccounted hardware – saving tens of thousands in spending a year. Calculations of company spending will be streamlined. Admins can also view warranty expirations, license renewals, and other time-sensitive information via a dynamic calendar. This application was designed with three primary points of value: increased productivity, loss prevention, and scalability for a growing company on a national scale.

Functional requirements defined by the initial client meeting covered processes such as viewing, administrating, and calculating, with specific functionalities like license and hardware data viewing, updating employee data, and utilizing built-in budget calculators. The primary users are

IT and administrative team members, and the user interface aligns with Socotec's branding. Tables in the database store data for employees, software licenses, and hardware, facilitating effective data tracking. Non-functional requirements address scalability, compatibility with Socotec's existing technologies, maintainability through database checks, usability with a well-structured database, security measures, and alignment with existing hardware and operating systems. The intentional exclusion of mobile compatibility reinforces security measures and aligns with company policy. Since the Socotec application is designed for administrators, privileged access is required to use the features on the platform. Featured functions include viewing and editing existing employees and creating new entries in the database.

During the project's analysis phase, an examination of associated risks was conducted along with a cost-benefit analysis. The primary risks associated with the project included issues arising from full system integration, erroneous data migration, security breaches in the database, and compatibility. Through an analysis of potential mitigations of the risks involved with the project, the team determined that all risk factors could be considered very low probability. Acknowledging the potential high impact of integration, data migration, and security risks on the company despite the low probabilities, the team established a Risk Adjusted Interest Rate of 12%.

The cost-benefit analysis indicates that implementing the new software system at Socotec will yield substantial benefits, surpassing the costs over the next five years. The software is expected to significantly reduce the $55,000 annual expense related to license renewal errors, resulting in an estimated cost avoidance of $82,000 after five years. Additionally, automating administrative tasks saves hundreds of hours annually for employees. Initial development and integration costs are estimated at $19,850, with annual software maintenance at $26,040. Although adapting to the new system may incur initial inefficiencies, a training program will minimize potential loss. Overall, the analysis suggests significant long-term financial and operational advantages for Socotec through the implementation of the new software system.

During the project turnover, the team collaborated with Mr. Traniello to explore use cases and workflows for the platform, providing a recorded session for future training. Integration documentation was delivered, resulting in a fully functional system without the need for a follow-up meeting. Regular communication throughout the design and implementation phases allowed the team to incorporate feedback and provide progress updates. The completed application exceeded Mr. Traniello's expectations, effectively addressing license tracking discrepancies. It enables efficient monitoring and updating of software licenses and hardware, with built-in calculators aiding budget analysis. Administrators foresee increased utility during license renewal periods with the added calendar component. Overall, the team's consistent communication and collaboration contributed to the successful implementation and integration of the application.

Introduction

Socotec, a construction consulting firm, currently boasts a workforce of approximately five hundred employees, comprising four hundred experts and one hundred supporting roles. With ambitious plans for expansion over the next five years, the company aims to grow its team to around seven hundred members. Given that each employee holds at least one license under their name, the potential for license management issues arises during the rapid growth phase. The license management tool seeks to monitor and manage employee license information to mitigate the risk of unnecessary expenditures stemming from human error.

Client Organization and Description

Socotec is a leading provider of technical advisory services specializing in testing, inspection, and certification. Their team of four hundred experts offer comprehensive support in the construction and infrastructure sectors, spanning the entire asset lifecycle. Socotec's historic approach leverages insights from various fields to foster effective communication amongst the different parties involved. They have a well-established and specialized in-house team who can manage multiple high-profile projects simultaneously. Additionally, Socotec prides itself on its impartiality as a trusted third-party, offering unbiased solutions. This unique combination of expertise, collaboration, and independence enables Socotec to address complex challenges effectively.

Their consistent engagement throughout an asset's life cycle and a history of success, with 80% of clients returning for their services, demonstrates their dedication to delivering outstanding projects. Furthermore, Socotec plays a role in leadership by actively contributing to industry standards and guidelines while advancing the education and technical knowledge of the field. Through their expertise and collaborative approach, Socotec addresses intricate challenges, ensuring the integrity and sustainability of assets in the built environment.

Anthony Traniello, the Director of Information Technology, served as the main point of contact for this project. He is responsible for supervising IT operations across all US offices. Communication primarily occurred through email using anthony.traniello@socotec.us, and the team was also provided with the New York City office phone number: (212) 689-5389.

Project Team

The project team consists of five students from Rensselaer Polytechnic Institute studying Information Technology and Web Science (ITWS). Each student brings technical expertise, collaborative prowess and unique skills and perspectives to the project.

Beatrice Dang was the team's project manager, client liaison, and one of the primary report writers and front-end designers. She is a senior majoring in ITWS with a concentration and minor in architecture. She has experience in UI design and front-end development through Rensselaer Center for Open Source and has worked on web design for the Museum Association for New York. She also has graphic design experience from her architectural coursework and was previously an intern at Socotec.

Eric Carson was one of the project's back-end developers and primary writers. His primary focus was on overall integration of website components such as connecting the database to the server and displaying the data on front-end React components. He also designed the structure of the databases that are used for calendar and calculation features. Eric is a senior ITWS and electrical and computer systems engineering double major. His expertise includes process automation and the creation of access point web servers to send information between hidden devices.

Jichuan Wu was one of the project's back-end developers that contributed to editing and deleting entries from the databases using APIs. These endpoints enabled the display and modification of data in response to front-end inputs such as forms or search queries. He is a junior dual majoring in ITWS and Computer Science and has prior experience in developing and operating back-end databases to create the API endpoints as was done in the project.

Ishita Pandey was one of the project's front-end developers. For this project, Ishita assisted in the design and implementation of the front-end features and applied both her technical and artistic skills to create a visually appealing and user-friendly web interface. Ishida is a junior dual majoring in ITWS and Computer Science who has prior experience in developing front-end features using React components.

Jordan Oberstein is a senior dual majoring in ITWS and Computer Science with a concentration in information security. For this project, Jordan assisted with implementing front-end features and ensuring overall security through the creation of an administrator login page. He has experience developing both front-end and back-end components working on previous projects complimented with extensive experience with implementing both low and high-level security.

Problem Statement

Socotec US is a rapidly growing company with a small internal IT team with less than ten employees within a company of over four hundred experts and one hundred supporting employees. The team faced challenges in manually monitoring employee software licenses and hardware distribution which leads to unnecessary annual expenditures. Individual license distributions could only be accessed through specific admin portals for the given product, lacking a centralized database to consolidate license information across various enterprise software. This decentralization complicated the tracking of employees with several licenses, risking payments for unused licenses or inadequate license renewals. As a result, there was a need for a more streamlined system capable of automating the once manual process of tracking through spreadsheets for monitoring employee hardware distribution.

IS/IT Solution Scope

The team developed an internal web application which tracks employee software licenses and hardware distribution. Relational databases associate employee, software license and hardware data. This data is displayed as a dynamic dashboard and includes functionality to update employee data (CRUD operations). The solution also features other helpful tools such as license and hardware budget calculators that utilize license and hardware pricing data stored in the database. The solution will also feature a dynamic calendar that displays license renewal dates and hardware warranty expiration dates. The team focused on five primary areas of development: relational database design, API design and CRUD operations, Node.js back-end development, React.js front-end design, and security.

The site offers a secure login feature for administrators and IT personnel, providing access to an up-to-date dashboard containing comprehensive data on current employees, licenses, and computer hardware. Within the employee table, specific details about each employee, including assigned software licenses and company-related information, are available. The license table presents a comprehensive overview of all licenses, featuring key metrics such as price and expiration dates. The license dashboard itself displays total license counts for each software type, including counts of active and inactive licenses. Under another header, the computer hardware table shows company hardware data, specifying the current employee assigned to each piece.

Administrators have the capability to add, remove, and update data within these tables. This functionality is crucial for tracking new hires, terminations, and changes in software licenses and hardware distributions. Furthermore, administrators can conduct targeted searches for specific users, licenses, and hardware, enhancing the efficiency of data retrieval and management.

Another feature administrators have is the ability to view and edit a dynamic calendar that serves as a repository for key dates such as annual software renewals and hardware warranty expiration dates. The feature enables administrators to schedule when new hardware will be ordered as well as schedule when specific licenses should be renewed. A budget calculator will allow them to calculate total costs when purchasing licenses or hardware units.

Methodology

The team adopted a customized Agile workflow characterized by two-week sprints. Biweekly update sessions were held during class meeting times to ensure regular progress tracking. Additionally, the team scheduled separate weekend meetings for components of the project that demanded collective effort, optimizing efficiency in addressing key project elements. This structured approach facilitated effective collaboration and timely updates, contributing to the overall success of the project. At the end of sprints, a list of updates and questions were devised by the team for Beatrice, who served as the client liaison, to communicate with Anthony Traniello, the primary point of contact with Socotec.

Right from the project's inception, the company needs were clear. The new platform's primary objectives included showcasing employee license information and providing administrators with robust tools for managing these licenses. This encompassed functionalities such as adding, modifying, and deleting data dedicated to employee, license, and computer hardware information. Additional capabilities that calculate capital expenditures spent on licenses coupled with a display of upcoming license expiration dates integrated into the website would allow for specific license management operations such as budget calculation for purchasing and renewing licenses.

After the initial meeting, the team developed a project proposal outlining the overall system architecture and how specific features within this architecture addressed the identified client needs. The proposal included a cost-benefit analysis, considering factors such as inflation. Upon analyzing the tangible and intangible costs and benefits, the team concluded that while the platform did not directly generate revenue for the company, the monetary value generated from avoiding costs such as unnecessary license expenditures and time saved through the integrated administrative features exceeded the cost of platform integration and maintenance by more than threefold.

The team split into three groups based on technical expertise: front-end design, back-end and database design, and website security. This division helped distribute the work amongst the five members and increased the productivity of each Agile sprint by allowing concurrent progress across the three technical categories. Once these three phases had their initial designs built out, the group reorganized into two new categories: one group for reporting and documentation and the other on website integration. The second split allowed the team to focus on fleshing out the final product to prepare it for handoff while simultaneously documenting the various workflows of the website to simplify the process integration of the new administrative platform into the overall Socotec architecture.

IS/IT Requirements

Based on the project requirements outlined by Socotec during the initial client meeting, the team developed a comprehensive set of functional and non-functional requirements that the platform includes to meet the client's expectations.

Functional Requirements:

Process

The primary use case of the application is for IT and administrative team members to view active and inactive software licenses, as well as actively update and change employee license assignments. The overall process consists of three general action types: viewing, administrating, and calculating.

Viewing

The landing page of the application displays a license dashboard with the following items available for users to view: a count of active and inactive employees or "users," a count of all active and inactive software licenses, and a table with employee data.

The table contains general information associated with all individual employees, including: their full name, email, division, and company within the Socotec corporation and their office's associated profit center. There is a "view details" button associated with each employee which displays a list of all software licenses that an employee currently has.

There is a dynamic calendar with options to view license renewal/expiration dates, as well as hardware warranty expiration. This feature is necessary for managing administrator workflow since it would otherwise be exceedingly difficult to track when specific licenses need attention.

Administrating

Admins can update employee data directly through the interface via forms. There are options to "edit" as well as "delete" and "activate/deactivate" users directly from the table, and these changes will be immediately viewable. Admins can also "create" new employees that will be added to the database and dynamically displayed.

Calculating

Admins can use two built-in budget calculators: one calculator for license costs and one for hardware costs. The license cost calculator allows admins to search for a license types, input the number of each kind of license, and return a total cost estimation. The hardware calculator is identical to the license cost calculator but instead allows admins to search for different existing hardware types.

People

The primary users for this application are IT and administrative team members. These users have access to privileged information, such as license and hardware distribution, which exist in their databases. Therefore, they can update, create, and delete employees from the database.

The client point-of-contact is Anthony Traniello, Director of IT for Socotec US. All fonts and colors have been approved for the application by Mr. Traniello. Mr. Traniello provided guidance and feedback throughout the course of the project and has acted as a representative for his team—the end-users.

The team has provided training to Mr. Traniello on how to use the platform effectively; he will leverage this training to teach his team as well as the administrative team to use the platform. The team has also provided documentation and code for the integration of the application with their internal servers and databases.

User Interface

The user interface is designed to align with Socotec's branding. It is designed with simple navigation and minimal pages for most-efficient use. Because this application will serve primarily as a tool, it was important to make the overall design as straightforward and user-friendly as possible to suit the different use-cases.

Database

The database consists of three primary tables: an employee table, a software license table, and a hardware table. An employees table is necessary to track each employee and their respective information. Each employee also has an associated array containing assigned license ids. A second table is necessary to track each software license and its respective data. Finally, a third table is necessary to track hardware and computer components and will have a similar structure to the second table.

Non-Functional Requirements:

Scalability

Socotec plans to quadruple its company size over the next five to ten years. The application has the capability to display all essential licensing data included within the employees, licenses, and hardware data. There are multiple filtering metrics such as active licenses or employees working under a specific division of the company integrated into the design so admins can view subsets of the datasets for more efficient processing.

Compatibility

The application was implemented utilizing React.js for the front-end, Express.js for the API, and MySQL to host the database. The platform is hosted using Node.js. MySQL was the ideal choice for the solution since Socotec uses Microsoft SQL Server to host the database and Microsoft Azure to host their company site. The conversion from MySQL to SQL Server requires minimal changes and would therefore be compatible in the overall integration of the solution with the company's main platform.

Maintainability

The database is editable for admins through the interface with sufficient checks and balances for inserting and deleting items from the database. For example, when an employee is terminated, their license statuses are automatically set to inactive. Additionally, administrators cannot remove employees from the database unless the database shows that the terminated employee does not possess any of the company's computer hardware. Measures such as these mitigate documentation errors, and the design supports a specific workflow that minimizes confusion while assisting processes such as employee termination.

Usability

A robust database serves as the backbone of the system, acting as the core component to store and manage critical data. It ensures the systemic organization of each user's licenses, as well as facilitate processes for license issuance, renewal, and revocation. This well-structured database will inherently track allocation of licenses and further ensure legal compliance. The database will be used by API calls supported in the back-end, for fetching, editing, deleting, and adding employees, hardware, licenses information. Since the team does not have access to the live employee database, a stand-in database with simulated employee, license, and computer hardware data is used to demonstrate and test the viability of the solution.

Security

While the scope of the project does not involve determining administrator access, documentation will be provided with recommendations for integrating the software so that only administrators who manage employee license information will have access to the data. The application is deployed for use only within the company network and is secured behind a firewall.

Hardware
Given that Socotec already operates services on Microsoft Azure and employees utilize their existing devices for current operations, there was no need for additional hardware during the implementation and integration of the project into the Socotec architecture. The only physical hardware required to run would be the servers responsible for storing the database containing the employees, licenses, computer hardware, calendar, and administrator login details. Utilizing existing resources minimized the implementation cost of the project while simultaneously aligning with Socotec's preferred technologies.

OS
Operating on the Microsoft Azure hosting platform, the project is entirely web-based, ensuring that the limitations on using the application are not tied to specific computer operating systems. The primary constraint on website usability lies in browser compatibility. However, given that administrators use company-issued computers, concerns about employees using outdated browser versions were not a significant consideration during the development of React.js components. The controlled computing environment allows for a standardized user experience within the company's network.

Mobile
With a focus on maintaining the security of employee and license data, the administrator login feature was implemented to restrict data querying and modification solely to the designated group of administrators responsible for license management. Consequently, the project was specifically designed for Socotec computer use within the secure company network. A mobile-compatible version was not developed, aligning with company policy that discourages the use of project features on personal mobile devices. This intentional omission serves as an additional deterrent, reinforcing the company's stance against the unauthorized use of the project on mobile devices by administrators.

IS/IT Design and Development

Use Case Diagram
The application has several different use case scenarios for IT and Administrative team members. Admins primarily use the application in the following scenarios: when processing a new hire for the company, when processing a termination in the company, when reassigning existing hardware or software licenses to employees, when purchasing and assigning new hardware or software licenses to employees, when scheduling annual software renewals or device maintanence, and when doing simple budget calculations.

Processing a New Hire
When processing a new hire, admins will add a new user to the Employee table in the database with a status set to "Active". Now that the employee exists in the table, admins can assign either existing or new software licenses and hardware devices to this employee. This may involve license or hardware reassignment, or the purchasing of new licenses and hardware.

Processing a Termination
When processing a termination, admins will set the status of the terminated employee to "Inactive" in the employee table. Even after the employee's status changes, their licenses and hardware still exist in the database. Their licenses will remain inactive until reassigned to another employee. If the licenses do not get reassigned before expiration, admins can choose not to renew the license and remove it from the database. Similarly, the employee's hardware, upon physical return, can be reassigned to another user, or retired from use and removed from the database. Lastly, admins can remove the employee from the database completely when their information is no longer needed.

Reassigning Existing Licenses or Hardware
When Socotec employees are assigned to new projects or divisions, they may need to be assigned new licenses. Likewise, they may no longer need some of their current licenses which could be used by other employees. In the License table, each software is associated with a number of "Active" and "Inactive" users. If a software type has a non-zero inactive count, this software has licenses that can be reassigned, and the inactive count will decrease by one for every newly assigned employee. If there are existing software licenses available, the inactive count will be zero, signifying to admins that a new license must be purchased for a user.

Similarly, if an employee needs a new hardware device, they can be reassigned an existing device. If the appropriate device exists in the Hardware table and has no assigned user, this device can be assigned to the employee. The device will then appear as assigned to that employee.

Purchasing
Purchasing can occur in two different ways: purchasing new assets from types that already exist in the database, or purchasing completely new hardware or software types. For the former case, in terms of software licenses, when the "Inactive" user count is zero, more licenses can simply be assigned and the "Active" user count will increase, signifying that more licenses have been purchased. For hardware in this case, a new hardware device must be created and added to the table, but can be autofilled with information if that hardware already exists in the database, and can provide a count if multiple of the same hardware are being purchased at once.

In the latter case, if admins need to purchase completely new hardware or software, they will simply add these using the "Create License" and "Create Hardware Device" pages, and then assign them to employees as necessary.

Scheduling
Software license data will include expiration dates and hardware data will include warranty expiration dates. This information is vital when admins are preparing to renew software licenses, or when considering replacing hardware devices. Admins can access the Calendar page to view all expiration dates for both hardware and software. On the expiration date of a software type the status, will automatically be set to "Inactive". If the admin has renewed the license externally, they can then reset the status of the license to "Active" in the table. This will help admins to proactively renew licenses, and if a hardware warranty is expiring, decide if any maintenance is necessary before that date.

Budget Calculations
The application has two purchasing calculators, one for software and one for hardware. Admins can search for existing software and hardware types, provide counts, and quickly return a total purchasing cost. This tool is useful when admins need to provide quick budget figures during meetings, or when considering the costs of new purchasing.

Updating Database
In some cases, admins may need to change the information related to an employee, software license, or hardware device. Each associated table allow admins to edit any data entry and update the information as necessary. Examples of this may be when the annual cost of a software license changes, or when an employee's email address changes.

Specific Scenarios
The team has also mocked some more specific use case scenarios that will be commonplace for Socotec admins. These use cases demonstrate how an admin may employ several of the above listed processes within one workflow.
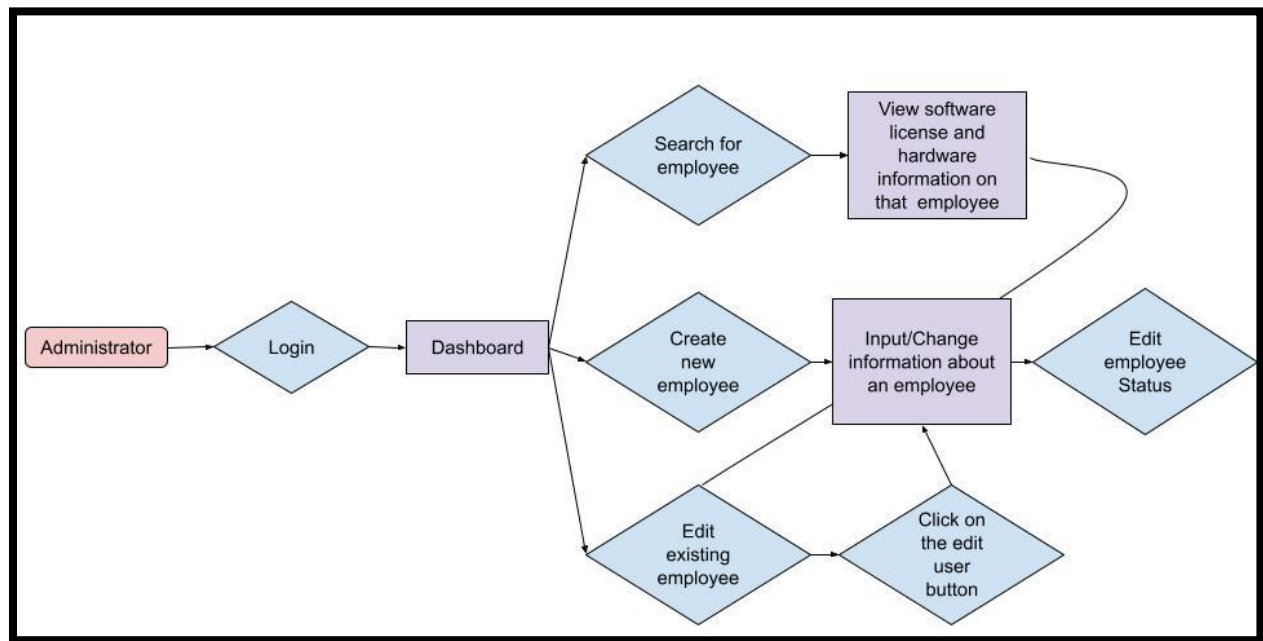
Figure 1: Administrator level use case diagram

Front-end Design

Before developing the application, Ishita and Jordan created mockups and wireframes of the application so the client could have a better idea of the product and provide the team any feedback which was used during the development stage of the project. Figures 2.1 and 2.2 show the wireframe that was created of the dashboard of the application.
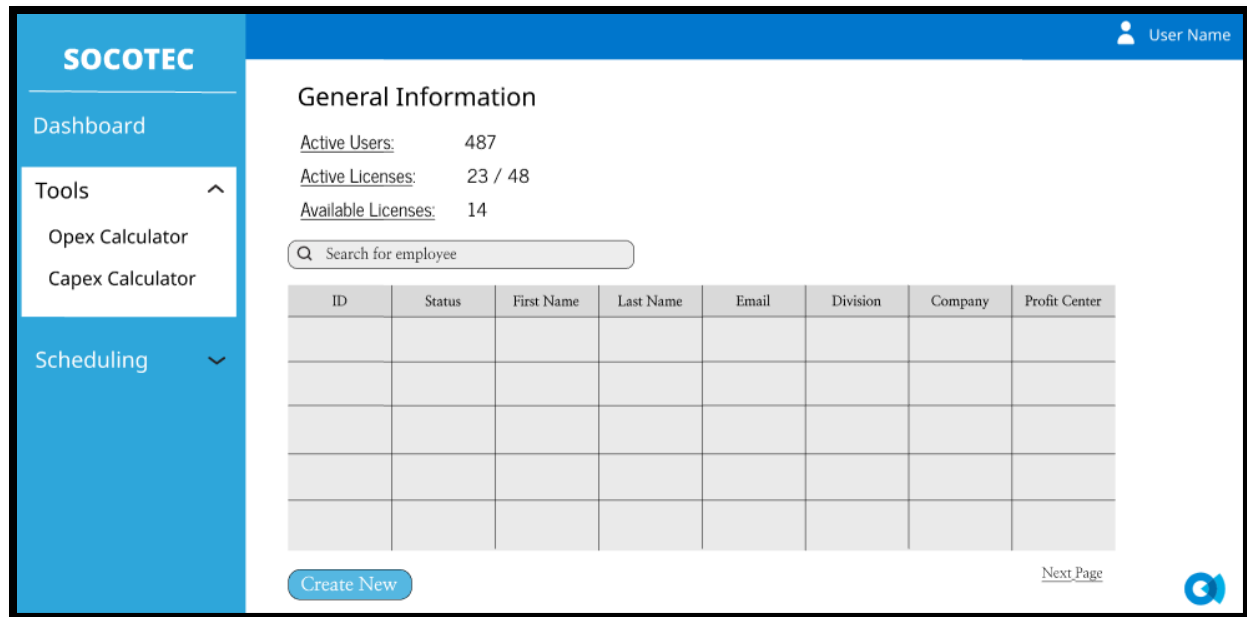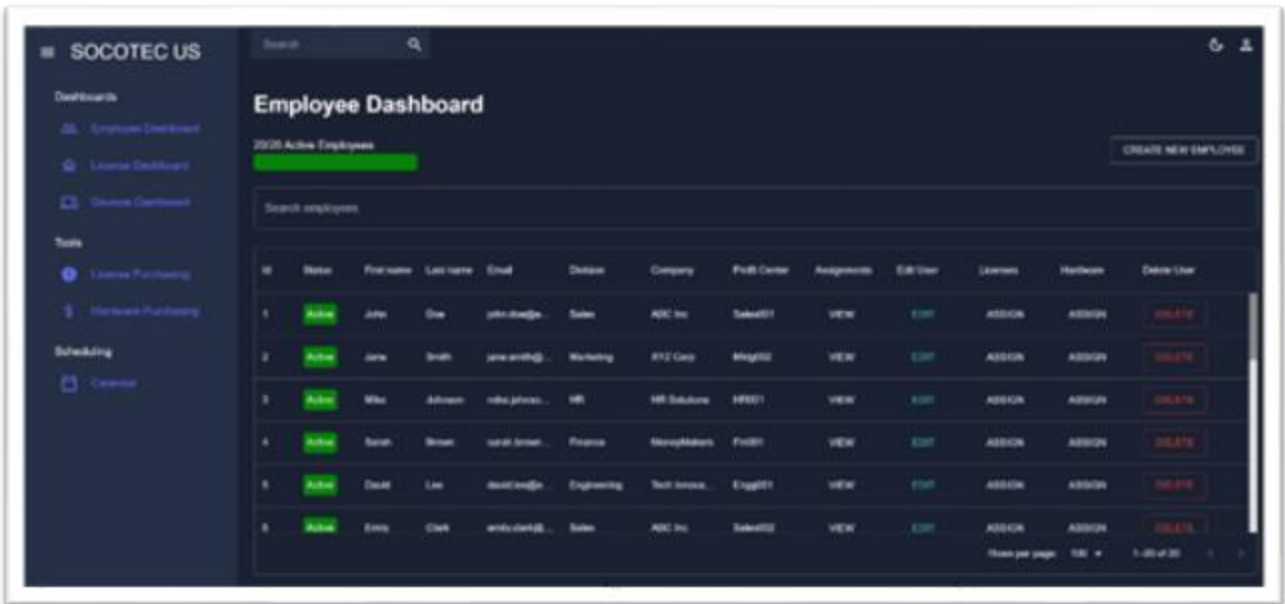
Figure 2.1: Mockup of dashboard with table collapsed.
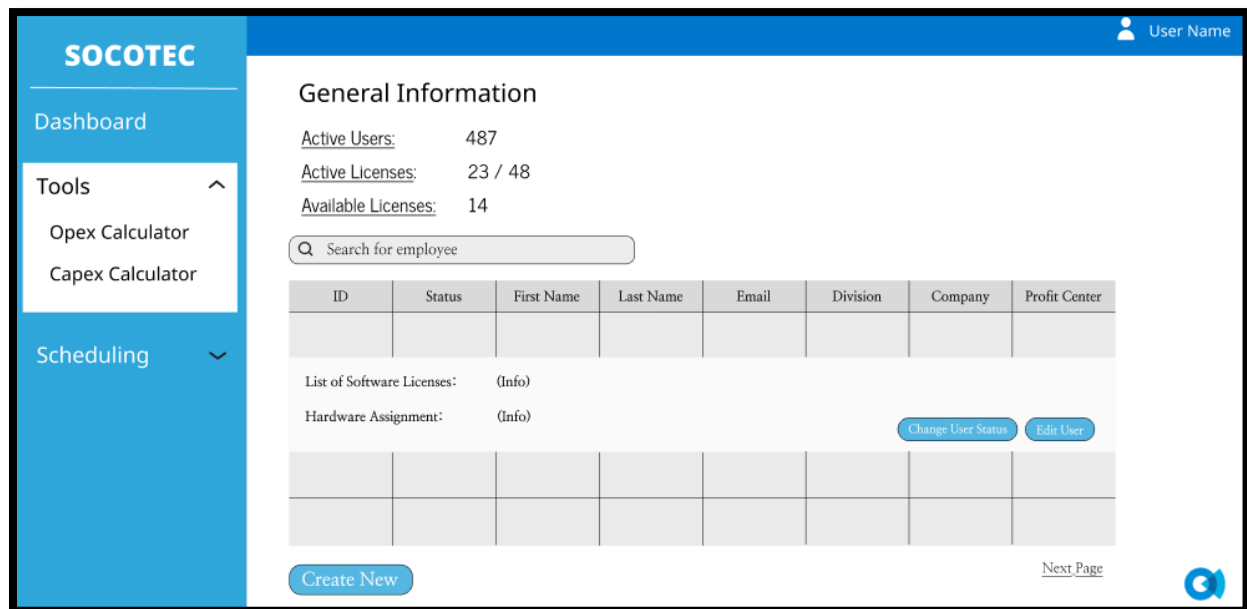
Figure 2.2: Mockup of dashboard with table open

Employee Dashboard

Figure 2.1: The Employee Dashboard

Figure 2.2: Edit an Employee
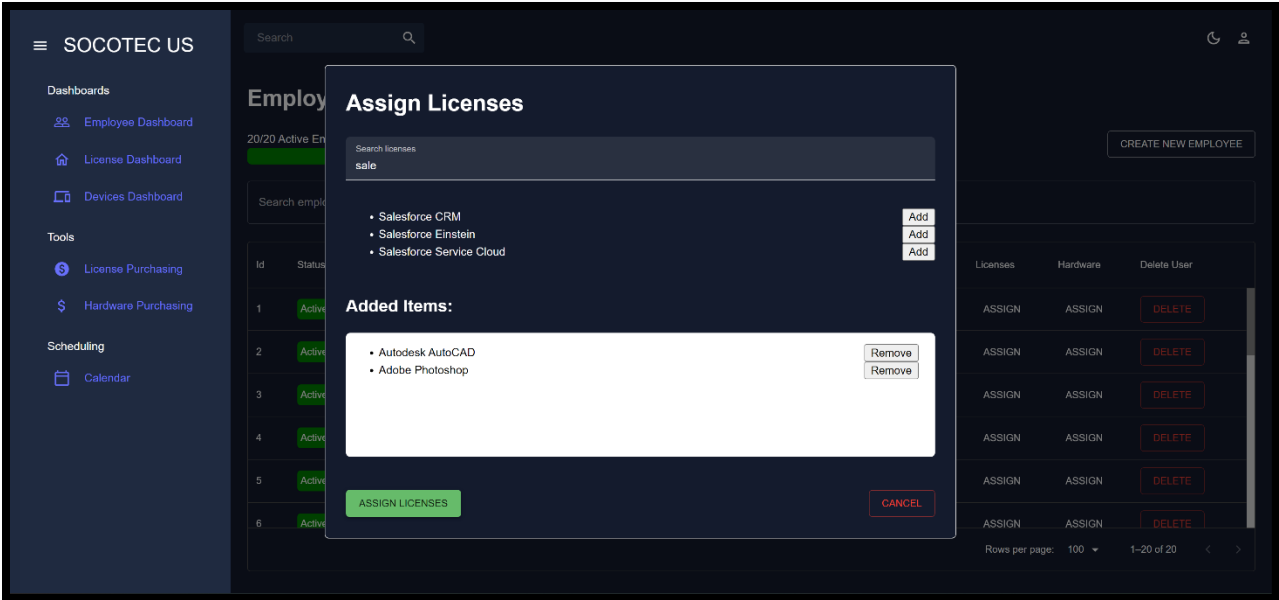
Figure 2.3: Search and Assign New Licenses to an Employee
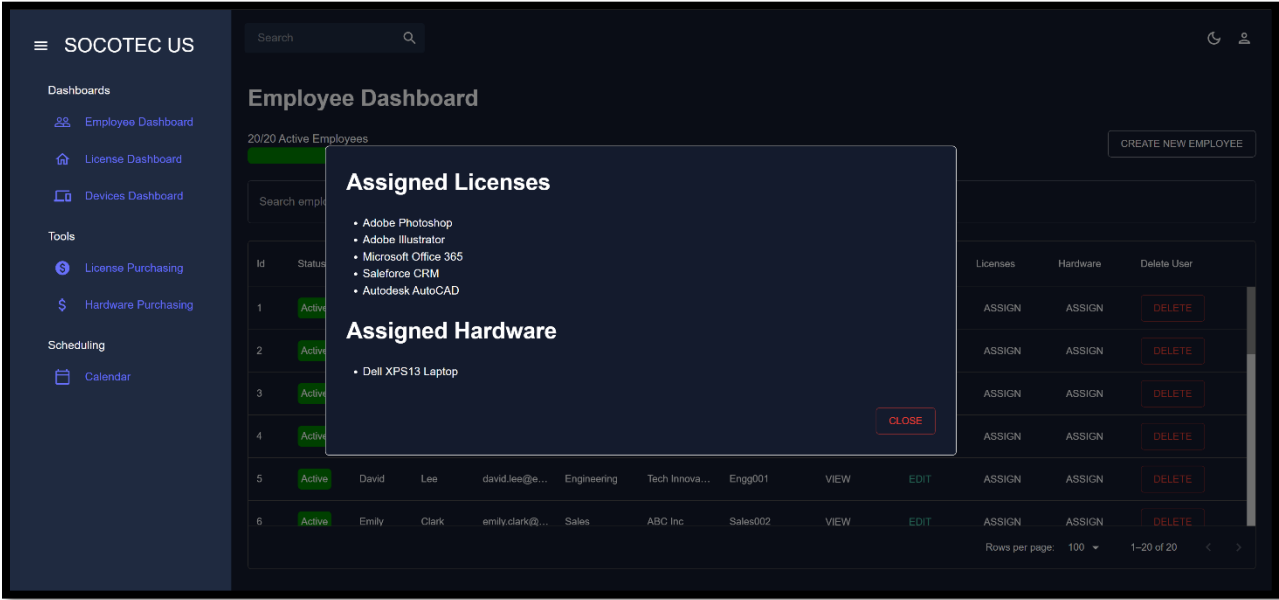
Figure 2.4: View an Employee's Assigned Licenses and Hardware

Software License Dashboard
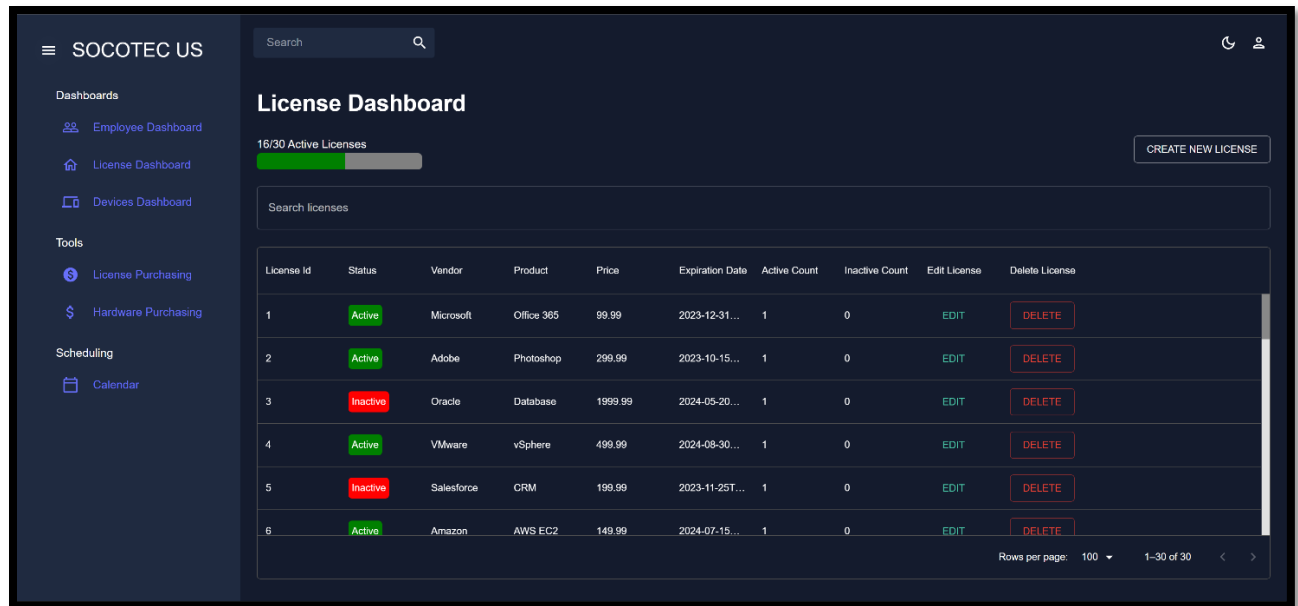
Figure 2.6: Software License Dashboard
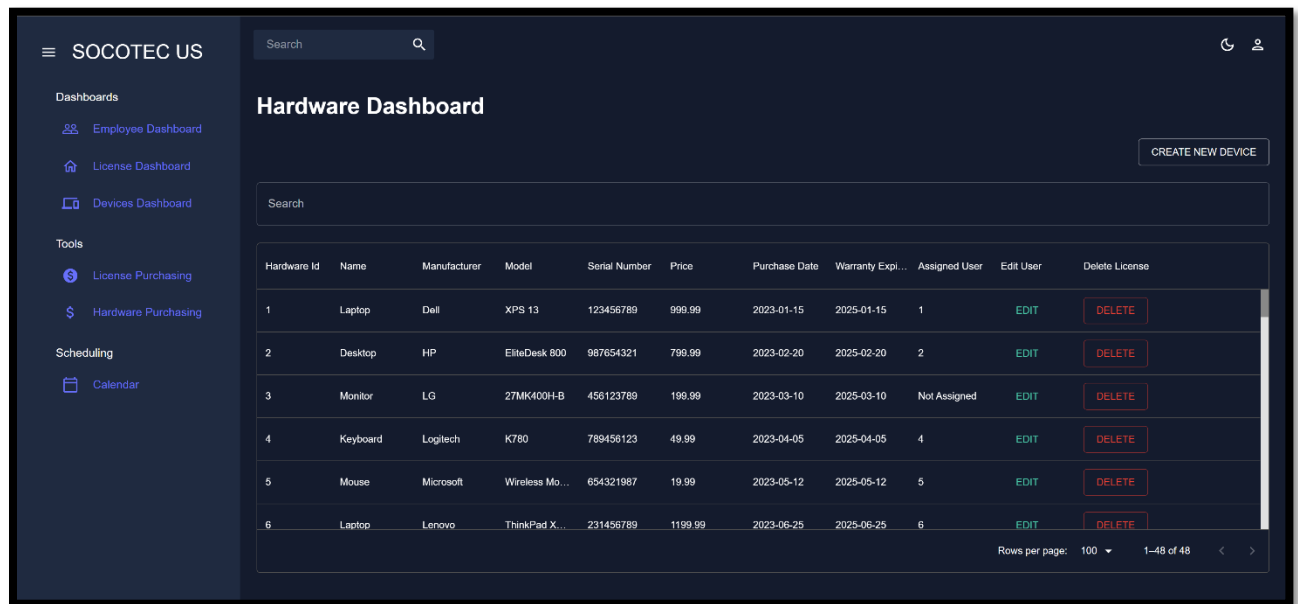
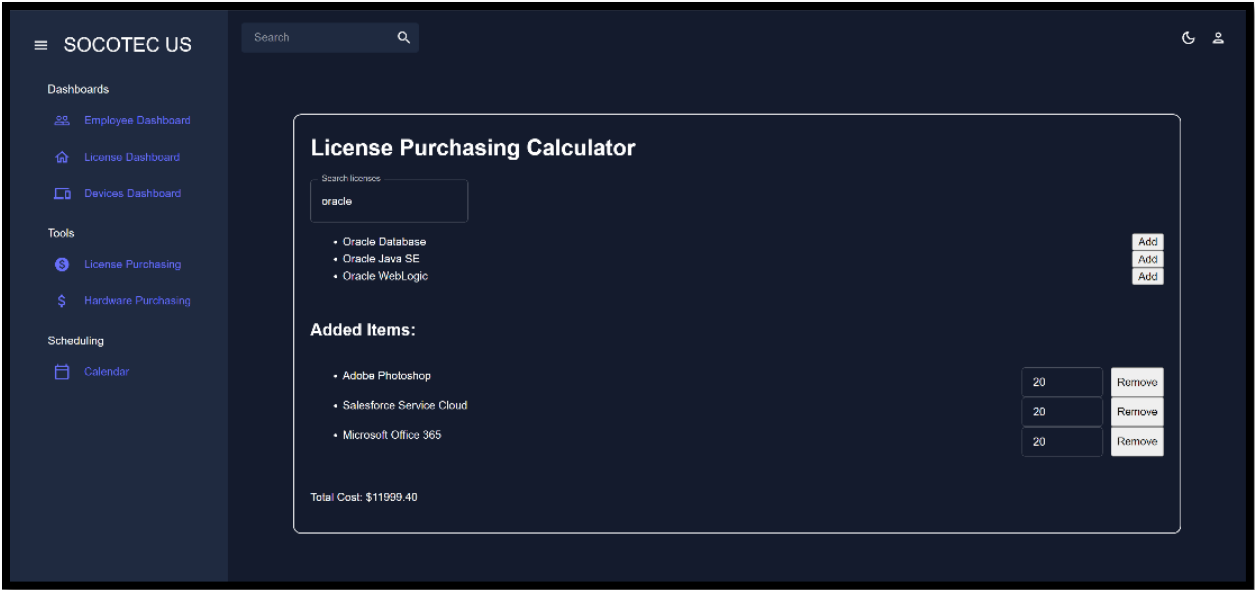## Hardware Device Dashboard

Figure 2.7: Hardware Dashboard
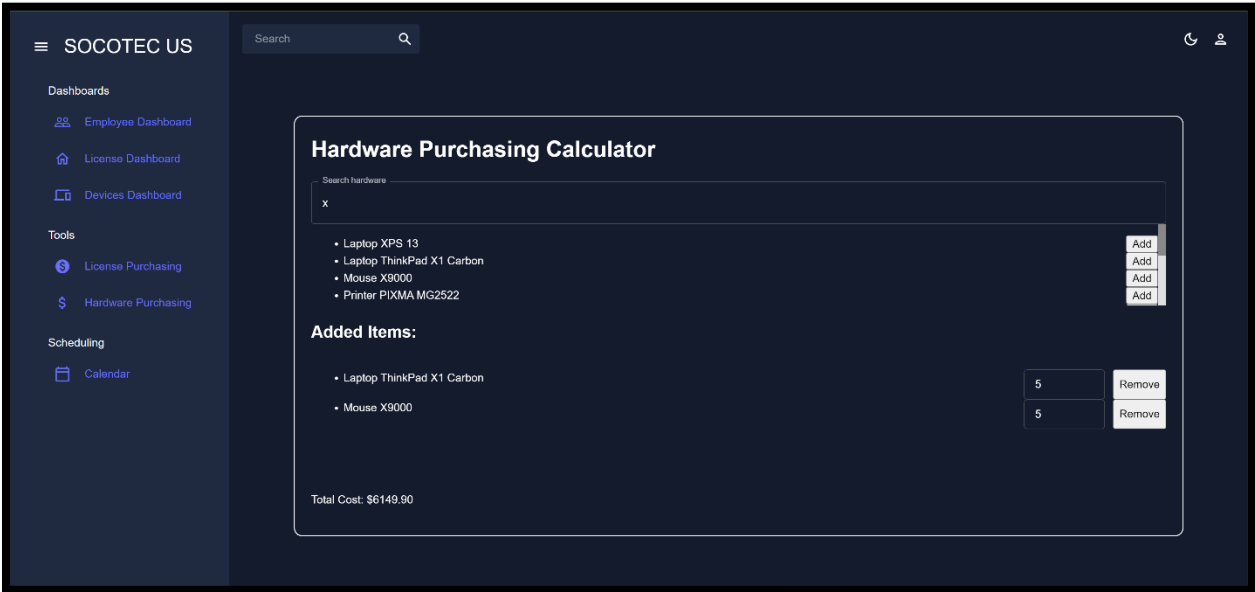
Purchasing Tools

Figure 2.8: License Purchasing Calculator

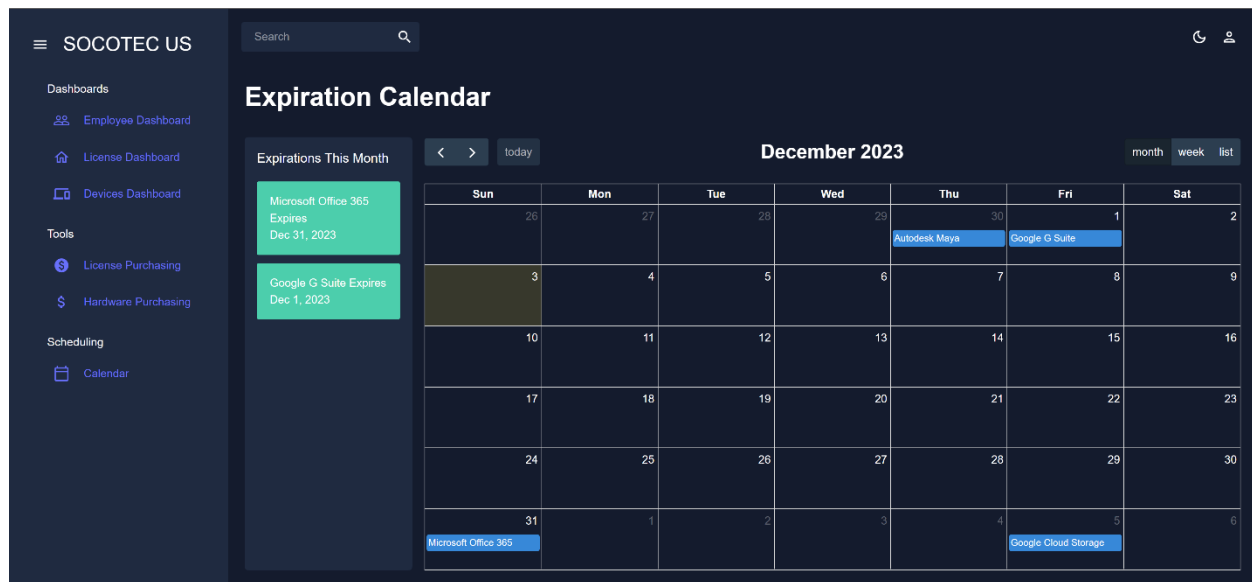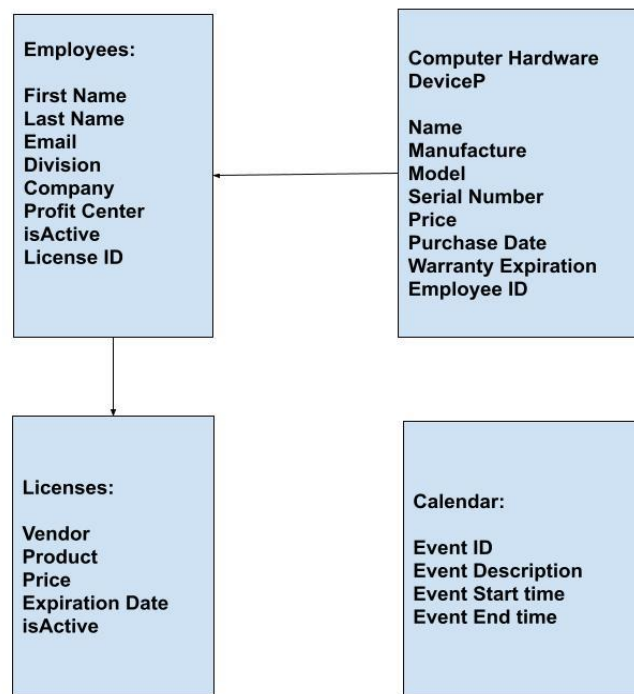*Figure 2.9: Hardware Purchasing Calculator*

Calendar

Figure 2.10: Software License Hardware Warranty Expiration Calendar

Back-end Design

Data Flow Diagram
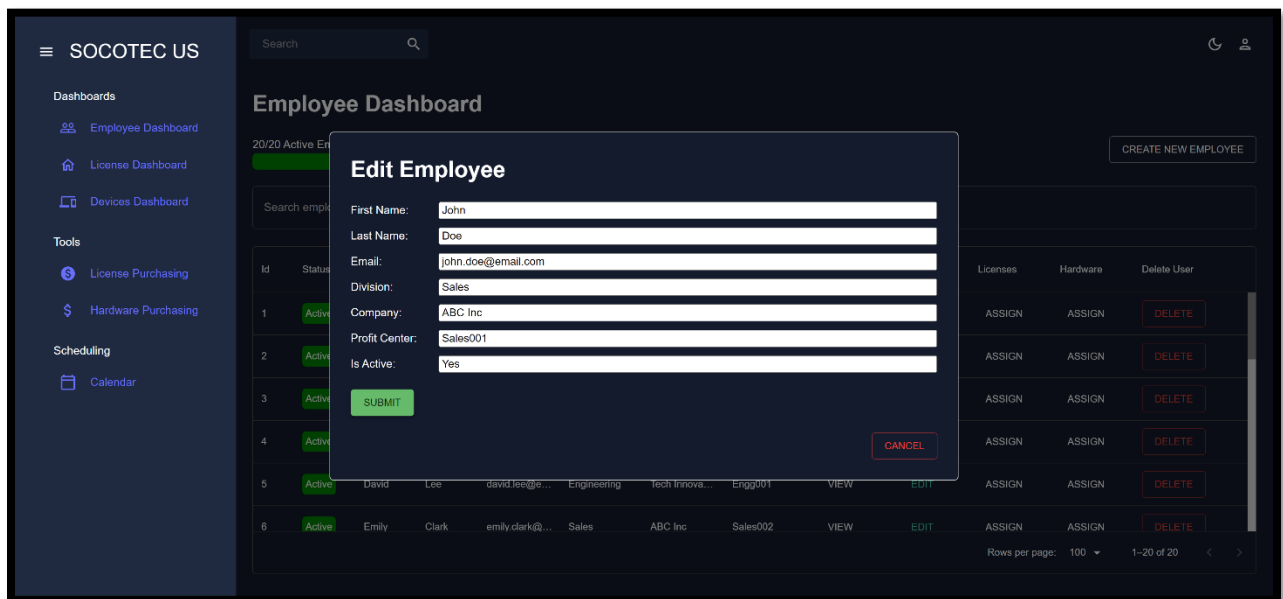
Employees:

First Name
Last Name
Email
Division
Company
Profit Center
isActive
License ID

Computer Hardware DeviceP

Name
Manufacture
Model
Serial Number
Price
Purchase Date
Warranty Expiration
Employee ID

Licenses:

Vendor
Product
Price
Expiration Date
isActive

Calendar:

Event ID
Event Description
Event Start time
Event End time
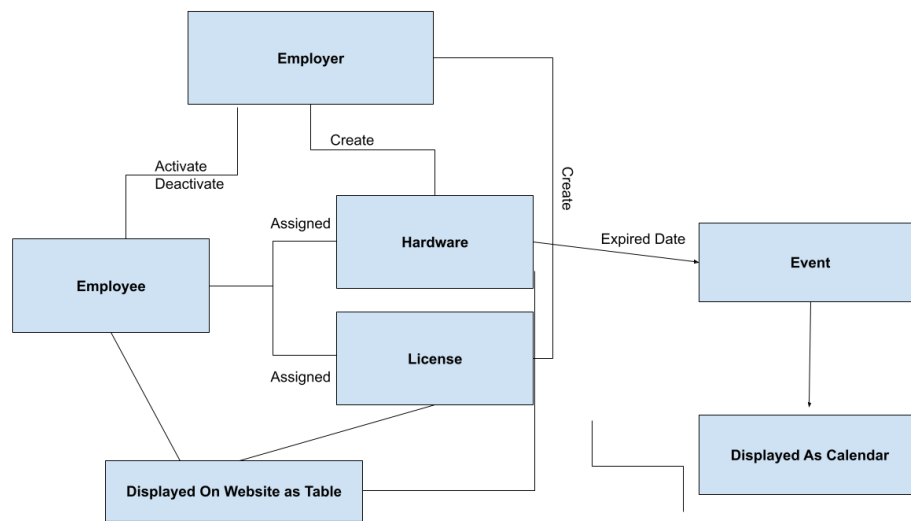
Back End Schema

Jichuan and Eric assumed the roles of back-end developers for the project, focusing initially on crafting databases that not only met specified requirements but also facilitated efficient communication of data across multiple tables. To ensure a seamless workflow, they established five essential tables: employees, licenses, computer hardware, calendar events, and administrator accounts. The databases for employees, licenses, and computer hardware incorporate foreign keys, facilitating references among them for straightforward cross-checking. Specifically, the employee database includes a foreign key pointing to the licenses database, enabling an employee to possess multiple licenses under their name. Similarly, the computer hardware database features a foreign key directed to the employee database, ensuring clarity regarding the assignment of a specific piece of hardware to an employee.

An integral part of the overall integration of the back-end was the implementation of safeguards within the API calls to prevent the inadvertent deletion of information linked to other databases. Specifically, an employee could only be removed from the employee database if there were no hardware devices associated with their name, ensuring proper accountability for the equipment of terminated employees. Moreover, an entry for an employee could only be added to the employee database if the license ID entered in the "Add Employee" form referenced an existing license in the licenses table. This measure eliminates the risk of hardware mismanagement within the system.

Similarly, an entry in the licenses table can only be removed if there are no entries in the employees table referencing the license ID being deleted to ensure all license costs are accounted for. This safeguard directly focuses on the primary purpose of the project: cost avoidance through human error.

Testing Plan and Test Results

To evaluate the functionality of our application, the team made sure to test all the possible error cases that may occur and observe if our application works as intended. Additionally, the team made sure to assess the application across multiple browsers to ensure that the application is accessible. For the testing process, the team used the use-case diagram to make sure every process and feature was tested.

The team also utilized some basic peer testing, where they invited classmates and peers to walk through the application while team members watched to see possible areas of confusion or inefficiency. The team also collected a small amount of feedback from these users, some of which was implemented into the final design.

Cost-Benefit Analysis and Risk Management

Group 4 CBA	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Benefits							
Cost Avoidance	-	$60,000	$66,000	$71,000	$77,000	$82,000	$356,000
Intangible Benefits (Cost Redution)	-	$37,500	$37,500	$37,500	$37,500	$37,500	$187,500
Total Benefits	$0	$97,500	$103,500	$108,500	$114,500	$119,500	$543,500
Costs							
System Development (One time Labor and Integration Cost)	$19,850	-	-	-	-	-	$19,850
System Maintenance	-	$600	$600	$600	$600	$600	$3,000
Software Maintenance	-	$26,040	$26,040	$26,040	$26,040	$26,040	$130,200
Intangible Cost (Cost Redution)	-	$2,000	-	-	-	-	$2,000
Admin Training Cost	-	$90	-	-	-	-	$90
Total Costs	$19,850	$28,730	$26,640	$26,640	$26,640	$26,640	$155,140
Cash Flow	($19,850)	$68,770	$76,860	$81,860	$87,860	$92,860	$388,360
Cumulative Cash Flow	($19,850)	$48,920	$125,780	$207,640	$295,500	$388,360	
Risk Adjusted Interest Rate		NPV	IRR				
	12%	$269,618	357%				

Figure 3: Cost-Benefit Analysis Results

In the comprehensive cost-benefit analysis, the team evaluated the implementation of a new software system designed to optimize the projects rather than generate direct revenue. The financial considerations were based on a careful analysis of numerous factors such as cost avoidance, intangible benefits, software and system management costs, intangible costs, and the initial development cost. The analysis determined the Internal Rate of Return (IRR) to be 357% and the Net Present Value at $269,618 within five years. The team used a risk adjusted interest rate of 12% determined from four primary risks: erroneous data migration during full system integration, security breaches in the database, browser incompatibility, and improper employee authorization and access to the platform.

The primary risk associated with the project is the failure to successfully integrate the new system into the existing Socotec software architecture after project turnover. Hiccups in complex system integration are a guarantee, even if minor. Data migration involves transferring employee license information from Excel spreadsheets to the SQL database. The risk of erroneous data transfer can be mitigated through clear documentation on each component of the project, including the data structure of the back-end and the API endpoints used to modify the database. Handing off the finished project from the development team to Socotec would be one of the most important times to review the documentation to ensure understanding. In the worst-case scenario, inaccurate management of licenses during the data transfer can potentially result in mismanagement, and worse, breaches of policy. These errors can lead to financial penalties or legal consequences, and at the very least a loss of valuable resources. This risk was classified as an elevated risk, high impact consideration since technical difficulties in integration are difficult to avoid and human error in data migration can result in large consequences. Ensuring that this system will accurately and precisely track licenses was of the utmost importance. The most

natural way to prepare for errors in data migration is to set aside an integration budget that can cover expected and unexpected integration costs.

Another consideration that needs to be addressed is the risk of security breaches in the database. Security risks can be mitigated through implementing security measures in the design along with documentation for the deployment of the app behind a firewall. Microsoft Azure, the hosting platform Socotec utilizes, also has its own built-in security measures. Furthermore, forms were checked upon submission to prevent SQL injections from malicious users. Since the platform is secured through Microsoft Azure, the risk of a security breach is low; however, the consequences of such a breach are high. Like the potential outcome of human errors during the data migration, a security breach could lead to lost or stolen license information.

Other risks considered in the risk analysis were deemed to be a significantly lower magnitude of risk relative to the risk of security breaches and the potential impact of erroneous data migration. These risks include factors such as compatibility and authorization. Compatibility can be classified as a low risk, low impact consideration since compatibility refers to the ability for specific React.js components to appear on various browsers. The impact was considered low since in the worst-case scenario, incompatibility slightly slows productivity for the administrator that can quickly be fixed by upgrading browser versions or switching to a mainstream browser. Furthermore, company devices should have the most recent browser versions installed to minimize the risk of security breaches.

Authorization to use the applications is a high-impact issue if unauthorized individuals manipulate the database. However, Socotec already has a company credential system with developed roles categorized by the role of the employees. As a result, the authorization was classified as low-risk.

Having defined the project's risks, the team established a Risk Adjusted Interest Rate of 12%. While compatibility and authorization were identified as low-risk factors for the project, the primary risks associated with product integration, data migration, and security were deemed to have a high impact on the company should they occur. Although errors in product integration are not considered major, they are anticipated to be almost inevitable in some form following the project handoff. The Risk Adjusted Interest Rate serves as a quantitative measure reflecting the overall risk exposure of the project, factoring in both the likelihood and potential impact of identified risks.

The primary advantage of this implementation lies in the substantial cost reduction achieved through the streamlining of the software license management system. At present, Socotec incurs an annual expense of $55,000 due to errors in license renewal management, equating to $110 per employee. This cost is projected to rise as their workforce expands over the next five years, with

an initial estimate of 500 employees in the first year, scaling up to 700 employees over this period. With the adoption of the new system, the team anticipates realizing significant savings, projecting an increase from $60,000 in cost avoidance after the first year of implementation up to $82,000 in cost avoidance using the project for five years. Moreover, Socotec currently possesses an established company database; therefore, the incorporation of this solution will not necessitate the expenditure of a new database platform.

In addition to the tangible benefits, the software promises invaluable intangible benefits. Currently, IT and administrative employees dedicate a substantial amount of time to manual tracking and administrative tasks, consuming approximately three hundred hours annually for five employees. Assuming Socotec administrators are paid $25 hourly, the company stands to save $37,500 annually by automating these processes.

Initial development and integration costs for the software are projected at $19,850, encompassing integration expenses such as developer rates and labor costs. Senior Socotec software engineers would oversee integrating the platform into the Socotec architecture. The bulk of the integration should be completed in approximately ten hours. Assuming an hourly wage of $45, a team of two developers would cost $900 for integration. Additionally, time should be spent developing features to improve overall integration such as connection to the company database. Five junior developers can be used for this role. At a maximum, these features can be implemented in about ten weeks assuming the developers work ten hours on the project per week. The junior developer cost would account for the remaining $18,750 in the projected development and integration cost.

Once implemented, the fixed cost of software maintenance should be accounted for in the event of bugs or requests to add new features to the integrated product. Ongoing software maintenance requires the involvement of senior software developers with an estimated average hourly rate of $43.40. Average hourly wage was calculated assuming a team of five employees: one project manager earning $45 hourly, and four web developers earning $43 hourly. This team was assumed to conduct maintenance for twelve weeks of the year for ten hours per week. Costs for routine maintenance amount to $26,040 annually. Furthermore, hosting the platform on Microsoft Azure incurs an additional expense of $600 per year.

As with the addition of every new software, adapting to using the new system incurs both intangible and tangible costs. System administrators accustomed to manually managing licenses may potentially take time to adapt to the new system; and in the worst case resist the change introducing the system brings about in their workflow. Assuming a decrease in efficiency of 25% for the first month, this incurs a one-time intangible cost of $2,000. To mitigate the potential loss of efficiency, Socotec should run a training program for the administrators that will use the system. The training should take no more than 2 hours and can be run by the project manager of the development team, incurring a one-time cost of $90.
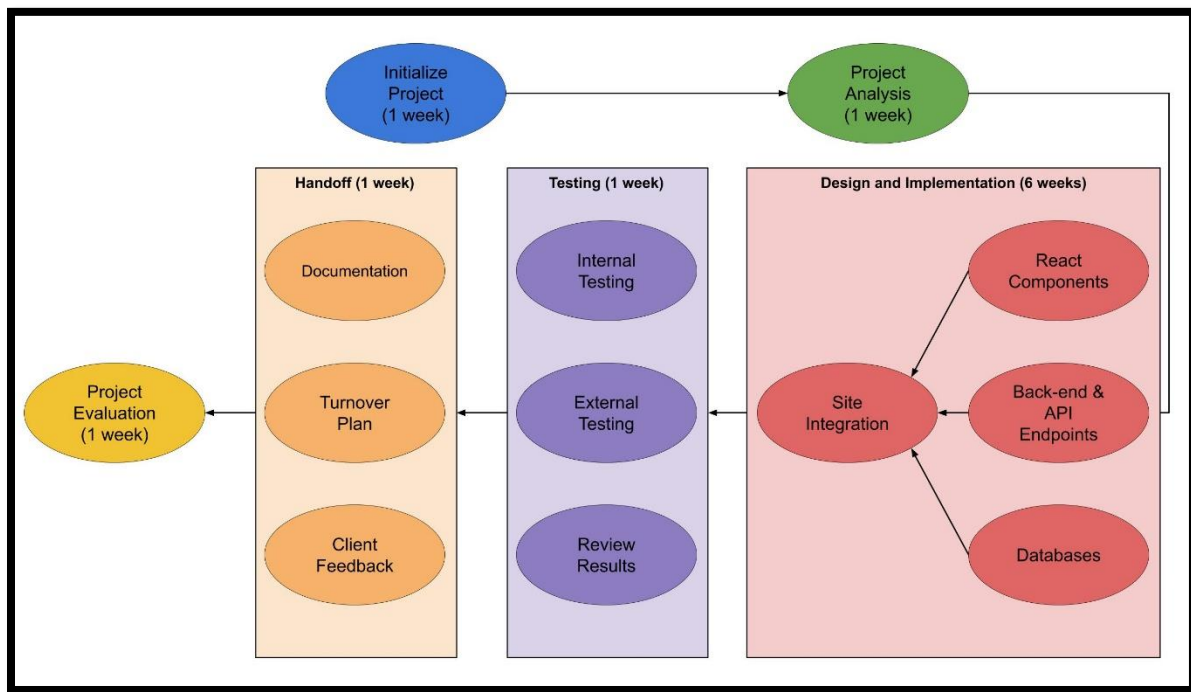
Project Management

Figure 4: Project Plan Flowchart

The solution encompasses six key development phases: project initialization, project analysis, design and implementation, testing, and handoff. These phases collectively guide the project from the initial proposal to its final handoff.

During project initialization, the team met with Socotec to thoroughly understand the needs and requirements for the proposed solution. Following this, a comprehensive cost-benefit analysis is conducted to evaluate the project's viability over the next five years. To ensure a systematic approach, a Gantt chart was created, detailing the necessary tasks, and effectively assigning responsibilities to team members. For a comprehensive schedule and breakdown of the project plan as well as specific task assignments, please refer to Appendix A.

After defining the project scope and obtaining client approval, the team transitioned to the design and implementation phase. This phase proved to be the most time-intensive aspect of the process, lasting approximately six weeks. The most complicated parts involved designing a fully functional database with corresponding API endpoints that effectively modify and query the data so administrators working with the solution could efficiently manage employee licenses. Creating interactive React components to enhance the user experience was vital to a good

reception of the product; and to ensure a seamless user experience, the front-end team developed mockups and flowcharts to streamline the development process.

Integrating front-end and back-end components was the final step in the design phase. With integration typically presenting the most challenges, the team completed the integration in the final integration Agile sprint.

Afterwards, one week was set aside exclusively for testing and revisions, with three days primarily focused on testing and the rest of the days incorporating necessary revisions. Internal testing conducted by the team assessed functionality, including the correctness of React component actions and the proper functioning of the API. External testing involved users outside the group, who provided feedback on the site's workflow. The remaining project timeline was dedicated to the completion of technical documentation for the application to prepare for the final handoff to Socotec, the task completed in the final week of the overall project timeline.

Post-Turnover Plan

The project turnover consisted of a meeting with Mr. Traniello to go through all use cases for the platform and what a typical work-flow would look like. The team provided a screen recording of the meeting to be referenced at later times for training IT and administrative team members. With the team familiar with the processes involved in license and hardware tracking, training via Mr. Traniello will be straightforward and would not require documentation such as user manuals for using the platform.

Turnover also consisted in the creation and delivery of documentation for integration of databases within the client's internal server to the back-end of the application. The team provided documentation and direct guidance to Mr. Traniello, who has already received insight over the course of the project on how to manipulate the provided API as necessary to create a new database connection for internal servers. Since the IT team has members currently working with their SQL Server, this process was straightforward. Beyond this, the team also scheduled a post-turnover follow-up meeting to help troubleshoot and provide support as necessary for the integration. This meeting proved unnecessary, as integration was fully functioning.

Results and Client Feedback

Throughout the design and implementation of the application, the team consistently communicated with the client on the progress of the project, receiving and integrating feedback, as necessary. Upon completion of the application, the client reported that the application helped to mitigate discrepancies in license tracking and met the requirements that were discussed agreed upon. With the new application in place, administrators are better able to track, update and consolidate information about purchased software licenses and hardware. They have also utilized built-in calculators to perform simple budget calculators, which were reported to be helpful for quick budget analysis for reports and in meetings. While the calendar component was reported to be underutilized, they expect that this will be more helpful during active license renewal periods.

At the conclusion of the project, the design and functionality of the final applications met, and in some ways surpassed, Mr. Traniello's expectations. The team's consistent communication with Mr. Traniello created a constructive feedback loop which drove a successful implementation and integration of the application.

Conclusion

Over the course of the project, the team faced multiple challenges on the path to success. Due to the time constraints, not everything that was initially discussed was implemented into the application. However, the team was able to pivot effectively and prioritize requirements to successfully complete this project.

Most of the challenges the team faced had to do with delivering a more ambitious scope than what was realistic for the time frame of the projects. The team was initially unsuccessful in predicting how much time a specific task would take which led to the team falling behind the anticipated schedule. To solve this problem, the team decided to let go of certain features that were not as important because it would be unreasonable to implement everything in time. After meeting with Mr. Traniello to alleviate the situation, the client and team narrowed the features to the most vital requirements to have the product ready in time.

Success was found despite these challenges, and often as a direct result of challenges. Some of the team's successes included adjusting tasks according to the feedback from the client, as well as scaling back ambitious features to prioritize realistic and more useful ones. This allowed the team to be able to manage the work and stick to the primary requirements. At times, team members were also willing to collaborate on certain tasks across roles to meet deadlines and achieve requirements more efficiently. While the team did find challenges in communication and syncing work schedules at times, holding regular meetings helped to mitigate some of these

problems and allowed the team to work together more effectively over time; this led to a successful project in the end.

Overall, this project was a great experience. The team gained real-world experience by working with a corporate and developing a custom solution within a rigid time frame. Each team member gained considerable experience from each phase of the project, including the analysis, design/implementation, and testing. Team members were also able to develop business insight from exercises such as cost-benefit analysis which allowed them to visualize a company's expenses and opportunities for profit, as well as how to analyze risks. This project created an opportunity for each team member to gain invaluable skills that will undoubtably carry throughout their careers.

Appendix A: Gantt Chart

	ⓘ	Name	Duration	Cost	Start	Finish	Predecessors	Resources
1		⊟**Initialize Project**	**11days**	**$2246.4**	**08/28/2023**	**09/08/2023**		
2	👤	Initial Meeting with Client	1day	$62.4	08/28/2023	08/29/2023		Beatrice
3	👤	Gather needs and requirements	2days	$124.8	08/29/2023	08/31/2023	2	Beatrice
4	👤	Determine scope of project	1day	$249.6	08/31/2023	09/01/2023	3	Jichuan,Ishita,Beatrice,Eric
5	👤	Create project proposal	5days	$1560	09/01/2023	09/06/2023	4	Jichuan,Ishita,Beatrice,Jordan,Eric
6	👤	Project schedule	2days	$249.6	09/06/2023	09/08/2023	5	Eric,Jordan
7		Milestone - Initialize Project Complete	0day	$0	09/08/2023	09/08/2023	1	
8		⊟**Analysis**	**5days**	**$1372.8**	**09/08/2023**	**09/13/2023**		
9	👤	CBA	3days	$748.8	09/08/2023	09/11/2023	1	Eric,Beatrice,Ishita,Jichuan
10	👤	Technology Architecture	2days	$624	09/11/2023	09/13/2023	9	Eric,Jordan,Beatrice,Ishita,Jichuan
11		Milestone - Analysis Complete	0day	$0	09/13/2023	09/13/2023	8	
12		⊟**Design**	**12days**	**$2620.8**	**09/13/2023**	**09/25/2023**		
13	👤	Review initial design with client	1day	$312	09/13/2023	09/14/2023	8	Eric,Jordan,Beatrice,Ishita,Jichuan
14	👤	Revise initial design with client	2days	$624	09/14/2023	09/16/2023	13	Eric,Jordan,Beatrice,Ishita,Jichuan
15	👤	Database	5days	$936	09/16/2023	09/21/2023	14	Eric,Beatrice,Jichuan
16	👤	Design UI	2days	$374.4	09/21/2023	09/23/2023	15	Jordan,Beatrice,Ishita
17	👤	Build User Interface	2days	$249.6	09/23/2023	09/25/2023	16	Jordan,Ishita
18	👤	API Endpoints	1day	$124.8	09/21/2023	09/22/2023	15	Eric,Jichuan
19		Milestone - Design Complete	0day	$0	09/25/2023	09/25/2023	12	
20		⊟**Implementation**	**16days**	**$3057.6**	**09/22/2023**	**10/08/2023**		
21	👤	Build API	1day	$124.8	09/22/2023	09/23/2023	18	Eric,Jichuan
22	👤	React Components	8days	$1497.6	09/23/2023	10/01/2023	16	Beatrice,Ishita,Jordan
23	👤	Integration of Frontend/Backend	4days	$499.2	10/01/2023	10/05/2023	21,22	Eric,Jordan
24	👤	Review completed design with client	1day	$312	10/05/2023	10/06/2023	23	Eric,Jordan,Beatrice,Ishita,Jichuan
25	👤	Revise completed design with client	2days	$624	10/06/2023	10/08/2023	24	Eric,Jordan,Beatrice,Ishita,Jichuan
26		Milestone - Implementation Complete	1day?	$0	10/08/2023	10/09/2023	25	
27		⊟**Testing**	**16days**	**$4180.8**	**09/25/2023**	**10/11/2023**		
28	👤	Security	2days	$124.8	09/25/2023	09/27/2023	12	Jordan
29	👤	Test Plan	1day	$312	09/27/2023	09/28/2023	28	Eric,Jordan,Beatrice,Ishita,Jichuan
30	👤	Conduct Internal Testing	2days	$624	09/28/2023	09/30/2023	29	Eric,Jordan,Beatrice,Ishita,Jichuan
31	👤	Find Test Users	1day	$62.4	09/30/2023	10/01/2023	30	Jordan
32	👤	Conduct External User Testing	1day	$312	10/01/2023	10/02/2023	31	Eric,Jordan,Beatrice,Ishita,Jichuan
33	👤	Analyze Test Results	5days	$1560	10/02/2023	10/07/2023	32	Eric,Jordan,Beatrice,Ishita,Jichuan
34	👤	Revise Website Backend	2days	$249.6	10/07/2023	10/09/2023	33	Eric,Jichuan
35	👤	Revise Website Frontend	2days	$249.6	10/07/2023	10/09/2023	33	Beatrice,Ishita
36	👤	Revise Website Security	1day	$62.4	10/07/2023	10/08/2023	33	Jordan
37	👤	Review Test Results with Client	2days	$624	10/09/2023	10/11/2023	34,35,36	Eric,Jordan,Beatrice,Ishita,Jichuan
38		Milestone - Testing Complete	0day	$0	10/11/2023	10/11/2023	27	

ID		Task Name	Duration	Cost	Start	Finish	Pred.	Resources
39		⊟ **Documentation and Handoff**	**27days**	**$5928**	10/11/2023	11/07/2023		
40	👤	Final Database Relational Model	1day	$124.8	10/11/2023	10/12/2023	27	Eric,Jichuan
41	👤	Incorporate design with existing data model	2days	$249.6	10/12/2023	10/14/2023	40	Eric,Jichuan
42	👤	API Functionality	2days	$249.6	10/14/2023	10/16/2023	41	Eric,Jichuan
43	👤	UI Flowchart	3days	$561.6	10/11/2023	10/14/2023	27	Jordan,Beatrice,Ishita
44	👤	Workflow Diagram	3days	$561.6	10/14/2023	10/17/2023	43	Jordan,Beatrice,Ishita
45	👤	Methodology of Development	2days	$624	10/17/2023	10/19/2023	41,42,43,44	Eric,Jordan,Beatrice,Ishita,Jichuan
46	👤	Methodology of Integration	2days	$374.4	10/17/2023	10/19/2023	41,42,43,44	Eric,Jordan,Jichuan
47	👤	IS/IT Design	2days	$374.4	10/19/2023	10/21/2023	46	Eric,Jichuan,Jordan
48	👤	IS/IT Requirements	2days	$249.6	10/21/2023	10/23/2023	47	Beatrice,Jordan
49	👤	Post-turnover Plan	3days	$561.6	10/23/2023	10/26/2023	48	Eric,Beatrice,Jordan
50	👤	Discuss turnover plan with client	1day	$312	10/26/2023	10/27/2023	49	Eric,Jordan,Jichuan,Ishita,Beatrice
51	👤	Revise turnover plan	3days	$936	10/27/2023	10/30/2023	50	Eric,Jordan,Beatrice,Ishita,Jichuan
52	👤	Feedback from Client	1day	$312	10/30/2023	10/31/2023	51	Eric,Jordan,Beatrice,Ishita,Jichuan
53	👤	Handoff Project	2days	$124.8	10/31/2023	11/02/2023	52	Beatrice
54	👤	Close Project	5days	$312	11/02/2023	11/07/2023	53	Beatrice
55		Milestone - Documentation and Handoff Complete	0day	$0	11/07/2023	11/07/2023	39	
56		⊟ **Project Evaluation**	**7days**	**$1435.2**	11/07/2023	11/14/2023		
57	👤	Document results of project	2days	$374.4	11/07/2023	11/09/2023	39	Ishita,Beatrice,Eric
58	👤	Project Executive Summary	1day	$62.4	11/09/2023	11/10/2023	57	Ishita
59	👤	Conclusions of Project	1day	$62.4	11/10/2023	11/11/2023	58	Ishita
60	👤	Integrate Evaluations into final report	3days	$936	11/11/2023	11/14/2023	59	Eric,Jordan,Beatrice,Ishita,Jichuan
61		Milestone - Project Evaluation Complete	0day	$0	11/14/2023	11/14/2023	56	

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Eric,Jichuan

Beatrice,Ishita,Jordan

Eric,Jordan

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Eric,Jichuan

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