Transport for NSW

UNSW THE UNIVERSITY OF NEW SOUTH WALES

GSOE9820 - Engineering Project

Transport Project Management Plan

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1 Project Charter

1.1 Background

When it comes to the technology utilized in public transportation, the industry has made great development over the last years. This proliferation of technological systems in the world of transport pursues different objectives, among them, making public transportation more accessible and comfortable, increasing safety, and reducing the time and costs of journeys. (Gershenfeld et al., 2004). Yet, COVID_19 pandemic brought new challenges to the table, enticing restrictions and limiting public engagement and customer reluctance to crowded environments and physical interaction within public transport trips. This means innovating and implementing new technologies to harness rapid changes in the economy has never been more important for the future transport network.

One of the main challenges in the application of technology to the world of transport is to incorporate cutting-edge technologies and innovative developments tested mainly in academic environments, into real solutions that can interact with the agents present in transport systems: vehicles, signage, infrastructure, etc.

Computer Vision (CV) is a field that is becoming more mature and reliable day by day, with multiple big tech companies already offering end-to-end solutions to incorporate this technology. Today, CV is becoming an indispensable element in the evolution of transport systems. However, not on its own, the maturity and reliability that it offers today are thanks to its combination with other areas of Artificial Intelligence. The combination of both disciplines, integrated with Edge IoT and Cloud systems will allows us to process large volumes of data quickly and in real time, and allow us to take the appropriate steps to reach a new paradigm for the use of transport networks and systems, which will become safer and more comfortable for users, where unexpected events and congestions can be prevented well in advance so that they do not pose a significant disruption to daily travel and mobility.

1.2 Project Objectives and Requirements

The objective of this project is to help Transport NSW achieve its FTTR strategic program by developing an innovative intelligent sensor lighting system and an end-to-end computer vision AI solution, which objective is to reduce light rail congestion and enhance service performance and customer experience on the L2 light-rail platforms from Central Chalmers Street to Randwick. The project will deliver benefits aligned to the Sensors and intelligent systems FTTR strategic program (NSW Government, 2021) whose objective is to create smarter transport networks for richer customer information, service performance, and incident response. The project should address the strategy in the following ways:

FTTR Strategic Objectives	**High Level Project Requirements**
New technologies and innovation	- Implement cutting-edge technology on intelligent systems and sensor technologies to support a modern, innovative and resilient transport network, and informing customers through smart systems.
Customer focused	- Transform the daily travel experiences of customers and increase the liveability, amenity and economic success of the UNSW and Randwick businesses/community. - Minimising inconvenience and disruption for customers.
Safety and performance	- Provide immediate, targeted and actionable insights, to optimise service delivery and network management. - Ensure appropriate data privacy and security management.

1.3 Key Objectives

The key objectives for this project are:

1. To Implement real-time intelligent sensors and an end-to-end computer vision AI platform across the L2 light-rail platforms from Central Chalmers Street to Randwick, for improved customer information, service performance and incident response.

2. To design and enhance customers' experiences for their end-to-end journeys to be seamless, interactive and personalised, supported by smart signage and a WebApp integrated to related systems and data analytics which provides accurate real-time information to customers.

3. To verify and test the system with emphasis on functionality, effectiveness and security. Three deployment trials are planned, to make sure the digital transport system detects real-time network conditions, deliver information automatically to decision support systems, and enable safer, more efficient network management and optimisation.

1.4 Project Boundaries

The boundaries of this project will include:

1. This project will start from 1st January 2023 and must be completed before 31st December 2024

2. Full budget of $8000000 and any ongoing payments will only be covered within the project period

3. The current TfNSW network will be upgraded to allow for people counting and carriage occupancy detection. Project deliverables will be developed in alignment with the FTTR strategic program.

1.5 High Level Risks

High level risks include insufficient network load and passenger's privacy breach.

1. Insufficient network load refers to the fact that insufficient network load can cause a system crash. It can cause the entire system to go down.

2. Passenger's privacy breach, lightly, will lead to errors in the system and affect the normal operation of the project. In serious cases, it will lead to the loss of credibility of the whole project and seriously affect the process of the project.

1.6 Summary of schedule and milestones

The project will be completed within two years. Below are the project schedule details:

- Project Start Date: 1-Jan-2023
- Project End Date : 24-Dec-2024

Major Milestones are as follows:

- Plan Finalization: 12-Jun-2023
- HW Infra Ready: 30-Jun-2023
- SW Ready: 01-Aug-2023
- Small Trial Completion: 10-Oct-2023
- Large Trial Completion: 15-Oct-2024

1.7 Summary of preliminary budget

The overall budget of the project was broken down and shared between 5 key areas:

- Surveying
- Project Management
- Software Development
- Hardware Development
- Functionality/Trialing

A fund totalling $800,000 has been given for the completion of the project with $400,000 available per calendar year from the 1st of January 2023 to the 31 of December 2024.

Expenditure was split between labour costs and also cost of materials and equipment. A high level overview of expenditure can be seen in table 3.3.

1.8 Stakeholder List

Stakeholders List	
Project Sponsor	Dylan Sanusi-Goh
Project Management Team	Qihang Tian
	Bojie Zhuang
	Sixing Ci
	Xianglin Fu
	Khushboo Rajhans Hadke
	Sebastian Del Basto
Industry	Suppliers
	Contracted Builders
	Contracted Software Engineers and Designers
	Contracted Hardware Engineers and Designers
	Light Rail Operator
Government	Transport for NSW Office
Local Community	Randwick Community
	UNSW Students and Staff

Table 1.8 Stakeholders list

1.9 PM Nomination

Name	Role
Bojie Zhuang	Project Manager
Khushboo Rajhans Hadke	Site and Procurement Manager
Qihang Tian	Process Engineer
Sebastian Del Basto	Cloud and Analytics Lead Engineer
Sixing Ci	Head Legal and Risk Advisor

Xianglin Fu	Embedded System Lead Engineer

Table 1.9 PM Nomination

1.10 Definition of Success

This project will be considered successful if the following has been achieved:

- Implementation of all project deliverables stated in Section 2.2.
- Completion of project activities before the promised end date with the total cost not exceeding $800,000.
- Effective stakeholder engagement to avert dissatisfaction and misalignment.
- Realistic estimation of project cost and time needed to finish work
- A detailed risk assessment including risk identification, mitigation strategy and risk response plan to ensure all risks are tracked and managed throughout project duration.
- Final agreement on project outcomes.

2.Scope Plan

This project aims to help Transport NSW achieve its FTTR strategic program, by implementing intelligent systems at platforms to count passenger occupancy. This will enhance the general public's commuting experience by reducing capacity imbalance on light rail carriages especially during peak hours.

2.1 Acceptance Criteria

The project will receive formal acceptance once all sub-deliverables listed below have been validated and verified to perform as expected, all requirements have been reviewed and formally approved by the project manager, and all deliverables have been turned over to the project sponsor. The project will be closed afterwards.

2.2 Deliverables

2.2.1 Surveying

A field survey will need to be conducted before project commencement, which includes preliminary data collection and defect inspection of existing infrastructure. The information gathered will be used to create a layout drawing and also the boundary plan for this project.

2.2.2 Sensor System

The Sensor System utilizes thermal cameras and Wifi-beacons to perform people counting at lightrail platforms. Sensors that detect passenger occupancy are mounted on platforms and are connected to the display system (Smart Signage). The collected data will be analyzed for identifying and predicting passenger congestion.

2.2.3 Smart Signage

Smart signages will be implemented at all light rail platforms to inform passengers about up-to-date travel information and redirect passenger flow during peak hours. Long-life LED strips are chosen for this case to ensure good readability.

2.2.4 Cloud Data

The data collected by sensors will be saved in cloud space for further processing and analysis. A cloud storage method has been carefully selected to be reliable, secure and cost-effective, providing transportation executives with an easy access to real-time data.

2.2.5 AI and Machine Learning Algorithms

The algorithm developed will be able to process images fetched from connected sensors within the region of interest. A counting logic is incorporated to aggregate the detected patronage number as output and send it to the cloud. Also, with error elimination being considered to achieve high accuracy counting, other analytic tasks such as staff detection, duration and occupancy measurements can be implemented for further optimization.

2.2.6 Application/Website Development

A mobile application and website will be launched to alert people to crowded carriages and congestion, hence to balance the distribution of passengers along platforms. User interface (UI) and user experience (UX) design are crucial elements of the application development, given their highly customizable features to meet user satisfaction.

2.2.7 Deployment Trial

Three deployment trials are planned as required by the project sponsor, each with emphasis on functionality, validation and overall verification. Performance reports will be created by the end of the allocated analysis period to explain trial results with future recommendations on improvements.

2.2.8 Project Documentation

Project documentation includes all the documents generated over the course of the project by recording the key project details and necessary information for project realization. Some associated benefits are: the project is moving at a speedy but manageable pace, all stakeholders are informed about the progress in a timely manner, and confirming that the project outcome has met the client's expectations.

2.3 Constraints

This project will need to be completed within a two-year time range under a fixed budget of $800,000, including any contingencies. Project funding will be provided by the project sponsor. The project should be managed in alignment with TfNSW's FTTR 2021-2024 strategy throughout the duration of the project. In addition, all groundwork and installation of utilities should be supervised by the project team and meet applicable Australian standards and safety regulations.

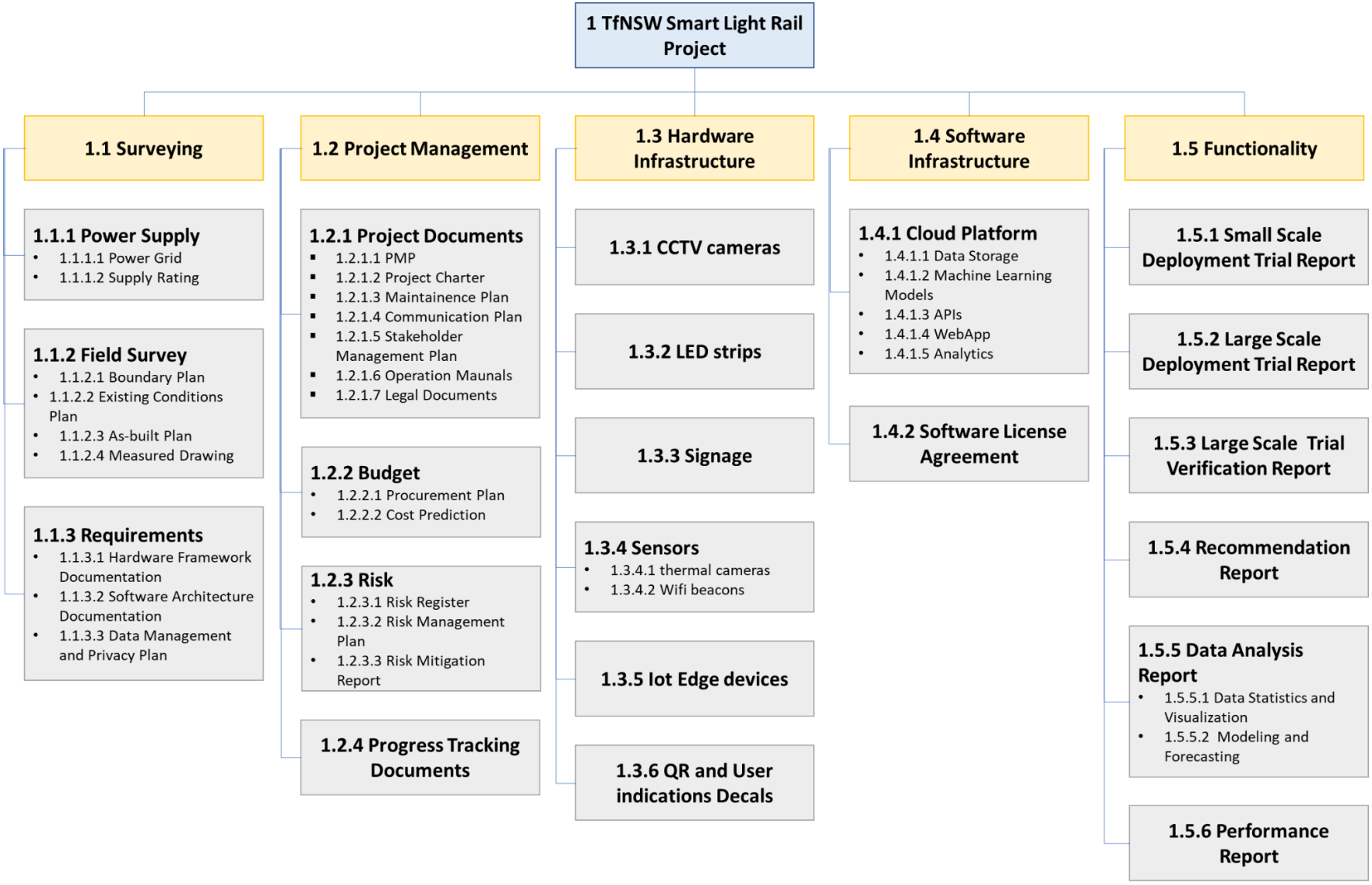
2.4 Exclusions

- This project should be implemented only at platforms and stops along the L2 light rail line from Central Chalmers Street to Randwick. Any work conducted at other stations and transport modes would form a separate project.
- The repair, upgrade and maintenance of the existing infrastructure would form a separate project.

2.5 Scope Statement

This two-year project shall implement an intelligent signage lighting system to mitigate congestion on light rail platforms from Central Chalmers Street to Randwick. The project shall implement platform occupancy counting to account for and manage capacity levels across light rail carriages. Along with the development of a project management plan the project will also include surveying prior to commencement. Software design consists of an end-to-end computer vision AI solution which will allow users to interact with the system via a WebApp in real-time. Occupancy data will be fed into the system through both optical and thermal sensors and displayed via platform signage. The project shall arrange for three individual deployment trials and analyze the results for verification in terms of functionality, insight tracking and overall improvements. The project shall commence on the 1st of January 2023 and be completed prior to the 31st of December 2024 with a budgetary constraint of $400,000 per calendar year. The project shall only be implemented on select platforms along the L2 line and any extension would form a separate project.

2.6 Work Breakdown Structure (WBS)



3 Budget Management Plan

3.1 Cost Estimation Strategy

The project WBS has been broken down into work packages which include activities that are to be fulfilled for project completion. In order to estimate costs, a bottom up approach has been taken in order to parametrically determine the cost of specific tasks. Contract rates for different project roles have been taken from average industry standard pay and shall act as the guideline for cost estimates. Estimations of materials and equipment have also been noted. All equipment and material costs were derived from researching relevant products and suppliers in order to compile all costs. Labour costs will be split into three different categories as shown in table 3.1. The maximum number of working hours in a day was placed at 9 hours. It is assumed that the maximum amount of days a working week could have is 5 days. To determine the specific duration of each task, the tasks were further broken down into activities. By estimating the time it would take for a select number of personnel to complete all eactivities in a task, the duration of each task was approximated.

Grade	Position	Pay/Day	Pay/Hr	Salary (Range)
Lvl 4	PM/Technical Stakeholder/Project lead	$540	$60	$125, 000
Lvl 3	Engineers (Process, Software, Electrical, QA Structural, Cloud Architects, ML)	$495	$55	$110, 000
Lvl 2	Developers, UI/UX designers Administration/HR/Procurement Manager	$405	$45	$87 ,000
Lvl 1	Construction Worker/Electrician/Maintanence	$270	$30	$61, 500

Table 3.1 Project Role Cost Breakdown

3.2 Cost and Time Estimation Table

WP ID	Task	Duration (Weeks)	Labour								Total Labour Cost	Total Material Cost	Total Cost
			Level 4		Level 3		Level 2		Level 1				
			Paid Hrs	Number	Paid Hrs	Number	Paid Hrs	Number	Paid Hrs	Number			
1.1.1	Power Survey	1	-	-	72	2	-	-	36	1	$5040	-	$5040
1.1.2.1	Boundary Plan	1	45	1	18	1	-	-	-	-	$3690	-	$3690
1.1.2.2	Existing Conditions Plan	1	45	1	72	2	-	-	-	-	$6660	-	$6660
1.1.3.1	Hardware Framework Documentation	2	36	1	144	2	-	-	-	-	$10080	-	$10080
1.1.3.2	Software Framework Documentation	2	36	1	144	2	-	-	-	-	$10080	-	$10080
1.2.1	PMP Documentation	3	135	1	270	2	-	-	-	-	$22950	-	$22950
1.2.2.1	Procurement Plan	2	90	1	-	-	-	-	-	-	$5400	-	$5400
1.2.2.2	Cost Estimation	1	36	1	90	2	-	-	-	-	$7110	-	$7110
1.2.3.1	Risk Register and Management Plan	1	45	1	-	-	-	-	-	-	$2700	-	$2700
1.2.3.3	Risk Mitigation Report	1	20	1	45	2	-	-	-	-	$3675	-	$3675
1.2.4	Progress Tracking Documents	1	20	1	45	2	-	-	-	-	$3675	-	$3675
1.2.5	Engineering and Construction Team Contract	4	20	1	-	-	80	2	-	-	$4800	$4000	$8800
1.3.1	CCTV Cameras	4	16	1	192	2	128	1	112	2	$20640	$9660	$30300
1.3.2	LED Strips	2	-	-	14	2	16	1	28	2	$2330	$1568	$3898
1.3.3	Signage	4	16	1	192	2	128	1	224	4	$24000	$39879	$63879
1.3.4.1	Thermal Sensor	4	16	1	192	2	128	1	112	2	$20640	$19012	$39652
1.3.4.2	Wifi Beacon	4	16	1	192	2	128	1	112	2	$20640	$7798	$28438
1.3.5	IOT Edge Device	5	40	1	400	2	64	1	56	4	$28960	$21420	$50380
1.3.6	QR and User Indications Decals	1	-	-	48	2	24	1	-	-	$3720	$100	$3820
1.4.1.1	Data Storage	4	20	1	640	4	-	-	-	-	$36400	-	$36400
1.4.1.2	Machine Learning Model	8	40	1	1280	4	-	-	-	-	$72800	-	$72800
1.4.1.3	API Endpoint	6	30	1	960	4	-	-	-	-	$54600	-	$54600
1.4.1.4	WebApp	8	30	1	1280	4	-	-	-	-	$72200	-	$72200
1.4.2	Software License Agreement	2	9	1	-	-	18	2	-	-	$1350	$12000	$13350
1.5.1	Small Scale Deployment Trial	8	64	1	128	1	-	-	240	1	$18080	-	$18080
1.5.2	Large Scale Deployment Trial	16	128	1	256	1	-	-	480	1	$36160	-	$36160
1.5.3	Final Trial Recommendations and Verification	24	192	1	768	2	-	-	720	1	$75360	-	$75360
1.5.5	Data Analysis Report	6	192	1	384	2	-	-	-	-	$32640	-	$32640
1.5.6	System Performance Report	6	192	1	384	2	-	-	-	-	$32640	-	$32640
Total Cost													$754457
Contingency Fund													$45543

Table 3.2 Cost and Time Estimation

3.3 Project Budget Breakdown

The duration of the project spans from January 1st, 2023 to December 31st, 2024. Overall $800,000 will be allocated to the completion of the project with $400,000 in available funds per calendar year. In order to allow for contingency action in the event of unforeseen issues, a fund of 5.7% of the budget will be put aside. A budget breakdown is provided in table 3.3.

WP ID	Task	Budget Allocation	Work Package Used
1.1	Surveying	4.4%	$35,550
1.2	Project Management	6.8%	$54,310
1.3	Software Infrastructure	31.2%	$249,350
1.4	Hardware Infrastructure	27.5%	$220,367
1.5	Functionality	24.4%	$194,880
Contingency Funds		5.7%	$45,543
Total			$800,000

Table 3.3 Budget Breakdown

4. Project Schedule Management

Schedule management deals with processes, procedures, and documentation for planning and managing project schedule. Different scheduling and estimating software can be used to plan, track and manage project schedule (Project Management Institute, 2017).

Project schedule for the **TfNSW Smart Light Rail Project** is created using MS Project starting with the deliverables identified in the project's Work Breakdown Structure (WBS). Activity sequencing is used to determine the order of work packages and assign relationships between project activities. Duration estimation is used to calculate the number of work periods required to complete each activity.

4.1 Activity Duration Estimates

Analogous estimation technique is used to estimate the duration of each activity. We have analyzed past project data and took expert opinion during the estimation process. Below is the detail of activity duration estimates:

Activity Name	Duration Estimate	Dependency/Predecessors
Power Grid Survey	7 days	
Supply Rating Survey	7 days	
Boundary Plan	30 days	3
Existing Condition Plan	20 days	
As-Build Plan	15 days	7
Measured Drawing	10 days	8
Hardware Framework	21 days	9
Software Framework	17 days	11
Data Management & Privacy	13 days	12
Creating Project Mgmt Plan	20 days	13
Legal Documents	15 days	9
Operation Manual	15 days	9
Purchase Plan	15 days	10
Risk Register Preparation	15 days	10
CCTV Installation	14 days	16

Sensors Installation	10 days	16
LED Installation	12 days	16
Signage Installation	10 days	16
Other Infra Devices Installation	8 days	16
Data Storage	14 days	28
Data API Integration	14 days	31
ML & AI Deployment	10 days	28
Webpage & App Development	10 days	28
Software License Readiness	4 days	31
Trial at Randwick	50 days	23,29
Trial at all stations	90 days	37
Analysis of Large Scale Trial	25 days	40
Large Scale Trial Verification	150 days	41
Analysis and Performance Report	50 days	42

Table 4.1 Activity Duration Estimates

4.2 Project Schedule

Schedule provides the start and end date of a project. Different schedule models can be used to define project schedule. Critical path method (CPM) is the most popular method to find project schedule. The critical path is used to find the shortest path to complete a project. The CPM technique calculates the early start, early finish, late start, and late finish dates for all activities by performing forward pass and backward pass on network diagram. The activities in the critical path do not have any float or schedule flexibility (Project Management Institute, 2017).

TfNSW Smart Light Rail project's schedule has been prepared using MS Project software. Critical path has been calculated using the concept of early start date, early finish date, late start date and late finish date.

WBS	Task Name	Duration	Start	Finish
1	**TfNSW Smart Light Rail Project**	**517 days**	**Mon 2/1/23**	**Tue 24/12/24**
1.1	Surveying	96 days	Mon 2/1/23	Mon 15/5/23
1.1.1	Power Grid Survey	7 days	Mon 2/1/23	Tue 10/1/23
1.1.2	Supply Rating Survey	7 days	Mon 2/1/23	Tue 10/1/23
1.1.3	Field Survey	45 days	Mon 2/1/23	Fri 3/3/23
1.1.3.1	Boundary Plan	30 days	Wed 11/1/23	Tue 21/2/23
1.1.3.2	Existing Condition Plan	20 days	Mon 2/1/23	Fri 27/1/23
1.1.3.3	As-Build Plan	15 days	Mon 30/1/23	Fri 17/2/23
1.1.3.4	Measured Drawing	10 days	Mon 20/2/23	Fri 3/3/23
1.1.4	Requirements	51 days	Mon 6/3/23	Mon 15/5/23
1.1.4.1	Hardware Framework	21 days	Mon 6/3/23	Mon 3/4/23
1.1.4.2	Software Framework	17 days	Tue 4/4/23	Wed 26/4/23
1.1.4.3	Data Management & Privacy	13 days	Thu 27/4/23	Mon 15/5/23
1.2	Project Plan	71 days	Mon 6/3/23	Mon 12/6/23
1.2.1	Project Documents	71 days	Mon 6/3/23	Mon 12/6/23
1.2.1.1	Creating Project Mgmt Plan	20 days	Tue 16/5/23	Mon 12/6/23

1.2.1.2	Legal Documents	15 days	Mon 6/3/23	Fri 24/3/23
1.2.1.3	Operation Manual	15 days	Mon 6/3/23	Fri 24/3/23
1.2.2	Budget Plan	15 days	Tue 16/5/23	Mon 5/6/23
1.2.2.1	Purchase Plan	15 days	Tue 16/5/23	Mon 5/6/23
1.2.3	Risk Plan	15 days	Tue 16/5/23	Mon 5/6/23
1.2.3.1	Risk Register Preparation	15 days	Tue 16/5/23	Mon 5/6/23
1.3	Hardware Infrastructure	14 days	Tue 13/6/23	Fri 30/6/23
1.3.1	CCTV Installation	14 days	Tue 13/6/23	Fri 30/6/23
1.3.2	Sensors Installation	10 days	Tue 13/6/23	Mon 26/6/23
1.3.3	LED Installation	12 days	Tue 13/6/23	Wed 28/6/23
1.3.4	Signage	10 days	Tue 13/6/23	Mon 26/6/23
1.3.5	Other Infra Devices Installation	8 days	Tue 13/6/23	Thu 22/6/23
1.4	Software Infrastructure	28 days	Fri 23/6/23	Tue 1/8/23
1.4.1	Cloud Platform Readiness	28 days	Fri 23/6/23	Tue 1/8/23
1.4.1.1	Data Storage	14 days	Fri 23/6/23	Wed 12/7/23
1.4.1.2	Data API Integration	14 days	Thu 13/7/23	Tue 1/8/23

1.4.1.3	ML & AI Deployment	10 days	Fri 23/6/23	Thu 6/7/23
1.4.1.4	WebApp Development	10 days	Fri 23/6/23	Thu 6/7/23
1.4.2	Software License Readiness	4 days	Thu 13/7/23	Tue 18/7/23
1.5	Functionality Test	365 days	Wed 2/8/23	Tue 24/12/24
1.5.1	Small Scale Trial	50 days	Wed 2/8/23	Tue 10/10/23
1.5.1.1	Trial at Randwick	50 days	Wed 2/8/23	Tue 10/10/23
1.5.2	Large Scale Trial	265 days	Wed 11/10/23	Tue 15/10/24
1.5.2.1	Trial at all stations	90 days	Wed 11/10/23	Tue 13/2/24
1.5.2.2	Analysis of Large Scale Trial	25 days	Wed 14/2/24	Tue 19/3/24
1.5.2.3	Large Scale Trial Verification	150 days	Wed 20/3/24	Tue 15/10/24
1.5.3	Performance Report	50 days	Wed 16/10/24	Tue 24/12/24
1.5.3.1	Analysis and Performance Report	50 days	Wed 16/10/24	Tue 24/12/24

Table 4.2 Project Schedule

4.3 Gantt Chart

In Gantt chart activity durations are shown as horizontal bars placed according to start and finish dates. These charts are relatively easy to read and are commonly used (Project Management Institute, 2017). The Gantt chart of TfNSW Smart Light Rail project shown below is an output of MS Project software. In the network diagram critical path activities are shown in red color. The critical path is the longest path through a project, which determines the shortest possible project duration. Float in critical path is usually zero.

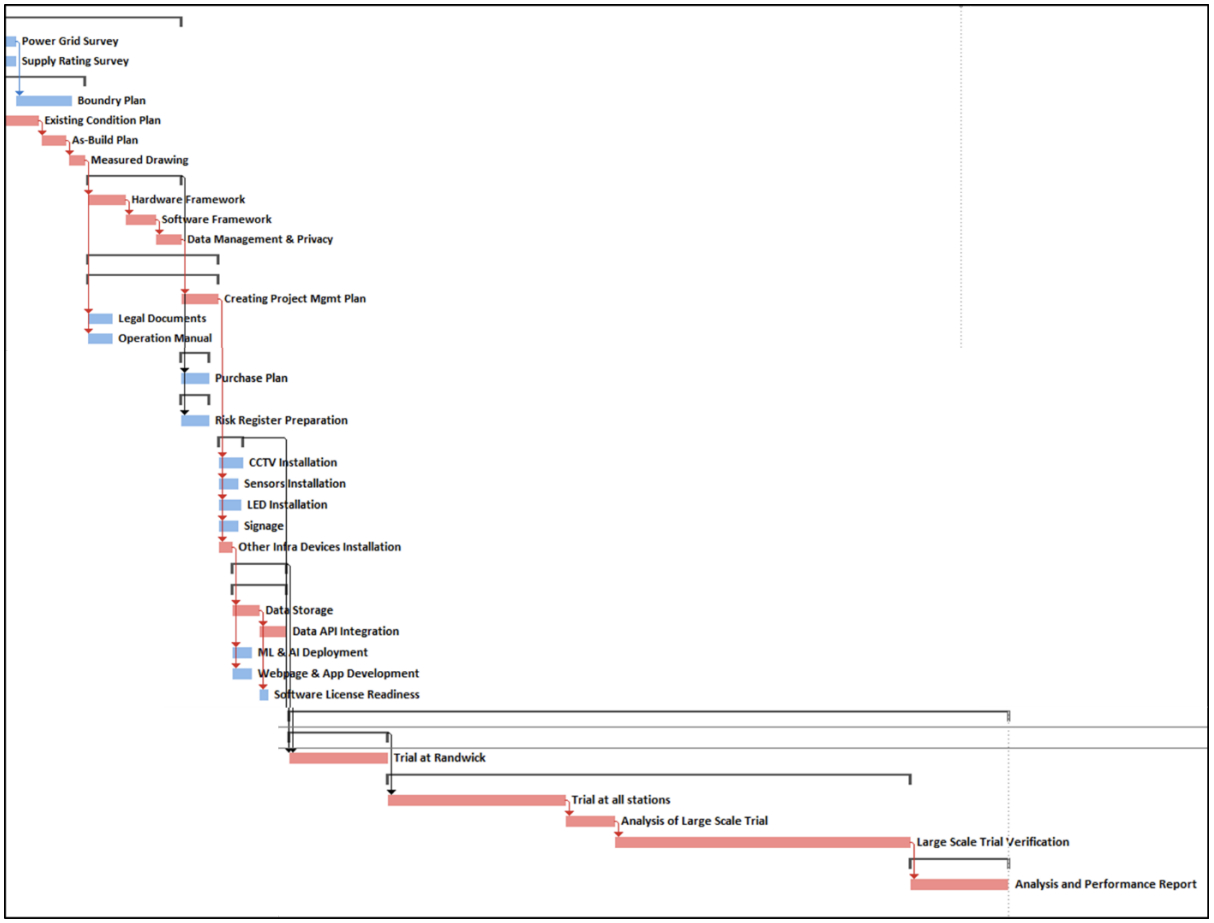


Figure 4.3 Gantt Chart

4.4 Major Milestones

Project milestones are important events in a projects that do not have any duration. Milestones are very popular for project reporting. The following will be designated as milestones for the project schedule reporting:

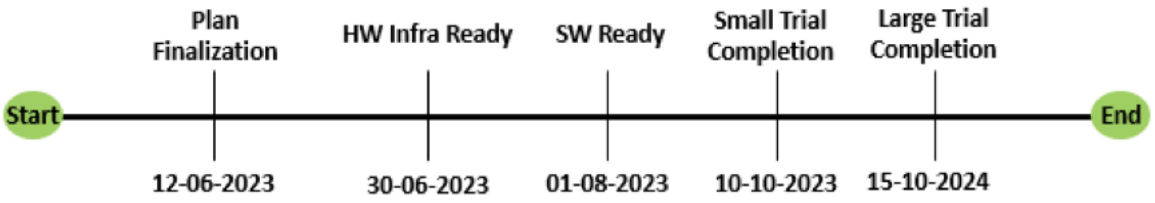


Figure 4.4 Major Milestones

Table 4.1 Activity Duration Estimates

4.5 Project Schedule Control

Schedule control is the process to monitor and control project schedule. It also deals with changes in project schedule baseline. Schedule control activities need to be performed throughout the project life cycles (Project Management Institute, 2017).

There are different project schedule control techniques that can be applied to manage project schedule. Below common tools can be applied to monitor and control schedule:

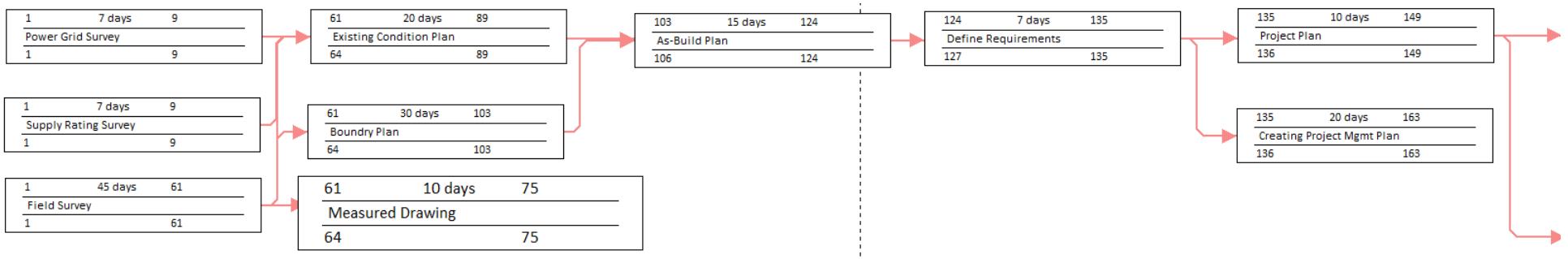
- Trend analysis. Trend analysis provides project performance over time and helps to determine whether schedule performance is improving or deteriorating.
- Crashing and fast tracking: These are schedule compression techniques. Schedule crashing uses more resources to complete project faster. On the other hand, fast tracking involves doing more works in parallel.

According to the project charter, **TfNSW Smart Light Rail** project needs to be completed within 31-Dec-2024. The schedule is developed based on this constraint and expected project end date is 24-Dec-2024. Project manager needs to monitor schedule variances regularly and need to apply compression techniques if needed. PM is primarily accountable to manage to control project schedule and any schedule deviation can be escalated as per communication plan.

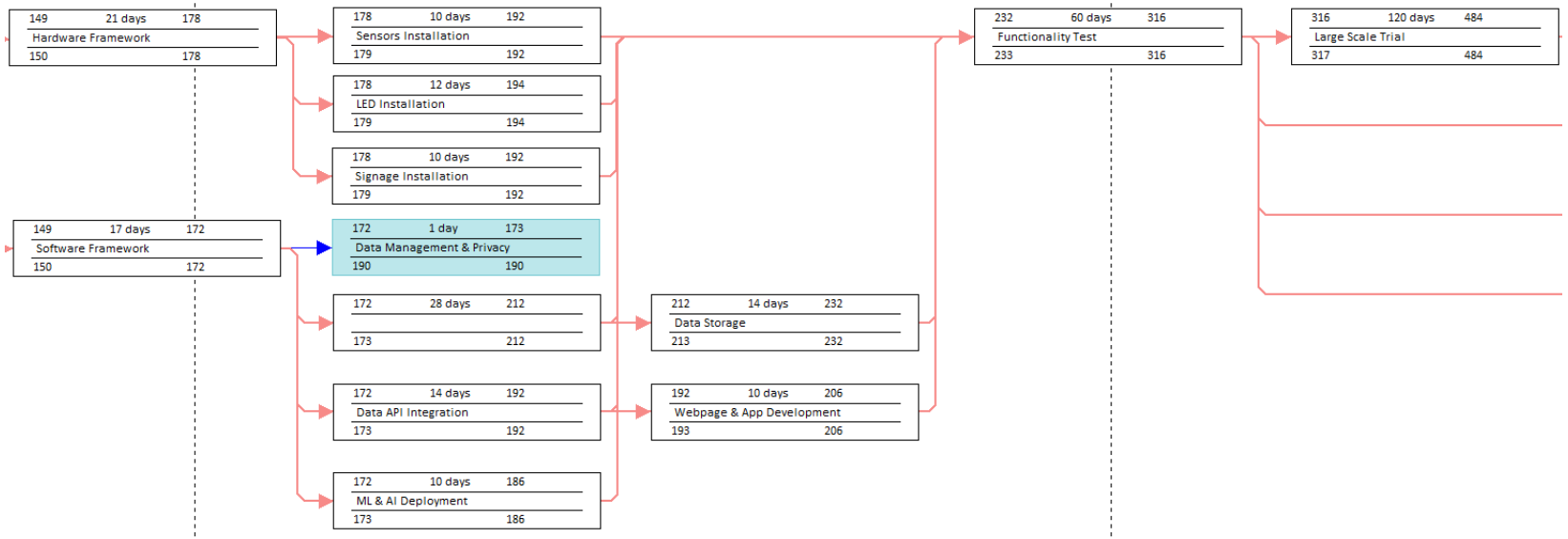
Also project schedule changes need to be performed and communicated as per project's change management plan.

4.6 Network Diagram

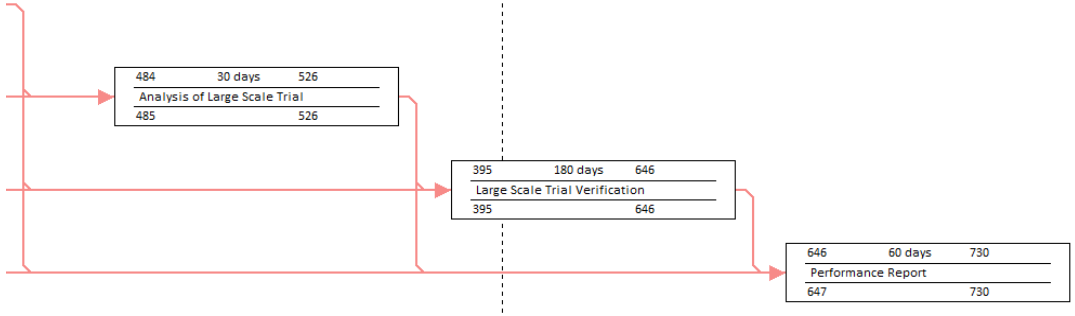
Part 1



Part 2



Part 3



5.Stakeholder Management Plan

5.1 Overview

Completing the assessment and management of stakeholders is a crucial part of this project. It allows the project team to identify stakeholders related to the project and also determine the magnitude to which they may influence project outcomes.

5.2 Identified Stakeholders List

The list below shows the identified stakeholders in this project, which consists of 5 main categories:

Project Sponsor:

- Dylan Sanusi-Goh

Project Management Team:

- Qihang Tian
- Bojie Zhuang
- Sixing Ci
- Xianglin Fu
- Khushboo Rajhans Hadke
- Sebastian Del Basto Rodriguez

Industry:

- Suppliers
- Contracted Builders
- Contracted Software Engineers and Designers
- Contracted Hardware Engineers and Designers
- Light Rail Operator

Government:

- Transport for NSW Office

Local Community:

- Randwick Community
- UNSW Students and Staff

5.3 Stakeholder Engagement Matrix

The engagement lever of stakeholder is analyzed by using the Stakeholder Engagement Assessment Matrix (PMBOK® GUIDE, 2017). Stakeholders have five main positions:

resistant, unaware, neutral, supportive and leading. The table below shows the positions of different stakeholders on the project after being assessed

Stakeholder Engagement Matrix

Position	Name	Unaware	Resistant	Neutral	Supportive	Leading
Project Sponsor	Dylan Sanusi-Goh				C	D
Project Management Team	Qihang Tian				CD	
	Bojie Zhuang				CD	
	Xianglin Fu				CD	
	Sixing Ci				CD	
	Khushboo Rajhans Hadke				CD	
	Sebastian Del Basto Rodriguez				CD	
Industry	Suppliers				CD	
	Contacted Builders				CD	
	Contracted Software Engineers and Designers				CD	
	Contracted Hardware Engineers and Designers				CD	
	Light Rail Operator				CD	
Government	Transport for NSW Office				C	D
Local Community	Randwick businesses/community			CD		
	UNSW Current Students	C		D		
	UNSW Future Students	C		D		
	UNSW Staff	C		D		

C=Current position
D=Desired position

Table 5.3 Stakeholder Engagement Matrix

5.4 Power Influence and Interest Grid

Different stakeholders have different levels of interest and influence on the project, so evaluating a relevant assessment of all stakeholders can help the project team develop a plan that balances the interests of all parties. This evaluation mainly refers to the method of Interest/Power Grid in PMBOOK (PMBOK® GUIDE, 2017).

Figures below show the influence and interest assessment for the stakeholders in the grids.

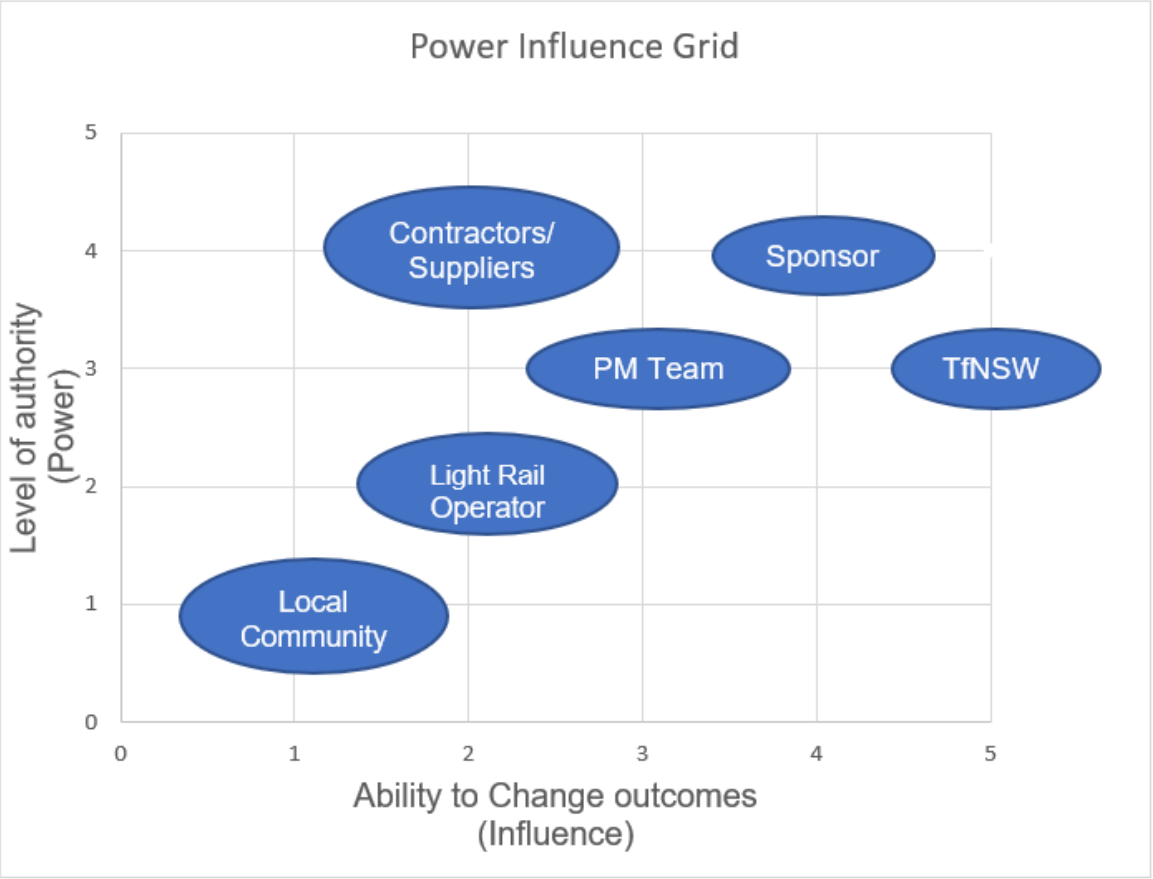


Figure 5.4.1 Power Influence Grid

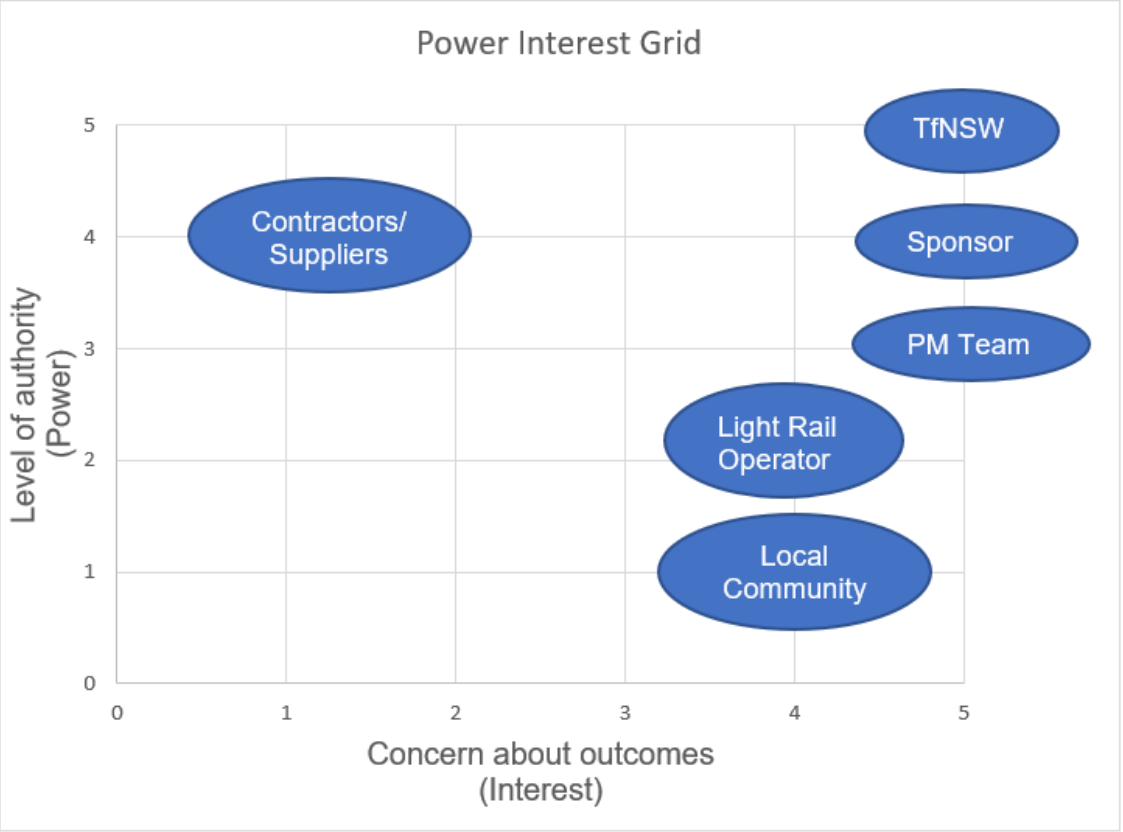


Figure 5.4.1 Power Interest Grid

6.Risk Management Plan

6.1 Overview

It is not possible for a project to completely avoid all risks, and the consequences of risks are not always absolutely negative (Melanie et al. 2022). The management team needs to weigh potential risks against opportunities and determine the level of risk they can tolerate. Afterwards, the management can use this information to make decisions. Risk management requires prioritizing the risks with the highest likelihood and greatest impact and addressing them first by mitigating them. This Risk Management Plan will follow the process recommended in the PMBOK® GUIDE, 2017. to outline how risks will be assessed and managed for the Sydney Light Rail project.

6.2 RBS Chart

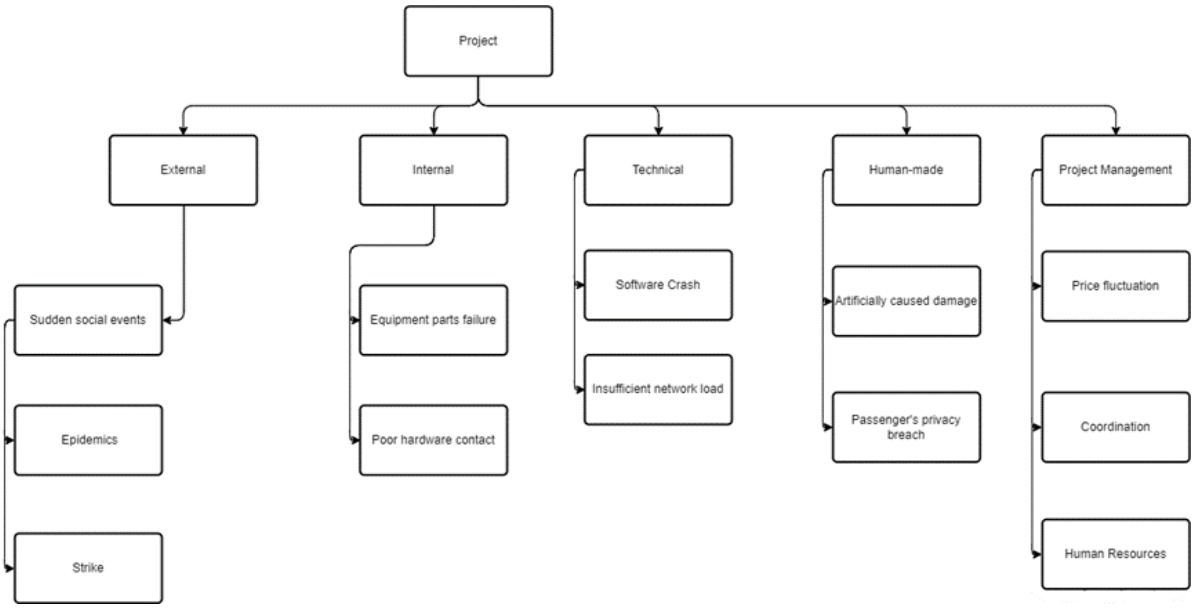


Figure 6.1 RBS Chart

6.3 Project Risk

Risk 1: Sudden social events impact

Description: Sudden social events cause additional costs, even delays in the engineering process. For example, a sudden strike of programmers can greatly affect the progress. Infectious disease epidemics can reduce people's travel capabilities, potentially resulting in the project progress being impacted or halted.

Solution: A contingency workplace could be set up remotely to ensure that work is continued. This could be achieved by shifting the workplace online or by utilising remote access software.

Risk 2: Equipment parts failure

Description: Bad weather resulting in delays in the project schedule. Damage to equipment, repair and adjustment requires more labor costs.

Solution: Timely update and maintenance of the front-end hardware equipment. Subject the system network, sensors, and other hardware equipment to regular checks, maintenance and updates, to prevent damage to the infrastructure or aging and other problems caused by the leakage or loss of information data; in order to deal with unexpected events.

Risk 3: Software Crash

Description: Defects in the software can lead to computational errors and tasks that do not function properly. Incomplete algorithms may lead to unworkable situations in the face of unforeseen circumstances, which may lead to the failure of the whole project.

Solution: The algorithm should be written with potential edge cases in mind. Utilise multiple trial runs to account for unexpected outcomes. Carry out regular software maintenance and security updates.

Risk 4: Insufficient network load

Description: In the process of data transmission, the hardware equipment in the intelligent transportation system due to functional lag or aging, resulting in reduced transmission rate and network delays, which may cause data leakage as well as loss, affecting data security.

Solution: Proper evaluation of capacity when setting up web servers. When there is a load problem, replace the backup network in time. Ensure regular maintenance and updates of the network.

Risk 5: Physical Damage to Infrastructure

Description: There is an artificial impact when the project is put into use. Unintentional human impacts include wear and tear on hardware facilities.

Solution: Replace damaged hardware measures in a timely manner. Strengthen the management of the front line when the project is put into use, and place some cameras to monitor malicious damage.

Risk 6: Passenger's privacy breach

Description: Deliberate human influence is similar to software attacks hacking techniques to steal user data. This can lead to user privacy breaches. More serious ones can affect the entire network system.

Solution: The protection system of the data center of smart transportation needs to set up comprehensive security protection, including the establishment of intrusion detection system, security audit, firewall, resistance to denial-of-service attacks, network anti-virus system, traffic shaping and control, and other measures. In addition, the data center of smart transportation should also monitor and control the whole process of traffic data from usage to migration and deactivation by using identification management technology, encryption technology and combining with other active security management technologies.

Risk 7: Price fluctuation

Description: Because the project will not officially start until two to three years from now, hardware materials and staff salaries may fluctuate due to inflation.

Solution: In case of budget overruns by inflation. First, the team should set aside a contingency fund as an insurance. Second, re-examine the entire procurement chain to reduce unnecessary overhead.

Risk 8: Coordination

Description: Coordination and communication problems may occur in management. It is difficult for the decisions of upper-level managers to reach the front line correctly. It is difficult to communicate the opinions of the lower level to the higher level. Thus, the efficiency of the project is seriously affected.

Solution: Optimize management and reduce the problem of lost information transmission due to long management chains. Upper management has to get involved in the front line to listen to the front line workers.

Risk 9: Human Resource

Description: Problems may arise when recruiting, such as new people needing extensive training to get started. Training new employees can greatly affect the project schedule.

Solution: Although finding experienced workers will again raise the budget, it is a good way to solve inadequate human resources.

6.4 Risk Assessment Matrix

Probability of Occurrence		Disaster	Critical	Modera	Minor	Negligible
Chance	Value	A	B	C	D	E
Very Likely	5	5A	5B	5C	5D	5E
Likely	4	4A	4B	4C	4D	4E
Moderate	3	3A	3B	3C	3D	3E
Unlikely	2	2A	2B	2C	2D	2E
Very Unikely	1	1A	1B	1C	1D	1E

Table 6.4.1 Risk Assessment Matrix

6.4 Risk Response Matrix

Risk No.	Risk Code	Risk Event	Likelihood	Impact	Detection difficulty	Risk Management Strategies	Response
1	**1C**	Sudden social events impact	1	3	1	Mitigate	Develop corresponding emergency measures
2	**4C**	Equipment parts failure	4	3	1	Accept	Timely update and maintenance of the front-end hardware equipment
3	**3B**	Software Crash	3	4	4	Mitigate	Pay attention to software maintenance in normal time.
4	**4B**	Insufficient network load	4	4	3	Mitigate	Do the maintenance and update of the network
5	**4C**	Artificially caused damage	4	3	2	Accept	Replace damaged hardware measures in a timely manner.
6	**3A**	Passenger's privacy breach	3	5	5	Mitigate	Set up comprehensive security protection
7	**5E**	Price fluctuation	5	1	2	Accept	Aside a contingency budget
8	**3D**	Coordination	3	2	1	Accept	Optimize management
9	**2C**	Human Resource Failure	2	3	1	Accept	Finding experienced workers

Table 6.4.2 Risk Response Matrix

We analyzed how each of the identified risks should be handled. From the matrix, risks 4, 6, 9, 7, 8, and 1 should be the first ones we should address. At the same time, risks 9, 8 and 1 should be taken care of by the project management manager. They should hire the right

managers in advance and make the management system of the whole team simple and prepare for emergencies. Risk 7 should be the responsibility of the team members. Negotiate with suppliers and purchasers in time to minimize costs. Risks 4 and 6 should be the responsibility of the technical team. The software should be well tested before project delivery to reduce the possibility of risks.

7. Communication Management Plan

7.1 Overview

The communication plan covers the main content, method, frequency, and relevant personnel of communication between the main stakeholders in the project, and arranges the main communication channels when the project encounters an accident. A well-developed

communication plan can significantly improve project completion efficiency and reduce project risk.

7.2 Project Information System Table

The main ways of communication are in-person and remote. There are various forms of remote communication, including email, Zoom (or other online meeting software), telephone, etc. Different communication contents are suitable for different communication methods. For example, in an emergency, in order to improve the efficiency of information access, telephone is the best choice.

The table below clearly shows the communication plan for this project.

Project Information System Table

Communication Plan				
Key information to be delivered	**Sender**	**Recipient**	**Method**	**Frequency**
Project scope,value of project and progress updates	PM Team	Sponsor	In-person or Online Meeting	Once a week
Requirements,constraints and budget	Sponsor	PM Team	In-person or Online Meeting	As necessary
Monthly project status reports	PM Team	Sponsor	Email	Once a month
Requirement & Restriction	PM Team	Engineering/Construction team	In-person or Online	Depends on the statements
Emergency status	Person in charge	PM Team	Phone call	Timely
System design features and implementations details	Engineering team	PM Team	In-person or Online Meeting and Email	Once
Project Performance reviews	Engineering team	PM Team	Online Meeting and Email	Once a week
Final Develop reports and future recommendations	Engineering team/PM team	TfNSW /Sponsor	In-person or Online Meeting and Email	Once after all trials and analysis end

Table 7.2 Power Influence Grid

8. Human Resource Plan

The Human Resource Plan was developed using the Project Resource Management guide provided within PMBOK

8.1 Identification of Resources

The project will be coordinated by a 6-person project management team. This was identified by determining the type and quantities of human resources required for each activity and the project as a whole using the Schedule and Work Breakdown Structure (WBS).

The human resource fixed-term contracts are generated from the RACI Chart's obligations and are associated with the previously specified schedule and work breakdown structure. Except for the Project manager, Process Engineer, and Work Packages Leads the positions will be on a fixed one-year contract. The Process Engineer, will be under contract for the duration of the entire project to guarantee that all deliverables, testing, and improvement steps are completed. Once the system is integrated the WebApp development and Data Science teams will be under a contract for 4 to build, test, and improve the web application and machine learning models to ensure they are suitable for production. Project Leads will be under a contract of 6 months to monitor their performance, deliver reports, and ensure continuous delivery practices to improve operational resilience and reproducibility of the WebApp AI analytics workflow. The Project Manager will be required to manage the smart light-rail project while also continuing involvement with Transport NSW, and contractors in order to continue expanding and iterating the implemented system on other light-rail platforms. In addition, IT architects and software developers will be engaged to deliver the end-to-end platform and train and capacitate the existing TfNSW IT team.

8.2 Acquiring resources

Recruitment will be managed internally. The human resource department will be given roles and duties, and favour internal recruitment when possible to reduce time to hire, shorten onboarding times, reduce costs, and ensure culture fit. Potential risks of a limited pool of applicants internally have been acknowledged in the risk management plan. For this reason, recruitment is expected to being to manage and lessen onboarding risks. With the exemption of the Azure Cloud service, to increase security and probity, and decrease time and costs, the resources needed for construction and procurement will be obtained within the recognized TfNSW’s established governance, control and policy, and procurement process, and the NSW eTendering services, which is Australia’s largest provider of state government tenders. Potential additional expenditures and a separate contingency budget were carefully

determined based on the risk assessments, and a complete list and in-depth evaluation of HR-related concerns are included in the Risk Management Plan.

8.3 Team development and Training

The team will continue working with the existing Microsoft Azure resource management and scheduling software used for managing and coordinating team members across the project activities. In addition, Microsoft Learning Studio online training will be readily accessible for project participants and TfNSW's IT department. In addition, along with TfNSW's People and Culture team, the design of training and development programs will be undertaken through the entire project lifecycle in order to develop the capability of the Transport workforce to operate effectively in alignment with the project scope and capability plans. Also, GSOE9820 T2 2022 Transport Team 4 UNSW HR was given a specific function and responsibility expectation for each job. This reduces the need for further training for internal team members and contractors. If the Professional Officer identifies further training that may help the project, it will be done at the discretion of the sponsor using funds from the contingency budget.

8.4 Organizational Chart

Figure 8.4 depicts the organizational chart that is necessary for the project. This will reduce authority disputes and make decision-making easier

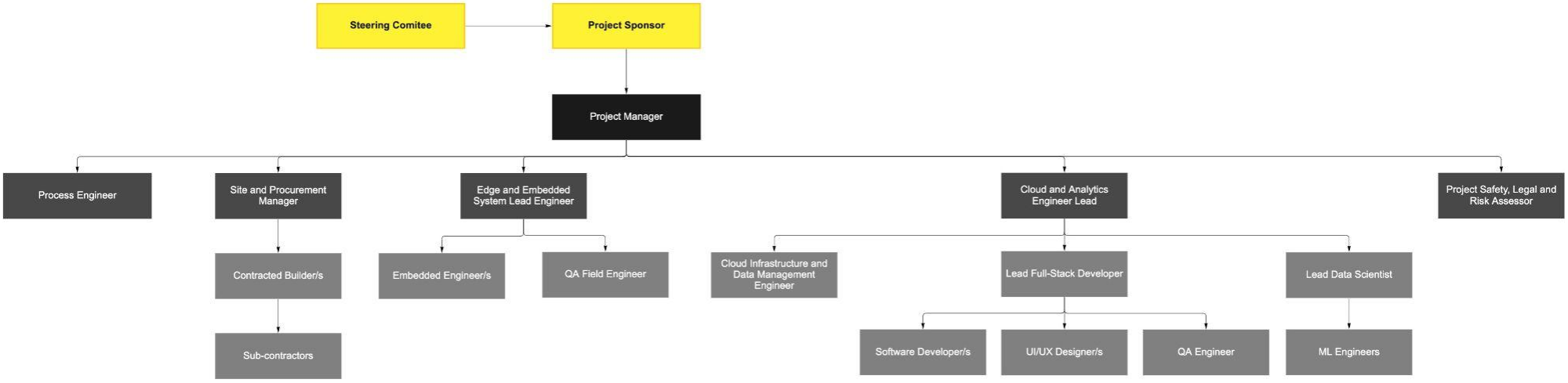


Figure 8.4 Organizational Chart

8.5 Roles and responsibilities:

Table 8.5 Roles and responsibilities

Roles	Level	Position	Duration (Years)	Salary (AUD)	Summary of Responsibilities	Competence:
Project Manager	4	Full-Time	Ongoing	$125,000	- Analyze plans, contract specifications, and requirements to determine project requirements. Follow up with appropriate management to assure understanding and satisfaction of project scope. - Lead the development of project plans in advance of project activity to assure effective execution by the Project Team and monitor progress to ensure compliance with the pre-determined execution plan. - Upon the successful completion of the project, they will also consolidate and approve project reviews, acceptance testing and handles the completion of all close-out documentation of designs, system operating instructions, billings, collections and payments, and all project records.	- Previous project management experience leading cross-functional teams. (8+ years). - Experience working with customers and leading customer interactions. - Experience in the railroad or large construction industry. - Familiarity with industry-related computer software and hardware. - Cloud Technology Project Management experience preferred - Knowledge, experience leading a software development team with Agile methodologies desired - Project Management Professional Certification (PMP) desired - Electrical or Computer Engineering Degree preferred
Process Engineer - Technology	3	Full-Time	2	$87,000	- Engage with program and business stakeholders to document requirements, create functional specifications and generate process maps. - Design, develop, test, launch and improve the smart sensing and intelligent system. - Engage with Work Package Managers to understand and guide evolving program technology - Deep dive technical product or operational issues to propose and implement simple and effective solutions - Coordinate preparation and execution of engineering schedules.	- Bachelor's degree in engineering, information technology, related technical field or the equivalent experience - Experience in a similar role (process development, product design, software development, business process improvement) - Working knowledge on Cloud architecture or Transport experience - Experience with scrum and delivering web application products.
Site and Procurement Manager*	2	Full-Time	1	$71,500	- Manage the sourcing activity of the Project: Ensure procurement competitiveness improvement plans are consistent. - Align product procurement strategy for development projects - Participate to the project management committees. - Encompass Project Material Managers output in the overall picture of the project - Propose committed savings and a risk register, including mitigation plan ("RAMP" = Risk Assessment & Mitigation Plan) - Communicate project needs and ensures they are properly taken into account: - Organize project procurement launch meeting with key stakeholders - Establish and agree with the Project Manager and/or Work Package Managers on a Project Procurement Strategy, in line Platform Procurement strategy.	- Studies in purchasing or equivalent (engineering, project management..) - 3 years of relevant work experience in Procurement and/ or Project Management. - Use financial and monthly forecasting to manage and contain costs. Prepare or coordinates the preparation of progress billings, pursue timely payments from the customer, and authorize payments to material suppliers and subcontractors. - Strong communication skills & team player - Challenging & adaptable - Results-driven - Rigorous and structured - Light-Railway or transport experience and familiarity is plus.
Edge and Embedded System Lead Engineer	4	Full-Time	1.5	$110,000	- Leading the project Design, development, production, testing, and maintenance of embedded systems (signage, smart sensor systems, and Edge cloud computing). - Work to drive the tech stack for real-time control systems as well as application code software architecture and segmentation. - Providing thought leadership on disruptive edge technologies - Driving the development of Edge technology for embedded software and hardware stacks used in public infrastructure applications. - Leveraging latest development in Edge and embedded cybersecurity solutions to define software and hardware requirements for secure edge applications - Present technical findings to cross-functional stakeholders	Master degree in computer science, electrical engineering, or related engineering field with a minimum of 15 years of experience. A minimum 10 years of experience leading teams or large projects Demonstrated deep domain knowledge in the areas of edge computing, software architecture, real-time controls, and advanced AI/ML based controls algorithms Experience leading large public infrastructure projects and writing successful PMP plans.
Software Embedded Engineer - Architect	3	Full-Time	1	$87,000	- Embedded Systems Engineer Architect responsibilities include designing and implementing software of embedded devices and systems, review and design code, integrate and validate new product designs, and develop system software from design through debugging. - Integrate sensor systems on an embedded platform, develop system validation and design tests, and bringup of new hardware. - Design and write low-level and application-level software to control and interact with components - Design and implement control, data, and timing paths for sensor interfaces - Support team on resolution of complex technical inquiries and escalations. - Develop and debug Linux kernel for customized applications	• Bachelor's degree in Engineering (ME, process engineering, Industrial Engineering, Computer Science, Software Engineering) or equivalent work experience. • Ability to work independently with limited supervision • Excellent written and oral communications skills for technical and non-technical content • Experience defining KPIs for measuring success of processes • Experience with Cloud Microsoft Azure • Good understanding of machine learning technologies (Edge and Cloud)
QA Field Engineer	2	Full-Time	1	$71,500	- Conducting field tests for embedded system that produces real-time machine learning inference based on input from multiple sensors and cameras. - Play an integral part across every part of the data pipeline from data collection, to evaluation, verification, debugging, and root-causing of potential issues. - Collaborate with the engineering team to perform gap analysis and root cause of failures - Assist in software and hardware quality testing Identify, analyze, and communicate design or performance faults in a systematic and timely fashion. - Analyze system performance and compile reports to engineering team	- BS in engineering with 1+ years of experience - Prior experience as a field, QA, technical project management (TPM), or test engineer on systems involving sensors and algorithms - Prior experience in debugging software/hardware issues - Proven track record of being self-motivated to operate independently, take initiative, and must have the ability to work autonomously and be adept at problem solving. - Excellent writing and communication skills - Familiarity with operation of python numerical and data science libraries (e.g. numpy, scipy, opencv, pandas) No past experience in computer vision or machine learning is required; we are mainly looking for a talented, self-motivated, self-starter individual who can be hands-on and grow in this field. Nevertheless, some familiarity with these concepts would be a plus
Cloud and Analytics Engineer Lead	4	Full-Time	1	$120,000	- Leading the project design, development, production, testing, and maintenance of IoT Azure Cloud architecture, Analytics and WebApp development. - Understand customers' overall data & AI business and IT priorities and success measures to design Data, Analytics & AI solutions that drive business value - Providing thought leadership on disruptive edge and AI technologies - Driving the development of AI and Computer Vision used in public infrastructure applications. - Leveraging latest development in Edge, Cloud, WebApp, and AI. - Present technical findings to cross-functional stakeholder.	Master degree in computer science, information technology, or related computing field with a minimum of 15 years of experience. A minimum 10 years of experience leading teams or large projects Demonstrated deep domain knowledge in the areas of edge computing, software architecture, Cloud architecture, and advanced AI/ML based controls algorithms. - Experience with scrum and delivering web application products Experience leading large public infrastructure projects and writing successful PMP plans. • Good understanding of machine learning technologies (Edge and Cloud).
Cloud Infrastructure and Data Management Engineer	3	Full-Time	1	$93,000	- Cloud Architecture and Design for Azure IoT Cloud - Responsible for building monitoring and managing cloud infrastructure and shared services (Data, WebApp, Analytics & AI) - Optimize data for cloud application, data management, and managing, monitoring and enforcing security privacy matters. - Ensure that solution exhibits high levels of performance, security, scalability, maintainability, repeatability, appropriate reusability, and reliability upon deployment - Work with Software Embedded Engineering team to remove key blockers and drive improvements.	- Bachelor's Degree in Computer Science, Information Technology, Data Science, Engineering, or related field AND 4+ years of experience in cloud/infrastructure technologies, information technology (IT) consulting/support, systems administration, network operations, software development/support, technology solutions. - Experience in a similar role - Working knowledge of data and process modeling - Experience with Cloud Microsoft Azure
Lead Full-Stack Developer	3	Full-Time	0.6	$93,000	- Leading the project design, development, production, and testing of projects WebApp. - Building simple, robust, and scalable platforms used by many external users (JavaScript, C++, and Python) - Work closely with UX designers, Developers and Machine Learning engineers to develop compelling experiences - Take a project from scoping requirements through the actual launch - Identify and resolve performance and scalability issues - Stay current with the latest test, development, and deployment practices and share your findings with the team and community	- BS or MS in Computer Science or a related field or equivalent practical experience Strong computer science fundamentals - Experience with large and complex code bases, utilizing API design techniques to help keep code clean and maintainable - Experience managing teams - Comfortable with the Agile and Lean development process - Understanding of supporting APIs, and cache layers - Strong Proficiency in JavaScript or typescript - Strong Proficiency in a system programming language such as Rust, C++, Go or Python, ... - Technical skills and experience in distributed systems and web services in a production setting - Strong communication and collaboration skills. - Ability to think creatively to debug and solve complex, hard-to-reproduce problems - Nice to have : proficiency with Azure WebApps Cloud Architecture
Software Developer/s*	2	Full-Time	0.4	$87,000	- Building simple, robust, and scalable platforms used by many external users (JavaScript, C++, and Python) - Work closely with UX designers, Developers and Machine Learning engineers to develop compelling experiences - Take a project from scoping requirements through the actual launch - Identify and resolve performance and scalability issues	- BS or MS in Computer Science or a related field or equivalent practical experience Strong computer science fundamentals - Experience with large and complex code bases, utilizing API design techniques to help keep code clean and maintainable - Comfortable with the Agile and Lean development process - Understanding of supporting APIs, and cache layers - Strong Proficiency in JavaScript or typescript - Strong Proficiency in a system programming language such as Rust, C++, Go or Python, ... - Technical skills and experience in distributed systems and web services in a production setting - Strong communication and collaboration skills. - Ability to think creatively to debug and solve complex, hard-to-reproduce problems - Nice to have : proficiency with Azure WebApps Cloud Architecture

Roles	Level	Position	Duration (Years)	Salary (AUD)	Summary of Responsibilities	Competence:
UI/UX Designer/s	2	Full-Time	0.4	$71,500	Understand the business and customer needs and transform those into intuitive customer journeys and interfaces. • Design usable, visually appealing and engaging user centric products and workflows. Be responsible for design decisions throughout the software development lifecycle. • Contribute to the team with user research, workflow and wireframe design to drive improvements in customer experience across a suite of products. • Develop interactive high resolution prototypes and conduct user testing to ensure prototypes meet usability requirements. • Collaborate with system architects, software and test engineers and end-users to generate a set of acceptance test requirements to ensure the user requirements have been met.	• Tertiary qualifications in a relevant discipline and/or extensive equivalent experience in UX design for software products. • Demonstrated proficiency and experience in engaging and translating business stakeholder requirements to deliver UX/or Web Design end-to-end solutions in line with technology policies and standards. • Good understanding of working in an environment with complex applications • Strong communication and presentation skills that see you presenting your designs and research findings to business stakeholders • Ability to be pragmatic, design around constraints and adapt to changing requirements • Experienced in running a range of user research activities which may include survey creation, user interviews, contextual interviews, running user focus groups and usability testing
QA Engineer WebApp	2	Full-Time	0.4	$71,500	Defining QA strategy and the design of automation testing frameworks that span web, mobile, cloud and embedded software in rail platforms. Defining the QA process and best practices in coordination with web development team. Performing integration, regression, and stress tests with relevant industry-standard tools Monitoring, analyzing, and reporting of quality metrics towards delivering high-quality well-tested software on-time Setup test cases using a combination of white box and black box testing along with edge case testing and achieve superior quality with a user-centric mindset Lead QA initiatives, develop and grow a strong QA team Advocate for best practices on test automation, documentation, and delivery of robust software on tight schedules	Bachelor's or Master's degree in Computer Science/Engineering or relevant technical work experience 7-8+ years of work experience in delivering high-quality software related to web, mobile, cloud and/or embedded systems Excellent understanding of SW engineering and best practices related to source code control, unit testing, CI/CD and continuous integration Proven experience in automation testing and building testing frameworks Experience with one or more modern programming languages (e.g., Java, Python) Experienced in automated testing frameworks with a combination of manual testing Experience working with testing of microservices in a Cloud-based environment is a plus Experience in test planning, strategy, and execution Experience designing and planning test conditions, scripts and data sets to ensure adequate coverage. Experienced working in a fast-paced environment with Agile and Scrum processes Strong organizational skills Passion for continuous improvement of SW quality and learning of best practices
Lead Data Scientist*	4	Full-Time	0.6	$120,000	Planning and creating a suitable working environment for data science workloads on Azure. Lead a team of ML engineers responsible for deployment. Develop novel algorithms and methodologies. Engage with sponsors to meet system requirements. Primary author on technical reports and proposals. Collaborate with Microsoft Cloud Solution Architects and Data Platform Engineers in developing complex end-to-end Enterprise solutions on Microsoft Azure platform. Lead data experiments and train predictive models. Manage, optimize, and deploy machine learning models into production. Understand customers' overall data & AI business and IT priorities and success measures to design Data, Analytics & AI solutions that drive business value Leveraging latest development in Edge, Cloud, WebApp, and AI Present technical findings to cross-functional stakeholder.	Master's degree or PhD in computer science. Understanding of deep learning and computer vision solutions such as classification, deep metric learning, object detection, semantic segmentation and instance segmentation Has worked on backend development for creating APIs Has worked on any of cloud providers such as AWS, Azure or GCP to train, deploy and run deep learning models. Able to read, understand and implement solutions that are proposed in academic papers. Team player, has worked with Agile and has knowledge on project management. Experience with ML Libraries like Pytorch, Tensorflow (2+ years) Demonstrate record of publication in machine learning, artificial intelligence, signal processing, or RF systems(1+ publications) Experience with image/signal processing or functional programming (2+ years)
ML Engineers	3	Full-Time	0.4	$87,000	Deploy machine learning models utilizing existing tooling. Coordinate frequently with team. Support data engineering, cleansing and design, development, analysis, and implementation of machine learning models.	Bachelor degree or higher in Mathematics, Statistics, Computer Science or a related discipline Demonstrated projects in machine learning, artificial intelligence, signal processing, or RF systems (1+projects) Experience with ML Libraries like Pytorch, Tensorflow (1+ years)

8.6 Project team resource management (RACI)

Table 8.6 RACI

Delivarable	Project Manager	Process Engineer	Site and Procurement Manager	Edge and Embedded System Lead Engineer	Cloud and Analytics Engineer Lead	Cloud Infrastructure and Data Management Engineer	Lead Full-Stack Developer	Lead Data Scientist	Project Safety, Legal and Risk Assessor
Surveying	A	R	R	R	R	I	I	I	R
Design	A	R	R	R	R	I	I	I	R
Smart Signage	A	A	R	R	I	I	I	I	I
Sensor System	A	A	R	R	I	I	I	I	I
IT System	A	A	I	R	C	I	I	I	I
Cloud Platform	A	A	I	C	R	R	I	I	I
Data Management	A	A	I	I	A	R	I	R	I
AI and Machine Learning Models and Algorithms	A	A	I	I	A	I	I	R	I
Analytics and Dashboards	A	A	I	I	A	I	I	R	I
Application/Website Development	A	A	I	I	A	I	R	I	I
Deployment Trials	A	R	C	R	R	R	R	R	A
Training	A	A	R	R	R	R	R	R	C
Project Documentation	R	R	R	R	R	I	I	I	R

Key:

R – Responsible for completing the work

A – Accountable for ensuring task completion/sign off

C – Consulted before any decisions are made

I – Informed of when an action/decision has been made

9 Appendix

9.1 Equipment/Hardware Cost Breakdown

Item	Cost	Description
Software License (2)	*2*2*3000 = $12000*	Software licenses required for software development. An average software license was found to cost $3000 per year.
CCTV Cameras (28)	*7*4*345 = 9960*	CCTV cameras installed on each of the 7 lightrail stations. Each station will contain a total of 4 cameras.
LED Strips (8)	*7*8*28 = $1568*	LED strips acts as lighting indicator on lightrail stations. 7 lightrail stations each contain 8 installations of LEDs
Signage (21)	*3*7*1899 = $39879*	LCD screen displays placed on lightrail platforms to display occupancy information to commuters. 7 stations contain 3 screens each.
Thermal Sensor (28)	*4*7*679 = $19012*	Thermal Sensors installed on each of the 7 lightrail stations to aid occupancy counting. Each station will contain a total of 4 cameras.
Wifi Beacon (14)	*7*2*557 = $7798*	Wifi Beacons act as a connection point for IOT devices. 2 beacons placed on each of the 7 platforms
IOT Edge Devices	*7*485 + 7*148 + 3*5664 = $21423*	Includes 7 Firewall routers and Wifi signal extenders for the 7 stations. 3 servers used as a centralised data storage.
Total	$124933	

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