EMGT 5220 Engineering Project Management

Summer 1 2024

Dynamic Pricing Through Mobile Ticketing Application for the Massachusetts Bay Transportation Authority (MBTA)

Team 7 members

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Letter of Transmittal

June 21st, 2024

Dr. XXXXXX

Northeastern Graduate School of Engineering

130 Snell Engineering

360 Huntington Avenue

Boston, MA 02115

Dear Dr. XXXXXX,

Please find enclosed the project proposal titled "Dynamic Pricing Through Mobile Ticketing Application for the Massachusetts Bay Transportation Authority (MBTA)."

The project aims to address the inefficiencies and fare inequities of the current flat-rate pricing model used by the MBTA subway system. By implementing a dynamic pricing strategy through a state-of-the-art mobile ticketing application, we seek to enhance fare equity, improve operational efficiency, and increase ridership.

This proposal includes a comprehensive overview of the problem and our innovative solution, detailing the technical aspects of mobile application development, dynamic pricing model, secure electronic ticket validation, and user support materials. The implementation plan covers the work breakdown structure, schedule, responsibility chart, and resource allocation.

We believe that this proposal offers a viable solution to the current challenges faced by the MBTA and will significantly benefit both the riders and the organization. We appreciate your guidance and feedback throughout the development of this project and look forward to your constructive comments.

Thank you for your support and consideration.

Sincerely,

Siddharth Avoodainayagam

Sampada Jindal

Aman Malawade

Sreelu P Nair

Sancia Saldanha

Supradeepa Vella

Jiahao Ye

Executive Summary

The Massachusetts Bay Transportation Authority (MBTA) is currently facing issues with its flat-rate pricing model, which lacks fare equity and fails to incentivize longer trips. This has led to reduced ridership and operational inefficiencies. To address these problems, a dynamic pricing strategy through integration into an existing mobile ticketing application is proposed. This project will enhance a cross-platform mobile app to calculate fares based on the number of stations traveled, enhancing fare equity and user convenience. The app will feature an intuitive interface for easy ticket purchase, travel history viewing, and account management. Key functionalities will include real-time updates and secure electronic ticket validation using QR codes or NFC technology.

The total project budget is $588,050.60, which covers labor costs, fixed costs such as materials and equipment, and indirect expenses. Labor costs include salaries and benefits for both technical and non-technical teams. Additional expenses such as contingency costs, overhead costs, and legal fees are also included to ensure the project has the necessary resources for successful implementation.

The dynamic pricing model will charge $0.40 per station for the first five stations traveled, with a flat rate applied thereafter. This model aims to reduce fares for shorter trips and encourage longer travel. The app will also integrate with existing MBTA systems, including the Charlie Card/Youth Pass, ensuring compatibility and secure data exchange. To facilitate a smooth transition, comprehensive user support materials, including step-by-step guides and video tutorials, will be developed. Continuous monitoring and optimization will be conducted post-implementation to ensure system performance and user engagement.

The project team consists of members with diverse backgrounds in data analytics, engineering management, software development, and logistics, ensuring a comprehensive and effective approach to developing and implementing the proposed solution. The project's mission is to empower MBTA riders with a more efficient and equitable fare system while enhancing the MBTA's operational efficiency and revenue growth. By leveraging advanced mobile technologies and a dynamic pricing model, the project aims to solve the inefficiencies of the current flat-rate system and provide a cost-effective and convenient travel solution for MBTA riders.

1.0 Introduction

1.1 Problem

The current flat-rate pricing model of the Massachusetts Bay Transportation Authority (MBTA) subway system is inefficient and lacks fare equity. It fails to account for the varying distances traveled by riders, leading to a system that does not incentivize longer trips and may discourage increased ridership. This impacts the overall revenue and operational efficiency of the MBTA, hindering its ability to provide optimal service. Additionally, the absence of a rewards system and electronic ticketing options further limits the system's appeal and convenience for riders.

1.2 Solution

To address these issues, the implementation of a dynamic pricing strategy through a state-of-the-art, cross-platform mobile ticketing application is proposed. This application will enable users to purchase tickets and pay fares based on the number of stations traveled, with a new dynamic pricing model designed to reduce fares for shorter trips. Specifically, the system will charge $0.40 per station for the first five stations traveled and a flat rate from the sixth station onwards. Additionally, the app will incorporate a rewards system where users earn a free ride after a certain number of tap-ins and tap-outs, incentivizing app usage and encouraging higher ridership, particularly for longer trips.

1.3 Project Components

The project will deliver the following key components:

- Integrating a user-friendly mobile application for ticket purchase and fare payment.
- A dynamic pricing model that charges fares based on the distance traveled.
- A secure electronic ticket validation system utilizing QR codes or NFC technology.
- Integration of the Charlie Card/Youth Pass into the app’s e-wallet section, allowing NFC transactions and top-ups through the app.
- Installation of sensors and scanners on trains for tap-in and tap-out payment portals.

1.4 Project Mission

The mission of this project is to implement a dynamic pricing model and user-friendly mobile application, and riders will gain the performance of a fare system tailored to

their travel needs, while the MBTA achieves optimal operational efficiency, increased ridership and revenue.

1.5 Justification

The approach leverages proven advanced mobile technologies and a dynamic pricing model successfully implemented in other transportation systems worldwide. By focusing on user convenience, fare equity, and operational efficiency, it aims to solve the problem where others have failed. Starting with the Green Line, where a majority of Northeastern University students live and commute, will allow for an effective rollout.

2.0 Purpose & Objectives

2.1 Purpose

This initiative aims to address the inefficiencies and lack of fare equity inherent in the current flat-rate pricing model. By implementing a pricing structure based on the number of stations traveled, The project aims to create a fairer fare system, enhance rider convenience, and make the subway more appealing to cost-conscious individuals.

2.2 Objectives

The primary objective of this project is to develop a dynamic pricing and mobile ticketing application for the MBTA to enhance fare payment convenience and promote a fairer pricing model based on the distance traveled. Additionally, this project aims to leverage advanced technologies for secure electronic ticket validation and ensure robust data privacy and security. The objectives of this project can be divided into operational and user-focused objectives as listed below:

2.2.1 Operational Objectives

- Enhance Fare Payment Convenience:
    - Develop a user-friendly mobile application for seamless ticket purchase and fare payment.
    - Integrate an e-wallet section, similar to Apple Pay, for users to access their Charlie Card or Youth Pass and perform NFT transactions.
    - Enable users to top up their Charlie Card through the app.
- Promote Fare Equity:
    - Implement a dynamic pricing model that reduces fares for shorter trips.
    - Charge $0.40 per station for the first five stations traveled and apply a flat rate from the sixth station onwards.
    - Ensure passengers tap out when getting off to register the number of stations traveled, with a flat rate charge of $2.40 for passengers who fail to tap out.
- Leverage Advanced Technologies:
    - Utilize QR codes or NFC technology for secure electronic ticket validation.
    - Install sensors for tap-in and tap-out on the trains, enabling seamless payment through these portals.
- Ensure Data Privacy and Security:
    - Implement robust data exchange protocols.
    - Ensure compliance with all relevant data privacy regulations.
- Monitor and Optimize:
    - Continuously monitor system performance and user engagement.
    - Make necessary updates based on feedback.

2.2.2 User-Focused Objectives

- Provide Comprehensive User Support:
    - Develop support materials to assist users in transitioning to the new system.
- Strategic Rollout:
    - Begin the project rollout primarily with the Green Line, as the majority of Northeastern University students live along and commute on this line, making it an ideal starting point for the implementation.

3.0 Technical Overview

3.1 Mobile Application Integration

The project involves integrating a user-friendly mobile ticket purchase and fare payment system into an existing application. This enhancement will ensure that the system is accessible on both iOS and Android devices, ensuring broad user adoption. The integration will feature an intuitive interface, allowing users to easily navigate through ticket purchasing options, view travel history, and manage their accounts. Key functionalities will include real-time updates, fare calculations based on distance traveled, and integration with existing payment methods to facilitate seamless transactions.

3.2 Dynamic Pricing Model

Central to this project is the implementation of a dynamic pricing model. Unlike the current flat-rate system, this model will charge fares based on the number of stations traveled, promoting fare equity. The pricing algorithm will be designed to adjust fares dynamically, considering factors such as peak hours, distance, and rider frequency. This model aims to incentivize longer trips and balance the load on the transportation system, ultimately increasing overall revenue and operational efficiency.

3.3 Secure Electronic Ticket Validation

The project will deploy a secure electronic ticket validation system using QR codes or Near Field Communication (NFC) technology. At each station entrance and exit, sensors and scanners will be installed to read the electronic tickets, ensuring quick and accurate fare validation. This system will enhance security by reducing the risk of fare evasion and streamline the boarding process, making it more efficient and user-friendly.

3.4 User Support Materials

To facilitate a smooth transition to the new system, comprehensive user support materials will be developed. These materials will include step-by-step guides, FAQs, and video tutorials, helping users understand how to use the mobile application and the new pricing model. Additionally, customer support will be available through multiple channels, including in-app chat, email, and phone support, ensuring users can get help whenever needed.

3.6 Integration and Compatibility

The new mobile application and dynamic pricing system will be integrated with existing MBTA systems. This integration will ensure secure data exchange and compatibility with current infrastructure, minimizing disruptions during the transition. The development team will work closely with MBTA representatives and selected vendors to ensure smooth integration and operation.

3.7 Data Privacy and Security

Ensuring data privacy and security is paramount. The project will implement robust data exchange protocols and comply with all relevant data privacy regulations. Regular security audits will be conducted to identify and mitigate potential vulnerabilities, ensuring user data is protected at all times.

3.8 Continuous Monitoring and Optimization

Post-implementation, continuous monitoring of system performance, user engagement, and reliability will be conducted. Feedback from users will be collected and analyzed to make necessary updates and improvements. This iterative process will help in optimizing the system and addressing any emerging issues promptly.

4.0 Implementation Plan

4.1 WBS

4.1.1 Project Initiation Phase :

The initial stage will establish the project's scope, goals, and identify stakeholders and their roles. Clear communication protocols will be instituted for effective stakeholder engagement throughout the lifecycle. A comprehensive schedule outlining task timelines and a detailed project budget allocating resources will be created. Formal approval will be obtained before proceeding further.

4.1.2 Project Planning Phase :

This intricate phase will commence with user research, infrastructure assessments, and ridership analyses to design the dynamic pricing strategy. Substantial efforts will plan the mobile app development spanning back-end, front-end, UI/UX, database, and API integration. Vendor selection for app development, payment gateways, and hardware will be critical. Testing methodologies incorporating environments, cases, and acceptance criteria will be devised. Project organization, staffing, sensor/scanner installation, and risk mitigation plans will be outlined.

4.1.3 Project Execution Phase :

Implementation will begin with installing sensors, scanners, and payment portals on trains and stations. The mobile app encompassing back-end, front-end, UI/UX, database, and APIs will be developed and integrated. Existing payment methods like Charlie Card and Youth Pass will be incorporated into the e-wallet. Rigorous system integration and user acceptance testing will be conducted. The dynamic pricing model will be operationalized, and the app and payment system deployed. Ongoing maintenance, monitoring, user support, and enhancements will follow.

4.1.4 Project Closing Phase:

This final phase will focus on training module development for user groups, accompanied by guides and videos. Comprehensive training sessions will ensure smooth user adoption. System documentation like manuals, configuration guides, troubleshooting resources, and API specifications will be compiled. Knowledge transfer sessions between the project team and MBTA staff will occur. System access will be granted, and account management protocols established. Project duties will be handed over to MBTA staff. Outcomes will be evaluated, a final report prepared, inspections conducted, remaining queries addressed, and a formal closure meeting organized.

Refer to Appendix A for the entire Work Breakdown Structure (WBS)

4.2 Schedule

To keep track of and manage project tasks, a detailed schedule has been made. Based on past similar projects, task lengths have been limited to two weeks or less. This short timeline approach allows for flexibility as the project moves forward. The schedule is kept in Microsoft Project, which lets the project manager update task durations as needed throughout the project. Microsoft Project's Gantt chart feature visually shows progress, so everyone can see the progress made with respect to the project at regular intervals.

The schedule, including Gantt charts, is provided in Appendix B.

4.3 Responsibility Chart

To ensure clarity on task ownership, a Responsibility Assignment Matrix has been developed, aligning with the Work Breakdown Structure. It follows the RACI model, where 'R' denotes individuals executing the tasks, 'A' signifies those answerable for successful completion, 'C' indicates contributors consulted during the process, and 'I' specifies parties to be kept informed of progress. Presented in a user-friendly format, the RACI matrix equitably distributes responsibilities across the team. While the project manager assumes a central role, being responsible and accountable for most critical activities, other departments contribute their expertise to relevant tasks within their functional areas. This matrix, available in Appendix C, serves as a reference guide for all stakeholders, ensuring a shared understanding of roles and responsibilities throughout the project's lifecycle.

4.4 Resource Allocation

Proper allocation of resources is crucial for the project's success and meeting objectives on time. Resources include people, money, and materials. The right resources need to be assigned in the right amounts. This involves carefully looking at the skills and availability of team members, understanding the project's budget, and determining what materials are needed. By properly planning and allocating the people, funds, and materials required, the project team can use resources efficiently, avoid delays, and complete the project within the set timeline. The project has a 7% contingency cost to allow for any unforeseen challenges that may occur during the project. Following table describes the necessary elements involved in resource allocation, for a detailed view, please refer to Appendix E.

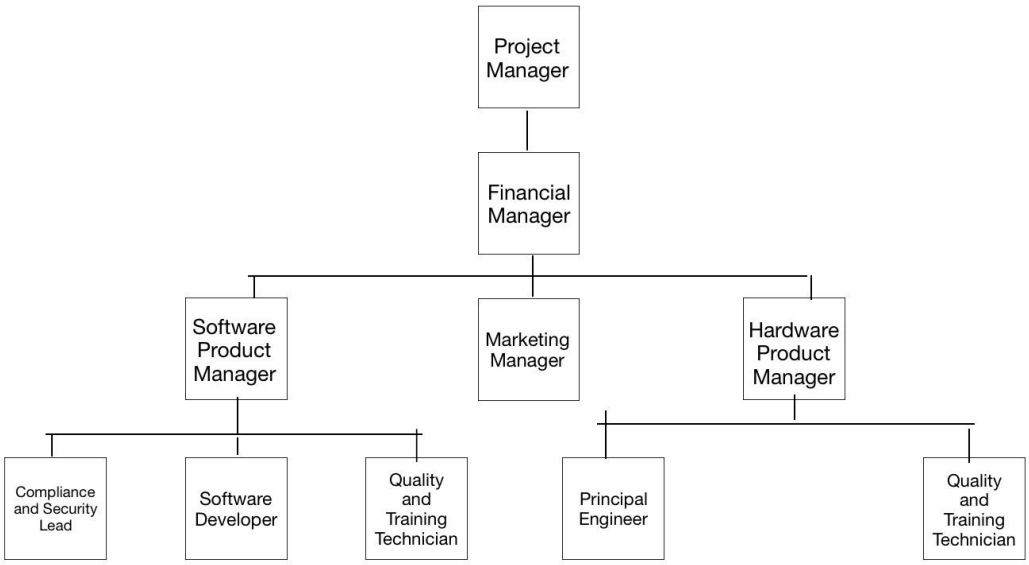


Fig 4.4.1- Stakeholders

4.5 Stakeholders

The list below includes the stakeholders in the project that have been referenced throughout this report. Their involvement is detailed further in the RACI matrix provided in the Appendix C:

- Project Manager
- Software Product Manager
- Hardware Product Manager
- Software Quality and Training Technician
- Hardware Quality Assurance and Testing
- Compliance and Security Lead
- Marketing Manager
- Financial Manager
- Software Development
- Hardware Development

5.0 Execution Plan

5.1 Project Monitoring

Effective project monitoring is an ongoing process throughout and post execution phase to ensure that the progress of the project is tracked and any deviations in the project are identified early on.

- To keep track of the progress of the project across the different milestones based on the project plan and timelines.
- Keep track of the Key Performance Indicators (KPIs) such as user adoption rates, system uptime, etc to measure the success of the project.
- Schedule review meetings and regular report progress tracking with stakeholders to address any issues and take corrective action accordingly.

5.2 Project Control

Project control is a critical aspect in the project as it ensures alignment with project goals, timelines and budget constraints.

- **Gantt Charts:** Utilization of gantt charts to track the progress across the project timeline, ensuring that tasks will be completed on schedule. This also significantly helped understand the dependencies if any, and identify delays in advance.
- **Risk Management:** Continuously monitoring and managing risks using a risk register. This approach helps anticipate potential risks early on and ensure proper mitigation strategies are implemented as needed before they escalate.
- **Change Management:** Implementing a structured process for managing any changes - this can include approving/rejecting changes to the scope, schedule or cost. All changes will be assessed and their impacts will be addressed.
- **Go/No-Go Phased Control**: This process control technique is used while moving from one stage to another in the execution phase, the need to check whether or not to progress into the next stage. This approach ensures that resources are used effectively and any potential issues are addressed as early as possible.

5.3 Project Auditing

This involves an independent examination of the project's processes and outcomes.

- **Internal audits:** Conducted at various stages to ensure financial management, compliance with established practices and meeting those standards, adherence to project management practices, etc.
- **External audits:** Involves external auditors to conduct an independent and objective assessment of the project's status. This helps identify any gaps in the execution phase and suggest improvements for the overall project.

- **Quality audits:** This is to ensure that all the project deliverables meet the quality standards - such as reviewing test plans, test results etc.

5.4 Project Closure

The Project Closure ensures that all the aspects of the project are completed and the project deliverables are handed over to the client.

Post-Implementation Review: Involves a final review before all the stakeholders to assess the project's success and performance. This helps understand if any further enhancements are needed.

Final Deliverables: Ensuring that all the final deliverables have been met, by testing for completeness, and accepted by the MBTA. This includes the overall functioning of the sensors, payment portals, the mobile app, and its integration with MBTA systems.

Training Sessions: Delivering and conducting training sessions based on the developed materials to the MBTA staff and riders, to ensure a smooth transition from the old fare system to the new one.

Marketing Campaigns: Conduct marketing campaigns to ensure that all the users and MBTA staff are made well aware of the benefits of teh app, the features provided, etc.

Project Sign-Off: Get the final approval from all stakeholders and the MBTA, confirming that all the project objectives have been met and satisfied based on the defined parameters.

6.0 Risk Assessment Management Plan

7.0 Financial Plan with Budget

7.1 High-Level Summary

Achieving the proposed objectives requires a well-planned financial component. Establishing and diligently tracking a comprehensive budget is crucial to the successful management and execution of this project. The budget encompasses all phases of the project, including initiation, planning, execution, deployment, and continuous monitoring and optimization. It accounts for labor costs, materials and equipment, miscellaneous expenses, and contingency funds to ensure that all aspects of the project are adequately funded and any unforeseen challenges can be effectively managed.

Below is the project's Budget Summary, detailing the estimated costs for each phase and task. For a more detailed breakdown and complete budget justification, please refer to Appendix D.

The calculation method for the labor cost in the budget is as follows

The labor cost is calculated based on the schedule and the RACI matrix. The steps involved are:

1. Determine Working Hours:

From the schedule table, multiply the number of days allocated for each task by 8 to get the total working hours for that task.

2. Determine Employee Allocation and Hourly Rate:

Use the RACI matrix to identify the number of employees working on each task, their allocation (percentage of time they will spend on the task), and their respective salaries.

Calculate the average hourly rate by multiplying each employee's allocation by their salary, and then dividing by the number of employees assigned to the task.

3. Calculate Labor Cost:

Multiply each employee's allocation by their salary, and then multiply by the total working hours for the task. This gives the total labor cost for that task.

For example:

In Task 1.1.1 Define project scope and objectives, according to the schedule, it take 4 days. So the working hours turns to be 4*8=32 hours.

According to the RACI matrix, we can get the following simple table.

Role	PM	SPM	HPM	FM	HQ	SQ	CSL	MM	SD	PE
Rate/Hour	55	65	65	60	55	45	50	45	70	75
Task 1.1.1	A	R	R	I	I	I	I	I	I	I

In this project, the RACI values are 100%, 80%, 40%, and 20%.

So the Hourly Rate turns to be
(55*0.8+65*1+65*1+60*0.2+55*0.2+45*0.2+50*0.2+45*0.2+70*0.2+75*0.2)/10=$25.40.

The labor cost of Task 1.1.1 turns to be

(55*0.8+65*1+65*1+60*0.2+55*0.2+45*0.2+50*0.2+45*0.2+70*0.2+75*0.2)*32=$8,128.00.

The materials cost part of the budget includes the following:

In Task 2.1.1.1 *Interview customers, determine capability, and validate needs*, we need a survey software license, which costs $300. We plan to purchase a license for a comprehensive survey software, which will facilitate the collection and analysis of customer feedback.

In Task 2.1.2.2 *Hardware Requirements – Sensors*, we require 10 sensors, each costing $1500. These sensors are tested and used in the company before installation. Their main uses are initial development, bug fixing, and maintenance testing.

In Task 3.1.1.1 *Create app wireframes and mockups*, a design software license costing $600 is needed. We will use industry-standard design tools such as Adobe Creative Suite, which includes applications like Adobe XD for wireframing and Photoshop for mockups.

In Task 3.1.3.2 *Test security measures*, security testing tools are required at a cost of $500. We plan to utilize tools for thorough security testing to identify and mitigate vulnerabilities.

In Task 3.2.1 *Ensure secure data exchange protocols*, secure data exchange software is needed, costing $400. We aim to purchase a robust solution to ensure encrypted and secure data transactions.

In Task 3.3.1 *Implement tap-in and tap-out payment portals on trains*, we need 48 sensors at $1500 each. For our project, Green e-Line, there are 12 on-ground stations, and we plan to place 4 sensors at each station on average.

In Task 3.4.1 *Develop functional test plan,* testing software and tools costing $300 are needed. We plan to acquire software like TestRail or qTest to structure and manage our testing processes effectively.

In Task 3.8.2 *Conduct training sessions*, training material printing costs $200. We will print comprehensive training manuals and materials to facilitate effective training sessions for staff.

In Task 4.2.2 *Conduct periodic security audits*, security audit tools costing $500 are needed. We plan to use tools for continuous monitoring and security audits.

In Task 4.3.1 *Close out vendor and manufacturer contracts*, audit tools costing $300 are needed. We will use software tools from MetricStream or SAP to ensure all vendor contracts are closed out properly.

The miscellaneous cost part of the budget includes the following:

In Task 3.9.2 *Launch marketing campaigns and user education*, marketing campaigns is planed to cost $25,000, because we must inform existing citizens about our app to change their commuting habits.

This project also includes Transportation Costs, and Stationery and Supplies. This part of the budget is planned at the beginning of the task, that is, task 1.1.1 *Define project scope and objectives.*

The table, labeled "Table 7-1 Budget Summary (resources)," details the total costs allocated to various resources. The largest portion of the budget is dedicated to Labor, amounting to $406,408.00, which constitutes 69% of the total budget. Materials and Equipment follow with a cost of $108,100.00, representing 18% of the budget. Miscellaneous expenses account for $35,000.00, making up 6%, and a 7% contingency is included, amounting to $38,470.60. The total budget sums up to $588,050.60. Correspondingly, a pie chart titled "Budget Summary Chart (resources)" visually represents these allocations, with the largest blue segment indicating Labor, the orange segment showing Materials and Equipment, the green segment depicting Miscellaneous expenses, and the light blue segment representing the contingency.

Table 7-1 Budget Summary (resources)

Budget Summary	
Resources	Total Cost
Labor	$406,408.00
Materials & Equipment	$108,100.00
Miscellaneous	$35,000.00
7% Contingency	$38,470.60
Total	$588,050.60

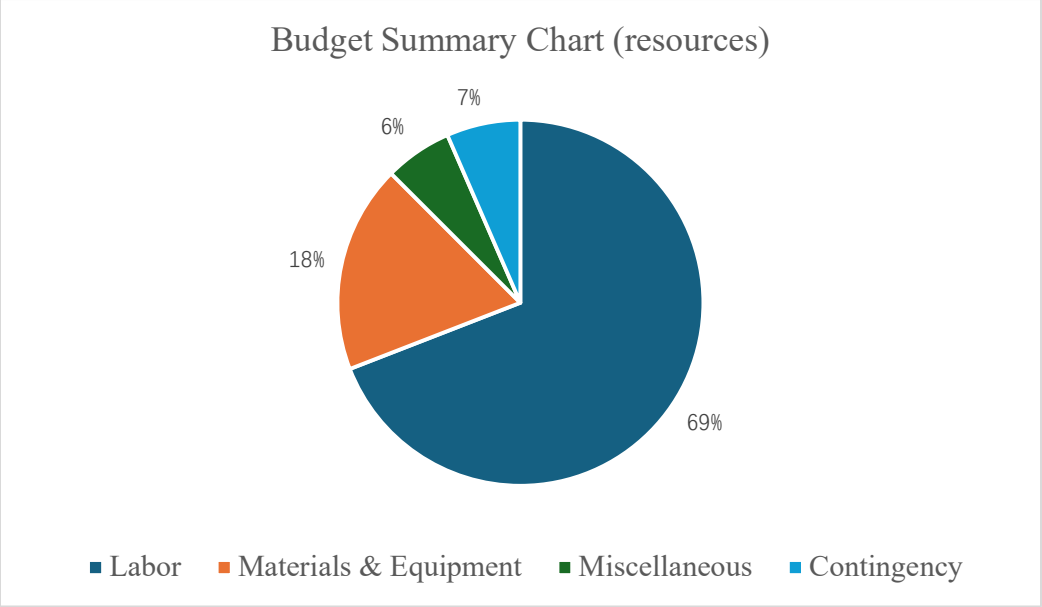


Figure 7-1 Budget Summary Chart (resources)

The table, labeled "Table 7-2 Budget Summary (phases)," outlines the total costs associated with each phase of the project. The costs are divided as follows: Project Initiation Phase costs $22,592.00, representing 4% of the total budget; Project Planning Phase costs $75,356.00, representing 14%; Project Execution Phase, being the largest segment, costs $363,408.00, which is 66% of the total budget; and Project Closing Phase costs $88,152.00, accounting for 16% of the budget. The total cost, excluding contingency, sums up to $588,050.60.

Correspondingly, the pie chart titled "Budget Summary Chart (phases)" visually represents these allocations with different colors: the smallest segment in dark blue for Project Initiation Phase (4%), the orange segment for Project Planning Phase (14%), the largest green segment for Project Execution Phase (66%), and the light blue segment for Project Closing Phase (16%).

Table 7-2 Budget Summary (phases)

Budget Summary (phases)	
Phases	Total Cost
Project Initiation Phase	$22,592.00
Project Planning Phase	$75,356.00
Project Execution Phase	$363,408.00
Project Closing Phase	$88,152.00
Total Cost (exclude contingency)	$549,580.00

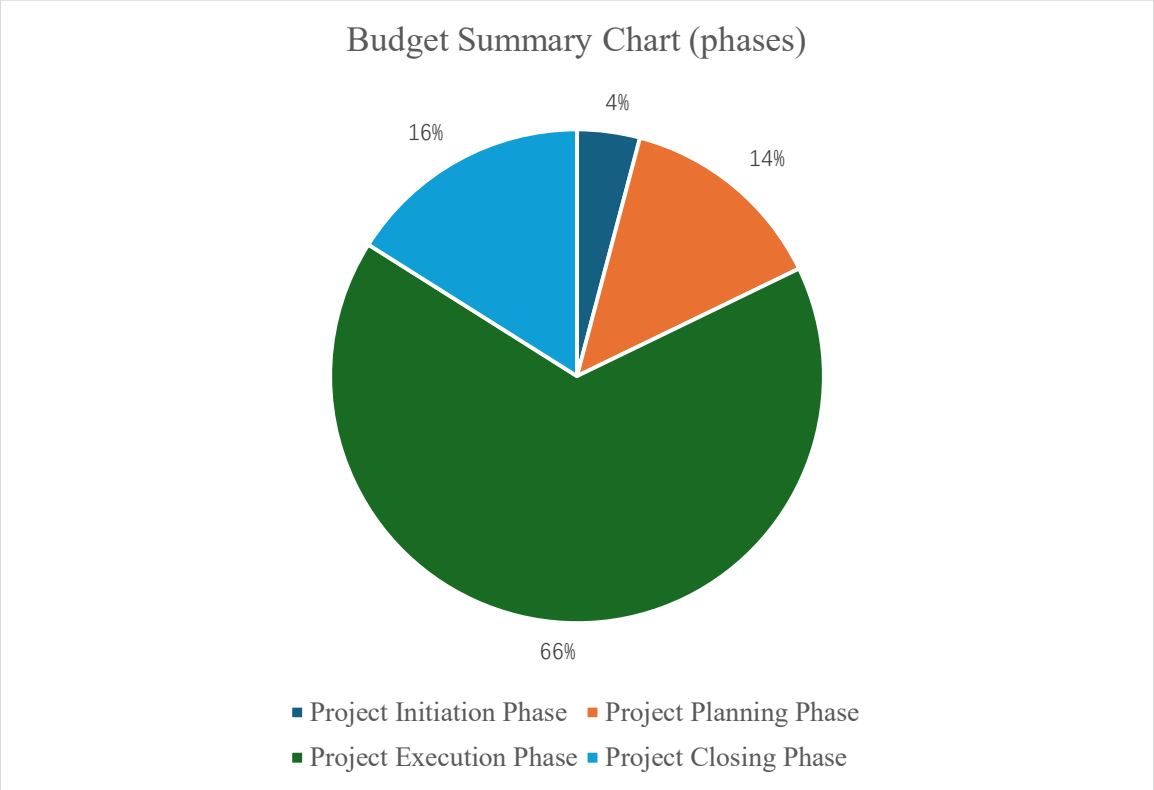


Figure 7-2 Budget Summary Chart (phases)

7.2 Budget Justification

Calculating the payback period for the MBTA Green Line E project is essential for budget management because it helps justify the initial investment and assess the financial viability of the project. By determining how long it will take to recoup the invested amount, stakeholders can make informed decisions about budget allocation and risk management. It also aids in planning and managing cash flows, ensuring the organization can maintain liquidity while the project is underway. Additionally, a clear payback period builds confidence among stakeholders, demonstrating that the project is expected to provide financial benefits within a specific timeframe, contributing to the overall financial health and sustainability of the MBTA.

The calculating method of Payback period:

The current yearly ridership for this line is 181,040 riders. Among these, 54,385 riders evade fares annually, leading to an annual revenue loss calculated as:

Annual revenue loss= $54,385 * fare = $130,524

After accounting for a 30% fare evasion rate, the annual revenue stands at:

Annual revenue = Total revenue - revenue loss = $304,191

The project aims to increase ridership by 18% post-launch, resulting in an estimated yearly ridership of:

Post-launch ridership = 181,040 * (1 + 0.18) = 213,627 riders

The fare for the first four stops is calculated based on a weighted average, using the formula:

Fare for first 4 stops = (0.05 * 0.4 + 0.10 * 0.8 + 0.15 * 1.2 + 0.20 * 1.6) * 213,627 = $128,176

For stops beyond the first four, a flat rate of 0.5 cents per stop is applied, generating an annual revenue of:

Flat rate revenue = 0.5 * 2.40 * 213,627 = $256,352

Consequently, the total projected fare revenue per year amounts to:

Total projected fare revenue = 128,176 + 256,352 = $384,528

After deducting costs, the annual profit is estimated at:

Annual profit = $384,528 - $304,191 = $80,337

The payback period, calculated by dividing the total investment of $560,112 by the annual profit, is approximately:

Payback period = $588,050/$80,337 ~ 7 years

In conclusion, the calculation of the payback period for the MBTA Green Line E project reveals that, with an annual profit of $80,537 and a total investment of $588,050, the project is expected to break even in approximately 7 years. This analysis demonstrates that the project is financially viable, with a reasonable timeframe for recouping the initial investment, ensuring that the project will start generating net positive returns after the payback period. This supports the decision to move forward with the project, given its potential for financial sustainability and contribution to the overall revenue of the MBTA.

8.0 Team Credentials

Sancia Serophene Saldanha is a Data Analyst currently pursuing an MS in Data Analytics Engineering at Northeastern University. With a background in Mechatronics from the Manipal Institute of Technology, she excels in Python, SQL, and data visualization tools like Tableau and Power BI. Her internship at Goldman Sachs involved enhancing risk calculations and automating trade confirmations, significantly improving efficiency. She also has research experience from Dasman Diabetes Institute. She is passionate about using data to drive strategic decisions and continuously seeks to expand my expertise.

Supradeepa Vella is currently majoring in Data Analytics Engineering at Northeastern University. With a background in Computer Science Engineering from Anna University, where she specialized in Machine Learning, SQL, and Python, she acquired comprehensive knowledge and developed practical skills in these areas. Alongside her course, she is gaining valuable experience in Data Analysis and Project Management as a part-time Governance Data & Analytics Intern at Schneider Electric. She is passionate about leveraging data to uncover insights that drive strategic decision-making and developing innovative solutions to complex problems.

Sampada Jindal is pursuing a Master of Science in Engineering Management at Northeastern University. She has experience as a Product Management Intern at Mercury Financial, where she applied her skills in user research, feature prioritization, and agile development. Proficient in Python, SQL, Tableau, and various productivity tools, she shines in both technical and leadership roles. Sampada has led significant projects as a Business Analyst at Deloitte. Currently, she contributes to the Digital Product Design and Management course at Northeastern as a Teaching Assistant.

Jiahao Ye is currently pursuing an MS in Engineering Management at Northeastern University. With a background in Logistics Engineering from Shanghai Maritime University, he excels in operations research and logistics management. During his undergraduate studies, he worked on a project for CP Lotus, optimizing the distribution center's logistics costs using MATLAB simulations. His graduation thesis focused on AGV transportation in automated container terminals. He is passionate about optimizing processes, improving efficiency, and reducing costs in supply chains, and is eager to further his expertise and career in this field.

Aman Malawade is currently pursuing a Master's in Engineering Management at Northeastern University, Boston. He completed his bachelor's in Mechanical Engineering from Pune, India. Recently, he completed a Project Management co-op at Dynavax Technologies in Emeryville, CA, where he managed a portfolio containing three different projects, each at a distinct stage of the vaccine development lifecycle. Before moving to the USA, Aman gained valuable experience working as an Associate Product Manager at Zocdoc in Pune and as a Product Manager at SAM Integrations Pvt. Ltd. His background in product management and engineering, coupled with his

hands-on project management experience, equips him with the skills necessary to effectively lead and contribute to interdisciplinary teams.

Sreelu P Nair is currently pursuing a Master of Science in Data Analytics Engineering at Northeastern University. She holds a Bachelor of Technology in Electronics and Communication Engineering from Amrita Vishwa Vidyapeetham. Her technical expertise includes programming languages like Python, C#, and JavaScript, as well as data science tools such as Pandas, Scikit-learn, and TensorFlow. She has professional experience as a Software Design & Analysis Co-op at Advanced Micro Devices (AMD), where she contributed to supply chain optimization through data transformations and analysis. Previously, as a Software Engineer at Experion Technologies, she improved application delivery times and enhanced customer processes through strong software engineering and data principles. Her project work includes implementing and applying deep learning models to real-world problems. Passionate about leveraging advanced technologies for data-driven decision-making, Sreelu is dedicated to developing innovative solutions to enhance operational efficiency and business processes.

APPENDICES

Appendix A: Work Break-down Structure

ID	Task
	Mobile Application w/ Dynamic Pricing for the MBTA
1	**1.0 Project Initiation Phase**
2	*1.1 Hold Project Kickoff Meeting*
3	1.1.1 Define Project Scope and Objectives
4	1.1.2 Identify Stakeholders and assign roles
5	1.1.3 Establish communication channels and protocols for stakeholder engagement
6	**2.0 Project Planning Phase**
7	*2.1 Define Requirements*
8	2.1.1 Customer Requirements
9	2.1.1.1 Interview customers, determine capability, and validate needs
10	2.1.2 Product Requirements
11	2.1.2.1 Application Requirements - Features and Functionality
12	2.1.2.2 Hardware Requirements – Sensors
13	2.1.2.3 Pricing Model Requirements – Dynamic pricing structure
14	2.1.2.4 Security Requirements – Data privacy and security protocols

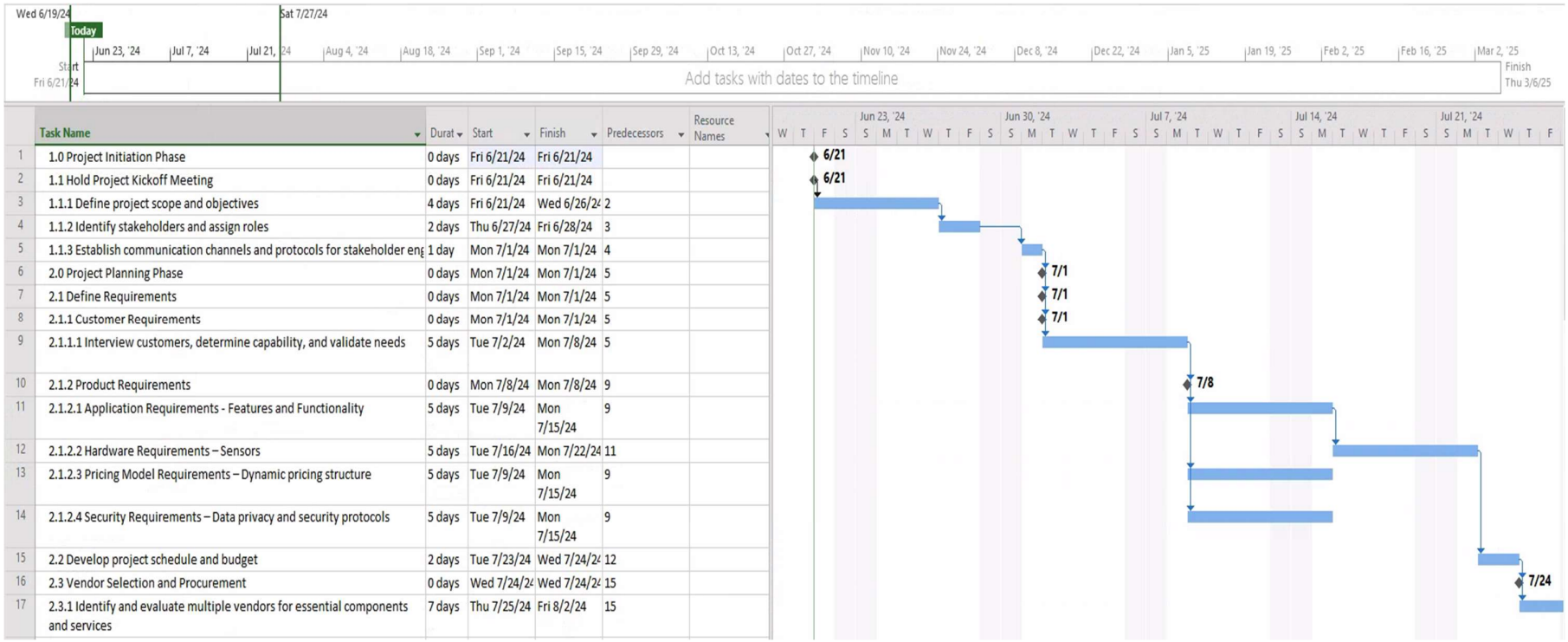
ID	Task
15	*2.2 Develop project budget and schedule*
16	*2.3 Vendor Selection and Procurement*
17	2.3.1 Identify and evaluate multiple vendors for essential components and services.
18	2.3.2 Schedule lead times on all parts and services
19	*2.4 Risk Management*
20	2.4.1 Develop risk management plan
21	**3.0 Project Execution Phase**
22	*3.1 Develop Mobile Ticketing Application*
23	3.1.1 Design Application Interface
24	3.1.1.1 Create app wireframes and mockups
25	3.1.1.2 Develop user interface based on best case designs
26	3.1.2 Implement Dynamic Pricing Model
27	3.1.2.1 Develop pricing algorithm
28	3.1.2.2 Integrate pricing algorithm into the app
29	3.1.3 Develop Security Features
30	3.1.3.1 Implement data privacy protocols
31	3.1.3.2 Test security measures

ID	Task
32	*3.2 Integration with MBTA Systems*
33	3.2.1 Ensure secure data exchange protocols
34	3.2.2 Test integration with existing MBTA systems
35	*3.3 Sensor and Hardware Implementation*
36	3.3.1 Implement tap-in and tap-out payment portals on trains
37	3.3.2 Test hardware reliability and integration
38	*3.4 Testing Mobile Ticketing System*
39	3.4.1 Develop functional test plan
40	3.4.2 Conduct functional In-House Testing
41	3.4.2.1 Validate system meets all required specifications
42	3.4.2.2 Perform corrective action and conduct retest if required
43	*3.5 Deployment of updated mTicket App*
44	3.5.1 Deployment of mobile ticketing system
45	3.5.2 Conduct Pilot Consumer Deployment
46	3.5.2.1 Implement pilot test and validate results
47	3.5.2.2 Perform corrective action and conduct retest if needed
48	3.6 Deployment of configured hardware

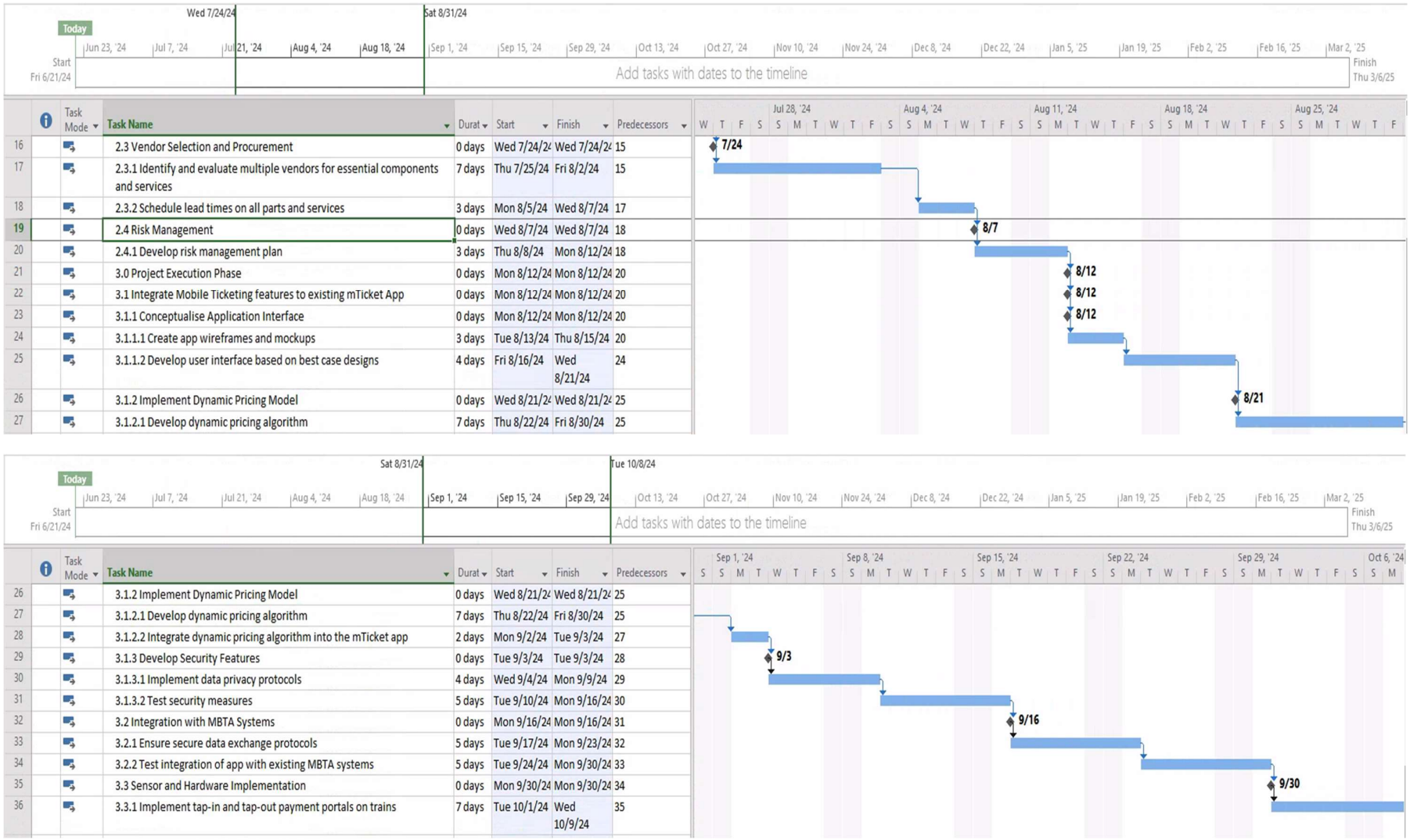
ID	Task
49	3.6.1 Deployment of Sensors in trains and stations
50	3.6.2 Conduct Pilot Consumer Deployment on the Green Heath Street E Line
51	3.6.2.1 Implement Pilot Tests and validate results
52	3.6.2.2 Perform corrective action and conduct retest if needed
53	*3.7 Management and Control*
54	3.7.1 Continuously monitor system performance
55	3.7.2 Monitor customer acceptance – Track user engagement and feedback
56	3.7.3 Implement updates based on performance data and feedback
57	*3.8 Training*
58	3.8.1 Develop training material for MBTA staff
59	3.8.2 Conduct Training sessions
60	*3.9 Develop Marketing plan*
61	3.9.1 Performance evaluation reliability and economic analysis
62	3.9.2 Launch marketing campaigns and user education
63	**4.0 Project Closing Phase**
64	*4.1. Hold project status meetings*
65	*4.2 Compliance and Security*

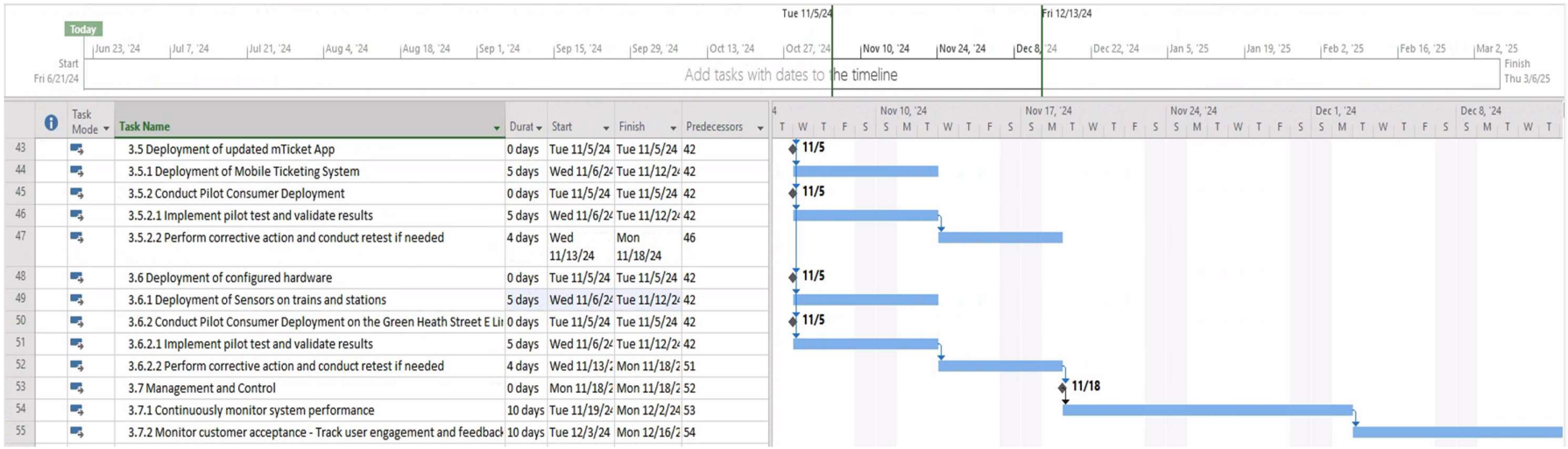
ID	Task
66	4.2.1 Ensure ongoing compliance with data privacy regulations
67	4.2.2 Conduct periodic security audits
68	4.2.3 Update security protocols as needed
69	*4.3 Audit Procurement*
70	4.3.1 Close out vendor and manufacturer contracts
71	*4.4 Final Report*
72	4.4.1 Document project outcomes and lessons learned
73	4.4.2 Submit final report to stakeholders

Appendix B: Project Schedule



	Task Name	Durat	Start	Finish	Predecessors	Resource Names
1	1.0 Project Initiation Phase	0 days	Fri 6/21/24	Fri 6/21/24		
2	1.1 Hold Project Kickoff Meeting	0 days	Fri 6/21/24	Fri 6/21/24		
3	1.1.1 Define project scope and objectives	4 days	Fri 6/21/24	Wed 6/26/24	2	
4	1.1.2 Identify stakeholders and assign roles	2 days	Thu 6/27/24	Fri 6/28/24	3	
5	1.1.3 Establish communication channels and protocols for stakeholder eng	1 day	Mon 7/1/24	Mon 7/1/24	4	
6	2.0 Project Planning Phase	0 days	Mon 7/1/24	Mon 7/1/24	5	
7	2.1 Define Requirements	0 days	Mon 7/1/24	Mon 7/1/24	5	
8	2.1.1 Customer Requirements	0 days	Mon 7/1/24	Mon 7/1/24	5	
9	2.1.1.1 Interview customers, determine capability, and validate needs	5 days	Tue 7/2/24	Mon 7/8/24	5	
10	2.1.2 Product Requirements	0 days	Mon 7/8/24	Mon 7/8/24	9	
11	2.1.2.1 Application Requirements - Features and Functionality	5 days	Tue 7/9/24	Mon 7/15/24	9	
12	2.1.2.2 Hardware Requirements – Sensors	5 days	Tue 7/16/24	Mon 7/22/24	11	
13	2.1.2.3 Pricing Model Requirements – Dynamic pricing structure	5 days	Tue 7/9/24	Mon 7/15/24	9	
14	2.1.2.4 Security Requirements – Data privacy and security protocols	5 days	Tue 7/9/24	Mon 7/15/24	9	
15	2.2 Develop project schedule and budget	2 days	Tue 7/23/24	Wed 7/24/24	12	
16	2.3 Vendor Selection and Procurement	0 days	Wed 7/24/24	Wed 7/24/24	15	
17	2.3.1 Identify and evaluate multiple vendors for essential components and services	7 days	Thu 7/25/24	Fri 8/2/24	15	


Wed 7/24/24
Sat 8/31/24
Today
Jun 23, '24
Jul 7, '24
Jul 21, '24
Aug 4, '24
Aug 18, '24
Sep 1, '24
Sep 15, '24
Sep 29, '24
Oct 13, '24
Oct 27, '24
Nov 10, '24
Nov 24, '24
Dec 8, '24
Dec 22, '24
Jan 5, '25
Jan 19, '25
Feb 2, '25
Feb 16, '25
Mar 2, '25
Start
Fri 6/21/24
Add tasks with dates to the timeline
Finish
Thu 3/6/25
Task Mode
Task Name
Durat
Start
Finish
Predecessors
16 2.3 Vendor Selection and Procurement 0 days Wed 7/24/24 Wed 7/24/24 15
17 2.3.1 Identify and evaluate multiple vendors for essential components and services 7 days Thu 7/25/24 Fri 8/2/24 15
18 2.3.2 Schedule lead times on all parts and services 3 days Mon 8/5/24 Wed 8/7/24 17
19 2.4 Risk Management 0 days Wed 8/7/24 Wed 8/7/24 18
20 2.4.1 Develop risk management plan 3 days Thu 8/8/24 Mon 8/12/24 18
21 3.0 Project Execution Phase 0 days Mon 8/12/24 Mon 8/12/24 20
22 3.1 Integrate Mobile Ticketing features to existing mTicket App 0 days Mon 8/12/24 Mon 8/12/24 20
23 3.1.1 Conceptualise Application Interface 0 days Mon 8/12/24 Mon 8/12/24 20
24 3.1.1.1 Create app wireframes and mockups 3 days Tue 8/13/24 Thu 8/15/24 20
25 3.1.1.2 Develop user interface based on best case designs 4 days Fri 8/16/24 Wed 8/21/24 24
26 3.1.2 Implement Dynamic Pricing Model 0 days Wed 8/21/24 Wed 8/21/24 25
27 3.1.2.1 Develop dynamic pricing algorithm 7 days Thu 8/22/24 Fri 8/30/24 25
Jul 28, '24
Aug 4, '24
Aug 11, '24
Aug 18, '24
Aug 25, '24
7/24
8/7
8/12
8/12
8/12
8/21
Sat 8/31/24
Tue 10/8/24
Sep 1, '24
Sep 8, '24
Sep 15, '24
Sep 22, '24
Sep 29, '24
Oct 6, '24
26 3.1.2 Implement Dynamic Pricing Model 0 days Wed 8/21/24 Wed 8/21/24 25
27 3.1.2.1 Develop dynamic pricing algorithm 7 days Thu 8/22/24 Fri 8/30/24 25
28 3.1.2.2 Integrate dynamic pricing algorithm into the mTicket app 2 days Mon 9/2/24 Tue 9/3/24 27
29 3.1.3 Develop Security Features 0 days Tue 9/3/24 Tue 9/3/24 28
30 3.1.3.1 Implement data privacy protocols 4 days Wed 9/4/24 Mon 9/9/24 29
31 3.1.3.2 Test security measures 5 days Tue 9/10/24 Mon 9/16/24 30
32 3.2 Integration with MBTA Systems 0 days Mon 9/16/24 Mon 9/16/24 31
33 3.2.1 Ensure secure data exchange protocols 5 days Tue 9/17/24 Mon 9/23/24 32
34 3.2.2 Test integration of app with existing MBTA systems 5 days Tue 9/24/24 Mon 9/30/24 33
35 3.3 Sensor and Hardware Implementation 0 days Mon 9/30/24 Mon 9/30/24 34
36 3.3.1 Implement tap-in and tap-out payment portals on trains 7 days Tue 10/1/24 Wed 10/9/24 35
9/3
9/16
9/30


Today
Tue 11/5/24
Fri 12/13/24
Jun 23, '24
Jul 7, '24
Jul 21, '24
Aug 4, '24
Aug 18, '24
Sep 1, '24
Sep 15, '24
Sep 29, '24
Oct 13, '24
Oct 27, '24
Nov 10, '24
Nov 24, '24
Dec 8, '24
Dec 22, '24
Jan 5, '25
Jan 19, '25
Feb 2, '25
Feb 16, '25
Mar 2, '25
Start
Fri 6/21/24
Add tasks with dates to the timeline
Finish
Thu 3/6/25
Task Mode
Task Name
Durat
Start
Finish
Predecessors
43 3.5 Deployment of updated mTicket App 0 days Tue 11/5/24 Tue 11/5/24 42
44 3.5.1 Deployment of Mobile Ticketing System 5 days Wed 11/6/24 Tue 11/12/24 42
45 3.5.2 Conduct Pilot Consumer Deployment 0 days Tue 11/5/24 Tue 11/5/24 42
46 3.5.2.1 Implement pilot test and validate results 5 days Wed 11/6/24 Tue 11/12/24 42
47 3.5.2.2 Perform corrective action and conduct retest if needed 4 days Wed 11/13/24 Mon 11/18/24 46
48 3.6 Deployment of configured hardware 0 days Tue 11/5/24 Tue 11/5/24 42
49 3.6.1 Deployment of Sensors on trains and stations 5 days Wed 11/6/24 Tue 11/12/24 42
50 3.6.2 Conduct Pilot Consumer Deployment on the Green Heath Street E Li 0 days Tue 11/5/24 Tue 11/5/24 42
51 3.6.2.1 Implement pilot test and validate results 5 days Wed 11/6/24 Tue 11/12/24 42
52 3.6.2.2 Perform corrective action and conduct retest if needed 4 days Wed 11/13/2 Mon 11/18/2 51
53 3.7 Management and Control 0 days Mon 11/18/2 Mon 11/18/2 52
54 3.7.1 Continuously monitor system performance 10 days Tue 11/19/24 Mon 12/2/24 53
55 3.7.2 Monitor customer acceptance - Track user engagement and feedback 10 days Tue 12/3/24 Mon 12/16/2 54
Nov 10, '24
Nov 17, '24
Nov 24, '24
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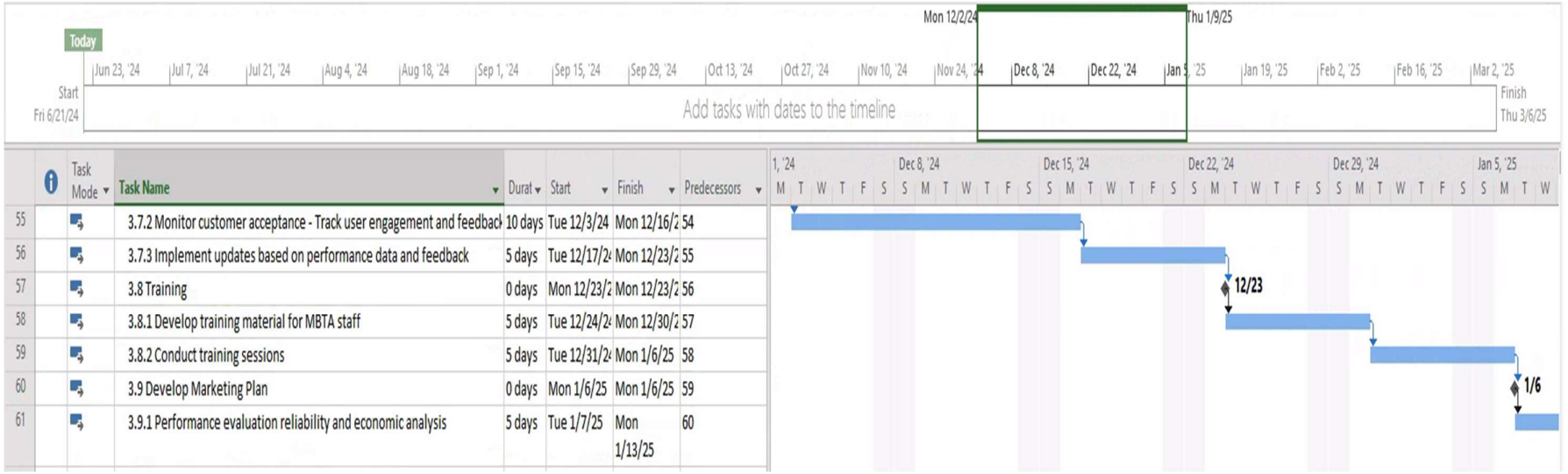
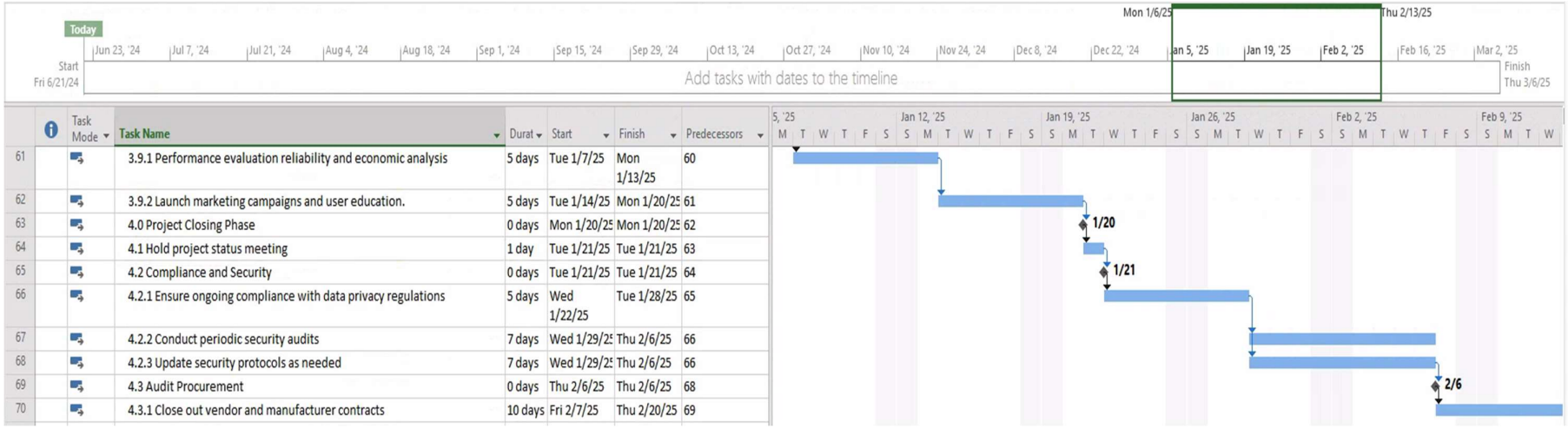
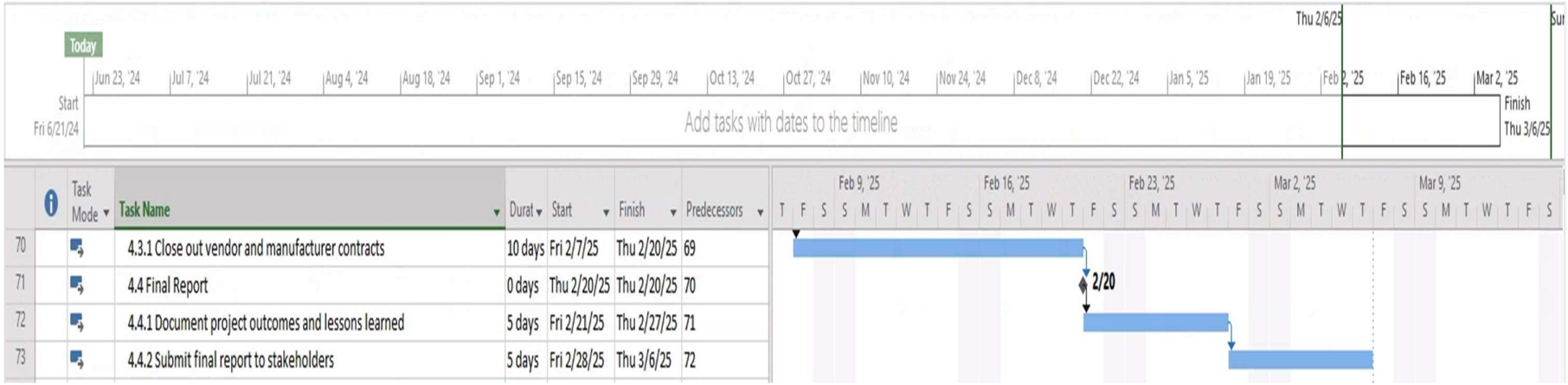
11/5
11/5
11/5
11/5
11/18


Today
Mon 12/2/24
Thu 1/9/25
Jun 23, '24
Jul 7, '24
Jul 21, '24
Aug 4, '24
Aug 18, '24
Sep 1, '24
Sep 15, '24
Sep 29, '24
Oct 13, '24
Oct 27, '24
Nov 10, '24
Nov 24, '24
Dec 8, '24
Dec 22, '24
Jan 5, '25
Jan 19, '25
Feb 2, '25
Feb 16, '25
Mar 2, '25
Start
Fri 6/21/24
Add tasks with dates to the timeline
Finish
Thu 3/6/25
Task Mode
Task Name
Durat
Start
Finish
Predecessors
55 3.7.2 Monitor customer acceptance - Track user engagement and feedback 10 days Tue 12/3/24 Mon 12/16/2 54
56 3.7.3 Implement updates based on performance data and feedback 5 days Tue 12/17/24 Mon 12/23/2 55
57 3.8 Training 0 days Mon 12/23/2 Mon 12/23/2 56
58 3.8.1 Develop training material for MBTA staff 5 days Tue 12/24/24 Mon 12/30/2 57
59 3.8.2 Conduct training sessions 5 days Tue 12/31/24 Mon 1/6/25 58
60 3.9 Develop Marketing Plan 0 days Mon 1/6/25 Mon 1/6/25 59
61 3.9.1 Performance evaluation reliability and economic analysis 5 days Tue 1/7/25 Mon 1/13/25 60
Dec 8, '24
Dec 15, '24
Dec 22, '24
Dec 29, '24
Jan 5, '25
12/23
1/6



	Task Mode	Task Name	Durat	Start	Finish	Predecessors
61		3.9.1 Performance evaluation reliability and economic analysis	5 days	Tue 1/7/25	Mon 1/13/25	60
62		3.9.2 Launch marketing campaigns and user education.	5 days	Tue 1/14/25	Mon 1/20/25	61
63		4.0 Project Closing Phase	0 days	Mon 1/20/25	Mon 1/20/25	62
64		4.1 Hold project status meeting	1 day	Tue 1/21/25	Tue 1/21/25	63
65		4.2 Compliance and Security	0 days	Tue 1/21/25	Tue 1/21/25	64
66		4.2.1 Ensure ongoing compliance with data privacy regulations	5 days	Wed 1/22/25	Tue 1/28/25	65
67		4.2.2 Conduct periodic security audits	7 days	Wed 1/29/25	Thu 2/6/25	66
68		4.2.3 Update security protocols as needed	7 days	Wed 1/29/25	Thu 2/6/25	66
69		4.3 Audit Procurement	0 days	Thu 2/6/25	Thu 2/6/25	68
70		4.3.1 Close out vendor and manufacturer contracts	10 days	Fri 2/7/25	Thu 2/20/25	69



	Task Mode	Task Name	Durat	Start	Finish	Predecessors
70		4.3.1 Close out vendor and manufacturer contracts	10 days	Fri 2/7/25	Thu 2/20/25	69
71		4.4 Final Report	0 days	Thu 2/20/25	Thu 2/20/25	70
72		4.4.1 Document project outcomes and lessons learned	5 days	Fri 2/21/25	Thu 2/27/25	71
73		4.4.2 Submit final report to stakeholders	5 days	Fri 2/28/25	Thu 3/6/25	72

Appendix C: RACI Matrix

Task ID	Task	Project Manager	Software Product Manager	Hardware Product Manager	Financial Manager	Hardware Quality and Training Technician	Software Quality and Training Technician	Compliance and Security Lead	Marketing Manager	Software Developer	Principal Engineer
1	1.0 Project Initiation Phase										
2	1.1 Hold Project Kick-off Meeting										
3	1.1.1 Define project scope and objectives	A	R	R	I	I	I	I	I	I	I
4	1.1.2 Identify Stakeholders and assign roles	A	R	R	I						
5	1.1.3 Establish communication channels and protocols for stakeholder engagement	A	R	R	I						
6	2.0 Project Planning Phase										
7	2.1 Define Requirements										
8	2.1.1 Customer Requirements										
9	2.1.1.1 Interview customers, determine capability, and validate needs	A	R	R	C	I	I	I	I	I	I
10	2.1.2 Product Requirements										
11	2.1.2.1 Application Requirements - Features and Functionality	I	A	I	C			I		R	
12	2.1.2.2 Hardware Requirements – Sensors	I	I	A	C			I			R
13	2.1.2.3 Pricing Model Requirements – Dynamic pricing structure	I	A	I	R						
14	2.1.2.4 Security Requirements – Data privacy and security protocols	R	C	C			I	A		R	
15	2.2 Develop project budget and schedule	A	R	R	C	I	I	I	I	I	I
16	2.3 Vendor Selection and Procurement										

Task ID	Task	Project Manager	Software Product Manager	Hardware Product Manager	Financial Manager	Hardware Quality and Training Technician	Software Quality and Training Technician	Compliance and Security Lead	Marketing Manager	Software Developer	Principal Engineer
17	2.3.1 Identify and evaluate multiple vendors for essential components and services	I	I	A	C			C			
18	2.3.2 Schedule lead times on all parts and services	R	C	A	C						I
19	2.4 Risk Management										
20	2.4.1 Develop risk management plan	A	R	R	C			C			
21	3.0 Project Execution Phase										
22	3.1 Develop Mobile Ticketing Application										
23	3.1.1 Design Application Interface										
24	3.1.1.1 Create app wireframes and mockups	I	A	I						R	
25	3.1.1.2 Develop user interface based on best case designs	I	A	I						C	
26	3.1.2 Implement Dynamic Pricing Model										
27	3.1.2.1 Develop pricing algorithm	R	A	I	C					R	
28	3.1.2.2 Integrate pricing algorithm into the app	I	A	I	I	I	I	I		R	
29	3.1.3 Develop Security Features										
30	3.1.3.1 Implement data privacy protocols	I	A	I			I	R		C	
31	3.1.3.2 Test security measures	I	A	I			I	R		C	
32	3.2 Integration with MBTA Systems										
33	3.2.1 Ensure secure data exchange protocols	I	C	A				C		R	R

Task ID	Task	Project Manager	Software Product Manager	Hardware Product Manager	Financial Manager	Hardware Quality and Training Technician	Software Quality and Training Technician	Compliance and Security Lead	Marketing Manager	Software Developer	Principal Engineer
34	3.2.2 Test integration with existing MBTA systems	I	C	A				C		R	R
35	3.3 Sensor and Hardware Implementation										
36	3.3.1 Implement tap-in and tap-out payment portals on trains	I	I	A		I	I	C		R	R
37	3.3.2 Test hardware reliability and integration	I	I	A		R		R		R	R
38	3.4 Testing Mobile Ticketing System										
39	3.4.1 Develop functional test plan	I	A	C		R	R	I	I	R	C
40	3.4.2 Conduct functional In-House Testing										
41	3.4.2.1 Validate system meets all required specifications	I	A	C		R	R			R	C
42	3.4.2.2 Perform corrective action and conduct retest if required	I	A	C		R	R			R	R
43	3.5 Deployment of updated mTicket App										
44	3.5.1 Deployment of mobile ticketing system	C	A	I		I	I	I		R	I
45	3.5.2 Conduct Pilot Consumer Deployment										
46	3.5.2.1 Implement pilot test and validate results	A	C	C		R	R			I	I
47	3.5.2.2 Perform corrective action and conduct retest if needed	A	C	C		I	I			R	R
48	3.6 Deployment of configured hardware										

Task ID	Task	Project Manager	Software Product Manager	Hardware Product Manager	Financial Manager	Hardware Quality and Training Technician	Software Quality and Training Technician	Compliance and Security Lead	Marketing Manager	Software Developer	Principal Engineer
49	3.6.1 Deployment of sensors in trains and stations	I		A		C					R
50	3.6.2 Conduct Pilot Consumer Deployment on the Green Heath Street E Line										
51	3.6.2.1 Implement pilot test and validate results	A	C	C		R	R			I	I
52	3.6.2.2 Perform corrective action and conduct retest if needed	A	C	C		I	I			R	R
53	3.7 Management and Control										
54	3.7.1 Continuously monitor system performance	I	R	R	I	I	A	I	I		
55	3.7.2 Monitor customer acceptance - Track user engagement and feedback	I	R	R	I	I	A	I	I		
56	3.7.3 Implement updates based on performance data and feedback	I	C	C	C	C	A	C	I	R	R
57	3.8 Training										
58	3.8.1 Develop training material for MBTA staff	A	C	C	I	R	R	I	I	C	C
59	3.8.2 Conduct Training sessions	A	C	C		R	R				
60	3.9 Develop Marketing plan										
61	3.9.1 Performance evaluation reliability and economic analysis	A	C	C	C	I	I	I	R		

Task ID	Task	Project Manager	Software Product Manager	Hardware Product Manager	Financial Manager	Hardware Quality and Training Technician	Software Quality and Training Technician	Compliance and Security Lead	Marketing Manager	Software Developer	Principal Engineer
62	3.9.2 Launch marketing campaign and user education	A	I	I	I	I	I	I	R		
63	4.0 Project Closing Phase										
64	4.1 Hold project status meetings	I	R	R	C	C	A	C	C		
65	4.2 Compliance and Security										
66	4.2.1 Ensure ongoing compliance with data privacy regulations	I	I	I				A		R	R
67	4.2.2 Conduct periodic security audits	I	I	I				A		R	R
68	4.2.3 Update security protocols as needed	I	I	I				A		R	R
69	4.3 Audit Procurement										
70	4.3.1 Close out vendor and manufacturer contracts	A	R	R	I						
71	4.4 Final Report										
72	4.4.1 Document project outcomes and lessons learned	A	R	R	R	R	R	R	R	I	I
73	4.4.2 Submit final report to stakeholders	A	R	R	R	R	R	R	R	I	I

Appendix D: Budget Classification

Project Name: Dynamic Pricing Through Mobile Ticketing Application for the Massachusetts Bay Transportation Authority Estimated Start time: June 21st, 2024								**Total Budget**	$588,050.60
Task description	**Resources**								**Task total cost($)**
	Labor				**Materials & Equipment**			**Miscellaneous ($)**	
	Number of people	**Working hours**	**Hourly rate($)**	**Estimated cost ($)**	**Quantity**	**Unit price ($)**	**Estimated cost ($)**		
1 Project Initiation Phase									
1.1 Hold Project Kickoff Meeting									
1.1.1 Define project scope and objectives	10	32	$25.40	$8,128.00				$10,000.00	$18,128.00
1.1.2 Identify Stakeholders and assign roles	4	16	$46.50	$2,976.00					$2,976.00
1.1.3 Establish communication channels and protocols for stakeholder engagement	4	8	$46.50	$1,488.00					$1,488.00
								Phase total cost	$22,592.00
2 Project Planning Phase									
2.1 Define Requirements									
2.1.1 Customer Requirements									

2.1.1.1 Interview customers, determine capability, and validate needs	10	40	$26.60	$10,640.00	1	$300.00	$300.00		$10,940.00

Task description	Resources								Task total cost($)
	Labor				Materials & Equipment			Miscellaneous ($)	
	Number of people	Working hours	Hourly rate($)	Estimated cost ($)	Quantity	Unit price ($)	Estimated cost ($)		
2.1.2 Product Requirements									
2.1.2.1 Application Requirements - Features and Functionality	6	40	$30.00	$7,200.00					$7,200.00
2.1.2.2 Hardware Requirements - Sensors	6	40	$30.83	$7,400.00	10	$1,500.00	$15,000.00		$22,400.00
2.1.2.3 Pricing Model Requirements – Dynamic pricing structure	4	40	$34.00	$5,440.00					$5,440.00
2.1.2.4 Security Requirements – Data privacy and security protocols	6	40	$37.67	$9,040.00					$9,040.00
2.2 Develop Project Schedule and Budget	10	16	$26.60	$4,256.00					$4,256.00
2.3 Vendor Selection and Procurement									
2.3.1 Identify and evaluate multiple	5	56	$24.00	$6,720.00					$6,720.00

vendors for essential components and services									
2.3.2 Schedule lead times on all parts and services	5	24	$34.40	$4,128.00					$4,128.00

Task description	Resources								Task total cost($)
	Labor				Materials & Equipment			Miscellaneous ($)	
	Number of people	Working hours	Hourly rate($)	Estimated cost ($)	Quantity	Unit price ($)	Estimated cost ($)		
2.4 Risk Management									
2.4.1 Develop risk management plan	5	24	$43.60	$5,232.00					$5,232.00
								Phase total cost	$75,356.00
3 Project Execution Phase									
3.1 Develop Mobile Ticketing Application									
3.1.1 Design Application Interface									
3.1.1.1 Create app wireframes and mockups	4	24	$36.50	$3,504.00	1	$600.00	$600.00		$4,104.00
3.1.1.2 Develop user interface based on best case designs	4	32	$26.00	$3,328.00					$3,328.00

3.1.2 Implement Dynamic Pricing Model									
3.1.2.1 Develop pricing algorithm	5	56	$42.80	$11,984.00					$11,984.00
3.1.2.2 Integrate pricing algorithm into the app	8	16	$23.50	$3,008.00					$3,008.00
3.1.3 Develop Security Features									
3.1.3.1 Implement data privacy protocols	6	32	$27.17	$5,216.00					$5,216.00

Task description	Resources								Task total cost($)
	Labor				Materials & Equipment			Miscellaneous ($)	
	Number of people	Working hours	Hourly rate($)	Estimated cost ($)	Quantity	Unit price ($)	Estimated cost ($)		
3.1.3.2 Test security measures	6	50	$27.17	$6,520.00	1	$500.00	$500.00		$7,020.00
3.2 Integration with MBTA Systems									
3.2.1 Ensure secure data exchange protocols	6	40	$42.33	$10,160.00	1	$400.00	$400.00		$10,560.00
3.2.2 Test integration with existing MBTA systems	6	40	$42.33	$10,160.00					$10,160.00
3.3 Sensor and Hardware Implementation									
3.3.1 Implement tap-in and tap-out payment portals on trains	8	56	$32.63	$14,616.00	12*4	$1,500.00	$90,000.00		$104,616.00
3.3.2 Test hardware reliability and integration	7	40	$46.57	$13,040.00					$13,040.00
3.4 Testing Mobile Ticketing System									
3.4.1 Develop functional test plan	9	40	$34.22	$12,320.00	1	$300.00	$300.00		$12,620.00

3.4.2 Conduct In-House Testing									
3.4.2.1 Validate system meets all required specifications	7	40	$41.29	$11,560.00					$11,560.00

Task description	Resources								Task total cost($)
	Labor				Materials & Equipment			Miscellaneous ($)	
	Number of people	Working hours	Hourly rate($)	Estimated cost ($)	Quantity	Unit price ($)	Estimated cost ($)		
3.4.2.2 Perform corrective action and conduct retest if required	7	32	$47.71	$10,688.00					$10,688.00
3.5 Deployment of updated mTicket App									
3.5.1 Deployment of mobile ticketing system	8	40	$25.25	$8,080.00					$8,080.00
3.5.2 Conduct Pilot Consumer Deployment									
3.5.2.1 Implement pilot test and validate results	7	40	$32.14	$9,000.00					$9,000.00
3.5.2.2 Perform corrective action and conduct retest if needed	7	32	$37.19	$8,352.00					$8,352.00
3.6 Deployment of configured hardware									
3.6.1 Deployment of Sensors in trains and stations	4	40	$40.00	$6,400.00					$6,400.00

3.6.2 Conduct Pilot Consumer Deployment on the Green Heath Street E Line									

Task description	Resources								Task total cost($)
	Labor				Materials & Equipment			Miscellaneous ($)	
	Number of people	Working hours	Hourly rate($)	Estimated cost ($)	Quantity	Unit price ($)	Estimated cost ($)		
3.6.2.1 Implement Pilot Tests and validated results	7	40	$32.14	$9,000.00					$9,000.00
3.6.2.2 Perform corrective action and conduct retest if needed	7	32	$37.29	$8,352.00					$8,352.00
3.7 Management and Control									
3.7.1 Continuously monitor system performance	8	80	$27.38	$17,520.00					$17,520.00
3.7.2 Monitor Customer acceptance - Track user engagement and feedback	8	80	$27.38	$17,520.00					$17,520.00

3.7.3 Implement updates based on performance data and feedback	10	40	$31.90	$12,760.00					$12,760.00
3.8 Training									
3.8.1 Develop training material for MBTA staff	10	40	$28.50	$11,400.00					$11,400.00
3.8.2 Conduct training sessions	5	40	$39.20	$7,840.00	1	$200.00	$200.00		$8,040.00
3.9 Develop Marketing Plan									

Task description	Resources								Task total cost($)
	Labor				Materials & Equipment			Miscellaneous ($)	
	Number of people	Working hours	Hourly rate($)	Estimated cost ($)	Quantity	Unit price ($)	Estimated cost ($)		
3.9.1 Performance evaluation, reliability, and economic analysis	8	40	$24.38	$7,800.00					$7,800.00
3.9.2 Launch marketing campaigns and user education	8	40	$19.63	$6,280.00				$25,000.00	$31,280.00
								Phase total cost	$363,408.00
4 Project Closing Phase									

4.1 Hold project status meetings	8	8	$32.63	$2,088.00					$2,088.00
4.2 Compliance and Security									
4.2.1 Ensure ongoing compliance with data privacy regulations	6	40	$37.00	$8,880.00					$8,880.00
4.2.2 Conduct periodic security audits	6	56	$37.00	$12,432.00	1	$500.00	$500.00		$12,932.00
4.2.3 Update security protocols as needed	6	56	$37.00	$12,432.00					$12,432.00
4.3 Audit Procurement									
4.3.1 Close out vendor and manufacturer contracts	4	80	$46.50	$14,880.00	1	$300.00	$300.00		$15,180.00
4.4 Final Report									

Task description	Resources								Task total cost($)
	Labor				Materials & Equipment			Miscellaneous ($)	
	Number of people	Working hours	Hourly rate($)	Estimated cost ($)	Quantity	Unit price ($)	Estimated cost ($)		

4.4.1 Document project outcomes and lessons learned	10	40	$45.80	$18,320.00					$18,320.00
4.4.2 Submit final report to stakeholders	10	40	$45.80	$18,320.00					$18,320.00
								Phase total cost	$88,152.00
	Labor total cost			$406,408.00	**Materials& Equipment total cost**		$108,100.00	$35,000.00	$549,580.00
								7% Contingency	$38,470.60
								Total cost	$588,050.60

Appendix E: Resource Allocation Plan

Client	MBTA
Project	Dynamic Pricing Through Mobile Ticketing Application
Budget Hours	7246
Contract Value	$588,050.60
Project Start Date	2024/6/21

Resource	Type	Company	Role	Effort (Hours)	Rate/Hour	% Allocation
Siddharth Avoodainayagam	Labor	MBTA	Project Manager	818	55	46%
Sampada Jindal	Labor	MBTA	Software Product Manager	1066	65	60%
Aman Malawade	Labor	MBTA	Software Quality and Training Technician	610	45	34%
Sreelu P Nair	Labor	MBTA	Compliance and Security Lead	560	50	32%
Sancia Saldanha	Labor	MBTA	Marketing Manager	237	45	13%
Supradeepa Vella	Labor	MBTA	Financial Manager	352	60	20%
Jiahao Ye	Labor	MBTA	Hardware Product Manager	1018	65	58%
Software Developer	Labor	MBTA	Software Development	867	70	49%
Hardware Quality and Training Technician	Labor	MBTA	Hardware Quality Assurance and Testing	528	55	30%
Principal Engineer 1	Labor	MBTA	Hardware Development	654	75	37%
Miscellaneous	Material	MBTA	Miscellaneous	-	-	
Development Tools & Software Licenses	Material	Microsoft, Oracle, Adobe	Development	-	-	
Sensors & Payment Portal	Material	Honeywell	Hardware	-	-	
Security Testing Tools	Material	Rapid7	Security	-	-	
Training Materials	Material	MBTA	Training	-	-	

Resource	Type	Company	Role	Effort (Hours)	Rate/Hour	% Allocation
Marketing Campaign	Material	MBTA	Marketing	-	-	
Servers & Related Hardware	Material	Dell Technologies	Hardware	-	-	
Documentation Software and Printing	Material	Microsoft, Adobe	Documentation	-	-	
EAC (Hours)	Contingency	Total (Hours)				
6709	8%	7246				

Appendix F: References

[1] MBTA System Wide Passenger Survey RAPID TRANSIT (2008–09) Green Line

https://www.ctps.org/data/pdf/studies/transit/MBTA_Passenger_Survey/Green_Line_Volume.pdf

[2] Study Raises Concern That Annual T Fare Evasion Costs Could Rise By More Than $30 Million Under AFC 2.0

https://pioneerinstitute.org/featured/study-raises-concern-that-annual-t-fare-evasion-costs-could-rise-by-more-than-30-million-under-afc-2-0/