



RUTGERS

THE STATE UNIVERSITY
OF NEW JERSEY

Term Project Final Report

Part 1: PLAN- Driven

Project Title: Construction of Smart Parking Lot

Part 2: AGILE- Driven

Project Title: Developing Smart Mobile App

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Semester: Sping 2024

Course: ENG PROJECT MANAGEMENT

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1.0 Abstract:

1.1 Part 1: Covered in Plan-Driven Project:

Covered in Plan-Driven Project: In today's landscape, smart solar parking lots represent a transformative approach to sustainable energy and urban infrastructure. By integrating solar panels with parking facilities, these innovative solutions harness renewable energy while providing essential services to users. Smart solar parking lots offer numerous benefits, including enhanced energy efficiency, reduced environmental impact, and improved user experience. Moreover, they contribute to the overall sustainability goals of cities and businesses.

The development of smart solar parking lots involves several key phases. The initial phase focuses on design and conceptualization, where careful analysis of market needs and future trends is essential. This stage requires thorough consideration of factors such as cost-effectiveness, simplicity, and scalability. Collaborating with experts in renewable energy and urban planning is crucial for designing an effective and adaptable system.

Following the design phase, the project moves to prototype development and testing. Building a functional prototype allows for validation of design concepts and ensures that the system meets performance requirements. Testing procedures should encompass rigorous evaluation of solar panel efficiency, charging infrastructure functionality, and integration with smart technologies.

Once the prototype is validated, the project transitions to procurement and implementation. This phase involves sourcing high-quality solar panels, energy storage systems, and smart parking technologies from reliable suppliers. Effective quality control measures are essential during installation to guarantee optimal performance and longevity of the infrastructure.

Furthermore, ongoing maintenance and monitoring are integral aspects of the project lifecycle. Implementing regular maintenance schedules, monitoring energy production metrics, and addressing potential issues promptly are vital for maximizing the lifespan and efficiency of the smart solar parking lot.

In summary, the development of a smart solar parking lot requires meticulous planning, interdisciplinary collaboration, and a commitment to sustainability. By leveraging renewable energy sources and advanced technologies, these innovative projects have the potential to revolutionize urban landscapes and contribute to a greener future system. .

1.2 Part 2: Covered in Agile Project:

It is also essential to continuously monitor continuous monitoring and optimization are vital for ensuring the long-term success of smart solar parking lots. By collecting and analyzing data on energy production, usage patterns, and system performance, stakeholders can identify areas for improvement and implement enhancements to maximize efficiency and user satisfaction. This iterative approach not only ensures the ongoing functionality of the parking lot but also contributes to the broader goals of sustainability and urban innovation.

2.0 Introduction:

The development of smart solar parking lots is a multifaceted endeavor that demands meticulous planning, precise implementation, and stringent quality assurance measures. The process encompasses various stages, starting from initial design and conceptualization, through prototyping, component acquisition, quality control, and ongoing monitoring. Each phase is essential for ensuring that the project progresses as intended and achieves its predefined objective. By using a plan-driven project management approach, the project team can ensure that the project stays on schedule, delivers on time and within budget, and meet the needs of stakeholders. This is a complex and high-risk project, where consequences of failure can be significant and hence this approach is justified.

3.0 Goals & Objectives

- **Enhancing Parking Precision and Efficiency:** The primary aim of the smart solar parking lot is to optimize parking precision and efficiency through innovative technology. By utilizing smart sensors and automation, vehicles can be guided to designated parking spots.
- **Ensuring Safety and Security:** The implementation of smart features such as IP cameras enhances the safety and security of the parking lot. This not only reduces the risk of accidents and theft but also provides users with peace of mind knowing their vehicles are protected.
- **Reducing Environmental Impact:** Through the integration of solar panels and EV charging station, the smart parking lot aims to reduce its environmental footprint. By harnessing solar energy to power lighting, charging stations, and other amenities, the project promotes sustainability and contributes to the mitigation of carbon emissions.

- **Optimizing Space Utilization:** By employing sensors and parking signage , the smart parking lot maximizes space utilization and minimizes congestion. This not only improves the overall flow of traffic within the parking facility but also enhances the user experience by reducing wait times and increasing accessibility.
- **Facilitating User Convenience:** The implementation of smart features such as mobile applications for parking reservations, cashless payment systems, and real-time availability updates enhances user convenience and satisfaction. By providing seamless and user-friendly experiences, the smart parking lot project aims to elevate the overall quality of urban mobility.
- **Promoting Sustainable Urban Development:** Overall, the objectives of the smart solar parking lot project are aligned with promoting sustainable urban development. By integrating renewable energy sources, enhancing user experience, fostering technological innovation, and optimizing resource utilization, the project contributes to the creation of resilient and environmentally friendly urban infrastructure.

4.0 Collection of Requirements

Section	Organization	Contribution	Component	End User
Section	Suppliers	Materials	Manufacturing Process	Parking Lot Users/ Visitors
	Authorities	Financing	Product Quality	Local Businesses/Property Owners
	Equipment	Work	Intellectual Property Rights	Community Perception
	Personal Resources	Technology	Surrounding Environmental Conditions	Operational Environment
	Worker	Work	Storage Infrastructure	Construction/Assembly

5.0 Scope Statement:

5.1 Product Scope

The Smart Solar Parking Lot project, the system is engineered to efficiently capture solar energy, prioritize precision and accuracy, maintain cost-effectiveness with a straightforward design and user-friendly interface, and ensure reliability. It will include real-time monitoring and feedback capabilities, advanced imaging and sensing technology, and thorough testing and validation to guarantee detailed visualization and precise performance.

5.2 Project Scope

To develop a Solar Parking Lot designed to optimize space utilization and energy efficiency. The project life cycle entails:

1. Pre-planning - Assessing site suitability and energy requirements.
2. Design - Drafting blueprints for solar panel placement and parking layout.
3. Procurement - Acquiring solar panels, sensors, and other components.
4. Construction - Installing solar panels and constructing parking infrastructure.
5. Start-up - Testing solar panels and automated systems.

This process includes:

- Discussing project objectives and site conditions.
- Finalizing solar panel configuration and parking layout.
- Compiling a list of required components.
- Estimating project costs.
- Developing initial design

6.0 Overall Summary

	Time	Costs
Planned Project	7 months + 1-month buffer	\$2,745,500.00
Agile Project	2 years Beta out in year 1 Full application in year 2	\$780,600

Additionally, it is planned that the application development work will start 3 months after the construction project is started. This will allow the application team to test their integration with the solar panel system as soon as it is available.

7.0 Schedule Overview

Stages	Duration (days)
Preparation of Project Plan	4
Preparation of Specifications	18
Procurement	23
Preparing site	3
Construction Foundation	11
Construction of Solar Canopy	49
Installation of EV Charging	31
Buffer	40
Total	7 months

8.0 Requirements Traceability Matrix:

Id	Requirement	Acceptance Criteria	Type	Status	Priority
6.1	Research and development	Identify need and supporting information	Stakeholder	Approved	High
6.2	Availability of Raw material	Check supplier capability and sustainability	Stakeholder	Approved	High
6.3	Machines and Tools	Check availability and ordered	Functional	Approved	Intermediate
6.4	Skilled Labor	Match the Education and experience or higher the employee	Stakeholder	Proposed	High
6.5	Skill improvement for engineers	Schedule proper training	Stakeholder	Approved	High
6.6	Standardization of Safety	Safety measures and methods of implementation such	Stakeholder	Approved	Intermediate
6.7	Trials of the lot	Schedule proper training	Stakeholder	Approved	Intermediate
6.8	Softwares	Check availability and ordered	Functional	Approved	High
6.9	Opinion of the people	Scheduled a meeting with the leadership team	Stakeholder	Proposed	Intermediate

9.0 Risk Analysis and Risk Management:

Risk	Probability	Consequences	Probability x Consequence	Recommended actions
Sensor redundancy	4	5	20	Many trials and observations required
Not meeting the Timeline goal	3	3	9	Frequent review meetings during the project
Space constraint	3	3	9	Check the availability of space and Decide on the plan accordingly
Improper production setup by the less skilled person	3	4	12	Proper work instruction and method to be defined
Delay in feedback from users	3	3	12	Active Participation of the sales team with customer and project
Trust of user	3	3	9	Building trust by creating awareness

Scales for probability and consequence of threats against the project:

Probability for risk to occur	Consequence if occurred
5 High Probability	5 Catastrophic
4 Probable	4 Severe
3 Small probability	3 Tangible
2 Very small probability	2 Minor
1 No	1 Negligent

10.0 Change Request Form to change the project

Change Request Form to change the Project				
Project Name:		Change Number:		Document No: Dated on:
Requested By:		Date of Request:		
Presented To:				
Change Name:				
Description of Change:				
Reason For Change:				
Effects:				
1. Effect on Deliverables				
2. Effect on Organization:				
3. Effect of Schedule:				
4. Effect on Budget:				
5. Effect on End User:				
Approval Date:		Decision	Accepted	Rejected
Approved By:				

11.0 Stakeholders Analysis and Communication Plan

11.1 Stakeholders Analysis and Communication Matrix:

Stakeholder Group	Communication Objective	Communication Channels	Frequency	Sender	Receiver
University Administration	Ensure parking lot meets the needs of students, faculty, and staff.	Project updates, progress reports, feedback sessions, town hall meetings, email	Monthly or as needed	Project team	University Administration
Transportation Services	Provide input on parking policies, permit pricing, and enforcement.	Stakeholder meetings, feedback sessions, email correspondence	Bi-weekly or as needed	Project team	Transportation Services
Government Agencies	Ensure compliance with zoning, permits, and environmental regulations.e	Regulatory compliance reports, permit applications, meetings with government officials	Weekly or as needed	Project team	Government Agencies
Emergency Services	Ensure access and safety within the parking lot.	Emergency response plans, site visits, meetings with emergency services personnel	As needed	Project Team	Emergency Services
Faculty and Staff	Provide information on parking facilities and address specific requirements.	Email updates, town hall meetings, feedback sessions, internal memos	As required by regulatory agencies	Project team	Faculty and Staff
Environmental and Sustainability Groups	Advocate for environmentally friendly design features such as electric vehicle charging stations.	Collaborative meetings, sustainability workshops, email updates	Quarterly or as needed	Project team	Environmental and Sustainability Groups
Students	Provide input on parking availability, accessibility, and preferences.	Surveys, focus groups, town hall meetings, social media interactions, Emails			

11.1 Stakeholder Engagement Matrix

Stakeholder Group	Engagement Objective	Engagement Activities
University Administration	Ensure parking lot meets the needs of students, faculty, and staff	Focus groups to gather input on parking preferences and requirements
Transportation Services	Provide input on parking policies, permit pricing, and enforcement	Organize stakeholder meetings to discuss and review parking policies, pricing structures, and enforcement strategies. Assign the project to contractor
Government Agencies	Ensure compliance with zoning, permits, and environmental regulations	Coordinate with relevant government agencies to obtain necessary permits and approvals for the project
Emergency Services	Ensure access and safety within the parking lot	Conduct site visits with emergency services to assess access points, traffic flow, and emergency response requirements
Faculty and Staff	Address specific parking requirements such as designated parking areas or permits	Participating in site visits to assess parking facilities and identify areas for enhancement or optimization.
Environmental and Sustainability Groups	Advocate for environmentally friendly design features	Engage in discussions to identify opportunities for incorporating sustainable design elements, such as electric vehicle charging stations
Students	Provide input on parking availability, accessibility, and preferences	Establishing a student advisory board or committee focused on parking issues, providing a structured forum for ongoing dialogue and collaboration.

12.0 Project meeting with Agenda, MOM, Issue log, Plus-delta evaluation:

12.1 : Project meetings and agenda:

Date: 02 March24

Time: 3.30 PM

Location: Busch Student Center Agenda:

1. Welcome and Introductions (5 minutes)

2. Project Status Update (15 minutes)

- Progress on the Construction

3. Stakeholder Engagement (10 minutes)

- Review of stakeholder engagement matrix
- Discussion of the stakeholder communication matrix
- Action items for improving stakeholder engagement.

4.Risk and Issue Management (10 minutes)

- Review of issues log
- Discussion of potential risks and mitigation strategies

5.Evaluation of Meeting (5 minutes)

- Plus-Delta evaluation form

6.Next Steps and Adjournment (5 minutes)

12.2 Minute of Meetings (MoM):

Date: 20-Feb-2024 Time: 3:30PM

Location: Busch Student Centre Attendees: Nikita, Amit, Pujita, Roody Agenda: Item

1. Welcome and Introductions

- Nikita welcomed everyone to the meeting and attendees introduced themselves.

Agenda Item 2: Project Status Update

- Nikita provided an update on the progress of the development of the parking lot.
- Feedback from stakeholders was discussed.
- Budget update was provided.

Agenda Item 3: Stakeholder Engagement

- Amit reviewed the stakeholder engagement matrix.

Agenda Item 4: Risk and Issue Management

- Pujita and Roody reviewed the issues log.
- Discussion was held on potential risks and mitigation strategies.


Agenda Item 5: Evaluation of Meeting

- Plus-Delta evaluation form was distributed and completed by attendees.
- Agenda Item 6: Next Steps and Adjournment
- Next steps were discussed and assigned.
- Meeting was adjourned.

12.3 Issue Log:

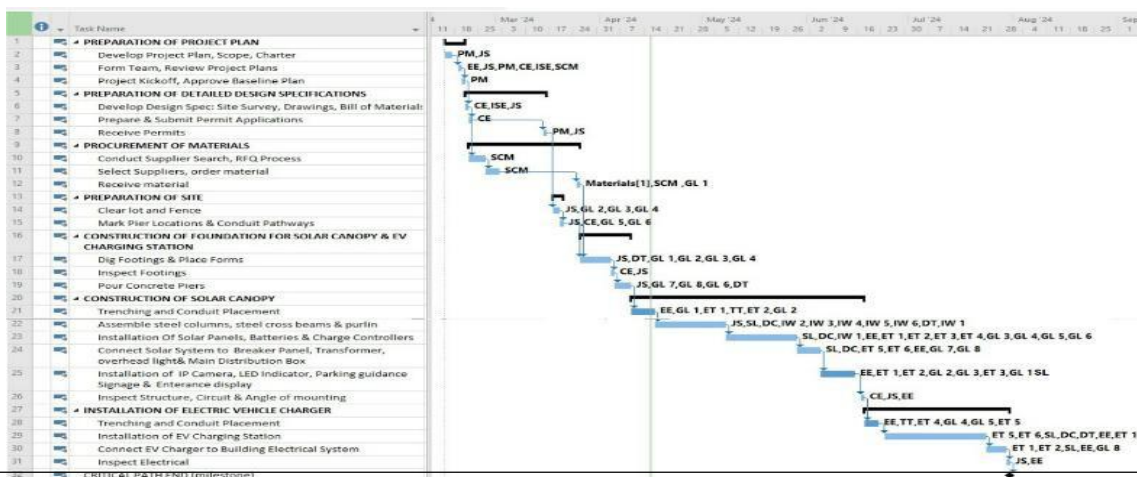
No.	Issue	Reported On	Reported By	Owner	Severity	Priority	Status
1.	Delay in Raw material acquisition	19-feb-24	Nikita	Pujita	Low	High	WIP
2.	Delay in App Design	19-feb-24	Amit	Roody	Medium	Low	WIP

12.3 Plus – Delta Evaluation:

Plus +	Delta 
Attendees came prepared with relevant information, data, and materials necessary for the discussion. This ensured productive and efficient meetings.	Meetings can often run over time, leading to rushed or postponed topics. Clear time limits for each agenda item and maintaining schedule are crucial. The meeting ran over time by 12 minutes, highlighting the need for better planning.
Important issues were identified and documented in the issue log, concluding with a clear plan of action, tasks, and deadlines. This ensures progress towards the goal of developing a solar parking lot.	Some attendees may hesitate to share their ideas or opinions. Encouraging participation and creating a supportive environment can foster comfortable contributions from all.
Communication with engineers from Rutgers University provided valuable insights as stakeholders.	There was a lack of focus for the initial 10 minutes of the meeting, with unclear agenda items. Avoiding such issues can save time. Discussions losing focus can be mitigated by keeping them centered on the primary goal of developing a solar parking lot.

13.0 Project Resources and Budgeting

13.1 Gantt Chart



13.2 Itemize Human Resources and Rates:

Resource Name	Std. Rate	Ovt. Rate	Initials
Project Manager	\$100/hr	\$120/hr	PM
ISE Engineer	\$100/hr	\$120/hr	ISE
Civil Engineer	\$100/hr	\$120/hr	CE
Electrical Engineer	\$100/hr	\$120/hr	EE
Job Supervisor	\$100/hr	\$120/hr	JS
Supply Chain Manager	\$80/hr	\$100/hr	SCM
General Laborer 2	\$35/hr	\$42/hr	GL 2
General Laborer 3	\$35/hr	\$42/hr	GL 3
General Laborer 4	\$35/hr	\$42/hr	GL 4
General Laborer 5	\$35/hr	\$42/hr	GL 5
General Laborer 6	\$35/hr	\$42/hr	GL 6
General Laborer 7	\$35/hr	\$42/hr	GL 7
General Laborer 8	\$35/hr	\$42/hr	GL 8
Iron Worker 1	\$80/hr	\$96/hr	IW 1
Iron Worker 2	\$80/hr	\$96/hr	IW 2
Iron Worker 3	\$80/hr	\$96/hr	IW 3
Iron Worker 4	\$80/hr	\$96/hr	IW 4
Iron Worker 5	\$80/hr	\$96/hr	IW 5
Iron Worker 6	\$80/hr	\$96/hr	IW 6
Electrician 1	\$80/hr	\$96/hr	ET 1
Electrician 2	\$80/hr	\$96/hr	ET 2
Electrician 3	\$80/hr	\$96/hr	ET 3
Electrician 4	\$80/hr	\$96/hr	ET 4
Electrician 5	\$80/hr	\$96/hr	ET 5
Electrician 6	\$80/hr	\$96/hr	ET 6

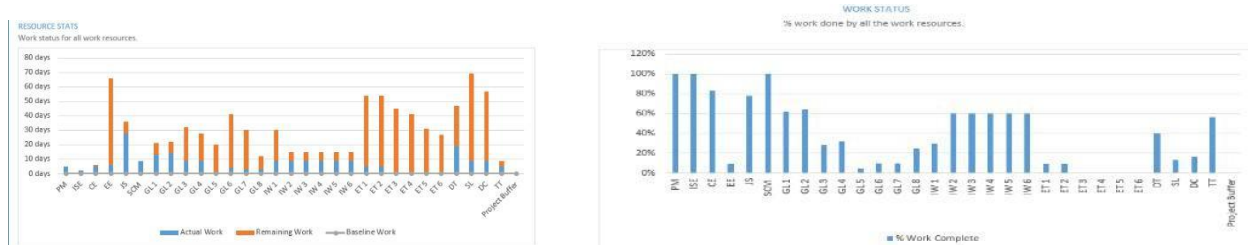
13.3 Equipment Cost

Equipment cost			
Item	Std. Rate	Ovt. Rate	Initials
Drigger Truck	\$100.00/hr	\$80.00/hr	DT
Scissors Lift	\$100.00/hr	\$80.00/hr	SL
Drivable Crane	\$100.00/hr	\$80.00/hr	DC
Trenching Tractor	\$100.00/hr	\$80.00/hr	TT

13.4 Material Cost

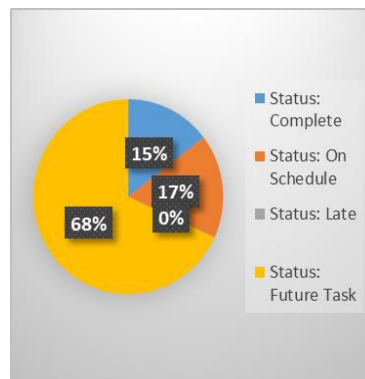
Material Cost			
Item	Qty	Rate	Cost
Solar Panels (includes attachment)	1980	\$400	\$792,000
Steel Columns	98	\$5,000	\$490,000
Steel Cross Beam	165	\$2,000	\$330,000
Purlin	330	\$500	\$165,000
Concrete Piers 2'dia x 10'w/rebar & bolts	120	\$700	\$84,000
Conduit (per ft)	10,000	\$5	\$50,000
Cable (per ft)	10,000	\$1	\$10,000
Lamps	100	\$100	\$10,000
EV charging Stations	30	\$5,000	\$150,000
Inverters, Breaker Boxes	8	\$5,000	\$40,000
Solar Controller, Meters	1	\$15,000	\$15,000
Main Transformer, Collector Box	1	\$50,000	\$50,000
IP Camera	196	\$37	\$7,252
LED Indicator	196	\$30	\$5,880
Parking guidance Signage	1	\$100	\$100
Entrance Display	1	\$100	\$100
Material Cost		Total	\$2,199,332

13.5 Work Status By resource



13.6 % Work Completed

Task	% Complete	Start Date	Finish Date
Prepare Project Plan	100%	Thu 2/15/24	Tue 2/20/24
Prepare Detailed Design Specification	100%	Wed 2/21/24	Fri 3/15/24
Procure Materials	100%	Thu 2/22/24	Mon 3/25/24
Prepare Site	100%	Mon 3/18/24	Wed 3/20/24
Construct Foundation	29%	Tue 3/26/24	Tue 4/9/24
Assemble Structure & Panels	0%	Wed 4/10/24	Mon 6/17/24
Construct & Connect Electricals	0%	Tue 6/18/24	Tue 7/30/24
Total	32%	Thu 2/15/24	Tue 7/30/24



13.7 Cost overview

Name	Labor Cost	Material Cost	Equipment Cost	Stage Total
Prepare Project Plan	\$8,640	\$0	\$0	\$8,640
Prepare Detailed Design Specification	\$4,800	\$0	\$0	\$4,800
Procure Materials	\$5,400	\$2,215,980	\$0	\$2,221,380
Prepare Site	\$5,440.	\$0	\$0	\$5,440
Construct Foundation	\$19,120	\$0	\$8,000	\$27,120
Construction Of Solar Canopy	\$191,680	\$0	\$90,400	\$282,080
Construction Of Electric Vehicle Charging Station	\$136,000	\$0	\$59,200	\$195,200
Total	\$363,280	\$2,215,980.00	\$157,600.00	\$2,744,660

Part 2: AGILE- Driven

Project Title: Developing Software for the parking lot

1.0 Product Vision:

Our product vision is to develop a management system for solar parking lots that will revolutionize the way parking facilities operate. Our system will provide users with the tools they need to efficiently manage parking spaces while maximizing the use of solar energy. Our goal is to create a reliable and user-friendly system that will make parking facilities more sustainable and cost-effective. Our system will have several key features, including a user-friendly interface, real-time monitoring of parking spaces and solar energy production, reservation capabilities, and billing integration. We aim to create a system that is intuitive and easy to use, so both parking administrators and users can navigate it effectively. Our system will also prioritize sustainability by optimizing solar energy usage and reducing carbon emissions. We envision our system being used in parking lots and garages worldwide, improving energy efficiency and reducing operating costs. Our system will also provide valuable data for analysis and research, contributing to advancements in sustainable transportation. Overall, our product vision is to create a management system that is reliable, sustainable, and user-friendly, helping to advance the adoption of solar energy in parking facilities.

2.0 Agile Workframe

- The Agile work frame used in the project is a traditional SCRUM approach. Since the development team for this project will be relatively small there is no need for more complicated systems like SAFe.
- Each sprint will be 2 weeks long and 2 features are planned for each release. This assumption should be validated with the team during each sprint planning phase to make sure that the workload is reasonable.
- The releases are quarterly and each total around 10 weeks of work - this is to account for PTO, holidays, and other common disruptions to work.

The following SCRUM rituals will be performed by the project manager:

- Daily Stand-Up Meeting
- Release Retrospective at the end of each release
- Sprint Planning at the beginning of each spring

2.1 Stand Up Meeting

The goal of the stand-up meeting is to establish what work was done yesterday, what work is planned, and what roadblocks the team is facing. The meeting should be limited to 15 min each day and occur early in the workday.

A meeting template is shown below:

Item	Details
Date and Time	[Date] [Time]
Participants	
Agenda	<ol style="list-style-type: none">1. Review yesterday's progress2. Set today's objectives3. Discuss blockers
Individual Updates	Name: - Yesterday's Achievements: - Today's Goals: - Blockers/Challenges:
Blockers and Challenges	[Summary and solutions]
Additional Notes	[Notes]
Next Meeting	[Date and Time]

2.2 Release Retrospective

The release retrospective is a methodology to collect and document feedback. The meeting length is dependent on how successful the team felt the release was and can range from half an hour to an hour and a half. The retrospective allows the project manager to better understand how to lead the next release and allows the team members to express concerns about how the work is being done. It is critical to assign action items and assign them to a person as well as to follow up on previous areas for improvement to see if they were successfully improved.

Below is a template for a release retrospective meeting:

Item	Details
Date and Time	[Date] [Time]
Participants	<ul style="list-style-type: none">- Participant 1- Participant 2
Release Overview	<ul style="list-style-type: none">- Release Name/Version- Release Date- Key Features/Changes
Objectives	<ul style="list-style-type: none">- Review the release process- Highlight successes- Identify areas for improvement- Discuss and agree on action items for future releases
What Went Well	<ul style="list-style-type: none">- Topic:-- Details:-- Contributing Factors: <i>Repeat for each positive aspect identified</i>
Areas for Improvement	<ul style="list-style-type: none">-- Topic:-- Details:-- Contributing Factors: <i>Repeat for each positive aspect identified</i>
Action Items	<ul style="list-style-type: none">- Action:-- Responsible Person:-- Deadline: <i>Repeat for each action item agreed upon</i>
Additional Notes	[Any other observations or comments]
Next Steps	<ul style="list-style-type: none">- Schedule for the next retrospective- Any follow-up meetings or deadlines for action items

2.3 Sprint Planning

Sprint planning is a meeting that is performed at the beginning of every sprint by the project lead and the team. During sprint planning, team members are assigned user stories according to their capacity and the time each user story will take. Critically, in this meeting, the Definition of Done is discussed for each story. This ensures that the work completed addresses the desired need. This meeting should be scheduled to last an hour.

Below is a template for this meeting:

Item	Details
Date and Time	[Date], [Time]
Participants	Product Owner, Development Team Members, Other Stakeholders (if necessary)
Sprint Duration	Start Date to End Date
Sprint Goals	Main objectives and expected outcomes for this sprint
Product Backlog Review	Items to be considered for this sprint, Updates or reprioritization as needed
Capacity Planning	Availability of team members, Holidays/planned leaves, Team's velocity and work capacity estimation
Task Breakdown	User Story/Feature, Tasks, Estimated Effort, Assigned To - Repeat for each item selected for the sprint
Definition of Done	Completion criteria, Quality standards, and documentation requirements
Risks and Dependencies	Identified risks, External dependencies, and coordination needs
Sprint Backlog	Final list of items selected for the sprint, Associated tasks, and assignments
Additional Notes	Any other relevant information
Next Steps	Next sprint planning meeting, any immediate tasks or preparations

3.0 Backlog and Timeline

The product backlog was created by determining desired features, splitting them into epics, and sorting them by priority. The complete backlog will be attached in the appendix. Key features for each release were selected and during the sprint planning meetings, those features would be broken down into user stories that the team would work on.

Overall the plan is to release an Android beta version of the app after the 4th release and the beta version of the iOS app after the 6th release. This will create a natural staggering of the initial users and allow the team to handle the active user load. By the end of the 8th release, both applications will be out of the Beta phase.

Features are managed by sorting them into epics. The following epics were used:

Epic 1: Mobile Application Infrastructure	Creating the mobile application for both Android and iOS
Epic 2: Backend System for Data Management	Backend systems and data warehousing features were included in this epic
Epic 3: Frontend Development	Frontend Development that was the same for both Android and iOS as well as the dashboard for the admin were grouped here
Epic 4: Account Management	All features related to the users being able to create, manage, and delete accounts were grouped here
Epic 5: Data Permissions	Data permission features made sure that data was collected according to the permissions allowed by regulations and by the relevant app stores.
Epic 6: Real-Time Parking and Charging Info	Features that related to integration with the actual IoT system in the parking lot. The system is composed of the solar panels, the occupied parking spot sensors, and the EV charging stations
Epic 7: Vehicle Location Memory	This epic is small and relates to features that track the previous location of vehicles for the account and the admin dashboard
Epic 8: Payment Integration	All features related to integrating payment are assigned to this epic
Epic 9: Notification System	Notification systems and alerts related to parking, paying, and reserving for both operating systems
Epic 10: Security Features	Any security and privacy features.
Epic 11: Bug & Release Testing	All “features” that were dedicated to bug testing and release testing are here. These “features” are in the backlog to indicate that time should be assigned for pre-release testing.
Epic 12: Customer Support and Onboarding	Customer support management and features that relate to onboarding
Epic 13: Unexpected Delays	A placeholder epic to allow time in the backlog for unexpected delays.

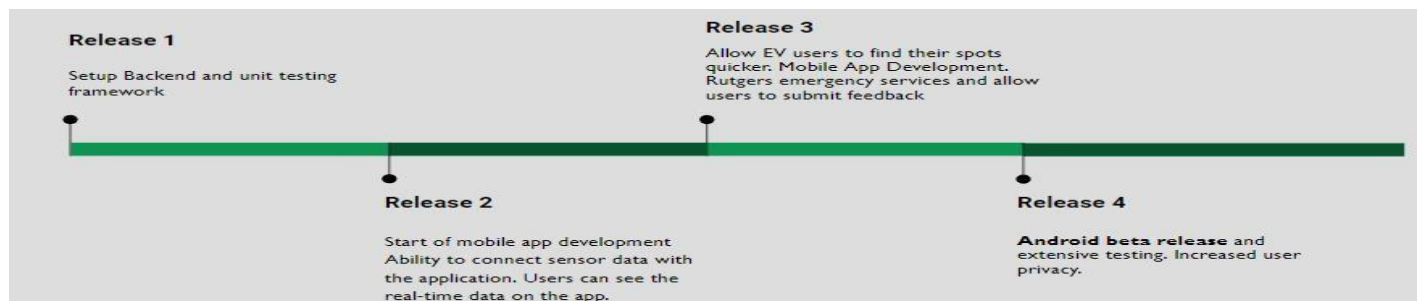
3.1 Release 1

All releases have a detailed feature backlog like release 1, for brevity, only this release is shown in detail.

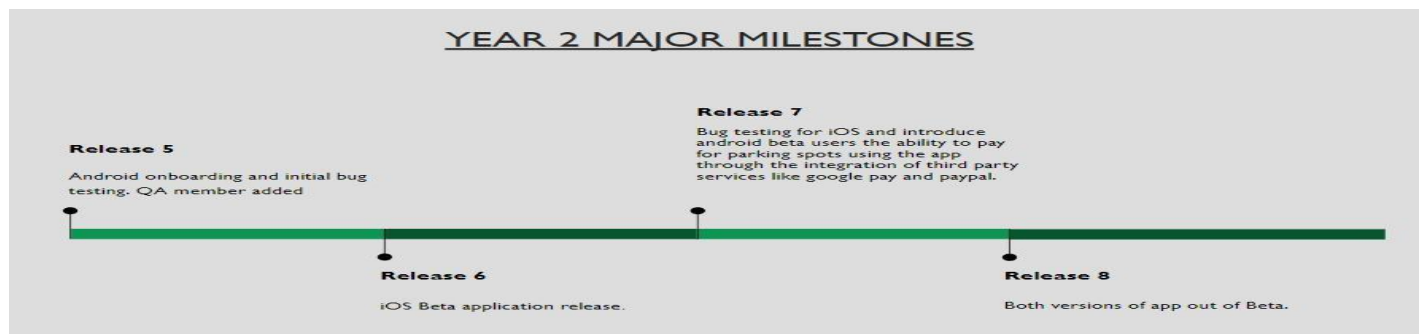
ID	Epic	Feature	Prioritization	Sprint (2 week long)	Time Duration(Weeks)
1	Epic 1: Mobile Application Infrastructure	CI/CD pipeline setup for agile development.	1 - Must have		2
14	Epic 2: Backend System for Data Management	Backend infrastructure setup for data processing.	1 - Must have		2
15	Epic 2: Backend System for Data Management	Database design for user and sensor data.	1 - Must have		4
17	Epic 2: Backend System for Data Management	Scalability planning for backend servers.	1 - Must have		4
20	Epic 2: Backend System for Data Management	Incident reporting tool for users and management.	1 - Must have		6
22	Epic 2: Backend System for Data Management	Real-time reporting tools for management	1 - Must have		6
24	Epic 2: Backend System for Data Management	Server load balancing for reliability.	1 - Must have		8
13	Epic 2: Backend System for Data Management	Data backup and recovery systems.	1 - Must have		8
18	Epic 2: Backend System for Data Management	Automated unit and integration testing setup.	1 - Must have		10
19	Epic 2: Backend System for Data Management	Admin dashboard for monitoring and management	1 - Must have		10
101	Epic 11: Bug & Release Testing	Internal Release 1 Testing	1 - Must have		12

In this release, the main focus was on creating the CI/CD pipeline and on developing the backend. This sets a solid foundation for the subsequent development tasks.

3.2 Year 1



3.3 Year 2



4.0 Budget

The budget for the agile project was broken up into the salary costs and the infrastructure costs.

4.1 Human Resources

- In the first year, the staff members who are working on the project are:
 - Product Owner/Scrum Master
 - They are responsible for managing the project, the backlog, meetings, risks, and external stakeholders
 - 4 Full Stack Developers
 - They are the development team throughout the project.

	Product Owner/Scrum Master	Full Stack Developer	
Amount	1	4	Total Salary per Sprint
Cost Per Sprint	\$3,654	\$3,462	\$17,500

- In the second year, an additional QA Engineer is brought on board to help maintain the quality of the engineering when customers are actively using the application.

	Product Owner/Scrum Master	Full Stack Developer	QA Engineer	
Amount	1	4	1	Total Salary per Sprint
Cost Per Sprint	\$3,654	\$3,462	\$2,692	\$20,192

4.2 Infrastructure Costs

Three pieces of critical infrastructure were accounted for in the development of the applications:

1) IoT Systems

- The IoT System is how all of the data from the hardware in the real world is managed and sent to the servers. This system is critical to the success of the project and it was determined that it would be better to purchase to create it in-house.
- ThingWorx is an example of such a system.

2) Cloud Services

- The app and the development need a cloud to “live” on.

3) Data Storage

- This is where the application stores the live data from the hardware systems and the user-generated data like their accounts and parking history

Infrastructure costs	Monthly Costs	Description
IoT System	300	System that gets the data from the sensors in the parking lot
Cloud Services	50	Location of the where the app
Data storage	100	Location where the backend is stored (servers)
Month Total	450	
Sprint Cost	225	

4.3 Total Costs

	Total Sprint Cost	Cumulative Cost
Year 1	\$17,725	\$372,225
Year 2	\$20,417	\$780,571

This is assuming that for year 1 there were 21 sprints and for year 2 there were 20 sprints. It is worth noting that several potential risks would increase the budget:

- Increased infrastructure needs
- The current plan for the infrastructure might not be sufficient to match the amount of active users or the amount of live data that will be collected
- There is a chance that the employees pay increases

5.0 Risk Analysis & Mitigation

Risk Event	Risk Owner	Risk Response Plans
Insufficient Funding	Product Owner	1. Seek additional funding sources through grants, investors, or stakeholders. 2. Optimize the project budget by prioritizing essential features and reducing non-essential expenses.
Technical Challenges	Technical Lead - Rotates through each developer	1. Conduct thorough technical feasibility studies before project initiation. 2. Allocate sufficient time for prototyping and testing to identify and address technical issues early on.
Delay in Deliverables	Product Owner	1. Establish clear project timelines and milestones to monitor progress. 2. Implement agile project management methodologies to adapt to changing requirements and mitigate delays.
Scope Creep	Product Owner	1. Define a clear project scope and requirements document. 2. Implement change control procedures to evaluate and approve any changes to the project scope.

6.0 Stakeholders and Communication Plan

Understanding the stakeholders, their priorities, and their level of interest in the project is crucial. To analyze this, we described each stakeholder's level of interest and power. Subsequently, we categorized the stakeholders into priority levels based on this analysis.

Stakeholder	Priority	Interest in Project	Power	Communication Plan
Project Sponsor	Key	High - Aligning project with organizational goals	High	Regular progress updates, strategic alignment meetings, risk and opportunities discussions
Project Manager	Key	High - Ensuring timely delivery and resource management	High	Daily stand-ups, weekly project status reports, resource planning sessions
Technical Team (Developers, Designers, etc.)	Key	High - Technical feasibility and implementation	Medium	Regular technical meetings, sprint planning and reviews, ad-hoc problem-solving sessions
Product Owner	Key	High - Meeting user needs and prioritizing features	High	Continuous engagement through backlog grooming sessions, sprint planning, and priority discussions
End Users (Parking Lot Visitors)	Medium	High - Usability and functionality of the app	Low	Surveys, feedback forms, beta testing invitations, user forums for ongoing feedback
Regulatory Authorities	Medium	Medium - Compliance and approvals for operation	High	Periodic updates on compliance status, consultations for guidance, preparation of required documentation
Investors and Funders	Key	High - Return on investment and project success	High	Investor meetings, financial performance updates, ROI discussions

Local Community and Residents	Low	Medium - Impact on local infrastructure and mobility	Low	Community forums, newsletters, public hearings for major developments
Environmental Organizations	Low	Medium - Environmental benefits and sustainable practices	Low	Presentations on environmental impact assessments, partnership discussions
Electric Vehicle Owners	Low	High - Access to charging stations and sustainable options	Low	Targeted communications, feature highlights, user experience feedback sessions

7.0 Appendix - Detailed Release Backlog

Year 1:

ID	Epic	Feature	Prioritization	Sprint (2 week long)	Time Duration(Weeks)	Release	Milestone
1	Epic 1: Mobile Application Infrastructure	CI/CD pipeline setup for agile development.	1 - Must have	1	2	1	
14	Epic 2: Backend System for Data Management	Backend infrastructure setup for data processing.	1 - Must have	1	2	1	
15	Epic 2: Backend System for Data Management	Database design for user and sensor data.	1 - Must have	2	4	1	
17	Epic 2: Backend System for Data Management	Scalability planning for backend servers.	1 - Must have	2	4	1	
20	Epic 2: Backend System for Data Management	Incident reporting tool for users and management.	1 - Must have	3	6	1	
22	Epic 2: Backend System for Data Management	Real-time reporting tools for management.	1 - Must have	3	6	1	
24	Epic 2: Backend System for Data Management	Server load balancing for reliability.	1 - Must have	4	8	1	
13	Epic 2: Backend System for Data Management	Data backup and recovery systems.	1 - Must have	4	8	1	
18	Epic 2: Backend System for Data Management	Automated unit and integration testing setup.	1 - Must have	5	10	1	Setup and Significant Work on the Backend to allow for future development
19	Epic 2: Backend System for Data Management	Admin dashboard for monitoring and management.	1 - Must have	5	10	1	
101	Epic 11: Bug & Release Testing	Internal Release 1 Testing	1 - Must have	6	12	1	
3	Epic 1: Mobile Application Infrastructure	Cross-platform app development (iOS and Android).	1 - Must have	6	12	2	
2	Epic 1: Mobile Application Infrastructure	Unit Testing for Mobile Platform	1 - Must have	7	14	2	
8	Epic 10: Security Features	User data anonymization for privacy protection.	1 - Must have	7	14	2	
69	Epic 5: Data Permissions	User role and permission settings development.	1 - Must have	8	16	2	
16	Epic 8: Real-Time Parking and Charging Info	Sensor data integration and processing system.	1 - Must have	8	16	2	Start of mobile app development as well as front end work.
33	Epic 3: Frontend Development	User-friendly mobile app interface design.	1 - Must have	9	18	2	Ability to connect sensor data with the application is achieved in this release. Users can see the real-time data on the app.
3	Epic 1: Mobile Application Infrastructure	Cross-platform app development (iOS and Android).	1 - Must have	9	18	2	
34	Epic 3: Frontend Development	Real-time data visualization on app frontend.	1 - Must have	10	20	2	
24	Epic 3: Frontend Development	Accessibility features for disabled users.	1 - Must have	10	20	2	
3	Epic 1: Mobile Application Infrastructure	Cross-platform app development (iOS and Android).	1 - Must have	11	22	2	
102	Epic 11: Bug & Release Testing	Internal Release 2 Testing	1 - Must have	12	24	2	
38	Epic 3: Frontend Development	User feedback collection feature.	2 - Should have	12	24	3	
39	Epic 3: Frontend Development	Interactive map development for parking lot navigation.	2 - Should have	13	26	3	
71	Epic 8: Real-Time Parking and Charging Info	Real-time parking space availability feature.	1 - Must have	13	26	3	The app will be more friendly towards EV users by allowing them to find their spots quicker.
40	Epic 3: Frontend Development	Search functionality for finding parking by location.	2 - Should have	14	28	3	Additionally, it will integrate with Rutgers emergency services and allow users to submit feedback.
72	Epic 8: Real-Time Parking and Charging Info	Electric vehicle (EV) charging station locator.	1 - Must have	14	28	3	
73	Epic 8: Real-Time Parking and Charging Info	Parking space reservation system.	2 - Should have	15	30	3	
74	Epic 8: Real-Time Parking and Charging Info	Filter options for EV charging stations.	2 - Should have	15	30	3	
66	Epic 8: Notification System	Emergency services notification integration.	1 - Must have	16	32	3	
103	Epic 11: Bug & Release Testing	Internal Release 3 Testing	1 - Must have	16	32	3	
9	Epic 10: Security Features	Encryption protocols for data transmission.	1 - Must have	17	34	4	
10	Epic 10: Security Features	Compliance checks for data protection standards.	1 - Must have	17	34	4	
26	Epic 2: Backend System for Data Management	Analytics feature for parking and charging usage.	2 - Should have	18	36	4	User privacy is the focus for this release as well as unaccounted time to allow for delays in critical features earlier in the backlog.
27	Epic 2: Backend System for Data Management	Detailed reports and analytics for stakeholders.	2 - Should have	18	36	4	
	Epic 13: Unspecified Delays	To account for delays in features up to now	1 - Must have	19	38	4	
	Epic 13: Unspecified Delays	To account for delays in features up to now	1 - Must have	19	38	4	
	Epic 13: Unspecified Delays	To account for delays in features up to now	1 - Must have	20	40	4	
	Epic 13: Unspecified Delays	To account for delays in features up to now	1 - Must have	20	40	4	
104	Epic 11: Bug & Release Testing	Testing For Beta Release - Android Only	1 - Must have	21	42	4	Extensive testing of the beta release will be done before it is published.
105	Epic 11: Bug & Release Testing	Testing For Beta Release - Android Only	1 - Must have	21	42	4	
End of Year 1							

Year 2: Year 2:

ID	Epic	Feature	Prioritization	Sprint (2 week long)	Time Duration(Weeks)	Release	Milestone
106	Epic 12: Customer Support and Onboarding	Initial Onboarding - Emergency Bugs	1 - Must have	1	2	5	Onboarding and initial bugs found through the Beta testing is the over arching goal for the release. Additionally, users will be able to create profiles.
92	Epic 11: Bug & Release Testing	Initial Beta User Bugs	1 - Must have	1	2	5	
93	Epic 4: Account Management	User authentication system design and development.	1 - Must have	2	4	5	
94	Epic 4: Account Management	User profile creation and management.	1 - Must have	2	4	5	
37	Epic 11: Bug & Release Testing	Vehicle information registration system.	1 - Must have	3	6	5	
35	Epic 3: Frontend Development	Initial Beta User Bugs	1 - Must have	3	6	5	The iOS application will be released at the end of this release. Additionally, backend work is done to allow for potential integration, and for better cloud solutions.
98	Epic 3: Frontend Development	Tutorial for first-time users.	1 - Must have	4	8	5	
99	Epic 3: Frontend Development	User manual and help section in the app.	1 - Must have	4	8	5	
103	Epic 11: Bug & Release Testing	Parking lot status alerts (full, nearly full, etc.).	2 - Should have	5	10	5	
25	Epic 2: Backend System for Data Management	Testing for 1st Public Update	4 - Must have	5	10	5	
41	Epic 3: Frontend Development	API development for mobile-backend communication.	3 - Could have	6	12	6	Both versions of the app will be out of Beta by the end of this release. Notifications will be improved and multifactor authentication will be added using Pluggins and OAuth2 service.
3	Epic 1: Mobile Application Infrastructure	Carbon footprint calculator for users.	3 - Could have	6	12	6	
70	Epic 1: Mobile Application Infrastructure	Cross-platform app development (iOS).	1 - Must have	7	14	6	
23	Epic 2: Backend System for Data Management	Cross-platform app development (iOS).	1 - Must have	7	14	6	
21	Epic 2: Backend System for Data Management	License plate recognition system integration.	4 - Worst have this	8	16	6	
103	Epic 11: Bug & Release Testing	Continuous user education program on app updates.	2 - Should have	8	16	6	Bug testing for the iOS release is done as well as allowing android beta users the ability to pay for parking spots using the app through the integration of third party services like google pay and paypal.
99	Epic 11: Bug & Release Testing	Performance optimization for high traffic.	3 - Could have	9	18	6	
103	Epic 11: Bug & Release Testing	Cloud storage solutions for scalability.	2 - Should have	9	18	6	
99	Epic 11: Bug & Release Testing	Testing for 2nd Public Update	1 - Must have	10	20	6	
99	Epic 11: Bug & Release Testing	Testing for Beta Release - iOS Only	1 - Must have	10	20	6	
99	Epic 4: Account Management	Payment method addition and management.	1 - Must have	11	22	7	Both versions of the app will be out of Beta by the end of this release. Notifications will be improved and multifactor authentication will be added using Pluggins and OAuth2 service.
90	Epic 4: Account Management	Secure payment gateway integration.	1 - Must have	11	22	7	
75	Epic 11: Bug & Release Testing	iOS Beta user Bugs	1 - Must have	12	24	7	
75	Epic 6: Real-Time Parking and Charging Info	Parking violation detection and alert system.	2 - Should have	12	24	7	
75	Epic 6: Real-Time Parking and Charging Info	Environmental impact reports and sustainability tracking.	2 - Should have	13	26	7	
77	Epic 11: Bug & Release Testing	iOS Beta user Bugs	1 - Must have	13	26	7	Both versions of the app will be out of Beta by the end of this release. Notifications will be improved and multifactor authentication will be added using Pluggins and OAuth2 service.
77	Epic 6: Real-Time Parking and Charging Info	Traffic flow analysis within parking lots.	2 - Should have	14	28	7	
89	Epic 7: Vehicle Location Memory	Parking location memory functionality.	2 - Should have	14	28	7	
91	Epic 8: Payment Integration	Reservation system integration with payment processing.	2 - Should have	15	30	7	
103	Epic 11: Bug & Release Testing	Testing for 3rd Public Update	1 - Must have	15	30	7	
92	Epic 8: Payment Integration	Payment history and invoice generation.	2 - Should have	16	32	8	Both versions of the app will be out of Beta by the end of this release. Notifications will be improved and multifactor authentication will be added using Pluggins and OAuth2 service.
97	Epic 9: Notification System	Push notification service for parking and charging updates.	2 - Should have	16	32	8	
99	Epic 9: Notification System	Custom alerts for preferred parking spot availability.	2 - Should have	17	34	8	
5	Epic 1: Mobile Application Infrastructure	Voice command features for hands-free use.	3 - Could have	17	34	8	
11	Epic 10: Security Features	Secure login with multi-factor authentication (MFA).	3 - Could have	18	36	8	
28	Epic 11: Bug & Release Testing	Bug Fixes	1 - Must have	18	36	8	Both versions of the app will be out of Beta by the end of this release. Notifications will be improved and multifactor authentication will be added using Pluggins and OAuth2 service.
29	Epic 2: Backend System for Data Management	Predictive analytics for parking space availability.	3 - Could have	19	38	8	
42	Epic 3: Frontend Development	Parking history feature for users.	3 - Could have	19	38	8	
43	Epic 3: Frontend Development	Customizable user dashboard development.	3 - Could have	20	40	8	
103	Epic 11: Bug & Release Testing	Testing for 4th Public Update	4 - Must have	20	40	8	
				End of Year 2			

Additional Features that were not planned:

ID	Epic	Feature	Prioritization
45	Epic 3: Frontend Development	In-app messaging system for user support.	3 - Could have
46	Epic 3: Frontend Development	QR code scanning for easy parking check-in/out.	3 - Could have
47	Epic 3: Frontend Development	User ratings and reviews for parking spots.	3 - Could have
48	Epic 3: Frontend Development	Chatbot for automated customer support.	3 - Could have
50	Epic 3: Frontend Development	User interface customization options.	3 - Could have
51	Epic 3: Frontend Development	Gamification elements to encourage eco-friendly practices.	3 - Could have
52	Epic 3: Frontend Development	Sponsorship and advertising module.	3 - Could have
53	Epic 3: Frontend Development	User interface animations for better UX.	3 - Could have
54	Epic 3: Frontend Development	Dark mode option for the app interface.	3 - Could have
55	Epic 3: Frontend Development	Badge and reward system for sustainable practices.	3 - Could have
66	Epic 4: Account Management	Corporate and group account management.	3 - Could have
67	Epic 4: Account Management	Legal document storage (e.g., insurance, registration).	3 - Could have
76	Epic 6: Real-Time Parking and Charging Info	Energy consumption tracking for EV charging stations.	3 - Could have
79	Epic 6: Real-Time Parking and Charging Info	Solar panel energy generation tracking.	3 - Could have
80	Epic 6: Real-Time Parking and Charging Info	Carpooling and ride-sharing feature integration.	3 - Could have
81	Epic 6: Real-Time Parking and Charging Info	Integration with local transportation schedules.	3 - Could have
82	Epic 6: Real-Time Parking and Charging Info	Parking guidance system for large vehicles.	3 - Could have
83	Epic 6: Real-Time Parking and Charging Info	Weather impact analysis on parking.	3 - Could have
84	Epic 6: Real-Time Parking and Charging Info	Event-based parking management.	3 - Could have
85	Epic 6: Real-Time Parking and Charging Info	Plugin for emergency vehicle priority.	3 - Could have
86	Epic 6: Real-Time Parking and Charging Info	AI-based parking spot recommendation engine.	3 - Could have
90	Epic 8: Payment Integration	Dynamic pricing feature based on demand.	3 - Could have
94	Epic 8: Payment Integration	Discounts and loyalty program management.	3 - Could have
6	Epic 1: Mobile Application Infrastructure	Integration with wearable technology.	4 - Worst have this
7	Epic 1: Mobile Application Infrastructure	Smartwatch app version for notifications.	4 - Worst have this
12	Epic 10: Security Features	Drone surveillance integration for security.	4 - Worst have this
30	Epic 2: Backend System for Data Management	Integration with smart city infrastructure.	4 - Worst have this
31	Epic 2: Backend System for Data Management	API for third-party integrations and collaborations.	4 - Worst have this
32	Epic 2: Backend System for Data Management	Smart grid integration for energy management.	4 - Worst have this
44	Epic 3: Frontend Development	Localization and multi-language support.	4 - Worst have this
46	Epic 3: Frontend Development	Augmented reality (AR) for parking spot navigation.	4 - Worst have this
56	Epic 3: Frontend Development	Sustainable driving tips and information section.	4 - Worst have this
57	Epic 3: Frontend Development	Social media integration for sharing locations.	4 - Worst have this
58	Epic 3: Frontend Development	User groups and forums within the app.	4 - Worst have this
60	Epic 3: Frontend Development	Partner program for local businesses.	4 - Worst have this
61	Epic 3: Frontend Development	Volunteer and community engagement features.	4 - Worst have this
62	Epic 3: Frontend Development	User-generated content moderation tools.	4 - Worst have this
68	Epic 4: Account Management	Fleet management features for businesses.	4 - Worst have this
68	Epic 6: Real-Time Parking and Charging Info	Electric vehicle battery health monitoring.	4 - Worst have this
88	Epic 6: Real-Time Parking and Charging Info	Advanced search filters (e.g., EV charger types).	4 - Worst have this
96	Epic 8: Payment Integration	Blockchain for secure transactions.	4 - Worst have this
100	Epic 9: Notification System	Customizable notification sounds.	4 - Worst have this