EARLY WARNING FOR PRE AND POST FLOOD RISK MANAGEMENT

2021-124

INTRODUCTION

Overall Project Description

- Flooding and landslides have been a very treacherous situation in Sri Lanka where many areas are flooded for the slightest rain.
- Flooding happens due to various reasons such as human and natural reasons.
- Comprehensive analysis on utilizing IOT devices for weather prediction
- Analyze 3rd party API solutions which provides and real-time weather information and develop Proof-of-Concept to verify the accuracy of weather information.
- Usage of data Mining algorithm for the weather prediction based on historic data analysis.
- The implementation of the solution will comply of a web application and mobile application will visualize the finalized data for the end users based on their needs

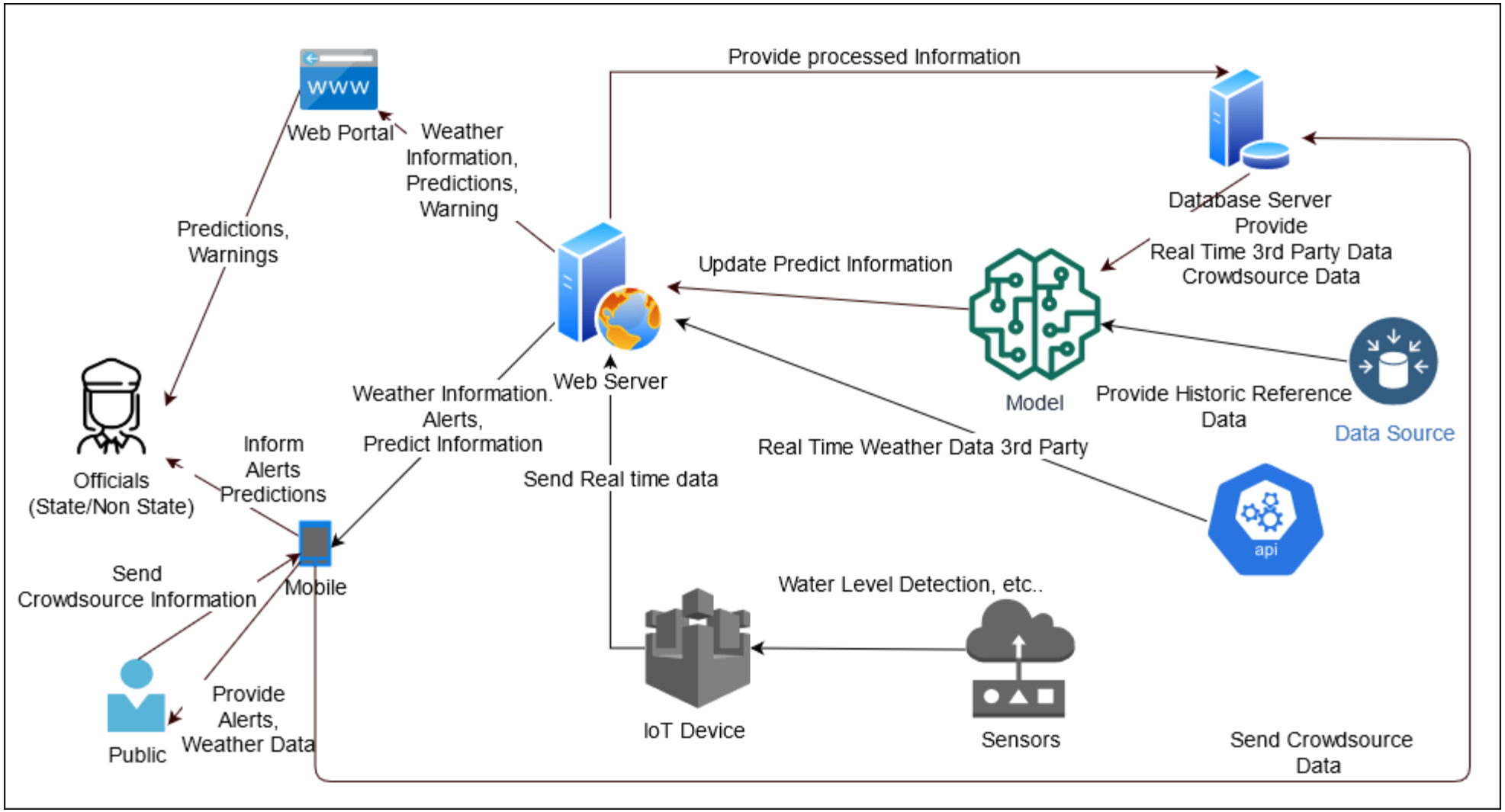
Research Problem

- Unavailability of an early warning tool will be very costly for most of the countries
- One of the major problems that countries face when a flooding situation takes place is, loss of human lives, property losses, agricultural losses, and economic losses.
- Due unadvanced system, poor coordination between people and the officials increase the flood disaster loses and recovery plans are delayed.
- To address these situations, we propose to develop an early warning structure to minimize the devastating destruction that could be caused.

Objectives

- Main Objective
  - Provide an early warning mechanism and predict severe weather conditions which may cause flooding with the use of real-time and historical data.
- Sub Objectives
  - Provide near real-time data collected from IoT devices feeds.
  - Develop severe rainfall prediction model based on historic data analysis and provide suggestions to the end users.
  - Develop crowdsourcing solution to gather weather information from public crowd, analyze and present them to the end users.
  - Create the Flood Forecasting Model to predict the flooding for the selected specific area using historic data collected from past years.

Overall System Diagram



Research Paper

1. ICAC - International Conference on Advancements in Computing - 2021 Conference (SLIIT)

2. ICITR - International Conference on Information Technology Research - 2021 (Moratuwa University)

Commercialization

- Use for weather information application.
- Weather predictions for farmers near river basin.
- Weather predictions for residents living near river basin.
- First Responders in disaster management.
- Government authorities.

IT18022902 | ILUKKUMBURE S. P. M. K. W

Information Technology

INTRODUCTION

Research Question

- Sudden Flooding from a Rainfall can be predicted by pre-existing models.

- Can residents in that area get informed as soon as possible before a heavy rainfall result it to flooding.

- Use of Data Driven Hydrological Models

  - Compared with hydrological models, data-driven models can obtain better or comparable forecasting results [3].

Challenges

- Forecasting Shorter Times
  - ❑ Urban Areas
- Forecasting Longer Times
  - ❑ Forecasting near river basin areas.
- Low Levels of accuracy
- Low Levels of performance

Objectives

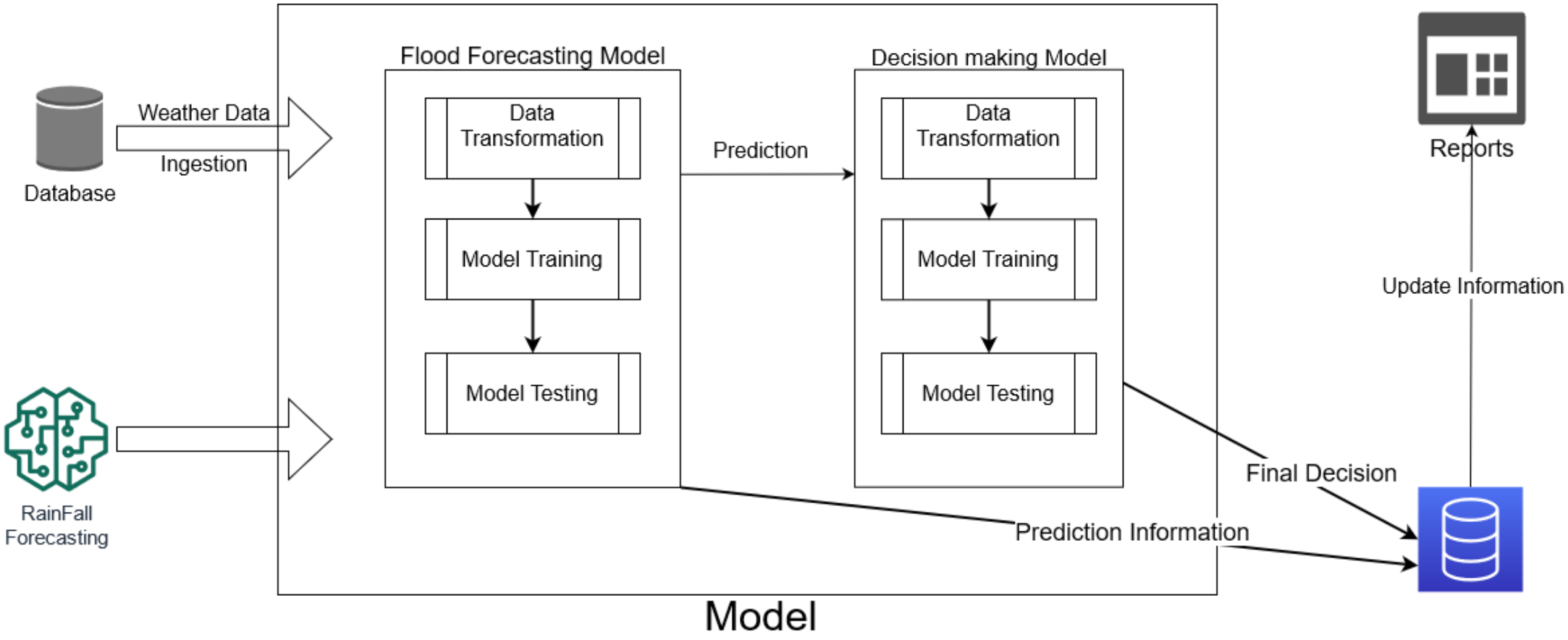
Specific Objective

- Create the Flood Forecasting Model to predict the flooding for the selected specific area using historic data collected about past 3 years.

Sub objectives

- Analysis on river basin flooding using Hydrological model and data-driven model.
- Provide method to overcome challenge of low performance and low accuracy.

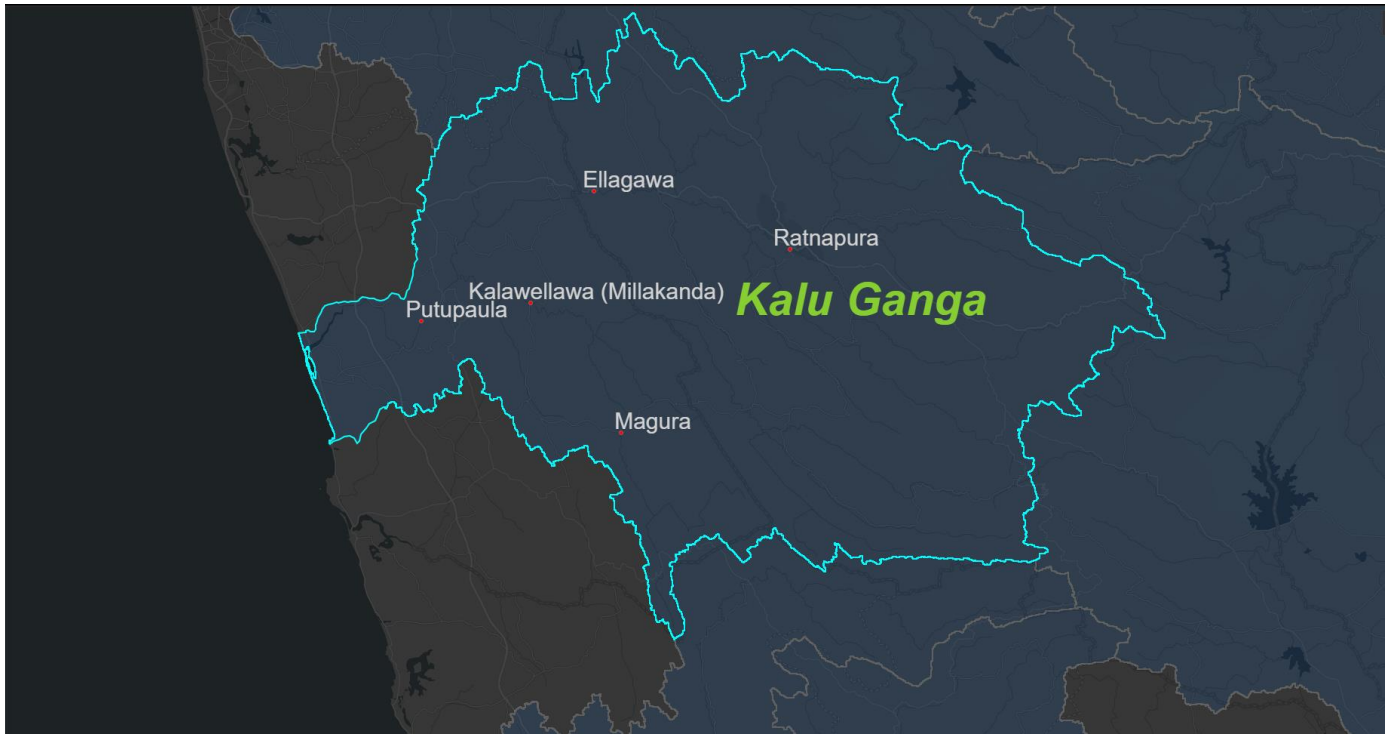
Model Design



Study Area in Research

Kalu River Basin

- Ellagawa
- Kalawellawa (Millakanda)
- Magura
- Putupaula
- Ratnapura



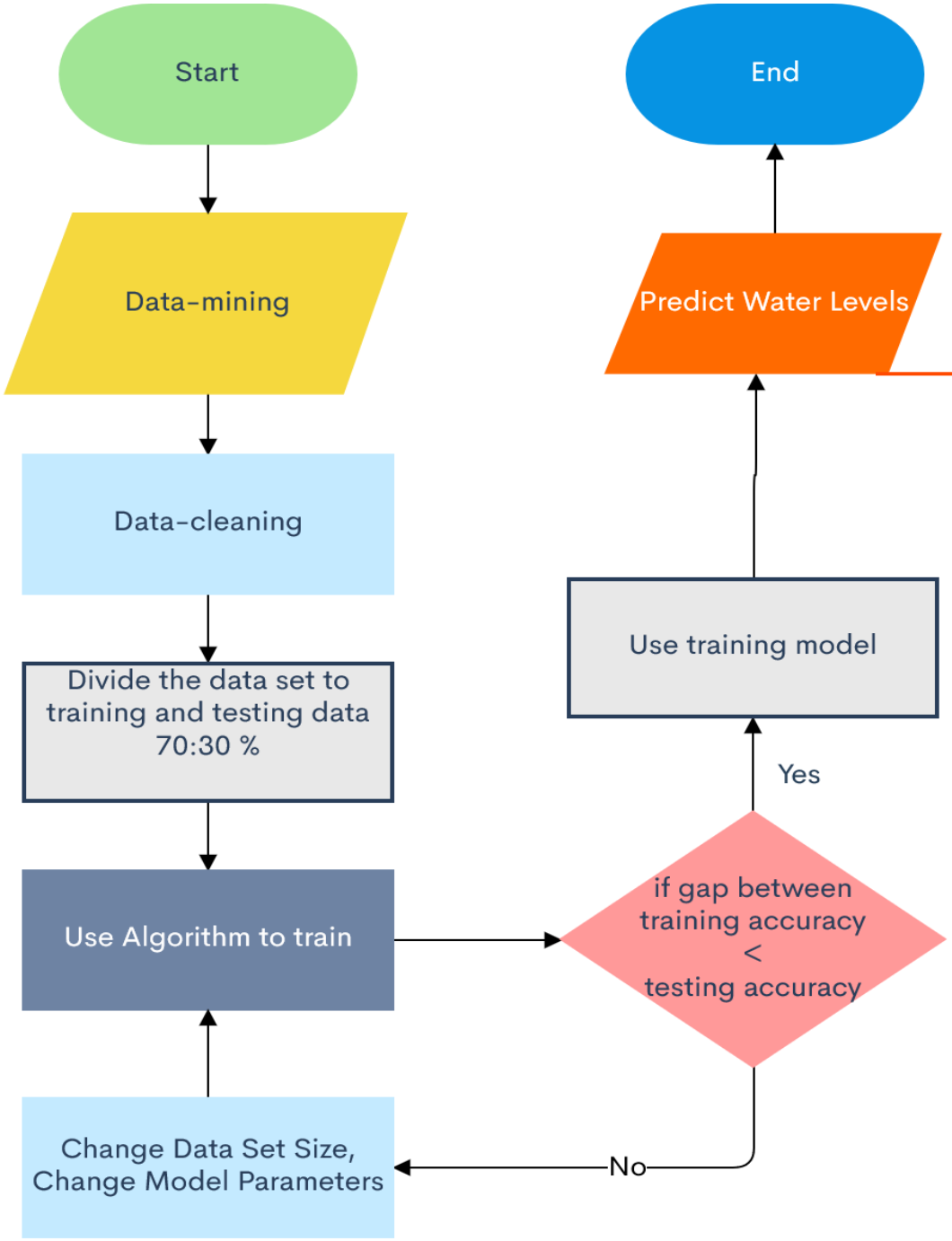
Why?

Suitable for Poof-Of-Concept

- Urban Areas
- Riverside Areas
- Availability of Riverside data

Methodology

- **Data-mining Gathering**
  - Data Reports from DMC (Disaster Management Centre).
  - Daily Reports → Database
- **Representation**
  - ➢ **Dashboards**



Water Model Flowchart

Change Batch Size

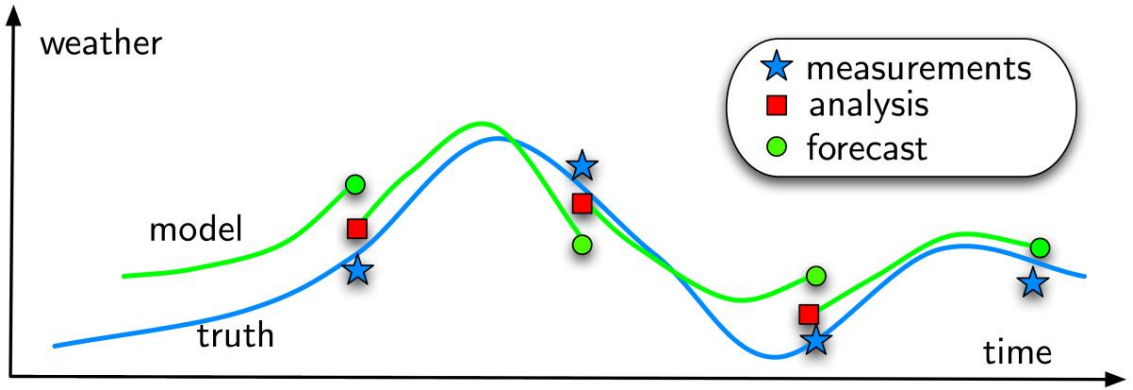
Increased from 50 to 100

Change Model Parameters

Use Normalized training set

Use Normalized test set

Data used



Water Levels of change in **river** on time basis

Number of water levels in a specific station.

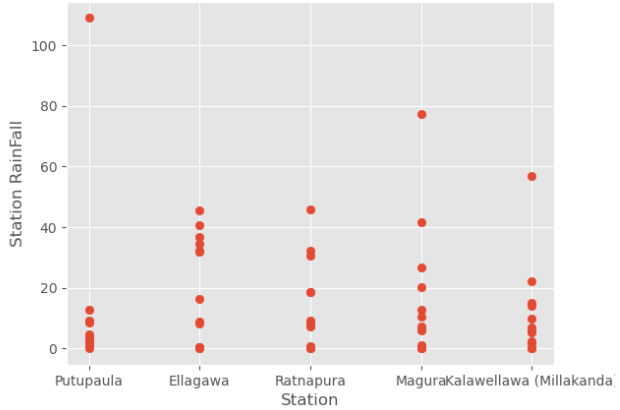
Real-time Water levels

Flow Directions of the river.

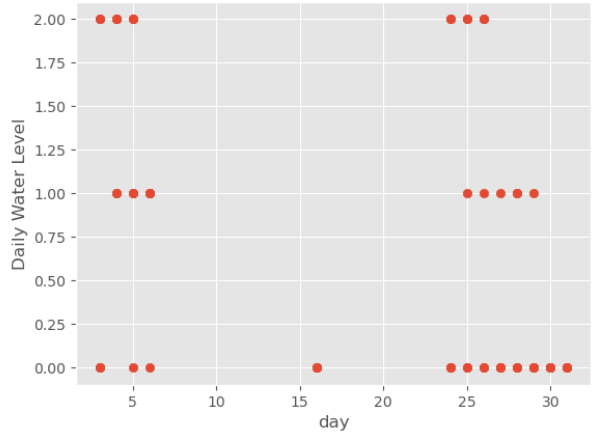
Rainfall model prediction's data

PP1 Achievement

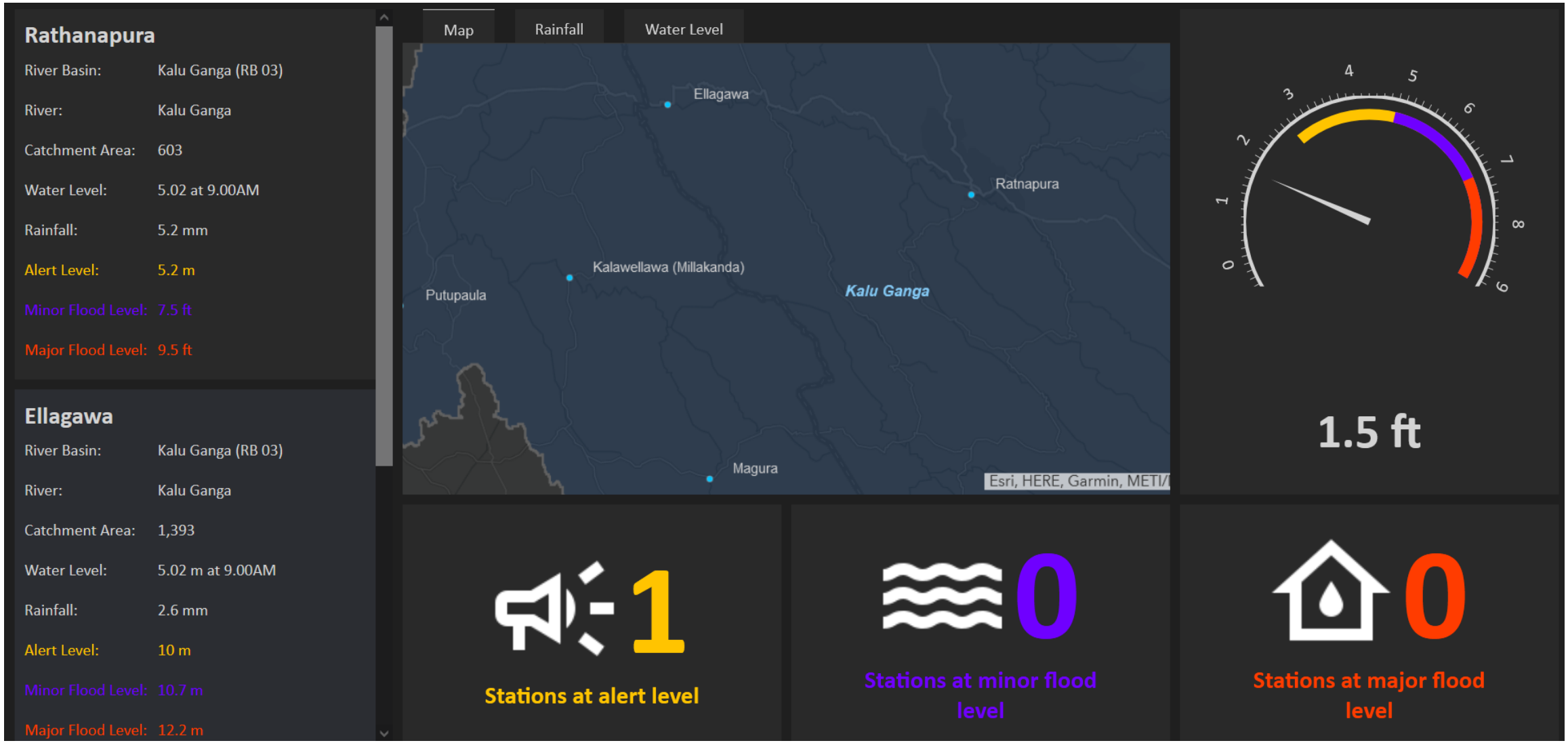
- Successfully crawled through DMC scrapped data
- Processed and cleaned data



- Predicted water level of 5 stations in June
- Daily water level Rising based on days of May.



Achievement



PP1 Achievement

- Training Accuracy of Simple Linear Regression

Data	Accuracy
Alert Level, RF in mm	36.51%
Alert Level, Minor Level, Major Level, Water RF in mm	51.24%
Alert Level, Minor Level, Major Level, Water Level 1h, Water Level at the time, Water RF in mm	62.5%
Alert Level, Minor Level, Major Level, Water Level 1h, Water Level at the time, Water RF in mm, Water Level Rising or Falling	65.84%
Alert Level, Minor Level, Major Level, Water Level 1h, Water Level at the time, Water RF in mm, Water Level Rising or Falling, Remarks	-4.29%

PP1 Achievement

- Training Accuracy of **Support vector machines**

Data	Accuracy
Alert Level, Minor Level, Major Level, Water Level 1h, Water Level at the time, Water RF in mm	79.5%
Alert Level, Minor Level, Major Level, Water Level 1h, Water Level at the time, Water RF in mm, Water Level Rising or Falling	93.84%

Achievement

- Training Accuracy of **Artificial Neural Network**

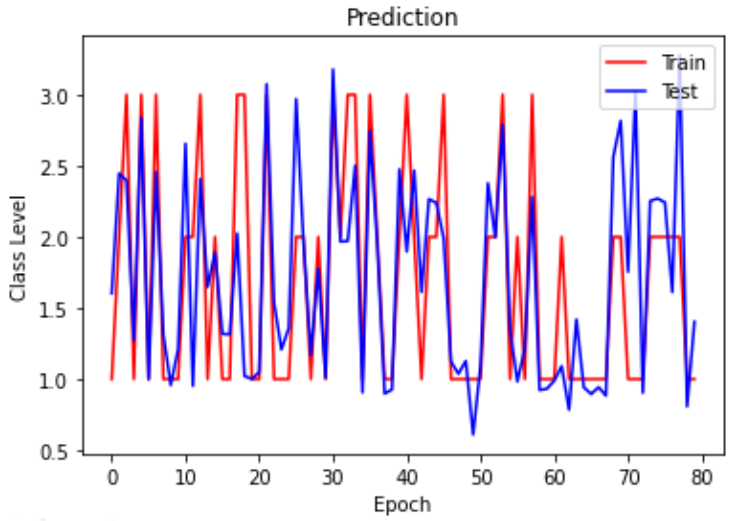
Data	Accuracy %
Alert Level, Minor Level, Major Level, Water Level 1h, Water Level at the time, Water RF in mm	84.3
Alert Level, Minor Level, Major Level, Water Level 1h, Water Level at the time, Water RF in mm	89.01

Adam

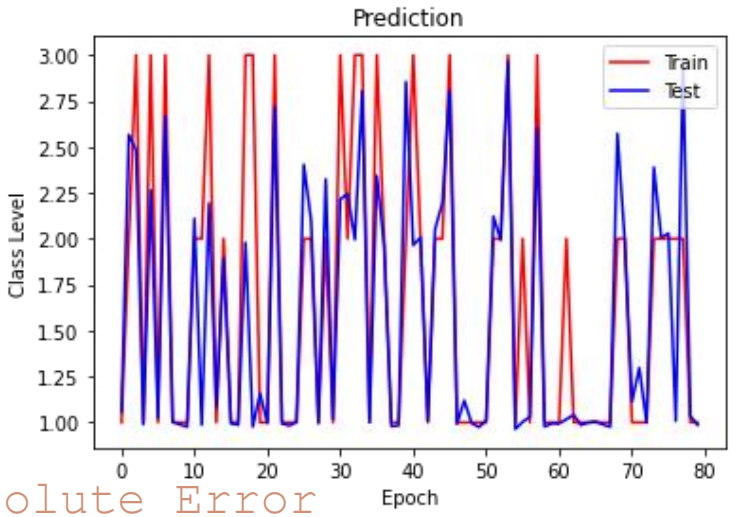
Epoch : 100

Learning Rate : 0.01

Learning Rate Power: 0



Mean Absolute Error



Adamax

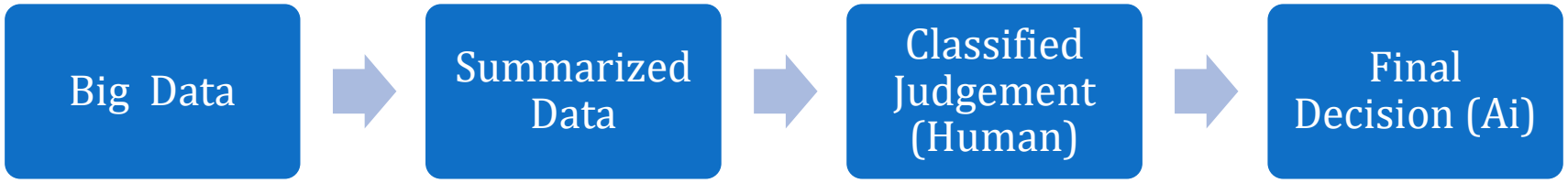
Epoch : 100

Learning Rate : 0.0001

Learning Rate Power: -0.5

➢Decision Making

- With Summarized Data



Progress

- **Decision Making Model**

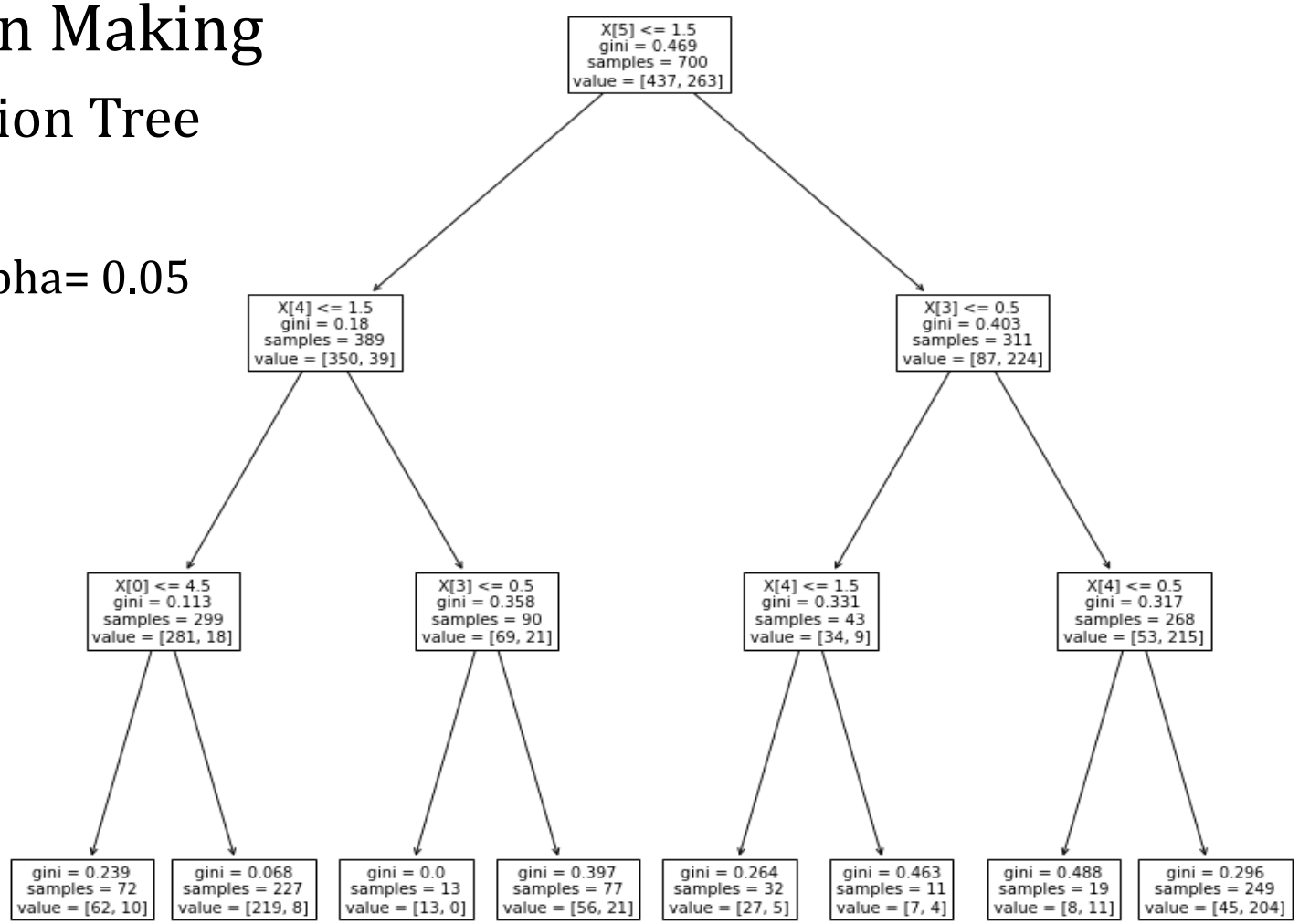
  ➢ Data Sources :-

  - IoT sensor live feed.
    - Ultra-Sonic Sensor Reading.
    - Temperature
    - Humidity
  - Rainfall Prediction value at the time.
  - Water Level Prediction Model Classification value at the time.

timestamp	|__name	||__value	|__name	|__value	|__name	|__value	Current_Rain	Rain_Range	Water_Level_Class
1629734639	Distance cm	4.097	Relative Humidity	78	Temperature °C	31.200001	FALSE	NoRain	0
1626886919	Distance cm	3.978	Relative Humidity	78	Temperature °C	31.6	FALSE	NoRain	0
1626886920	Distance cm	3.978	Relative Humidity	78	Temperature °C	31.6	FALSE	NoRain	0
1626887029	Distance cm	3.995	Relative Humidity	78	Temperature °C	31.6	FALSE	NoRain	0
1626887030	Distance cm	3.995	Relative Humidity	78	Temperature °C	31.6	FALSE	NoRain	0
1626887039	Distance cm	3.961	Relative Humidity	78	Temperature °C	31.6	FALSE	NoRain	0

➢ Decision Making

- Decision Tree
  - alpha= 0.05



- X[0] = Distance
- X[1] = Humidity
- X[2] = Temp
- X[3] = Current Rain
- X[4] = Rain Rage
- X[5] = Water levels

Progress

- **Decision Making Model 2**
  - ➢ Data Sources :-
    - Crowdsource Data. (Accepted)
      - Is Flooding.
      - Is Affected.
      - Water level.
    - Rainfall Prediction value at the time.
    - Decision Tree Classification.

Progress

- **Decision Making Model2**
  - ➢ Data Sources :-
    - Crowdsource Data. (Accepted)
      - Is Flooding.
      - Is Affected.
      - Water level.
    - Rainfall Prediction value at the time.
    - Decision Tree Classification.

Completed Models Accuracy

Data	Accuracy(percentage)		
	SLR	SVM	ANN
Train	81.2	79.4	89.01
Test	79	77.0	84.3

Accuracy table of water prediction models

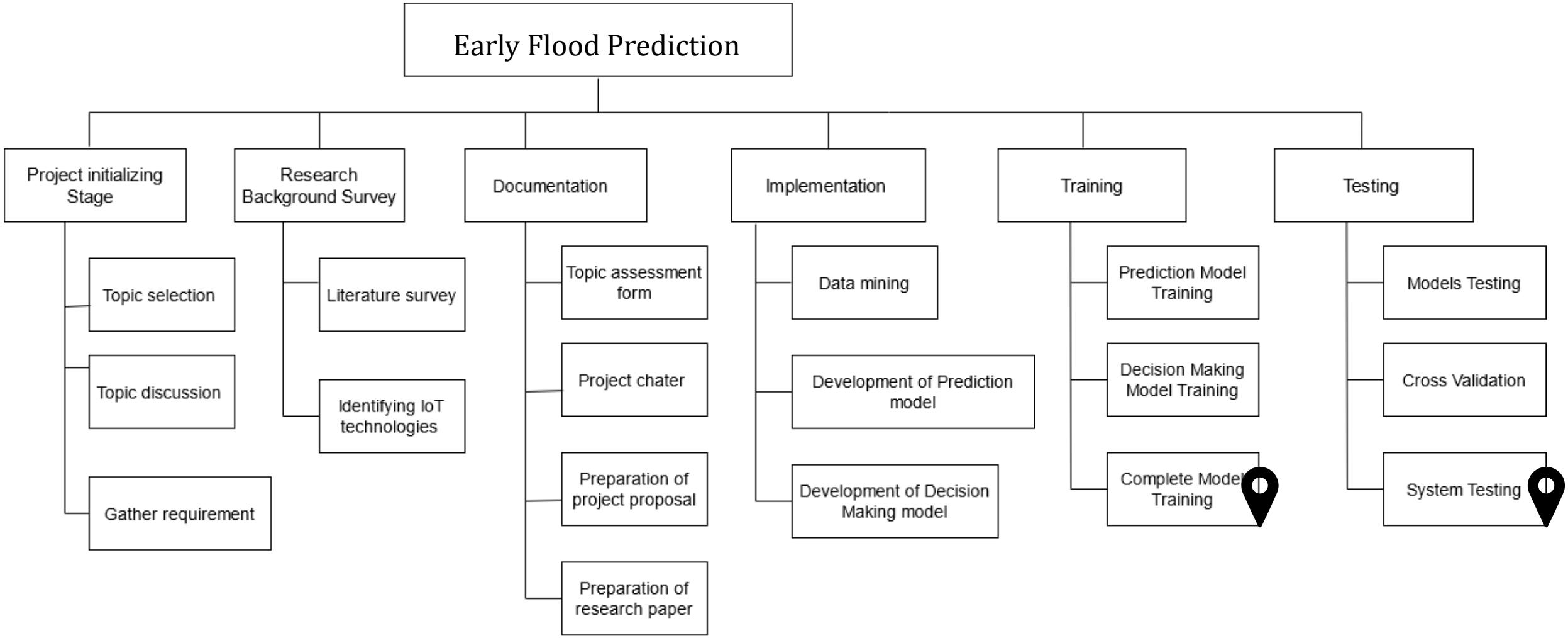
Data	Decision Tree
Train	50.4%
Test	52.4%

Accuracy table of decision tree model

Water Model Classification Levels

Classification	Value
Normal	1
Alert Level	2
Minor Level	3
Major Level	4

Work Breakdown Structure



Progress Completion

1. Obtained detailed data of daily water levels from Irrigation . Department.(2020-2021).
2. Processed and cleaned data of the obtain data.
3. Training the flood forecasting model with river level data.
4. Built Dashboard to represent Daily Water Level.
5. Evaluation.
6. Build the decision-making model.
7. Test Models

Final Touches

1. Update the Web Dashboard to Represent Decision Making Model Predictions.

Commercialization of Models API

Subscription (monthly/ annually) based API access for forecasts.

One-time payment access for forecast in IoT device purchase

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[2] S. Kokularamanan, A. W. M. Rasmy, D. Perera, and T. Koike, “Development of a Flood Forecasting and Data Dissemination System for Kalu River Basin in Sri Lanka,” *Annual Sessions of IESL, The Institution of Engineers, Sri Lanka*, vol. 1, pp. 205–210, 2017.

[3] A. Mosavi, P. Ozturk, and K. W. Chau, “Flood prediction using machine learning models: Literature review,” *Water (Switzerland)*, vol. 10, no. 11, pp. 1–40, 2018, doi: 10.3390/w10111536.

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[5] S. Puttinaovarat and P. Horkaew, “Flood Forecasting System Based on Integrated Big and Crowdsource Data by Using Machine Learning Techniques,” *IEEE Access*, vol. 8, pp. 5885–5905, 2020, doi: 10.1109/ACCESS.2019.2963819.

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[7] R. J. Moore, V. A. Bell, and D. A. Jones, “Forecasting for flood warning,” *Comptes Rendus - Geoscience*, vol. 337, no. 1–2, pp. 203–217, 2005, doi: 10.1016/j.crte.2004.10.017.

[8] H. Thilakarathne and K. Premachandra, "Predicting Floods in North Central Province of Sri Lanka using Machine Learning and Data Mining Methods," Research, 2017.

IT18003406 | MOHAMED M. F.

Information Technology

INTRODUCTION

Research Problem

- Monitoring weather data
- Transmission live of weather data
- All users not able to access the applications.
- Providing weather data for users who could not access the system.

We will be focusing on a comprehensive solution to overcome such issues.

Objectives

Specific Objective

- Implementation of smart weather monitoring device which will transmit information to the application and implementation of a method to cater to the users who could not use our system.

Sub objectives

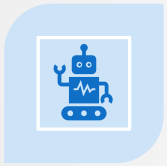
- Implementing a smart weather monitoring device to monitor weather factors.
- Successfully transmit information from the IoT device to the application without any commotions.
- SMS based weather information providing for non subscribed users.

RESEARCH METHODOLOGY

Technologies and Techniques

IOT TECHNOLOGIES

IOT DEVICES AND SENSORS



IOT DEVELOPMENT PLATFORM(ARDUINO IDE)

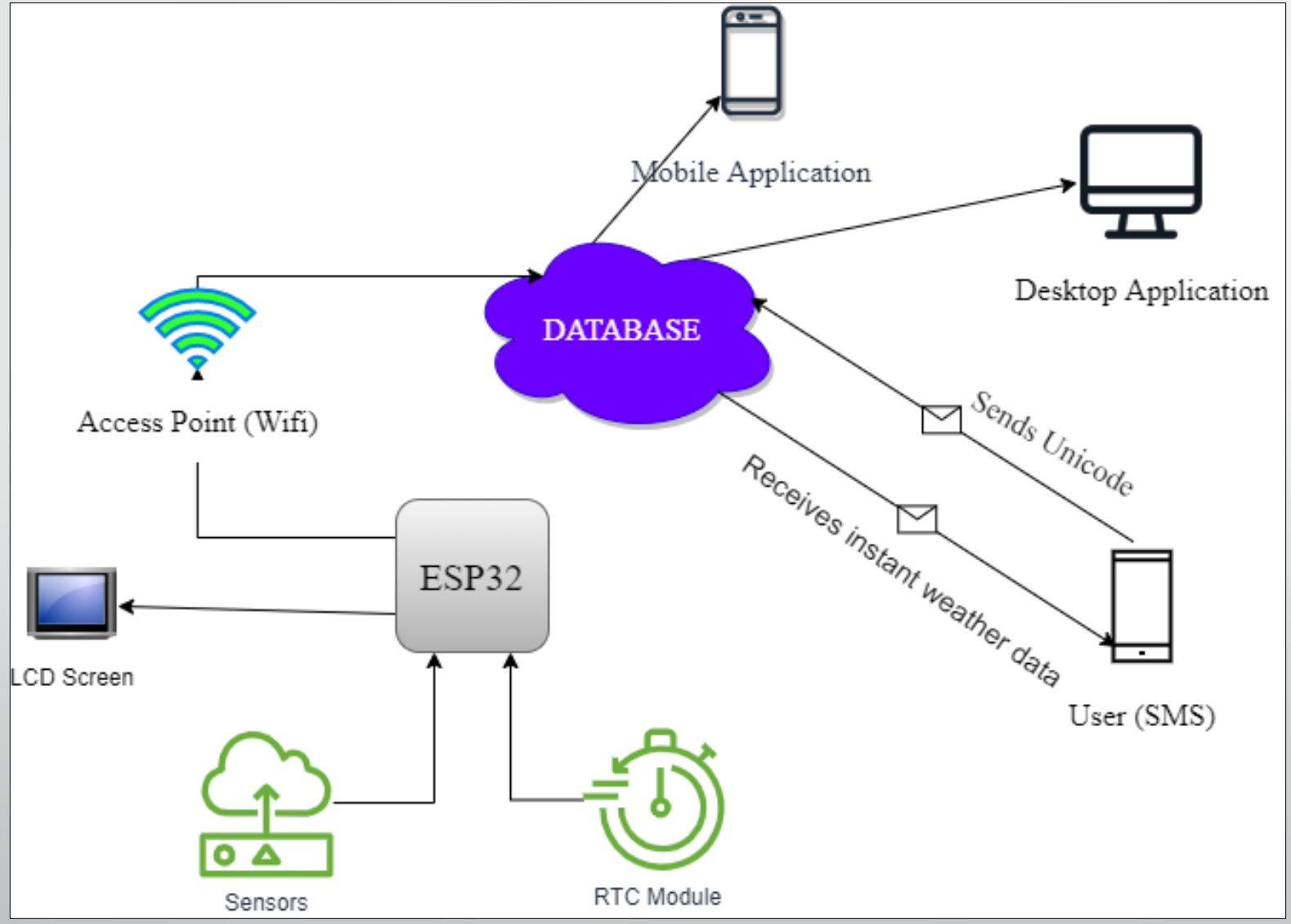
CONNECTIVITY (WI-FI)

FIREBASE

OPTIMAL DATA CAPTURING AND PROCESSING TECHNIQUES

JAVA, C++

High-Level Component Diagram



Methodology

The IoT Device perspective will be consisting of 2 major parts

1. Implementation a smart weather monitoring device.
2. Non-Subscribed users to be able to receive weather data information.

<u>1. Implementation a smart weather monitoring device</u>

- Weather monitoring is done with the help of IoT sensors.
- Gathered weather data will be transmitted to the DB with the help of an ESP32 module.
- These transmitted data will be previewed on the mobile application IoT data dashboard.

Methodology

2. Non-Subscribed users to be able to receive weather data information.

- Users could receive weather information despite of access to the applications.
- User will receive weather information upon request only.
- User needs to request information based on the location.
- User needs to request via SMS by stating the location and will receive the update via same mode.

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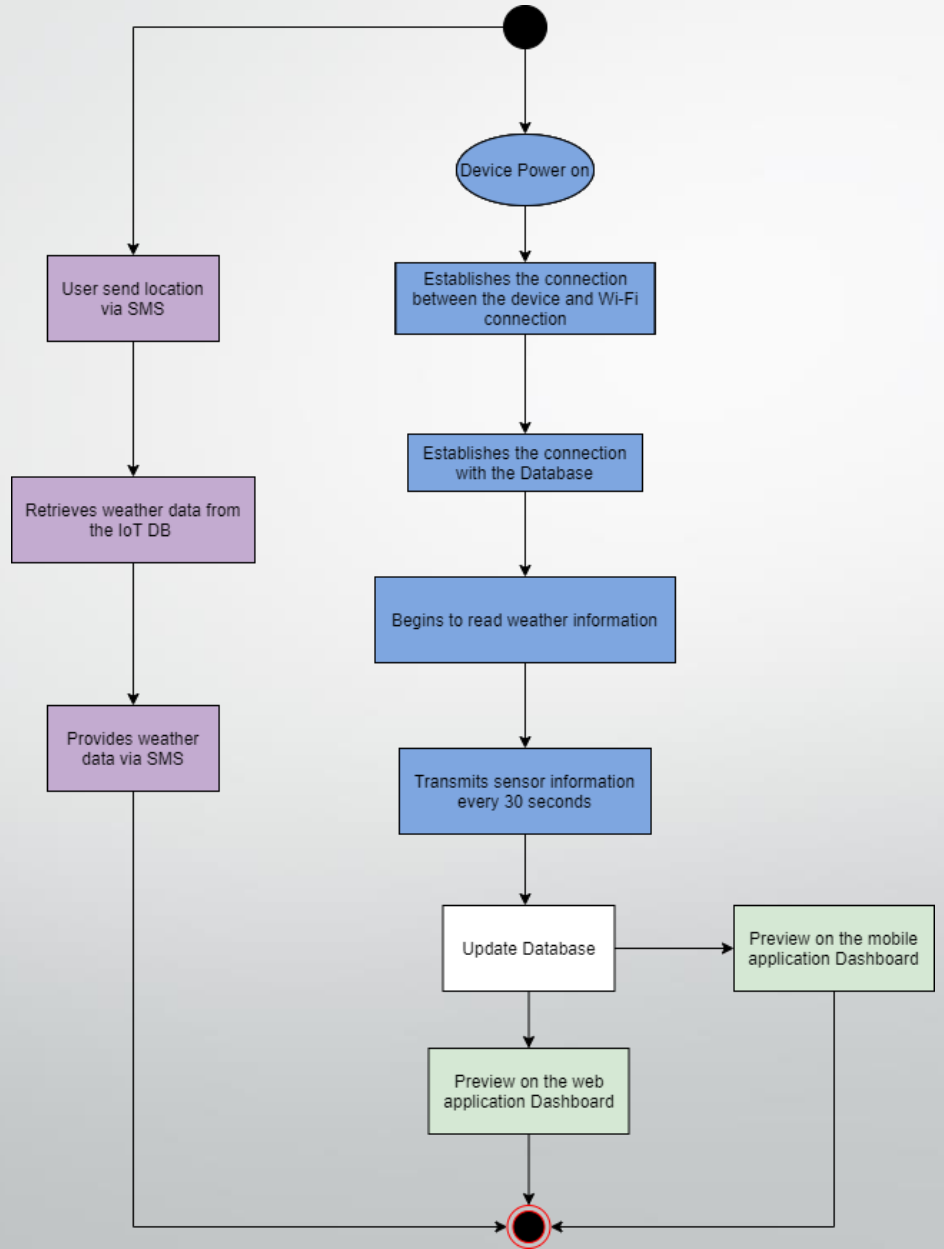
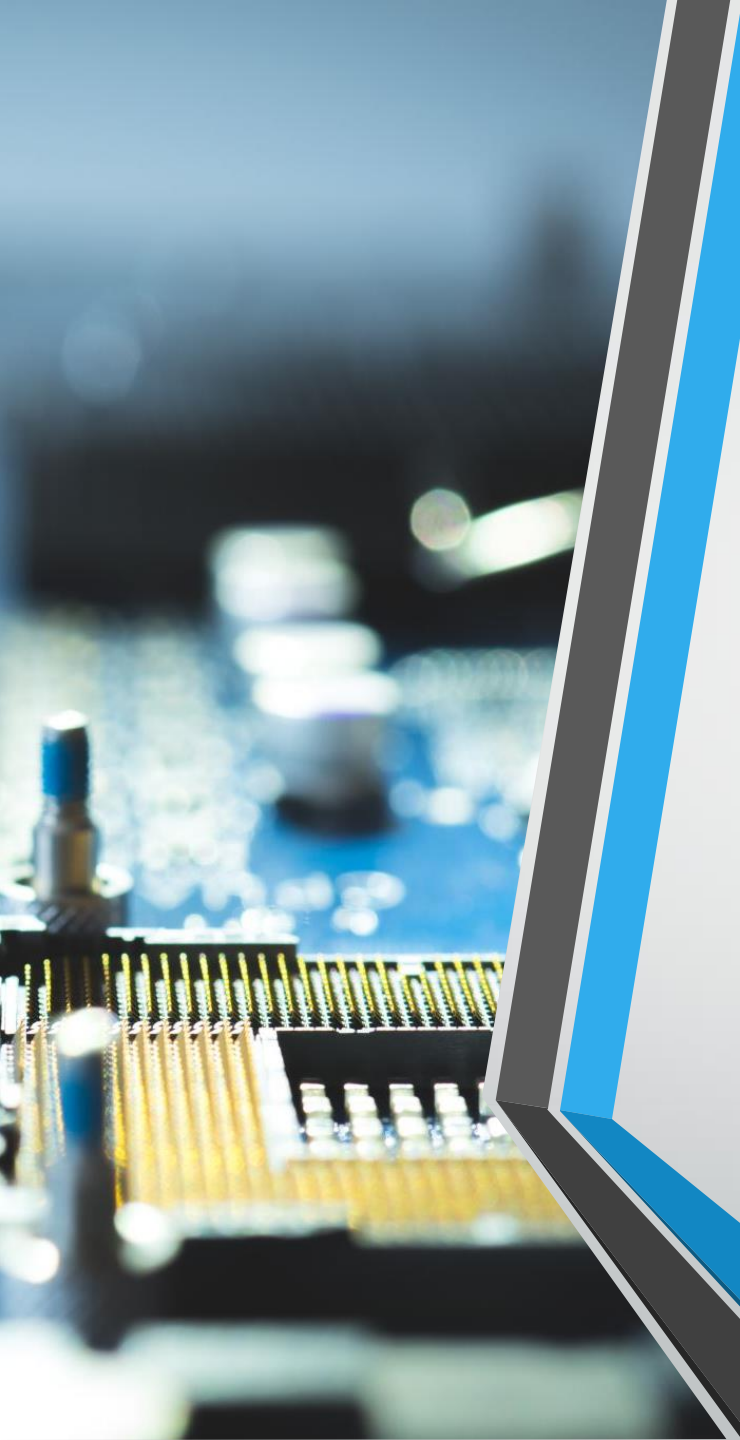
Flow Diagram of the IoT system function

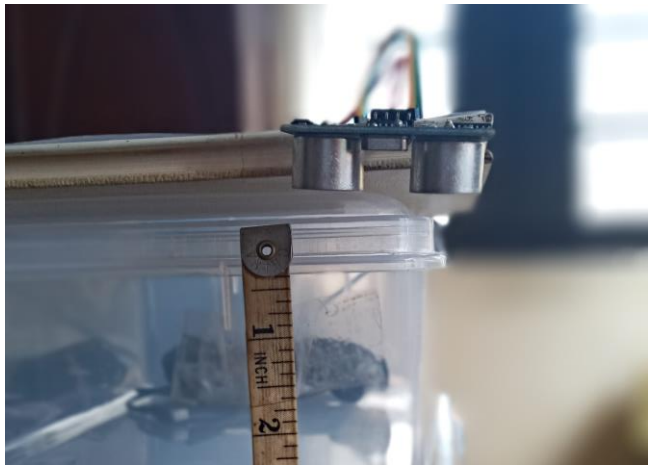


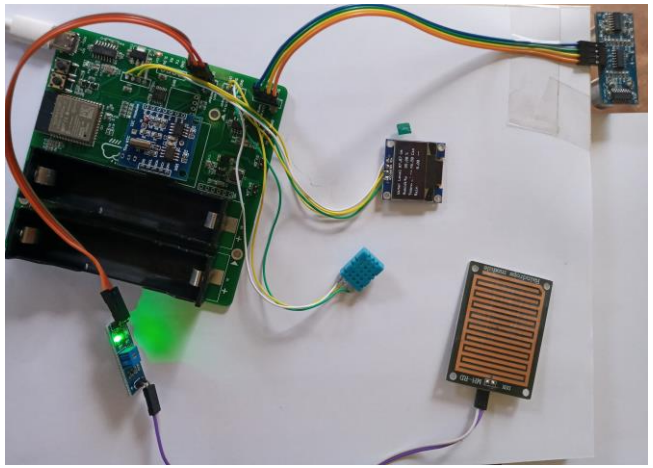


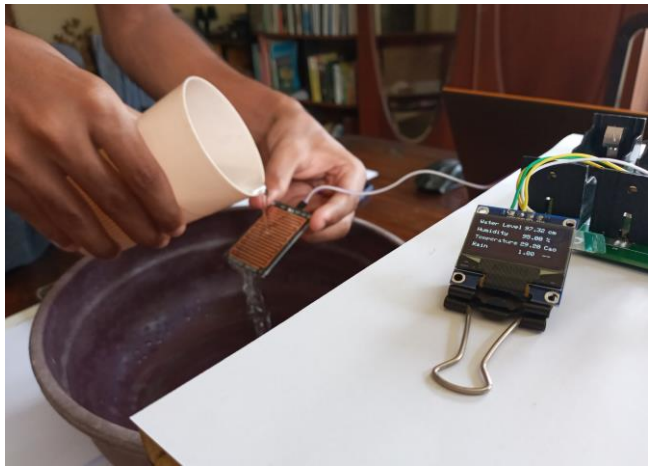
Completion of the project

- Designing a PCB for the IoT device to increase the productivity and the performance of it.
- Assembling of the IOT device with all relevant modules(Sensors, microcontroller).
- Successfully established the IOT device and the Database connection successfully.
- Successfully preview the IOT device data on the mobile application dashboard.
- Partially completed the SMS based weather data providing methodology.

Images of the tasks completed

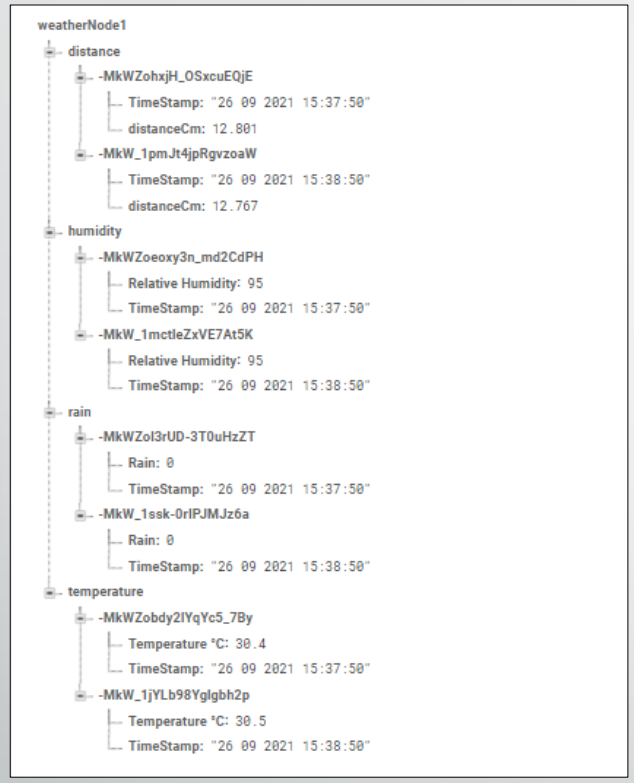


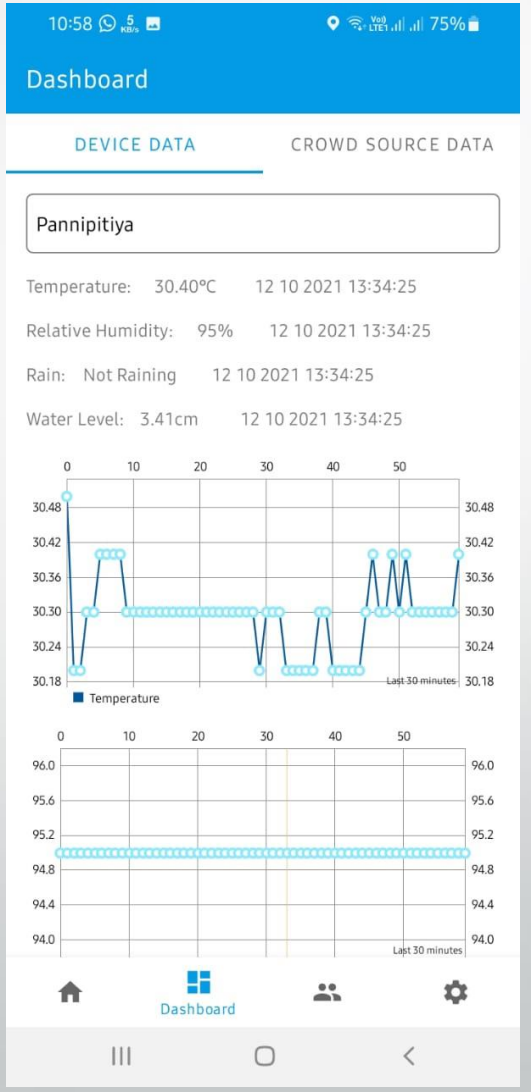


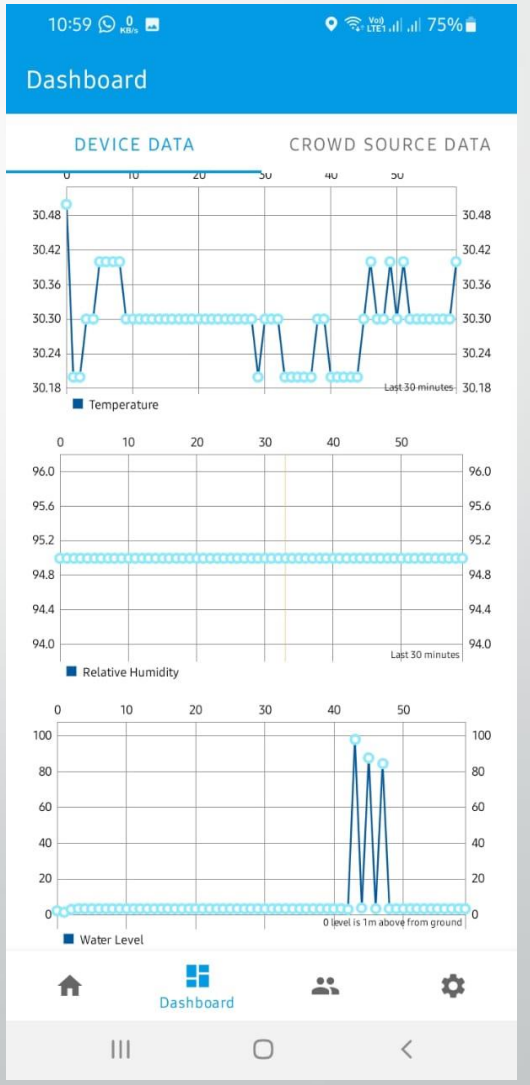


Images of the tasks completed

- Data is transmitted from the ESP32 to the Firebase live database and the mobile application previews the IoT device data







Commercialization

Contract with external parties to transmit live data to there own Databases.

Contract with the state authorities which they could purchase this device for there day to day needs.

Next Progress

DESIGNING OF AN ENCLOSURE FOR THE IOT DEVICE

FURTHER TUNINGS IN THE MOBILE APPLICATION REGARDING THE IOT INTERFACES.

IMPLEMENTATION AND CONFIGURATION OF THE SMS WEATHER DATA PROVIDING SYSTEM.

IT18012620 | V.Y SAMARASIRI

Information Technology

INTRODUCTION

Research Problem

- Usually, the input source of data for a crowdsourcing solution gathered from the public crowd.
- Identified challenges
  1. Sourcing the right crowd
  2. Validate the accuracy of data (Data integrity)
  3. Receive data in precise and concise format
  4. Periodically receive live data
- During this research, the primary focus is to design a comprehensive solution.

Objectives

Specific Objective

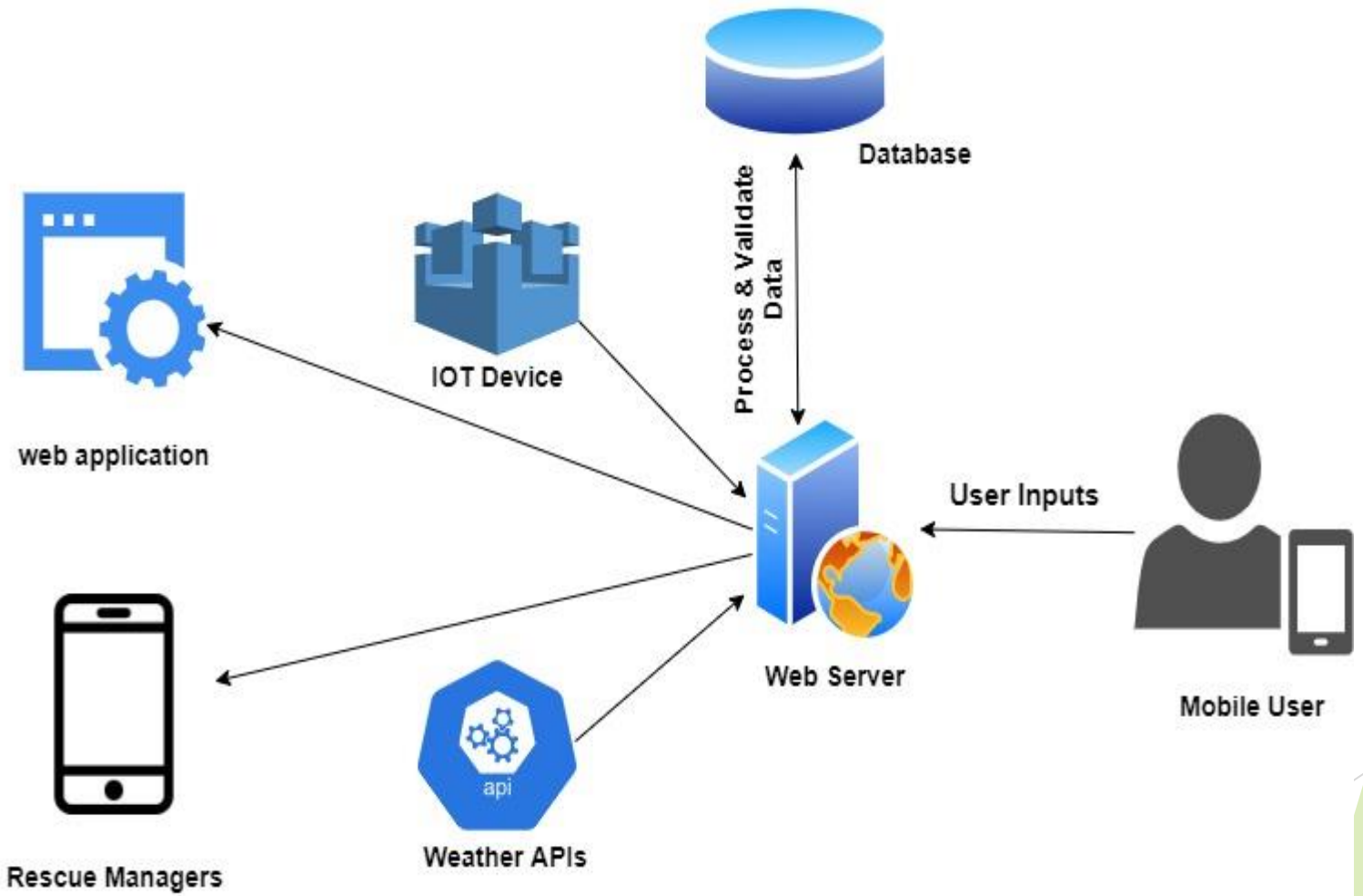
- Main objective is to collect weather information from public crowd, analyze and validate gathered information using statistical data analysis techniques

Sub objectives

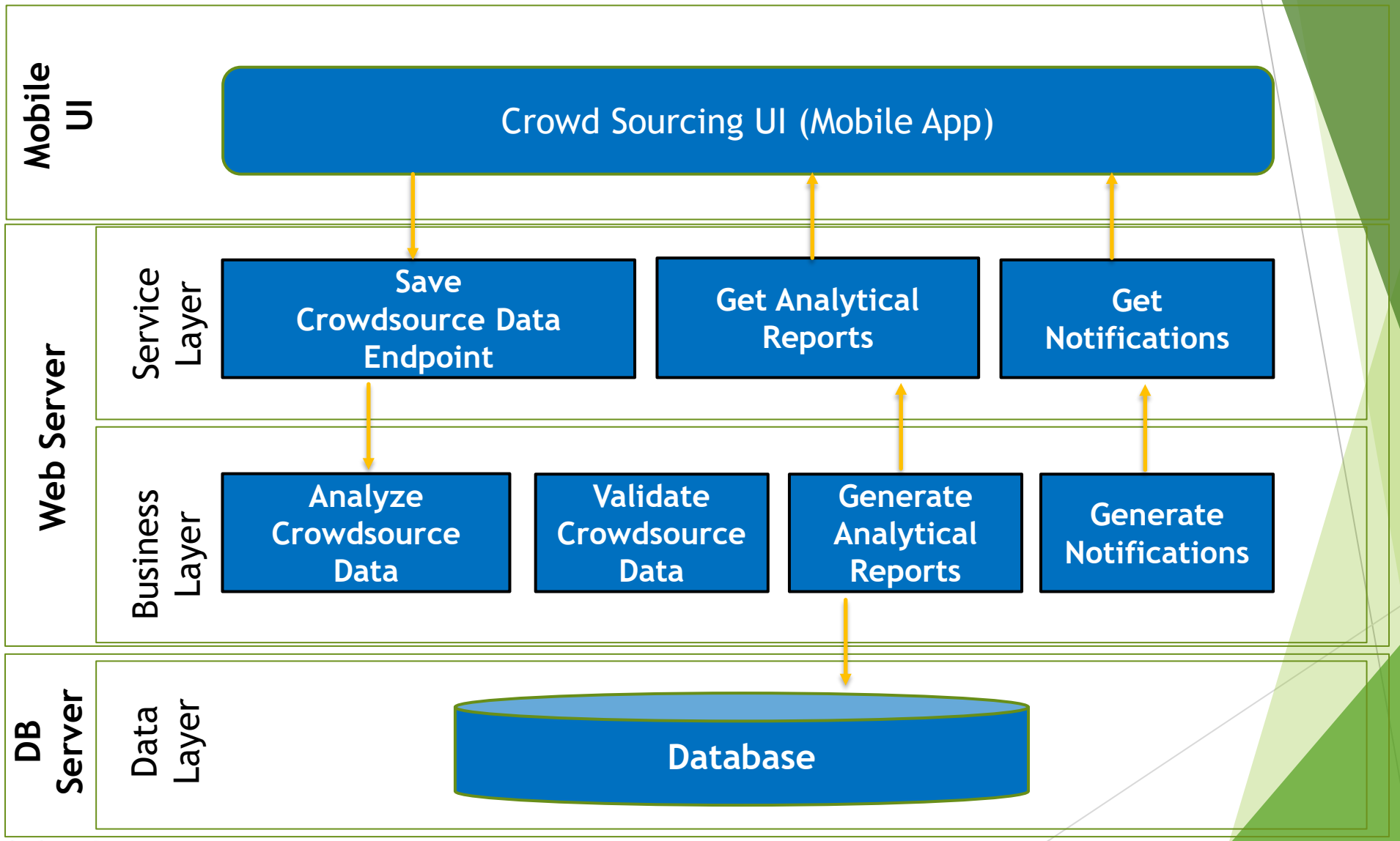
- Implement a way to source the right crowd
- validate the accuracy of crowd sourcing data (Data integrity)
- Structure the data in precise and concise format
- periodically receive live data

RESEARCH METHODOLOGY

High-Level Component Diagram



Crowdsourcing Solution Logical View



Methodology

The Crowdsourcing solution is divided into two main parts

1. Gather weather information from the crowd
2. Display crowdsourcing data to the users

1. Gather weather information from the crowd

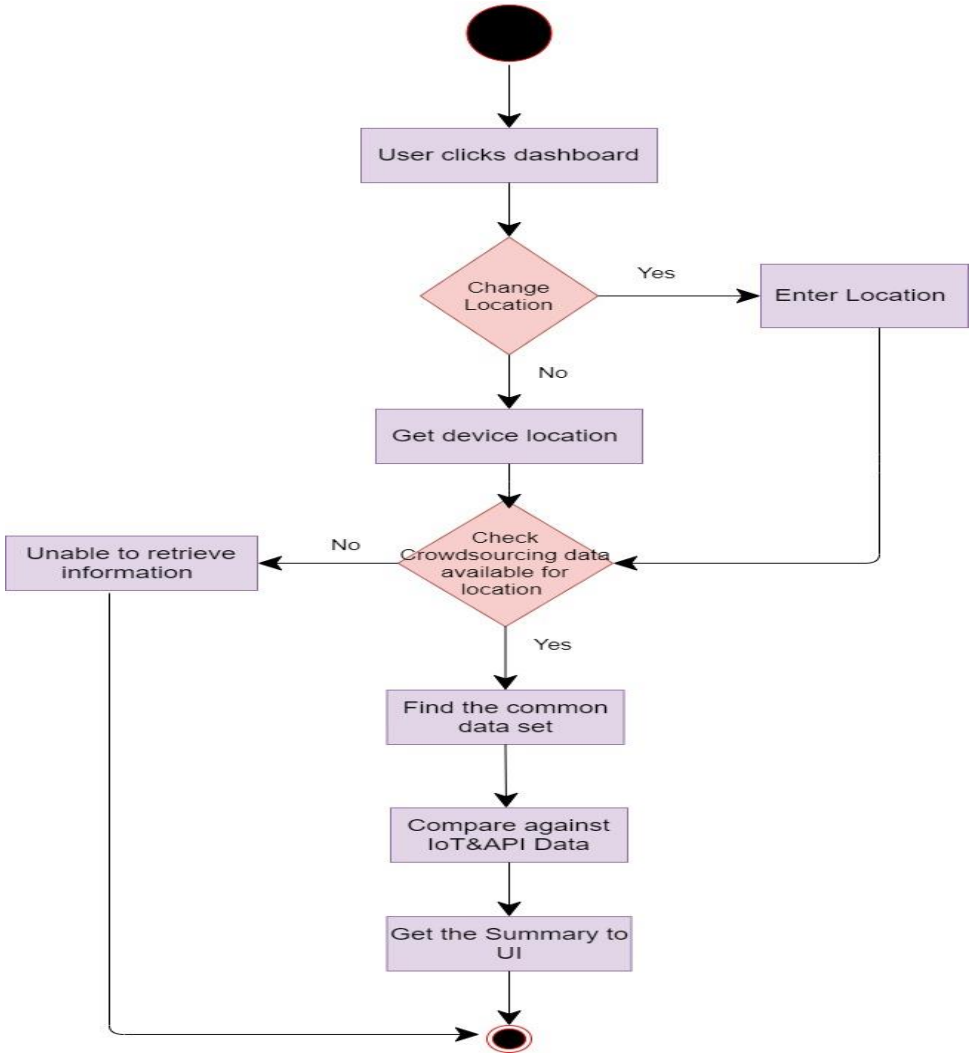
- Information gathered through set of questionaries
- User interface for answering questionaries
- User should be able to easily provide near accurate information
- Impacted location is automatically captured through Mobile location feature

Methodology

2. Display crowdsourcing data to the users

- Current location of the user who views data should automatically captured
- If user needs, he should be able to change the location
- Captured/selected location specific crowd sourcing information can be visualized
- Crowdsourcing data manipualtion follows sequence of processings

Data Manipulation Flow



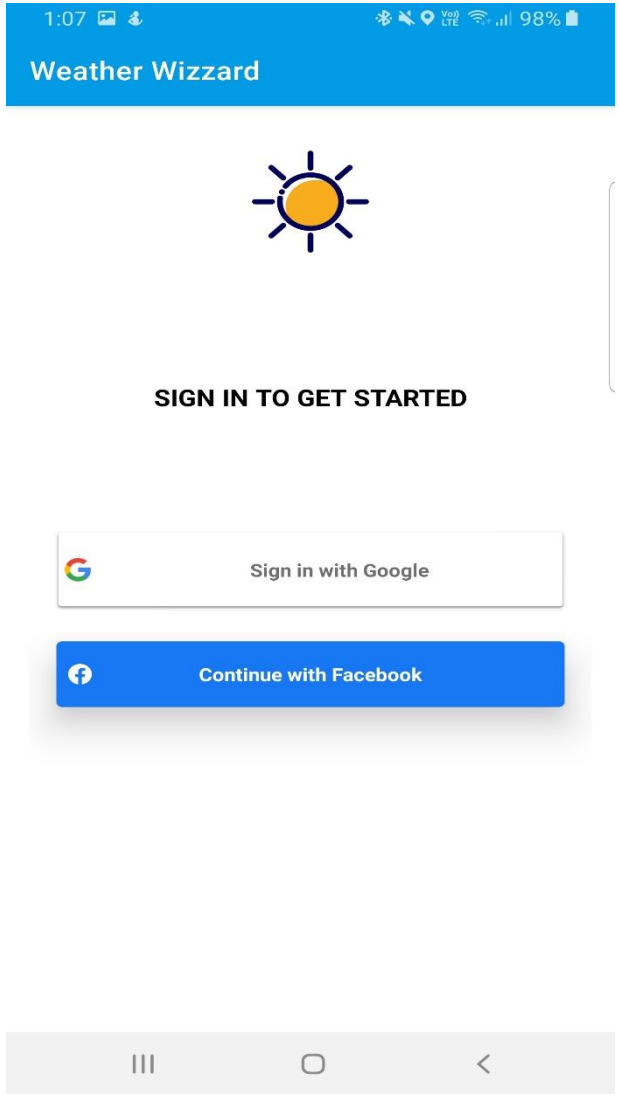
Achievement

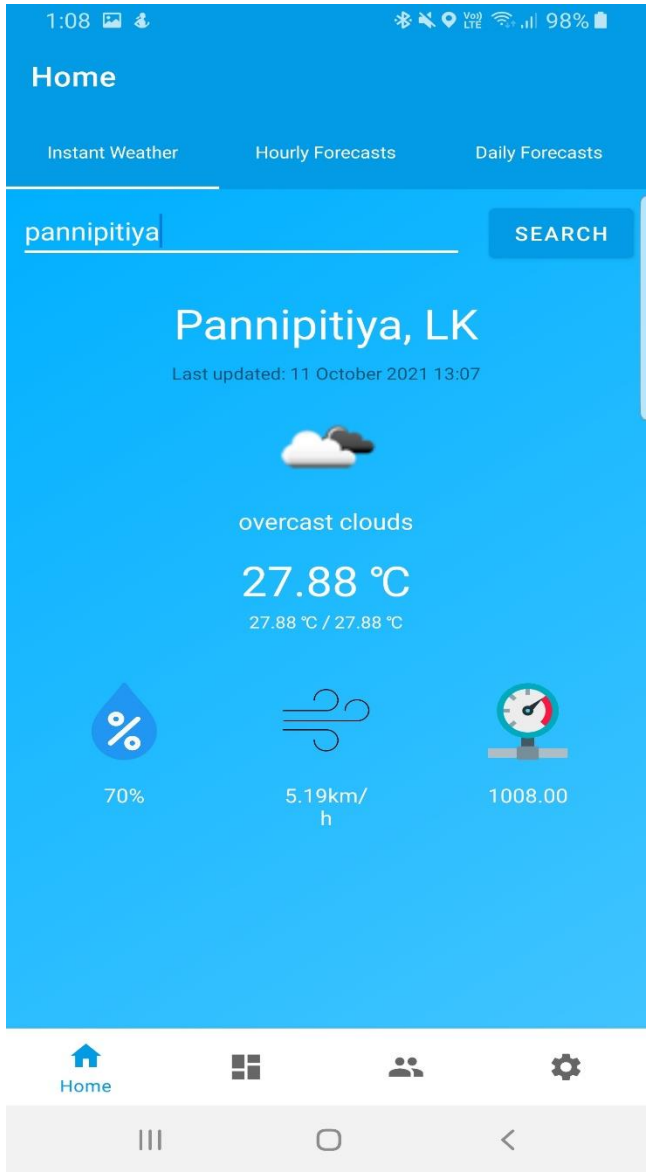
- Successfully implemented mobile user registration
- Establishing connection to the open weather map API using unique API key
- Successfully retrieved live weather data from Open Weather Map API
- Finalized the crowdsourcing data
- Implemented the crowdsourcing UI
- retrieve crowdsourcing weather data from DB and find the common data set and validate the data set against IOT data & weather API data
- Finally visualize the summary to main dashboard

Tools and Technologies

- Android studio
- Java
- Java Script
- Firebase
- OpenWeatherMap API

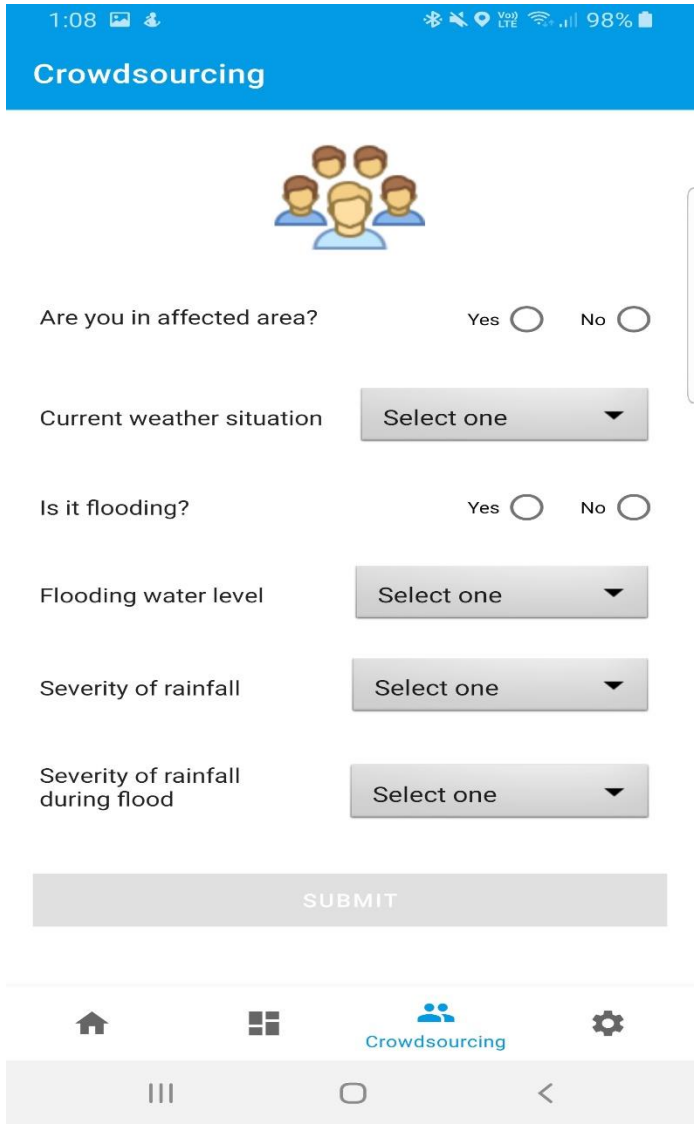
Evidence for Completion

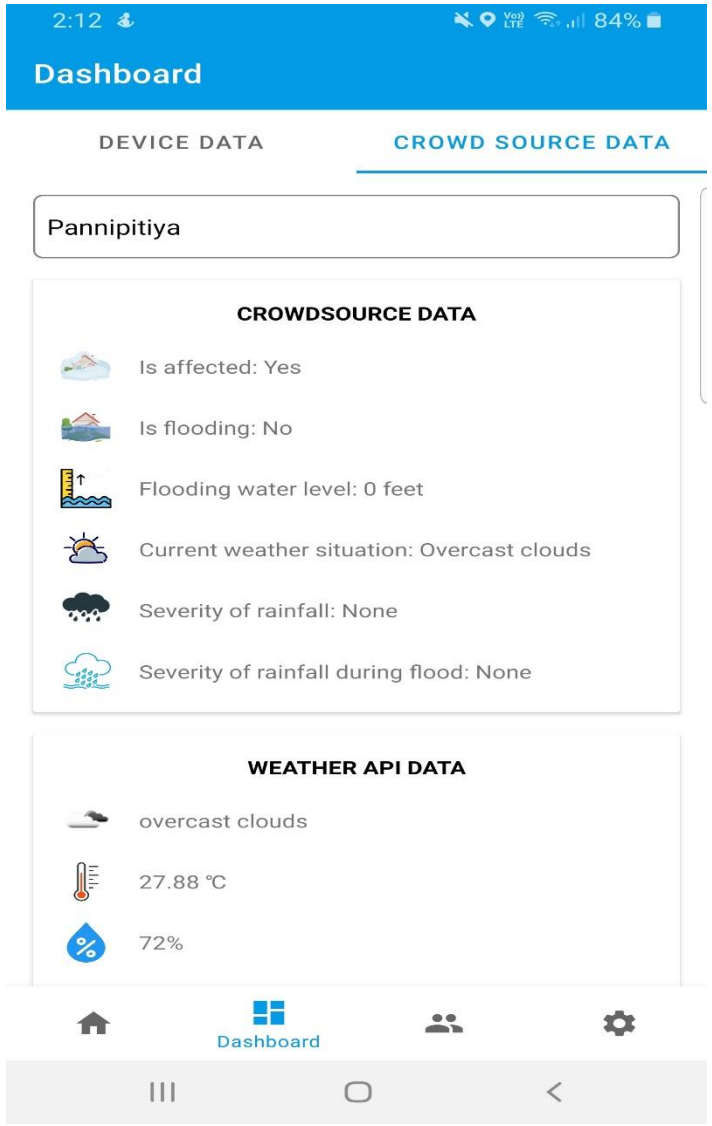


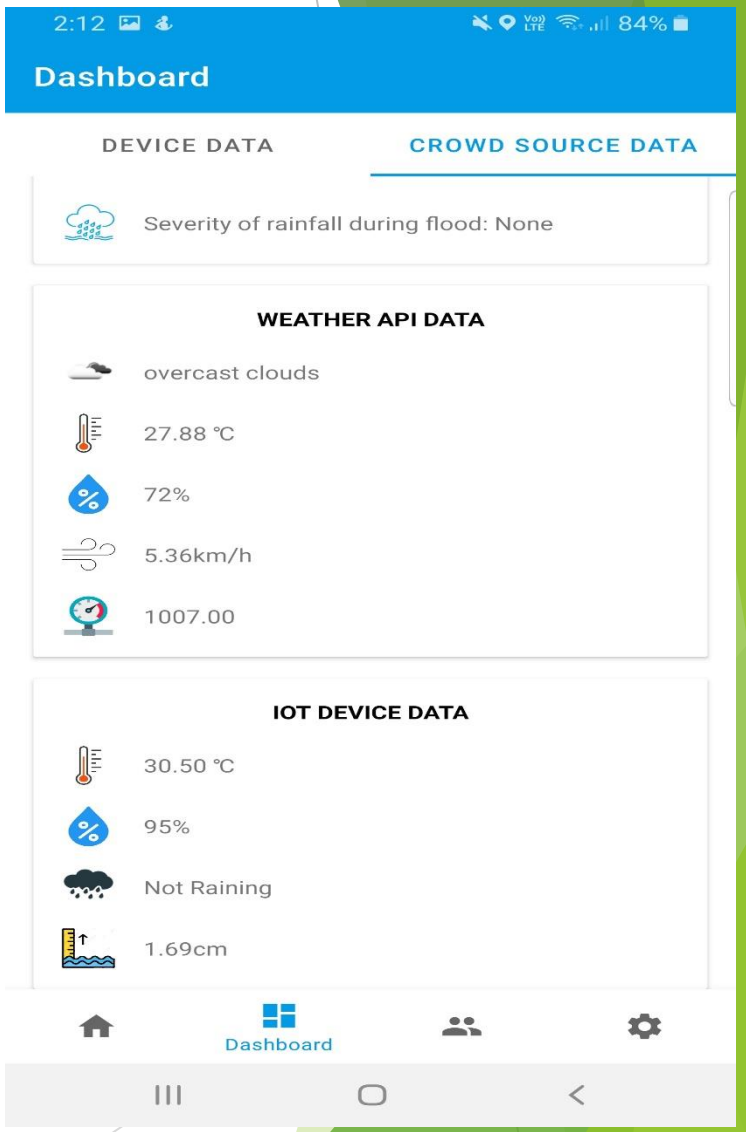

1:08
98%
Home
Instant Weather
Hourly Forecasts
Daily Forecasts
pannipitiya
SEARCH
Pannipitiya, LK
Last updated: 11 October 2021 13:07
overcast clouds
27.88 ℃
27.88 ℃ / 27.88 ℃
70%
5.19km/ h
1008.00
Home


1:08
98%
Home
Instant Weather
Hourly Forecasts
Daily Forecasts
11 October 2021 07:00
light rain
28.1 ℃
11 October 2021 08:00
overcast clouds
27.93 ℃
11 October 2021 09:00
overcast clouds
28.03 ℃
11 October 2021 10:00
overcast clouds
27.74 ℃
11 October 2021 11:00
light rain
27.33 ℃
11 October 2021 12:00
light rain
26.55 ℃
Home


1:08
98%
Home
Instant Weather
Hourly Forecasts
Daily Forecasts
Monday 11 October 2021
moderate rain
28.29 ℃
Tuesday 12 October 2021
moderate rain
26.37 ℃
Wednesday 13 October 2021
moderate rain
28.08 ℃
Thursday 14 October 2021
moderate rain
28.75 ℃
Friday 15 October 2021
moderate rain
28.62 ℃
Saturday 16 October 2021
moderate rain
28.27 ℃
Home


1:08
98%
Crowdsourcing
Are you in affected area?
Yes
No
Current weather situation
Select one
Is it flooding?
Yes
No
Flooding water level
Select one
Severity of rainfall
Select one
Severity of rainfall during flood
Select one
SUBMIT
Crowdsourcing


2:12
84%
Dashboard
DEVICE DATA
CROWD SOURCE DATA
Pannipitiya
CROWDSOURCE DATA
Is affected: Yes
Is flooding: No
Flooding water level: 0 feet
Current weather situation: Overcast clouds
Severity of rainfall: None
Severity of rainfall during flood: None
WEATHER API DATA
overcast clouds
27.88 ℃
72%
Dashboard


2:12
84%
Dashboard
DEVICE DATA
CROWD SOURCE DATA
Severity of rainfall during flood: None
WEATHER API DATA
overcast clouds
27.88 ℃
72%
5.36km/h
1007.00
IOT DEVICE DATA
30.50 ℃
95%
Not Raining
1.69cm
Dashboard

Commercialization

- Contracting with relevant state authorities
- The application is sold to the state authorities

Progress

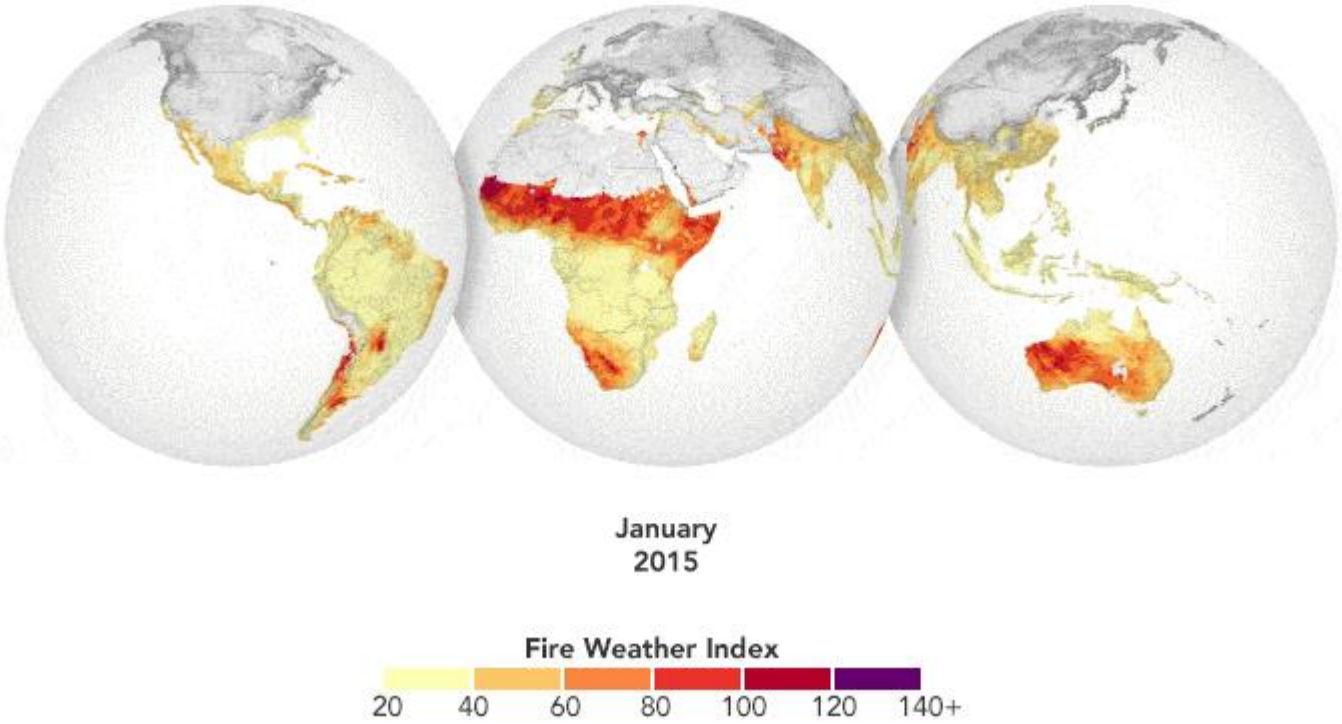
- UI Improvements for the final presentation
- Website design

References

[1] S. Frigerio, L. Schenato, G. Bossi, M. Mantovani, G. Marcato, and A. Pasuto, "Hands-on experience of crowdsourcing for flood risks. An android mobile application tested in Frederikssund, Denmark," *Int. J. Environ. Res. Public Health*, vol. 15, no. 9, 2018, doi: 10.3390/ijerph15091926.

[2] Z. Song, H. Zhang, and C. Dolan, "Promoting disaster resilience: operation mechanisms and self-organizing processes of crowdsourcing," *Sustain.*, vol. 12, no. 5, pp. 1–14, 2020, doi: 10.3390/su12051862.

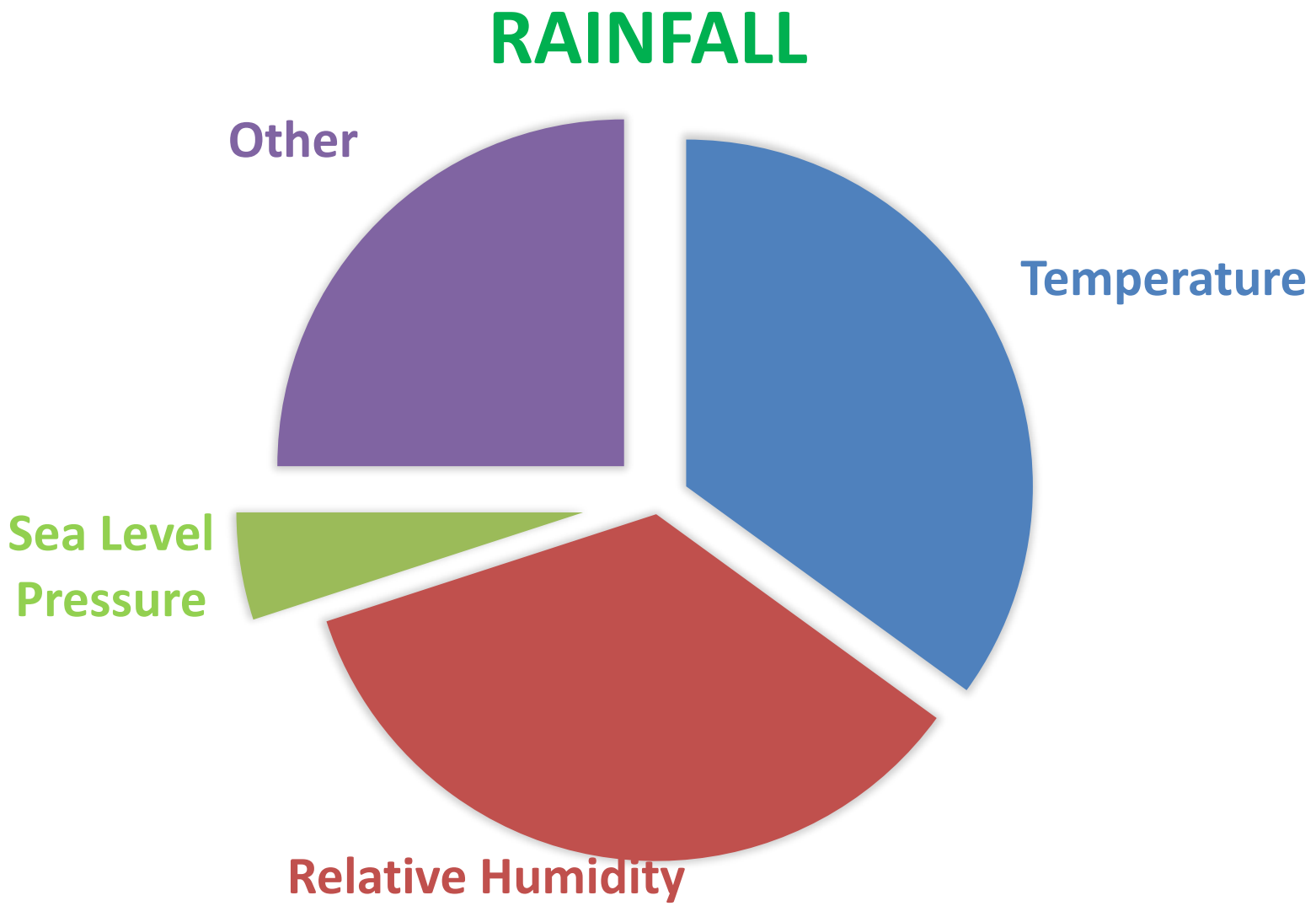
[3] G. Q. Daniele Mezzana, "Crisis mapping and crowdsourcing in flood management," *Integr. Flood Manag. Tool Ser.*, vol. 26, no. 1.0, pp. 1–90, 2017, doi:10.13140/RG.2.2.35313.07527.



Information Technology

IT17181648 | Vinobaji S.

Background Study



Research gap

Exiting projects

- Machine Learning models and algorithms-based approach.

Proposed Research

- Temperature, humidity, Pressure, Location, Time(day, month)
- Logistic Regression & Support Vector Machine.

Research question & Problems

1. **Out of main 3 factors smaller factors too affect rainfall?**
2. **Small factors also will be need to consider in predicting rainfall?**
3. **There is chance to small factors becomes considerable?**

Research Problems

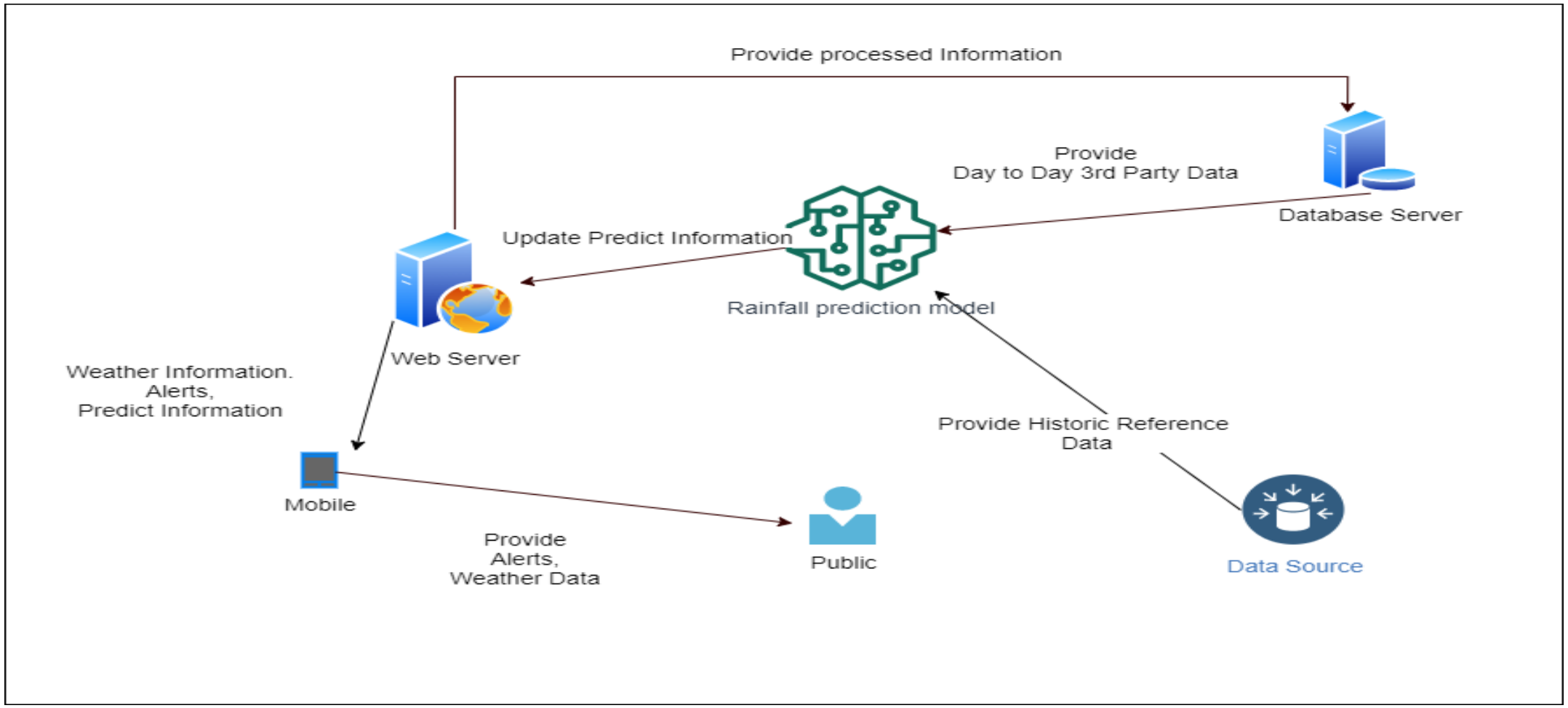
- **Collects historical weather data different time frame.**

Specific objectives and sub-objectives

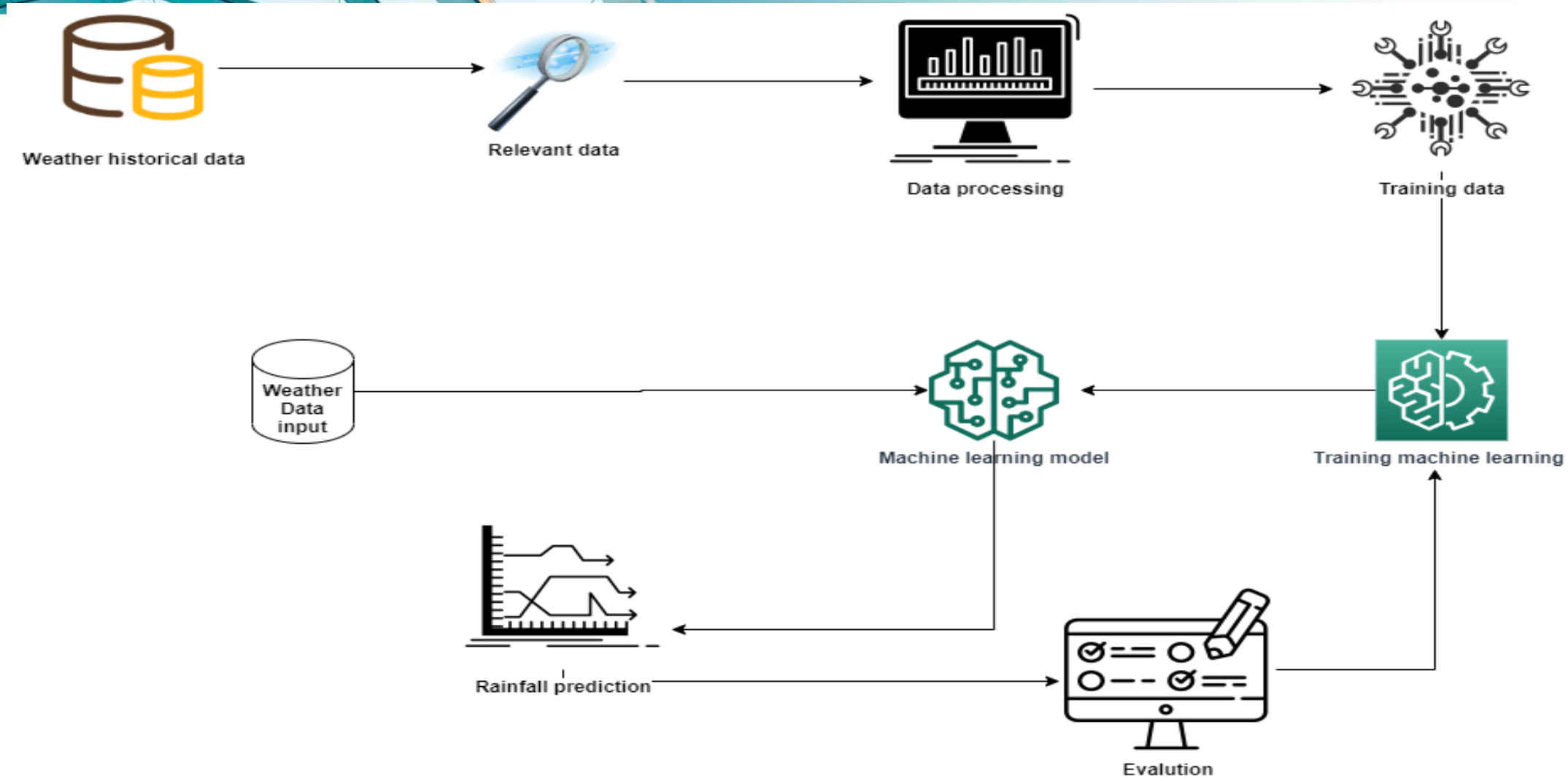
- **Main objectives**
- **To find out effective data set for predict rainfall based on machine learning and identify which dataset contribute to predict flooding.**

- **Specific Objectives**
  - **Analysis of weather historical data(temperature, relative humidity, Sea level pressure) and predict rainfall.**
  - **Analysis of weather historical data(temperature, relative humidity, Sea level pressure) based on Location and time(day, month)predict rainfall.**
  - **Checking accuracy different between each model.**

RESEARCH METHODLOGY
System design



RESEARCH METHODLOGY



RESEARCH METHODLOGY

Data Processing

Daily Data(2015-2019)

- ✓ Rainfall
- ✓ Temperature
- ✓ Relative Humidity
- ✓ Sea Level pressure

After cleaning missing data rows
(2015-2019 = 1826 days X 3 stations = 5478)

Row – 5390
Columns – 07

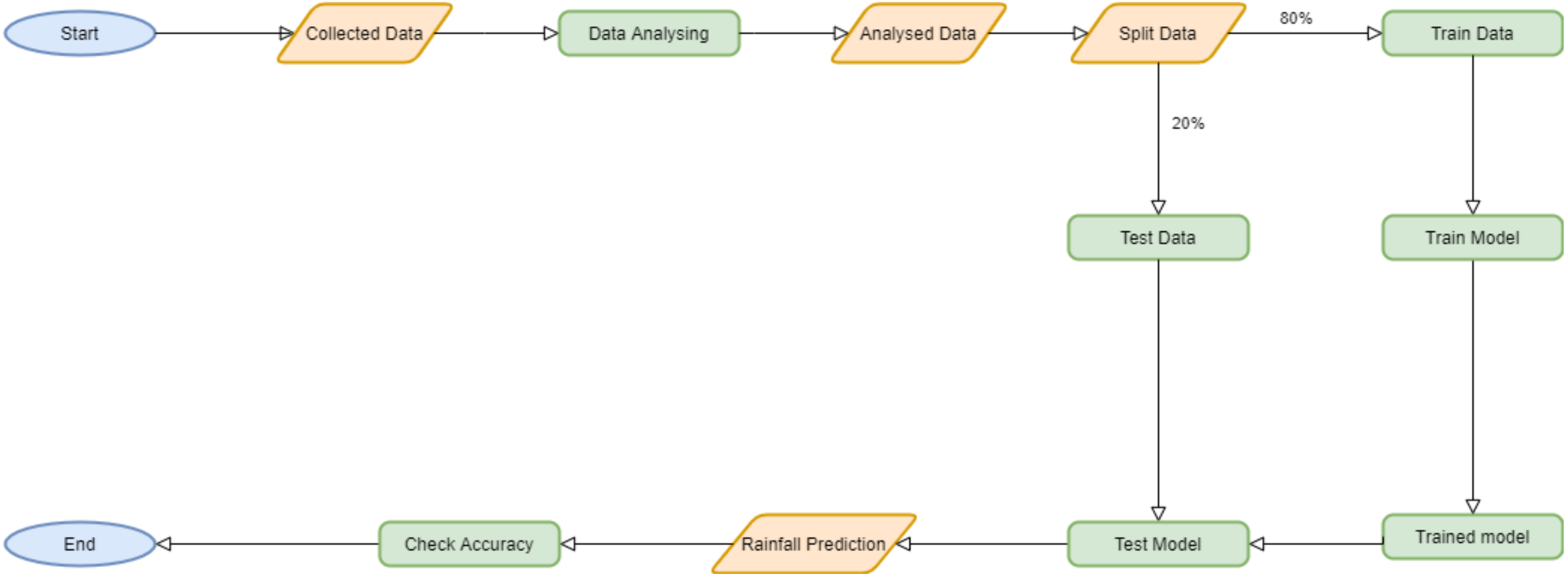
RESEARCH METHODLOGY

Data Processing

	A	B	C	D	E	F	G
1	Station_Name	yy	mm	dd	Tem_Max	RH_Min	Rainfall(mm)
2	COLOMBO	2015	1	1	30.3	76	0
3	COLOMBO	2015	1	2	29.9	72	0
4	COLOMBO	2015	1	3	30.2	70	0
5	COLOMBO	2015	1	4	31.2	68	1.5
6	COLOMBO	2015	1	5	31	73	0
7	COLOMBO	2015	1	6	32.5	74	7.5
8	COLOMBO	2015	1	7	31.4	65	0
9	COLOMBO	2015	1	8	30.1	75	0
10	COLOMBO	2015	1	9	30	73	0
11	COLOMBO	2015	1	10	31.9	60	0

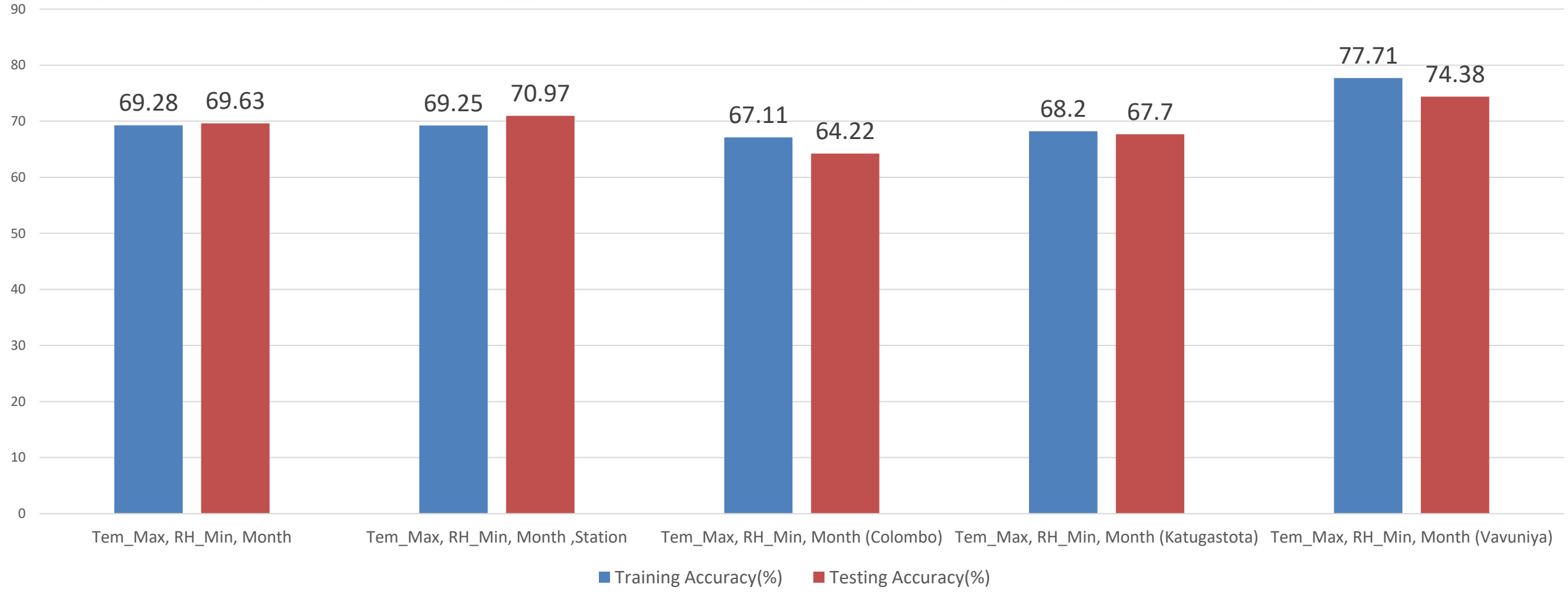
RESEARCH METHODLOGY

TRAINING PROCESS



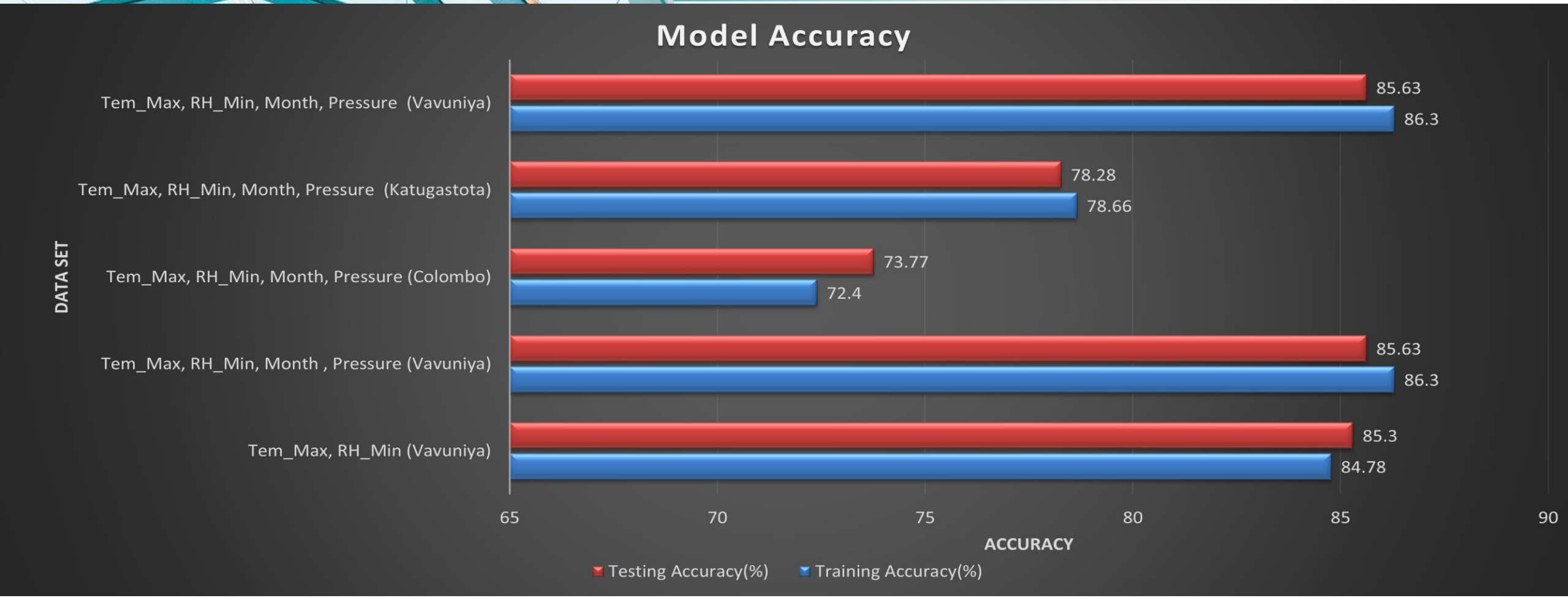
RESEARCH RESULTS

Training Logistic regression(Daily Data)



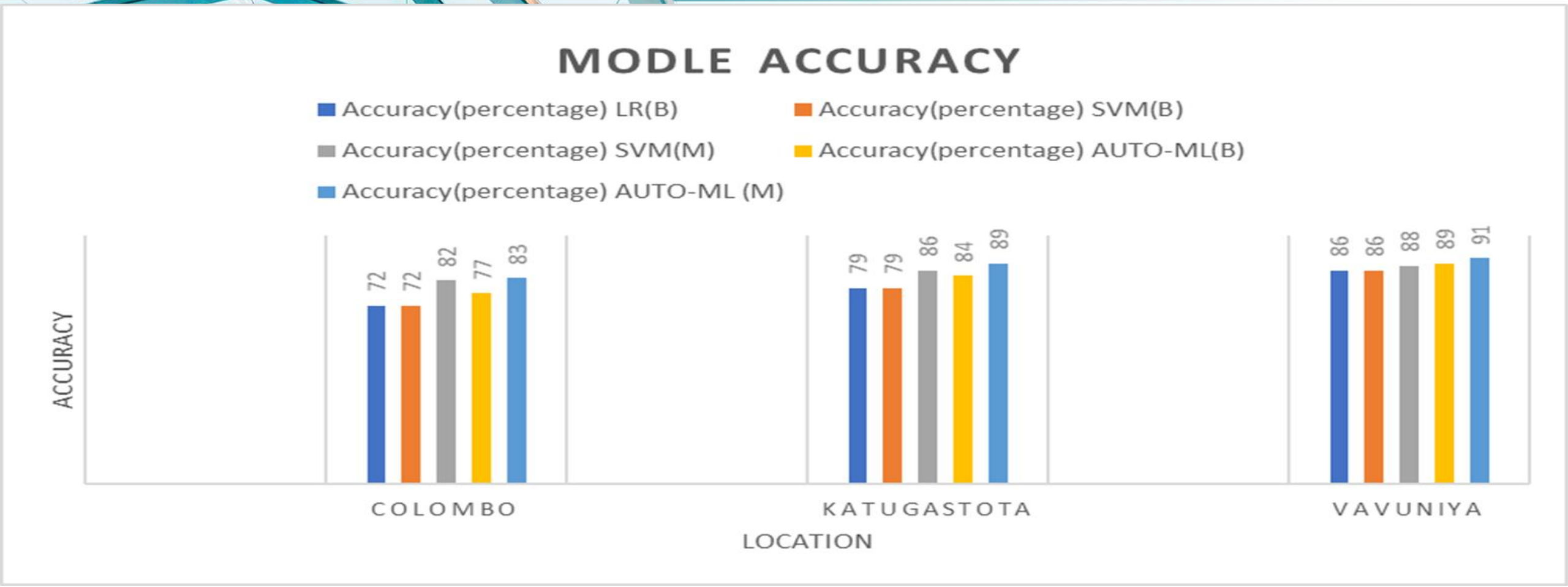
RESEARCH RESULTS

Training Logistic regression(Daily Data)

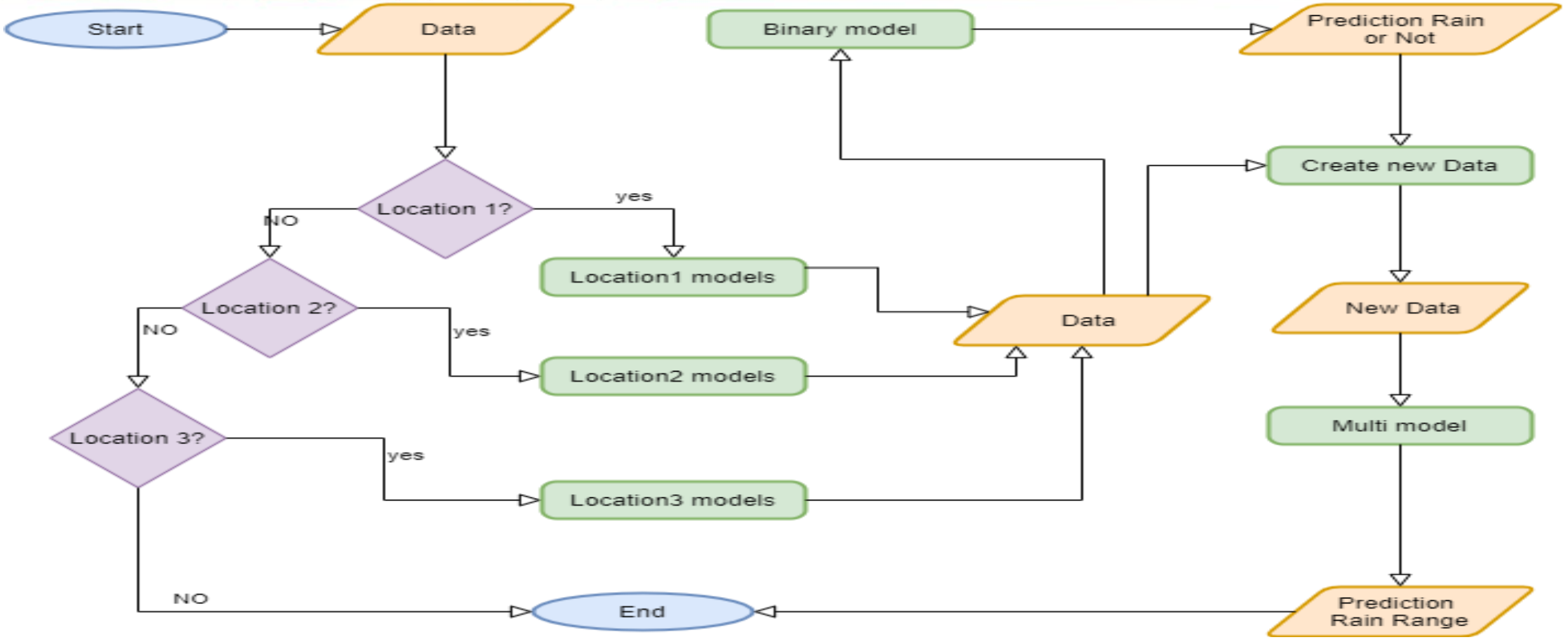


RESEARCH RESULTS

Accuracy Comparison



Prediction Process



RESEARCH ACHIEVEMENTS

- ✓ Data Collection
- ✓ Data Processing
- ✓ Train the Model
- ✓ Choose a Model
- ✓ Evaluate Model
- ✓ Make Predictions

Current Process

- Integration
- Testing

Demo

Q & A

Thank You!