

**MACHINE LEARNING BASED AUTOMATED CONSTRUCTION  
PLANNING SYSTEM FOR SRI LANKA**

Group ID: RPJ\_24-25J-201

Research Logbook

Ahamed R A - IT21158018

B.Sc. (Hons) Degree in Information Technology Specialization in  
Information Technology

Department of Information Technology

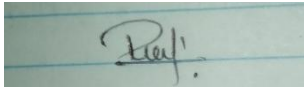
Sri Lanka Institute of Information

Technology Sri Lanka

June 2025

## DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Ahamed R A	IT21158018	

The supervisor/s should certify the proposal report with the following declaration.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

.....  
Signature of the Supervisor  
(Mr. N.H.P. Ravi Supunya Swarnakantha)

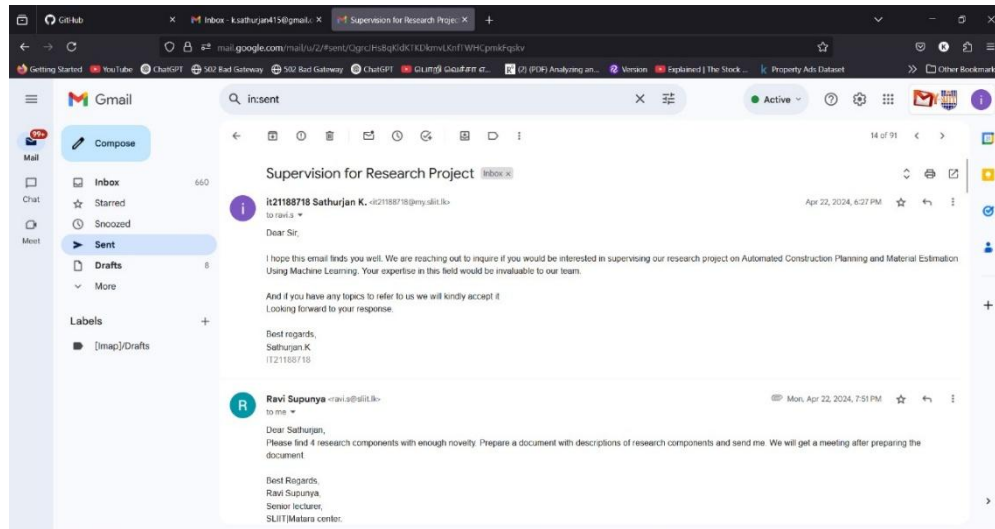
.....  
Date

.....  
Signature of the Co-Supervisor  
(Dr. Dharshana Kasthurirathna)

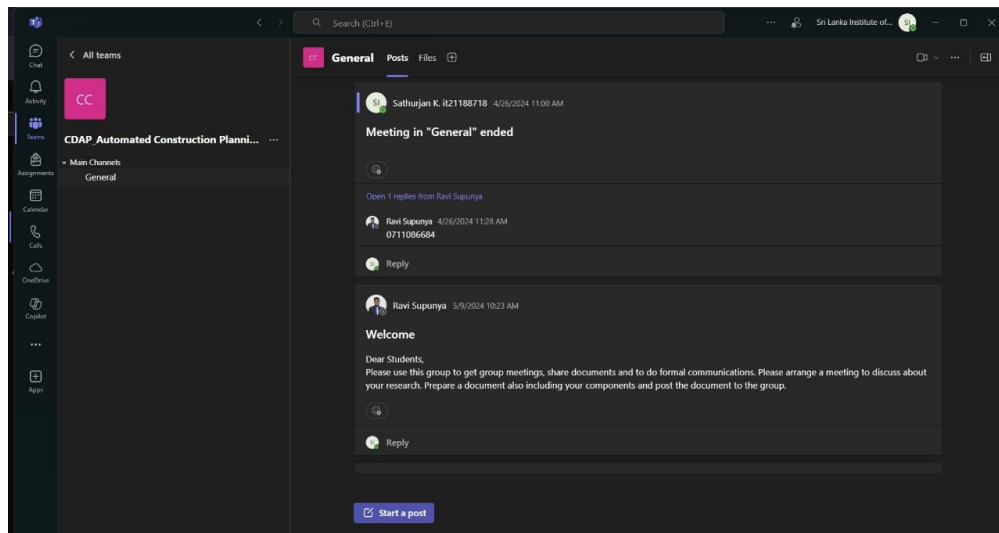
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Date

## Tasks

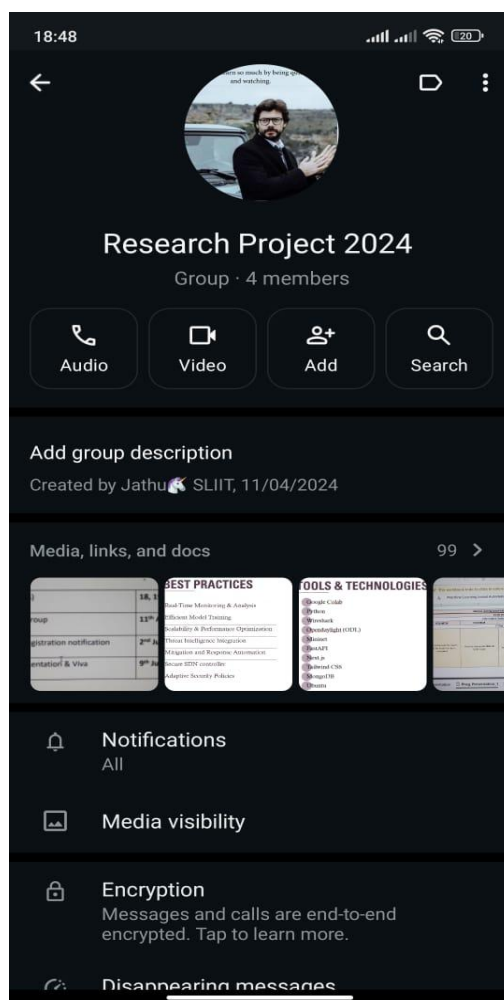
- ❖ Supervisor accept the Topic through the mail and check the send the details about topic.



- ❖ Meeting with the supervisor to discuss the project topic for the first time.
  - Meet the supervisor online.
  - Discuss the research project topic area.
  - Get the supervisor's ideas about the research topic.

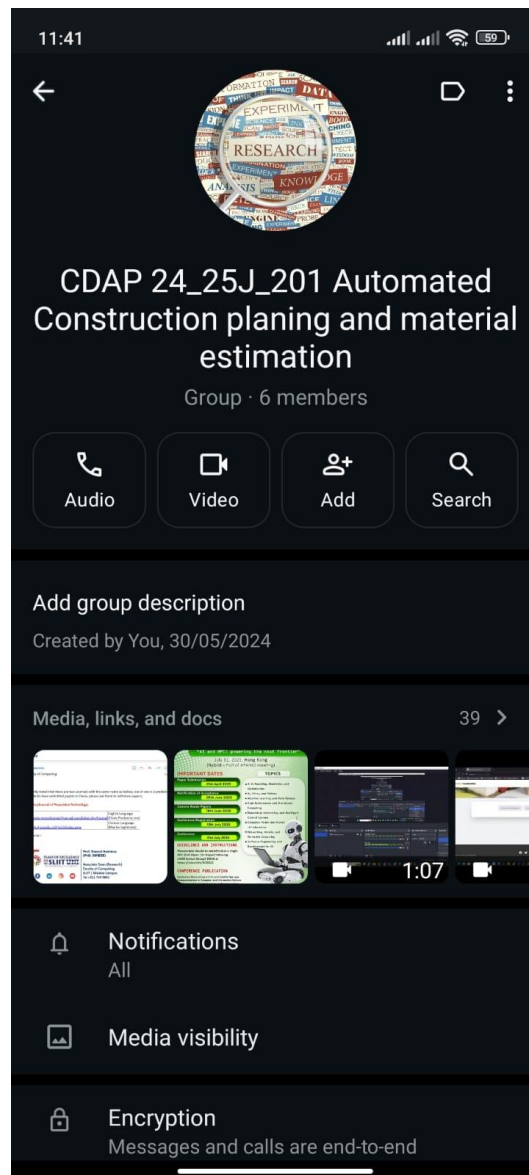


❖ Created separate WhatsApp Group for Conversation with team members.



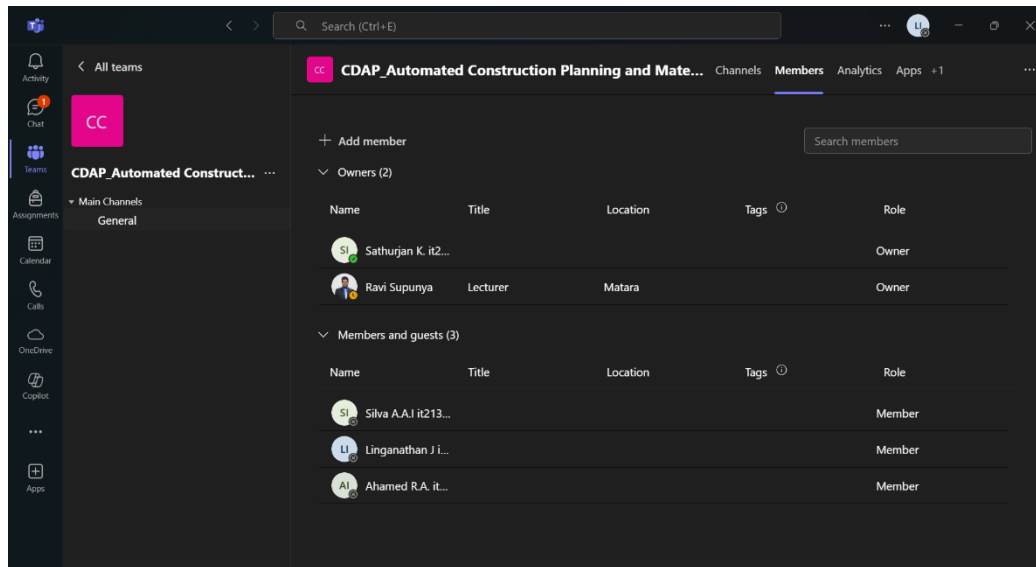
## ❖ Created the Research Team WhatsApp Group.

- Discuss the research topic with team members.
- Discuss the research problem.
- Get the solution ideas with brainstorming sessions.
- Identify the main solutions.
- Assign tasks and conversation highlights.



## ❖ Created a separate MS Teams channel with Supervisor conversation.

- Assign tasks and conversation highlights.
- Completed task and conversation highlights.



## ❖ Completed Task and Conversation Highlights

- Contacting Mr.Supunya Swarnakantha and Dr.Dharshana Kasthurirathna regarding the research topic.
- Writing a literature survey about the topic as requested by Mr.Supunya Swarnakantha.
- Narrowing of the scope as suggested by the Supervisor and Co-Supervisor.
- Submit proposal draft document.
- Changing the draft submission upon the advice of the supervisor.
- Accepting the proposal document.

...
X

CDAP 24\_25J\_201 Automated Construction planning and material estimation

✓ **Create Project Charter**  
Completed on 36 minutes ago by you

+

LI

SI

SI

AI

High
X

Documentation
X

Bucket

Done

v

Progress

Completed

v

Priority

Medium

v

Start date

05/13/2024

v

Due date

05/24/2024

v

Repeat

Does not repeat

v

Notes

Show on card

After the TAF Submission , We received our research project panel feedback with minor changes. According to the feedback given by the panel to TAF, we changed it, obtained supervisor and co-supervisor signature and submitted it before the due date.

...
X

CDAP 24\_25J\_201 Automated Construction planning and material estimation

✓ **Project proposal individual report**  
Completed on today by Sathurjan K. it21188718

+

LI

SI

SI

AI

Documentation
X

Bucket

Done

v

Progress

Completed

v

Priority

Medium

v

Start date

08/10/2024

v

Due date

08/23/2024

v

Repeat

Does not repeat

v

Notes

Show on card

Create an individual Project Charter Report for adding overall Project details with research gap in our components

## ❖ Completed Task and Conversation highlights.

- Creating the proposal document at supervisor request.
- Doing a literature review upon supervisor request.

### 1.4 Research Problem

The construction and real property sectors in Sri Lanka face significant inefficiencies due to guide approaches, previous methodologies, and terrible communication, main to delays, fee overruns, and faulty predictions. These challenges are specifically reported in 4 key regions, which these studies goals to deal with:

First off when picking out solar panels, folks don't have the right gear to figure out the best ones based on how big their land is where it's at, or the weather around them. This makes it hard to get the kind of energy setup that does the job well. The stuff out there now, from references isn't cutting it because it doesn't give advice that considers Sri Lanka's hot and wet weather, with all its rainy seasons and sticky air messing with how well solar panels do their thing.

Second, folks dealing with property in Colombo find it tough to guess prices right because they change so much. The old way of doing things just isn't cutting it, with all the different types of houses and places making it even harder to nail down the best moves for putting your money into property. The current ways—stuff from sources just isn't built for the ups and downs of Sri Lanka's money scene so the price guesses they make aren't too solid.

As for the third bit figuring out how much it's going to cost to build stuff is super tricky. The way people do it now just doesn't factor in all the changing prices for stuff you need, like materials and people to do the work. In Sri Lanka, the cash situation is all over the place so not getting this right means you could end up spending way more than you thought. The tools folks have right now, those things from just can't keep up with all the changes as they happen, and that's just making everything worse.

In the end, teaming up on interior design projects hits a snag when clients and designers don't speak the same language about tech stuff. Clients can't get their technical tastes across, which messes things up and slows everything down. The platforms out there, like numbers 16 to 20, haven't got the high-tech AI needed to fix this problem. So, the design workflow in Sri Lanka isn't as smooth or happy as it could

These challenges are combined by Sri Lanka's unique socio-economic and environmental context, which fails to address the existing systems widely. Economic instability, such as inflation rate in recent years, directly affects the price of material costs and real estate, though most ML models are not designed to control such instability. Similarly, with tropical climates, with its rain and moisture, affects the efficiency and timelines of the solar panel, but solar recommendation systems are rarely responsible for these factors in terms of Sri Lanka.

Moreover, lack of integration in these fields creates a fragmented approach to construction planning. For example, the decision to install solar panels affects construction costs, though



**❖ Proposed Solar Panel Recommendation and Cost Estimation System.**

MEMBER 3

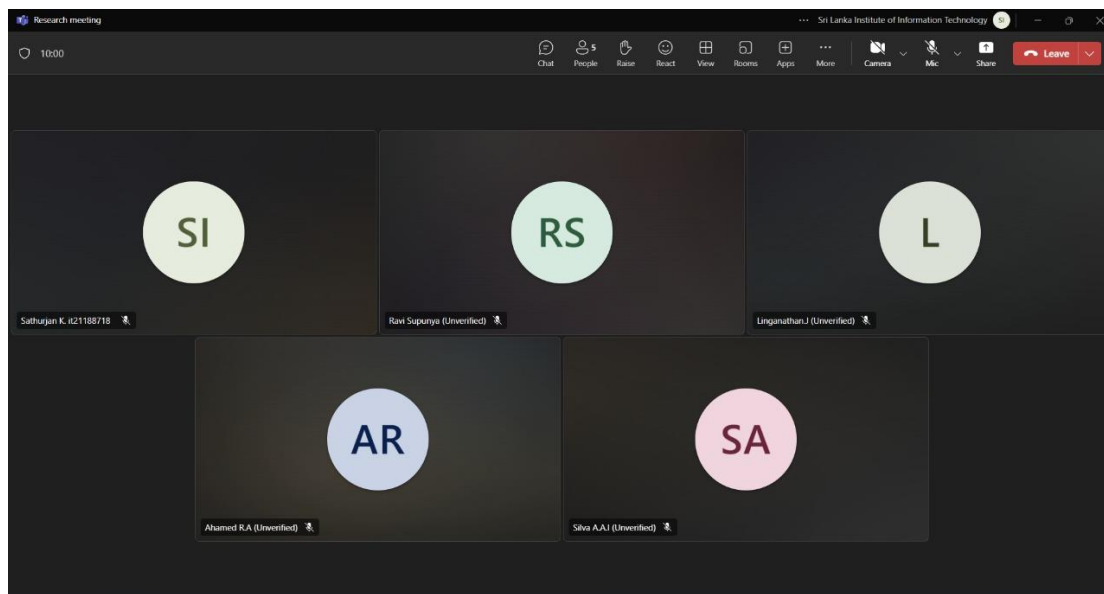
Ahamed R A

**Construction Cost Estimation**

- The main purpose of the Construction Cost Estimation component is to provide users with accurate predictions of building costs based on factors such as location, building size, material selection, and labor availability. This helps users plan budgets effectively and make informed decisions before starting construction projects.
- The system uses algorithms such as linear regression, random forest, and artificial neural networks to estimate construction costs by analyzing historical construction data, current material and labor prices, and project specifications.
- This technology considers both static factors (like building type and size) and dynamic factors (like real-time market rates and regional labor costs) to deliver reliable, data-driven cost estimations.
- User inputs key construction details such as project type (residential/commercial), location, total floor area, preferred materials, and expected duration.
- The system collects relevant historical cost data, real-time prices for materials and labor, and any region-specific cost variations.
- The data is processed using trained ML models that identify cost patterns and dependencies based on the provided project details.
- A predicted total cost is generated for the construction project, including material, labor, equipment, and contingency expenses.
- The system presents a detailed cost breakdown, including component-wise estimates and potential cost-saving alternatives.
- Optional forecasting tools may display future cost trends based on inflation, supply chain changes, or market demand.
- Overall, the Construction Cost Estimation module improves budgeting accuracy and financial planning in construction projects. It empowers users to make data-driven decisions by integrating real-time pricing, predictive analytics, and historical insights.

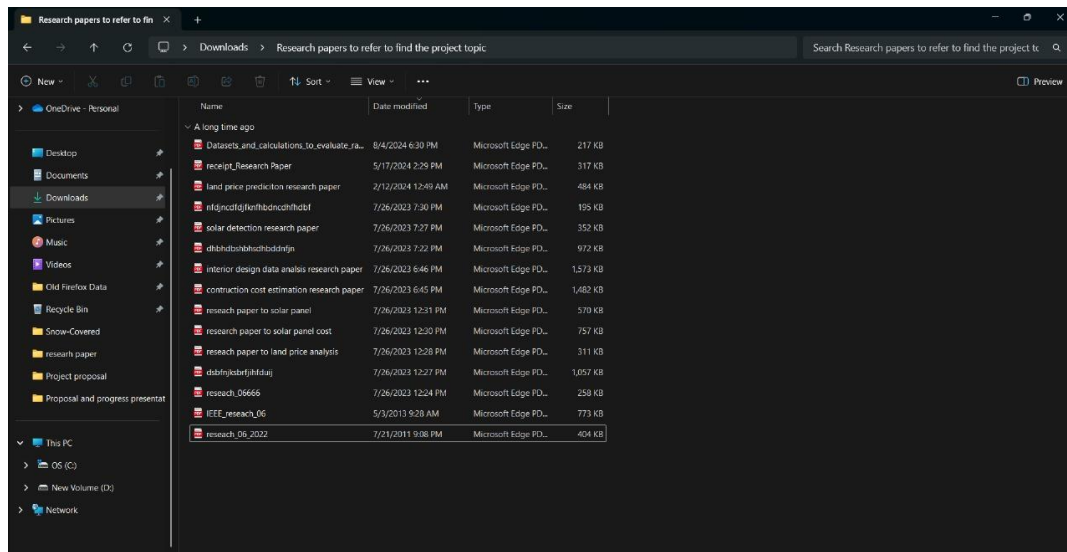
### ❖ Completed Task and Conversation Highlights.

- Determining the components for each member and discussing with the Supervisor.
- Fine tuning the scope for each component.
- Discussing the proposed components with Supervisor.



### ❖ Completed Task and Conversation Highlights.

- Find the Related research paper for individual Land and house price prediction Component.
- Get a full idea of each research paper.
- Mark down the not covering Land and house price prediction
- Estimation areas in these research papers.
- Identify the novelty parts of each individual component.
- Creating the Topic Assignment Form (TAF)
- Getting the approval from the Supervisor.



## VI. REFERENCES

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- [3] Zhang, X., Li, Q., & Wang, J., "IoT-Driven Construction Cost Estimation Using Machine Learning: A Real-Time Approach," *Automation in Construction*, p. 112, 2020.
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**IT4010 – Research Project - 2024**

**Topic Assessment Form**

**Project ID:**

24-25J-201

1. Topic (12 words max)

Machine Learning based Automated Construction Planning system for Sri Lanka

2. Research group the project belongs to

Software Systems & Technologies (SST)

3. Research area the project belongs to

ICT for Development (ICTD)

## ❖ Complete Task and Conversation Highlights

- Reading research papers related to time series prediction.
- Reading documentation of Land and house price prediction and understanding which data set could be taken.
- Developing different models for prediction of time series.

...

×

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✓

~~Implement the model to the land and house price prediction~~

Completed on today by you

SI

Sathurjan K. it21188718

Dark blue

×

Bucket

Done

▼

Progress

✓ Completed

▼

Priority

● Medium

▼

Start date

02/15/2024

Due date

03/16/2024

Repeat

↺ Does not repeat

▼

## ❖ Completed Task and Conversation Highlights

- Finding the sample dataset until system develop.
- Discussing with the supervisor the potential model and its accuracy and which model we should proceed with for the prediction.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Built-up Area (sq ft)	Project Type	Construction Quality	Location	Number of Floors	Cement Brand	Foundation Type	Roof Type	Total Construct	Material Breakdown	Labor Cost Estimat	Foundation Cost	Roofing Cost	Cost Per Square Foot (R)
2	2872	Residential	Standard	Urban		2 LANWIA Cement	Shallow	Flat	7533775.25	102883.08	1656711.72	54897.41	214160.12	2623.18
3	2386	Residential	Standard	Urban		6 Swisstek Cement	Shallow	Pitched	5842537.45	104064.11	1097608.32	53868.12	301185.63	2104.56
4	2965	Residential	Standard	Rural		4 ULTRATEC Cement	Deep	Pitched	8066843	105105.27	1772009.2	120991.93	308489.91	2702.46
5	3642	Residential	Basic	Rural		7 Insee Cement	Shallow	Flat	7355361.52	131254.75	1612971.89	45520.41	215688.69	2019.59
6	3324	Commercial	Basic	Rural		2 Insee Cement	Shallow	Flat	4750434.6	90061.61	978743.51	52012.39	206060.5	2044.68
7	2324	Industrial	Standard	Urban		2 Tokyo Super	Shallow	Flat	6287512.39	84476.29	1397637.48	51541.42	200037.1	2705.47
8	3684	Residential	Basic	Rural		1 Insee Cement	Shallow	Flat	7825361.27	131254.37	1686387.46	54215.55	189822.48	2124.15
9	3075	Residential	Basic	Suburban		1 Tokyo Super	Shallow	Flat	6686737.14	123958.7	1478185.58	53505.89	214631.54	2172.6
10	2147	Commercial	Premium	Urban		8 LANWIA Cement	Shallow	Pitched	9054590.05	77070.21	1943798.04	47888.87	329727.81	4217.51
11	2906	Residential	Premium	Urban		1 Insee Cement	Shallow	Flat	12348976.46	117983.53	2862001.34	54608.48	209696.74	4249.48
12	2152	Commercial	Basic	Suburban		1 Swisstek Cement	Shallow	Pitched	4574722.66	92725.17	919926.47	45106.03	316763.94	2125.8
13	2150	Residential	Standard	Urban		2 Swisstek Cement	Shallow	Flat	6062414.35	96693.06	1325307.57	52137.69	194194.82	2819.73
14	2681	Residential	Premium	Urban		5 Tokyo Super	Shallow	Pitched	10640581.84	94301.7	2351886.67	54076.04	271615.84	3976.35
15	1065	Industrial	Standard	Suburban		1 Tokyo Super	Shallow	Flat	3152547.54	43130.1	654182.98	47160.92	195989.39	2969.14
16	1206	Commercial	Basic	Urban		5 ULTRATEC Cement	Deep	Pitched	2820501.66	43327.39	563500.73	120807.57	295361.9	2338.72
17	2070	Commercial	Basic	Suburban		5 Swisstek Cement	Shallow	Pitched	4560292.08	93332.52	947254.45	54693.8	320073.98	2194.56
18	1740	Residential	Premium	Rural		3 Insee Cement	Shallow	Flat	7360527.34	66772.69	1618282.89	51210.06	184280.74	4230.19
19	2735	Infrastructure	Standard	Rural		3 Insee Cement	Shallow	Flat	7760279.7	96290.34	1690602.79	50509.37	202038.62	2637.4
20	1810	Commercial	Premium	Rural		3 Insee Cement	Shallow	Flat	7040344.08	74367.8	1530773.84	47220.42	195580.55	3872.58
21	1440	Residential	Basic	Urban		1 Tokyo Super	Shallow	Pitched	3159159.83	57090.05	621910.94	46646.89	270663.8	2193.86
22	3590	Industrial	Basic	Rural		2 LANWIA Cement	Deep	Flat	7808290.01	130017.82	1756400.58	127419.14	180672.94	2169.57
23	2330	Residential	Luxury	Suburban		2 Swisstek Cement	Shallow	Pitched	13131879.25	93401.75	3028195.68	45824.48	280274.44	5636
24	2550	Commercial	Standard	Rural		7 ULTRATEC Cement	Shallow	Pitched	6953328.79	90630.52	1537390.63	54414.92	274981.02	2726.8
25	1431	Residential	Premium	Urban		3 Swisstek Cement	Deep	Flat	5653947.53	59904.64	1240483.32	109996.62	192447.68	3979
26	2091	Residential	Standard	Urban		1 Tokyo Super	Shallow	Flat	5871481.3	87507.32	1297991.61	46356.32	210081.3	2807.56
27	2583	Residential	Standard	Rural		1	Shallow	Pitched	6810799.01	102055.04		46085.72	321563.95	2636.78

```
# Define a function to evaluate models
def evaluate_model(model, x_test, y_test):
    predictions = model.predict(x_test)
    mae = mean_absolute_error(y_test, predictions)
    mse = mean_squared_error(y_test, predictions)
    rmse = np.sqrt(mse)
    r2 = r2_score(y_test, predictions)
    print(f"MAE: {mae}, MSE: {mse}, RMSE: {rmse}, R2_SCORE: {r2}")

# Evaluate Linear Regression
print("Linear Regression Evaluation:")
evaluate_model(linear_model, x_test, y_test)

# Evaluate Decision Tree Regressor
print("\nDecision Tree Evaluation:")
evaluate_model(dt_model, x_test, y_test)

# Evaluate Neural Network (MLP)
print("\nNeural Network Evaluation:")
print("MAE:", mae, "MSE:", mse, "RMSE:", rmse, "R2_SCORE:", r2)
```

```
Linear Regression Evaluation:
MAE: 139150.33287103343, MSE: 94446337966.15373, RMSE: 307321.229279973, R2_SCORE: 0.9898372733722975

Decision Tree Evaluation:
MAE: 37040.14638780513, MSE: 93938417887.73921, RMSE: 306493.7485296221, R2_SCORE: 0.9898919271896589

Neural Network Evaluation:
MAE: 90043.54524722611 MSE: 58620912470.31687 RMSE: 242117.55919453027 R2_SCORE: 0.9936922032030951
```

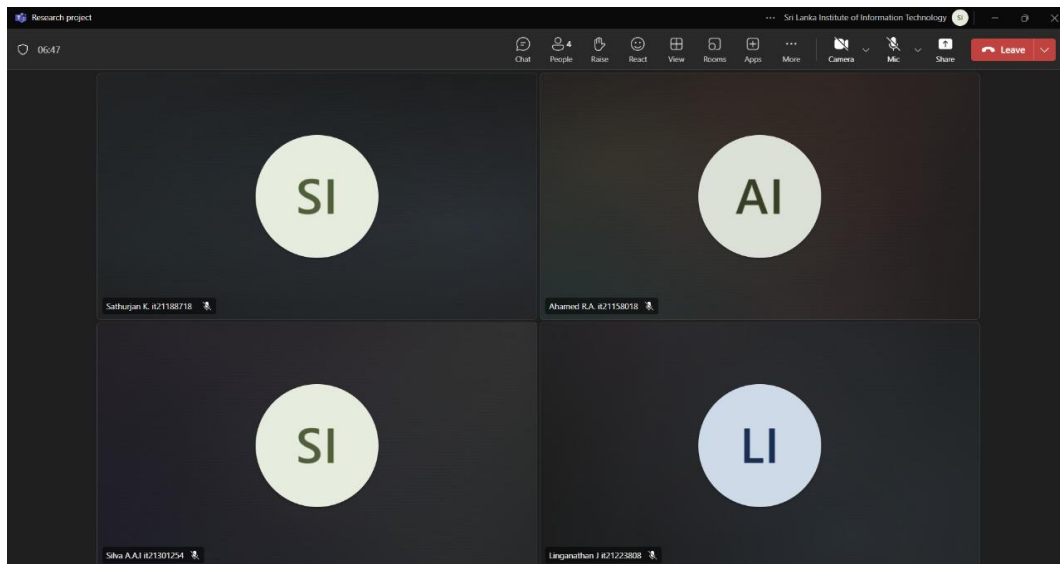
```
1 from flask import Flask, request, jsonify
2 from flask_cors import CORS
3 import pandas as pd
4 import joblib
5 import pickle
6 from sklearn.preprocessing import LabelEncoder
7 import traceback
8 import numpy as np
9 import io
10 from tensorflow.keras.models import load_model
11 from PIL import Image
12 import time
13
14 # Load trained models and datasets once on startup
15 linear_reg_model = joblib.load('./pickle/linear_regression_model.pkl')
16 price_model = joblib.load('./pickle/price_model.pkl')
17 size_model = joblib.load('./pickle/size_model.pkl')
18
19 solar_data = pd.read_excel('./Synthetic_Env_SolarData_Optimized.xlsx')
20 substation_data = pd.read_excel('./Sub_Station_data.xlsx')
21
22 solar_data.columns = solar_data.columns.str.strip()
23 substation_data.columns = substation_data.columns.str.strip()
```

VITE v6.1.0 ready in 1569 ms

→ Local: http://localhost:5173/  
→ Network: use --host to expose  
→ press h + enter to show help

```
119 def recommend():
120     pass
121
122 @app.route('/calculate_cost', methods=['POST'])
123 def calculate_cost():
124     data = request.get_json()
125     location = data.get('location')
126     land_size = data.get('land_size')
127     desired_capacity = data.get('desired_capacity')
128
129     if not location or not land_size or not desired_capacity:
130         return jsonify({"error": "location, land size, and desired capacity are required"}), 400
131
132     desired_capacity_w = desired_capacity * 1000
133     substation_row = substation_data[substation_data['name of the substation'] == location.lower()]
134     allowed_capacity = substation_row['Allowed capacity (w)'].values[0] if not substation_row.empty else None
135
136     if allowed_capacity is None:
137         return jsonify({"error": "Allowed capacity not found for location '" + location + "'"}), 400
138
139     max_capacity_w = min(desired_capacity_w, allowed_capacity)
140     tolerance = 0.1
141
142     matching_panels = solar_data[
143         (solar_data['Min Power (W)'] <= max_capacity_w * (1 + tolerance)) &
144         (solar_data['Max Power (W)'] >= max_capacity_w * (1 - tolerance))
145     ]
146
147     if matching_panels.empty:
148         solar_data['difference'] = abs(solar_data['Max Power (W)'] - max_capacity_w)
149         matching_panels = solar_data.nsmallest(5, 'difference')
150
151     if matching_panels.empty:
152         return jsonify({"error": "No suitable panels found even with closest selection."}), 400
153
154     avg_panel_size = matching_panels['Panel Size'].mean()
```

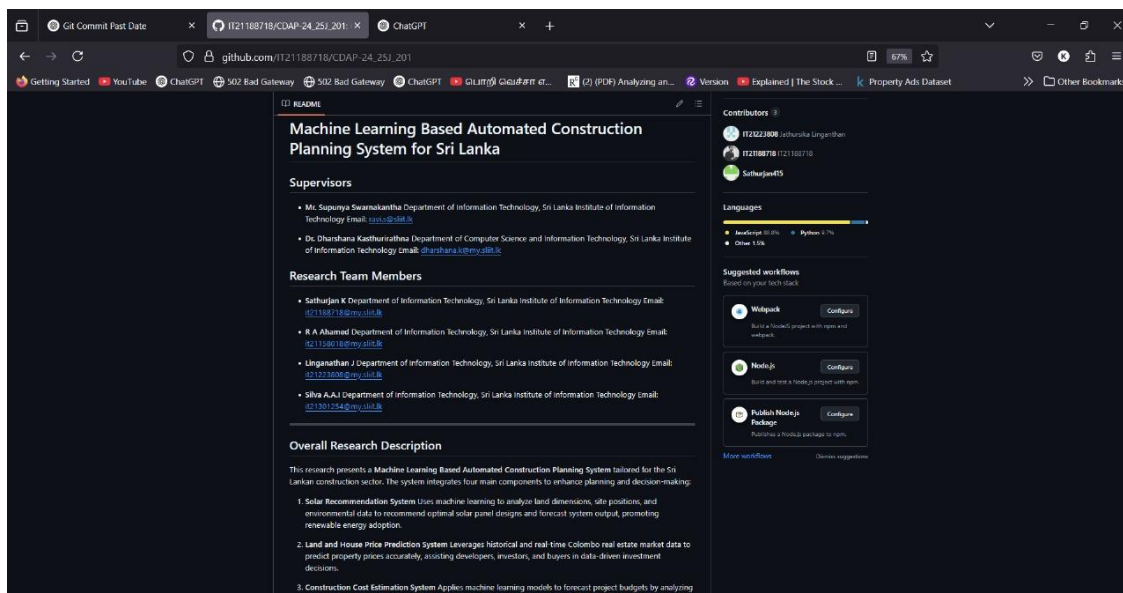
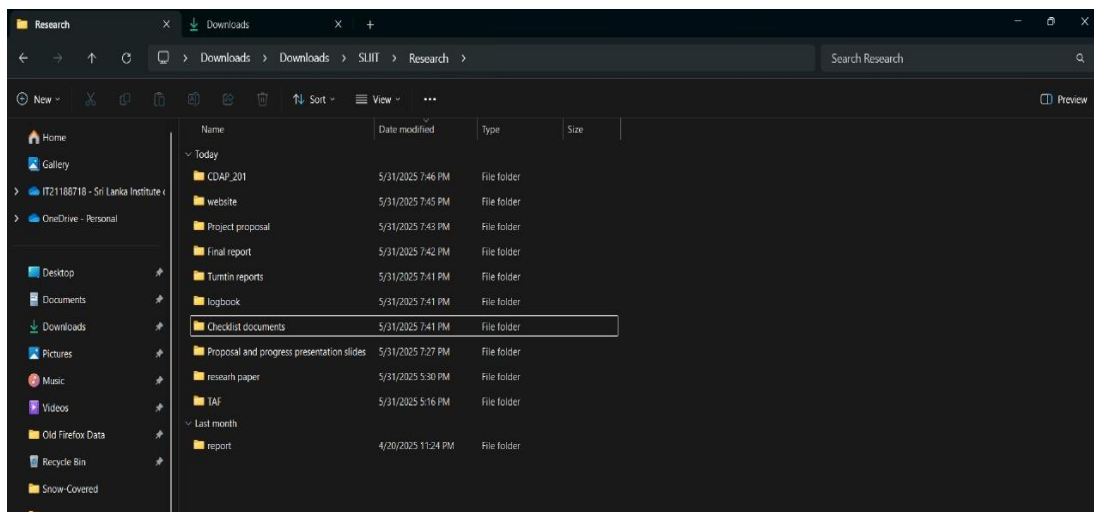
python -m flask run





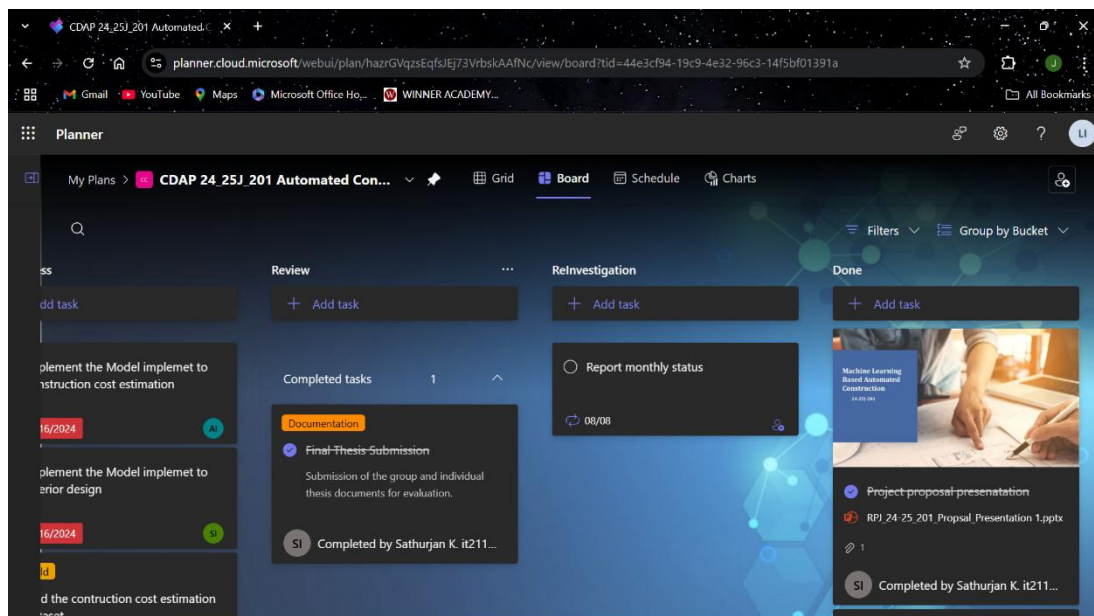
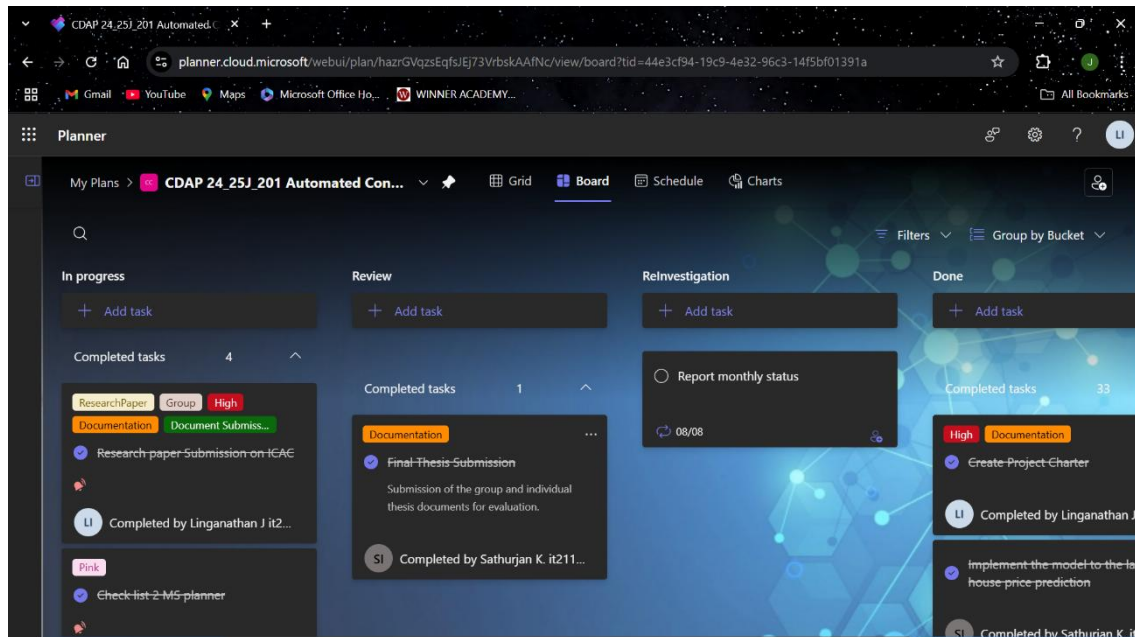
## ❖ Complete Tasks and Conversation Highlights

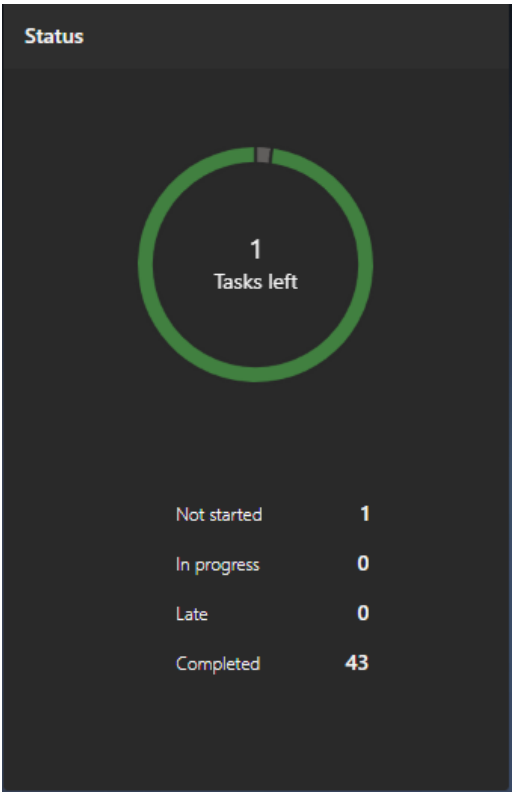
- Creating initial project folder structure.
- Adding the readme files, configuration files and setup instructions for the project.
- Initializing the startup scripts.

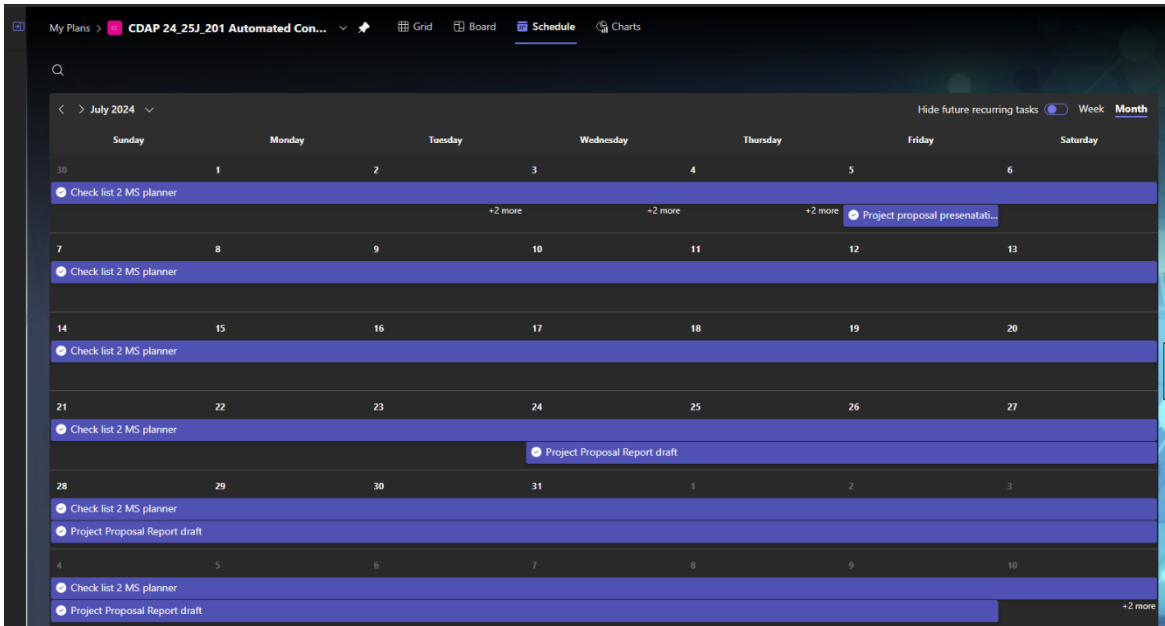
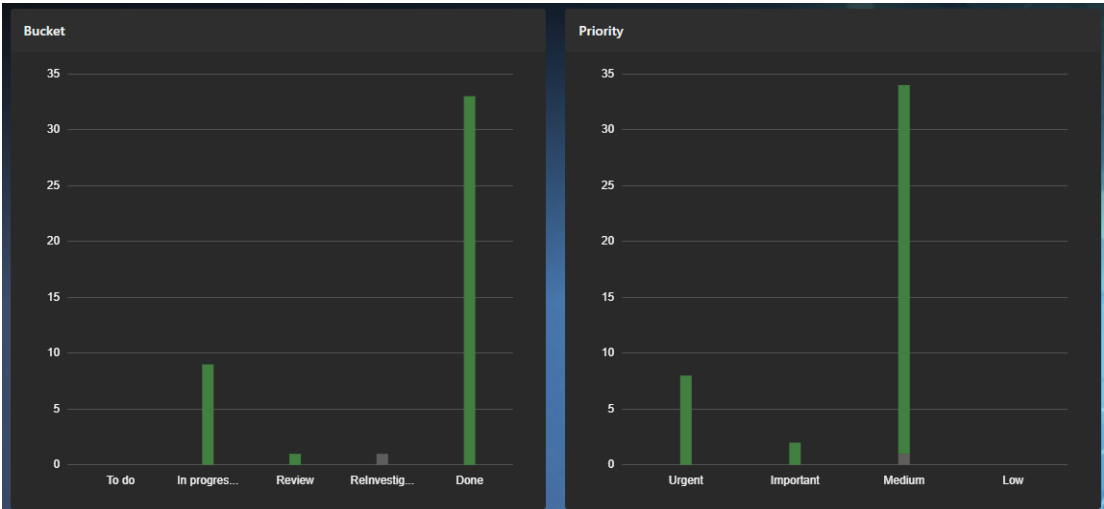


## ❖ Complete Tasks and Conversation Highlights

- Meeting with the research team and deciding the implementation milestone on Microsoft planner.
- The tasks were labeled so that it's easy to filter the important tasks.

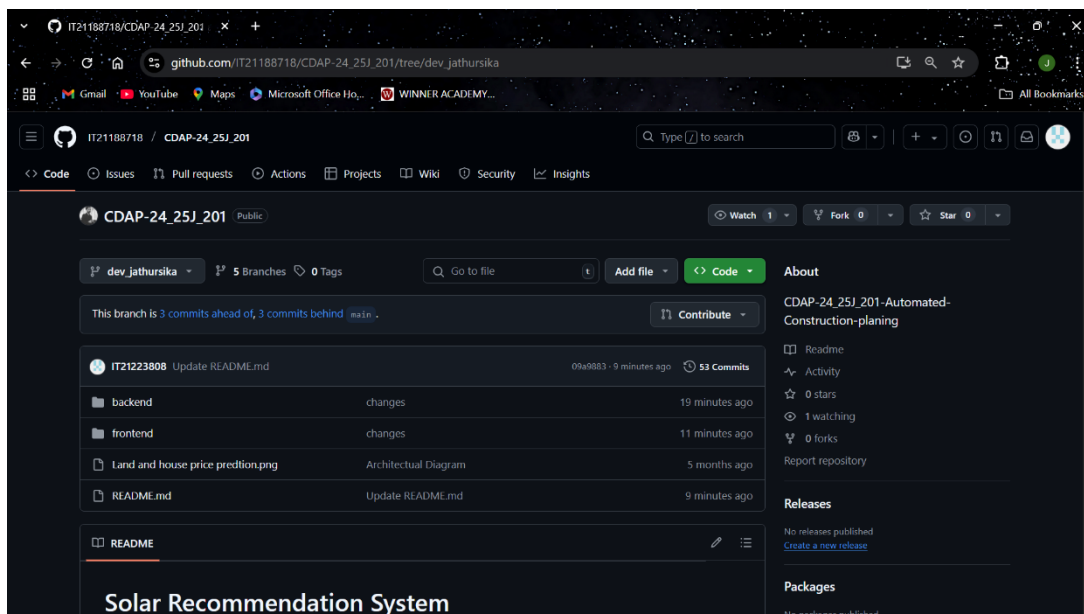






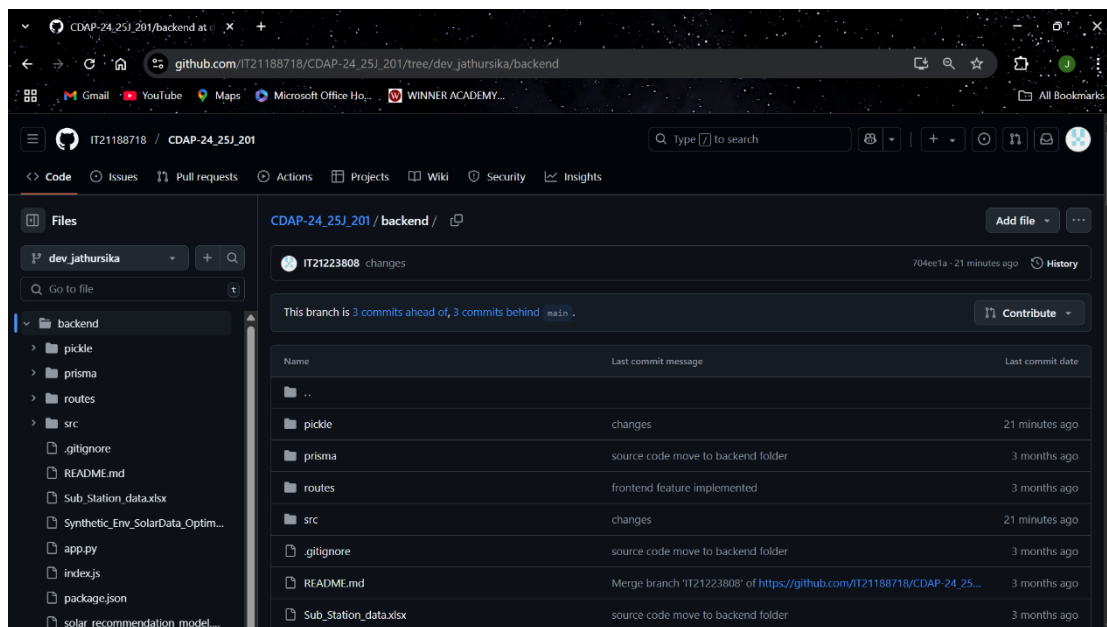
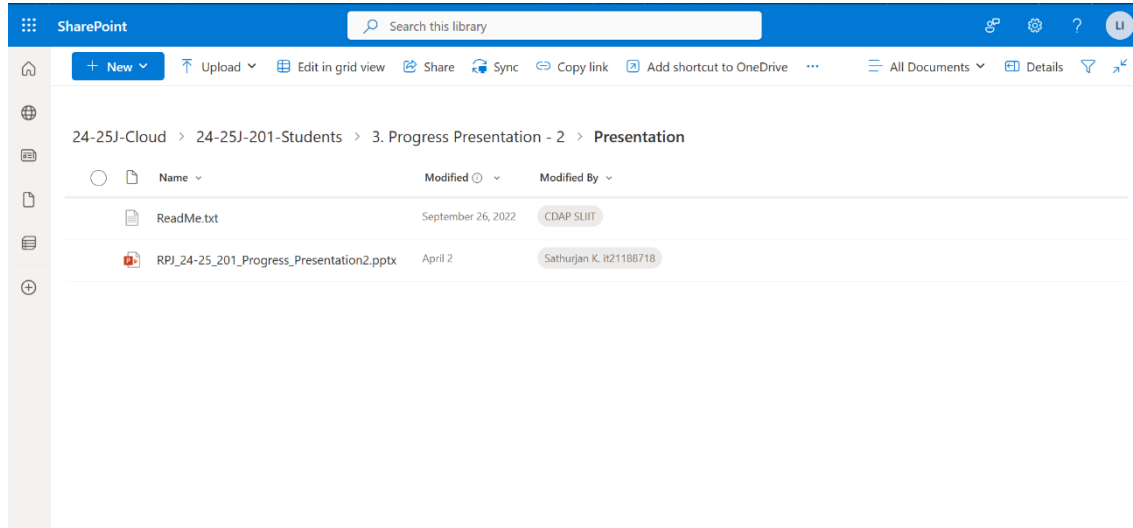
## ❖ Completed Tasks and Conversation Highlights

- Prepare for Progress Presentation 1 (PP1).
- Creating the presentation.
- Finalizing the GitLab Projects.
- Communication with the supervisor after finalizing the project.



## ❖ Completed Task and Conversation Highlights

- Prepare for Progress Presentation 2 (PP2).
- Creating the presentation.
- Finalizing the GitHub Projects.
- Communication with the supervisor after finalizing the project.



## ❖ Completed Task and Conversation Highlights


- Started writing the research paper.
- Exploring Mendeley tool.
- Exploring the IEEE standards and word tools.
- Communicating with supervisor and getting the supervisor feedback.
- Attending Prof. Dasuni Nawinna's Session on how to write a good research paper.
- Writing 3 separate research papers for:


... ×



CDAP 24\_25J\_201 Automated Construction planning and material estimation

✓ **Research written**

Completed on yesterday by Sathurjan K. it21188718



 Add label

Bucket	Progress	Priority
Done ▾	✓ Completed ▾	• Medium ▾
Start date	Due date	Repeat
01/15/2025 	03/12/2025 	↺ Does not repeat ▾

CDAP 24\_25J\_201 Automated Construction planning and material estimation

Research-paper-Submission-on-ICAC

Completed on 2 minutes ago by you

LI

SI

AI

SI

ResearchPaper

Group

High

Documentation

Document Submission

Bucket

In progress

Start date

Start anytime

Progress

Completed

Due date

05/26/2025

Priority

Urgent

Repeat

Does not repeat

Notes

Show on card

Research meeting

18:32

Take control

Pop out

Chat

People

React

View

Apps

More

Camera

Mic

Share

Leave

Machine Learning Based Automated Construction Planning System for Sri Lanka

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Abstract: Decision-making processes in multiple commercial sectors depend primarily on traditional methodologies which present both time-intensive operations together with manual processing. The proposed framework uses machine learning alongside predictive analytics to create an AI system for inspecting four specific operations regarding solar energy recommendations as well as real estate price predictions and construction cost estimation and interior design collaboration. Through machine learning models the Solar Recommendation System evaluates land dimensions combined with site position and environmental data to suggest suitable solar panel designs as well as forecast system output. The Land and House Price Prediction System uses past and present Colombo market data to generate property price forecasts which help developers allocate resources and buyers make data-based choices. The Cost Estimation for Construction Projects automatically generates project budgets from material expenses and labor costs and project environment changes while reducing overall financial uncertainties. The Interior Design Collaboration Platform facilitates seamless interaction between clients and designers through AI-powered recommendations and interactive visualization.

The system aims to assist both residential and business stakeholders in Sri Lanka toward adopting renewable power solutions which combine financial efficiency with environmental sustainability.

The Land and House Price Prediction System utilizes historical data along with real-time market data to generate precise property value estimations which help developers and investors and potential buyers in their investment planning process. An ML-based system will examine Colombo real estate market data about location and land size and amenities and market trends to forecast upcoming property values in this busy Sri Lankan market [1] [2].

The Cost Estimation for Construction Projects system brings an intelligent solution to control project budgets through its features [3]. The system leverages historical datasets and real-time feed to adjust cost predictions through ML models that monitor material prices and labor costs and market changes thus minimizing budget overruns for construction projects.

The Interior Design Collaboration Platform creates connections between designers and clients through AI-driven

SI

Sathurjan K. K21108718

RS

Ravi Supunya (Unverified)

L

Lingarithan J (Unverified)

SA

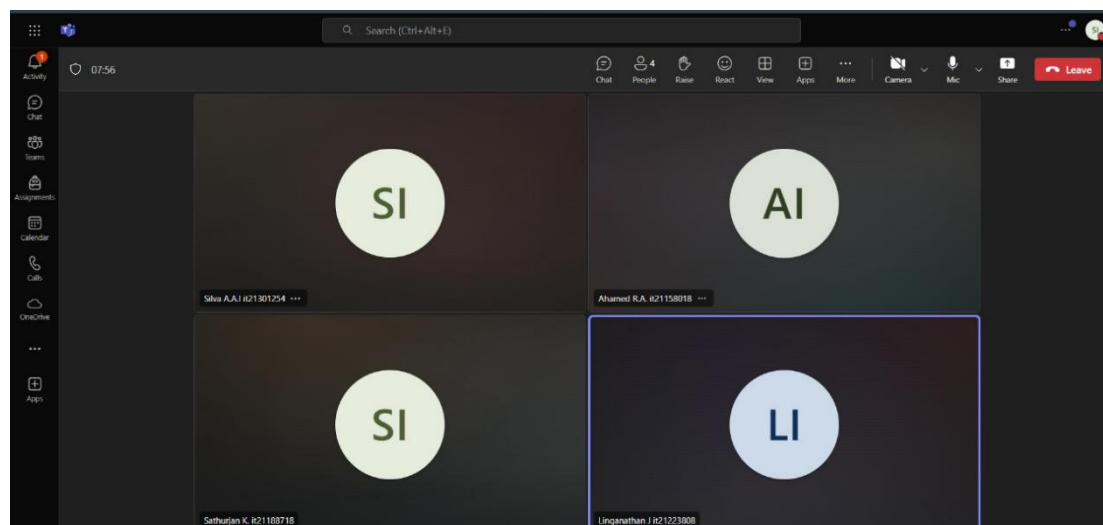
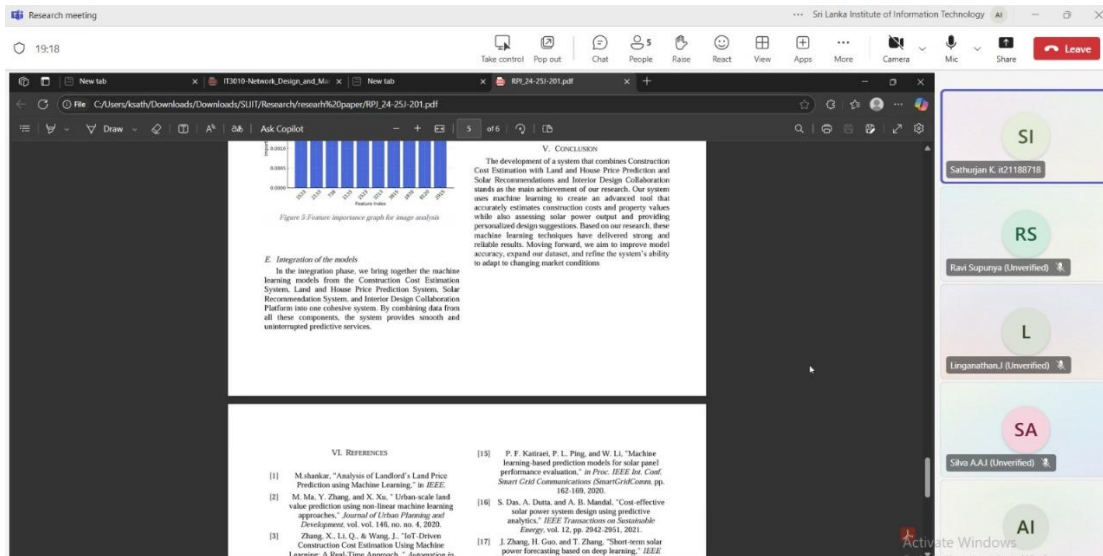
Silva A.A.J (Unverified)

AI

Activate Windows

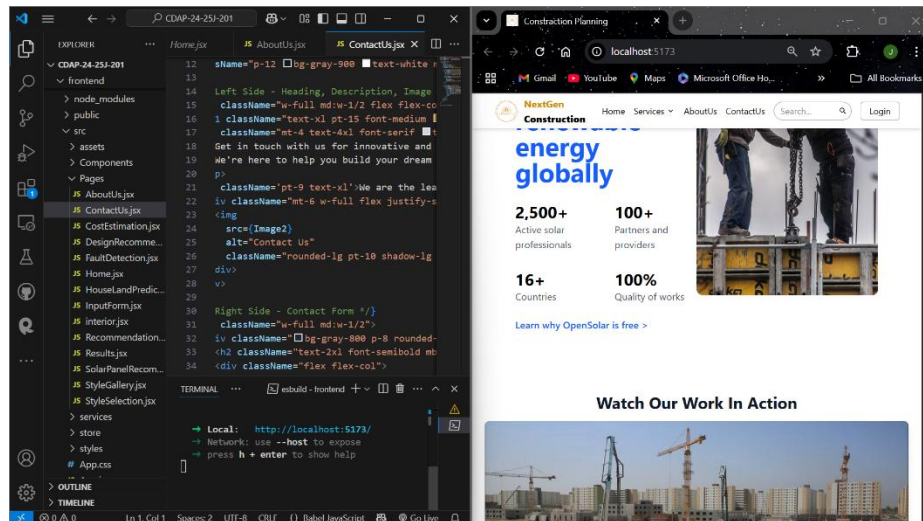
Page 24 of 31





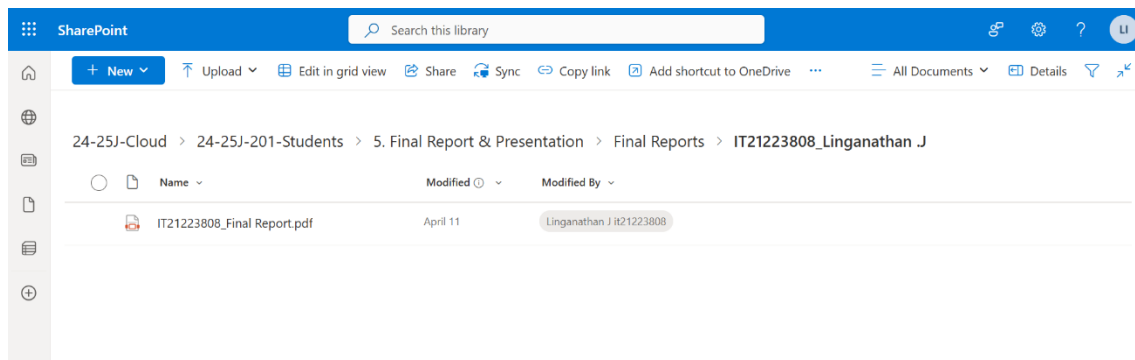
## ❖ Completed Tasks and Conversation Highlights

- Creating the front-end of the application.
- Integration of all the components.
- Discussing the supervisor's suggestions.



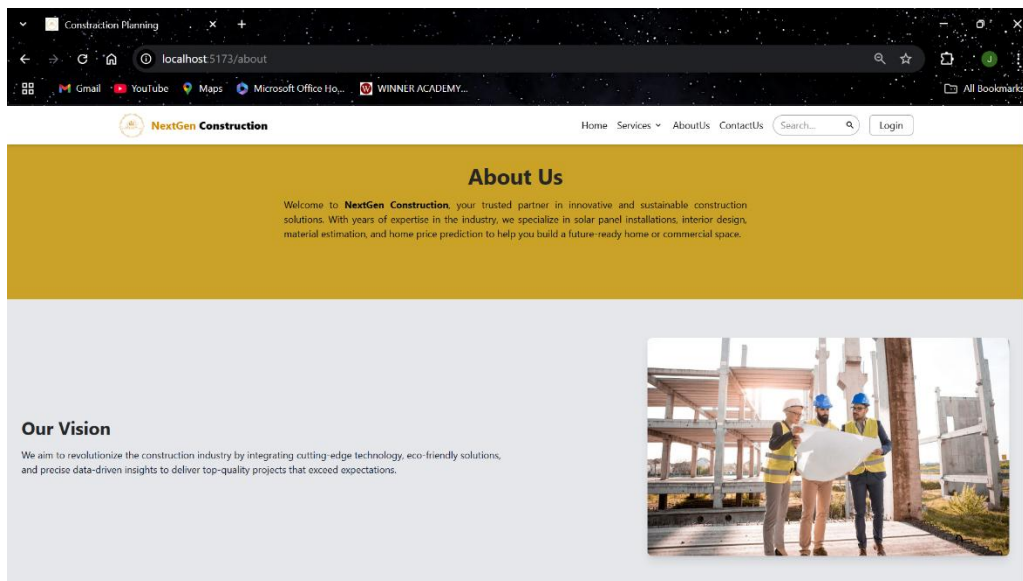
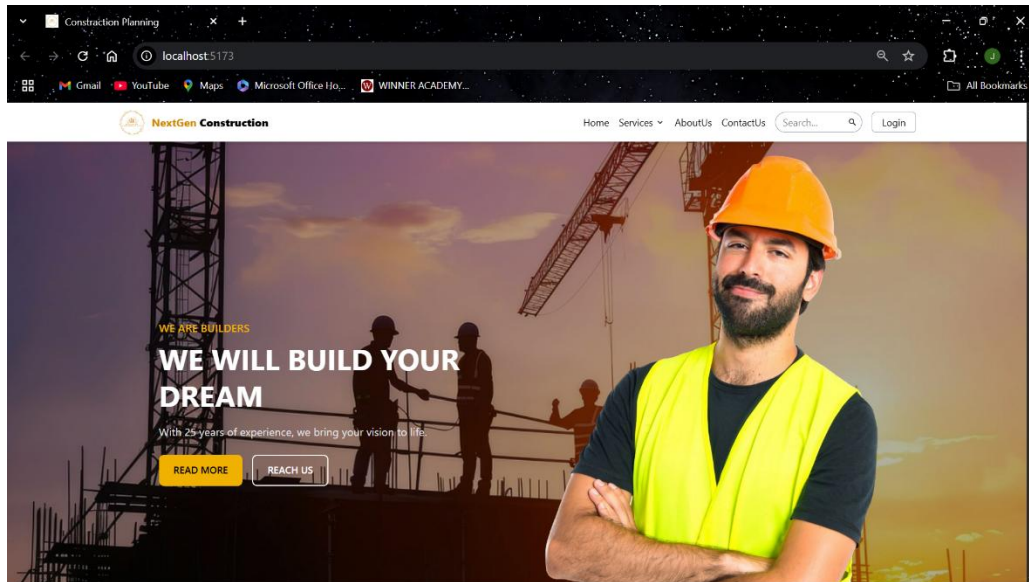
## ❖ Completed Tasks and Conversation Highlights

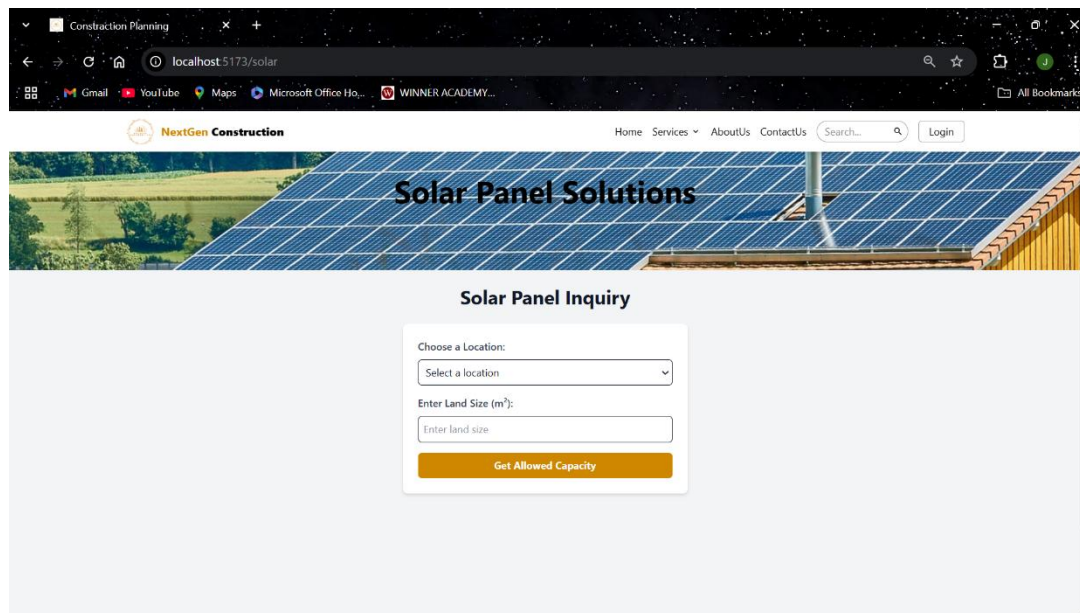
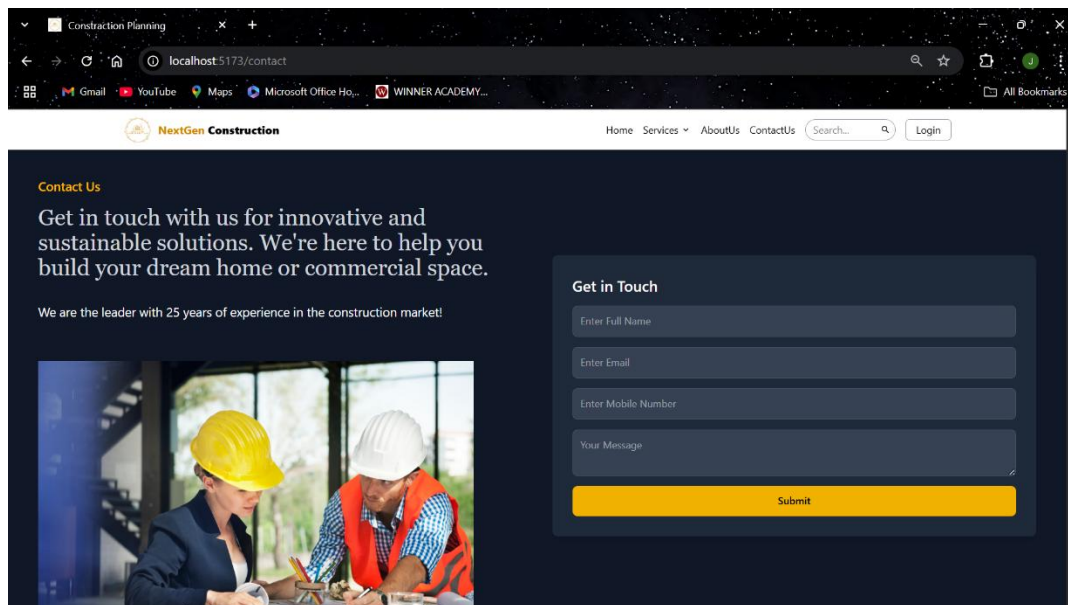
- Complete Individual Thesis Reports.
- Creation Group Thesis Reports.



## ❖ Completed Tasks and Conversation Highlights

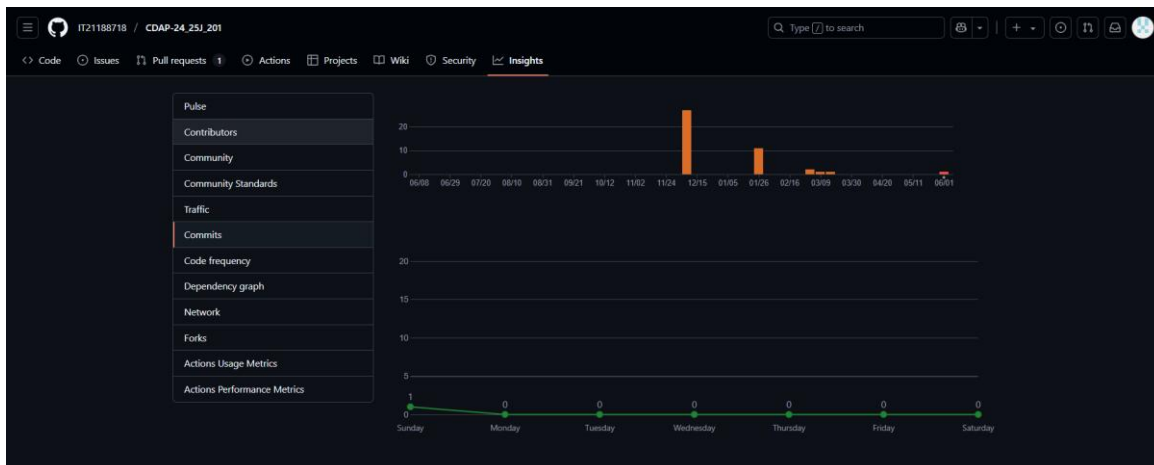
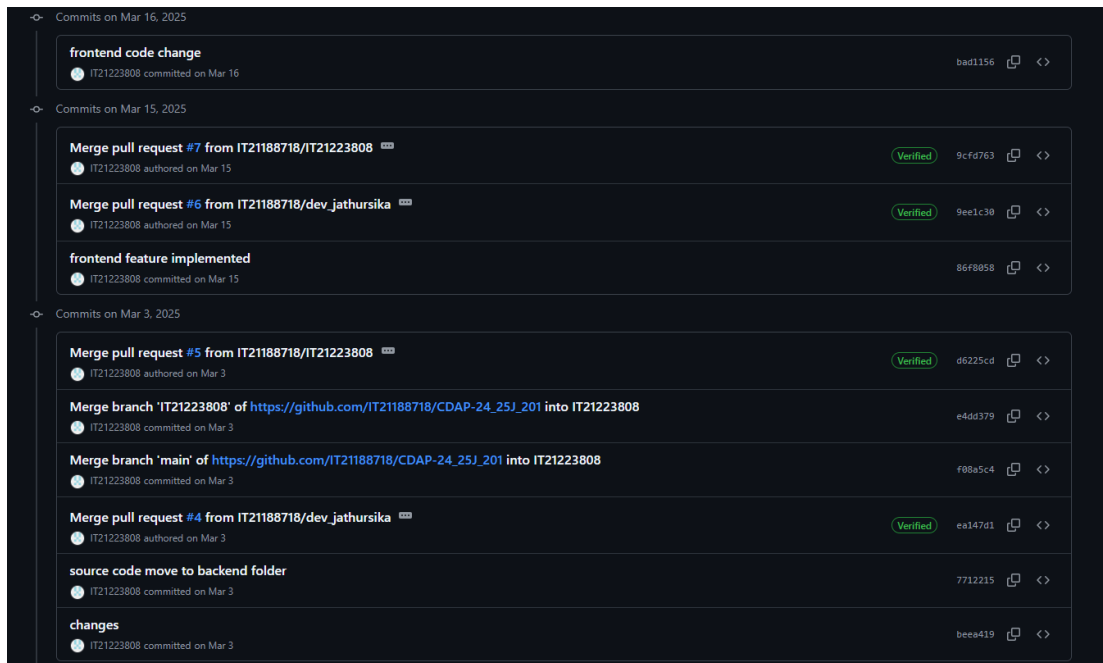
- Create a website for the solution.





## ❖ Completed Tasks and Conversation Highlights

- Creation Branches for Each Commitments.
- Merge Request to Main Branch



Commits on Dec 9, 2024		
implemented database connection	Verified	7fe9be1f
● 1721223808 authored on Dec 9, 2024		
Create util.js	Verified	c61e58a
● 1721223808 authored on Dec 9, 2024		
Delete src/models/model.js	Verified	d57c2e5
● 1721223808 authored on Dec 9, 2024		
implemented models	Verified	3559d38
● 1721223808 authored on Dec 9, 2024		
Create model.js	Verified	c66c263
● 1721223808 authored on Dec 9, 2024		
Delete src/services/service.js	Verified	ee295c4
● 1721223808 authored on Dec 9, 2024		
service functions implemented	Verified	34cde18
● 1721223808 authored on Dec 9, 2024		
Create service.js	Verified	95d233b
● 1721223808 authored on Dec 9, 2024		
Delete src/solarRecommendController.js	Verified	88c914a
● 1721223808 authored on Dec 9, 2024		
Delete src/controllers/s.js	Verified	1e7e67b
● 1721223808 authored on Dec 9, 2024		
Delete src/recommendationService.js	Verified	2666fe7
● 1721223808 authored on Dec 9, 2024		

main			All users	All time
Commits on Dec 9, 2024				
Delete src/locationController.js	Verified	3a68a1e		
● 1721223808 authored on Dec 9, 2024				
Delete src/controllersolar.js	Verified	e42e872		
● 1721223808 authored on Dec 9, 2024				
controller functions implemented	Verified	c3c6f5a		
● 1721223808 authored on Dec 9, 2024				
Create s.js	Verified	6c77f5b		
● 1721223808 authored on Dec 9, 2024				
controller functions implemented	Verified	ca51b57		
● 1721223808 authored on Dec 9, 2024				
Create controllersolar.js	Verified	f9b3da1		
● 1721223808 authored on Dec 9, 2024				
Create routes.js	Verified	01892a8		
● 1721223808 authored on Dec 9, 2024				
Schema implemented	Verified	184ac7f		
● 1721223808 authored on Dec 9, 2024				
Create prismaffiles.js	Verified	c18ae8b		
● 1721223808 authored on Dec 9, 2024				
Models implemented	Verified	6eacdf5		
● 1721223808 authored on Dec 9, 2024				
Create model.pkl	Verified	3a6c81b		
● 1721223808 authored on Dec 9, 2024				
solar prediction implemented	Verified	f9ae959		
● 1721223808 authored on Dec 9, 2024				

