CHAPTER 3 – METHODOLOGY

RESEARCH METHODOLOGY

3.1 Agile Software Development

The gradual and iterative approach to software development is known as the Agile development methodology. It begins with requirements, which are collected and assessed to ensure understanding of the project's nature. The design phase releases system architecture and detailed designs, allowing for flexibility and modularity. The development phase involves coding and feature implementation in incremental builds, allowing for continuous progress tracking. The testing phase involves rigorous testing to identify and resolve bugs, ensuring the system meets specified requirements and meets high quality standards. These phases allow continuous repetition, feedback, and improvement. However, as an undergraduate student running this project, the other two phases are not required for undergraduate students because developing and maintaining this project takes a long time. In Figure 3.1, the project model is presented.

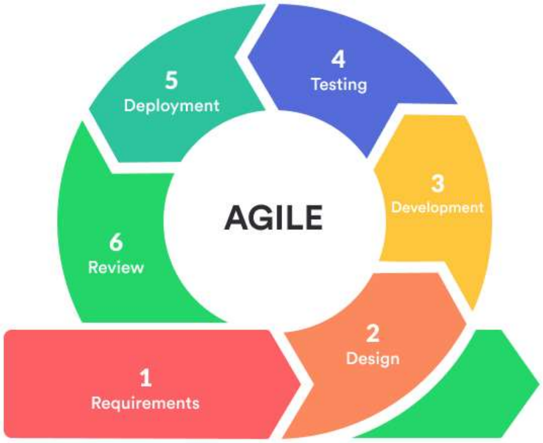
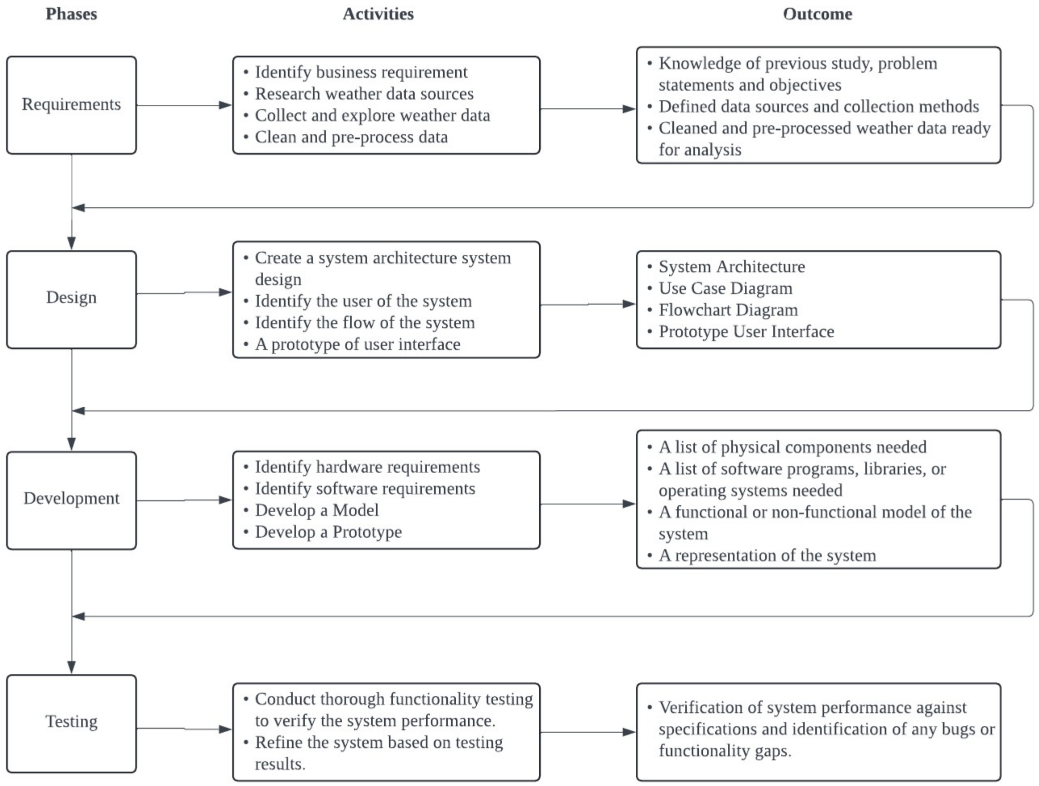


Figure 3.1 Agile Model

(Source: https://serenagray2451.medium.com/what-is-the-agile-methodology-in-software-development-c93023a7eb85)

3.2 Project Framework



Phases	Activities	Outcome
Requirements	• Identify business requirement • Research weather data sources • Collect and explore weather data • Clean and pre-process data	• Knowledge of previous study, problem statements and objectives • Defined data sources and collection methods • Cleaned and pre-processed weather data ready for analysis
Design	• Create a system architecture system design • Identify the user of the system • Identify the flow of the system • A prototype of user interface	• System Architecture • Use Case Diagram • Flowchart Diagram • Prototype User Interface
Development	• Identify hardware requirements • Identify software requirements • Develop a Model • Develop a Prototype	• A list of physical components needed • A list of software programs, libraries, or operating systems needed • A functional or non-functional model of the system • A representation of the system
Testing	• Conduct thorough functionality testing to verify the system performance. • Refine the system based on testing results.	• Verification of system performance against specifications and identification of any bugs or functionality gaps.

Figure 3.2 Overall project framework in Agile Methodology

3.3 Phase 1: Requirement Analysis

3.3.1 Business Requirements

The phase focuses on defining the goals and expectations for a weather prediction system. It begins by identifying key problem statements and defining the project scope. This ensures everyone understands the system's limitations and aims. This phase also analyses previous studies and research to learn from successes and mistakes. This subtopic establishes the foundation for the project by establishing clear objectives and leveraging existing knowledge.

3.3.2 Data Collection

To train and evaluate machine learning models for a weather prediction system, the data collecting step entails obtaining historical and current weather data from multiple sources. This extensive data set encompasses a wide range of weather patterns and situations, offering valuable insights into extended trends and guaranteeing precise forecasts. The accuracy and dependability of the model in predicting upcoming weather occurrences can only be increased with a vast and diverse dataset.

3.3.3 Data Source

Finding reliable sources of meteorological data is essential to ensure the accuracy of a weather prediction system. For consistency and accuracy to be guaranteed, data integrity is essential. The system can produce precise and dependable weather forecasts by choosing trustworthy sources. For this project, the source of data will be from Visual Crossing or Kaggle website.

3.3.4 Data Preprocessing

In order for the machine learning models to properly extract knowledge from the collected data, it must first be cleaned up and organized. This covers necessary tasks including normalizing the data, fixing missing data, and eliminating abnormalities. The obtained meteorological data is refined and arranged in an analysis-ready format during preprocessing. The primary step in this phase is the shrinking of the data, which maintains its quality and reduces the predicted mistakes caused by the machine learning models.

3.4 Phase 2: Design

The application's design takes importance at this stage. This section will cover the four main design categories for this application: system architecture, the use case diagram, the flow diagram with a flowchart, and the UI design. Once the design phase is complete, the application will be prepared for development.

3.4.1 System Architecture

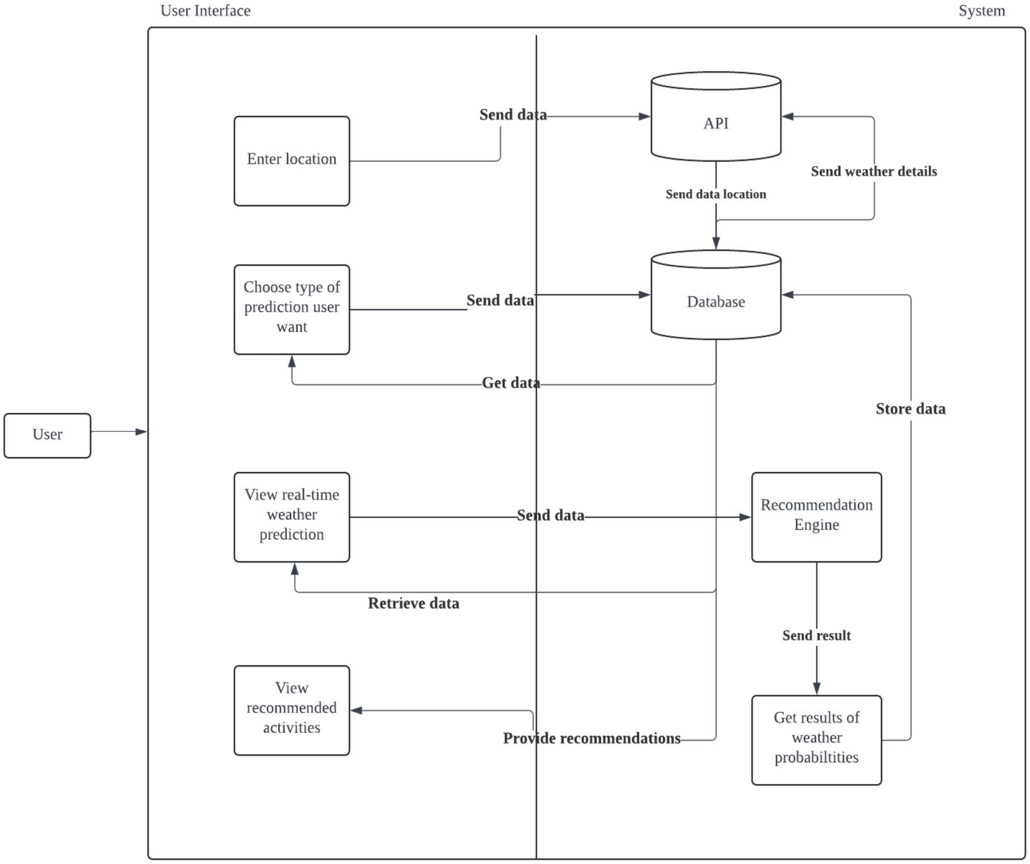


Figure 3.3 Overview of System Architecture

Based on Figure 3.3, it shows the system architecture of this project. It involves a user interface, API interaction, database storage, prediction and recommendation, and result retrieval. The user enters their location, selects the desired prediction type, and the system sends location data to the API for retrieval. The received weather details are stored in a database, and the recommendation engine calculates and provides weather-related recommendations, ensuring accurate and timely weather prediction and activity suggestions.

3.4.2 Use Case Diagram

A use case diagram is used to display the overall design of this application. It is used to determine the users along with the activities that the application itself is capable of. The following figure illustrates the overview of the application.

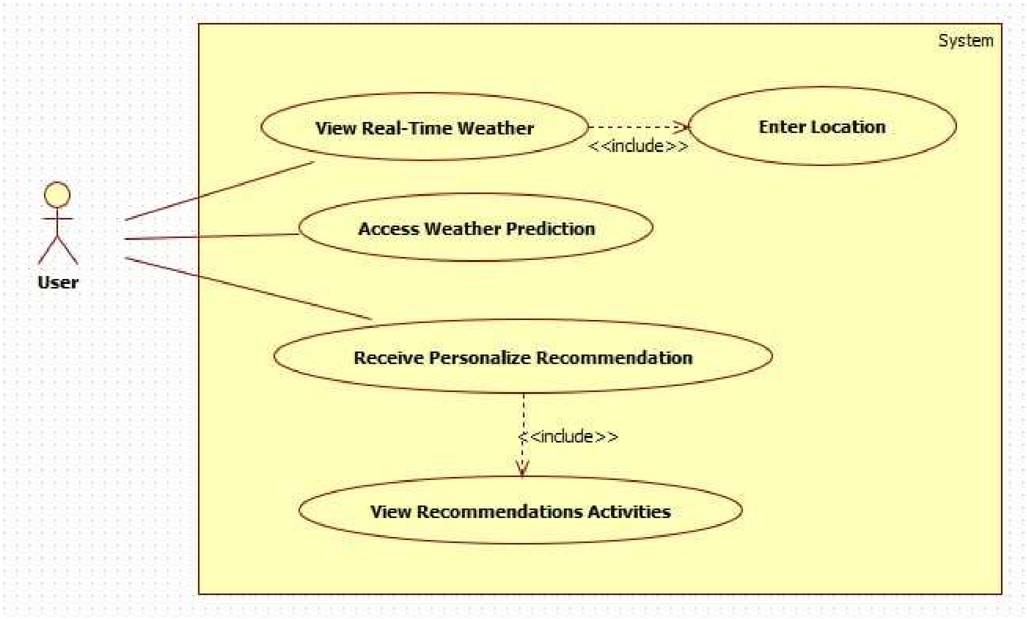

System
View Real-Time Weather
<<include>>
Enter Location
User
Access Weather Prediction
Receive Personalize Recommendation
<<include>>
View Recommendations Activities

Figure 3.4 Application Design Overview

3.4.3 Flowchart Diagram

The system's process will be described in this section. A flowchart will be used to illustrate the system's workflow by describing the steps involved.

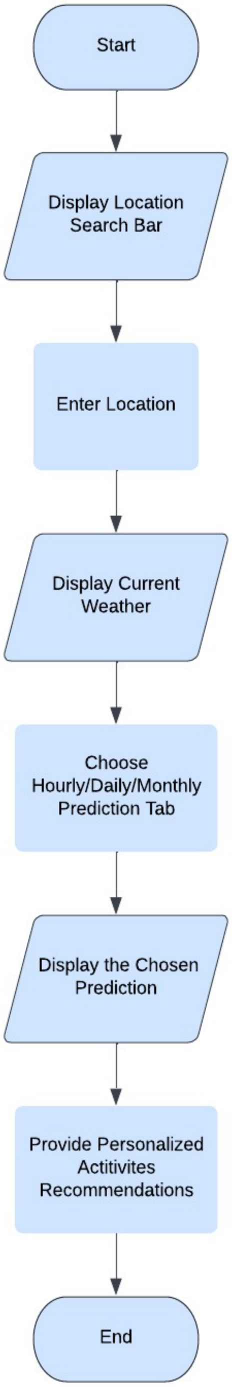
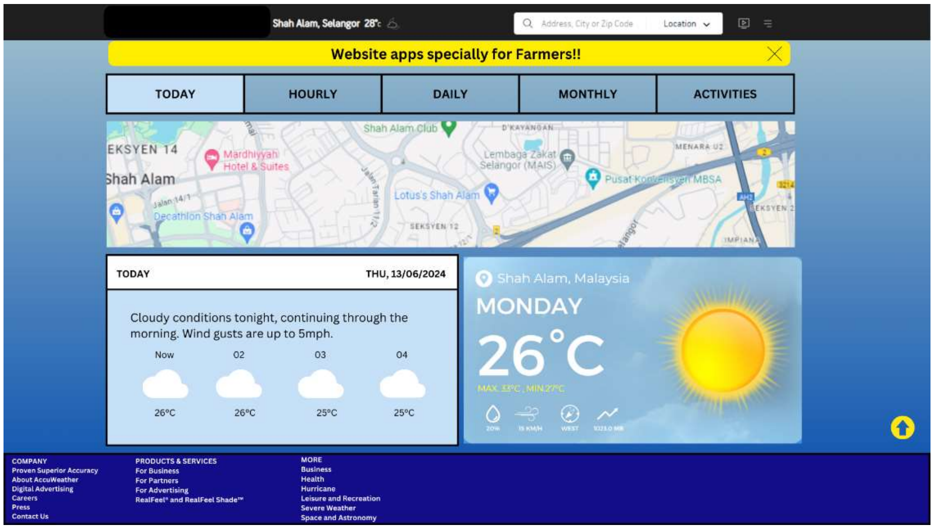

Start
Display Location Search Bar
Enter Location
Display Current Weather
Choose Hourly/Daily/Monthly Prediction Tab
Display the Chosen Prediction
Provide Personalized Actitivites Recommendations
End

Figure 3.5 The flow of the user throughout usage of the application.

3.4.4 User Interface (UI) Design

For the UI design, the application will consist of 6 main pages. The following shows the respective pages of the landing page.

a) Landing Page



[redacted]

Cloudy conditions tonight, continuing through the morning. Wind gusts are up to 5mph.

Now	02	03	04
26°C	26°C	25°C	25°C

COMPANY
Proven Superior Accuracy
About AccuWeather
Digital Advertising
Careers
Press
Contact Us

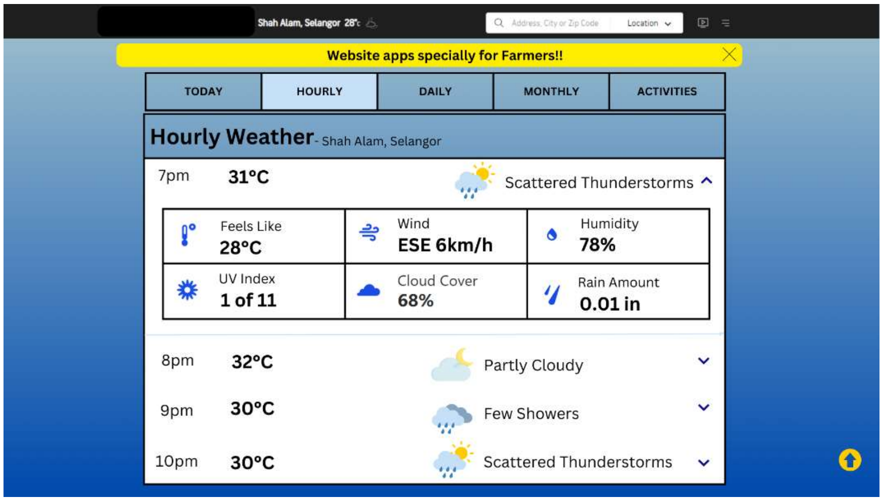
PRODUCTS & SERVICES
For Business
For Partners
For Advertising
RealFeel® and RealFeel Shade™

MORE
Business
Health
Hurricane
Leisure and Recreation
Severe Weather
Space and Astronomy

Figure 3.6 Overview of User Landing Page

The website redirects users to the weather prediction system landing page, featuring a clean design with a top navigation bar, location input, and tabs for daily, weekly, monthly, and activities. A prominently displayed map shows the selected location. The main section provides current weather conditions in Shah Alam, Malaysia, while the footer includes links to company information, products, and services.

b) Hourly Weather Page



[redacted]

Hourly Weather - Shah Alam, Selangor

7pm 31°C Scattered Thunderstorms

Feels Like 28°C	Wind ESE 6km/h	Humidity 78%
UV Index 1 of 11	Cloud Cover 68%	Rain Amount 0.01 in

8pm 32°C Partly Cloudy

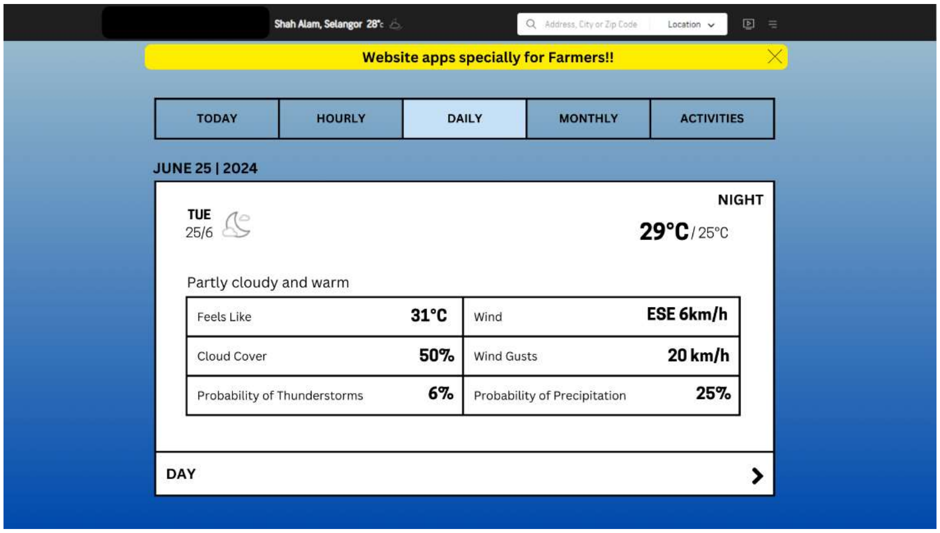
9pm 30°C Few Showers

10pm 30°C Scattered Thunderstorms

Figure 3.7 Overview of Hourly Weather Page

The hourly weather page provides detailed weather information for each hour. For example, in the above figure, it displays the weather for this present hour: temperature, what the temperature feels like, wind, UV index, cloud, humidity and rainfall. This is followed by an hour-by-hour prediction for the upcoming few hours.

c) Daily Weather Page



JUNE 25 | 2024

NIGHT

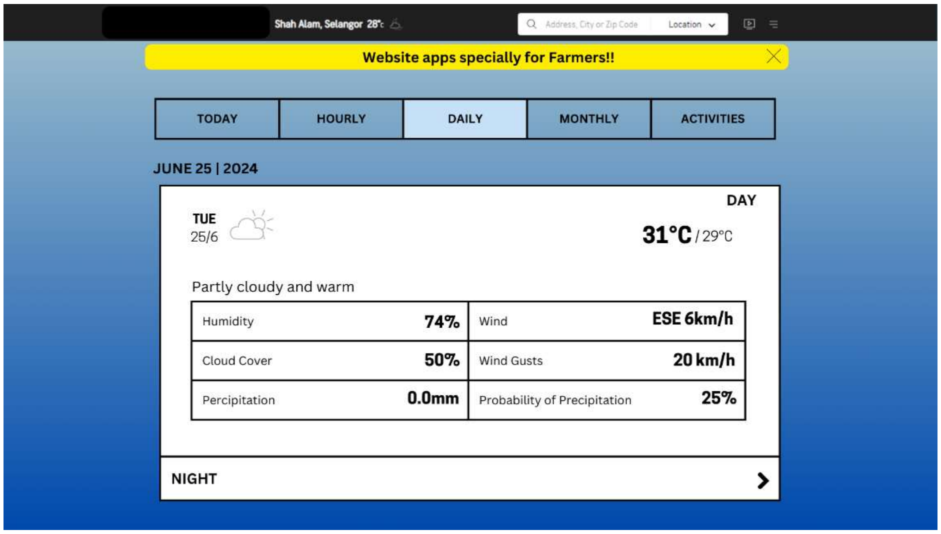
TUE
25/6

29°C / 25°C

Partly cloudy and warm

Feels Like	31°C	Wind	ESE 6km/h
Cloud Cover	50%	Wind Gusts	20 km/h
Probability of Thunderstorms	6%	Probability of Precipitation	25%

Figure 3.8 Overview of Daily Weather Page – Night



JUNE 25 | 2024

DAY

TUE
25/6

31°C / 29°C

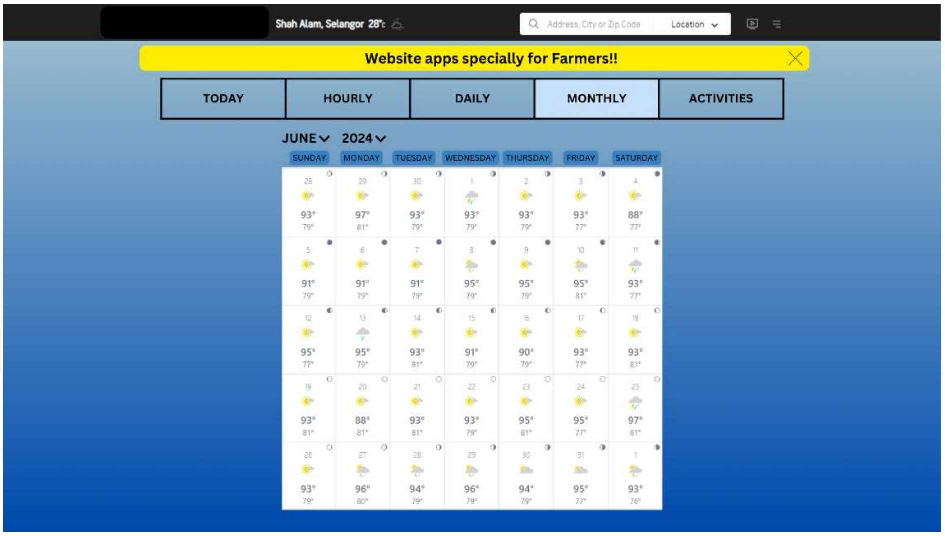
Partly cloudy and warm

Humidity	74%	Wind	ESE 6km/h
Cloud Cover	50%	Wind Gusts	20 km/h
Percipitation	0.0mm	Probability of Precipitation	25%

Figure 3.9 Overview of Daily Weather Page – Day

Users will be provided with daily information like wind, percentage of humidity, cloud cover, and any probability of precipitation or thunderstorms.

d) Monthly Weather Page

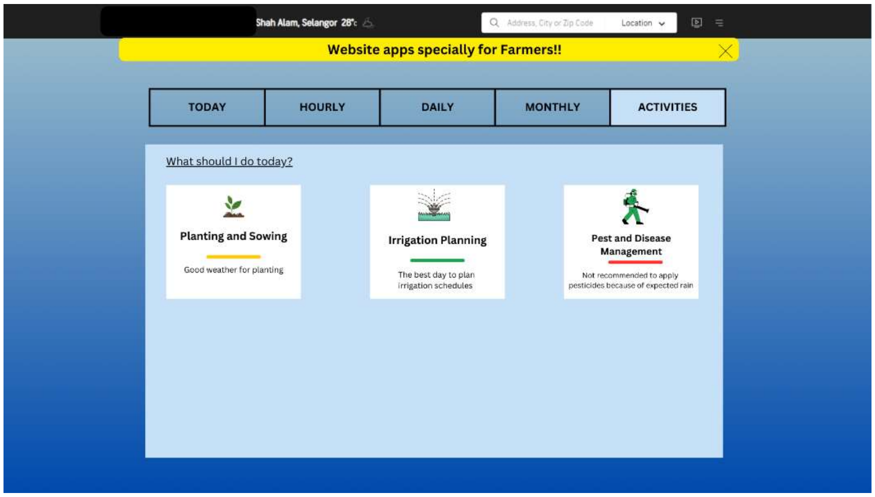


SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
28 93° 79°	29 97° 81°	30 93° 79°	1 93° 79°	2 93° 79°	3 93° 77°	4 88° 77°
5 91° 79°	6 91° 79°	7 91° 79°	8 95° 79°	9 95° 75°	10 95° 81°	11 93° 77°
12 95° 77°	13 95° 79°	14 93° 81°	15 91° 79°	16 90° 79°	17 93° 77°	18 93° 81°
19 93° 81°	20 88° 81°	21 93° 81°	22 93° 79°	23 95° 81°	24 95° 77°	25 97° 81°
26 93° 79°	27 96° 80°	28 94° 79°	29 96° 79°	30 94° 79°	31 95° 77°	1 93° 76°

Figure 3.10 Overview of Monthly Weather Page

The monthly weather page displays a calendar view of the weather prediction for selected month. Each day shows the expected high and low temperatures along with a weather icon indicating the general conditions (e.g., sunny, partly cloudy, rain). The layout is structured with days of the week labelled at the top and dates filling the grid below, providing an at-a-glance view of the month's weather patterns. Navigation options at the top allow users to switch between different time frames (Today, Hourly, Daily, Monthly) and access other features like Activities.

e) Activities Recommendation



What should I do today?

Planting and Sowing
Good weather for planting

Irrigation Planning
The best day to plan irrigation schedules

Pest and Disease Management
Not recommended to apply pesticides because of expected rain

Figure 3.11 Overview of Activities Recommendation Page

Figure 3.11 presents an activity recommendation page tailored for farmers, indicating which activities are advisable and which ones should be avoided on a given day.

3.5 Phase 3: Development

The project is being developed using hardware and software, with minimal requirements met to ensure smooth development and avoid installation issues. The development phase is crucial for achieving the project's third purpose, involving creating a prototype based on the design, which is the final delivery.

3.5.1 Hardware Requirement

To develop the project, the minimum hardware requirements needed are as follows:

- Intel(R) Core 2 Duo CPU @ 2.00 GHz, 2.00 GB of RAM
- Any good quality personal computer such as Dell, Lenovo, Asus, Acer, HP or Compaq
- 320 GB Hard Disk Driver
- Keyboard and mouse

3.5.2 Software Requirement

- Windows 7 or newer
- BlueJ, NetBeans, or Notepad++ for system development coding
- Microsoft Office Word
- Google chrome
- Firebase
- Canva

3.5.3 Model Development

To achieve optimal performance, key procedures must be followed when developing a machine learning model. Selecting a suitable algorithm is the first stage; the Random Forest method, which manages intricate, non-linear relationships in data, is one such way. The model is trained using a large amount of historical meteorological data, which is analysed for patterns and connections. Using new datasets and hyperparameter tweaking techniques, performance is evaluated. The process of cross-validation is used to guarantee precision and dependability. The updated model is set up with the required data streams and linked to a real-time system in order to deliver precise and fast weather forecasts. The model is anticipated to become the most accurate and dependable for real-time weather prediction due to this recursive process.

3.5.4 Prototype Development

Prototype development is a crucial stage in the development of a system, where essential hardware and software components are assembled to create a functional model. This stage allows engineers to test and refine the design, ensuring it meets project requirements and performs as expected. Prototype development involves iterations to experiment with different configurations, interfaces, and functionalities, providing stakeholders with a hands-on understanding of the system's capabilities. By simulating real-world conditions, prototype development helps identify and resolve issues early in the development process.

3.6 Phase 4: Testing

Functionality testing is used to cross-check whether an individual feature of a system complies with requirements and operates as expected. It involves going through each facet of the program step by step, from backend activities to frontend operations that confirm its capability. Test cases are conducted to ensure the system's functionality, including recommendation creation, forecast accuracy, and data intake. This ensures robustness and reliability, ensuring customer satisfaction and accurate weather forecasts. Thorough testing helps identify and resolve issues, ensuring system functionality as intended. The test case of this project is shown in Table 3.1 below.

Table 3.1 Test Cases

Component	**Test Case**	**Expected Outcome**
View Real-Time Weather	Input correct location.	Display accurate real-time weather for the specified location.
	Refresh page.	Real-time weather updates correctly with current data.
Access Weather Prediction	Request hourly prediction.	Provide accurate and detailed hourly weather prediction for the location.
	Request daily prediction.	Display accurate and detailed daily weather prediction for the location.
	Request monthly prediction.	Shows accurate and detailed monthly weather prediction for the location.
Receive Personalize Recommendations	Check that users receive tailored recommendations based on their preferences and current weather conditions.	Users receive relevant and personalized recommendations consistently.

3.7 Gantt Chart and Milestones

The project consists of several phases that are expected to be completed within a timeframe. Figure below shows the scheduled phase.

Table 3.1 Gantt Chart for The Project Proposal Semester 5

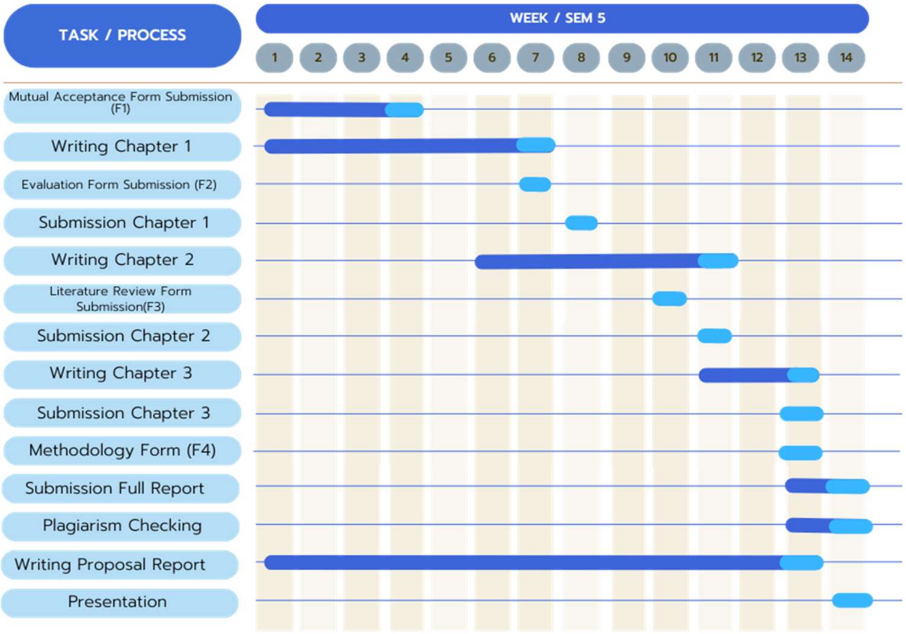
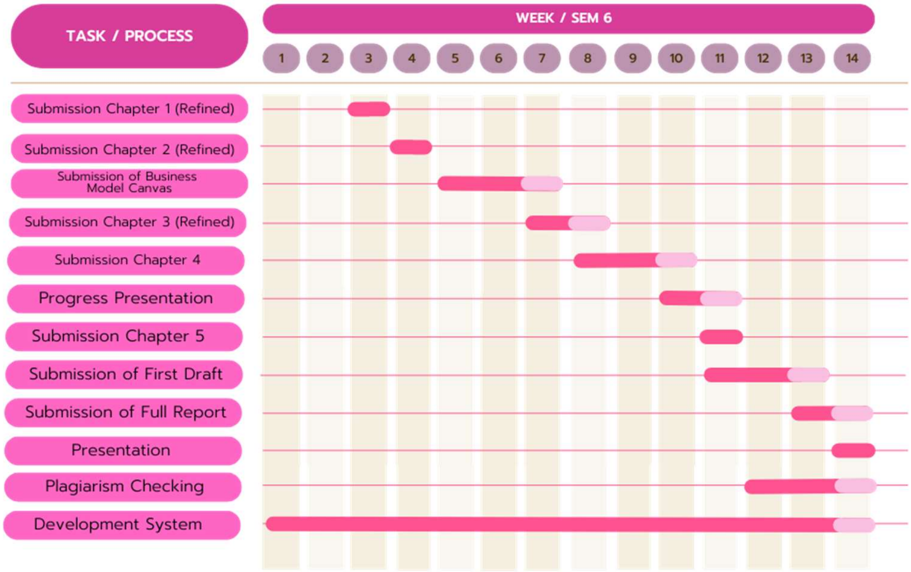


Table 3.2 Gantt Chart for The Project Proposal Semester 6



3.8 Summary

The chapter introduces a step-by-step procedure to develop a weather forecasting system through agile software development. At the beginning, a need-based requirement is stressed; it includes the necessity of defining business requirements, using various data sources, converting the data through preprocessing, and unity with the system's architecture. The user interface design is the key feature, and it is furnished by key pages like the landing page and the one showing the weather of the current hour, the current day, and the next month. The design includes hardware and software parts, model development using machine learning algorithms, and activity recommendation features. The research paper mentions the key importance of the research, the outcome of the system in terms of the user interface, and the use of a Gantt chart in the project planning phase. To sum up, the approach shows a clear-cut technique for creating a trustworthy and easily accessible weather prediction system with very accurate predictions.