

Respect

Excellence

Integrity

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PROJECT MANAGEMENT PLAN <Template>

Smart Parking Management System

All task, no chill

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National Project Management System

Business Projects-IT-Enabled

Planning Phase



Public Works and
Government Services
Canada

Travaux publics et
Services gouvernementaux
Canada

Canada

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Authority Signatures

The Project Lead (Business Side) and the Project Manager agree to deliver the Delivery Stage of this project in accordance with this Project Management Plan and amend it periodically as project parameters change.

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1 Executive Summary

Problem/Opportunity

Urban parking inefficiency has long been a significant challenge in cities such as Toronto. In 2023, Toronto ranked as the 17th most congested city in the world, with drivers losing an average of 63 hours annually in traffic delays (City of Toronto, 2023). A major contributing factor to this congestion is the time spent searching for available parking. Studies have found that up to 30% of inner-city traffic is caused by drivers circling the streets looking for parking spots, which not only worsens traffic flow but also increases carbon emissions and driver frustration (Shoup).

Project Identification

Our Smart Parking Management System project is proposed to address this kind of problem. It is a combination of IoT sensors, AI-powered algorithms, cloud infrastructure and a user-friendly mobile application that functions with real-time parking availability, automated payment options and intelligent parking recommendations. It aims to modernize the parking experience for urban drivers and improve operational efficiency for parking operators. In the initial Project identification stage our team evaluated two primary options:

1. the partially automated system with reservation and static occupancy monitoring
2. A fully integrated smart system with real-time detection, AI optimization and dynamic pricing.

After careful analysis and estimated the second option was selected due to the higher scalability, user experience and good market potential despite requiring a higher upfront investment. The business case also showed that the long-term operational benefits and revenue potential far outweigh the initial setup cost. After the detailed cost analysis, our estimated total cost of the project is \$714,237.

Feasibility Assessment

Technical Feasibility

- Existing cloud infrastructure and mobile expertise within the project team support seamless deployment, AI model development requires more investment in terms of time, skilled engineer and computing resources.
- Scalable APIs enable integration with current transportation data systems and payment gateways.

Operational Feasibility

- System design incorporates stakeholder feedback, ensuring adaptability to city-specific workflows.

- Maintenance and support protocols are embedded from launch.

Financial Feasibility

- While the initial estimate was \$352,25, After updated cost modeling in the Earned Value Analysis indicates a total of **\$770,061**, encompassing software development labor (\$519,011) and project execution costs including hardware, training, cloud infrastructure, and support (\$251,050).”

Regulatory Feasibility

- All data processing complies with municipal data privacy laws.
- Cashless payment and license plate recognition will follow local consumer protection regulations.

Project Objectives and Intended Business Results

Project Objectives:

- **Reducing the parking search time by at least 30% in target areas**, the system will guide users directly to available parking spots using real-time data from IoT sensors and AI-based prediction models. that minimizes time spent circling for parking and contributes to directly reducing urban congestion and improving driving experience.
- **Increase Parking space utilization and revenue by 25% through dynamic pricing** Leveraging AI algorithms, the system will implement demand-based pricing strategies that adjust fees according to occupancy, time of day, and location. This maximizes space usage during peak hours while optimizing revenue for the city or operators.
- **Ensure 100% secure payment and data compliance** With the integration of encrypted payment gateways and strict adherence to data privacy regulations, all transactions and user information will be protected. Compliance with local cybersecurity laws and best practices (e.g., PCI-DSS, PIPEDA) will be enforced.
- **Reach high app adoption among registered drivers.** A well-designed, intuitive mobile application will be developed to encourage widespread adoption. It will provide essential services such as real-time parking updates, booking, payments, and in-app support, increasing user engagement and satisfaction.
- **Support urban sustainability by lowering traffic-related emissions.** Reducing the time spent on searching for parking not only improves traffic flow but also directly lowers vehicle idle time and fuel consumption. This aligns with the city’s climate and environmental goals by reducing greenhouse gas emissions in densely populated areas.

Intended Business Results:

Faster decision making using real time occupancy analytics:

City planners and parking authorities will gain access to a dashboard of live and historical data, enabling data-driven decisions about policy, expansion, enforcement and dynamic pricing adjustments.

Revenue growth through demand-based pricing and improved enforcement:

By automatically detecting occupancy and violations using sensors and AI-Powered cameras enforcement becomes more accurate and efficient. Paired with smart pricing models, It ensures a steady increase in parking-generated revenue, also due to the convenience of searching and booking the parking lot the significant increase in customer will lead the revenue growth During the analysis showing that Achieve a positive ROI within three years of full deployment. .

Improved user satisfaction and stakeholder trust:

Offering a seamless, modern parking experience builds trust with citizens and stakeholders. Real-time features, clear payment records, and customer support will elevate the perception of parking services as reliable and user-friendly.

2 Integration Management

Overview

The project Integration Management focuses on ensuring all aspects of the Smart Parking Management System are aligned, coordinated, and executed in a structured manner. It facilitates collaboration across multiple functions like softwares development, hardware deployment, stakeholder engagement , and system integration, to ensure that project objectives are met effectively. The action is to outline the process involved in managing project tasks, resources stakeholders, risks and deliverables throughout the project lifecycle.

Integration Activities

Effective integration will be accomplished through the following coordinated activities:

1. Project Charter Development and DeclarationThe project begins with the creation of a comprehensive Project Charter, which defines the following foundational elements: 1,Project objectives and success criteria 2,Stakeholders and their roles 3,Project scope and strategic alignment 4,High-level assumptions, risks, and constraints.

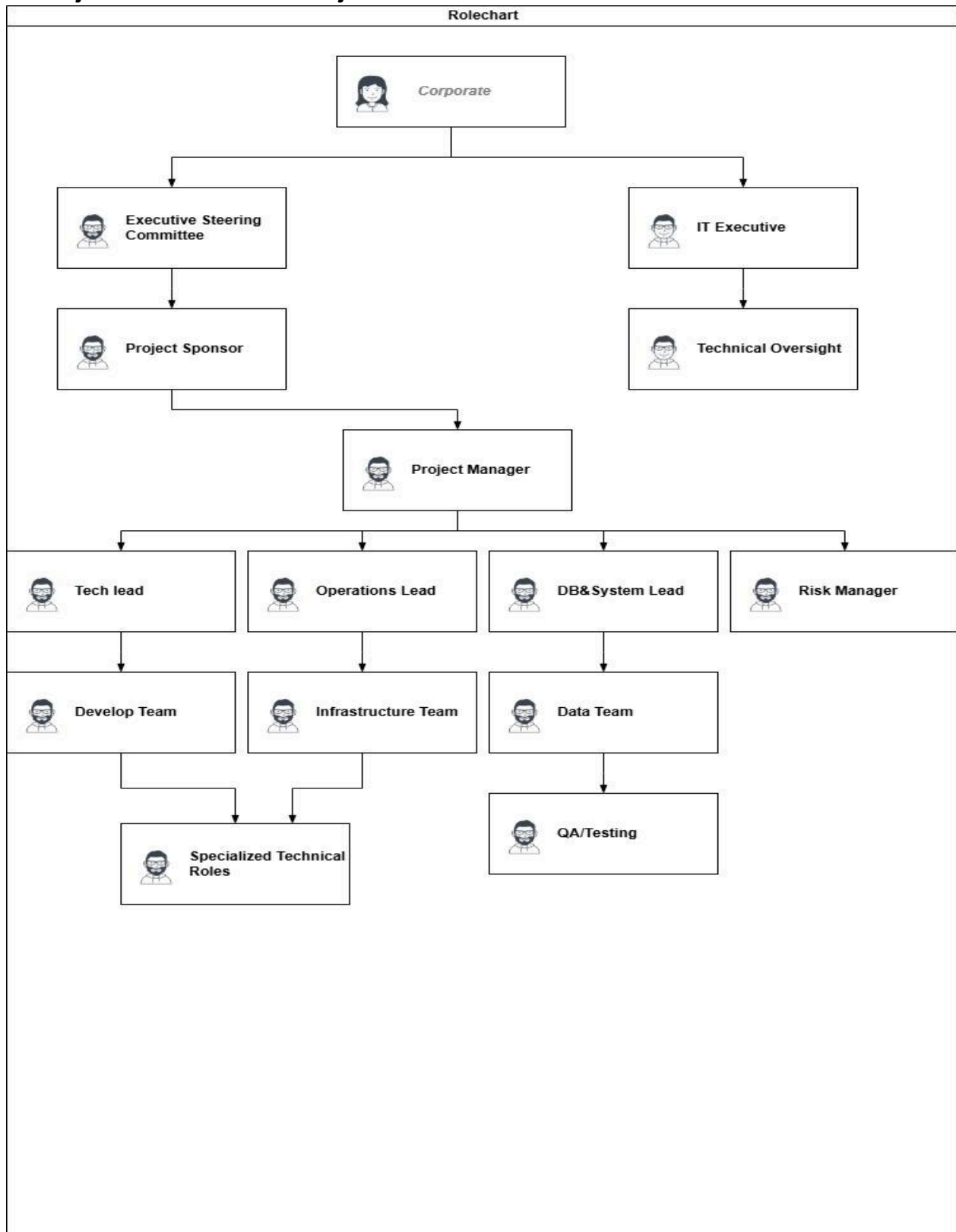
2. Project Plan Development A Project Management Plan will be established to unify the subsidiary planning documents) and act as a roadmap for execution and monitoring. This plan will: 1,Define major milestones and deliverables 2, Establish a around 6 month timeline for each work package 3,Allocate resources to specific tasks 4,Set budgetary boundaries based on the cost estimate (\$714 thousand)

3. Monitoring and Controlling of Project Work This includes the ongoing oversight of project activities to ensure alignment with the plan. The Project Team Leader and technical leads will:1,Track performance using Earned Value Management 2,Update timelines, resource usage, and status dashboards weekly 3,Take corrective or preventive actions when deviations are detected 4 ,Maintain compliance with scope, budget, and quality.

4. Integrated Change Control Implementation of a system to determine if changes have occurred, document changes, and describe the processes on how to make changes to ensure a systematic approach.

5. Closeout Phase At the conclusion of the project,Finalize all activities and transfer completed work to the appropriate people. Create project document updates, final reports, update organizational projects and assets, and complete a lessons learned report to be submitted as organization assets.

2.1 Project Governance and Project Team Structure



2.2 Roles and Responsibilities

Corporate Level

Corporate

Functionally act as the beneficiary of the project

Responsibilities:

provide strategic vision and general direction for overall project development, also serve as the “end-goal”; the project is developed to support organizational objectives and long term goals.

Executive Steering Committee

A high-level organizational body that offers oversight and strategic guidance.

Responsibilities:

Guides the project from a strategic level, ensures alignment with corporate goals, approves major changes in scope, budget, or timeline, and provides conflict resolution across departments.

Project Sponsor

Serves as the internal executive supporter of the project.

Responsibilities:

Secures funding and resources, supports the project vision, assists in scope development, and ensures the project delivers outcomes aligned with organizational strategy and expectations.

IT Executive

Senior member responsible for overseeing technical feasibility and alignment.

Responsibilities:

Ensures the system design is compatible with the organization's IT infrastructure and long-term vision. Provides guidance on architecture, overseas technical risk, allocates technical resources, and ensures that integration and cybersecurity standards are met.

Project Management Team

Project Manager

Leads the project across planning, execution, monitoring, and closure.

Responsibilities:

Oversees the project’s scope, schedule, cost, and quality management. Manages cross-functional communication, stakeholder engagement, issue escalation, and ensures the project delivers measurable value within defined constraints.

General Project Team

Technical Team Leader

Manages the AI, backend, and system integration teams.

Responsibilities:

Leads development of technical components such as AI prediction models and API architecture. Ensures technical milestones are achieved, resolves development issues, and communicates updates to the Project Manager.

Operations Team Leader

Overseas infrastructure stability during development.

Responsibilities:

Ensures legacy systems remain operational while new components are integrated. Supports cross-team data access, load testing, and environmental preparation for deployment.

Database & Systems Team Leader

Manages data infrastructure and system-level integration.

Responsibilities:

Designs database schemas, manages data migration and transformation, and ensures that post-deployment systems meet quality and performance benchmarks.

Risk Manager

Responsible for project risk governance.

Responsibilities:

Identifies, tracks, and mitigates technical and operational risks throughout the project lifecycle. Works with the Project Manager to escalate issues and adjust strategies when needed.

Business Analyst

Acts as the interface between business stakeholders and the project team.

Responsibilities:

Ensures financial feasibility, maps business needs to system capabilities, and evaluates potential ROI. Supports communication with the Steering Committee and helps define success metrics.

Specialized Technical Roles**Backend Developer**

Builds the server-side infrastructure and APIs required for system operation and mobile integration.

UI/UX Designer

Designs the mobile interface and optimizes user experience across different devices and access points.

Cybersecurity Engineer

Implements user authentication, encryption, disaster recovery, and ensures compliance with data protection standards.

Cloud & IoT Specialist

Deploys IoT hardware, manages sensor calibration, and integrates cloud-based backend systems for real-time operation.

Machine Learning Engineer

Develops AI models that enable dynamic pricing, real-time recommendations, and predictive analytics based on sensor data.

QA Engineer

Performs functional, load, and security testing across system components and leads post-deployment performance monitoring.

DevOps Engineer

Coordinates system deployment to the production environment and manages infrastructure automation and rollout continuity.

2.3 Change Management

1.0 Identification

Potential changes to any aspect of the project (scope, schedule, cost, quality, technology, etc.) are identified by team members, stakeholders, or system monitoring. These are to be formally communicated through the Change Request Form to initiate review.

2.0 Assessment

The Risk Manager and Project Manager conduct a preliminary assessment of the change. This step evaluates the potential impact on project scope, schedule, cost, technical feasibility, and performance outcomes. A recommendation is formed for escalation to the approval stage.

3.0 Approval

All change requests are reviewed by the Project Steering Committee, which functions as the Change Control Board). No changes may be implemented until they have received formal approval from this body. Approval is based on project alignment, risk level, and organizational priorities.

4.0 Implementation

Once approved, the change is assigned to the relevant team for implementation. All changes must undergo adequate testing and quality assurance to confirm they are functional, secure, and consistent with project standards.

5.0 Communication

The Project Manager will ensure that all stakeholders are informed of the nature, scope, and implications of approved changes. Timely and clear communication ensures transparency and maintains alignment between project activities and strategic objectives.

Roles and Responsibilities

- Project Manager: Oversees the change management process from identification through communication. Ensures each change follows the defined path and aligns with project baselines.
- Risk Manager: Leads the assessment of each proposed change, identifies associated risks, and defines mitigation strategies to be implemented during or after the change.
- Change Control Board (Steering Committee): Reviews and approves all significant changes, ensuring they are consistent with project objectives, resource constraints, and stakeholder expectations.
- Team Leaders: Evaluate and implement approved changes within their respective domains (technical, operational, database, security, etc.). Responsible for ensuring change adoption does not compromise current deliverables or schedules.

Tools and Techniques

- **Change Request Form:** A standardized document that captures all key details of a proposed change, including rationale, urgency, affected components, and requestor information.
- **Impact Analysis Matrix:** A decision-support tool that helps assess a change's impact across multiple dimensions, including cost, schedule, scope, and performance.
- **Change Log:** A continuously updated register that tracks the status, approval, and implementation history of all requested and approved changes.

Reporting

All approved changes are recorded in the Change Log. The Project Manager will provide status updates in weekly or milestone-based progress meetings, detailing the implementation progress, any issues encountered, and newly submitted or approved changes. These updates are shared with the CCB and key stakeholders to maintain visibility and alignment.

2.3.1 Change Control

Change Governance

Governance of the Change Control Process will be overseen by the **Project Steering Committee**, acting as the **Change Control Board (CCB)**. This board is composed of key stakeholders and holds the authority to approve, reject, or defer any change request based on alignment with project goals, risk level, and impact on key constraints such as scope, cost, and timeline.

Change Identification and Request Management

All changes must be formally initiated through a **Change Request** submitted by project team members or stakeholders. The Change Request must include the following details:

- Description of the proposed change
- Date of submission
- Reason for the change
- Affected system components (e.g., DBMS, AI, API, UI)
- Potential impacts on the project

The **Project Manager** will review each request for completeness and initiate the assessment process.

Impact Analysis

Once submitted, the **Risk Manager** conducts an **Impact Analysis**, assessing how the change may affect the project's scope, timeline, budget, and quality. Relevant **Team Leaders** are consulted to evaluate the impact on system design, integration, security, and overall performance.

Change Approval Process

Following the analysis, the **Project Manager** presents the request and findings to the **CCB**. The board will review all relevant information, assess alignment with strategic objectives, and determine whether the change will be:

- Approved
- Rejected
- Deferred for further analysis

If approved, the change will be documented formally and reflected in updated project planning materials.

Change Tracking

All approved changes will be logged in the **Change Log**, which records the full change lifecycle: identification, approval, assignment, and implementation. The **Project Manager** is responsible for maintaining and updating the log and for communicating the status of changes to stakeholders in regular project updates.

2.4 Issue Management

Issue Identification

Issues will be identified through team reports, stakeholder feedback, and monitoring tools throughout the execution of the project. Each issue will be logged into an **Issue Log**, capturing crucial details including:

- Issue Definition
- Origin
- Priority
- Date of Identification

Issue Classification

Issues will be classified based on severity and potential impact on the project following:

- High** - Issues that block progress.
- Medium**: Issues that impact project objectives.
- Low**: Issues that do not significantly impact project outcomes.

All issues should be logged and tracked to ensure the smooth completion of the project.

Issue Priority

The impact of each issue will be assessed by the project manager and relevant team leaders, issues will be prioritized based on urgency and potential impact on project success. High-priority issues will be addressed first.

Escalation Process

If an issue cannot be resolved at the level where it was identified, it will be escalated to higher levels of management. The levels of issue engagement are identified below as the following:

- Level 1** - The issue is addressed by the team responsible for the area in which the issue occurs.
- Level 2** - An issue in an area cannot be addressed by the team responsible and must be addressed by the Project Manager

Level 3 - An issue in an area cannot be addressed by the team responsible OR the Project Manager and must be addressed by the CCB.

Reporting

Issues Will be documented in the Issue Log with regular updates. The project manager will provide reports on issue resolution status during project meetings.

2.5 Project Close Out Staff Reassignment Plan

At the conclusion of the implementation and stabilization phase, all project team members will be formally released from project-specific dates. A detailed reassignment schedule will be documented and communicated prior to the closure date to ensure minimal resource downtime and a smooth transition.

Archiving Project Materials

All project-related materials, including source code, architectural diagrams, requirement documents, records, test results and changelogs, will be archived in the organization's central knowledge repository, the version control will be preserved and appropriate access permissions will be applied to ensure long-term availability for audit, training and future reference.

Post-Mortem Debrief

A post-mortem debrief will be conducted with the project team and key stakeholders to review the project's successes, challenges, and areas for improvement. The debriefing will allow for open discussion for the future success of all the members.

Final Report

The final report will be summarizing project objectives vs actual outcomes, earned value metrics and performance data, ROI analysis and post-implementation benefits, stakeholder satisfied or not and documented lessons learned, it will distribute to the project sponsor, steering committee and relevant department,

3 Scope Management

The scope of this project will be presented in server parts including the scope statement, requirements management, project deliverables, work activities, requirements control, constraints, assumptions, and stakeholders. For the requirements management, it will be presented using the Requirements Traceability Matrix which is a table listing out all the requirements, attributes, and the status of the requirements. It helps to make sure that all the requirements are addressed. The project will be broken into different tasks and activities which will be presented using the Work Breakdown Structure (WBS). WBS helps to define the total scope of the project by grouping and organizing all the tasks. It also includes the WBS Dictionary which consists of a detailed description of the functions.

3.1 Scope Statement

Activities In Scope	Activities Out of Scope
System design	Parking lot security surveillance
Data security and encryption	Parking violation management
Data collection and processing	
Maintenance and customer support	

3.2 Requirements Management

- Requirements Traceability Matrix

Requirement No.	Name	Category	Source	Status
R01	Servers	Hardware	AWS	Completed
R02	IoT Sensors	Hardware	IoT manufacturer : Bosch	In Progress
R03	Mobile Devices	Hardware	Any mobile device manufacturer that supports app testing and demo - Apple, Samsung, Google Pixel etc.	Completed
R04	Cloud Storage	Software	AWS	In Progress
R05	Parking Management App	Software	custom built by the team through React Native (a mobile application creator)	Completed
R06	Security Encryption Tools	Software	Symantec Encryption (a tool used to secure data both in transit and at rest)	Completed

3.3 Project Deliverables

Deliverable	Recipients	Delivery Date	Delivery Method
Project Scope & Stakeholder Report(1.1)	Project Sponsor,Team	2025-03-10	Email & Google Docs
Stakeholder Identification & Market Analysis Report(1.2.1,1.2.2)	Project Team	2025-03-12	PDF Shared Folder
KRIs and Project Timeline Plan(1.3,1.4)	Risk Analyst<Team lead	2025-03-16	Gantt Chart Report PDF
System Requirements Document(2.1)	Dev Team	2025-04-18	Google Docs
Database Design & ERD(2.2)	Database Engineer	2025-04-25	SQL Dump
System Architecture & API Design(2.3-2.4)	Backend Dev	2025-05-01	PDF+ SwaggerHub
Security Authentication & Disaster Recovery Strategy(2.5)	Cybersecurity Lead	2025-05-04	Security Report
AI Use Case Plan & Dataset Prep Report (2.6)	ML Engineer	2025-05-10	CSV
UI/UX Design Prototypes (3.1)	Stakeholders	2025-5-15	Figma Prototype
Mobile Frontend App Build(3.2)	QA,Tester	2025-05-20	APK File & TestFlight
Backend Functionality +API Integration(3.3,4.4)	Dev Team	2025-05-28	GitHub Repo
IoT Sensor Setup Report & Network Infrastructure Setup(4.1&4.2)	Hardware Ops Team	2025-06-01	Photos & Calibration Log
Cloud Backend Infrastructure Setup(4.3)	Cloud Engineer	2025-06-04	Deployment Doc
Prototyping for Stakeholders and users	Dev team	2025-06-08	Demon Testing
Beta Testing Summary & Performance Log(5.2,5.3)	QA Team	2025-06-10	Bug Tracker Summary
Final System Launch Report(5.4)	Sponsor & Stakeholders	2025-06-12	PDF Guide & Demo
Maintenance Manual & Assistance Materials(6.0-6.2)	Support Team	2025-06-17	PDF Guide + Help Center
System updates and Performance Optimization(6.3-6.5)	Project Team	2025-06-20	Update patch & Drive Folder

3.3.1 Work Activities

The finalized Work Breakdown Structure incorporating all updates is available through the link below:

[Finalized WBS](#)

3.3.2 Requirements Control

Requirement Traceability Matrix (RTM)

- Ensure constant updates and regular check-ins to track the progress of each requirement, and how it relates to the development of the parking system itself

Baseline Management

- Manages current requirements and potential changes
- All amendments moving forward should reference back to the baseline that was set
- Each requirement change should be assigned a version number

Stakeholder Approval

- All amendments in requirements should be notified to and reviewed by stakeholders

Change Control Board (CCB)

- a group of committee members that are responsible for making decisions regarding approval of potential changes in requirements

3.3.3 Constraints

- Financial constraints : hardware, software and safety maintenance is a long term and ongoing cost which might be a constraint for future system upgrades as per limited funds.
- Technological constraints : a long term deficit that technology brings is transmission limitations where there are failures in connecting to the network or failed connection between IoT sensors and user devices.
- Time constraints : in order to reach the hard deadline of the implementation of the Smart Parking Management System, time for fine tuning and testing are limited.
- User acceptance : the effectiveness and efficiency of the system depends on how users adapt to and make use of the service.

3.3.4 Assumptions

- all users have access to a mobile device in order to gain access to the Smart Parking Management System
- parking detection tools/IoT sensors would provide 100% accurate and efficient data to the system, and therefore reflected to the users
- full and smooth cooperation between our team and the parking lot operators in order to maintain service of the system
- increased amount of users over time in order to support future maintenance cost and ongoing data collection/analysis

3.3.5 Stakeholders

Stakeholder	Involvement	Effect
System users / parking lot users	Drivers who seek help in finding available parking spots	Positive: enhance quality of life through finding parking spots more quickly and effectively

System developer/designer	Takes the key role of designing, developing, and implementing the system	<p>Positive: decision making power in system design and development</p> <p>Negative: pressure to produce system as planned and meet expectations</p>
Parking lot operators	Manages the daily operation of the parking lot	<p>Positive: enhance parking lot management efficiency and enjoy higher revenue from increased parking lot users</p>
IoT hardware supplier	Provides sensors to support the functioning of the parking system	<p>Positive: increased revenue through increased use of IoT hardware</p> <p>Negative: pressure to supply quality products that meets expectations</p>
Data analyst	Perform data analysis to ensure smooth system function and implementation	<p>Positive: constant opportunities to perform data analysis and plays an important role in system overall performance analysis</p> <p>Negative: pressure of making the right judgement and providing the most accurate data</p>
Maintenance and support team	keeps an eye on potential mechanical failures or problems that arises	<p>Positive: constant opportunities to learn and grow because of ongoing technical issues that may occur</p> <p>Negative: non-stop dealing with technical issues, possibility of burnout</p>
Customer support team	direct contact to system users, receives, handle and seek user feedback/review	<p>Positive: increase user satisfaction through direct contact</p> <p>Negative: pressure dealing with user complaints or constant phone calls/message responds</p>

4 Schedule Management

The schedule for the Smart Parking Management System will be managed using ProjectLibre, a project scheduling tool that allows detailed task tracking, resource allocation, and critical path analysis. Time management throughout the delivery stage follows a structured process of planning, monitoring, and updating at the work package level to ensure task-level accuracy and accountability.

The schedule was developed based on the project's Work Breakdown Structure (WBS). Each task was assigned dependencies, durations, and both human and physical resources. The Project Manager is responsible for maintaining the schedule, making updates, and resolving conflicts. Team members are responsible for reporting progress on their assigned tasks during regular check-ins. The team uses weekly progress reviews to assess actual vs. planned performance and determine if corrective actions are needed.

The schedule was refined to ensure alignment with best practices in project scheduling. Dependencies were defined at the work package level to maintain clarity and avoid logical inconsistencies. A comprehensive set of physical resources, such as IoT sensors, software licenses and networking equipment, was also included to reflect real implementation needs. Additionally, resource allocations were reviewed and adjusted using ProjectLibre's resource analysis tools to prevent overallocation and ensure sustainable task distribution across team members.

4.1 Milestones

Key project milestones are summarized below. These represent high-level approval points, deliverables, or transitions between major phases:

Description	Forecast Date	Gate / Approval
Project Scope and Objectives Finalized	03/03/2025	Project Sponsor
Risk Management Plan Completed	10/04/2025	Project Steering Committee
Requirements Gathering Finalized	25/04/2025	Business Analyst + Stakeholder Review
System Design Completed	16/05/2025	Technical Lead / Architecture Review Board
Backend and Infrastructure Setup Finished	04/06/2025	Implementation Manager
Beta Testing Completed	17/06/2025	QA Lead / Client Feedback
Performance Optimization Completed	01/07/2025	Quality Assurance Team
System Go-Live	02/07/2025	Project Sponsor / Change Management Board
Final Presentation & Report Submission	10/07/2025	Project Sponsor + Stakeholder Sign-Off

4.2 Schedule Control

To control the schedule and manage progress throughout the project lifecycle, the team uses the following control mechanisms:

- **Baseline Tracking:** A baseline schedule will be used in ProjectLibre to compare actual progress against planned performance. Deviations are monitored weekly.
- **Variance Analysis:** Schedule variance (SV) and schedule performance index (SPI) will be used to detect delays or early completions.
- **Resource Monitoring:** The Resource Usage and Histogram views in ProjectLibre are used to detect and resolve overallocation. Overbooked resources were corrected by adjusting durations and units (% workload).
- **Change Management:** If a task is significantly ahead or behind, the Project Manager reviews options and updates the schedule. Any changes are discussed in weekly meetings and shared with all team members for confirmation.

The finalized Gantt chart incorporating all updates is available through the link below:

<https://drive.google.com/file/d/1doozD4YEvIJ22wQAF0Rbpoc9RStKAuoT/view?usp=sharing>

5 Cost Management

Cost management throughout the project lifecycle ensures accurate budgeting, control, and monitoring of financial resources allocated to the Smart Parking Management System. Effective cost management helps support informed decision-making, which allows timely corrective actions, and maximizes resource efficiency.

5.1.1 Estimation

Cost estimates were carefully prepared based on the detailed Work Breakdown Structure (WBS) items aligned with the finalized Gantt Chart schedule. The estimation process involved:

Methods & Techniques:

- A bottom-up estimation method was employed to estimate labor and physical resource costs at the work-package level, clearly reflecting scheduled tasks and allocated resources.
- Labor costs for software development were decomposed and calculated based on detailed hourly estimates and specific resource rates, aligning with the labor estimate sheet provided.

Timing & Participants:

- The initial cost estimation was performed after finalizing the project schedule during the project planning phase.
- Project Manager, Business Analyst, and Technical Leads collaboratively participated in the estimation process.

Documentation & Review:

- Estimates were documented in a structured Excel spreadsheet clearly specifying each WBS item's labor hours, unit costs, and subtotals.
- The estimates were reviewed and approved by the Project Sponsor and Project Manager to ensure accuracy and reliability.

Confidence Level & Contingencies:

- Current cost estimates reflect a high confidence level due to the detailed analysis.
- While no explicit contingency reserves were applied in the initial estimate, a buffer of approximately 15-20% is suggested as a measure to address potential cost variations or uncertainties that might arise during project execution.

5.1.2 Budget Allocation

The budget allocation process involved breaking down resources and costs systematically across the major work activities defined in the project's WBS. Each WBS Level 1 activity was budgeted based on labor and physical resource costs summarized clearly in tabular form. The major budget categories are:

- **Labor Costs:**
Clearly defined for each task based on hourly rates and estimated hours.
- **Physical Resources:**
Resource are categorized explicitly in each WBS level 1. The physical resources include software licenses, IoT sensors, cloud infrastructure, network equipment, testing tools, and devices. They are distributed in alignment with the scheduled timeline.

The detailed Cost Estimate and EV Analysis documents can be accessed via

 [Project_04_Cost Estimate and Earned Value Analysis_AllTaskNoChill \(final\).xlsx](#)

5.1.3 Budget Control

Cost control mechanisms have been established to track and manage the project's financial performance continuously:

- **Earned Value Management (EVM):**
 - Utilized to monitor project cost and schedule performance monthly.
 - EV indicators (CV, SV, CPI, SPI, EAC, and ETC) provide insights into project status and prompt corrective actions when variances occur.
- **Periodic Reporting:**
 - Cost reports including planned versus actual expenditures, will be reviewed monthly during project status meetings.
 - Reports will be generated using Excel spreadsheets, highlighting variances clearly and proposing mitigation strategies.
- **Corrective Actions:**
 - In case of significant deviations (e.g., CPI or SPI below acceptable thresholds), the Project Manager will initiate corrective actions, such as resource reallocation, adjusting task priorities, or revisiting the contingency reserve.

Summary of Current Project Status (as of May 31):

- **Cost Variance (CV)**
CV = \$17,410: Positive CV indicates that the project is under budget.
- **Schedule Variance (SV)**
SV = -\$5,460: Negative SV indicates minor schedule delay.
- **CPI**
CPI \approx 1.1098 (110.98%): Reflect efficient cost utilization and management.
- **SPI**
SPI \approx 0.9699 (96.99%): Indicates a slightly lagging schedule performance.
- **Estimate at Completion (EAC):**
EAC = \$225,753
Based on current performance (as of May 31), if trends continue, you are projected to finish at \$225,753, which is below the original budget of \$250,550.
- **Estimated Time to Complete (ETC):**
ETC = 6.19 months
The project is expected to take about 0.19 months (roughly 6 extra days) longer than planned to indicate a slight schedule overrun.

Continued diligent cost management will ensure the project remains within budget and schedule targets maintaining transparency and control until successful completion.

6 Quality Management

Quality Management directs and ensures the Smart Parking Management System delivers high-quality results, meeting stakeholder expectations and adhering to industry standards within the established project timeline. This includes implementing quality standards and metrics to monitor, document, and improve the cloud-based backend of the AI system, IoT sensor network, mobile app, and physical components such as sensors, cameras, and smart signage.

Quality Assurance

Quality Assurance is ensuring a timely and high quality delivery of the Smart Parking Management System project. It should meet all stakeholder expectations and be user friendly.

Governance

Project Manager, Quality Assurance Lead, Quality Control Team, Development Team, Stakeholders.

Roles and Responsibilities

The **Project Manager** coordinates QA activities, ensures resources are allocated, and reports on progress.

The **Quality Assurance** Lead establishes QA processes, conducts audits, and reports on compliance.

The **Quality Control Team** performs testing and ensures deliverables meet quality standards.

The **Development Team** addresses issues identified by QA and implements corrective actions.

The **Stakeholders** provide input and validate the final deliverables.

Tools and Techniques

Root Cause Analysis (RCA): Tools like Fishbone Diagrams and the 5 Whys for identifying and addressing issues.

Checklists and Templates: Standardized documentation to ensure all quality checkpoints are covered.

Statistical Analysis Tools: Minitab and Tableau will be used to analyze quality data, generate visual reports, and track key quality metrics.

Quality Control

Peer Reviews: Conduct code and design reviews to detect and fix defects early.

Product Testing: Perform unit, integration, system, and acceptance testing to ensure deliverables function as expected.

Configuration Management: Ensure consistency and traceability of configurations across development, testing, and production environments.

Verification and Validation (V&V): Ensure system requirements are correctly implemented and meet shareholder expectations.

7 Human Resource Management

The success of the Smart Parking Management System project depends largely on getting and assembling a proper skilled team. Human resource management must endow staff properly, make them grow, and provide them with incentives in order to reach successful project targets. Though this begins with assessment of work accomplished, it also involves identifying resource needs, hiring appropriate talent, ensuring team capability, and overseeing management performance throughout the project lifecycle.

Human Resource Management in this project will adhere to a structured, phased multi-staged approach that covers the entire delivery stage — from initial planning to post-deployment support. The process begins with determination of the required skillsets based on the Work Breakdown Structure (WBS) and technical specs. Project manager, technical leads, and business analysts together review these resource needs to ensure full alignment with project scope and milestones.

The resource acquisition approach combines internal redeployment with external recruitment. Internal team members are chosen based on availability, prior involvement in IT-enabled projects,

and alignment with organizational strategy. For areas where in-house capability is weak or doesn't exist, external contractors or vendors will be engaged — especially in specialized roles such as AI engineering, cybersecurity, and cloud infrastructure.

Once on board our human resources will be managed through clearly defined roles and responsibilities, constant communication and performance monitoring. Role-based access control systems, agile task boards (via Jira), and version-controlled code repositories (e.g., GitHub) will ensure operational efficiency. Cross-functional team structures will allow developers, data scientists, and sensor experts to cooperate with one other. TBD A strong focus will be placed on team development, the exchange of knowledge, and building capacity.

Mentoring, technical workshops, and group retrospectives will further improvement. Events to promote team-building and mark progress will consolidate morale and unity between team members. Programs recognizing success (e.g. MVP of the Sprint) or rewards for key contributions will stimulate performance.

Reports on human resource-related decisions, performance trends, and workload balance will be made during steering committee reviews. Any human resource risks, such as attrition or a mismatch in skill sets, will be tracked on the project risk registry and addressed through risk management plans that include cross-training, non-standard recruiting plans and potential contingencies.

7.1 Human Resources Acquisition

Resource acquisition strategy focuses on human resources, preferably in-house and from external sources with experience around IoT systems, cloud computing, AI development and mobile application programming. The decision for selecting any task to be outsourced will depend on the time frame of the project, criticality of the task, availability of internal talent, and cost-effective.

The roles are filled according to project phases — planning, development, integration, testing, maintenance — taken in association with work packages offered in the WBS. Work with the HR departments to coordinate where contractors should be sourced from to ensure skilled recruitment and contract placement through vendors.

The required resources and roles include:

Role	Source	Skill Set/ Experience	Duration
Project Manager	Internal	PMBOK-based project management, stakeholder engagement	Full project
IoT Engineer	Internal/External	Sensor deployment, calibration, environmental tuning	Development and Testing
AI/Machine Learning Engineer	External	Predictive modeling, dynamic pricing, model training	Development
Software Developer	Internal	Mobile app development	Development
Cloud Engineer	Internal	Cloud hosting, real-time data syncing	Development and Maintenance
Cybersecurity Engineer	Internal/External	Data encryption, Secure login, compliance	Full project
UI/UX Designer	Internal	Mobile interface design and user testing	development
QA/ Test Engineer	Internal	System stress, Security testing	Post-launch
Customer Support Lead	Internal/External	User inquires, help desk systems	Post-launch

The onboarding involves an orientation session where you learn about project goals, tools (e.g., Jira, Git, AWS), security procedures, communication protocols, and team workflows. Members of the team will be inducted in several phases to avoid idle capacity (not ready when key tasks begin) and aligned to project schedule.

We will emphasize cross-functional collaboration especially between AI engineers, software developers, and IoT specialists in the integration phase. From the first moment of the project at least basic role definitions and access rights will be defined to keep the work effective and the data safe.

7.2 Human Resources Development

Team development should focus on building both technical capability and collaborative working to ensure that each team member has the technical skills, problem-solving ability, and communication competency required to enable successful delivery. We do this not only for the benefit of individual employees, while adding to a better synergy as a whole.

Training Sessions: Targeted workshops focusing on API integration and middleware development, in addition to IoT sensor calibration, cloud services (especially AWS), AI model tuning, and secure code development will be provided. Workshops will be scheduled in accordance with major development stages and will consist of practical exercises and use cases.

Knowledge Sharing: Peer to peer knowledge transfer during weekly sessions will give team members an opportunity to showcase features they've built, tools they've explored, or obstacles they've overcome. Knowledge sharing sessions. These sessions help in promoting transparency, knowledge diffusion, and innovation within the team.

Mentoring: Establish a mentoring structure that pairs senior engineers with newer or junior members. Mentors will guide you through technical problem-solving, architecture decisions, and career development. This is very helpful while in the system integration phase where coordination and code compatibility is a prime concern.

Have Engagement Activities: For productivity, engagement is very important. Retrospective talks, casual games, coffee chats, and creative exercises to build interpersonal trust and avoid siloed thinking will be done monthly in virtual (or in-person if possible) team events. Consider it International: acknowledging cultural and timing differences, team activities will be inclusive and will allow flexibility.

Performance Feedback: A formal feedback process will be embedded into the lifecycle of a project. Every member will have contributions in mid-project and final evaluation with assessment including but not limited to technical delivery, collaboration, initiative and communication. Outstanding performance will receive reward in the form of recognition programs such as "Sprint MVP" or a highlight in the stakeholder meeting.

Education Access: All engineers will have access to an internal learning platform with curated resources, documentation, tutorials, and troubleshooting guides related to their role. This promotes self-paced growth and facilitates just-in-time learning.

Continuous Improvement Framework — The iterative process of sprint retrospectives and quality assurance sessions are used to inform professional development plans. If certain issues arise repeatedly within feedback, targeted micro-trainings will be developed to rapidly fill knowledge gaps.

With this broad approach, the human capital developed as part of the project keeps up with the system, allowing for maximum productivity and least possible mistakes, accompanied by a learning environment where success is shared.

8 Communications Management

Keeping everyone on the same page is important for timely collaboration, stakeholder buy-in, and project visibility. This plan includes stakeholder engagement, reporting, and communication approach.

Communication Management — In this project communication management is applied to ensure that the right information reached the right people at the right time, in the right format and through the right channel. This covers everything from internal communication among team members themselves to external communication with stakeholders such as sponsors, regulatory agencies, systems users, etc. The method makes sure to balance updating sync (emails, dashboards) with sync touchpoints (meetings, reviews) to ensure all parties understand where they need to be responsive.

We have based this communication strategy on transparency, consistency, and accessibility. Relevant levels of the organization can expect regular updates on key performance indicators and status updates. Centralized documentation, task updates, and collaboration in real-time will be done in communication tools (e.g. Slack, Trello, Google Workspace) dedicated to stay within the project.

Communication activities will have clear roles and responsibilities. The Project Manager will be the official point of contact for reporting, and technical leads will provide updates related to their areas of expertise. Moreover, a communications lead will also ensure that all outputs to stakeholders (e.g., presentations, newsletters, system documentation) are polished, accurate, and in alignment with project branding.

The plan will contain tailored messages to suit all the stakeholders that will be impacted by this initiative, which could vary from Executive sponsors to technical teams to end-users. This helps that communications are meaningful, appropriately scoped and actionable for each audience group. This process will include mechanisms like stakeholder surveys and focus group feedback, as well as usage analytics that will make the outreach and engagement more effective over time.

8.1 Stakeholder Analysis

Stakeholder Name	How they will impact the project	How they will be impacted by the project	Communication Requirements
City of Toronto	Provides funding, policies, and regulatory approval	gains insights, improved urban traffic control	monthly progress reports, milestone meetings
Toronto Parking Authority	Implements and maintains infrastructure	Gains revenue, improves parking management	Bi-weekly updates, technical integration meetings
Infrastructure Ontario	Supports procurement and city compliance	Efficiency in public-sector investments	quarterly reviews, documentation sharing

Stakeholder Name	How they will impact the project	How they will be impacted by the project	Communication Requirements
End Users (Drivers)	Adoption of mobile app, feedback loops	Gains parking convenience, lower wait times	Surveys, app alerts, support channels
IoT and Cloud Providers	Tech provision and system reliability	Business expansion, performance metrics	contractual reviews, integration sync meetings

8.2 Project Reporting and Communication

Type of Communication	Communication Schedule	Communication Mechanism	Initiator	Recipient
Weekly Status Report	Every Friday	Email and Google Docs	Project Manager	Full Project Team
Sprint Review	Bi-weekly	Zoom/Slack call	Developer Team Leads	Project Manager and QA Team
Stakeholder Report	Monthly	PDF dashboard	Project Manager	Sponsors, Steering Committee
Urgent Issue Notification	As Needed	Slack/Email	Relevant Lead	Project Manager and Stakeholders
Beta Feedback Summary	Post-beta Test	Survey results and Notes	QA Manager	Developer Team and UI/UX Designer

8.3 Metrics Collection

Project performance will be tracked using the following metrics:

- **Schedule Performance Index (SPI) and Cost Performance Index (CPI)** through Earned Value Management
- **Bug tracking reports** from testing phases via Jira
- **Feature delivery velocity** (story points per sprint)
- **System uptime and latency** during staging and production via AWS CloudWatch
- **App adoption and engagement rates** from analytics tools (e.g., Firebase)
- **Support ticket volume and resolution time** post-launch

These metrics will be validated weekly, analyzed by the PMO, and reported monthly in executive dashboards. Long-term data will be stored on cloud repositories with access control.

9 Risk Management

9.1 Overview

To ensure the success of the Smart Parking Management System, risks need to be identified, assessed, monitored, and responded to. If the project team prepares for risks ahead of time, product security, ease of use, and unexpected costs can be managed efficiently. This part describes how the project risks will be controlled during the entire project life cycle. This section outlines the process for managing risks throughout the entire project life cycle, from planning to post-launch maintenance.

9.2 Risk Identification Plan

Throughout each stage of the project, risks will be detected on an on-going basis. Key risks can be identified include:

- Standard team discussions during the planning and execution phases
- Interviews with Subject Matter Experts and relevant stakeholders
- Comments and suggestions from testing sessions
- Experience gathered from previous like projects
- Application of a predefined risk identification template

9.3 Risk Analysis and Prioritization

Each risk will be analyzed based on:

- Probability
 - Low
 - Medium
 - High
- Impact
 - Low
 - Medium
 - High

9.4 Risk Management Tasks

Risk #1: System failure due to IoT sensor not working properly

- Category: Technical
- Strategy:
 - Conduct rigorous sensor testing under various environmental conditions
 - Implement more sensor systems for critical areas
 - Establish 24/7 monitoring with automated alerts
- Role in charge: IoT Engineer
- Priority: High
- Impact: High
- Time: 15 hours (Each 4 months)

Risk #2: Data privacy breaches or cybersecurity attacks

- Category: Security
- Strategy:
 - Implement end-to-end encryption for all data transmissions

- Implement regular security audits and penetration testing
 - Implement two factor authentication
- Role in charge: Cybersecurity Engineer
- Priority: High
- Impact: High
- Time: 10 hours

Risk #3: Poor user adoption of mobile application

- Category: Operational
- Strategy:
 - Conduct extensive user testing during development
 - Gather continuous user feedback for improvements
- Role in charge: UI/UX Designer
- Priority: Medium
- Impact: High
- Time: 1 month

Risk #4: Budget overruns

- Category: Financial
- Strategy:
 - Conduct monthly budget reviews
 - Find alternative vendors for cost savings
- Role in charge: Project Manager
- Priority: High
- Impact: High
- Time: 2 months

Risk #5: Delay in hardware procurement and installation

- Category: Operational
- Strategy:
 - Identify multiple or alternative vendors
 - Draft contingency installation plans
- Role in charge: Operations Leader
- Priority: Medium
- Impact: High
- Time: 1 week

10 Procurement Management

10.1 Key Objectives

- Acquire IoT sensors, cloud services, and payment gateways cost-effectively.
- Hold vendors liable through contracts and service level agreements.
- Follow public sector purchasing policies.

10.2 Process

- Planning
 - Define requirements (IoT, cloud, security).
 - Research vendors, budget approval.
- Solicitation & Selection
 - Issue bids, evaluate proposals (cost, quality, support).
 - Negotiate contracts with penalty clauses for delays.
- Contract Management
 - Monitor vendor performance vs. service level agreements.
 - Process payments upon milestones.
 - Quarterly reviews and conflict resolution.

10.3 Vendor Management and Quality Control

During the delivery phase, vendor performance will be tracked continuously. Key activities are include:

- Checking in and meeting with vendors monthly
- Request progress reports for deliveries in line with project milestones
- Do post-delivery evaluations based on vendor reliability, communication and outcomes

11 Stakeholder Management

- **Sample Stakeholder Register**

Name	Position	Internal/External	Project Role	Contact Information
Alice	VP of Operations	Internal	Project Sponsor	alices@smartpark.com
Johnson	CFO	Internal	Senior manager, approves funds	johnsonl@smartpark.com
Michael	CIO	Internal	Senior manager, PM's boss	michaelk@smartpark.com
Emily	Director of Software development	Internal	System developer/designer	emilyl@smartpark.com
Jaime	Team lead of data analyst team	Internal	Data Analyst	jaimek@smartpark.com
Lily	Director of support team	Internal	Maintenance and Support Team	lilys@smartpark.com
Tommy	Director of cs team	Internal	Customer Support Team	tommyc@smartpark.com
James	Consultant	External	Project manager	james_lee@gmail.com

Yorkdale Shopping Mall	Parking Lot Operators	External	cooperate with system developer, support system	yorkdale_parkinglot@gmail.com
Supplier	IoT Hardware Supplier	External	provide support for IoT sensor and devices	iotsupplier@gmail.com

• **Stakeholder Management Strategy**

Name	Level of Interest	Level of Influence	Potential Management Strategies
Alice	High	High	<ul style="list-style-type: none"> Engage regularly in meetings Provide project updates on milestones and risks Involve in key decision making processes Align system goals with business operations
Johnson	Medium	High	<ul style="list-style-type: none"> Provide financial reports Justify budget needs Ensure alignment with financial goals.
Michael	High	High	<ul style="list-style-type: none"> Keep informed on IT-related decisions align with IT strategy, involve in tech reviews.
Emily	High	Medium	<ul style="list-style-type: none"> regular meetings to foster effective communication within team and set expectations provide support and easy access to resources for team members and ensure teamwork is embedded in the process
Jaime	Medium	Medium	<ul style="list-style-type: none"> regular meetings to ensure aligned expectations and communicate trends/data found provide easy access to resources/data needed for analysis involve them in major decision makings based on analysis provided
Lily	High	Medium	<ul style="list-style-type: none"> regular updates on system performance encourage proactive practice of troubleshooting and provide easy access to different monitoring tools regular maintenance/check up schedules

			to prevent potential system failure/loophole <ul style="list-style-type: none"> encourage maintenance work as a team to foster professional sharing and crosscheck
Tommy	High	Medium	<ul style="list-style-type: none"> regular meetings to ensure customer support team members' expectations align with system goal provide training on ways to tackle user needs and problems set clear guideline/procedure where customer support team can easily reference back to when handling user issues
James	High	High	<ul style="list-style-type: none"> Collaborate on risk management Monitoring project timelines Ensure the project runs successfully and smoothly.
Yorkdale Shopping Mall	Medium	High	<ul style="list-style-type: none"> clear communication between system developer and parking lot operators regular check-ins, survey to seek parking lot operator feedback and review involve operators in division makings and major improvements in the system provide data in service effectiveness and keep them in the loop for areas of improvement
Supplier	Low	Medium	<ul style="list-style-type: none"> provide clear expectations and quality standards for suppliers to achieve

• **Expectations Management Matrix**

Measure of Success	Priority	Expectations	Guidelines
Scope	1	The system must include real-time parking availability, automated payments, and intelligent parking recommendations. Optional features include AI-driven analytics for demand forecasting.	Focus on delivering core functionalities first before adding enhancements. Ensure compliance with business requirements

Time	1	The project must be completed on schedule to align with operational deadlines	Any delays must be communicated to the project sponsor immediately. Strict adherence to milestone timelines is necessary
Cost	3	The project budget is flexible if a string justification is provided for additional funds	While cost control is important, it is secondary to meeting deadlines and ensuring the system meets core requirements. All expenses must follow escalation and approval procedures
Technology/ standards	2	The system must integrate with existing IoT infrastructure and meet cybersecurity standards. Some deviations from corporate IT policies may be allowed if justified.	Prioritize compatibility with parking lot operators and IoT hardware. Security and scalability should not be compromised, even if adjustments to IT policies are needed

12 Team Contribution Composition

<Leave this table blank if all team members contribute to the project equally. Otherwise, specify the percentage of each team member's contributions to the term project and its deliverables and describe the detailed contributions each team member make to the term project.>

Team Member Name	Percentage of Contribution	Description of Contribution

13 Description of Revisions

- ☒ We have revised our cost estimate and earned values, analyzed the excel file and uploaded it under the cost estimate management.
- ☒ We have revised our gantt chart and resource plan and uploaded under the schedule management

14 References

The following documents are attached to this Project Plan for immediate reference.

Appendix	Document Name	Version	Date
A			
B			
C			
Etc			