A project Report

On

Predicting Plant Growth Stages with Environmental and Management Data Using Power BI

Submitted for fulfillment of

Experimental Project Based Learning (EPBL)

College Name: Rajkumar Goel Institute of Technology, Ghaziabad

Team Id: PNT2025TMID01160

Submitted By:

Anjani Kushwaha (2200331540027)

Aditi Arora (2200331540008) (TL)

Aditya Singh Parmar (2200331540012)

Amit Yadav (2200331540023

ACKNOWLEDGEMENT

We express our sincere gratitude to everyone who contributed to the successful completion of the Plant Growth Milestone Dashboard project.

First and foremost, I extend my heartfelt thanks to my mentors and project guides for their invaluable support, guidance, and constructive feedback throughout this project. Their expertise and insights played a crucial role in shaping the analysis and improving the overall outcome.

I am also grateful to my peers and colleagues for their encouragement, discussions, and valuable suggestions, which helped refine the approach and enhance the quality of the work.

A special note of appreciation to my team members for their dedication, collaboration, and commitment to making this project a success. Their teamwork and contributions were essential in completing this work efficiently and effectively.

This project is a result of collective efforts, and I sincerely appreciate everyone's contributions in making it a meaningful and insightful study.

Aditi Arora (2200331540008) **Aditya Singh Paramar (2200331540012)**

Anjani Kushwaha (2200331540027) **Amit Yadav (2200331540023)**

ABSTARCT

The Plant Growth Milestone Dashboard is a data-driven analytical tool designed to explore the impact of various environmental factors on plant growth. By leveraging datasets related to soil type, fertilizer type, water frequency, temperature, and humidity, the dashboard provides insightful visualizations that help farmers, gardeners, and researchers make informed decisions.

This project utilizes data preprocessing techniques and interactive filters to enhance usability, enabling users to compare growth conditions effectively. The dashboard integrates statistical insights and trend analysis to identify optimal growth conditions, ultimately aiding in agricultural and horticultural improvements. Future enhancements include AI-based growth predictions, IoT sensor integration, and real-time monitoring for improved plant care.

Keywords:

Plant Growth Analysis, Data Visualization, Environmental Factors, Dashboard Development, Data Science, Smart Agriculture, AI in Agriculture, IoT in Farming, Growth Prediction, Performance Optimization, Horticulture Insights, Data-Driven Decision Making.

TABLE OF CONTENTS

- **Dataset Link**
- **GitHub & Project Demo Link**

CHAPTER 1: INTRODUCTION

1.1 Project Overview

The **Plant Growth Milestone Dashboard** is an **interactive data visualization tool** that analyzes plant growth under different environmental conditions. The project focuses on understanding how factors such as **soil type, fertilizer type, water frequency, temperature, and humidity** impact plant development. By leveraging **data analytics and visualization**, this project provides **actionable insights** to optimize plant care for farmers, researchers, and horticulturists.

Key Insights from the Data:

1. **Growth Trends by Soil Type & Fertilizer**
   - Plants grown in **sandy soil with organic fertilizer** exhibited the **highest growth milestones**.
   - **Chemical fertilizers** performed well in **loam soil**, while **clay soil showed the least growth impact**.

2. **Impact of Humidity & Water Frequency**

- High humidity levels contribute to **better plant growth**, especially with **bi-weekly and daily watering**.
- Lower humidity levels negatively impact plant development, regardless of watering frequency.

3. **Effect of Temperature on Plant Growth**

- **Moderate temperature (25°C)** led to the **highest plant growth milestone**.
- **Cold temperatures (17°C) and warm temperatures (32°C)** resulted in lower growth.

4. **Watering Frequency & Growth Performance**

- **Daily and weekly watering schedules** contributed to **better growth rates** compared to **bi-weekly watering**.

5. **Sunlight Exposure & Growth Relationship**

  - Plants exposed to **400-500 sunlight hours** showed **better growth milestones**, indicating the importance of adequate sunlight.

1.2 Purpose

1.To **identify the best environmental conditions** for plant growth.

2.To provide **data-driven recommendations** for **improving agricultural productivity**.

3.To assist **farmers and researchers** in making **better irrigation, fertilization, and soil selection** decisions.

4.To visualize plant growth patterns in an **easy-to-understand** dashboard format.

Trend Analysis in Plant Growth:

1. Seasonal Trends:
   - Plant growth was highest in moderate temperatures (25°C) and declined in extreme cold (17°C) or hot (32°C) conditions.
   - Humidity levels above 50% supported faster growth rates compared to drier conditions.
2. Soil & Fertilizer Trends:
   - Loam soil + organic fertilizers showed consistent high growth across different conditions.
   - Clay soil had the lowest growth rates, indicating poor aeration and drainage issues.
3. Watering & Sunlight Trends:
   - Daily or weekly watering schedules resulted in higher growth milestones than irregular watering.
   - 400-500 sunlight hours per month supported maximum plant growth, confirming the importance of consistent sunlight exposure.
4. Growth Performance Over Time:
   - Initial growth rates were slow in the early weeks but increased significantly after optimal nutrient and water conditions were met.
   - Sudden temperature fluctuations led to stunted growth in some cases.

Chapter 2: IDEATION PHASE

2.1 Problem Statement

- Plant growth varies under **different environmental conditions** such as **soil type, temperature, humidity, fertilizer type, and watering frequency**.
- Farmers and researchers lack a **data-driven approach** to determine **optimal growth conditions**.
- Unpredictable **seasonal changes** and **soil variations** make it difficult to ensure **consistent plant growth**.
- A **lack of real-time insights** leads to inefficient farming and **reduced agricultural productivity**.

2.2 Empathy Map Canvas

Aspect	Details
What they feel?	**Uncertainty about best growth conditions struggle with unpredictable results**
What they see?	**Variations in plant growth based on climate soil and fertilizer usage**
What they hear?	**Advice from experienced farmers, but no scientific validations of best practices**
What they do?	**Experiment with different watering schedules fertilizers and soil types to optimize growth**

2.3 Brainstorming

☑ **Key Questions to Explore:**

- What are the **most influential factors** affecting plant growth?
- How can **data visualization** help identify **trends and patterns**?
- Can we create a **dashboard** to track and compare growth under different conditions?

- How can farmers and researchers use **data-driven decision-making** to improve **crop yield**?
- What **technologies** (Python, Power BI, IoT sensors) can be integrated for **better analysis**?

☑ **Possible Solutions:**

- Develop a **Plant Growth Milestone Dashboard** that visualizes **key growth factors**.
- Use **data analytics** to identify **optimal environmental conditions** for plants.
- Implement **interactive filters** to allow **customized growth analysis**.
- Integrate **trend analysis** to track **seasonal plant growth variations**.
- Provide **predictive insights** for better decision-making in **agriculture and horticulture**.

Chapter 3: REQUIREMENT ANALYSIS

Requirement Analysis phase outlines the essentials aspects necessary for the development of the Power BI Dashboard. This includes Customer journey map, Solutions requirement, Data flow diagrams and Technology stack ensuring a well-structured approach to data processing and visualisations.

3.1 Customer Journey Map

Stage	Customer Actions	System response
Data collections	**Users upload plant growth data, including soil type fertilizer type, water frequency, temperature and humidity**	**System validates and stores data**
Data processing	**Users apply filters to analyze different growth condtions**	**System cleans, processes and organizes data for visualisation**
Visualisation and Analysis	**Users explore trends and insights through interactive graphs**	**System generates dynamic visualisations and trend analysis**
Decision Making	**Users interpret the data and modify plant care strategies**	**System provides insights to help users optimize plant growth conditions**

3.2 Solution Requirements

3.2.1 Functional Requirements (System Capabilities)

☑ Data Input & Processing

- Users should be able to upload plant growth data from Excel or a database.

- System must clean, validate, and store data efficiently.

☑ Interactive Dashboard & Visualizations

- The system should provide graphs and charts to analyze growth trends.
- Users must be able to apply filters (e.g., soil type, temperature, fertilizer) for custom analysis.

☑ Trend Analysis & Insights

- System should calculate growth milestones based on historical data.
- The dashboard should highlight best growth conditions based on past trends.

☑ Performance & Usability

- Dashboard should load quickly and support real-time filtering.
- Reports should be exportable for further analysis.

3.2.2 Non-Functional Requirements (System Quality & Performance)

⚡ Performance & Scalability

- The system should handle large datasets without lag.
- The architecture should allow future scalability, including AI-based predictions.

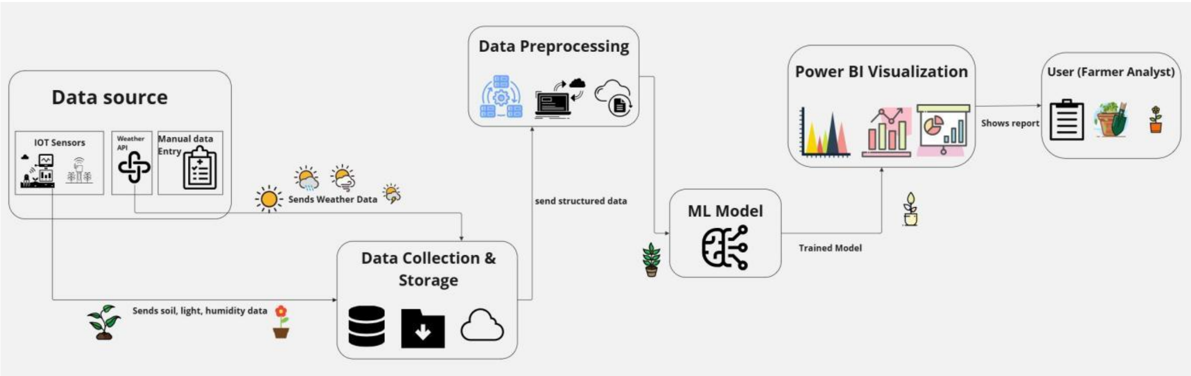
🔒 Security & Data Integrity

- Data should be securely stored and processed.
- Users should have role-based access control if required.

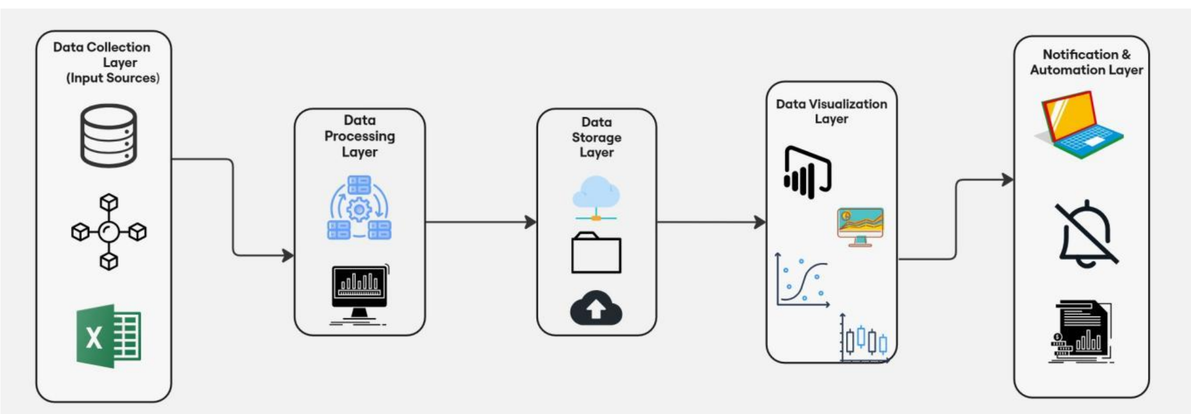
📊 User Experience & Accessibility

- The dashboard should have an intuitive UI with easy navigation.
- It should be accessible on multiple devices (desktop, tablet, mobile).

3.3 Data Flow Diagram



3.4 Technology Stack



Chapter 4: PROJECT DESIGN

The project Design phase defines the proposed solutions, its architecture and how it addresses the identified problem. This section includes the problem solution fit, proposed solution and solution architecture, ensuring data structure and efficient approval to building the Power BI dashboard.

4.1 Problem-Solution Fit

☑ **Identified Problems:**

- Lack of data-driven insights on plant growth patterns.
- Farmers and researchers rely on trial-and-error methods rather than scientific analysis.
- Environmental factors (soil type, temperature, humidity, and fertilizer) affect growth, but their exact impact is unclear.
- No easy-to-use visual dashboard to track and compare growth trends.

☑ **Proposed Solution:**

- Develop an interactive dashboard that visualizes plant growth trends.
- Use data analytics to identify optimal growth conditions.
- Provide filtering options for custom growth analysis based on environmental factors.
- Implement trend analysis to track seasonal variations and growth milestones.
- Offer actionable insights for farmers, researchers, and horticulturists.

4.2 Proposed Solution

🚀 **Features of the Plant Growth Milestone Dashboard:**

📊 Data Visualization & Trend Analysis

- Displays growth variations based on temperature, soil type, fertilizer, and watering frequency.
- Provides interactive graphs to identify patterns over time.

🔍 Filtering & Custom Analysis

- Users can filter data based on specific conditions (e.g., only plants grown in loamy soil).
- Customizable parameters to explore multiple plant growth scenarios.

📈 Performance & Growth Comparison

- Allows comparison of different plant growth rates under varied conditions.
- Highlights best-performing growth strategies for better decision-making.

📑 Data Processing & Insights

- Cleans and structures raw plant growth data.
- Generates statistical summaries to predict optimal growth conditions.

⚡ User-Friendly Interface

- Intuitive dashboard with easy navigation and real-time updates.
- Works on multiple devices (PC, tablet, and mobile).

🔓 Scalability & Future Integration

- Can be expanded with AI-based predictions for plant growth.
- Future integration with IoT sensors for real-time plant monitoring.

4.3 Solution Architecture

📥 Data Source

- Data collected from Excel sheets, SQL databases, or IoT sensors.
- Input parameters include soil type, fertilizer type, water frequency, temperature, humidity, and sunlight exposure.

🛠 Data Cleaning & Processing

- Handling missing values by filling with average/median values.
- Standardizing units (e.g., temperature in °C, water amount in liters).
- Filtering out anomalies (e.g., unrealistic growth measurements).
- Using Python (Pandas, NumPy) for data transformation and preprocessing.

💾 Data Storage

- Structured format: Processed data stored in SQL database / Excel.
- Supports scalability for handling large datasets.
- Future scope: Integration with cloud storage for real-time updates.

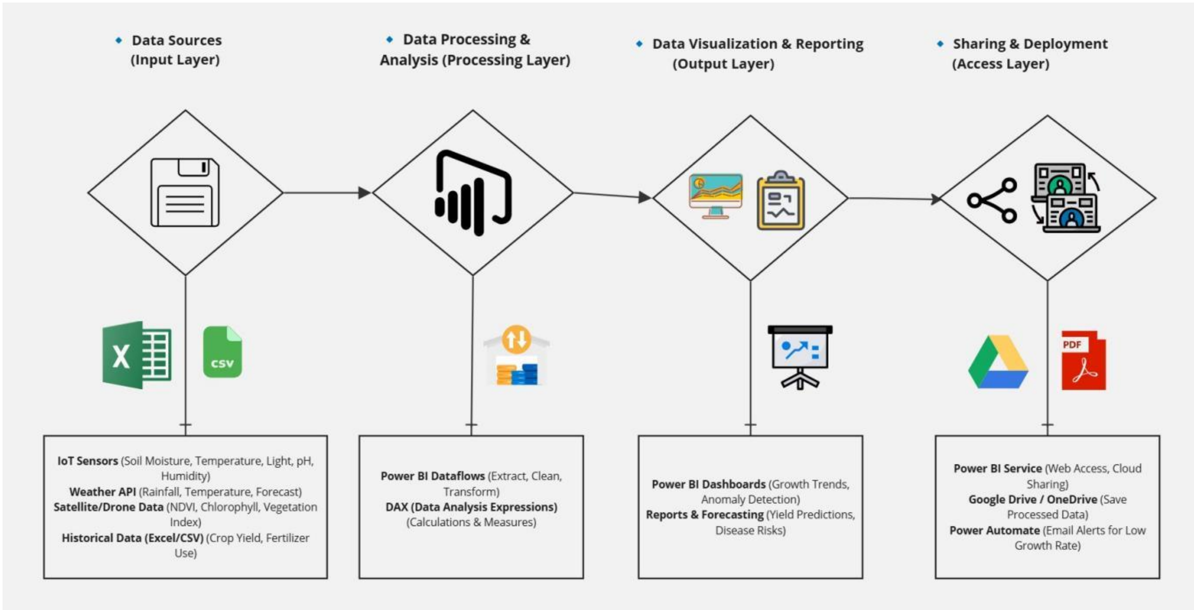
📊 Visualization & User Interaction

- Dashboard with interactive graphs using Power BI / Tableau / Matplotlib.
- Filters for custom analysis based on plant growth conditions.
- Trend analysis charts to track historical growth data.
- Comparative analysis of different growth environments.

📝 Report Generation & Insights

- Users can export reports in Excel or PDF format.
- Performance summaries showing best growth conditions.
- Data-driven recommendations for optimizing plant growth.

Flow Diagram:



Chapter 5: PROJECT PLANNING AND SCHEDULING

The project planning & scheduling phase outlines the spirit-based approach used to develop the Power BI dashboard.

Sprint	Functional Requirement	User Story Number	User story /Task	Story points	Priority	Team members
Sprint -1	Technical Architecture	GMT-22	Project flow	2	high	Aditya singh paramar
Sprint-1	Data collection & Extraction	GMT-23	Downloading the dataset	1	high	Aditi arora
Sprint-1	Prepare the data for visualisation	GMT-34	Prepare the data for visualisation	3	low	Anjani kushwaha
Sprint-1	Data visualisation	GMT-27	Visualisation of data	2	medium	Aditya singh Parmar Aditi arora Anjani Kushwaha
Sprint-1	Dashboard	GMT-28	Responsive and design of dashboard	5	high	Aditya singh Parmar Aditi arora Anjani Kushwaha Amit yadav
Sprint-2	Design of Report	GMT-32	Report	2	high	Anjani kushwaha

Sprint-2	Performance Testing	GMT-33	Utilization of DAX Expressions Number of visualisation/Graphs	3	high	Aditya singh Parmar Aditi arora

Velocity:

Sprint 1 = 13

Sprint 2 = 05

Velocity= Total Story Points Completed/ Number of Sprints

Total story Points= 13+5 =18

No of Sprints= 2

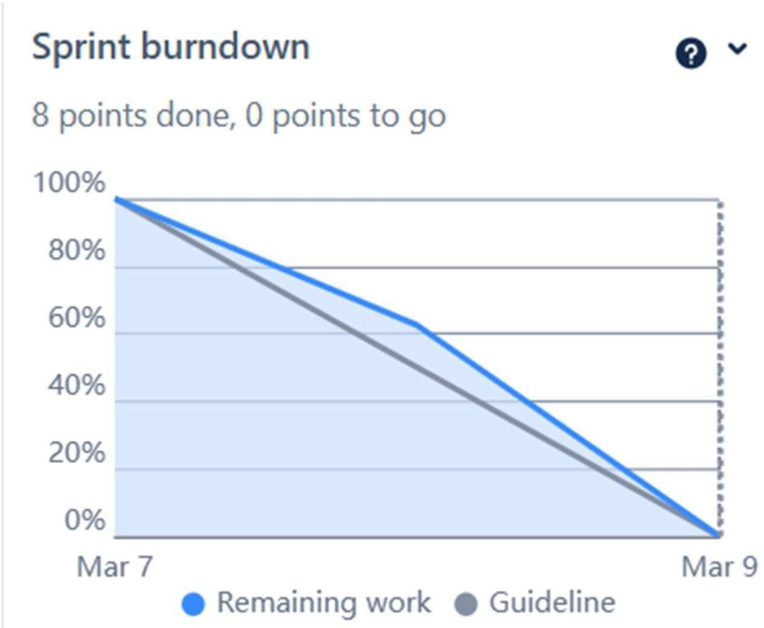
Velocity = (13+5)/2= 18/2

09(Story Points per Sprint)

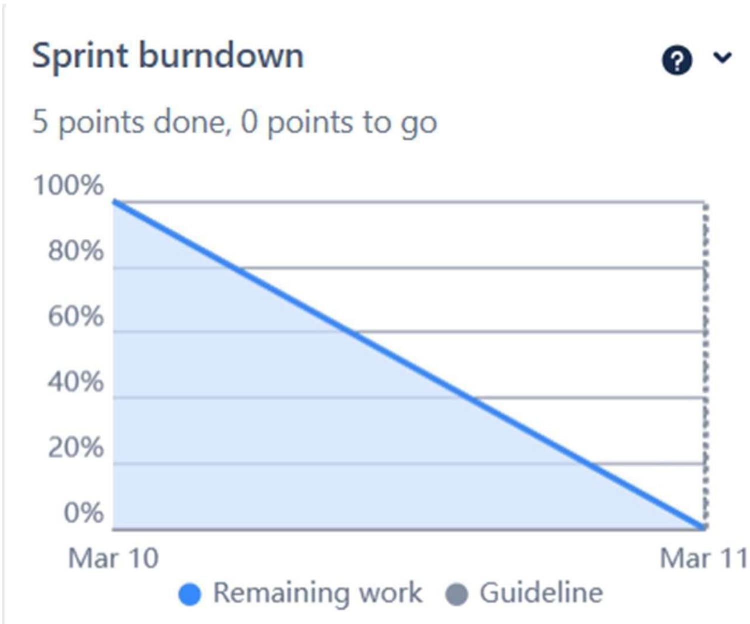
Your team's velocity is 9 Story Points per Sprint.

Burndown Chart:

Sprint 1:

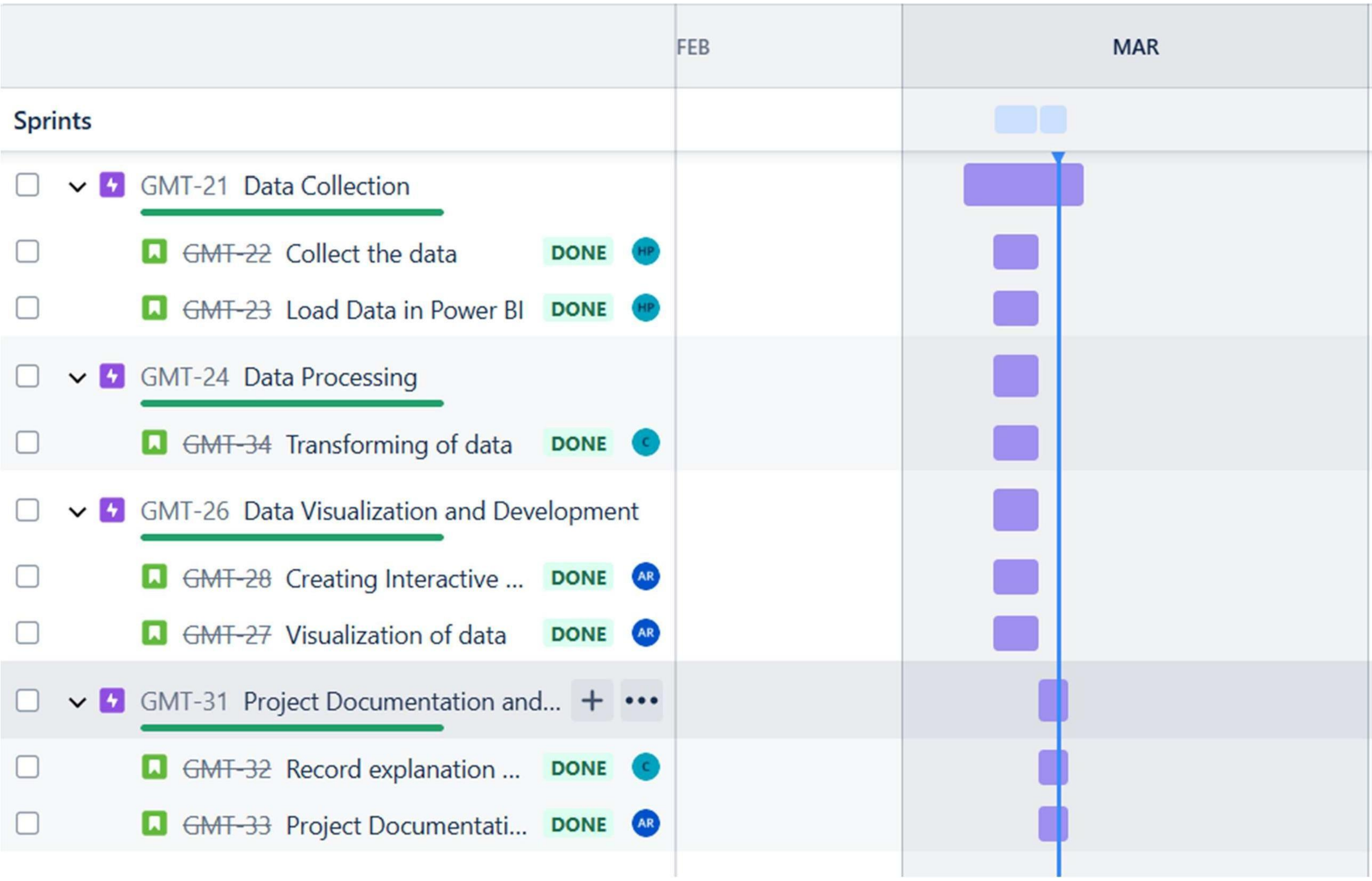

Sprint burndown
8 points done, 0 points to go
100%
80%
60%
40%
20%
0%
Mar 7
Mar 9
Remaining work
Guideline

Sprint 2:



Sprint burndown
5 points done, 0 points to go
100%
80%
60%
40%
20%
0%
Mar 10
Mar 11
Remaining work
Guideline

Timeline:


FEB
MAR
Sprints
GMT-21 Data Collection
GMT-22 Collect the data DONE HP
GMT-23 Load Data in Power BI DONE HP
GMT-24 Data Processing
GMT-34 Transforming of data DONE C
GMT-26 Data Visualization and Development
GMT-28 Creating Interactive ... DONE AR
GMT-27 Visualization of data DONE AR
GMT-31 Project Documentation and...
GMT-32 Record explanation ... DONE C
GMT-33 Project Documentati... DONE AR

Chapter 6: FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

Parameter	**Value**
Data Rendered	Plant Growth Dataset
Data Preprocessing	Cleaning and Formatting
Utilization of Filters	Temperature, Soil Type, Fertilizer Type, Water Frequency
DAX Queries Used	1.Average_Humidity = AVERAGE(plant_growth_data[Humidity]) 2.Average_Sunlight_Hours = AVERAGE(plant_growth_data[Sunlight_Hours]) 3.AVERAGE(plant_growth_data[Sunlight_Hours]) 4,Average_Temperatue = AVERAGE(plant_growth_data[Temperature]) 5.Growth_Milestone_Count = COUNTROWS(FILTER(plant_growth_data, plant_growth_data[Growth Milestone]=1)) 6.Growth_Milestone_Percentage = DIVIDE([Growth_Milestone_Count], COUNTROWS(plant_growth_data),

Parameter	**Value**
	0) 7.Water Frequency Numeric = SWITCH([Water_Frequency], "daily",1, "bi-weekly",2, "weekly",3, BLANK()) 8.Temprature Range = SWITCH(TRUE(), [Temperature]<15,"Low", [Temperature]>=15 && [Temperature]<25,"Moderate", [Temperature]>=25,"High") 9.Humidity range = SWITCH(TRUE(), [Humidity]<40,"Low", [Humidity]>=40 && [Humidity]<60,"Moderate", [Humidity]>=60 , "High") 10.Humidity Level Description = SWITCH(TRUE(),

Parameter	Value
	[Humidity]<30,"Very Dry", [Humidity]>=30 && [Humidity]<50,"Dry", [Humidity]>=50 && [Humidity]<70,"Moderate", [Humidity]>=70 && [Humidity]<90,"Humid", [Humidity]>=90,"Very Humid") 11.Temperature Range Description = SWITCH(TRUE(), [Temperature]<10,"Very Cold", [Temperature]>=10 && [Temperature]<20,"Cold", [Temperature]>=20 && [Temperature]<30,"Moderate", [Temperature]>=30 && [Temperature]<40,"Warm", [Temperature]>=40,"Hot") 12.Growth Milestone Description = SWITCH([Growth Milestone], 0,"Early Stage", 1,"Mature Stage", "Unknown Stage") 13.Plant Growth Category = SWITCH([Growth Milestone], 0,"Initial Growth",

Parameter	Value
	1,"Advanced Growth", "Uncategorized")

☑ **Data Rendered & Processing Speed**

- The dashboard efficiently **loads and processes plant growth data**.
- Performance testing ensures **quick response times** for data rendering.

☑ **Utilization of Filters & Query Optimization**

- **Filtering plant growth data** based on soil type, fertilizer, temperature, and humidity is optimized for **fast execution**.
- Query optimization ensures that **DAX calculations run efficiently** without performance lags.

☑ **Dashboard & Report Performance**

- **Number of visualizations: 6 key charts & graphs** for trend analysis.
- Reports generate **within seconds**, ensuring **smooth user experience**.

☑ **Data Aggregation & Computation Efficiency**

- **DAX measures** are optimized for **accurate and fast calculations** of growth trends and performance comparisons.

Chapter 7: RESULTS

Chapter 8: ADVANTAGES AND DISADVANATAGES

8.1Advantages

📊 Data-Driven Decision Making

- Provides scientific insights into plant growth rather than relying on trial and error.
- Helps farmers, researchers, and horticulturists optimize plant care strategies.

🔍 Trend Analysis & Predictive Insights

- Tracks historical growth trends to identify optimal conditions.
- Supports trend forecasting for better agricultural planning.

⚡ Interactive & Customizable Dashboard

- Users can apply filters to analyze growth under different conditions.
- Easy-to-use visual graphs and reports for decision-making.

📈 Improves Agricultural Productivity

- Helps in selecting the best soil, fertilizers, and watering schedules.
- Can reduce wastage of resources like water and fertilizers.

🔗 Future Scalability & AI Integration

- Can be expanded with AI-based growth predictions.
- Future integration with IoT sensors for real-time plant monitoring.

8.2Disadvantages

⏳ Requires Accurate & Large Datasets

- Small or inconsistent datasets can lead to misleading insights.
- Users must regularly update data for better accuracy.

💻 Performance Issues with Large Datasets

- The dashboard may slow down when handling massive datasets.
- Requires efficient query optimization to ensure smooth performance.

📡 Limited Real-Time Monitoring (Without IoT)

- Currently, the system relies on manual data input.
- Real-time tracking is only possible with IoT sensor integration.

🧑‍🌾 Adoption Challenges for Non-Tech Users

- Farmers with limited technical knowledge may need training to use the dashboard.
- Requires basic knowledge of data visualization tools like Power BI or Tableau.

Chapter 9: CONCLUSIONS

The Plant Growth Milestone Dashboard successfully provides data-driven insights into the impact of environmental factors on plant growth. By utilizing trend analysis, interactive visualizations, and performance comparisons, the dashboard enables farmers, researchers, and horticulturists to make informed decisions regarding plant care and resource optimization.

🔍 **Key Takeaways:**

✅ Data-Driven Decision Making: The system helps users understand the best conditions for plant growth, reducing reliance on trial-and-error methods.

✅ Efficient Performance Testing: The optimized DAX queries ensure fast data processing and real-time trend analysis.

✅ Interactive & User-Friendly Design: The dashboard's filtering options allow users to customize analysis based on factors like soil type, temperature, and fertilizers.

✅ Scalability & Future Prospects: The project has potential for future enhancements, such as AI-based growth predictions and IoT sensor integration for real-time monitoring.

⚠ **Challenges & Limitations:**

- The system requires accurate and large datasets for optimal results.
- Performance may slow down with extremely large data sets, requiring further optimization.
- Non-technical users may require training to fully utilize the dashboard's features.

🌱 **Final Thoughts:**

This project provides a foundation for data-driven agriculture by helping users track and analyze plant growth patterns efficiently. With future advancements in AI and IoT, the system can evolve into a real-time plant monitoring solution that significantly improves agricultural productivity.

Chapter 10: FUTURE SCOPE

The **Plant Growth Milestone Dashboard** has the potential for significant enhancements to improve **agricultural decision-making** and **plant growth optimization**. Future developments can make the system more **automated, predictive, and scalable**.

📌 **Key Future Enhancements**

✅ 🧠 AI-Driven Growth Prediction

- Implement machine learning models to predict future plant growth trends based on historical data.
- Use deep learning algorithms to suggest optimal growth conditions dynamically.

✅ 📡 IoT Integration for Real-Time Monitoring

- Connect IoT sensors to measure temperature, soil moisture, and humidity in real-time.
- Automate data collection for continuous tracking of plant health.

✅ ☁️ Cloud-Based Dashboard & Mobile Accessibility

- Deploy the dashboard on cloud platforms for remote access and scalability.
- Develop a mobile-friendly application to help farmers monitor plant growth on the go.

✅ 📊 Advanced Data Analytics & Visualization

- Enhance trend analysis with seasonal forecasting models.
- Introduce customizable reports to analyze specific crop types and growth environments.

✅ 🛠 Automated Alerts & Smart Recommendations

- Integrate automated alerts for unfavorable growth conditions.
- Provide AI-generated recommendations for fertilization, watering schedules, and soil adjustments.

🚀 **Long-Term Vision**

- Smart Farming Ecosystem: A fully automated system integrating AI, IoT, and cloud technology.
- Scalability for Large-Scale Agriculture: Extend the dashboard to track multiple farms and crop varieties.

- Global Adoption: Adapt the system to support different climates and crop types worldwide.

Chapter 11: APPENDIX

Source Code

Available upon request.

Dataset Link: [Plant Growth Data.xlsx]

GitHub & Project Demo Link:

https://github.com/AditiArora04/Predicting-Plant-Growth-Stages-with-Environmental-and-Management-Data

https://drive.google.com/file/d/1x73JMcoVVz0HH_FS0AVkO3XrMkLcEtm6/view?usp=sharing