

## Assignment 1: Design Space

**Important : Views, [something I didnt hear], DD reflect on solution, Inventory services, viewpoint (optional - 1 point more if do correctly),How create view convey the questions, design decision&documentations, also we should do the meta model for extra points.**

This assignment refers to the case *"Fighting Malnutrition in a Changing Climate"*. Your project report will be structured according to the sections described in this document and reporting the key characteristics of your design. All diagrams should be drawn by using a software modeling tool supporting UML, for instance [diagrams.net](https://diagrams.net).

**Note that each section should carry the name of the individual group member responsible for its quality (e.g., Section 1, Business Domain [Tom de Kat]).** Alternatively, you can choose to provide an overview of Group Responsibilities in the beginning or end of the document, e.g., as follows:

Section Team member
Section 1: Business domain: Robel

<b>Section 2: Functional Requirements :</b> Cindy
<b>Section 3: Quality requirements:</b> -
<b>Section 4: Business services:</b> Yana <b>Section 4.1.: Crop Yield Prediction Service:</b> Robel <b>Section 4.2.: Fair Price Advisor Service:</b> Yana <b>Section 4.3.: Investment Database:</b> Cindy <b>Section 4.4.: Recommendation Service:</b> -
<b>Section 4 (cont.): Context:</b> Robel
<b>Section 5: Design space:</b> Yana
<b>Section 6: Sustainability strategies:</b> Cindy

**Selection of target usage scenario/s<sup>1</sup>:** Before you get started, choose the problem you want to focus on, defined in terms of your target participants and the usage scenario/s involving these participants. For the assignment, you must consider the *problem* you chose.

#### **Project report structure:**

- **Section 1: Business domain:** [see material Week 1 and Week 2 (step 0)]

Your business domain must be described through the following two parts:

- o Description of the ‘usage scenario’ that you will consider and that elaborates on the general functionality you chose. You are encouraged to include new ideas!
- o Identification of the ‘participants’ that interact to realize these scenarios. These participants should comply with the ones mentioned in the case description, and add (if applicable) new stakeholders and/or users. Participants should be visualized in a business domain model and be complemented with a table explaining each participant and their role in detail.

## **Section 1: Business Domain**

Description of the User Scenario:

#### **Background Problem:**

Child malnutrition is a pressing concern in East African countries, particularly in the Global South. It is often identified only when children are visibly starved, indicating a severe level of malnutrition. This issue is exacerbated by socio-technical and environmental limitations unique to these regions. Statistics reveal that a significant portion of the child population suffers from malnutrition in these areas, emphasising the urgency of addressing this problem. Furthermore, the vast majority of the population in these regions relies heavily on agriculture for their livelihoods. The unpredictable climate patterns and limited resources in East African farming make it challenging for farmers to produce enough nutritious food for themselves and their communities, perpetuating the cycle of

malnutrition.

This project highlights the critical link between sustainable agricultural practices and combating malnutrition in these regions. The project aims to harness business services and software services to empower farmers, increase economic sustainability, and ultimately provide access to nutritious foods for children in East African countries.

**Goal of the Project:**

The main goal of this project is to harness business and software services to empower farmers, enabling them to become highly productive despite the challenges posed by climate change. Additionally, the project seeks to enhance the economic sustainability of these farmers while ensuring access to nutritious foods for children in East African countries. This holistic approach not only addresses agricultural productivity and economic viability but also directly contributes to the well-being and nutrition of the region's children.

**Solution and Connection to the Case Problem:**

The proposed solution is rooted in providing essential business services tailored to address the problem. These services include crop yield prediction, fair pricing advice, international investment guidance, and recipe recommendations. These services are specifically designed to empower farmers in the Global South, especially in East African countries and improve their economic conditions. By making these services accessible, the project aims to create a direct link between sustainable farming practices and the reduction of child malnutrition.

**Functionality:**

***Functionality Provided:***

The project offers several critical functionalities:

**Crop Yield Prediction Service (BS-CYP):** Provides farmers with data-driven predictions to optimise crop production.

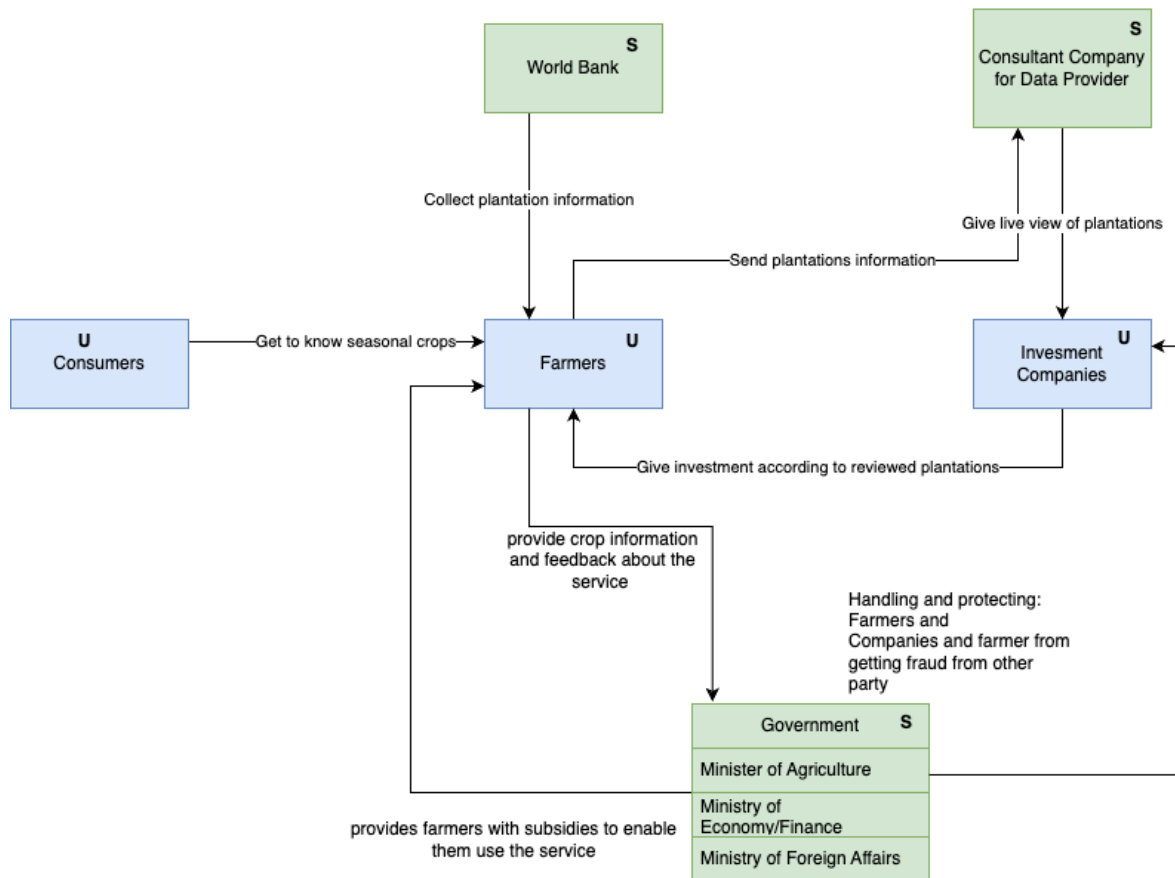
**Fair Price Advisor Service (BS-FPA):** Helps farmers make informed decisions on pricing their produce.

**International Agriculture Investment Dataspace Service (BS-IAI):** Facilitates access to international markets and investments.

**Recipe Recommendation Service (BS-RRS):** Aids consumers in preparing nutritious meals from the available crops.

**Stakeholders and Users:**

Stakeholders in this project include investment companies, government bodies (such as the Ministry of Agriculture, Ministry of Economy/Finance, and Ministry of Foreign Affairs), and The World Bank. The World Bank offers financial and developmental support to drive positive change. Farmers are the primary users of the provided business services, relying on them to improve their income and sustainability. Investment companies are also among the users, as they support farmers by offering funding and expertise, while government bodies contribute through regulation and broader initiatives to address malnutrition. Consumers play a pivotal role by purchasing crops grown by farmers and utilising the recipe recommendation service. Each of these stakeholders and users interacts with the business services, collectively working toward the project's overarching goal of reducing child malnutrition in East African countries.



*Image 1: business domain model*

**Section 2: Functional requirements:** [see material Week 1]

Given the *problem* you chose, you should identify and describe the two<sup>2</sup> core functional requirements of your service-based application. Each functional requirement should be associated with a unique identifier and short name (e.g., FR1-CheckProgress).

The most crucial business service is Crop Yield Prediction Service, that consists of two essential functional requirements. In order to guarantee that data requesters can obtain the information they need, Requirement ID FR1-C-DataSharing is dedicated for seamless sharing of the agricultural data, whether in its raw form or as in-depth analytical insights. Requirement ID FR2-C-CustomisedCropRecommendation is designed to generate the in-depth analytical insights, by tailoring recommendations and information. It provides customised advice by taking into consideration the geographic location of each farmer as well as particular regional climate and soil variances, enabling farmers to maximise their crop yields sustainably. Together, these requirements form the backbone of our service, enabling data sharing and customised support to enhance agricultural productivity.

<b>Requirement ID</b>	<b>FR1-CropAnalysts</b>
<b>Business Service</b>	Crop Yield Prediction Service (BS-CYP)
<b>Definition</b>	Service is designed to generate in-depth analytical insights, by tailoring recommendations and information. It provides customised advice by taking into

	consideration the geographic location of each farmer as well as particular regional climate and soil variances, enabling farmers to maximise their crop yields sustainably. Analyst results are shared safely to data requesters, whether in its raw form or as in-depth analytical insights.
<b>Motivation</b>	Early prediction tools should be able to mitigate the prevalence of harvest failures. These predictions are based on sensor data, which offers essential information about different agricultural elements. This functionality assists farmers in making quick adjustments regarding how to better care for their land by offering information about the current health state of the land as well as its predicted future. Additionally, the service should be able to suggest tips for land care. This functionality ultimately contributes to an abundant harvest. Moreover, by sharing both sensor readings and prediction data, the service will be able to collaborate with other services. This cooperative sharing approach generates significant value for the participating services by building a positive economic ecosystem for farmers, raising harvest amounts, reducing hunger, and improving farmer livelihoods.

<b>Requirement ID</b>	<b>FR2-PriceInformation</b>
<b>Business Service</b>	Fair Price Advisor Service (BS-FPA)
<b>Definition</b>	Service should be able to provide current market price specific to the crop species and plantation area of the requesters. Moreover, the service should be able to predict the future price of requester crops, which is map to their personalised crop yield prediction.
<b>Motivation</b>	In many East African countries, farmers often lack awareness of the market prices for their agricultural products, resulting in the sale of their produce at undervalued prices. This economic challenge contributes to malnutrition problems in the area. By providing users with access to current market prices and allowing them to align these prices with their personalised crop yield predictions, this functionality empowers farmers to make informed decisions about when and where to sell their produce, ultimately contributing to economic improvement and malnutrition reduction.

<b>Requirement ID</b>	<b>FR3-InvestmentDataspace</b>
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<b>Business Service</b>	International Agriculture Investment Dataspace Service (BS-IAI)
<b>Definition</b>	The service facilitates the international sharing of data, responding to specific requester requests and adhering to the regulations of the involved nations. Additionally, there is an extensive audit trail covering all user interactions and data alterations within the system. All access and data changes, both recent and historical, are logged and timestamped as part of this careful record-keeping, laying a solid foundation for accountability and auditing needs.
<b>Motivation</b>	<p>The motivation behind this service is rooted in the potential for major agricultural development in East African nations through additional finance. Better financial access has the ability to change farming technologies and outcomes in the area. However, to instil trust in foreign investors, a strong basis in research and auditing is required.</p> <p>The challenge arises from the fact that different countries have different rules and regulations regarding data exchange, which can make the procedure more difficult. Establishing a standardised and secure dataspace that complies with local legislation while also enabling overseas investors to confidently analyse and consider their funding options is critical. Based on credible data, the investment potential might result in significant monetary assistance for East African farmers, which gives them the chance to improve their agricultural technologies and outcomes. Ultimately, this service plays a pivotal role in bridging the gap between the potential for agricultural improvement and foreign funding.</p>

<b>Requirement ID</b>	<b>FR4-Recipe Recommendation</b>
<b>Business Service</b>	Recipe Recommendation Service (BS-RRS)
<b>Definition</b>	Service is built upon an AI-powered recommendation engine that will publish recipe suggestions based on the availability of in-season ingredients. Each of the recipes are equipped with nutritional details, including the number of calories, the amount of macronutrients, and the presence of important vitamins and minerals.
<b>Motivation</b>	The motivation driving this service is rooted in addressing a prevalent challenge—many individuals lack the knowledge and skills needed to effectively utilise in-season, locally sourced foods. This knowledge gap results in missed opportunities for individuals to take advantage of the



	<p>cost-effectiveness of locally available, in-season products.</p> <p>In most cases, in-season local foods are more affordable than other options, making them accessible to individuals and families. Moreover, when these products remain unsold and uneaten, it contributes to food waste and, consequently, financial losses for the local economy. The services empower people by promoting ways to process locally produced food stocks.</p>
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Requirement ID	FR1-R-RecipeGenerate
Business Services	Recipe Recommendation Service
Description	AI-driven recommendation engine that suggests recipes based on the availability of on-season ingredients, user preferences, and dietary restrictions.

Requirement ID	FR2-R-NutrientsDetails
Business Services	Recipe Recommendation Service
Description	Provide nutritional information for each recipe, including calorie count, macronutrient content, and essential vitamins and minerals.

Requirement ID	FR3-P-HistoricalPrice
Business Services	Fair Price Service
Description	<ul style="list-style-type: none"> <li>● Offer insights into price fluctuations over time and factors influencing these changes.</li> <li>● Provide historical market price data to help farmers compare current prices with past trends.</li> </ul>

Requirement ID	FR4-P-PricePrediction
Business Services	Fair Price Service
Description	Calculate and provide real-time or periodic market price predictions for various crops based on the ML model's output. Hence Allowing farmers to specify the crop type and location for personalised price predictions.

Requirement ID	FR5-C-DataSharing
Business-Services	Crop-Yield-Prediction-Service
Description	Sharing-Data (Either Raw or Depth Analysis) to data requesters.

Requirement ID	FR6-C-CustomisedCropRecommendation
Business-Services	Crop-Yield-Prediction-Service
Description	Customise recommendations and information based on the geographical location of the farmer, taking into account regional climate and soil variations.

Requirement ID	FR5-I-InternationalDataSharing
Business-Services	International-Agriculture-Investment-Dataspace-Service
Description	Sharing data internationally, based on requester request and nations regulations.

Requirement ID	FR6-I-AuditData
Business-Services	International-Agriculture-Investment-Dataspace-Service
Description	<ul style="list-style-type: none"> <li>● Maintain a comprehensive audit trail of all user interactions and data modifications within the system for auditing purposes.</li> <li>● Log and timestamp all access and data changes for accountability</li> <li>● Keeping historical and current data</li> </ul>

- **Section 3: Quality requirements:** [see material Week 1 and Week 2]  
Identify and describe the two most important quality requirements (or service aspects) that are relevant for the *problem* you chose. Similar to functional requirements, associate each quality requirement with a unique identifier and short name (e.g., QR1-maintainability).

# ACCESSIBILITY

# ACCURACY

# DATA SECURITY

## Section 3: Quality requirements

This section identifies two key quality requirements that are important for the business services in this project:

Requirement ID: QR1-Accessibility

Name: Accessibility

The services should be easily accessible to farmers across East Africa, including those in remote rural areas. The interfaces and communication channels need to be designed for low literacy users with basic mobile devices and limited connectivity.

Requirement ID: QR2-Accuracy

Name: Accuracy

The predictions and recommendations generated by the services need to have a high degree of accuracy to be useful for farmers. The data analysis and algorithms should be rigorously tested and validated.

Requirement ID: QR3-DataSecurity

Name: Data Security

Farmer data needs to be properly secured and access controlled to maintain privacy. Encryption and access control mechanisms should be implemented to prevent data leaks. Auditing capabilities are also necessary.

<sup>1</sup> Depending on the chosen problem scope, you can select one or multiple scenarios.

<sup>2</sup> At least one per team member (i.e., at least 2 for teams of two students, 3 for teams of three, etc.)

**Section 4: Business services:** [see material Week 2 (step 1+2)]

After documenting your requirements, you should identify and explicitly document the core Business Services from your functional requirements. The description should follow the format reported in Table 1.

**Table 1: Business Service Description Template**

Field	Description
Unique ID	Give a unique ID for this business service
Short Name	Give a short name for this business service
Involved Participants	Specify the participants involved in this business service
Detailed Operational Description	Give a textual description of the business service
Service Behavior	UML activity diagram illustrating the behavior of the business service
Service Candidates Decomposition	UML use case diagram illustrating the decomposition of services into service operations
Data Model <sup>3</sup>	UML class diagram illustrating the identification/extension of service candidates managing data

## Section 4.1: Crop Yield Prediction Service

**Unique ID:** BS-CYP

**Short Name:** Crop Yield Prediction Service

**Involved Participants:**

- Users - Farmers
- Stakeholder: Government(Ministry of Agriculture) provides subsidies for the farmers to enable them to use the service.

### Detailed Operational Description

The Crop Yield Prediction Service (CYPS) is a crucial component of the broader agricultural support ecosystem within this project. CYPS is designed to assist farmers in East African countries in optimising their crop production and increasing their yields. It achieves this by utilising data-driven analytics and predictive algorithms to estimate future crop yields based on various factors including weather patterns, historical data, and current agricultural practices.

CYPS works in tandem with other project services, such as the Fair Price Advisor (FPA) service. The collaboration between CYPS and FPA enables farmers to access not only yield predictions but also future price estimates for their crops. This integration provides a comprehensive view, allowing farmers to make decisions that maximise both their yield and their profitability.

CYPS collaborates with the Investment Advisor Service to provide farmers with comprehensive insights. By combining crop yield predictions from CYPS with investment advice, farmers can make informed decisions about resource allocation, access to international markets, and potential investments that enhance their agricultural practices and economic sustainability.

While CYPS primarily focuses on crop yield predictions, it can indirectly benefit the Recipe Recommendation Service. Farmers who receive accurate yield predictions can plan their crop production more efficiently, ensuring a stable supply of ingredients. This, in turn, supports the Recipe Recommendation Service by providing a consistent source of locally-sourced, nutritious ingredients for consumers preparing meals.

**Key Features:**

- **Data Collection:** CYPS gathers data from various sources, including weather stations, soil quality assessments, historical crop yield data, and farming practices. This data serves as the foundation for predictive modelling.
- **Predictive Modelling:** Advanced algorithms analyse the collected data to generate crop yield predictions. These predictions provide farmers with insights into expected

crop yields for the upcoming season.

- Risk Mitigation: By understanding the potential risks associated with crop production, such as droughts or excessive rainfall, farmers can take proactive measures to mitigate these risks and protect their crops.

**Service Behaviour**

**Data Model diagram**

## Section 4.2: Fair Price Advisor Service

**Unique ID:** BS-FPA

**Short Name:** Fair Price Advisor Service

**Involved Participants:**

- Users - Farmers
- Stakeholder - World Bank: Collaborates to provide access to market prices information.

### Detailed Operational Description

Fair Price Advisor is a business service designed to empower farmers in East African countries by maximising their profits from crop cultivation while ensuring fair prices and resisting malnutrition. It does this by providing farmers with [updated quarterly market prices](#) and approximate future prices. Users are able to see upcoming profits, avoiding that they will sell their crop for very low prices. As a result, not only do individual farmers benefit, but the entire economy of East African countries stands to improve. When farmers are well-informed about prevailing and future prices, they can make decisions that lead to more stable incomes and economic growth in their communities.

BS-FPA service collaborates with another business service, BS-CYP (Crop Yield Prediction Service), to provide Future Price Estimation to users. However, it's important to note that BS-FPA can operate independently if a user chooses not to utilize the Price Prediction Service. In such cases, users can still benefit from other features of BS-FPA, such as [updated quarterly prices](#), even if they opt not to access future price estimates through BS-CYP.

**Key Features:**

- Farming Data Management: Users can manage their farming data, including changing crop types or planting dates to tailor the prices they see.
- Real-time Pricing: Fair Price Advisor provides farmers with up-to-the-minute market prices for their crops, ensuring they are always well-informed about the current value of their produce.
- Future Price Estimates: Approximate future prices, enabling farmers to make informed decisions on when to sell their crops, avoiding the risk of selling at unprofitable rates.

**Service Behaviour**

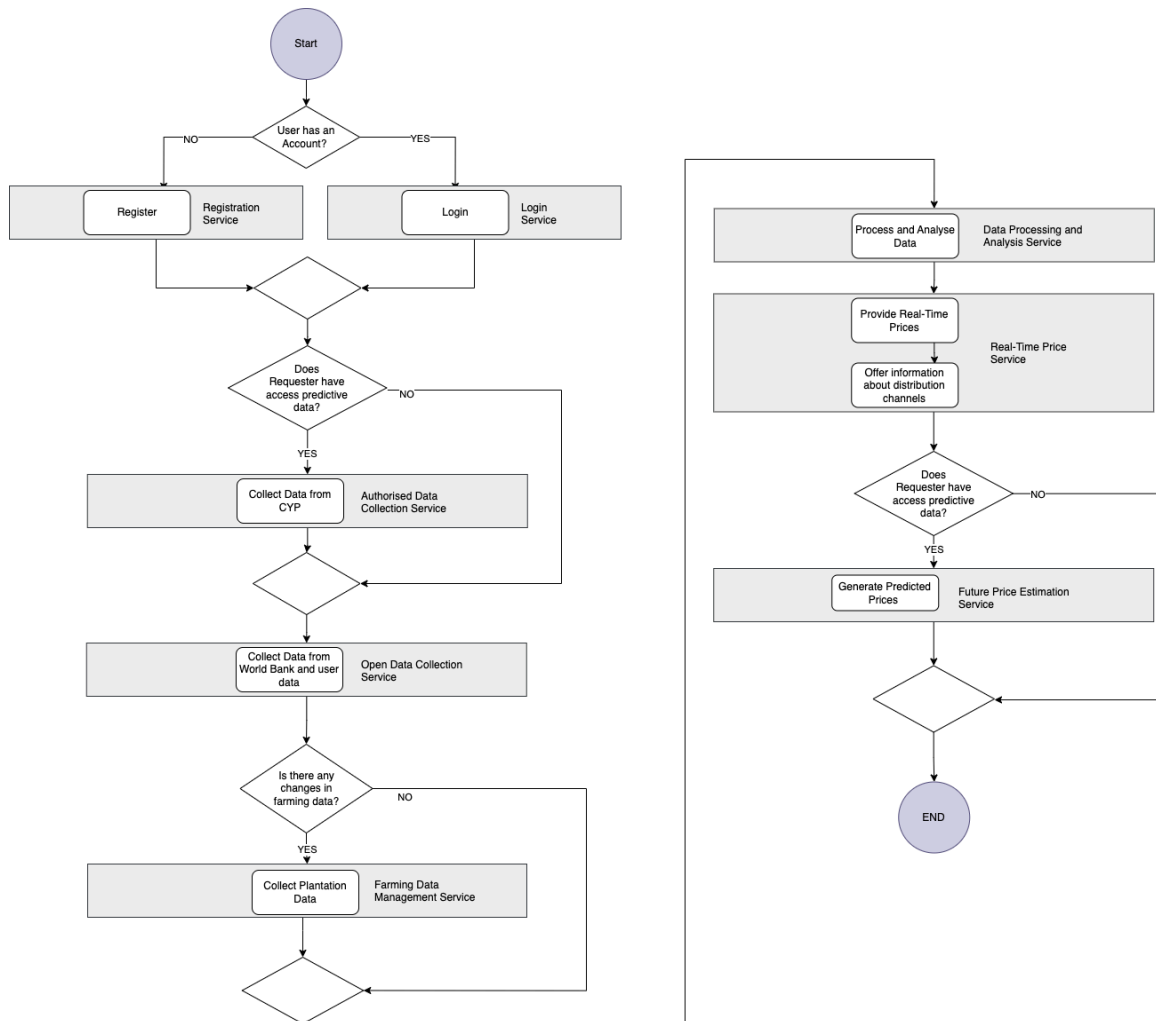


Figure XX - BS-FPA Activity diagram

The Activity diagram in Fig. XX illustrates the behaviour of the Fair Price Advisor business service. It begins by checking whether the user has an existing account. If the user has an account, the service proceeds to the "Login Service" otherwise it directs the user to the "Registration Service" for account creation.

Since only authorised users from **BS-CYP** service have the possibility to see future price estimates, there is another checking of whether a user has access to predictive data. If yes, the service collects personalised crop prediction data from the **BS-CYP**, if not, this step is skipped to the next step.

Next, all the general data is being collected from:

1. Market data, including current prices information from The World Bank;
2. Farming data provided by the user, especially in cases where the user is not connected to the BS-CYP.

If a user wishes to change the personal data, it takes place in “Farming Data Management Service”. This service allows users to make changes such as adjusting crop types or



planting dates to customise the prices they view.

Next, all the data is being processed and analysed in “Data Processing and Analysis Service”. The result of this analysis is then made available to the user through two entity services:

1. "Real-Time Price Service" providing users with access to updated market quarterly prices information. This output is accessible for all users.
2. "Future Price Estimation Service" which maps real-time prices to personalised crop prediction data, offering users insights into approximate future prices based on the BS-CYP predictions. This output is accessible for users who have an authorization to the BS-CYP.

This comprehensive flow ensures that users are well-informed and equipped with the necessary data to make informed decisions regarding their crop sales.

### Service Candidates Decomposition

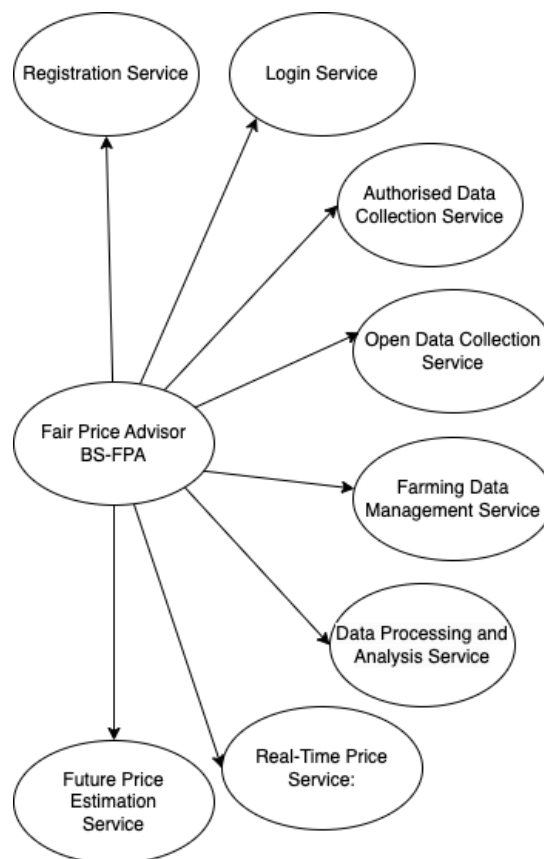


Figure XX - BS-FPA Use Case diagram

In the Fig. XX are illustrated 8 software services of the “Fair Price Advisor Service” business service. It includes: Registration Service, Login Service, Authorised Data

Collection Service, Open Data Collection Service, Farming Data Management Service, Data Processing and Analysis Service, Real-Time Price Service and Future Price Estimation Service.

## Data Model

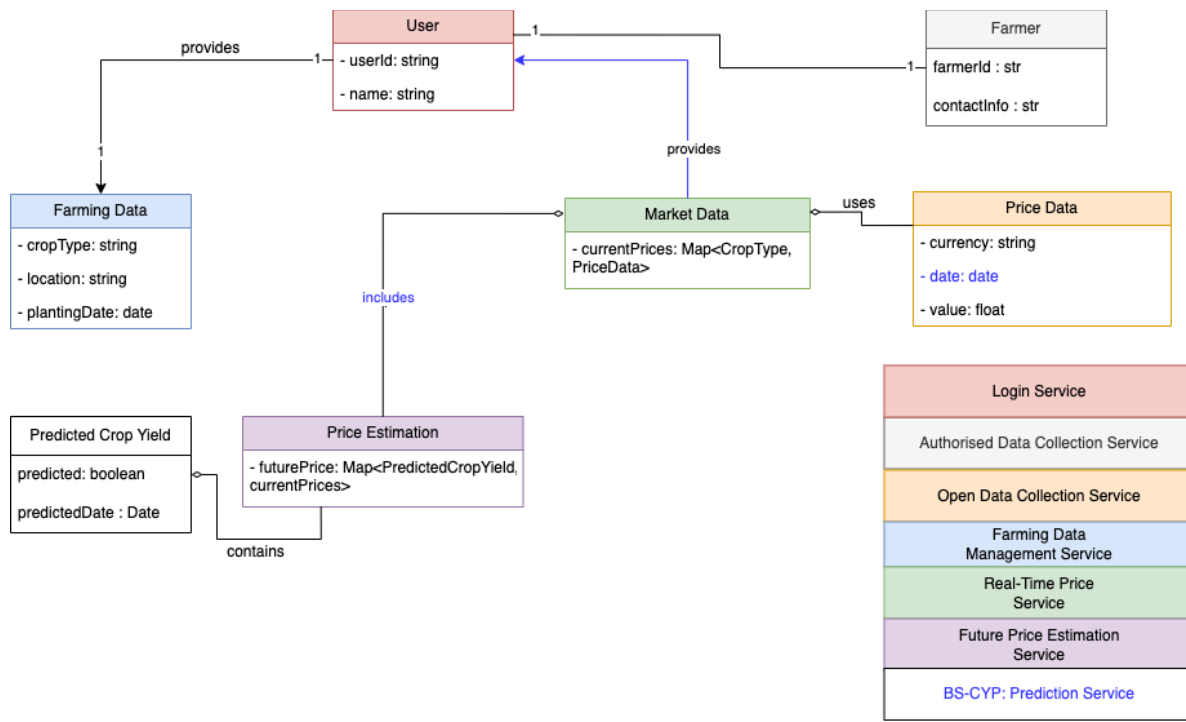


Figure XX - BS-FPA Class Diagram

The Class diagram in Fig. XX illustrates data interaction of all 8 software services.

### Farming Data Class:

- *cropType*: This attribute stores the type of the crop being cultivated. It identifies the specific crop that a farmer has planted or will be planted.
- *plantingDate*: This attribute represents the date when the crop was planted or will be planted.
- *location*: String: This attribute holds information about the geographic location of a plantation.

### Price Data Class:

- *currency*: Represents the currency in which the price value is denominated.
- *date*: This attribute holds the date of the value of the price.
- *value*: This attribute holds the numeric value of the price.

### Market Data Class:

- *currentPrices*: This attribute is represented as a mapping (Map) from CropType which is coming from the Farming Data class and the PriceData from the Price Data

class.

Price Estimation Class:

- *futurePrice*: This attribute is represented as a mapping (Map) from PredictedCropYield, external class from BS-CYP, representing the predicted crop yield and PriceData which contains real-time price. This mapping associates each predicted crop yield with its corresponding current price data.

Predicted Crop Yield is an outside class from the BS-CYP which allows access to predicted crop data. As well as outcoming Farmer class, which indicates if a user is authorised to the BS-CYP service.

### Section 4.3: International Agriculture Investment Dataspace Service

**Unique ID:** BS-IAI

**Short Name:** International Agriculture Investment Dataspace Service

#### Involved Participants

Users :

- Landowners/Land Tenant : In this service the user 'farmer' will be called landowners/land tenant, as the service stands on the viewpoint of the ownership of land property.
- Companies : Investment companies that need information to make investment decisions for the farmers.

Stakeholders:

- Crop Yield Prediction Service Provider: Responsible for providing crop prediction data.
- Governments: Collaborates to provide information regarding international regulations of data-sharing.

#### Detailed Operational Description

International Agriculture Investment Dataspace Service is a business service designed to help foreign investors to make informed decisions about their agriculture investments. The service does this by providing real-time and historical data of plantations across the globe. It gives a prediction of the future yield and analytic data about the land quality as well.

The data sharing will be standardized to ensure the service can fit to investors from any country to any plantation globally. Moreover, the service will adhere to regulations of each country about which data is allowed to be shared.

As a result, foreign companies will have a clear image of their investment, and therefore give more confidence for them to invest. Raising funds will allow farmers to access modern technologies that can increase the harvest yield. Toward tenant farmers, foreign funds will raise their possibility to own their own land, by co-owned the land they planted with the foreign investors.

BS-IAI service collaborates with another business service, **BS-CYP (Crop Yield Prediction Service)**, to provide the real-time and future analytic data from plantations. However, there is no authorized checking of **BS-CYP**, either by land owning cooperation status or by national regulations {Example : Republic of Indonesia Law No. 39/2014 on Plantations}.

However, it's important to note that BS-FPA can operate independently if a user chooses not to utilize the Price Prediction Service. In such cases, users can still benefit from other features of BS-FPA, such as **current market price** insights, even if they opt not to access future price estimates through **BS-CYP**. BS-IAI maintains, and standardises the collaboration

between local farmers and foreign investors, which in long term will build an protected dataspace environment.

#### Key Features:

- Access and Authentication:
  - Implement robust authentication and authorization mechanisms based on international Memorandums of Understanding (MOUs).
  - Define user roles (e.g., investors, auditors, administrators) with varying levels of access to data and functionality.
- Data Security and Encryption:
  - Encrypt data transmission and storage to protect sensitive information to be transferred internationally.
  - Implement security best practices to safeguard against unauthorized access or data breaches.
- Audit Trail:
  - Maintain a comprehensive audit trail of all user interactions and data modifications within the system for auditing purposes.
  - Log and timestamp all access and data changes for accountability.
- Real-time Notifications:

Provide notification alerts to investors and auditors for critical events or significant changes in plantation conditions, such as extreme weather events or disease outbreaks.
- Integration with External Systems:

Allow integration with external systems, such as ERP (Enterprise Resource Planning) or financial systems, to support investment tracking and financial analysis.

#### Service Behavior

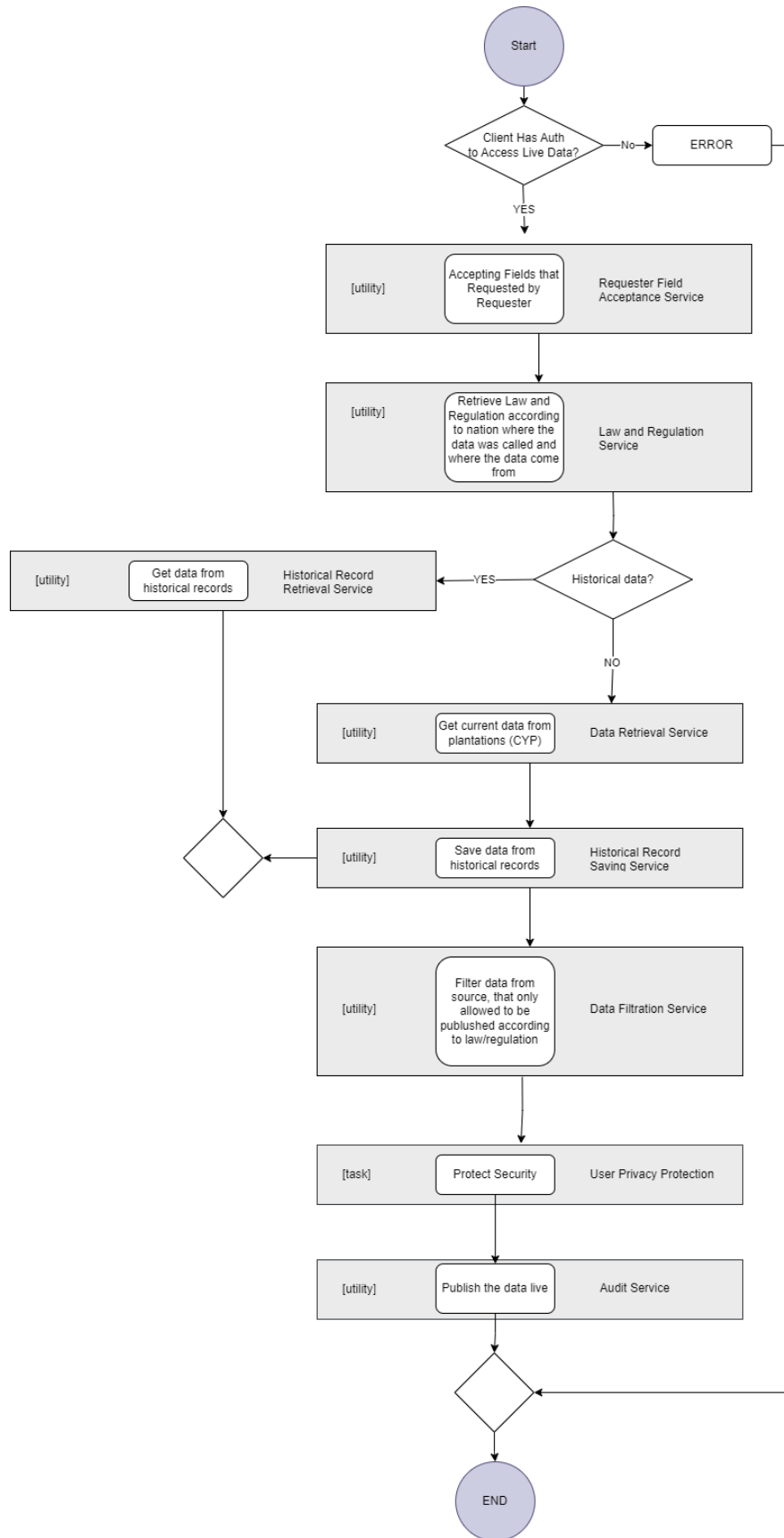


Figure XX - BS-IAI Activity diagram

The Activity diagram in Fig. XX illustrates the behaviour of the International Agriculture Investment Dataspace business service. It begins by checking whether the requester has authorisation to access the data. If the user has an account, the service proceeds to the data retrievals, otherwise it directly ends the process

Following the authorisation, the service proceeds to accept fields for data filtering in “Requester Field Acceptance Service”. The requested fields list are received from requester, and national law and regulations are retrieved by “Law and Regulation Service”.

On the next step, plantation data will be acquired. The International Agriculture Investment Dataspace Service will check whether there was the same request before. If there is the same request, “Historical Record Retrieval Service” will retrieve the historical data. Otherwise, the “Data Retrieval Service” will retract the data from the BS-CYP (Crop Yield Prediction Service). In the event of retraction, retracted data will be saved on the database for logging and reusability purposes by “Historical Record Saving Service”.

After that, acquired plantation data will be filtered for only leaving data that have been requested by the user and allowed by laws and regulations, by “Data Filtration Service”. The data will be secured by encryption for privacy purposes, by “Data Secured Service”. Finally, the secured data will be returned to the requester, by the “Returning ROI Service”.

This comprehensive flow ensures that investment companies are with the necessary data to make informed decisions regarding their investment plan.

### **Service Candidates Decomposition**

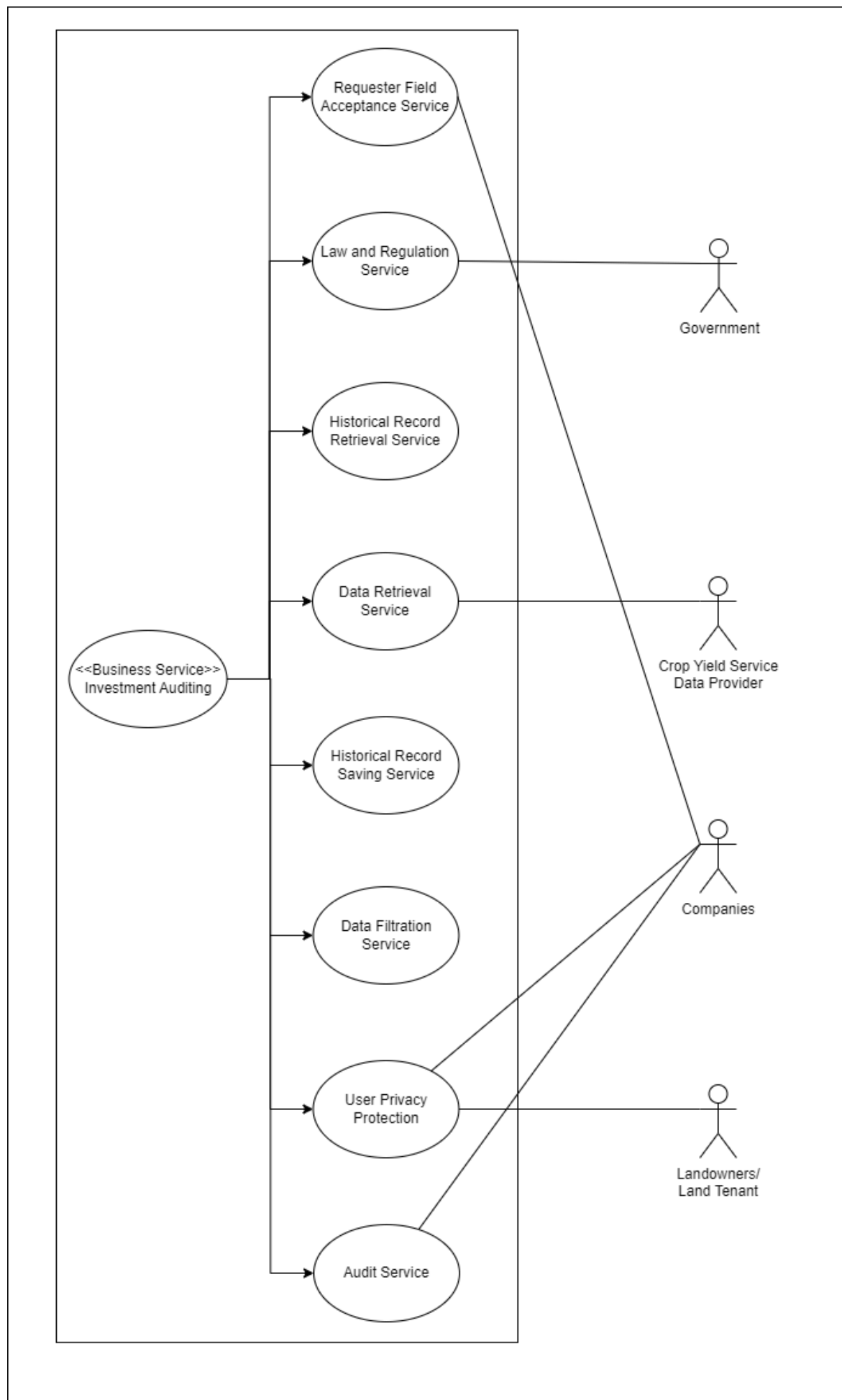




Figure XX - BS-IAI Use Case diagram

(Investment) Companies as the main user are interacting with three use cases, where they will request data from the service, and get a return of a protected dataset from the service. The second user is Landowners/Land Tenant, which need to give authorization for the service and companies to access their plantations information.

Meanwhile, stakeholders are involved in specific use cases to contribute essential data. Government plays a crucial role in providing laws and regulations, as clear guidelines to be adhered to for data protection. Finally, the prediction of future prices is based on real-time and prediction data generated by the last stakeholder, Crop Yield Prediction Service

All users and stakeholders are giving information to The International Agriculture Investment Dataspace Service, where the information will be processed and published to the requesters. This process ensures that investors receive accurate and timely data to make informed decisions, and raises their confidence for funding landowners/land tenants.

### Data Model

Robel will help with this part

- **Section 4 (cont.): Context:** [see material Week 2 (step 3)]

Conclude this section with the context model for your service candidates. To this aim, use a UML use case diagram. If needed, update your business domain model (provided in section 1).

Farmers, as primary users, interact with all four use cases of the service, as these use cases are designed to benefit farmers by providing valuable information for decision-making. In contrast, stakeholders are involved in specific use cases to contribute essential data. The World Bank plays a crucial role in two key use cases: "Real-Time Price Service" and "Future Price Estimation Service". Additionally, The World Bank offers insights into distribution channels, facilitating farmers in selling their crops effectively. The prediction of future prices is based on mapping real-time prices to predictions generated by the Crop Yield Prediction Service, as explained in detail in Design Decision 1 in Section 5. And both stakeholders are connected to the Data Collection Service where the provided data is being processed and analyzed. This collaborative approach ensures that farmers receive accurate and timely data to make informed decisions.

**Section 5: Design space:** [see material Week 4]

Given the business services you have identified in Section 4 and your selected service aspects, you should identify the one most important *design concern* you plan to address. This concern should be described according to the AK design-space modeling template (AK-SPAM<sup>4</sup>). This section should also include a visual representation of the concern with the QOC notation. Notice that, if more (or different) quality requirements are needed for the AK-SPAM, Section 3 should be updated to document them. Also, the QOC should always include at least three options. Note: How the accepted options are reflected in the project (e.g., in terms of additional services, stakeholders, etc.) should be reflected in the deliverable for consistency.

Table XX - Design Decision

<b>Concern (Identifier: Description)</b>		<i>Con#1: How can citizens benefit nutritionally from the crop prediction service?</i>
<b>Ranking criteria (Identifier: Name)</b>		<i>Cr#1: Accessibility Cr#2: Accuracy Cr#3: Data Security</i>
<b>Options</b>	<b>Identifier: Name</b>	<b><i>Con#1-Opt#1: Personalised nutrition recommendation</i></b>
	<b>Description</b>	<i>Provide personalized nutrition recommendations to individuals based on their individual dietary preferences, health goals, and dietary restrictions.</i>
	<b>Status</b>	<i>This option is <b>REJECTED</b>.</i>
	<b>Relationship(s)</b>	<i>-</i>
	<b>Evaluation</b>	<i>Cr#1: Accessibility may be limited for individuals who are unable to provide their personal information. Cr#2: Personalized recommendations can be highly accurate, considering the individual's specific dietary needs. Cr#3: The service would require access to extensive personal data, including allergies and dietary preferences, which could raise privacy and security concerns.</i>
	<b>Rationale of decision</b>	<i>This option is rejected due to concerns related to data security and limited accessibility for users without the ability to input their personal information.</i>
	<b>Identifier: Name</b>	<b><i>Con#1-Opt#2: Recommendation by institution</i></b>
	<b>Description</b>	<i>Partnering with schools, hospitals, and other institutions to provide recommendations on seasonal food to their students, patients, or staff. Allow cafeterias of that institutions may provide customised food for their members.</i>
	<b>Status</b>	<i>This option is <b>REJECTED</b>.</i>
	<b>Relationship(s)</b>	<i>Continuing the idea of Con#1-Opt#1 with control of an institution.</i>
	<b>Evaluation</b>	<i>Cr#1: Access to the service is restricted to individuals affiliated with specific institutions, limiting its availability. Cr#2: Personalized recommendations can be highly accurate, considering the individual's specific dietary needs. However, in this case institution representative may manually input personalized dietary</i>

		information, which could introduce errors or inaccuracies. Cr#3: Personal data, including allergies, is owned and managed by institutions.
	<b>Rationale of decision</b>	This option is rejected due to concerns regarding accessibility. Only people in certain institutions have access to the service.
	<b>Identifier: Name</b>	<b>Con#1-Opt#3: Recommendation by area of a user</b>
	<b>Description</b>	A Recipe Recommendation Service that offers recommendations based on the seasonal availability of ingredients in the region of a user.
	<b>Status</b>	This option is <b>ACCEPTED</b> .
	<b>Relationship(s)</b>	-
	<b>Evaluation</b>	Cr#1: Information about seasonal food is freely accessible to everyone, promoting inclusivity regardless of income, location, or other factors. Cr#2: Prediction data comes from the Crop Yield Prediction service which is reliable for a high. Cr#3: Users are not required to share extensive personal data, except for their location, reducing privacy concerns.
	<b>Rationale of decision</b>	This option is accepted because it shows promise in terms of all criteria. This option is accurate, accessible, and beneficial for citizens in terms of nutrition.

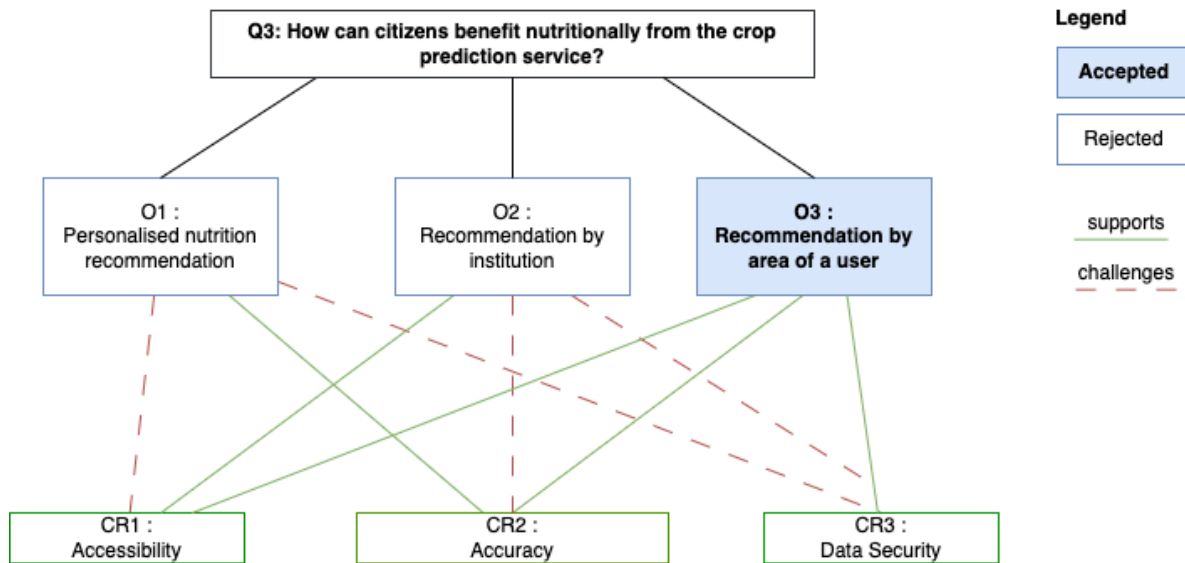


Figure XX - Graphical Representation of the Design Decision

● **Section 6: Sustainability strategies:** [see material Week 5]

Identify and describe a sustainability strategy that (if adopted) facilitates accomplishing a specific

sustainability goal that is realized through, or concerning, service-based systems. The sustainability strategy should follow the format reported in Table 2. It should also be mapped to at least one QOC diagram and AK-SPAM from section 5, i.e., related elements in these two sections should reference each other.

Add image from draw.io

Field	Description
Unique ID	SUS-RRS-1
Short Name	Nutrition benefits of agriculture increase.
Description	Description of the strategy in terms of goals and actions For addressing critical global challenges related to nutrition, affordability, and food waste, innovative services leverages the power of crop prediction technology to benefit citizens in multiple ways. By raising funding and improving harvest, the food stock will be increased. By price transparency, farmer livelihood will be better and the agriculture industry will flourish. Lastly, by encouraging the consumption of seasonal foods, the food waste will be decreased. All initiatives are aim to contribute to a world with Zero Hunger and improved well-being for all citizens.
Type of Strategy	Specify the type of strategy (service awareness or people awareness) Process awareness, for decreasing hunger by supporting whole agriculture supply chain, consist of supporting agriculture industry, raising crop yield, and decreasing food waste.
Relevance for Business Domain	Give a justification of the relevance for your business domain This sustainability strategy directly connects with Recipe Recommendation Service (BS-RRS), which information come from Crop Yield Prediction (BS-CYP). Meanwhile, for raising agriculture productivity BS-CYP are cooperated with funding companies via International Agriculture Investment Dataspace Service (BS-IAI). Another factor for raising agriculture industry is by raising the income of the farmer with price transparency (Fair Price Advisor Service / BS-FPA). Therefore with good collaboration of the business services, final sustainability goal of better food accessibility can be achieved.
Diagram	Graphical representation of the strategy (as seen in the theory lecture)

<sup>3</sup>If not relevant for all business services, you can choose to illustrate the Data Model only once at the end of Section 4, or just for those business services where appropriate. In any case, the identified (entity) services should be included in the service candidates' decomposition.

<sup>4</sup>The AK-SPAM template is available on Canvas (Files > Templates > AK\_SPAM.xls).

Table 2: Strategy Description Table

Field	Description
Unique ID	Unique ID for this strategy
Short Name	Short name for this strategy
Description	Description of the strategy in terms of goals and actions
Type of Strategy	Specify the type of strategy (service awareness or people awareness)
Relevance for Business Domain	Give a justification of the relevance for your business domain
Diagram	Graphical representation of the strategy (as seen in the theory lecture)

**Deadline for submission at Canvas**

Friday October 6, 23:59  
(grace period until Sunday October 8, 23:59)