Documentation Phase

Final Report

Date	9 March 2025
Team ID	PNT2025TMID00740
Project Name	Global Food Production and Trend Analysis

Contents:

1. Introduction:

1.1 Project Overview:

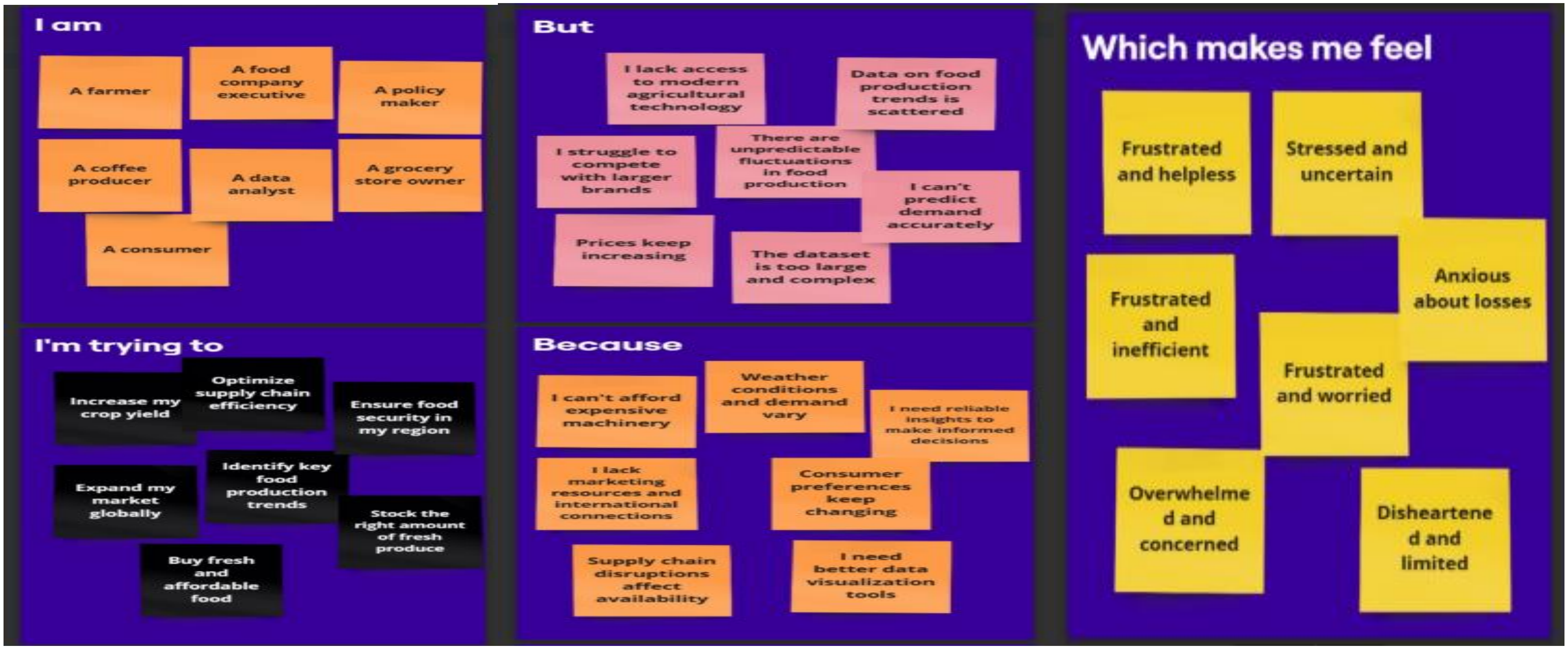
Food production plays a crucial role in global sustainability, economic stability, and food security. This report provides an in-depth analysis of worldwide agricultural trends, highlighting key food production statistics, variations over time, and future projections. The data-driven insights presented here will help policymakers, industry stakeholders, and researchers make informed decisions regarding food supply chains and sustainability.

1.2 Objective of the project:

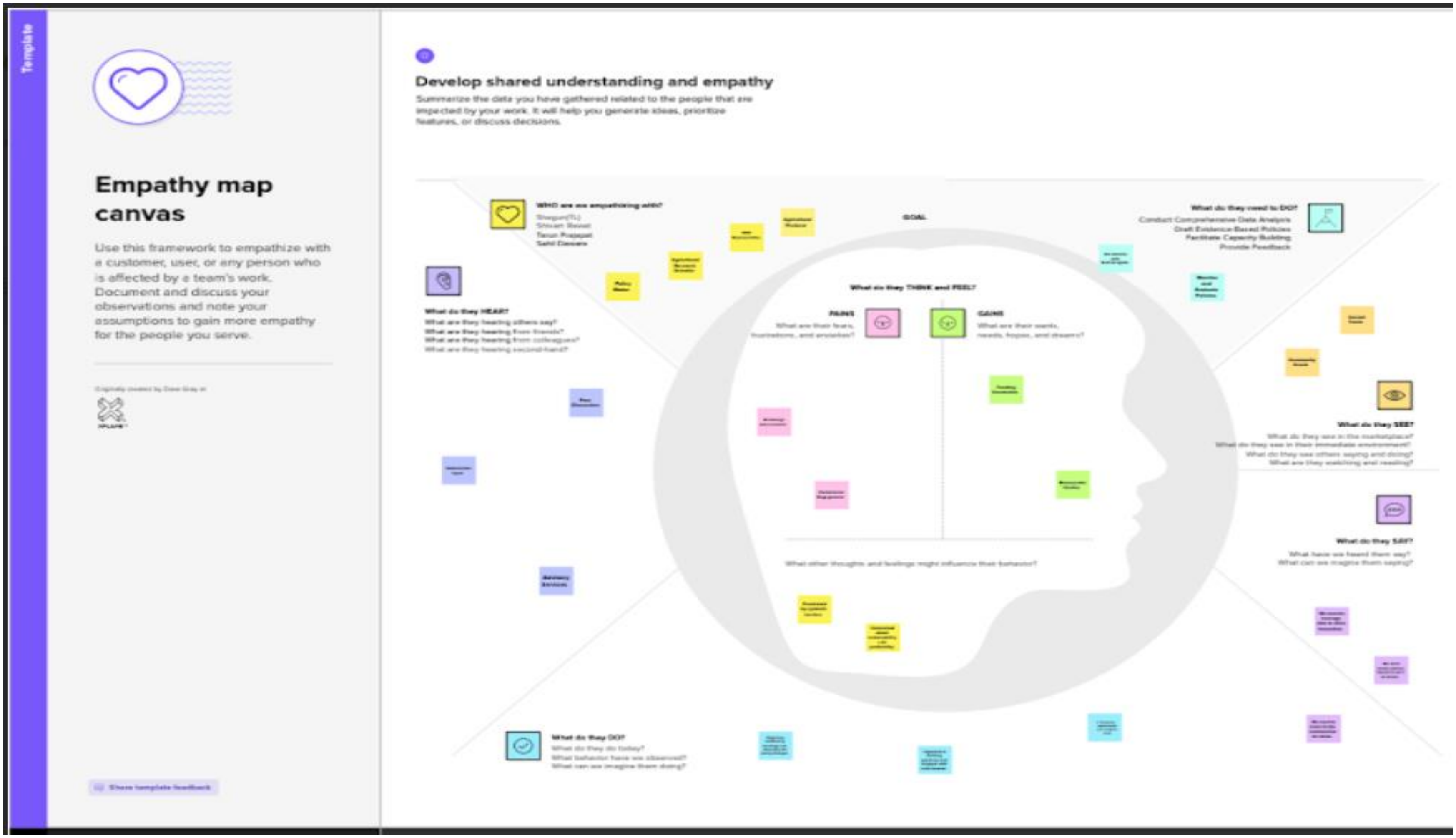
- To analyze year-wise food production trends across different regions and categories.
- To identify major contributors to global food production.
- To examine fluctuations in food production due to economic, climatic, and technological factors.
- To provide actionable insights for improving food sustainability and security.

2. Ideation Phase:

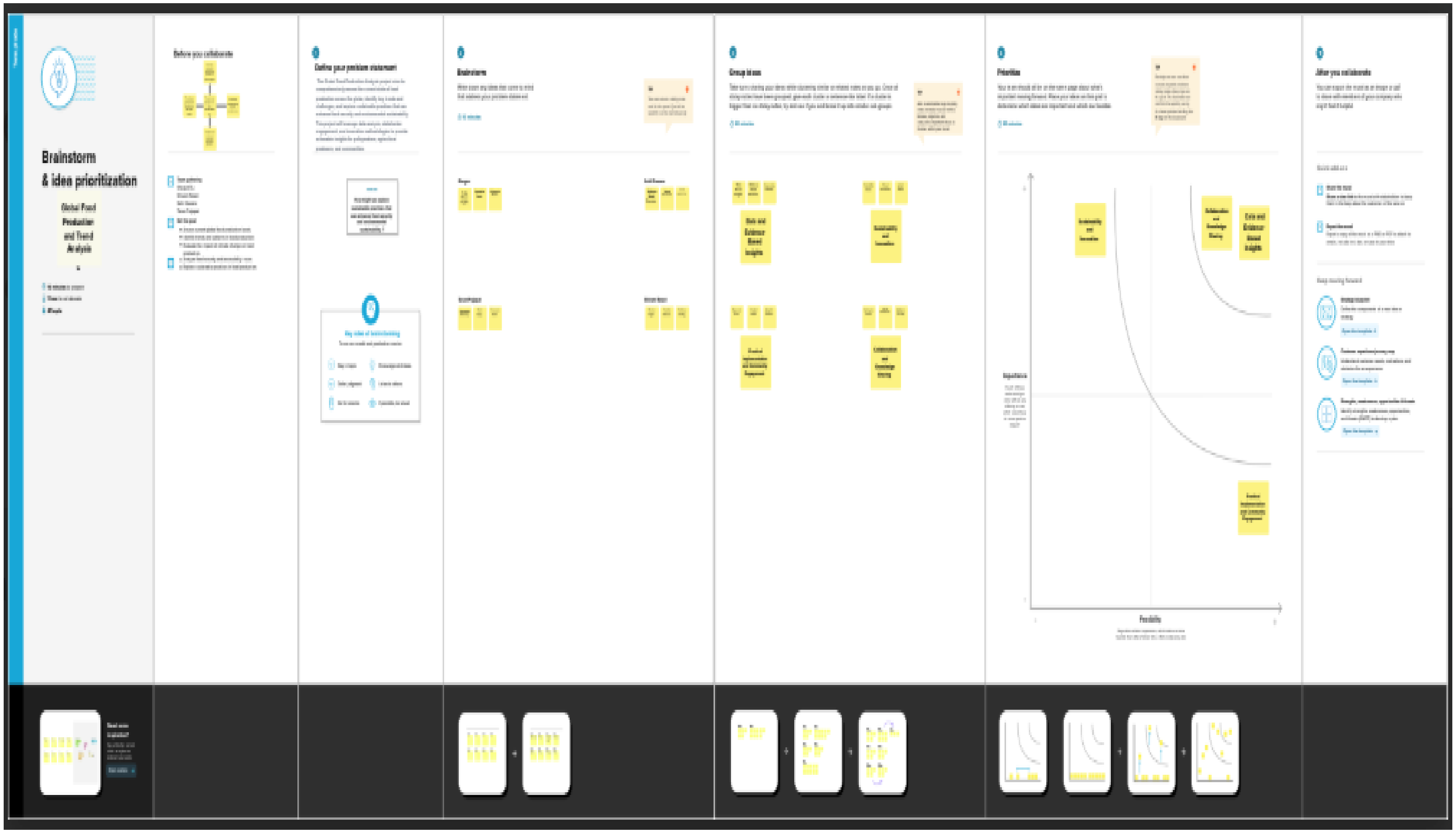
2.1 Problem Statement:



2.2 Empathy Map:

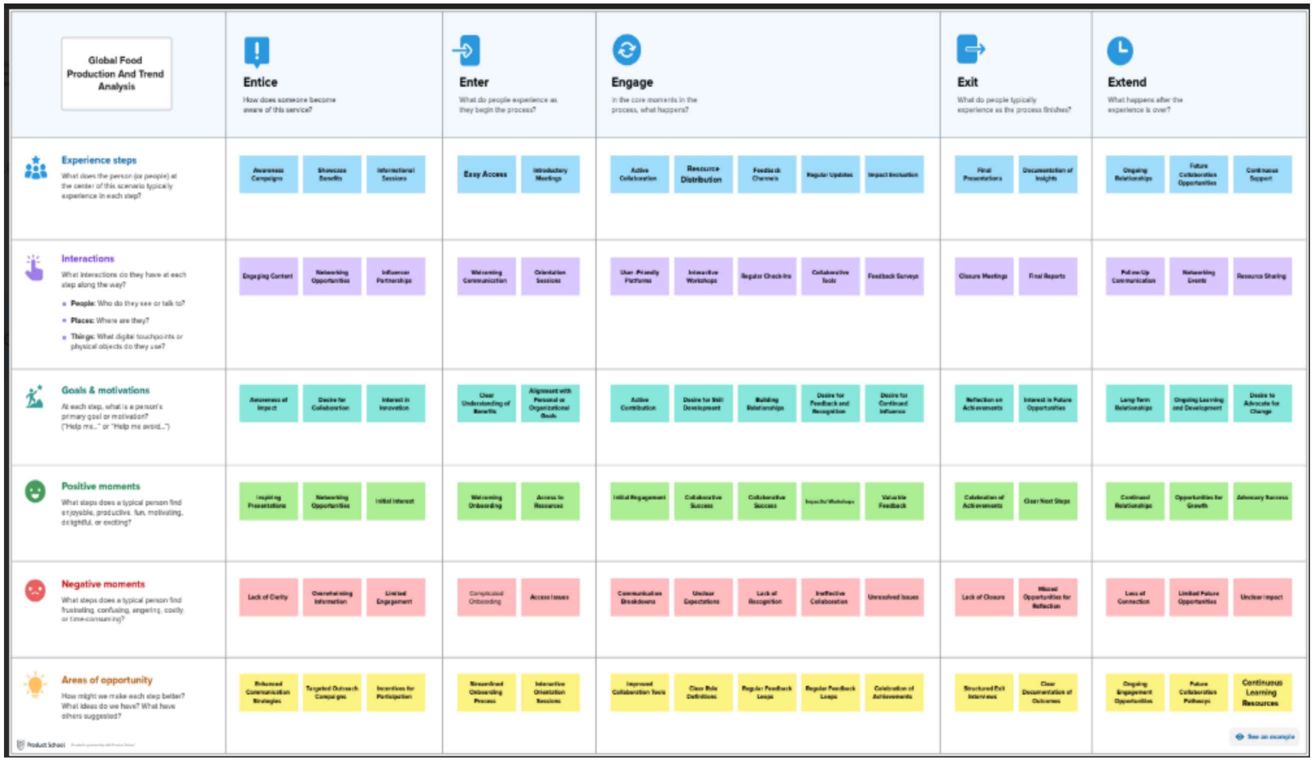


<u>2.3 Brainstorming:</u>



3. **<u>Requirement Analysis:</u>**

   <u>3.1 Customer Journey Map:</u>



3.2 Solution Requirement:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Data Collection & Cleaning	Gather historical food production data (1961-2023)

		Remove inconsistencies & missing values
		Standardize units & formats for analysis
FR-2	Data Processing & Transformation	Aggregate production data by region and crop type
		Calculate yearly growth trends & anomalies
		Prepare dataset for visualization in Power BI
FR-3	Power BI Report Creation	Design interactive dashboards for food production trends
		Create visualizations for staple crops (rice, wheat, maize)
		Develop regional comparison charts for fruit production
FR-4	Insights & Decision Support	Identify key trends in food security & production growth
		Provide data-driven recommendations for stakeholders
		Enable export of reports for business & policy use

NFR No.	**Non-Functional Requirement**	**Description**
NFR-1	Usability	The Power BI dashboard should have

		an intuitive and user-friendly interface for analysts, policymakers, and business users.
NFR-2	Security	Access control mechanisms should ensure only authorized users can view or modify the dataset and reports.
NFR-3	Reliability	The system should ensure consistent and accurate data visualization, with automated alerts for missing or inconsistent data.
NFR-4	Performance	Power BI reports should load within 5 seconds for optimal user experience, even when handling large datasets.
NFR-5	Availability	The Power BI reports should be accessible 24/7 with minimal downtime, ensuring continuous data availability.
NFR-6	Scalability	The solution should handle growing data volumes and support future integration with additional data sources.

3.3 Data Flow Diagram:

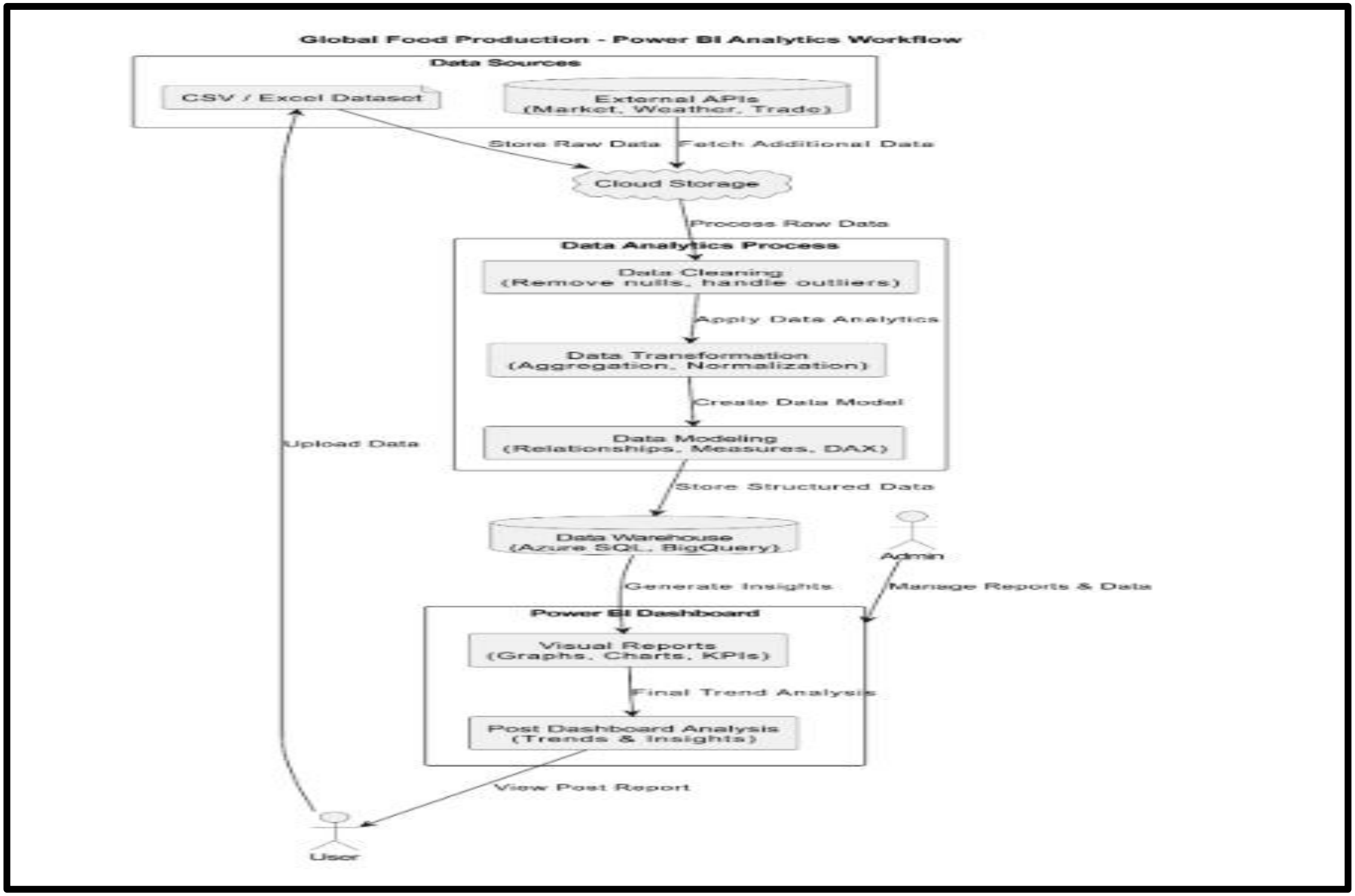
User Type	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Task**	**Acceptance criteria**	**Priority**	**Release**
Agricultural Research Scientist	Access to Research Data	USN-1	As an Agricultural Research Scientist, I want to access a centralized research data repository so that I can analyze trends and derive insights to improve agricultural practices.	• The data repository is accessible to authorized users. • Data is organized and searchable. • Users can download datasets.	High	Sprint-1
	Collaboration with Stakeholders	USN-2	As an Agricultural Research Scientist, I want to collaborate with policymakers and NGOs so that I can ensure my	• Collaboration tools are available (e.g., shared documents, communication channels).	Medium	Sprint-2

			research findings are translated into actionable policies and community programs.	• Feedback from stakeholders is documented.		
Policy Maker	Evidence-Based Policy Development	USN-3	As a Policy Maker, I want to receive evidence-based insights from research data so that I can develop effective policies that address food security and sustainability.	• Research data is presented in a clear and actionable format. • Policy drafts are informed by research findings.	High	Sprint-1
	Stakeholder Engagement	USN-4	As a Policy Maker, I want to engage with stakeholders, including farmers and NGOs, so that I can gather diverse perspectives and	• Stakeholder meetings are scheduled and documented. • Feedback from stakeholders is incorporated into policy drafts.	High	Sprint-2

			create inclusive policies.			
NGO Representative	Community Needs Assessment	USN-5	As an NGO Representative, I want to conduct community needs assessments so that I can advocate for policies that truly reflect the needs of marginalized communities.	• Assessment tools (surveys, interviews) are developed. • Results are compiled and shared with policymakers.	High	Sprint-2
	Access to Data on Food Security Issues	USN-6	As an NGO Representative, I want to access data on food security issues so that I can effectively communicate the challenges faced by communities to policymakers.	• Data on food security is available and up-to-date • Reports can be generated for advocacy purposes.	Medium	Sprint-2

Agricultural Producer	Practical Recommendations	USN-7	As an Agricultural Producer, I want to receive practical recommendations based on research findings so that I can implement sustainable practices that improve my crop yields.	• Recommendations are tailored to specific crops and regions. • Producers can provide feedback on the recommendations.	High	Sprint-3
	Workshops and Training Sessions	USN-8	As an Agricultural Producer, I want to participate in workshops and training sessions so that I can learn about new technologies and practices that can enhance my farming operations.	• Workshops are scheduled and advertised. • Attendance and feedback are collected after each session.	Medium	Sprint-3

3.4: Technology Stack:



1. Technical Architecture:

S.no	Components	Description	Technology

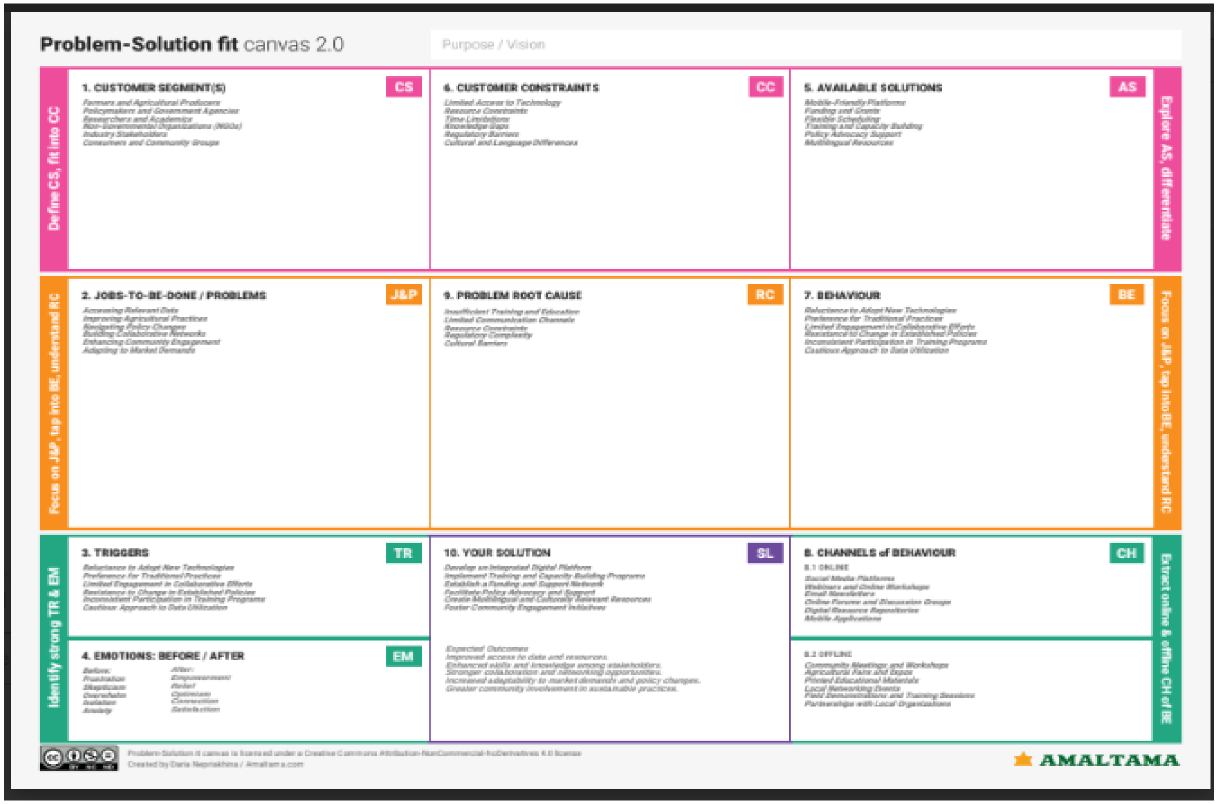
1	User Interface	How users interact with Power BI reports and dashboards (e.g., Web UI, Interactive Reports).	Power BI, Web UI
2	Data Collection	Collecting historical food production data from various sources.	Python, Pandas, APIs
3	Data Cleaning & Preprocessing	Handling missing values, standardizing formats, and normalizing data.	Python, SQL, Power Query
4	Data Storage (Local)	Storing processed data for further analysis.	MySQL, PostgreSQL, CSV, Excel
5	Cloud Database	Storing structured data for accessibility and scalability.	AWS RDS, Azure SQL, Google BigQuery
6	Data Processing & Transformation	Aggregating data, calculating trends, and structuring for visualization.	Python, Power Query, SQL
7	Visualization & Reporting	Creating dashboards and reports with interactive insights.	Power BI, Tableau
8	External APIs	Fetching additional data like weather patterns, crop indices, and market prices.	OpenWeather API, FAO API, Market Data APIs
9	Machine Learning Model (Optional)	Predicting future food production trends based on historical data.	Scikit-learn, TensorFlow, Azure ML

2. Application Characteristics:

S.no	**Characteristics**	**Description**	**Technology**
1	Open-Source Frameworks	List the open-source frameworks used in data processing and visualization.	Power BI, Python (Pandas, NumPy), Excel
2	Security Implementations	Basic security measures like role-based access and dataset permissions.	Power BI Row-Level Security (RLS), Power BI Service Permissions
3	Scalable Architecture	Ensures scalability for handling large datasets and multiple users.	Power BI Cloud Service, Azure SQL, Google BigQuery
4	Availability	Ensuring accessibility of reports through cloud deployment.	Power BI Service, Power BI Embedded, SharePoint Integration
5	Performance	Optimizing report load times and data refresh rates.	Power BI Data Modeling, DAX Optimization, DirectQuery vs. Import Mode.

4. Project Design:

4.1 Problem-Solution Fit:



4.2 Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	There was a lack of detailed analysis of global food production trends, which is crucial for agricultural decision-making and food security.
2.	Idea / Solution description	Using Power BI, food production data from 1961 to 2023 was analysed, focusing on key commodities such as rice, wheat, maize, coffee, tea, and various fruits like apples, bananas, and grapes. The study provides interactive visualizations to track trends and regional contributions.
3.	Novelty / Uniqueness	This study uniquely leverages Power BI to visualize long-term trends and regional contributions, offering real-time insights and comparative analysis for better decision-making.
4.	Social Impact / Customer Satisfaction	The analysis benefits agricultural decision-makers, policymakers, and farmers by providing **data-driven insights** that can help improve food security and promote sustainable production practices.
5.	Business Model (Revenue Model)	This data analytics solution can be monetized through **subscription-based services**, consultancy for agricultural firms, or by providing insights to policymakers and research institutions.
6.	Scalability of the Solution	The solution can be scaled by integrating **more agricultural commodities**, real-time data updates.

4.3 Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behaviour, and other aspects of the
- software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed,
- and delivered.

Architecture Overview:

The project leverages **Power BI** for data visualization and analytics to study global

food production trends from 1961 to 2023. The architecture consists of:

1. Data Sources:

  - FAO and other global food production datasets (CSV, Excel, SQL databases)
  - Public APIs for agricultural production statistics
  - Historical datasets manually processed for trend analysis

2. Data Processing & Transformation:

- Data cleaning and transformation using Power Query in Power BI
- Creating relationships between various datasets (commodities, regions, years)
- Aggregating data for insightful reporting

3. Data Modeling & Storage:

- Data is structured and stored in Power BI's in-memory model
- Measures and calculated columns created using DAX (Data Analysis Expressions)

4. Visualization & Reporting Layer:

  - Power BI Dashboards & Reports featuring:
    - Gauge Charts (Tea production analysis)
    - Bar & Stacked Charts (Fruit & coffee production comparison)
    - Area Charts (Trends of wheat, maize, and rice over time)
    - Donut Charts (Maize production distribution)
  - Interactive filtering by year, region, and commodity

5. Deployment & Accessibility:

- Hosted on Power BI Service for real-time data access
- Reports shared via Power BI Embedded & Power BI Mobile for accessibility

6. Scalability & Future Enhancements:

- Integration with real-time data sources via APIs
- Expansion to include more agricultural commodities and regional insights

<u>Example - Solution Architecture Diagram:</u>

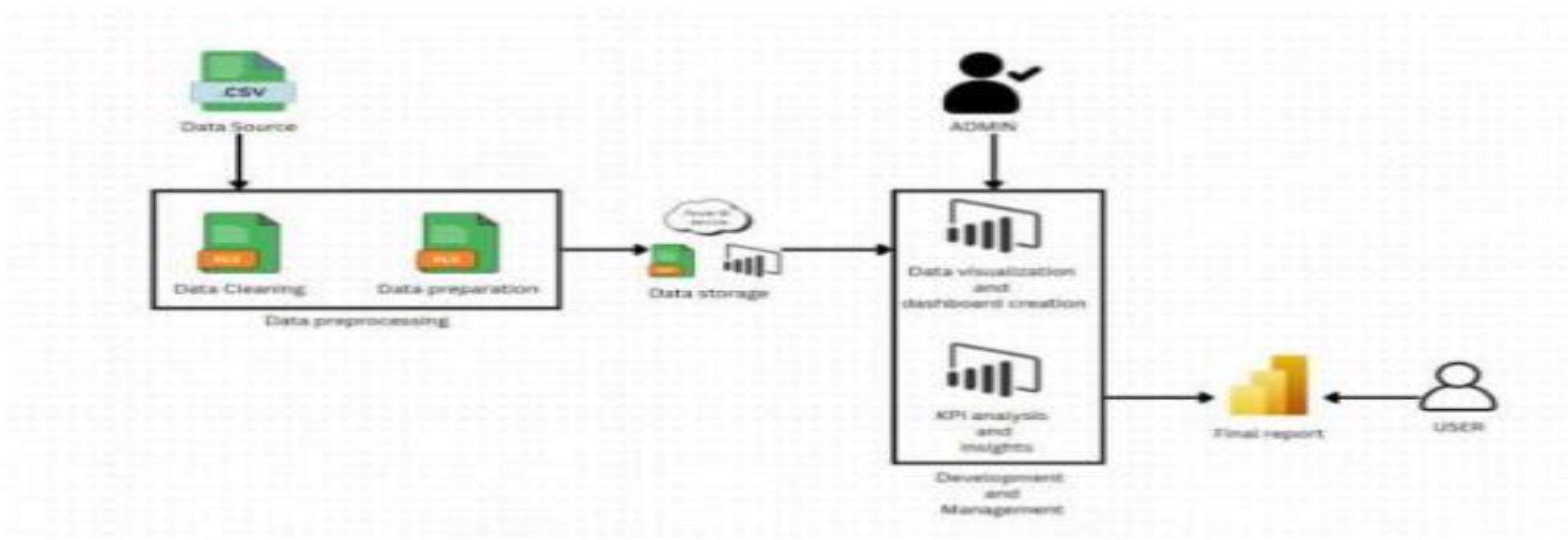


Figure 1: Architecture and data flow of the Global food production analysis system

5. **Project Planning:**

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data Collection	USN-1	Identify and gather data sources for food production.	5	High	Gauri Upadhyay
	Data Preparation	USN-2	Clean and preprocess collected data for analysis.	8	High	Shagun
	Dashboard Design	USN-3	Create wireframes for Power BI dashboard layout.	3		Shivam Rawat
		USN-4	Define key metrics and visualizations for the dashboard.	5	High	Harsh Verma
Sprint-2	Data Modeling	USN-5	Build data models in Power BI to connect data sources.	8	High	Shagun
	Visualization Development	USN-6	Create interactive visualizations for key metrics.	8	High	Harsh Verma
	Testing	USN-7	Conduct testing of dashboard functionality and accuracy.	5	Medium	Shivam Rawat
	Feedback Collection	USN-8	Gather feedback from stakeholders on initial dashboard.	3	Medium	Gauri Upadhyay
Sprint-3	Training and Documentation	USN-9	Develop training materials for stakeholders.	5	High	Shagun

		USN-10	Conduct training sessions for users on Power BI dashboard.	5	High	Harsh Verma
	Launch	USN-11	Officially launch the Power BI dashboard.	3	High	Shagun Harsh Verma Shivam Rawat Gauri Upadhyay
	Evaluation	USN-12	Evaluate dashboard effectiveness and gather further feedback.	5	Mediu m	Shagun Harsh Verma Shivam Rawat Gauri Upadhyay

Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	21	10 Days	21 Feb 2025	02 March 2025	21	02 March 2025
Sprint-2	20	10 Days	03 March 2025	12 March 2025	21	12 March 2025
Sprint-3	13	2 Days	13 March 2025	14 March 2025	13	14 March 2025

Velocity:

Total Story Points Completed: 58

Total Number of Sprints = 3
Velocity = Total Story Points Completed / Number of Sprints

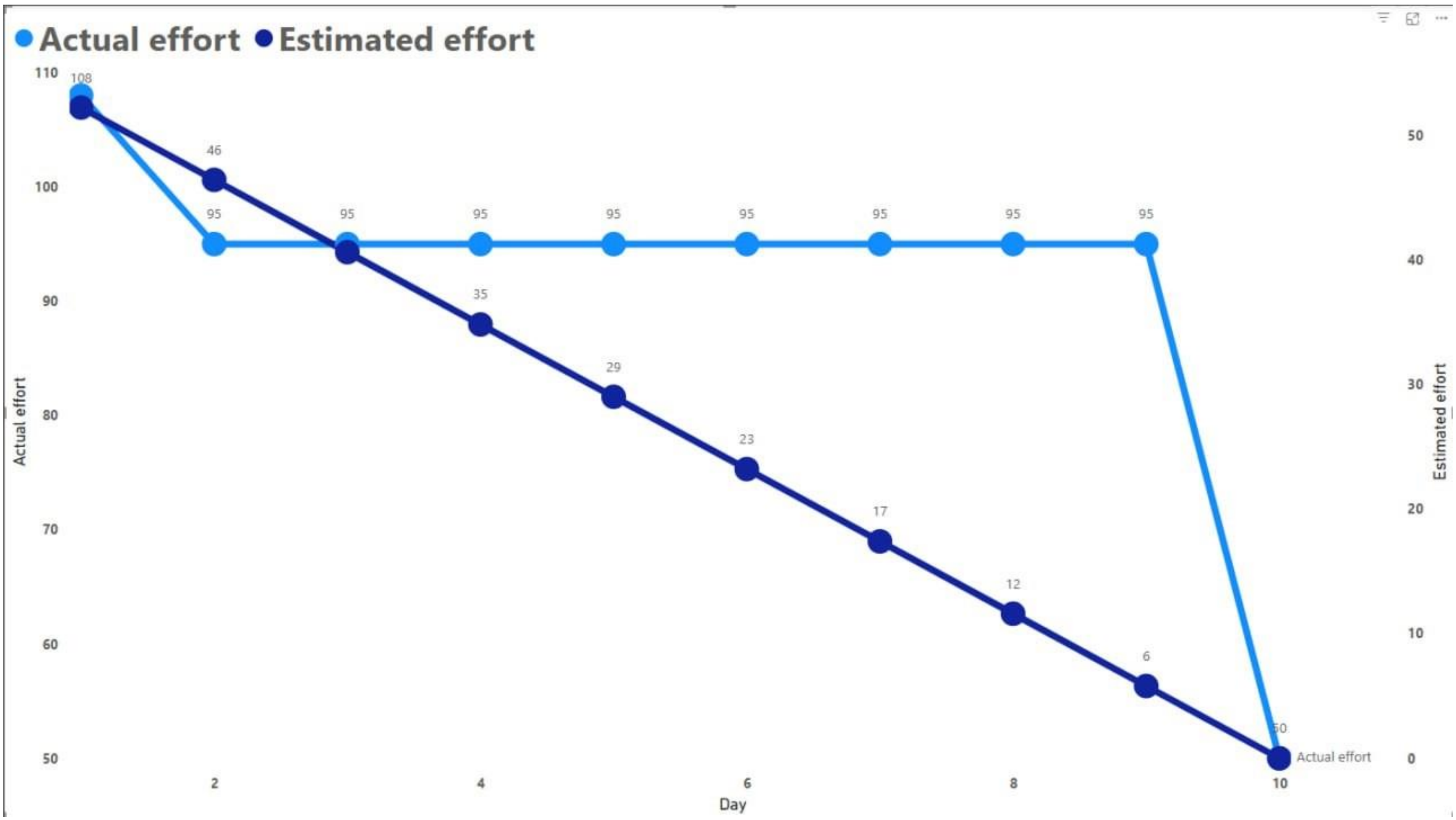
Velocity = 58 / 3 ≈ 19.33

Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

Sprint	Day	Total Story Points	Story Points completed	Remaining Story Points
1	1	58	0	58
	2	58	0	58
	3	58	0	58
	4	58	0	58
	5	58	0	58
	6	58	0	58
	7	58	0	58
	8	58	0	58
	9	58	0	58
	10	58	21	37
2	1	58	21	37
	2	58	21	37
	3	58	21	37
	4	58	21	37
	5	58	21	37
	6	58	21	37
	7	58	21	37
	8	58	21	37
	9	58	21	37
	10	58	45	13
3	1	58	45	13

	2	58	58	0



Actual effort
Estimated effort
Actual effort
Estimated effort
Day
110
100
90
80
70
60
50
50
40
30
20
10
0
2
4
6
8
10
108
46
95
95
95
95
95
95
95
95
35
29
23
17
12
6
50
Actual effort

6. Functional and Performance Testing:

Model Performance Testing:

<table>
<tr><th>S.No.</th><th>Parameter</th><th>Screenshot / Values</th></tr>
<tr><td>1.</td><td>Data Rendered</td><td>Data is successfully imported, tables are visible, all required columns are present, and visuals correctly display aggregated values.

</td></tr>
<tr><td>2.</td><td>Data Preprocessing</td><td>Changed the decimal values to whole numbers</td></tr>
<tr><td>3.</td><td>Utilization of Data Filters</td><td>Filtered Top Production Results whether it is by Year or Entity</td></tr>
<tr><td>4.</td><td>DAX Queries Used</td><td>Creation of new columns:
1. Beverages Production = 'world food production'[Tea Production (tonnes)]+'world food production'[Coffee, green Production (tonnes)]</td></tr>
</table>

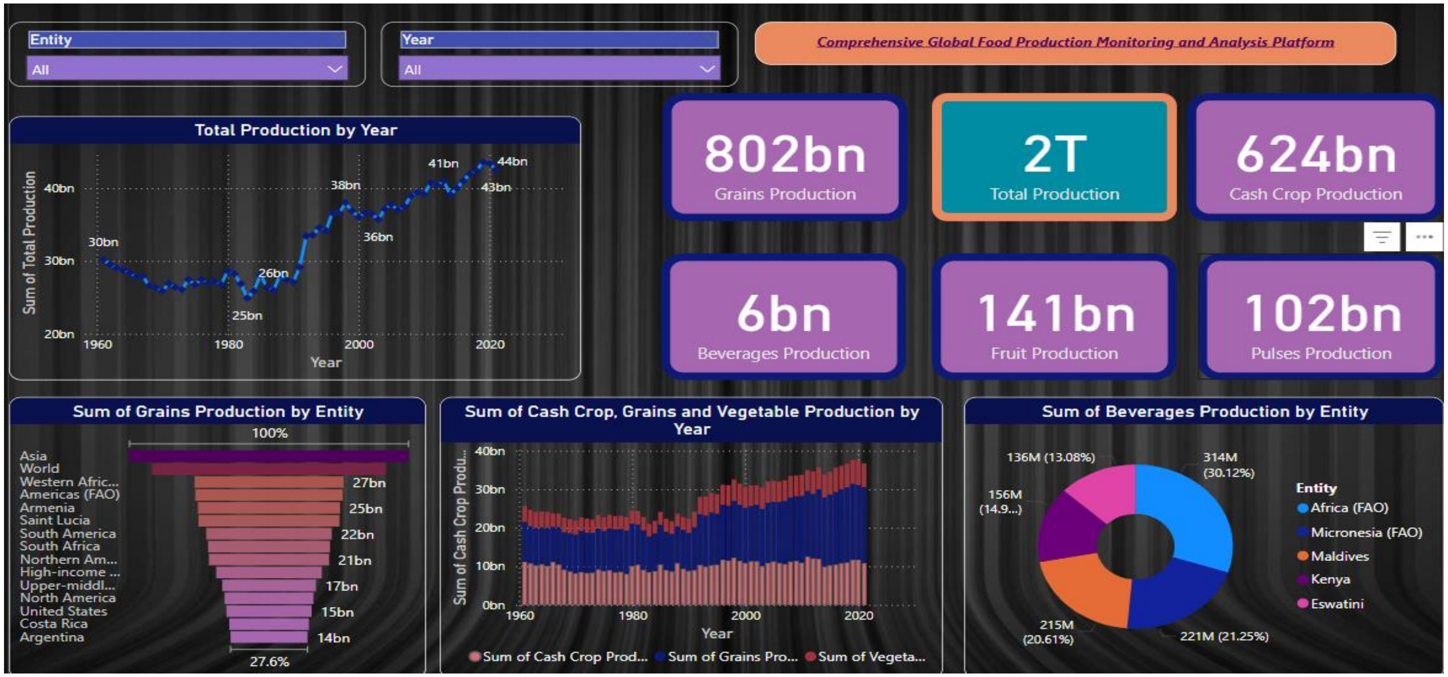
		``
		2. Cash Crop Production = 'world food production'[Cocoa beans Production (tonnes)]+'world food production'[Sugar cane Production (tonnes)]
		3. Fruit Production = 'world food production'[Oranges Production (tonnes)]+'world food production'[Grapes Production (tonnes)]+'world food production'[Bananas Production (tonnes)]+'world food production'[Apples Production (tonnes)]+'world food production'[Avocados Production (tonnes)]
		4. Grains Production = 'world food production'[Maize Production (tonnes)] + 'world food production'[Rice Production (tonnes)] + 'world food production'[Wheat Production (tonnes)] + 'world food production'[Rye Production (tonnes)]
		5. Pulses Production = 'world food production'[Soybeans Production (tonnes)]+'world food production'[Peas, dry Production (tonnes)]
		6. Vegetable Production = 'world food production'[Tomatoes Production (tonnes)]+'world food production'[Sweet potatoes Production (tonnes)]+'world food production'[Potatoes Production (tonnes)]+'world food production'[Yams Production (tonnes)]
		``
		Creation of New Tables:
		``
		1. total_production_per_year =
		SUMMARIZE(
		    'world food production',
		    'world food production'[Year],
		    "Total Production",
		    SUMX(
		        'world food production',
		        'world food production'[Maize Production (tonnes)]
		+
		        'world food production'[Rice Production
		(tonnes)] +
		        'world food production'[Yams Production (tonnes)]
		+
		        'world food production'[Wheat Production (tonnes)]
		+
		``

		<pre> 'world food production'[Tomatoes Production
		(tonnes)] +
		        'world food production'[Tea Production
		(tonnes)] +
		        'world food production'[Sweet potatoes Production
		(tonnes)] +
		        'world food production'[Sunflower seed Production
		(tonnes)] +
		        'world food production'[Sugar Cane Production
		(tonnes)] +
		        'world food production'[Soybeans Production
		(tonnes)] +
		        'world food production'[Rye Production (tonnes)]
		+
		        'world food production'[Potatoes Production
		(tonnes)] +
		        'world food production'[Oranges Production
		(tonnes)] +
		        'world food production'[Peas, dry Production
		(tonnes)] +
		        'world food production'[Palm oil Production
		(tonnes)] +
		        'world food production'[Grapes Production
		(tonnes)] +
		        'world food production'[Coffee, green Production
		(tonnes)] +
		        'world food production'[Cocoa Beans Production
		(tonnes)] +
		        'world food production'[Meat, chicken Production
		(tonnes)] +
		        'world food production'[Bananas Production
		(tonnes)] +
		        'world food production'[Avocados Production
		(tonnes)] +
		        'world food production'[Apples Production
		(tonnes)]
		    )
		)</pre>

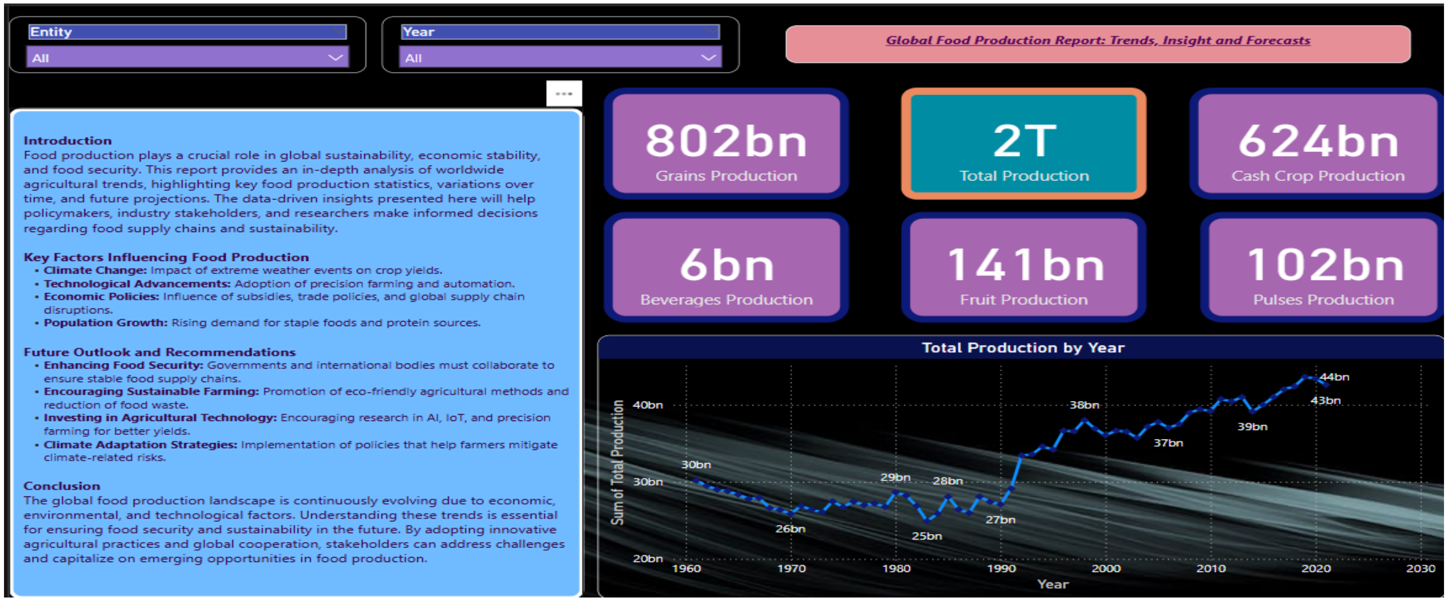
<table>
<tr><td></td><td></td><td><pre><code>2. category_production_per_year =
SUMMARIZE(
    'world food production',
    'world food production'[Year],
    "Grains Production", SUM('world food
production'[Grains Production]),
    "Pulses Production", SUM('world food
production'[Pulses Production]),
    "Cash Crops Production", SUM('world food
production'[Cash Crop Production]),
    "Vegetables Production", SUM('world food
production'[Vegetable Production]),
    "Fruit Production", SUM('world food production'[Fruit
Production]),
    "Beverages Production", SUM('world food
production'[Beverages Production]),
    "Meat Production", SUM('world food production'[Meat,
chicken Production (tonnes)])
)</code></pre></td></tr>
<tr><td>5.</td><td>Dashboard design</td><td>12| 2 slicers, 6 cards, 1 line chart, 1 column chart,
1 donut chart, 1 funnel chart</td></tr>
<tr><td>6</td><td>Report Design</td><td>9| 2 slicers, 6 cards and 1 line chart with a brief description of the report</td></tr>
</table>

7. Results:

7.1Screenshots of Dashboard and observation:



Screenshot of Report and observation:



Advantages:

- **Data-Driven Insights:** Provides a comprehensive analysis of food production trends over six decades, helping policymakers and researchers make informed decisions.
- **Interactive Visualizations:** Power BI allows for intuitive exploration of food production trends, improving data accessibility.

- **Identification of Key Patterns:** Helps detect seasonal trends, production peaks, and anomalies in global food supply.
- **Real-Time Data Updates:** Ensures timely responses to food production fluctuations and supply chain issues.
- **Scalability and Customization:** Can be expanded with additional datasets and predictive analytics for deeper insights.

Disadvantages:

- **Data Accuracy Concerns:** Historical data may have inconsistencies due to variations in collection methods.
- **Performance Limitations:** Large datasets spanning multiple decades may cause performance issues in Power BI.
- **Technical Complexity:** Advanced users may need expertise in DAX, SQL, and Power Query for deeper customization.
- **Limited Predictive Capabilities:** While great for historical analysis, additional integrations are needed for AI-based forecasting.
- **Data Privacy & Sharing Constraints:** Some organizations may restrict public sharing of Power BI reports due to data sensitivity.

Conclusion: The global food production landscape is continuously evolving due to economic, environmental, and technological factors. Understanding these trends is essential for ensuring food security and sustainability in the future. By adopting innovative agricultural practices and global cooperation, stakeholders can address challenges and capitalize on emerging opportunities in food production.

Future Scope:

- **Enhancing Food Security:** Governments and international bodies must collaborate to ensure stable food supply chains.
- **Encouraging Sustainable Farming:** Promotion of eco-friendly agricultural methods and reduction of food waste.
- **Investing in Agricultural Technology:** Encouraging research in AI, IoT, and precision farming for better yields.
- **Climate Adaptation Strategies:** Implementation of policies that help farmers mitigate climate-related risks.

Appendices:

- **Dataset link:** https://www.kaggle.com/datasets/rafsunahmad/world-food-production
- **Github link:** https://github.com/Shagun5114/Global-Food-Production-Trends-and-Analysis-A-Comprehensive-Study-from-1961-to-2023-Using-Power-BI.git
- **Demo link:** https://drive.google.com/file/d/1lSRNg9ZXql1iMi26TejfrC4XqvPEonkL/view?usp=sharing