CMU EAST Garage Site

Project Management Report

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Overview

Purpose, Objectives, and Overview of the Project

The purpose of this project is to add parking space detectors and develop a web application that provides real-time updates on the availability of parking spaces at the CMU East Campus Garage (ECG). Currently, garage users have no way to know the status of the garage before they arrive. Sometimes the garage is full, sometimes it is limited to leaseholders, and users waste a lot of time going up and down the garage just to find there is no space. Additionally, users cannot tell if the EV chargers are working or available.

The objectives of the project

To provide accurate and timely information on parking space availability and EV charger status to users of the CMU East Campus Garage.

To minimize the time and effort required for garage users to locate available parking spots and avoid unnecessary trips

To improve the overall experience of commuting to and from CMU for students, faculty, and staff.

The project will involve designing, developing, and implementing a web application that users can access from any internet-connected device. The application will use a user-friendly interface to display the availability of parking spaces and EV charger status in real-time. The sensors will be installed at the entrances to the garage and near each parking spot to detect occupancy and transmit this data to the web application.

Justification and Return on Investment

This project is not intended to generate a monetary return as it does not involve any changes to the ECG operations or payment system. Instead, it aims to provide value by improving the user experience and potentially reducing the need for street parking. By adding parking space detectors and developing a web application that provides real-time updates on parking space availability and EV charger status, this project aims to address the current issues with the ECG, mainly falling into the categories of availability and usability.

Users face multiple challenges, such as the unavailability of real-time updates on EV charger status, the inability to check the number of available parking spaces before entering the garage, and the gate not preventing entry even when the garage is full. These challenges make parking at the ECG a stressful experience, especially when the garage is unexpectedly unavailable, finding alternative parking spaces nearby is difficult and time-consuming.

This project aims to reduce the stress associated with parking at the ECG by providing real-time updates on parking space availability and EV charger status. This information can help users make informed decisions and avoid surprises. In addition to improving the user experience, there is also potential for energy savings through systems such as one that can turn off lighting when no one is present on a particular floor of the garage. This can provide some monetary value and reduce carbon footprint.

Stakeholders

1. CMU administration and management team. They have a vested interest in ensuring that the parking facilities on campus are efficient, safe, and accessible.

2. Parking and transportation office. They will be involved in the planning, design, and implementation of the project, and will work closely with the project team to ensure that the new website meets the needs of all stakeholders. The parking and transportation office will also be responsible for maintaining the sensors and the web application after the project is completed.

3. Students. Students are one of the primary user groups for the CMU East Campus Garage, and they will benefit greatly from the new parking status website.

4. Visitors. Visitors to CMU, such as prospective students, parents, and guests, will also benefit from the new parking status website.

5. Faculty and staff. Faculty and staff members at CMU also rely on the parking facilities on campus, and the new website will be a valuable resource for them.

Risks

This project involves several potential risks that must be addressed to ensure its success.

1. One of the risks is the potential interference with the normal operating hours of the garage during the hardware installation. To minimize the inconvenience for students, the project team will adjust the installation time to reduce the interference with normal operating hours.

2. Another potential risk is the technical difficulties associated with compatibility issues between the hardware that detects empty parking spaces and the application that displays the availability of parking spaces. To mitigate this risk, the project team will conduct rigorous testing and troubleshooting during the development phase to ensure compatibility.

3. A further risk is the potential privacy and security risks associated with collecting personal information from students, such as locations, vehicle information, and daily routines. To mitigate these risks, the project team will comply with data protection regulations and implement security measures to protect the data from breaches. Overall, the project team will carefully consider and address these potential risks to ensure the success of the project.

Schedule

The project schedule will be based on the work breakdown structure, and each major task will be scheduled to proceed concurrently, unless there are dependencies. The website development and hardware installation in the garage will be scheduled to occur concurrently to maximize efficiency. Additional project tasks will be scheduled after the completion of the website development and hardware installation.

Our project is scheduled to begin on April 25th, 2023, and we estimate that it will be completed by September 20th, 2023. The project team will regularly review and adjust the schedule to ensure that the project is completed on time and within budget.

High-Level Budget

While the budget components have not been fully detailed, we have made rough estimates based on high-level factors. Some of the high-level budget components include the materials needed for the project and the cost of labor. Based on our rough estimates, we anticipate that the materials will cost approximately $80k, and the labor will cost around $180k. Adding the contingency budget of 10%, our rough estimates suggest a total budget of $210k to $300k, which could vary significantly depending on factors such as the implementation of the hardware and software, and the salary of the workers.

Project Management Tool

We will be using the MS project as our main project management tool along the way. MS Project provides a wide range of features and functionalities that can be leveraged to ensure that the project is delivered on time, within budget, and to the satisfaction of all stakeholders.

Work Breakdown Structure

This section presents the work breakdown structure of the project. The project comprises four main components: website creation, hardware installation, staff training plan, and manual and maintenance plan. We developed this work breakdown structure by identifying the major deliverables, breaking down each deliverable into small

components, and then further breaking down each component into actionable steps. Lastly, we broke down each step into smaller tasks required to complete the step. For a complete work breakdown structure, please refer to Appendix 1.

Statements of Assumptions

We have made certain assumptions regarding the success of the project:

1. We assume that the project will be completed within the planned schedule and budget.
2. We assume that the developed website and hardware system will meet the requirements and needs of CMU's parking garage as outlined in the project specifications.
3. We assume that the website and hardware system will be able to seamlessly integrate with CMU's existing IT infrastructure.
4. We assume that major external factors, such as unforeseen circumstances or events, will not significantly impact the project budget or timeline. We will closely monitor and adjust the project plan if necessary to ensure the successful completion of the project.

Discussion of managing the change control

To manage changes during the project, a change control process will be implemented. This process will ensure that any proposed changes to the project scope, schedule, or budget are thoroughly evaluated and approved by the project manager to prevent delays or cost overruns.

Regular project updates will be provided to stakeholders to keep them informed of the project status. Additionally, any changes made to the project will be documented and communicated to stakeholders. Further details on the change control process and documentation will be provided later in the project plan.

Project Schedule

This section outlines the schedule of the project, including the start date, end date, and duration of each task. The project is scheduled to commence on April 25th, 2023, and we estimate that it will be completed on September 20th, 2023. Our team will closely manage and monitor the project schedule to ensure timely completion of all tasks.

For more information on the project schedule and critical path, please refer to Appendix 2.

Dependencies

The project comprises four main sections with various dependencies. The website section includes design, development, testing, and launching. The hardware section includes getting permits, hardware acquisition, installation, testing, and integration. The hardware section is dependent on the software design since the main value of the project is the accessible website with parking garage information. The software design will determine the appropriate hardware selection and integration with the website.

The staff training plan and manual section depends on the completed integration of hardware and software since the final usage of the entire system may change until final integration, such as backend management tools or hardware labeling. This section includes training for garage staff and software staff.

The maintenance plan section includes plans for the website and sensors, long-term maintenance budget estimates, any final fixes, and training staff for maintenance. The planning and estimating parts of the maintenance plan section are independent but will be best done after the installation and testing of their respective components.

The sub-tasks of each section follow a waterfall method with estimated durations. The tasks will be managed by the project manager to keep track of the work.

Risks in Schedule

There are some uncertainties in the schedule due to certain dependencies such as planning and estimating, and obtaining required permits for the project. We are uncertain if additional permits or clearances will be required for the project, and if so, it could cause delays as they may take a long time to obtain. To mitigate this risk, we will consult with relevant subject matter experts and obtain necessary approvals in advance.

If this risk occurs, we have built in enough buffer time in the schedule to accommodate any potential delays and still meet project deadlines. As creating and launching the website takes longer than installing hardware, a delay in obtaining permission for installation can be covered. Our project team will closely monitor the schedule and take necessary actions to ensure timely completion of all tasks.

Solution for the delay in the project

As the project progress has a lot of dependencies, a delay in a preceding task can delay the subsequent task which can lead to delay in the whole project.

1. Revise the project schedule: Review and revise the project schedule to account for the delay and adjust the timeline. This may include extending the deadline or adjusting the tasks.

2. Resource allocation: Allocate the additional resources like personnel, and budget to fasten the tasks and to make up for the lost time.

3. Reprioritizing tasks: Reprioritize tasks to focus on critical path tasks that will cause a big impact.

4. Negotiation: Talk to stakeholders or contractors to adjust the deadline or budget if the delay is caused by external factors.

Schedule Management

If a delay occurs in the project, the project manager will take the following steps:

1. Identify the cause of the delay: These factors may include unforeseen events, resource limitations, scope changes, or other issues.

2. Assess the impact of the delay: The project manager will evaluate the impact of the delay on the project schedule, budget, and overall project objectives.

3. Communication: Communicate with stakeholders, the project team, and other related parties about the delay and its impact on the project to inform the current status and how it will be addressed.

4. Develop and implement a recovery plan to bring the project back on track.

5. Monitor the progress: Keep track of the progress to see if the recovery plan is working effectively. Regular status reports should be provided to the stakeholders to keep them informed of the project's progress.

The project manager will take appropriate action to mitigate the impact of the delay and ensure that the project objectives are met within the allocated resources and timeline.

Risk Register

This section presents the risk matrix explanations for the parking garage system. See Appendix 3 for the graph for the risk matrix. The risk matrix identifies potential risks associated with the project, assesses their likelihood and impact, and outlines mitigation strategies to address them. The likelihood and impact of each risk are assigned scores based on a qualitative scale: High, Medium, and Low. The results here are the state of risks upon first identification. The risk matrix helps guide the team in addressing the identified risks and ensures a thorough understanding of potential challenges during the project.

Risk Matrix Scoring Methodology

To assign the likelihood and impact scores for each risk, we conducted a qualitative risk analysis based on historical data and industry benchmarks. This involved gathering input from project team members and comparing our project to similar projects in the past. By analyzing this information, we were able to make informed judgments about the likelihood and impact of each identified risk.

In a future state, we aim to quantify the magnitude of these risks by using a quantitative risk analysis approach. This can involve developing numerical estimates of the likelihood and impact of each risk, such as the probability of occurrence, the expected cost impact on labor and other resources, or the potential schedule delay. We can then use these estimates to calculate risk exposure, prioritize risks, and allocate resources more effectively for risk mitigation.

Risk Matrix

1. Disruption to normal operations during hardware installation

   Likelihood: High

   Impact: High. Disruption to normal operations may inconvenience students and faculty members who rely on the garage for parking, affecting their productivity and efficiency.

   Mitigation strategy: Minimize disruption by adjusting the installation schedule to accommodate normal operations.

2. Privacy and security risks associated with personal information collection and storage

   Likelihood: Medium

   Impact: High. Inadequate management of personal information may lead to identity theft, financial fraud, or other cybercrimes, damaging the institution's reputation and potentially resulting in legal liability and regulatory penalties.

   Mitigation strategy: Comply with data protection regulations, implement appropriate security measures, and conduct regular data privacy and security reviews.

3. Technical difficulties with hardware and software compatibility

   Likelihood: Medium

   Impact: Medium. Incompatible hardware and software may cause system malfunctions or unreliability, leading to incorrect parking availability information and inconveniencing students and faculty members.

Mitigation strategy: Ensure compatibility through thorough testing before installation.

4. Project delivery delay due to unforeseen circumstances

   Likelihood: Low

   Impact: Medium. Project delays may result in additional costs, missed deadlines, or unmet stakeholder expectations, but these impacts can be mitigated with contingency planning and time buffers in the project timeline.

   Mitigation strategy: Develop a contingency plan to manage unforeseen circumstances and implement a flexible project management framework that allows for adjustments.

   By addressing these risks and implementing the appropriate mitigation strategies, the team can effectively manage potential challenges and ensure the successful completion of the parking garage system project.

By addressing these risks and implementing the appropriate mitigation strategies, the team can effectively manage potential challenges and ensure the successful completion of the parking garage system project. By refining our risk assessment methodology and incorporating quantitative risk analysis techniques, we will be better equipped to quantify the magnitude of these risks and make more informed decisions about resource allocation and risk mitigation.

Risk Management

Risk management is an essential part of project management, and the project manager will follow these steps to manage risks:

1. Identify the risk: The project manager will identify potential risks that could affect the project's objectives, including task delays, resource constraints, or other factors.

2. Assess the impact of the change: Once the risk has been identified, the project manager will assess the impact of the risk on the project schedule, scope, and budget. This would include adding new risks, updating existing risks, or deleting risks that are no longer relevant.

3. Evaluate the risk: The project manager will assess the severity of the risk and decide whether to take immediate action or conduct further analysis.

4. Communication: The project manager will communicate the risks or changes to the team, stakeholders, and relevant parties. It is important to provide clear information about risks and changes.

5. Revise the project: Based on the impact assessment, the project manager will change the schedule, scope, or budget. This could include adjusting task durations, shifting task dependencies, adding new tasks to the schedule, cutting the budget, or changing the scope.

6. Monitor change: The project manager will monitor the implementation of the changes on the schedule and make adjustments when necessary. Regularly updating the schedule and reports will keep stakeholders informed of any changes and their impact on the project.

By implementing a robust risk management process, the project manager can minimize the impact of potential risks and ensure the project is delivered successfully.

Resource Loading

This section provides a detailed breakdown of the resources required for the project, including an explanation for each task, the roles and responsibilities of each resource, the source of salary information, and potential adjustments in case of changes. For a detailed breakdown sheet, please refer to Appendix 4.

Resource Overview

The project is divided into several tasks, and resources are allocated based on their skills and expertise. We have identified two main categories of resources required for the project: labor and materials. The total cost of labor is estimated at $181,768.00, while the total cost of materials is estimated at $78,880. Adding an estimated 10% of contingency cost, the overall cost for the project is $286,712.80.

1. Labor

The labor cost is derived from average salary rates obtained from salary.com. The tasks are divided among various resources, such as project managers, graphic designers, developers, quality assurance testers, security consultants, installation specialists, and training specialists. Each resource is assigned tasks based on their expertise and the requirements of the project.

Task Breakdown and Justification

1. Design: Determine requirements - 1 Project Manager is responsible for gathering and documenting the project requirements. Their experience in managing projects ensures that all necessary aspects are considered and properly documented.

2. Design: Develop a design concept - 1 Graphic Designer creates the initial design concept for the system, utilizing their expertise in visual communication to develop an appealing and user-friendly interface.

3. Design: Review and revise design - The Project Manager and Graphic Designer work together to refine the design based on feedback and requirements, ensuring the final design meets project objectives.

4. Development: Develop Front-end Layout - 3 Front-end Developers are responsible for implementing the user interface, ensuring a smooth user experience that aligns with the design concept.

5. Development: Develop Back-end Functionality - 3 Back-end Developers create the underlying system architecture, ensuring seamless integration between the front-end layout and back-end functionality.

6. Development: Integrate Third-party Services - The same 3 Back-end Developers integrate necessary third-party services, such as payment processing or data storage, to create a fully functional system.

7. Testing: User and Performance testing - 2 Quality Assurance Testers conduct user and performance testing to ensure the system functions as intended and meets user expectations.

8. Testing: Identify issues - The same 2 Quality Assurance Testers identify any issues or defects in the system, which will be addressed by the development team.

9. Testing: Security testing - 1 Security Consultants perform security testing to ensure the system is protected against potential threats and vulnerabilities.

10. Testing: Integration testing - 3 Back-end Developers conduct integration testing to ensure all system components work together seamlessly.

11. Launching: Launch Site - The Project Manager oversees the site launch, ensuring all necessary preparations are in place and the launch is successful.

12. Launching: Post-launch Testing and Fixes - Quality Assurance Testers and Back-end Developers perform post-launch testing and address any issues arising after the system goes live.

13. Hardware system: Get required permits for installation - The Project Manager obtains necessary permits for hardware installation, ensuring compliance with local regulations.

14. Hardware system: Installation plan - The Project Manager develops a detailed installation plan, outlining the steps and resources required for a successful installation.

15. Hardware system: Install - 6 Installation Specialists install the hardware system according to the installation plan. When calculating the installation specialist required, we took the total number of CMU east campus garage size of 1192 and assumed that each installation takes around 30 mins.

16. Hardware system: Testing and quality assurance - 2 Quality Assurance Testers verify the proper functioning of the hardware system and ensure it meets quality standards.

17. Hardware system: Integration with Software - Back-end Developers integrate the hardware system with the software, ensuring seamless communication between the two components.

18. Staff training plan and manual: Training for garage staff - 2 Training Specialists provide training to garage staff, ensuring they understand and can effectively use the new system.

19. Staff training plan and manual: Training for website and back-end administrators - Training Specialists train website and back-end administrators, ensuring they can manage and maintain the system effectively.

20. Maintenance plan: Budget Estimation - The Project Manager estimates the budget required for ongoing system maintenance.

21. Maintenance plan for sensor system: Purchase additional backup hardware - 1 Procurement Specialist.

22. Maintenance plan for sensor system: Regular inspection and cleaning & Replace batteries in sensors if needed - 2 Maintenance Specialists will be working on that.

23. Maintenance plan for website and back-end: We will have our back-end developers working on regular updates, training specialists to train the maintenance specialist and maintenance specialist on regular monitoring and addressing issues or malfunctions.

Labor Cost Assumptions:

1. We assumed that all workers would be working 8-hour days, 5 days a week, for the duration of the assigned tasks.

2. We assumed that the hourly rates we used were in line with industry averages retrieved from *salary.com*.

3. We assumed that each worker would be fully utilized during the project and would not be working on other projects or tasks during this time.

4. We assumed that only one Project Manager was required throughout the project.

5. When calculating the installation specialist required, we took the total number of CMU east campus garage size of 1192 and assumed that each installation takes around 30 mins.

2. Materials

The materials required for the project include sensor hardware, backup hardware components, batteries for sensors, and other miscellaneous materials for installation and maintenance. The costs are based on an estimation we made based on research online and consultations with CMU staff.

Material Cost Assumptions

1. We assumed that the materials required for the project, such as sensors and hardware components, would be purchased at market rates based on industry research and analysis.

2. According to the University's Parking and Transportation Services website, the East Campus Garage is a multi-level parking structure with a total of 1192 parking spaces. Based on this, we assumed 2116 sensors to prepare for failure and breakdown of the sensors.

3. We assumed the sensors needed 4 batteries for each sensor.

4. We assumed that the quantities of materials required for the project would be accurately estimated and that there would be no major discrepancies or changes in the number of materials needed during the project.

5. We assumed some cost preparing for maintenance and problems occurred later after the finish of the project.

Materials Breakdown

1. Sensor hardware: A total of 1216 sensors are required for the parking garage system based on our research, with an estimated cost of $55 per sensor, amounting to a total cost of $66,880.

2. Backup hardware components: A budget of $500 is allocated for purchasing additional backup hardware components, ensuring the system's continuous functioning in case of any hardware failures.

3. Batteries for sensors: 5000 batteries are required for the sensors, with an estimated cost of $2 per battery, totaling $10,000. These batteries will ensure the proper functioning of the sensors and may need to be replaced during regular maintenance.

4. Other materials: An estimated cost of $1,500 is allocated for miscellaneous materials needed for installation and maintenance, such as cables, connectors, and tools.

Salary Information Source

The salary information used in this resource breakdown is obtained from salary.com, a reputable online source for salary data. This data provides average salaries for various job titles and roles across different industries and regions, which allows us to estimate the labor cost for the project.

Contingency Plans

In the event of changes in the project's scope or unforeseen challenges, the following contingency plans will help manage resource allocation and ensure project success:

1. Cross-training team members to perform multiple roles, allowing for flexibility in resource allocation and ensuring smooth progress even if team members become unavailable.

2. Regularly monitor and update the project timeline to accommodate any changes in scope or unforeseen circumstances, ensuring that the project remains on track and within budget.

3. Establishing a contingency budget to cover additional labor or materials costs that may arise due to changes in the project's scope or unforeseen challenges.

4. Actively engaging with stakeholders to gather feedback and address any concerns or issues that may impact the project's success.

Risk and Contingency Budget

To ensure the successful completion of the project, a risk and contingency budget has been established. This budget is designed to cover unforeseen circumstances, potential risks, and cost overruns that may occur during the project. The risk and contingency budget will be used to address issues as they arise, ensuring that the project remains on track and within budget.

Risk and Contingency Budget Breakdown

A risk and contingency budget of 10% of the total project cost has been allocated, amounting to $26,064.80. This percentage was chosen based on industry standards and best practices for contingency planning. The contingency budget is broken down into the following categories:

Labor Contingency: 10% of the total labor cost, or $18,176.80. This budget will cover potential increases in labor costs, such as overtime, additional staff requirements, or changes in project scope that require additional labor resources.

Materials Contingency: 10% of the total materials cost, or $7,888.00. This budget will cover potential increases in material costs, such as fluctuations in the prices of hardware components, additional materials required due to changes in project scope, or the need to replace damaged or faulty components.

Earned Value Matrix

Several values and metrics need to be tracked to have a real time measure of project performance. These metrics can be used to inform stage gates, changes, and help with communication. Performance can be measured in a variety of variances, indexes, and charts.

Reports

In terms of project reporting, it is essential to establish the frequency and format of the reports. In this project, we will provide weekly status reports to stakeholders and monthly progress reports to senior management. The project manager will be responsible for collecting data from various sources, including team meetings, progress updates from team members, and project management software. The data will then be compiled and analyzed by the project manager, who will prepare the reports.

The reports will include key project metrics such as progress against the schedule, budget, and scope. Additionally, the reports will highlight any risks or issues that have been identified during the project. The stakeholders and senior management will receive the reports and take appropriate actions to address any issues or risks identified.

The format of the reports will be standardized and will include charts and graphs to visually represent the project's progress. The reports will also include a narrative section, which will provide an explanation of the key metrics and any issues or risks identified. Regular project reporting ensures that stakeholders and senior management are informed of the project's progress and can take appropriate actions to ensure the project's success.

Earned Value Matrix

Since we are not actually doing the project, we will not have any real values to work with. Instead, this section will detail which values and metrics the PMO will and how the PMO should report and react to performance. After the PMO compiles reporting from project members as they progress, the report can be used for internal analysis and for communication purposes for the stakeholders.

There are three main values to track throughout the project. The first is Planned Value (PV), which is expected spending to date. The second value is Earned Value (EV), which is the value of the work completed so far. This would be tracking the progress of the project based on how much we have completed and how much we estimated

they are worth. This value can be hard to define since installing parking space sensors does not directly generate monetary value. The third value is Actual Cost (AC), which is the actual spending like purchases and wages. Other values at complete like budget at complete are not listed here because we do not have an actual budget or scenario of completion.

These values can be used to calculate Cost Variance (CV), Cost Performance Index (CPI), Schedule Variance (SV), and Schedule Performance Index (SPI). In general we want to check if the two variances are in the negative, which indicates a cost overrun or that the project is behind schedule. In case of negative variance, the project team should first internally analyze the problem to see if internal changes like schedule changes or risk budget can make up for the deficit. If the issue is persistent, the PMO should communicate this to the stakeholders and initiate project control processes as detailed in the Project Control section.

The two indexes can also indicate progress or problems. The ratios given by the CPI and SPI can help the PMO and stakeholders have a better understanding of how much the project is from expected performance. Indexes that stray too far from 1 should alert the PMO of issues or anomalies. For example, an index of 0.5 should trigger project control processes and potentially exit through stage gates if the problem cannot be solved. Or, an index of 1.5 could indicate a suspiciously unexpected high performance. This can trigger an investigation to see if reporting processes are correct.

These metrics would be reported at the times specified and at milestones as defined in the schedule. Other project metrics like the Estimate To Completion and Estimate At Completion can be calculated from the above values and used to analyze stage gates or negotiate changes. They can also help with acquiring more resources since the PMO would have an actually predicted number to negotiate with. Example charts of the Estimated Value Chart and Burndown Curve are shown in Appendix 5.1 and 5.2. These charts are useful for analyzing overall project performance and for communication purposes.

Project Control

Project control will consist of keeping track of assets like hardware, finances, HR, and scheduling, managing communications, and defining processes for scope and change control. The PMO will define when and what to report and adhere to that throughout the project to both maintain project transparency and reduce unnecessary anxiety for stakeholders. The PMO will also define scopes early on and adhere to a change control process for any project changes.

Assets, Milestones, Stage Gates

This project will have to manage assets like physical inventories of hardware sensors, human resources for construction and software development, finances, and time assets.

Physical hardware will need to be acquired and stored before installation, and additional hardware for maintenance and contingency will need to be acquired and stored during and after project completion.

Human resources control will involve monitoring performance and building training for garage operators. Track down subject matter experts to examine our processes for integrating software and hardware as well as security-related concerns with integrating the system into CMU's IT system. Additional control is needed for managing the training process for garage operators. We need to consider when to schedule training for when the project is near completion or consider new hires to manage the system after completion.

Financially speaking, we will need to manage what is ultimately CMU's money during the project. CMU may pay the cost of the project in full, or infuse cash at key stages like hardware acquisition and software development. There will also be additional costs associated with running the system after the competition, like personnel cost, replacement parts, server costs etc.

There will be stage gates at the beginning and completion of sections in the project schedule. During this the project management office will examine the assets mentioned above, review the project status and progression, and decide if any additional resources are needed. For example, at the end of hardware installs, if the installation process is not finished, the software team may begin testing with the installed sensors while additional time is given to the hardware team to finish installing the hardware.

Communication

There will need to be communication between the project team, CMU administration, and East Campus Garage users during the project. Generally, progress on the project should be transparent to all parties involved, but the project should not be under constant monitoring from all stakeholders.

There will be reporting on progress weekly, monthly, and at the set times of important milestones as defined in the project schedule, during which progress and delays will be made clear to all stakeholders. Weekly progress communications can be helpful for CMU to post updates in their established weekly newsletters for stakeholders. Problems and delays should be kept from the public until reports, before which the project team will try to solve them internally. This is to avoid unnecessary bad press and anxiety for stakeholders when the problem can be solved. For example, refrain from reporting a shipping delay if modifying the schedule or using float within the existing schedule means the project is still delivered on time. If problems are not resolved before reporting, they will be made clear.

Since the software portion of the project will likely integrate with CMU's existing software systems, communications with the CMU IT team will be very important. The software team will be either working directly with the CMU team or be in constant contact with them.

Scope Control

We do not anticipate any significant scope changes in this project since the technology and process are already well-established. Existing examples of similar projects are common and subject matter experts can be hired to work out scopes initially. All variables of the project will be defined and determined before the project begins.

Some scope related changes could include:

1. Integrating the software for a mobile app in addition to the website.
2. Expansion of the system to other garages in the Pittsburgh campus.
3. Additional sustainability or smart parking related software features such as variable parking rates based on available space

All scope definitions can be defined before the project begins so we expect no major scope creeps. Minor scope changes will rely on the change control process.

Change Control

A change control board will be formed, which will process all changes during the project. The board will be composed of the CMU administration, the project management office, representatives from project contractors, representatives from faculty or garage lease holders, and representatives from students, perhaps in the form of SLICE or the student body.

All changes will be evaluated in terms of costs and benefits, as well as impacts on scope, cost and schedule. Representatives from contractors and PMO will provide feasibility studies, produce change orders, and any other contract changes. Representatives from users of the garage like faculty and students can voice their opinions on the change, and CMU administration has the final say on changes since they own the garage and provide funding for the project. Additional parties related to the CMU campus or local construction related authorities may be brought in for advising.

Approved changes must be recorded in writing and signed by all parties involved. Comprehensive change orders must be generated for every change. Budgets and schedules must be immediately updated or reevaluated. If a new project baseline is needed, it must also be approved using the change control process.

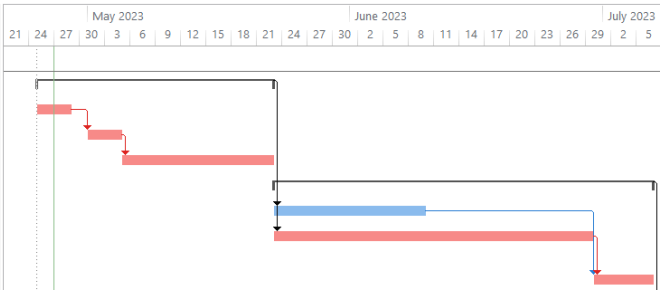
Appendix

1. Work Breakdown Structure

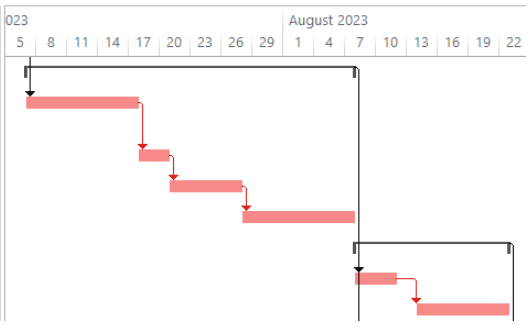
Deliverable	Tasks	Subtask	Description
Website	Design	Determine requirements	Identify and document the necessary features and functionalities needed for the site
		Develop a design concept	Create a high-level visual representation of the project's structure and layout
		Review and revise design	Analyze and refine the design concept based on feedback and requirements
	Development	Develop Front-end Layout	Develop the user interface and visual components
		Develop Back-end Functionality	Build the core logic and functionality of the project
		Integrate Third-party Services	Incorporate external services and APIs that are needed for the project
	Testing	User and Performance testing	Conduct user testing to gather feedback for website.Test website functionality and performance
		Identify issues	Identify and fix any bugs and issues
		Security testing	Since system will be integrated into CMU's IT services, test for vulnerabilities can conpromise the CMUI network
		Integration testing	Make sure the software correctly interacts with the hardware
	Launching	Launch Site	Launch the site
		Post-launch Testing and Fixes	monitor the website after launch, identify and fix any bugs or issues, and perform any necessary updates or improvements
Hardware system	Get required permits for installation		Check if additional permits are needed to build and operate this system and get those permits
	Acquire sensor hardware		Purchase hardware, do inventory, and do inspections of quality.
	Installation	Installation plan	plan out how the installation will go and put up signs/notices of ongoing construction
		Install	Install hardware as detailed in installation plan
	Testing and quality assurance	Test sensors	Check that all hardware works as intended
		Test wiring	Check that all the wiring and signals are stable
	Integration with Software		Connect the sensor's data to the website.
Staff training plan and manual	Training for garage staff	Create manual	Create user manual for staff to reference when operating the garage
		Create training video for staff	Training video for new staff members
		Conduct training sessions	Conduct training sessions for garage staff on system operation, maintenance, and troubleshooting
	Taining for website and back-end administrators	Create manual	Create user manual for staff to reference when operating the website
		Create training video for staff	Training video for new staff members
		Conduct training sessions	Conduct training sessions for website and back-end system administrators on system operation, maintenance, and troubleshooting
Maintenance plan	Budget Estimation		Estimate budget over time for maintenance
	Maintenance plan for sensor system	Purchase additional backup hardware	Procure extra sensors and other necessary hardware components to have on hand in case of equipment failure or malfunction.
		Regular inspeaction and cleaning	Conduct regular inspections of the sensor system to ensure proper function and cleanliness. Clean sensors and surrounding areas as needed to maintain accuracy and reliability of data.
		Replace batteries in sensors if needed	Monitor sensor battery levels and replace batteries as needed to ensure accurate data collection and prevent downtime.
	Maintenance plan for website and back-end	Regular updates	Develop and implement a plan for regularly updating the website and back-end system, including security patches and feature updates.
	Train maintenance staff		Train on maintenance procedures for sensor system and website/back-end system
	Regular monitoring		Conduct regular maintenance and monitoring of sensor system and website/back-end system
	Address issues or malfunctions		Address any issues or malfunctions in a timely manner to minimize downtime and ensure reliable operation.

2. Project Schedule

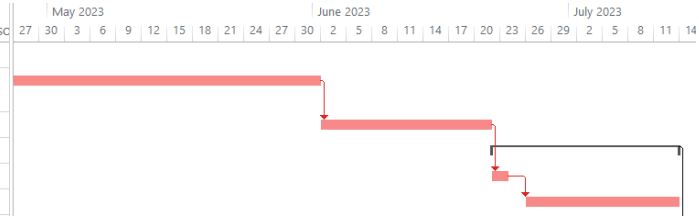
	Task Mod	Task Name	Duration	Start	Finish	Predece
1		**Website**				
2		**Design**	**20 days**	**Tue 4/25/23**	**Mon 5/22/23**	
3		Determine requirements	4 days	Tue 4/25/23	Fri 4/28/23	
4		Develop a design concept	4 days	Mon 5/1/23	Thu 5/4/23	3
5		Review and revise design	12 days	Fri 5/5/23	Mon 5/22/23	4
6		**Development**	**33 days**	**Tue 5/23/23**	**Thu 7/6/23**	
7		Develop Front-end Layout	14 days	Tue 5/23/23	Fri 6/9/23	2
8		Develop Back-end Funtionality	28 days	Tue 5/23/23	Thu 6/29/23	2
9		Integrate Third-party Services	5 days	Fri 6/30/23	Thu 7/6/23	7,8



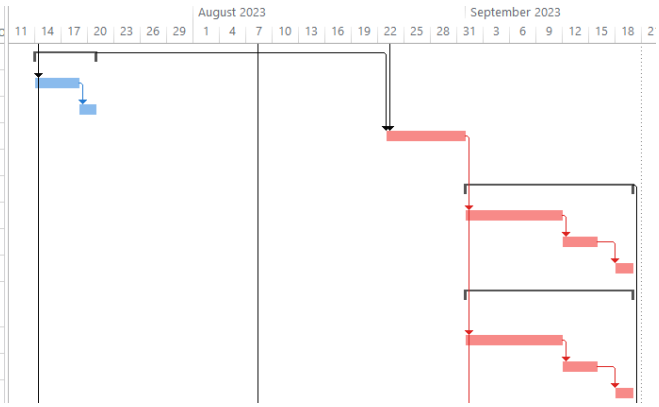
	Task Mod	Task Name	Duration	Start	Finish	Predece
10		**Testing**	**22 days**	**Fri 7/7/23**	**Mon 8/7/23**	
11		User and Performance testing	7 days	Fri 7/7/23	Mon 7/17/23	6
12		Identify Issues	3 days	Tue 7/18/23	Thu 7/20/23	11
13		Security Testing	5 days	Fri 7/21/23	Thu 7/27/23	12
14		Integration Testing	7 days	Fri 7/28/23	Mon 8/7/23	13
15		**Launching**	**11 days**	**Tue 8/8/23**	**Tue 8/22/23**	
16		Launch Site	4 days	Tue 8/8/23	Fri 8/11/23	10
17		Post-launch Testing and Fixes	7 days	Mon 8/14/23	Tue 8/22/23	16



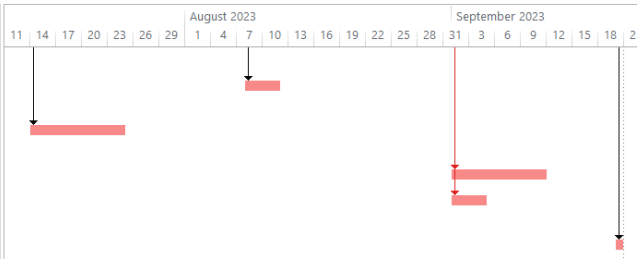
	Task Mod	Task Name	Duration	Start	Finish	Predecessc
18		**Hardware System**				
19		Get required permits for installation	28 days	Tue 4/25/23	Thu 6/1/23	
20		Acquire sensor hardware	14 days	Fri 6/2/23	Wed 6/21/23	19
21		**Installation**	**16 days**	**Thu 6/22/23**	**Thu 7/13/23**	
22		Instatllation plan	2 days	Thu 6/22/23	Fri 6/23/23	20
23		Install	14 days	Mon 6/26/23	Thu 7/13/23	22



	Task Mod	Task Name	Duration	Start	Finish	Predecessc
24		**Testing and quality assurance**	**5 days**	**Fri 7/14/23**	**Thu 7/20/23**	
25		Test sensors	3 days	Fri 7/14/23	Tue 7/18/23	21
26		Test wiring	2 days	Wed 7/19/23	Thu 7/20/23	25
27		Integration with Software	7 days	Wed 8/23/23	Thu 8/31/23	15,24
28		**Staff training plan and Manual**				
29		**Training for garage staff**	**13 days**	**Fri 9/1/23**	**Tue 9/19/23**	
30		Create Manual	7 days	Fri 9/1/23	Mon 9/11/23	27
31		Create training video for staff	4 days	Tue 9/12/23	Fri 9/15/23	30
32		Conduct training sessions	2 days	Mon 9/18/23	Tue 9/19/23	31
33		**Training for website and back-end administrators**	**13 days**	**Fri 9/1/23**	**Tue 9/19/23**	
34		Create Manual	7 days	Fri 9/1/23	Mon 9/11/23	27
35		Create training video for staff	4 days	Tue 9/12/23	Fri 9/15/23	34
36		Conduct training sessions	2 days	Mon 9/18/23	Tue 9/19/23	35



	Task Mod	Task Name	Duration	Start	Finish	Predecessc
37		**Maintenance Plan**				
38		Maintenance plan for website and back-end	4 days	Tue 8/8/23	Fri 8/11/23	10
39		Maintenance plan for sensor system	7 days	Fri 7/14/23	Mon 7/24/23	21
40		Budget Estimation	7 days	Fri 9/1/23	Mon 9/11/23	27
41		Address issues or malfunctions	2 days	Fri 9/1/23	Mon 9/4/23	27
42		Train maintenance staff	1 day	Wed 9/20/23	Wed 9/20/23	29



3. Risk Matrix

		Impact		
		Low	**Medium**	**High**
Likelihood	**High**			1. Risk of disruption to normal operations during hardware installation
	Medium		3. Technical difficulties with hardware and software compatibility	2. Privacy and security risk associated with the collection and storage of personal information
	Low		4. Delay in project delivery due to unforeseen circumstances	

Critical	Serious	Medium	Moderate	Ignore

4. Resource Allocation

4.1.Total Cost

Resource	Cost	Contingency Budget	Total Cost
1. Labor	$181,768.00	$18,176.80	$199,944.80
2. Materials	$78,880	$7,888	$86,768
Total	$260,648.00	$26,064.80	**$286,712.80**

4.2. Labor Breakdown

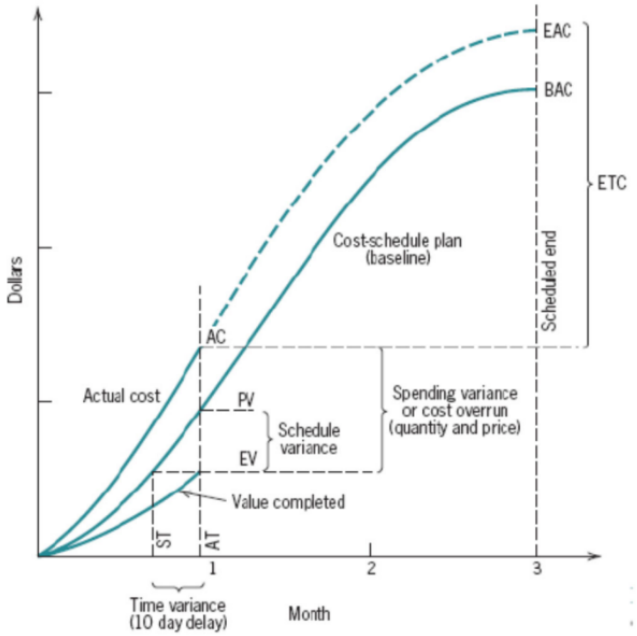
1. Labor				Based on Average Salary from salary.com		
Task	**Resource**	**Duration (days)**	**Labors Required**	**Cost/hr**	**Cost per Task**	**Notes/Assumptions**
Design: Determine requirements	Project Manager	4	1	60	$1,920	Assume project managers required
Design: Develop a design concept	Graphic Designer	4	1	28	$896	
Design: Review and revise design	Project Manager	12	1	60	$5,760	PM and GD will work together on the revision
	Graphic Designer	12	1	28	$2,688	
Development: Develop Front-end Layout	Front-end Developer	14	3	50	$16,800	
Development: Develop Back-end Functionality	Back-end Developer	28	3	55	$36,960	
Development: Integrate Third-party Services	Back-end Developer	5	3	55	$6,600	
Testing: User and Performance testing	Quality Assurance Tester	7	2	22	$2,464	
Testing: Identify issues	Quality Assurance Tester	3	2	22	$1,056	
Testing: Security testing	Security Consultant	5	1	60	$2,400	
Testing: Integration testing	Back-end Developer	7	3	55	$9,240	
Launching: Launch Site	Project Manager	4	1	60	$1,920	
Launching: Post-launch Testing and Fixes	Quality Assurance Tester	7	3	22	$3,696	
	Back-end Developer	7	3	55	$9,240	
Hardware system: Get required permits for installation	Project Manager	28	1	60	$13,440	
Hardware system: Installation plan	Project Manager	2	1	60	$960	
Hardware system: Install	Installation Specialist	14	6	30	$20,160	total 1192 sensor required
Hardware system: Testing and quality assurance	Quality Assurance Tester	5	2	22	$1,760	
Hardware system: Integration with Software	Back-end Developer	7	3	55	$9,240	
Staff training plan and manual: Training for garage staff	Training Specialist	7	2	28	$3,136	
Staff training plan and manual: Training for website and back-end administrators	Training Specialist	7	2	28	$3,136	
Maintenance plan: Budget Estimation	Project Manager	4	1	60	$1,920	
Maintenance plan for sensor system: Purchase additional backup hardware	Procurement Specialist	7	1	50	$2,800	
Maintenance plan for sensor system: Regular inspection and cleaning	Maintenance Specialist	7	2	30	$3,360	
Maintenance plan for sensor system: Replace batteries in sensors if needed	Maintenance Specialist	7	2	30	$3,360	
Maintenance plan for website and back-end: Regular updates	Back-end Developer	7	3	55	$9,240	
Maintenance plan for website and back-end: Train maintenance staff	Training Specialist	2	2	28	$896	
Maintenance plan for website and back-end: Regular monitoring	Maintenance Specialist	7	2	30	$3,360	
Maintenance plan for website and back-end: Address issues or malfunctions	Maintenance Specialist	7	2	30	$3,360	
Total					**$181,768.00**	

4.3. Materials Breakdown

2. Materials				
Item	**Quantity**	**Cost per Unit**	**Total Cost**	**Justification**
Sensor hardware	1216	$55	$66,880	Based on estimated need and procurement specialist input
Backup hardware components	1	$500	$500	Based on estimated need and procurement specialist input
Batteries for sensors	5000	$2	$10,000	Based on estimated need and maintenance specialist input
Other materials	1	$1,500	$1,500	Estimated cost for miscellaneous materials needed for installation and maintenance
Total			**$78,880**	

5. Example Earned Value Chart and Burn Down Curve

5.1 Example Earned Value Chart



5.2 Example Burndown Curve