



THE UNIVERSITY OF
SYDNEY

Project Management Plan

For

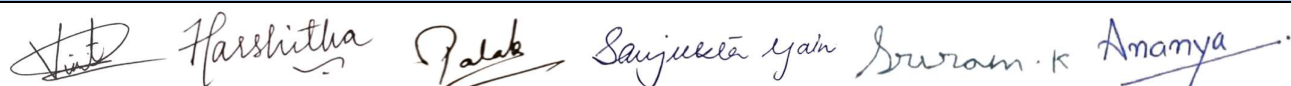
Mapping of Mineral Resources on the sea floors using AI-powered visualization

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PROJECT CHARTER

Project Title	Mapping of Mineral Resources on the sea floors using AI-powered visualization		
Project Start Date	August 01, 2022	Project End Date	August 6, 2024
Brief Background			
<p>Human technology has reached new heights in the past 20 years and is continuously reaching new peaks. Infrastructure, physical or technological, requires resources, and rapid development has started to affect the number of resources available for exploitation on the surface. This is leading us towards the tragedy of the commons, an economic problem where the resources would be highly sought after and exploited at such a rate that it would lead to the exhaustion of the resources and leave everyone in a lurch.</p> <p>We would need to either find new alternatives or search for natural resources. In either case, the existence of natural resources is unquestionable. At this point in time, we can find our focus shifting towards seabed mining. Of the 360 million km² area of the seabed on the earth's surface, only a combined area of 1.4 million km² has been explored for mineral resources. This project would be aimed at creating the technology which would enable the mapping of the untapped resources in the ocean and provide data through which subsequent research can be conducted to mine the resources.</p>			
Project Objectives			
<ul style="list-style-type: none"> ● Cost-efficient and innovative Machine learning algorithm to detect deep-sea resources. ● Algorithm provides accurate interpretive maps of natural resource-filled regions in sea-beds. ● 3-D visualization of the natural resource deposits to aid project planning of natural resource collection. 			
Project Success Criteria			
<ul style="list-style-type: none"> ● Delivery of the completed software and hardware. ● Delivery of accurate 3-D Visualizations of natural resource deposits. 			
Project Milestones			
<ul style="list-style-type: none"> ● September 9, 2022 – Completion of Market Research ● October 21, 2022 – Completion of Project Plan ● June 22, 2023 – Finalization of Documentation ● March 28, 2024 – Finalization of Software ● March 20, 2024 – Procurement of Hardware ● May 09, 2024 – Complete integration of Hardware and Software ● August 5, 2024 – Finalization of product ● August 6, 2024 – Product Release 			
Budget Information			
<ul style="list-style-type: none"> ● Total cost - est. AUD 4.00 million 			
ROLES AND RESPONSIBILITIES			
Name	Role	Responsibility	
Vinit R Iyer	CEO	Project Sponsor, monitor the project	
Harshitha Balakumar	IT department Head	Management of technical operations	
Palak Kalra	Project Manager	Plan and execute project whilst coordinating multiple teams	
Sanjukta Gain	Team Director	Identify team goals and coach team members and links the Project manager with the team	
Sriram Karthikeyan	Finance Officer	Manage the budget, Prepare financial reports	
Ananya Vadhera	Market Research Analyst	Research, compile and analyze information on products	
SIGNATURES OF STAKEHOLDERS			
			

PROJECT SCOPE

Project Title	Mapping of Mineral Resources on the sea floors using AI-powered visualization		
Date	September 9, 2022	Prepared by	INFO6007 Team 33

Project Justification	Provide a market disruptive algorithm that can decrease land resource exploitation and help in discovering new resources.
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Project Objectives	<p>To implement an innovative machine learning algorithm to detect resources available in deep seas.</p> <ul style="list-style-type: none"> • To translate this algorithm into an efficient and cost-effective software product that will provide interpretive maps of sea beds in deep sea regions that abound in natural resources. • To formulate 3D visualization of natural resource deposits to help the planning of natural resource collection.
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Product Characteristics and Requirements	<ul style="list-style-type: none"> • Algorithm should be able to process bug data quickly and efficiently. • Algorithm should be able to produce a detailed mapping of seabed sites with resources.
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Summary of Project Deliverables	
Project Management related deliverables	<ul style="list-style-type: none"> • Project Proposal • High level plan of the Project • Project Plan • Step by step plan for team • Work breakout plan for team • Project status reports • Meeting records
Product related deliverables	<ul style="list-style-type: none"> • Refined form of collected big data • Software design and algorithm • Algorithm test reports • Software prototype • Software refining reports • Final functional software • Final test plan • Final test reports

Project Scope	
In Scope	<ul style="list-style-type: none"> • Data Refinement of collected data • Efficient, high accuracy software used for visualizing the seabed resources • Integration of software with provided hardware

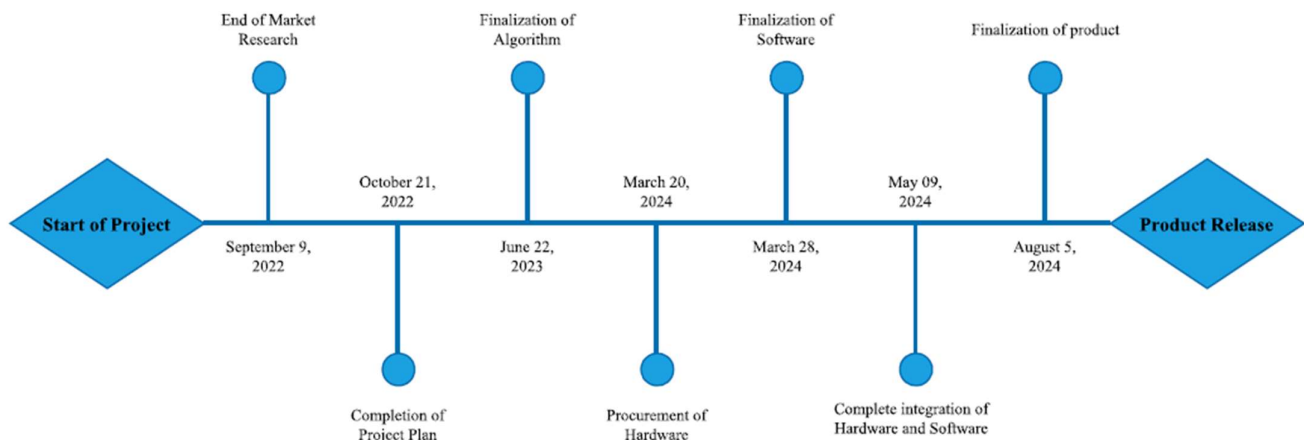
Out of Scope	<ul style="list-style-type: none"> • Data collection • Mapping of life underwater • Hardware procurement • Hardware to collect resources
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Project Success Criteria	
	<ul style="list-style-type: none"> • Development of the software • Software passes all tests • Software is able to create high accuracy data visualization of the seabed resources

Project Constraints	
Cost	The cost of the entire project should be less than estimated project cost and not touch the buffer sum.
Time	The time taken for the entire project must be according to the planned milestone and work breakdown structure.
Scope	The project should be within the defined scope.

Project Assumptions	
Data	The data has been collected, secured and used for refinement from trusted sources without any cost.
Resources	Our team members do not resign during the term of the project.
Delivery	Project servers arrive as scheduled.
Budget	Project cost stays well within the budget with no additional costs.
Scope	The scope of the project remains unchanged.
Schedule	The project follows the project schedule and does not allow scope creep.
Hardware	We have a Third Party who sells us the hardware which is compatible with the software.

Project Timeline



MARKET RESEARCH

Introduction

71% of the Earth is covered in water whereas the rest 29% is covered through islands and continents (“What percent of Earth is water?”, 2014). Yet from this large area of water, 95% of the world’s ocean is still unexplored. The oceans are full of mystery and of untapped resources. The race to explore valuable base metals, sulphides and numerous other elements, including calcium, lead, gold, silver, arsenic, cobalt, molybdenum and platinum in the deep ocean recently emerged, and nations now seek to secure prospective areas for minerals that may support the low-carbon transition, from electric vehicles to wind turbines (Skolotnev, 2006).

This main idea of this project is to create detailed visualizations of the mineral resources hidden in the seabed. With the 95% of oceans unexplored we have 95% of untapped resources waiting to be explored. Through this project, a detailed visualization of the resource locations and quantity of resources available could be determined. This in turn would lead to the appropriate planning from the specific clients to deploy the necessary equipment for the mining of these resources. In the 21st century the rapid exploitation of land resources has led to the depletion of the resources available. This rapid exploitation of land resources will lead to an economic problem known as the “Tragedy of the Commons”. This economic problem refers to a situation in which individuals with access to public resource act in their own interest and ultimately deplete the resource (Spiliakos, 2019).

Competitive Rivalry

At present the next-generation ocean monitoring system’s development has already begun in the US, Japan and European countries. Underwater drones and portable submersible robots with intelligent sensors for monitoring water temperature, auto compass heading and depth, turns, and pitch-and-roll are developed with the goal of mapping oceans by 2030. Researchers from Massachusetts Institute of Technology’s (MIT) Department of Earth, Atmospheric and Planetary Sciences have used AI and Machine learning to reveal connections and patterns in the oceans. ExxonMobil, USA, is working with MIT to design AI robots for ocean exploration (Theo, 2021).

Nereus is the world’s deepest-diving underwater vehicle. It can be configured to operate as an ROV or operate independently of human control as an AUV (“Hybrid Remote Operated Nereus”, 2014). Ocean-One is the ROV developed by Stanford Robotics Lab (Ocean One Robot, 2022). Crabster developed by Korea Institute of Ocean Science and Technology, is the world’s deepest and largest underwater robot used in scientific exploration projects far beneath the waves (Falconer, 2013).

Gaps in the market

Niche software/algorithms applied in sea mining can support only the subsystems used for exploring and harnessing ocean resources. It can provide backup to hardware that only includes sensors, acoustic systems, electronics, offshore systems and structures, and deep-sea systems like submersibles and mining machines. Whereas, the gaps in the market catering to the mining of sea bed lies in the non-availability of robust algorithms that can support the upscaling of and integrating of different subsystems and making them work on a sustained basis continuously for 365 days/year under extreme conditions, such as following

- Meteorological factors (rainfall, winds, cyclones),
- Hydrographic conditions (high pressure, low temperature, currents, lack of natural light);
- Seafloor environment (undulating topography, variable sediment thickness and compactness, and heterogeneous distribution of deposits).

However, the major gap in the market can be plugged by having software that is compatible with the hardware that is operational for ~300 days/year under extreme environmental conditions such as 1-2o C temperature, ~500 bars pressure, total darkness, uneven micro-topography, variable seafloor characteristics, and heterogeneous nodule distribution.

Henceforth the software will be integrated with those Unmanned Underwater Vehicles/Crawlers/Robots that are self-propelled active devices equipped with acoustic sensors, 3D sensing, autonomous navigation, and robotic manipulators and empower them to detect 'promising areas' and to avoid unfavourable areas, to save on power consumption and time, and be cost-effective.

Gaps in the literature

Through this research a few gaps in literature were found. These gaps are necessary steps that need to be completed before or during the implementation and utilization of our algorithm. These gaps are as follows:

- With the current rate of progress of the mapping, we require the mapping of deep sea-beds to be completed. This will unfold the possibilities of finding precious metals, new medicines, energy resources, etc. Through the data collected from the mapping, our algorithm would be able to create an effective visualization for the resource deposits.
- In depth analysis of the oceans need to be explored further with use of AI. This would be beneficial for oil and gas industries, defence applications, study of climate change, earthquakes, tsunamis, endangered species and unmanned submarine science.
- To systematically evaluate large quantities of image data being captured from the oceans a standardized workflow needs to be developed in order to facilitate the oceanographers.
- To speed up the exploration and study of hard-to-reach deep-sea ecosystems; next generation autonomous robots need to be developed. This is of utmost importance as the current machinery being used have very limited reach and if used with our algorithm would lead to an extended amount of time used for the mapping due to limited movement of the machinery.
- Grant of commercial licences for mining the minerals in oceans by the ISA should be done only after full environmental-impact assessment.

Literature summary and conclusion

The current market for the Deep sea bed exploration using automated robots are at a steady incline. In 2015, the sustainable development of oceans was targeted in the sustainable development goals (SDG) of the United Nations (UN) that aim to achieve a better and more sustainable future for all by 2030 (Wolfl, 2019).

Our project is aimed towards the algorithm of which can be used through such robots and automated vehicles. The algorithms used for such machinery is outdated and has not been modified since the inception of the plan. Our goal is to provide an efficient algorithm which can be implemented into these machineries which can then easily map and create detailed visualizations of the sea bed mineral and natural resources.

Our main advantage in this project is that we are a new entrant in the market with an appropriate algorithm which can be disruptive for the market. We can quickly scale the market and match the incumbents using the algorithm which is being currently developed. Through this project, we would be able to implement a higher level of computing technology that can create high specification visualizations for the sea bed floor natural resource deposits. This is not possible currently with the kind of legacy systems being used by the companies and governments world-wide for the sea bed exploration.

S.W.O.T. Analysis

BASIC SWOT MATRIX

INTERNAL FACTORS			INTERNAL FACTORS		
STRENGTHS (+)		IMPORTANCE	WEAKNESSES (-)		IMPORTANCE
1	New Entrant in the market	Not many big companies will pay attention to us	1	New Entrant in the market	As we are new entrants, the incumbents might try and suppress us. Other than this, we also need resources to proceed.
2	Patented High end specialised Algorithm for mapping and visualization	Governments and Companies in this market are using algorithms designed for their legacy systems which fall short against our algorithm.	2	Data dependency	Our algorithm depends on the data used. The data needs to be collected, cleaned and manipulated to suit our algorithm.
3	Low Cost	Current market scenario demands tens of billions of USD in renumeration for out dated technology, we provide better technology at lower cost.	3	Limited buyer	The current buyers of the algorithm can be anyone, yet only a few companies and countries have the clearance to mine.
4	Uniqueness of algorithm	The algorithm uses data in a particular format which is a patented technology.	4		

EXTERNAL FACTORS			EXTERNAL FACTORS		
OPPORTUNITIES (+)		IMPORTANCE	THREATS (-)		IMPORTANCE
1	Lack of new technology	Current market competitors use outdated algorithms due to the constraints of their legacy system	1	Buyouts	Acquisition or merger of the technology team which might lead to imbalance in the current team and hindrance of process.
2	Untouched market	The market does not have a lot of competition in means of the IT industry as much as it is in the robotic sector. We focus on the IT sector of the market.	2		

DETAILED WORKBREAKDOWN STRUCTURE

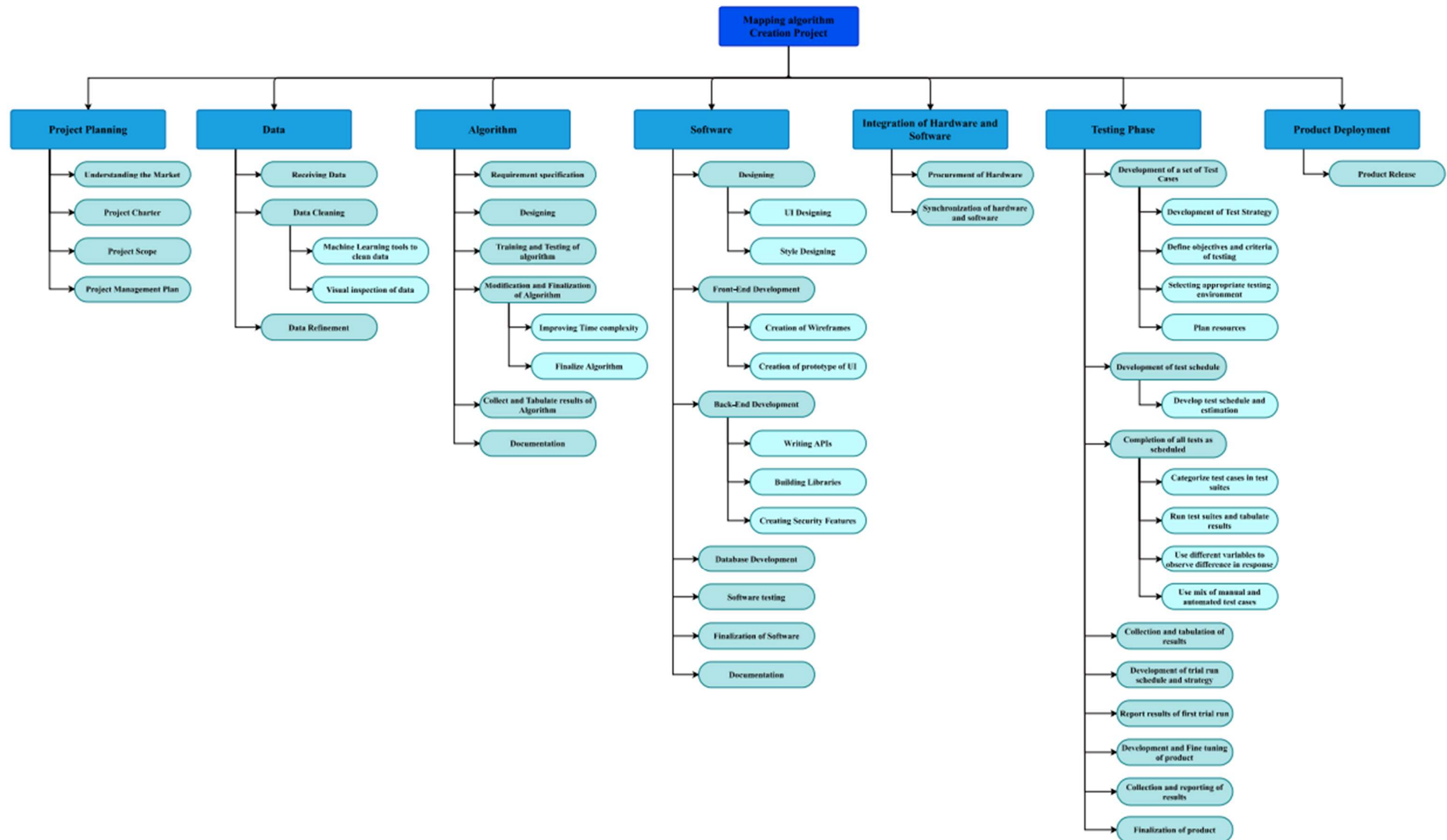


Figure 1 – Detailed Work Breakdown Structure for the Project.

The following table provides an overview of the Project Work Packages and the activities involved in each of the package along with their deliverables.

Table 1 – Detailed Project Work Packages

Sr No	Project Work Package	Activities	Deliverable
1	Project Planning	<ul style="list-style-type: none"> • Understanding the Market • Project Charter • Project Scope • Project Management Plan 	Project Management Plan
2	Data	<ul style="list-style-type: none"> • Receiving Data • Data Cleaning <ul style="list-style-type: none"> • Machine Learning Tools to clean data • Visual Inspection of Data • Data Refinement <ul style="list-style-type: none"> • Data Aggregation • Data Validation • Data Presentation 	Refined Data
3	Algorithm	<ul style="list-style-type: none"> • Requirement Specification • Designing • Training and Testing of the algorithm • Modification and Finalization of the algorithm <ul style="list-style-type: none"> • Improving time complexity • Finalize algorithm • Collect and Tabulate the results of Algorithm • Documentation 	Algorithm of the software
4	Software	<ul style="list-style-type: none"> • Designing <ul style="list-style-type: none"> • UI Designing • Style Designing • Front-End Development <ul style="list-style-type: none"> • Creation of wireframes • Creation of prototypes of UI • Back-End Development <ul style="list-style-type: none"> • Writing APIs • Building Libraries • Creating security features • Database Development • Software Testing • Finalization of the Software • Documentation 	Complete software
5	Integration of Software and Hardware	<ul style="list-style-type: none"> • Procurement of Hardware • Synchronization of Hardware and Software 	Client's hardware with integrated software

6	Testing Phase	<ul style="list-style-type: none"> • Development of a set of test-cases <ul style="list-style-type: none"> • Develop a test strategy • Define objectives & criteria for testing • Select an appropriate testing environment • Plan resources • Development of test schedule <ul style="list-style-type: none"> • Develop test schedule and estimation • Completion of all tests as scheduled <ul style="list-style-type: none"> • Categorize test cases into appropriate test suites • Run test suites and tabulate the results • Use different variables to observe difference in response • Use a mix of manual and automated test cases • Collection and tabulation of results • Development of trial run schedule and strategy • Report results of first trial run • Development and fine tuning of product • Collection and reporting of results • Finalization of product 	Test suite and results report
7	Product Deployment	• Product Release	Final Product

Given below is a detailed list of activities for each of the Work packages along with a brief description of what the activity entails.

Table 2 – Detailed Work Package and Activities

Sr No	Activity	Description
1.1	Understanding the Market	We conduct market research and understand the current market conditions for the product including market competitions, suppliers, laws, etc.
1.2	Project Charter	We create the project charter outlining the brief of the entire project.
1.3	Project Scope	We create the project scope document which would encompass the scope of the entirety of the project. The ins, outs, timeline, etc.
1.4	Project Management Plan	We create the entire project management plan which shall be used by the Project Manager to manage the entire project and make sure to eliminate any anomalies and failure of the project.
2.1	Receiving Data	We receive data from external trusted sources.
2.2	Data Cleaning	We clean the data for any null values, outliers, etc.
2.2.1	Machine Learning Tools to clean data	Machine learning makes it easier to process data quickly and provide error-free datasets. Creating a project scope, adding missing information, removing rows, and decreasing data size are a few of the quality criteria for cleaning the data in machine learning.

2.2.2	Visual Inspection of Data	One of the oldest and most reliable methods for assessing the state of datasets as part of the entire data evaluation process is a visual inspection. Finding any potential errors in the datasets that could reduce the accuracy of our AI model is the aim of a visual inspection.
2.3	Data Refinement	We manipulate the data and its structure to suit our algorithm.
2.3.1	Data Aggregation	In order to analyse the data faster and produce more accurate results, it is crucial to group related data from the available datasets together.
2.3.2	Data Validation	Before the data is used in the analytics process, the data discrepancies are found through the data validation and cleansing procedures.
2.3.3	Data Presentation	Data Presentation can effectively showcase massive volumes of complex data in a simplified form and make it simple to apply data analytics tools to further process the data for results. Data Presentation can simplify the data by making it easily intelligible & readable at the same time.
3.1	Requirement Specification	We gather the requirements of the algorithm and document it.
3.2	Designing	We design the algorithm based on the different models available in Machine Learning to result in desired outputs.
3.3	Training and Testing of Algorithm	We create the algorithm based on the requirement specification document (RDS) and train and test it using the data we refined in Activity 2.3
3.4	Modification and Finalization of algorithm	We refine the algorithm on the basis of the test case results.
3.4.1	Improve Time Complexity	The most effective algorithm is one that uses the least amount of memory and execution time while yet producing accurate results. Any industry-level algorithm must be written with its complexity in mind. We must maximise the optimisation of our code for massive data in order to make anything scalable.
3.4.2	Finalize Algorithm	Finalization of the algorithm after repeated test case refinements.
3.5	Collect and tabulate results of algorithm	We run and document the test cases and responses of the algorithm.
3.6	Documentation	We create a documentation regarding the algorithm for which the document created in Activity 2.6 is a subset.
4.1	Designing	We design the software based on the Software Requirement Specification (SRS) document.
4.1.1	UI Designing	To create a blueprint of how the front end would look like.
4.1.2	Style Designing	Consideration and selecting process of theme, style, text color, etc. for UI.
4.2	Front End Development	We develop the front end of the software.
4.2.1	Creation of Wireframes	To create a layout how functions would work and navigate in the frontend.
4.2.2	Creation of prototype UI	Basically creating a prototype from the blue print we prepared in the last step.
4.3	Back End Development	We develop the mainframe of the software.

4.3.1	Writing APIs	It includes creation of APIs for the communication of backend and frontend.
4.3.2	Building Libraries	It includes creating libraries for server-end framework.
4.3.3	Creating Security Features	Creating firewalls, traps, etc. against cyberattacks in the form of viruses or hacking.
4.4	Database Development	We develop the database of the software.
4.5	Software Testing	Intensive testing of the software is conducted to ensure Quality and functionality of the software.
4.6	Finalization of Software	The final adjustments to the software is done.
4.7	Documentation	The Software documentation is created for reference for user.
5.1	Procurement of Hardware	We receive the hardware from the Supplier.
5.2	Synchronization of hardware and software	We integrate the product software created in Activity 4.6 into the hardware.
6.1	Development of a set of test-cases	We develop a test suite for the testing of the integrated product in multiple scenarios.
6.1.1	Develop a test strategy	The test strategy lays out a formal plan for implementing testing. A strategy will ensure that everyone on the team is aware of the test objectives and schedule.
6.1.2	Define objectives & criteria for testing	A test objective describes the purpose for any test case. Test cases could be used for testing existing/known features, new features, bug detection, etc. Test criteria are often decomposed, smaller parts of test objectives. They also define a definite plan to achieve these smaller objectives.
6.1.3	Select an appropriate testing environment	It's vital to select the right software testing solution to carry out testing activities. These tools may be software-oriented or may work with hardware machines. Very often, different activities may require different tools.
6.1.4	Plan resources	A resource plan will often contain details about the number and types of people required for the testing step. It may also detail their skill sets and any training that they may need.
6.2	Development of test schedule	We create a rigorous test schedule for the implementation and testing of each test case in the test suite and the subsequent refinement.
6.2.1	Development of test schedule and estimation	A definite, well-planned test schedule will allow us to outline project milestones and deadlines pertaining to testing activities. A few common milestones are beta tests, internal tests, etc.
6.3	Completion of all tests as scheduled	All test cases in the test suite are passed.
6.3.1	Categorize test cases into appropriate test suites	Test cases with a common purpose must be grouped into the same suite. An example of this could be test cases that have been designed to test a specific feature of our product.
6.3.2	Run test suites and tabulate the results	The test suites need to be run sequentially based on the test plan. The results obtained from these runs must be carefully documented.
6.3.3	Use different variables to observe difference in response	The input variables for different test cases should be tweaked for different runs to observe for any possible behavioural changes. This is important to capture any possible defects/errors and understand the product's limits.

6.3.4	Use a mix of manual and automated test cases	Test cases are sometimes custom made to test certain specific features while automated test cases that test general features are also available. It's important to select and use an appropriate mixture of both kinds of test cases ensuring that no feature is left out of the testing process.
6.4	Collection and tabulation of results	The results of the Activity 6.3 are documented and presented for the use case scenarios for the customer.
6.5	Development of trial run schedule and strategy	Schedule of the trial run of the integrated product in a larger area and its strategies are mapped out.
6.6	Report results of first trial run	A report for the first trial run is created and suggestions noted.
6.7	Development and fine tuning of product	Suggestions are taken into consideration during the refinement and fine tuning of the integrated product.
6.8	Collection and reporting of results	The data is collected from the final test suite and a report is created.
6.9	Finalization of product	The integrated product is finalized for sale.
7.1	Product Release	We release the product in the market.

DETAILED PROJECT SCHEDULE

Detailed Project Timeline

Table 3 – Detailed Project Timeline

Phase	Activities	Start Date	End Date	Duration in Days
A	Understanding the Market	August 1, 2022	September 9, 2022	30
B	Project Charter	September 12, 2022	October 21, 2022	7
	Project Scope			7
	Project Management Plan			16
C	Receiving Data	October 21, 2022	December 16, 2022	2
	Data Cleaning			
	• Machine Learning tools to clean data			20
	• Visual Inspection of Data			10
	Data Refinement			9
D	Requirement Specification	December 16, 2022	June 22, 2023	15
	Designing			40
	Training and Testing of the algorithm			45
	Modification and Finalization of the algorithm			
	• Improving Time Complexity			6
	• Finalize Algorithm			4
	Collect and Tabulate the results of Algorithm			15
	Documentation			10
E	Designing	June 23, 2023	March 28, 2024	
	• UI Designing			20
	• Style Designing			10

	Front-End Development			
	• Creation of Wireframes			7
	• Creation of Prototypes of UI			18
	Back-End Development			
	• Writing APIs			10
	• Building Libraries			20
	• Creating Security Features			20
	Database Development			25
	Software Testing			50
	Finalization of the Software			10
	Documentation			10
F	Procurement of Hardware	February 20, 2024	March 20, 2024	22
G	Synchronization of Hardware and Software	March 29, 2024	May 09, 2024	30
H	Development of a set of test-cases	May 10, 2024	August 5, 2024	
	• Development of Test strategy			2
	• Define objectives and criteria			2
	• Selecting testing environment			2
	• Plan resources			4
	Development of test schedule			
	• Develop Test schedule and estimation			3
	Completion of all tests as scheduled			
	• Categorize test cases in test suites			1
	• Run test suites and tabulate results			4
	• Use different variables			5
	• Use mix of manual and automated tests			5
	Collection and tabulation of results			3
	Development of trial run schedule and strategy			17
	Report results of first trial run			3
	Development and fine tuning of product			10
	Collection and reporting of results			3
	Finalization of product			1
I	Product Release	August 6, 2024		
Total Duration of Project until deployment				678

Note: The above table takes into considerations the weekends but not the public holidays.

P.E.R.T Diagram

The Program Evaluation Review Technique (P.E.R.T) Diagram below displays the schedule of the entirety of the project. It displays the precedence, dependencies and the duration between the start of each task.

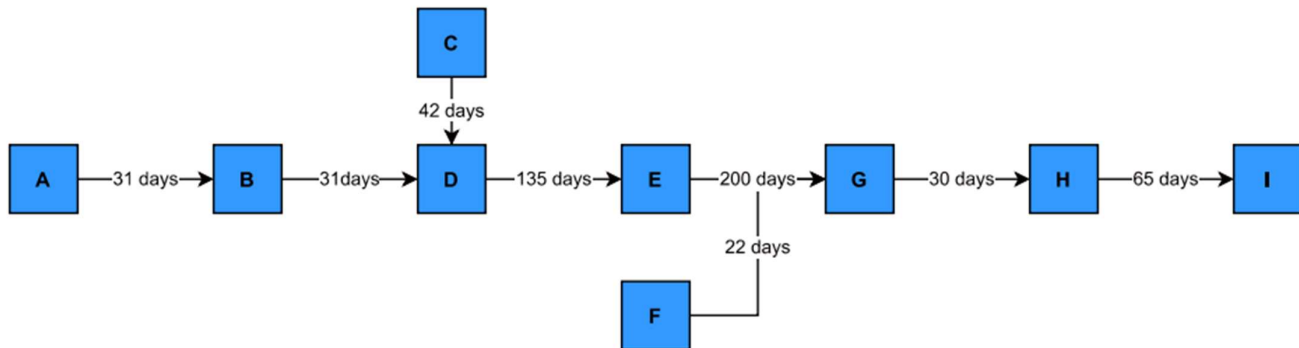


Figure 2 – P.E.R.T diagram for the project.

Table 4 – Details of the Processes in P.E.R.T Diagram

Process	Description
A → B	Task B will start only after the completion of task A. It will take 31 days for Task A to finish.
B → D	Task D will start only after the completion of task B. It will take 31 days for Task B to finish.
C → D	Task C will start independently after Task B is finished. It will then provide its deliverable (Refined Data) during the process of Task D (Deliverable of Task C will be provided to Task D before the training and testing of algorithm starts)
D → E	Task E will start only after the completion of task D. It will take 135 days for Task D to finish.
E → G	Task G will start only after the completion of task E and F.
F → G	Task F will start independently and needs to provide its deliverable (Outsourced hardware) before the completion of Task E.
G → H	Task H will start only after the completion of task G. It will take 30 days for Task G to complete.
H → I	Task I will start only after the completion of task H. It will take 65 days for Task H to complete.

Gantt Chart of the Project Schedule

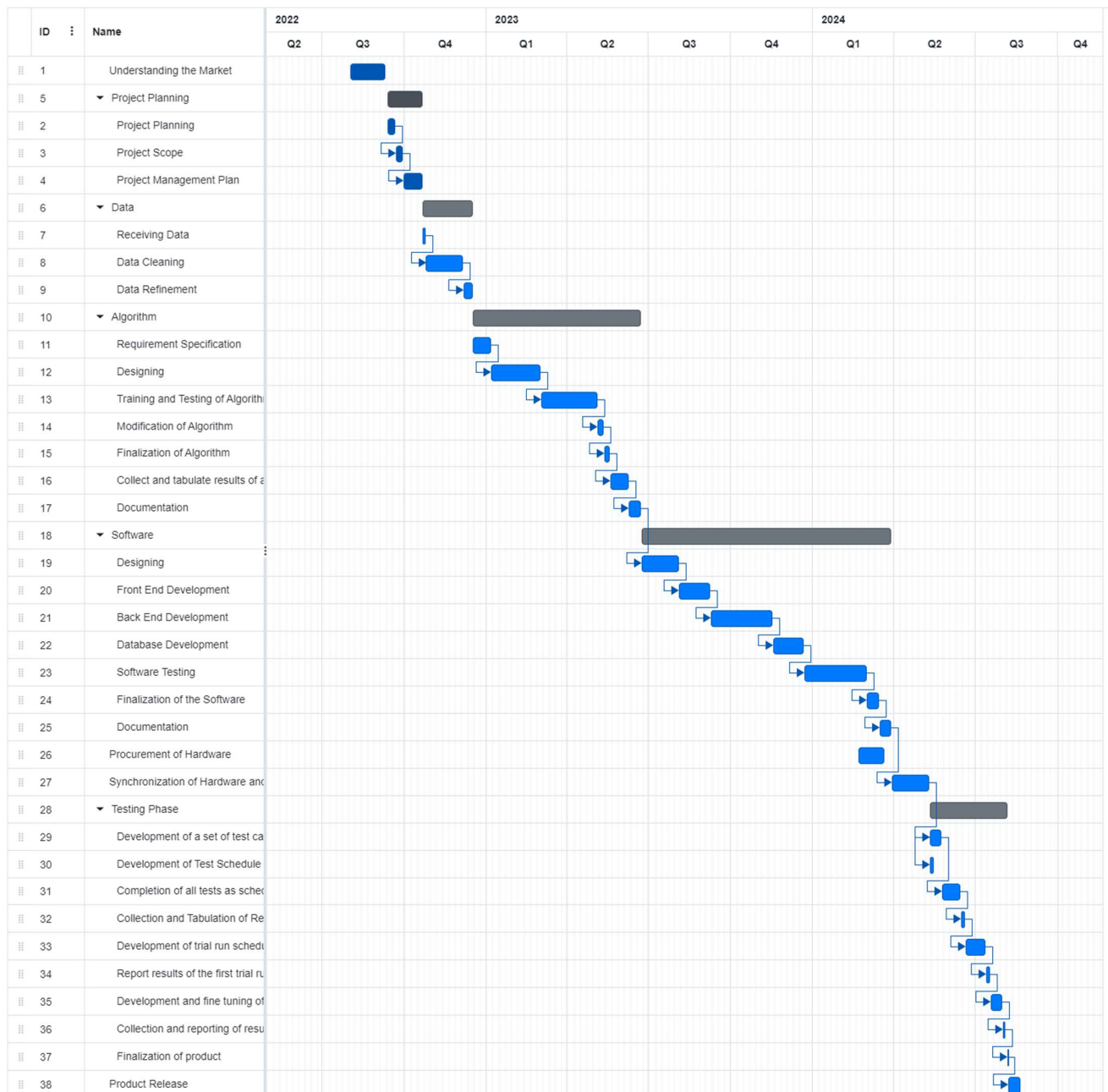


Figure 3 – A detailed Project Schedule of the project.

DETAILED COST MODELLING

Important Descriptions

- Human Resource Cost
 - These costs cover the daily wages of every employee working on the project who range from data engineers to software testers.
- Non-Human Resource Cost
 - These costs include but are not limited to warehouse costs, office rental costs, basic office supplies cost, Computer, servers, etc.
- Other Cost
 - These costs cover the costs incurred through the outsourced hardware.
- Contingency Funds
 - This is an emergency fund which has been created solely for the purpose of covering unplanned expenses.
- Management Reserve
 - This is another emergency fund which has been created to make sure that in case of any change in the daily wage of the employees, the project cost would not be affected.

Cost Estimates in AU\$

Table 5 – Cost Estimates of Human Resources in AU\$

WBS Items	Unit/Day	No of Days	Cost/Day	Sub-Total	WBS Total
Project Planning					77,568.00
• Understanding the Market	6	31	256	47616	
• Project Charter	3	7	256	5376	
• Project Scope	4	7	256	7168	
• Project Management Plan	4	17	256	17408	
Data					76,128.00
• Receiving Data	2	2	312	1248	
• Data Cleaning	6	30	312	56160	
• Data Refinement	6	10	312	18720	
Algorithm					215,250.00
• Requirement Specification	4	15	350	21000	
• Designing	6	40	350	84000	
• Training and Testing of the algorithm	4	45	350	63000	
• Modification of the algorithm	6	5	350	10500	
• Finalization of the algorithm	3	5	350	5250	
• Collect and Tabulate the results of Algorithm	4	15	350	21000	
• Documentation	3	10	350	10500	

Software					371,000.00
• Designing	6	30	350	63000	
• Front-End Development	5	25	350	43750	
• Back-End Development	5	50	350	87500	
• Database Development	5	25	350	43750	
• Software Testing	6	50	350	105000	
• Finalization of the Software	4	10	350	14000	
• Documentation	4	10	350	14000	
Integration of Hardware and Software					155,200.00
• Procurement of Hardware	4	22	400	35200	
• Synchronization of Hardware and Software	10	30	400	120000	
Testing Phase					169,100.00
• Development of a set of test-cases	4	10	380	15200	
• Development of test schedule	3	3	380	3420	
• Completion of all tests as scheduled	6	15	380	34200	
• Collection and tabulation of results	3	3	380	3420	
• Development of trial run schedule and strategy	10	17	380	64600	
• Report results of first trial run	4	3	380	4560	
• Development and fine tuning of product	10	10	380	38000	
• Collection and reporting of results	4	3	380	4560	
• Finalization of product	3		380	1140	
Product Deployment					1,600.00
• Product Release	4	1	400	1600	
Total					1,065,846.00

Table 6 – Non-Human Resource Costs in AU\$

Items	Total Cost for duration of Project	WBS Total
Workspace		678,000.00
Rental Fee	610200	
Internet	67800	
Office Hardware		146,000.00
Computer and Servers	50000	
Others	96000	
Hardware		850,000.00
Outsourced	400000	
Total		1,674,000.00

Detailed Cost Baseline

Table 7 – Detailed Cost Baseline of the project in AU\$

		Project Year Quarterly Cost Baseline									
		Y1 Q1	Y1Q2	Y1 Q3	Y1 Q4	Y2 Q1	Y2 Q2	Y2 Q3	Y2 Q4	Y3 Q1	Total Cost
	WBS Categories										
1.1	Understanding the Market	47616									47616
1.2	Project Charter	5376									5376
1.3	Project Scope	7168									7168
1.4	Project Management Plan		17408								17408
2.1	Receiving Data		1248								1248
2.2	Data Cleaning		56160								56160
2.3	Data Refinement		18720								18720
3.1	Requirement Specification		21000								21000
3.2	Designing			84000							84000
3.3	Training and Testing of Algorithm			63000							63000
3.4	Modification of algorithm				10500						10500
3.5	Finalization of algorithm				5250						5250
3.6	Collect and tabulate results of algorithm				21000						21000
3.7	Documentation				10500						10500
4.1	Designing					63000					63000
4.2	Front End Development					43750					43750
4.3	Back End Development						87500				87500
4.4	Database Development						43750				43750
4.5	Software Testing							105000			105000
4.6	Finalization of Software							14000			14000
4.7	Documentation							14000			14000
5.1	Procurement of Hardware								35200		35200
5.2	Synchronization of hardware and software								120000		120000
6.1	Development of a set of test-cases								15200		15200
6.2	Development of test schedule								3420		3420
6.3	Completion of all tests as scheduled								34200		34200
6.4	Collection and tabulation of results								3420		3420
6.5	Development of trial run schedule and strategy								64600		64600
6.6	Report results of first trial run									4560	4560
6.7	Development and fine tuning of product									38000	38000
6.8	Collection and reporting of results									4560	4560
6.9	Finalization of product									1140	1140
7.1	Product Release									1600	1600
	Total	60160	114536	147000	47250	106750	131250	133000	276040	49860	1065846

Estimated Budget*Table 8 – Overall Estimated Budget Table in AU\$*

Cost Type	Total Cost
Human Resources Cost	1,065,846.00
Non-Human Resource Cost	1,674,000.00
Contingency Funds (30%)	821,953.00
Management Reserve	438,201.00
Total	4,000,000.00

DETAILED COMMUNICATION PLAN

Type/List of Stakeholders	Level of interest in the Project	Description of interest	Document name	Communication medium	Frequency of Communication	Contact Person	Communication Owner
Sponsors	High	Takes care of the expenses that incur throughout the project and overlooks the progress of the project. They are the most impacted by the outcome of the deliverables.	Deliverables Status Report	Board Meeting & Hard Copy	Quarterly	Sanjukta	Team Director
Suppliers	Low	Provides the necessary supplies or raw materials for the devices, equipment and software. They are not directly impacted by the outcome of the project.	Procurement Status Report	E-mail / Telephone	Monthly	Sriram	Finance Officer
Customer Management	High	Takes care of prospective, current and future clients. They are responsible for ensuring all the deliverables meet their deadlines and milestones.	Monthly Progress Report	Email/Meeting/Telephone	Monthly	Sanjukta	Team Director

Communities	High	Communities are major stakeholders in a business because both are codependent and mutually benefit from one another. The business would create jobs, contribute to economic development and also have an impact on the environment.	Annual Community Report	Meeting/Media	Annual	Vinit	CEO
Government Agencies	High	Government Agencies are major stakeholders in any business as they have to ensure all restrictions and guidelines are being followed and that there are no harsh consequences on consumers and businesses. Corporate taxes and other subsidies are handled by the agencies such that revenues are fair and responsible business decisions are rewarded.	Legal and Tax Report	Post/Email	Annual	Ananya	Market Research Analyst
Investors	Med	The investors would be the limited partners who would invest in the aspects of the project and as well as push for certain features within the design.	Progress Report	Email/Meeting/Telephone	Monthly	Ananya	Market Research Analyst

Competitors	Med	There are no major competitors in this sector at present. Most work on deep-sea exploration is in the development phase and is not expected to be fully deployed for commercial purposes before the next decade.	Business Report	Hard copy/Digital format	Quarterly	Ananya	Market Research Analyst
Service and safety team	Low	They are in charge of repairing the hardware as required as well as ensuring the safety of the staff in harsh conditions.	Safety Status Report	Hard copy/Intranet/Tel ephone	Quarterly	Harshitha	IT Department Head
Software team	High	The team is in charge of designing the software used within the product, as well as the dashboard from which all the data can be read and worked on for further.	System Update Report	Email/Intranet	Monthly	Harshitha	IT Department Head
Management team	High	This team is responsible for managing the different teams and reporting to the right stakeholders on the progress as well as any setbacks faced by the teams.	Progress Report	Email/Intranet	Monthly	Palak	Project Manager

Finance team	High	Finance team's job is to manage the budget along with the buffer amount so that the total cost doesn't surpass the initial amount. They are also responsible to report to the managers if the budget for any particular deliverable is performing above or below the threshold line.	Progress Report	Email/Intranet	Monthly	Sriram	Finance Officer
Trade Unions	Low	Trade unions protect the rights and the safety of employees/labourers. They would also be in charge of making sure that the work conditions for the employees are under the safety rating.	Union Regulation Report	Hard copy/Email	Annual	Ananya	Market Research Analyst
QA team	High	This team would get the requirements from the scope and the deliverables from the software team and then further test it for any errors or bugs.	Monthly Progress Report	Email/Meetings/ Digital copy	Weekly	Palak	Project Manager

Data Analysis Team	High	The team is responsible for analyzing the data extracted by the software on various subjects like terrains, and other findings from the device. They are also responsible for working with the software team and building a dashboard for the client to refer to.	Data Analysis Report	Hard Copy/Intranet	Bi-Monthly	Harshitha	IT Department Head
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DETAILED QUALITY MANAGEMENT PLAN

1. Purpose of the Project Quality Management Plan

The purpose of this Quality Management Plan is to devise and execute a plan that will monitor, measure and maintain an appropriate standard of quality in our project. This will enable us to deliver a project of optimum quality to the stakeholders.

This quality management plan will keep our entire project team informed about the level of quality that is expected of the project overall and from each of their individual roles and contributions. This way, the expected level of quality becomes an indirectly shared goal that the team is expected to strive for across the board.

This quality management plan will explicitly lay out rules, measures, guidelines and principles that the project team and the output is supposed to adhere to. This document will lay out the quality standards that we believe to be important and how they will be measured. We intend to execute our project without any functional error and as per the client's requirements and expectations.

2. Quality Planning

2.1. Define Project Quality

The following are the quality standards that our project will follow:

- All the goals of our project must be accomplished and must adhere to the prepared project schedule. The clients must receive the completed, deployable project at the expected time. The final product must meet all the stakeholder's requirements and expectations in terms of functional and non-functional requirements.
- All the documents pertaining to the project must be complete, unambiguous, legible and coherent. The clients must receive all the set of relevant documents along with the completed product.
- The code used for the project must be documented appropriately with suitable comments, no ambiguity and with no errors. The algorithm used will be retained as it is an intellectual property.
- The project software must be error-free, functional and must run completely.
- All the expected functions must be completed and must work as per the client requirements.
- Test schedules must be updated as per the plan and results procured from test cycles at various stages must be captured appropriately, tabulated, stored and presented in a manner that is comprehensible.
- Adequate performance testing must be performed to ensure there is no unsatisfactory or anomalous behaviour from the product during different scenarios.
- The security system of the product must be tested sufficiently to check if there may be any discrepancies pertaining to data and project security.
- In the development front, frequent and periodic checks for cooperation between different members and factions of the team must be performed to ensure adherence to the expected timeline.
- Every individual member of the team must perform individual quality checks to ensure their own contribution is in agreement with the quality-related principles laid down.
- The code documents must be appropriately classified and explained. These documents must be shared with the relevant teams on time.
- All the project costs must be tracked and compared with the expected cost estimates drawn.
- The project progress must be measured periodically and must be honed based on feedback received for the shared project specifics and documents.
- The tests must be checked to ensure a good standard of testing and to ensure if all the necessary functionalities/components of the project are tested.
- The project must overall be user-friendly.

- The hardware used must not be detrimental to the environment. Since our product will be deployed underwater, the hardware components used must not pose any environmental threats to the underwater ecosystem.
- The customer experience and satisfaction has to be regularly measured and documented. It has to be maintained at an optimum standard.
- The clients must receive the completed, deployable project at the expected time. The final product must meet all the stakeholder's requirements and expectations in terms of functional and non-functional requirements.
- The clients must receive all the set of relevant documents along with the completed product. The clients must find the documents unambiguous and easy to understand.
- The same is expected of the code to be produced to the clients too. It must be well-documented and error-free.
- The clients must be informed of the timelines and schedule well in advance.

2.2. Measure Project Quality

A good standard of communication must be maintained with the clients and all the stakeholders involved throughout the project duration. All the stakeholders must be encouraged to provide feedback which must be taken into consideration with importance.

Any estimates pertaining to scope, time and costs must be presented to the stakeholders periodically, including any revisions or updates made. The progress made must also be presented to them.

Our project has been broken down into smaller, achievable work packages which have further been decomposed into smaller activities. The progress made in the activities will be measured against time.

We will constantly measure the time, cost and scope extended/utilized by our project against the respective estimates drawn up. This is to ensure that our project is on track with the estimates and to help us identify areas of weaknesses such as any possible scope creep and take preventative/necessary actions to tackle such scenarios. Metrics such as Cost Value, Benefit Value, will help us assess cost-related figures in-depth.

Surveys and interviews will be conducted across the project team and across all the stakeholders involved in an effort to better understand their level of satisfaction and to garner any possible improvements/suggestions. This will also be an indirect measure of the quality of communication maintained across the team and with the stakeholders. The code will be periodically reviewed to ensure it is error-free and adheres to a certain standard.

3. Quality Assurance

3.1. Analyse Project Quality

A few aspects of the project that we would like to analyse as part of quality management are:

- Software and algorithm quality
- Hardware standards
- Documentation quality
- Test set and schedule standard
- Time involved
- Costs involved
- Scope feasibility
- Customer communication level

- Project usability
- Customer experience and satisfaction

We will start by devising an effective quality assurance plan. Since the quality aspects to be measured and analysed are laid out, roles and responsibilities will be assigned to team members and the quality team to analyse and inspect project quality at different levels. Information relevant to the project's standards will be

procured. Metrics such as Cost Value, Benefit Value, Rate of Failure, Scope Creep, Time Expenditure, Budget Deviation, etc. will be tracked regularly and measured against the baseline and estimates drawn out.

Regular audits will be performed to check if the activities being carried out are in line with the plan. This will reveal to us any loopholes in the process that could lead to a potential failure. Quality analysis will also involve a few other processes such as identifying experienced problems. These will be further analysed using methods such as fit analysis, corrective measures, root cause analysis, etc.

3.2. Improving Project Quality

If any discrepancies are identified and outlined in the project implementation, it will be appropriately reported to the relevant team members. Cost, scope, time, developmental and implementation progresses will be checked to ensure quality assurance standards. If any of these metrics/aspects fails to satisfy the laid out criteria, the plan will be revised accordingly and updated. This information is relayed to the quality assurance team and ultimately to the entire team and all the stakeholders.

The project plan will be regularly visited and maintained. Version control of the plan and different aspects of the entire project will be carried out periodically to ensure the feasibility of the project and its adherence to quality standards.

Regular well-planned audits will reveal to us any deficiencies in the project. This will help us reduce overall quality management cost and avoid any failures along the line. The output document of the assurance activity will also formally lay out any preventative/corrective actions and changes involved.

The following are a few measures that could reduce costs and decrease time taken in the project:

- Optimum and appropriate resources will be identified, allocated and procured early on to avoid discrepancies and incompatibilities later
- Draw out feasible and realistic time, cost and scope estimates taken into consideration a range of scenarios and adding adequate buffers as needed
- Manage the budget appropriately
- Take risks into consideration and perform elaborate risk estimation activities
- Review team-member estimates in terms of efforts, work load, skills and man-hours and draw out an optimum plan
- Use project management and quality management softwares available in the market for ease of information tabulation and handling

4. Quality Control

The following are a few quality control activities that will be undertaken:

- Procure quality measurements and metrics. These are often the output of all the quality related activities.
- Plan and execute regular audits to invigilate the project and expose potential loopholes

- Suggestions/improvements will be collected in the form of feedback and incorporated into the project. This will also include corrective and preventive measures.
- Devise backups and reinforcements and different levels of the project taking into account risks and potential discrepancies.
- Quality control reports will be produced detailing corrective actions reviewed.
- Use appropriate quality control tools to carry out control processes. These tools include: control charts, Six Sigma, cost values of compliance/non-compliance, cost-benefit analysis.
- Plan and execute different levels of testing such as user testing, integration testing, component testing, user-acceptance testing, system testing. Tabulate and compare the results from these tests to the baseline standards expected.

DETAILED RISK MANAGEMENT PLAN

Project risk management is the art and science of identifying, analysing, and responding to risk throughout the life of a project and in the best interests of meeting project objectives. (Hasan, 2022) The risks that were identified for the project are outlined in the table below, along with essential information such as mitigation and contingency plans, so that the team may take action within the golden hours to minimise losses.

Detailed Risk Register

Sr No	Risk	Description	Risk Owner	Category	Mitigation Plan	Impact Level	Description	Chances	Contingency Plan
1	Security breach	The data of stakeholders is vitally important and must be safeguarded. Additionally, other data must be protected.	Project Manager, Security Manager, Software Programmers, Database administrator	Security	To ensure that our system is up to date and secure on multiple levels. In addition, to have a good security culture.	High	Customer loss Reputation loss Financial loss	Possible	Backup of your server. Storage of important data on a remote server. Strengthen your second line of defense in data security.
2	Budget shortage	Unforeseen cost rises of products, inflation, unexpected conditions, bad planning that can lead to budget problems.	Finance Officer, Project Manager	Financial risk	Insightful survey, good planning, continuous monitoring, and allocation of contingency expenses	Moderate	Delay in the completion of the project, increased workload, stakeholder unhappiness	Possible	Use of contingency funds to bridge the gap. To pitch in the funding sources.
3	Tech hurdles	New technological advancements, such as those in software or hardware, may cause compatibility problems.	IT Department Head Software development team lead, Project Manager, Testing team lead	Technology risk	Keeping updated about cutting-edge and emerging technology.	Moderate	More resources and time consumption.	Unlikely	To outsource professional consultation and then draft the action plan.

4	Human error	Inadequate actions taken by the individuals later cause great loss to the organization/stakeholders.	Individual, Project Manager	People risk	Sensitizing the individuals about the importance of organization image and adhering to the highest standards of work ethics.	Moderate	Depending on the extent of the error, it might range from minor to severe.	Possible	Report and plug the gap as soon as it surfaces.
5	Improper documents	When necessary, procedures and protocols are not followed in documentation, then the process will stray from its intended path.	Project Manager	Structure/process risk	Proper protocols should be adhered. Audits should be conducted regularly and prudently.	High	Consumption of resources and time. Can lead to huge errors.	Unlikely	Correct and update the documentation according to the protocols where needed and found as soon as possible.
6	External Hazard Risks	One of the most unpredictable risks that arise from wholly external sources, such as natural calamities, societal problems, market crashes, and so on.	Project Manager	External Hazard Risks	Conducting a risk assessment to identify the potential hazards and implementing the steps for project sustainability.	Moderate	Data loss, time, resources, reputation	Rare	Act according to the disaster management plan.

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