FARM MANAGEMENT INFORMATION SYSTEM

By

Rafsan Jani Ratul, ID-011161113
Himel Mazumder, ID-011161045
Salman Ibn Arshad, ID-011162131
Kazi Fariha Ferdows, ID-011153060

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Department of Computer Science and Engineering
United International University

Abstract

Our country is an agricultural country. Here the vast majority of people directly rely on agriculture for their livelihood. Our country's agriculture is complex and labour intensive. Here, our farms practice different production systems. Most of the large farms may have more than one enterprise that may be complementary or supplementary depending on the situation. As a result, an improved efficiency of management practices would benefit our agricultural sector significantly. Farm Management Information System is used for optimization and management of farm operations and production activities. Farms will be able to have instantaneous data regarding labours, products and other critical management activities. This will also help them make decisions that would improve productivity and maintain quality.

Acknowledgements

This work would have not been possible without the input and support of many people over the last two trimesters. We would like to express my gratitude to everyone who contributed to it in some way or other.

First, we would like to thank my academic advisors, Mr. Suman Ahmmed (Assistant Professor, Dept. Of CSE, UIU) and Dr. Md. Motaharul Islam (Professor, Dept. Of CSE, UIU)

Last but not the least, We owe to our family including our parents for their unconditional love and immense emotional support.

Publication List

[Optional] The main contributions of this research are either published or accepted or in preparation in journals and conferences as mentioned in the following list:

Journal Articles

1.

Conference Papers

1.

Additional Publications

Following is the list of relevant publications published in the course of the research that is not included in the thesis:

1.

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Chapter 1

Introduction

Our project is titled "Farm Management Information System". The objective of our project is to build a management system for farms so that the operational and management activities of farms become easier.

1.1 Project Overview

Though in several parts of our country traditional methods are still being used for farming activities, still in many parts of the country, application and adaptation of mechanical and technological equipment are clearly visible. With these improvements already playing their role, if a real time management system can be introduced with proper decision making facilities, it would immensely benefit our country's farming sector. Besides, due to the increasing trend of urbanization, many people are leaving for urban areas. So, the numbers of people interested in farming are gradually decreasing. This also results in labour scarcity. With a proper management facility that ensures the best utilisation of the farm resources, this gap can be filled. Thus overall production of farm goods may be kept in balance.

1.2 Motivation

In our project, we endeavour to demonstrate how it can be done considering the whole farm as a production unit and providing a single software and hardware based solution point utilising which the farms can be managed in a more efficient and productive manner. Our motivation for this project is as follows:

- Our country is a land of agriculture. We have a strong human resource blessed with generations old experience and techniques in this sector. Our country is also full of agricultural resources. In this era of technological advancement and globalization, we are very keen to employ our best efforts to introduce new technologies and concepts which will benefit this sector and people involved. We would be very happy if we

could contribute to our country's development as a whole through our efforts and by bringing new ideas to the table.

- An efficient management system for a farm will reduce the cost and increase productivity. If we can take this project to a larger scale then it might revolutionize the country's farming sector. Which directly or indirectly affect our socioeconomic status in a positive way. If we can set an example, that might inspire others in future.

- As students of Computer Science and Engineering, it is our responsibility to research and analyse the implementation and application of new technologies to the potential sectors. FYDP provides us huge opportunities for this purpose. We would very much like to try our level best to make the best utilisation of this opportunity.

- If we have a successful project then we might extend its efficiency of services. This will probably open an industrial opportunity in the country.

1.3 Objectives

Farm management information software (FMIS) includes all the software used for supporting various processes involved in advanced agricultural operations like contract management, crop management, customer management, financial management, greenhouse management, inventory management, labor force management, livestock management, pricing management, supplier management, as well as order processing, financial calculations and analysis, bar-coding/RFID, and traceability (Capterra.com, 2017). FMIS is an innovative technology used for optimizing the use of resources in the farms. It includes best agricultural practices based on usage of farm software, data analytics solutions, and software delivery models, among others. This kind of software helps in enhancing farm production and reducing the wastage of input and is integrated with hardware equipment and devices to enhance the productivity of the farmland with the help of GPS, sensing, and communication technologies (MarketsAndMarkets, 2016). These objectives are targeted for our relatively smaller domain of Farm Management Information System

- Wider Marketplace: Providing farmers a wider marketplace.for their products.

- Knowledge sharing: Helping farmers to improve their productivity and profitability by article and blog section.

- Safe and healthy food: Providing consumers a platform from where they can get chemical free farm goods.

- Marketplace for farming tools and seeds: Providing farmers a platform from where they will be able to buy products necessary for farming

1.4 Methodology

In our project, methodologies are divided into three parts namely as Analysis, Design and Implementation. Analysis involves studying the current state of farming sector, existing systems and literatures, Design part consists of building models using UML diagrams and designing user interface and user experience based on the study. Finally, implementation part of the project involves coding and testing parallelly. For the first part, we tend to explore current situation of our farming sector, study different similar systems and research papers. Based on knowledge and information obtained from our exploration, we tend to design system models using different tools and techniques. Then according to the models and designs we will implement our project.

1.5 Project Outcome

In our project, we intend to build a system that would keep track of farming operation and production activities. The main focus is to reduce the workload of farm management in our country. Using this system, a farm will be able to increase its production with the efficiency of resources.

We are keen to see and inspect different aspects of farming that can be made more developed and efficient through digitalization. We are looking forward to studying issues might originate from digitalization of farming so that we can keep track of negative impacts as well. We tend to research about different parts of a farm and crucial data regarding each part and ways we can make valuable information out of these data by combining, filtering and manipulating them.

We focus on discovering how digitalization might make it easier and faster for farms when it comes to management and making critical production decisions. How a well thought implementation of a digital system in a traditional sector can change the total outcome of the sector also included in our study. We are to determine whether the implementation should be gradual or not. If not gradual then what problem might arise. Through all our efforts we will try to create an advanced and time-befitting system that will gradually improve the management and operational tasks previously relied on traditional procedures.

1.6 Organization of the Report

`Problem statement:` Problem statement: This section describes the necessities behind building the system mentioned in our project along with important role it might play in the concerned domain.

`Motivation:` This section explains motivations behind selecting the topic of our project.

`Objectives:` This section explains what exactly we aim to achieve through our project and what purpose our system ought to serve.

`Methodologies:` This section gives a brief idea about how we plan to carry on our project activities dividing it into separate parts.

`Contribution:` This section is about our desired outcome from this project.

Chapter 2

Background

This chapter presents the summary of the literatures we studied so far for our projects. Literatures consist of different reading materials such as books, thesis, and related web articles. It also includes analysis of some related research, a thoroughly benchmark study, and the gap analysis regarding current farm management information systems.

2.1 Preliminaries

This chapter is mostly based on research and studies we conducted on different aspects of Farm Management Information System.
A Farm Management Information System (FMIS) is a computerized system that facilitates managing, organizing and operating a farm.
In the literature review part, a reference architecture for Farm Management information Systems has been discussed. A reference architecture (RA) is a generic architecture in software architecture design, which can be used as a guide for designing software architecture for a specific domain.
In the later part of the chapter, we explored some existing FMISs and mentioned their features and functionalities.
We mentioned related researches and key information we gained from these research papers and articles in the related research part.
Lastly, the GAP analysis of our project is mentioned in the GAP analysis part.

2.2 Literature Review

Why we choose this Journal:
The article we studied is titled **"Reference Architecture Design for Farm Management Information System"**[1]. It is part of the journal named **"Precision Agriculture"** with an impact factor of 4.454. As the title suggests, this article is about reference architecture for Farm Management Information System applications. Here, authors analyzed key aspects of farm management and studied current reference architectures and

based on their findings endeavor to provide improved reference architecture.

As we intend to build a farm management information system it is crucial that we build software architecture first. There is a domain specific general architecture understanding and using which application architecture can be built easily. It is called reference architecture. Reference architecture on farm management information system can give us key concepts about how a proper farm management application should be. Reference architecture can help us build our application architecture efficiently. We can have a technical and logical guideline which will help us to decide how our farm management application should behave

Abstract:
Farm management information system is responsible for data management, analytics and subsequent decision support. In the development of Farm management information system, software architecture is a key element that defines the gross level structure of the system. For understanding the system, analyzing the design decision and guiding the further development the software architecture plays a vital role.
Here, a reference architecture dedicated to the Farm management information system domain is described. The systematic approach for deriving application architecture from the proposed reference architecture is also provided here.

Introduction:
A continuous development in the information technology is taking place. It has a substantial amount of impact on various industrial domains including farming sector. For example, field monitoring, plant/breed selection, pest management, irrigation etc can be done more precisely with the help of IOT. A farm management information system becomes a great and time-befitting tool to manage the large amount of information involved in various farming processes and to keep track of and support the farm activities.
Software architecture is a very crucial point to the design of an application. It is defined as, how we define relationships among different components of an application. Properties of each component are also well defined in the architecture.
When a specific type of software architecture is generic for a particular domain and can be used as a reference to design specific software architecture, it can be termed as reference architecture.
Reference architecture is used to derive specific application architecture. It helps design application architecture quicker and with greater quality.

FIMS (Farm Management Information System):
There are some definitions of FMIS. They can be summarized as a planned system for the collecting, processing, storing and dissemination of data in the form of information needed to carry out the operational functions of the farm. The Primary goal of FMIS is to reduce

the production cost, maintain high quality and comply with the agricultural standards. Stakeholder is a key concept in the realm of software architecture design. It can be defined as an individual, group or organization, who may affect, be affected by or perceive itself to be affected by the decision, activity or outcome of a system. A study conducted on a unique set of relevant stakeholders and their concerns regarding the development of FMISs is shown in the table given below(Figure 2.1).

Table 1 The identified stakeholder and their concerns. Adapted from Tummers et al. (2019)

Role	Concerns
Farmer	Responsible person on the farm and end-user of the system
Government	Has an interest in FMISs for registration purposes, and to obtain farm information
Agricultural expert	Has expert knowledge about the agricultural sector and can be used for requirements for FMISs
Farm employee	Works on the farm and has to work with the FMIS
Research Institute	Multiple kinds of researchers and institutes can be used as knowledge input for FMISs
FMIS developer	Develops the FMIS and its underlying software
Input supplier	Delivers inputs to the farm; these inputs can be registered in an FMIS
Agricultural advisor	Helps the farmer with making decisions based on their knowledge, an FMIS can assist them
Agriculture service provider	Assists the farmer with the provision of services. Can use FMIS for registration purposes
Contractor	Hired by the farmer to perform field tasks. FMISs can improve communication with the farmer
Equipment producer	Makes new machinery for the farmer, an FMIS can provide machinery management
Customer	Companies and other entities greater than the individual consumer. FMISs can provide details about the purchased products
Administrator	Can set up system, and manages the FMIS. Is not necessarily the FMIS developer
Farmers association	Organised group of farmers with common interests. Wants FMIS for the implementation of modern technology
Neighbour	Can be influenced by decisions of FMIS (odour nuisance, noise disturbance, etc.)
Non-governmental	Group of persons with their own (ecological) interest that can be intertwined with the FMIS
Product processor	FMIS can provide information on products coming from the farm
Veterinarian	Can use the FMIS for retrieving animal information and can register veterinarian actions
Accountant	Can use the financial modules of FMISs to verify and assist the farmer with bookkeeping
Equipment dealer	Can provide machinery support and services via the FMIS
Media	Provides communication with the outside world and has an influence on the farm image
Weather service provider	Provides weather information as input for the FMIS

Figure 2.1: FIMS (Farm Management Information System)

Feature:
A feature is defined as a prominent or distinctive user visible aspect, quality or characteristic of a software system or system.
A feature model is a tree shaped model. It shows common, alternative and optional features of a system.
The feature model provided below contains the features for the FMIS and it is divided into four groups namely as

a. General management information system: Features that are not agriculture specific. It is rather management specific.

b. Data management: Features related to management of data and databased decision making.

c. Crop management: Features related to crop farming.

d. Animal management: Features related to animal management.

Figure 2.2: Features

Architecture Design:
Each software has an architecture that defines its structure. It is an abstract representation of the system. It is important for supporting communication among stakeholders, for guiding design decisions and for the analysis of the overall system. The architecture model used here is known as Architecture view model. It consists of multiple views and viewpoints. Each view addresses the whole system from the perspective of one or more of the stakeholder concerns. Each viewpoint focuses on a particular aspect of the architecture. The architecture view describes the architecture of a system.

Current Reference Architecture:
There are few reference architectures for Farm management information system. A class diagram of a reference architecture describing relationships between different components in the FMIS is given. The components are application components, ICT components, Information system and Agri-food Company. Furthermore, relationship between different actors was shown. These actors farm manager, farm owner, customer, government, infrastructure provider etc. Context diagram to show how different entities are connected to the system and a visual representation of all the possible modules are also provided. It is seen that the farm, clients and sensors in the fields might use different applications and UIs. Sometimes they can be from different vendors as well. There can also be a cloud node.

Reference Architecture:

Selection of views:
Two sets of viewpoints have been used for the reference architecture. These viewpoints are Context viewpoints and Decomposition viewpoints. These viewpoints can be applied for both application and stakeholder concerns. Few crucial points are taken into the consideration while designing the reference architecture. Points such as features supporting long term vision along with flexibility to customize the architecture for different sectors of farming.

Context view:
The context view of a system is represented using a so-called context diagram. This diagram represents the overall purpose of the system and its interfaces with an external environment. It shows the system boundaries, its environment and the entities it interacts with.

Figure 2.3: FIMS :Reference Architecture

Decomposition view:
The decomposition view defines the decomposition of the system over different modules. The only relation that is used is the decomposition relation which is usually shown by embedding a module in the overall system module. The view thus shows the decomposition of larger modules into smaller modules. The modules from the decomposition view should cover all features.

Figure 2.4: Decomposition view

Deriving application architecture from reference architecture:
A specific view from the RA is reused to derive the corresponding view of the AA. First the requirements of the application are identified. Based on these requirements, features from the family feature model are selected. Based on the selected features, the required FMIS modules for the AA are selected from the FMIS RA. If the required module can be found in the RA, then this will be reused; if not, a new module will be added to the AA.

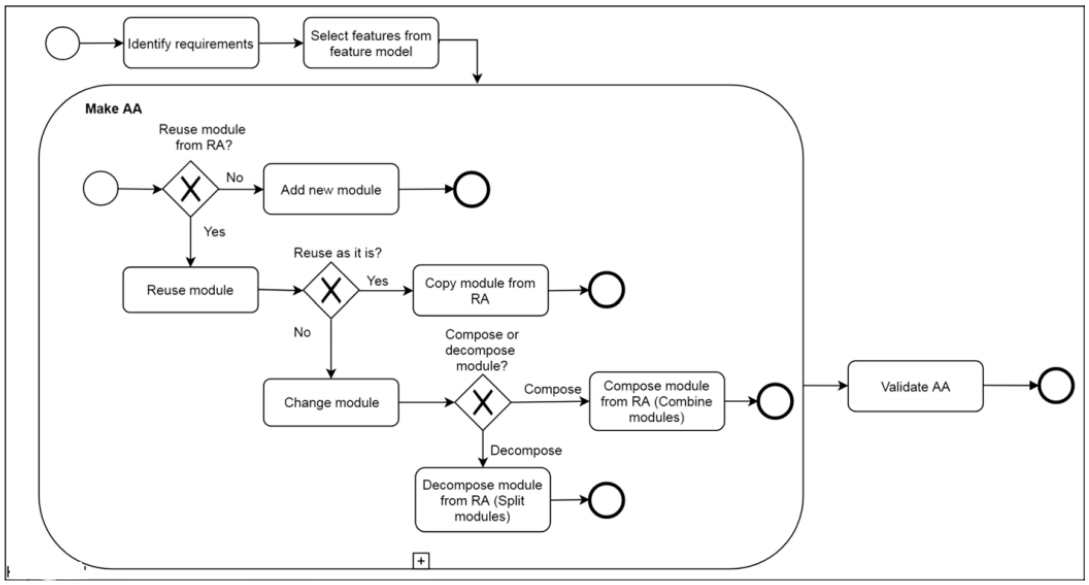


Figure 2.5: Deriving application architecture from reference architecture

2.2.1 Similar Applications

Farming is not only a combination of activities to produce food for domestic consumption. It's also a business venture. Farming has also challenges like resource limitations, management complexities etc. With the help of farm management information software, farm owners can monitor various farm activities easily. It helps them acquire different information as well as makes decision making easier and real time oriented. Our Analysis of few farm management information software is given below.

i. **Agrivi** (`www.agrivi.com`): This software is used for planning, monitoring andanalyzing farm activities like planting, spraying, fertilization, irrigation,harvesting etc. `Some features of Agrivi:`

   a. Management of activities such as finance, inventory, workforce, resource etc.

   b. Analytics to monitor farm performance.

   c. Weather monitoring and pest detection.

ii. **Granular** (`granular.ag`): This is software allows farm owners and managers to monitor all aspects of operation, enabling them to make informed real time decisions.

Owners and managers can assign tasks to their workers using this software. This software also has native apps for Android and iOS devices. This software has three different packages namely as Insight, Business and Agronomy.
`Some features of Granular:`

a. Pinpoint and fix production issues.
b. 3-m satellite imagery
c .Analyze profits
d. Control inputs and inventory
e. Crop and field planning
f. Mobile access

iii. **FarmERP** (`www.farmerp.com`): This is a complete ERP solution for farming and agriculture-based businesses. This software is the most widely used software for farm management. It is highly scalable. It has a good data management and analysis feature along with solutions covering critical business functions.
`Some features of FarmERP:`

a. Input management
b. HR management
c. Production management
d. Financial and marketing management
e. Resource optimization
f. Managing multiple farms at multiple locations

2.2.2 Related Research

In the book titled ***"Information Systems for Management: A Book of Readings"***[2], it is stated that an MIS is an organizational method of providing past, present and ***"projected information related to internal operations and external intelligence."***[3], It is also mentioned the book that Supporting decision making is one of its main objectives which it aims to accomplish by providing timely information about the planning, control and operational functions of an organization.
In the article titled ***"Conceptual model of a future farm management information system"***[4] from journal ***"Computers and Electronics in Agriculture"***, A Farm management information system is defined as a planned system for the collecting, processing, storing and dissemination of data in the form of information needed to carry out the operations functions of the farm.
Another article titled ***"Farm management information systems: Current situation and future perspectives"***[5] from the same journal mentioned that an FMIS can

support decision making by finding the best practices for farm management. Themain purpose of existing FMISs is to reduce the production cost, maintain high product quality and safely, and to comply with agricultural standards.

Article ***"Farming for the Future towards better information-based decisionmaking and communication"***[6] defined feed management referring to managing the quantity of nutrients fed to livestock and poultry, financial management and labor management as some widely supported features of FMIS.

Different FMISs are developed for different sectors of agriculture. There are FMISs designed for arable farming, livestock farming etc. FMISs also vary in context of licensing and delivery models. Some of them can be used in mobile phones, some of them can be used in desktop computers and some of them can be used in both platforms.

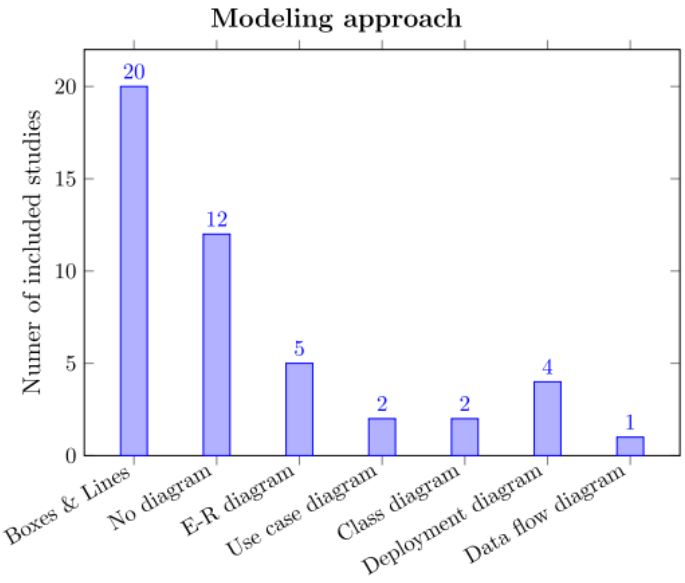
In the article ***"Farm management information systems: Current situation and future perspectives"***[5] a study was conducted to set standard features for FMIS, where 141 different commercial FMISs coming from 75 vendors were explored. A set of 11 different major features were extracted. These features are field operation management, best practices to support decision making, finance, inventory, traceability, reporting, site-specific features, sales, machinery management, human resource management, and quality assurance.

In their research article titled ***"Data standards used for data-exchange of FMIS"***[7], Robbemond and Kruize conducted a similar study and enlisted a set of 11 features for FMISs. These features are procurement, inventory management, product management, marketing and sales, human resource management, technology management, energy management, real-state management, quality assurance, finance and accounting.

Capterra(`www. capterra. com`) a leading web platform for software review and selection, explored 156 farm management software. In their review they mentioned 13 key functionalities for FMISs. These functionalities are bar coding, contract management, crop management, customer management, financial management, green house management, inventory management, labormanagement, livestock management, order processing, pricing management, supplier management and traceability.

The article ***"Obstacles and features of Farm Management Information Systems: A systematic literature review"***[8] from journal "Computer and Electronics in Agriculture", describes that precision agriculture and Management Information System (MIS) is mostly used for the arable farming. Livestock is the second domain that makes the most use of these technologies after arable farming.// In this article modeling approaches that are applied to FMISs are also described. Software modelling can be done following Unified Modeling Language (UML). There are other modeling methods such as E-R diagram, data flow diagram. E-R diagram represents data model and shows data layer of a system. Data flow diagram represents logic models and shows how data is transformed in a system. Other UML diagrams such as use case diagram, class diagram, deployment diagrams are also mentioned this article. Use case diagrams shows use cases and the concerned actors. Class diagram represents different objects of the system and relationships among them.

Deployment diagram shows physical relationship among software and hardware components in the delivered system. This article explains different delivery models for FMISs.



. The used modeling approach for the 38 primary studies. A study can describe zero (No Diagram), one, or multiple modeling approaches.

Figure 2.6: Modeling Approach

Delivery models are mainly divided into 2 categories. These are application and Platform. The article considered a platform as a software that can be customized and extended in context of functionalities. An application is a computer program that can perform tasks directly and can be deployed locally and used directly.
FMISs are further divided into 3 types. These are Web-based FMIS, Mobile-based FMIS, and Standalone/Desktop FMIS.
There are two types of licenses namely as Academic and Commercial. Academic license allows the software to be used for academic or research purposes. Commercial license allows the user to use the software for the commercial purposes.
According to the ***Project Management Institute (PMI)***, stakeholder for a project is defined as an individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project.
22 different stakeholders are identified in the article ***"Obstacles and features of Farm Management Information Systems: A systematic literature review"*** from journal "Computer and Electronics in Agriculture". These stakeholders are presented in the following table.

The identified stakeholders and their relationship to FMISs.

Stakeholder name	Description	#
Farmer	Responsible person on the farm and end-user of the system.	38
Governmental	Umbrella term for multiple stakeholders that relate to the government. Has an interest in FMIS for registration purposes, and to obtain farm information	10
Agricultural expert	Has expert knowledge about the agricultural sector and can be used for requirements for FMISs.	7
Farm employee	Works on the farm and has to work with the FMIS.	6
Research Institute	Multiple kinds of researchers and institutes can be used as knowledge input for FMISs.	6
FMIS developer	Develops the FMIS and its underlying software.	5
Input supplier	Delivers inputs to the farm, these inputs can be registered in an FMIS	5
Agricultural advisor	Helps the farmer with making decisions based on their knowledge, an FMIS can assist them.	4
Agriculture service provider	Assists the farmer with the providence of services. Can use FMIS for registration purposes.	4
Contractor	Hired by the farmer to perform field tasks. FMISs can improve the communication with the farmer.	4
Equipment producer	Makes new machinery for the farmer, an FMIS can provide machinery management.	4
Customer	Companies and other entities greater than an individual consumer. FMIS can provide details about the purchased products.	3
Administrator	Can setup system, and manages the FMIS. Is not necessary the FMIS developer.	2
Farmers association	Organized group of farmers with common interests. Want FMIS for implementation of modern technology.	2
Neighbour	Is influenced by decisions of FMIS (Odor nuisance, noise disturbance, etcetera).	2
Non-governmental	Group of persons with their own (ecological) interest that can be intertwined with the FMIS.	2
Product processor	FMIS can provide information on products coming from the farm.	2
Veterinarian	Can use the FMIS for retrieving animal information and can register veterinarian actions.	2
Accountant	Can use the financial modules of FMISs to verify and assist the farmer with bookkeeping.	1
Equipment dealer	Can provide machinery support and services via the FMIS.	1
Media	Provides communication with the outside world and has an influence on the farm image.	1
Weather service provider	Provides weather information as input for the FMIS.	1

Figure 2.7: Stakeholders

2.3 Gap Analysis

Understandability: Farm owners or farmers are often not well educated. They might lack complex skills to operate a FMIS. Moreover, complex UI can make itvery difficult for them to use a FMIS. This might discourage farm owners to use FMISs. The UX and UI design of a FMIS must be easy-to-understand. The FMIS should support different languages rather than a single language.Our FMIS should support Bangla language so that farm owners and farmers with less educational qualification can easily operate the system.

Support for measurement unit conversion should be there so that local units can be converted to standard units and vice versa for the ease of understanding

A Glossary support should be there so that difficult local terminologies can be understood by all.

2.4 Summary

To have a better view on the system, we studied different articles, research papers. Essence of our literature review is mentioned in this article. This study provides us with a step-by-step guide on how to design and implement our project. We explored different similar applications. It helped us to identify existing features and functionalities of Farm Management Information Systems. We conducted a GAP analysis, that enabled us to see current obstacles and challenges of developing FMISs. We also discussed some possible solutions

to overcoming these obstacles

Chapter 3

Project Design

Our project is designed to meet the specific needs of the farmers, consumers, sellers. This project is designed with a simplified user interface that allows customization to different user profiles. With a friendly user interface, it will be easily operating for those users who aren't experienced with software.

3.1 Requirement Analysis

3.1.1 Functional Requirements

Functional requirements analysis is a very critical process that helps the projects to succeed in a system to be assessed. Functional requirements are the requirements that the end-to-end user will demand as basic facilities that the system should offer.[9] All these functionalities need to be necessarily incorporated into the system. So our project basically deals with issues like:

1. All users should be able to log in to the system with authentic credentials.
2. New users should be able to create new accounts.
3. There should be 3 types of accounts. Namely as Farmer, Seller, and Consumer.(Here seller is the person who sells farming equipment and seeds to farmers. A consumer is a person who buys farm products from farmers.)
4. New accounts should be verified using email verification.
5. Farmers and seller accounts should be able to post.
6. A post should be in text, image, or video format.
7. All types of users should be able to comment on a post, rate, or report a post.
8. Users should be able to bookmark a post.
9. Farmer and seller accounts should be allowed to update or remove their own posts.

10. Admins should be able to have control over all other accounts and posts.
11. Admins Each account should have a control dashboard and should be able to review reported posts.
12. All the posts should be allowed to be sorted in different orders and by different filters.
13. Users should be able to log out from the system.
14. Users should be able to remove their accounts.
15. Each account should have a control dashboard.

3.1.2 Nonfunctional Requirements

Our project will be built with basic quality constraints that the system must run according to the project module. In this project, the priority will be the extent to which these factors are implemented varies from one function to another.[10] In our project, we called non-behavioral requirements. They basically deal with issues like:

1. Security:
    a. System should have business logic to detect different types of fraud.
    b. The system should be able to detect and prevent the possible use of vulgar words.
2. Localization:
    a. Support for the Bangla language should be given.
    b. A facility for a user-generated glossary for Bangla words related to farming should be there.
    c. A currency and measurement converter should be there so those equivalent units for different currencies and measurements become available.
3. Usability:
    a. Icons and labels for User Interface and navigation should be easy to understand.
4. Capacity:
    a. System should be able to store high qualities videos from the posts.
5. Compatibility:
    a. System should be tested on browsers from different vendors on different platforms.

6. Performance constraints:
    a. Reliability, security, response time, etc.
7. Interface constraints:
    a. These describe how the system is to interface with its environment, users, and other systems. For example, user interfaces and their qualities (e.g., user-friendliness).
8. Economic constraints:
    a. Immediate and/or long-term costs.
9. Lifecycle requirements:
    a. Quality of the design measured in terms such as maintainability, enhanced ability, portability.

3.1.3 Context Diagram

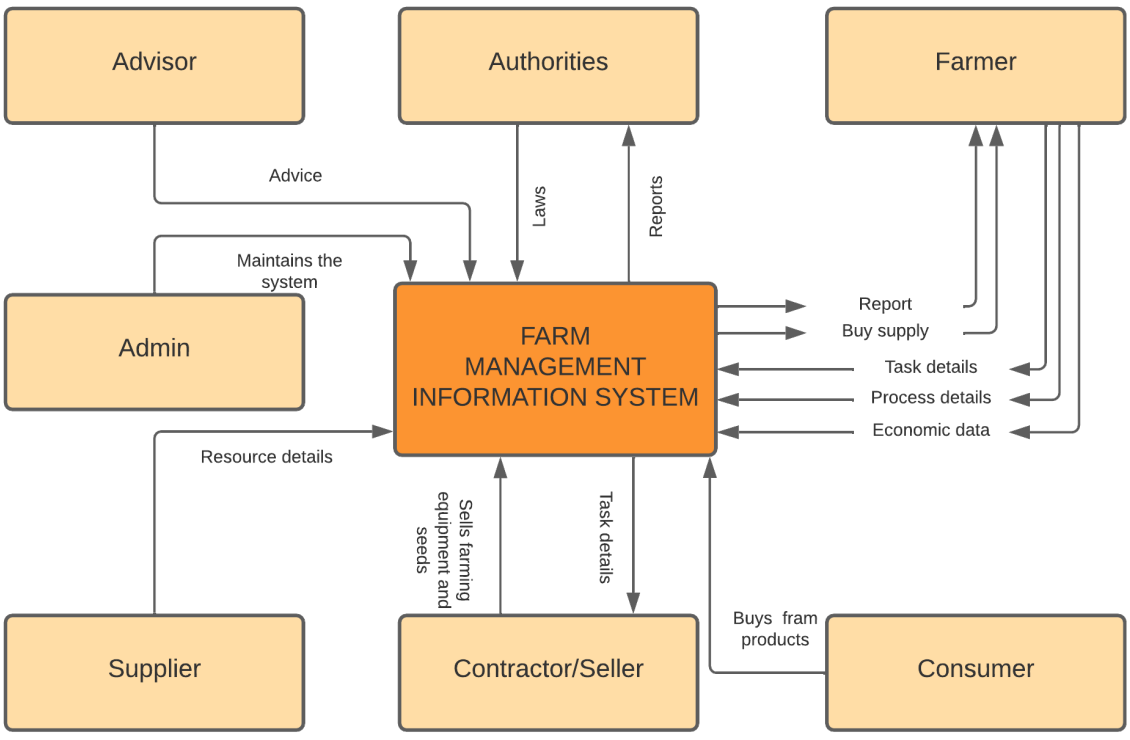


Figure 3.1: Context Diagram

3.1.4 Data Flow Diagram Level 1

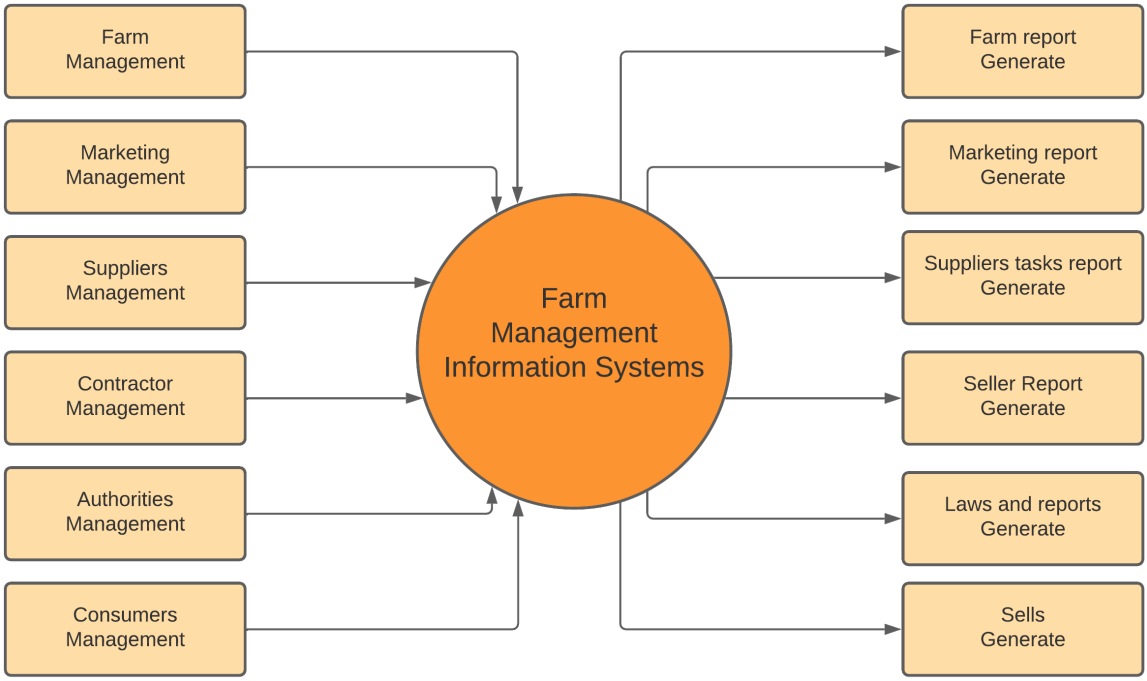


Figure 3.2: Data Flow Diagram Level 1

3.1.5 UI/UX Design

Figure 3.3: User Login Page

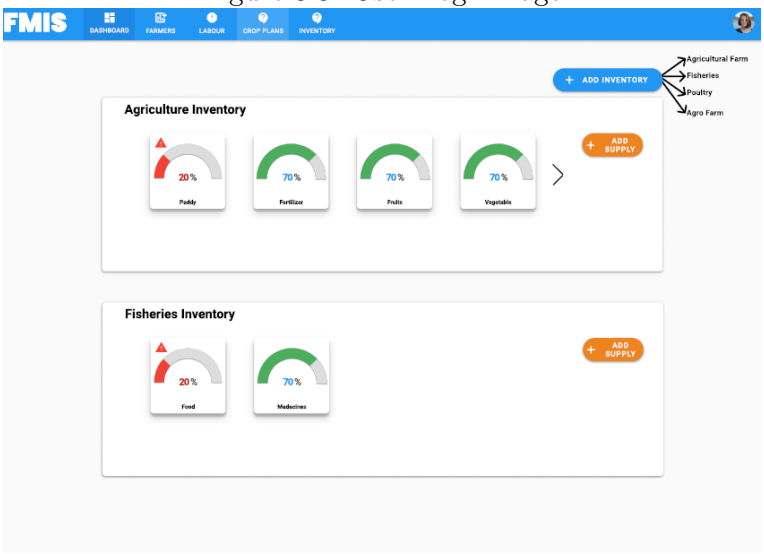


Figure 3.4: Inventory Dash page

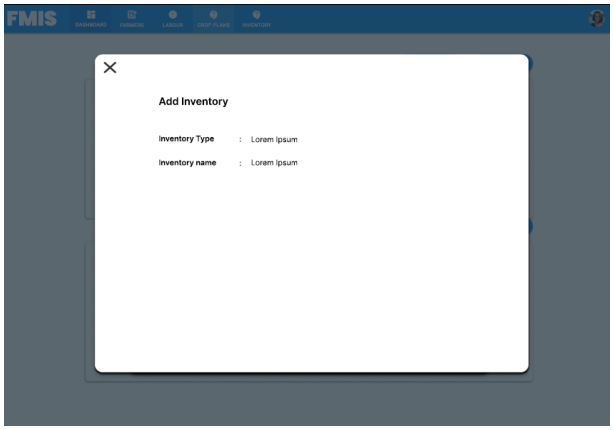


Figure 3.5: Add Inventory Page

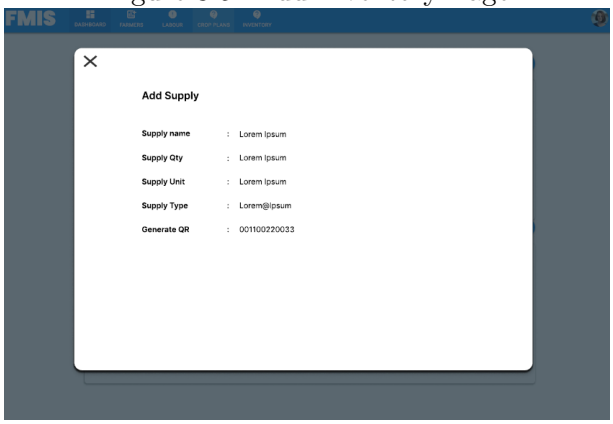


Figure 3.6: Add supply page

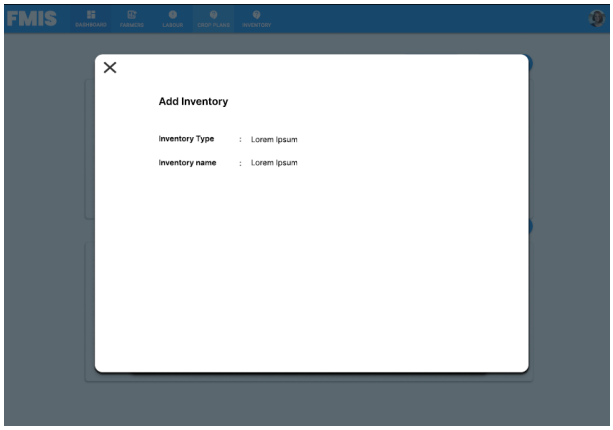


Figure 3.7: Add Inventory Page

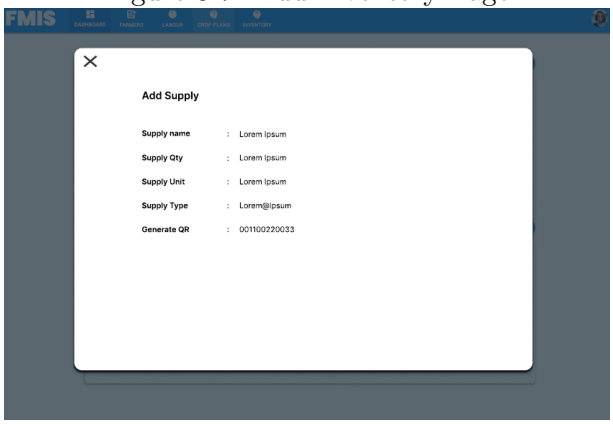


Figure 3.8: Add supply page

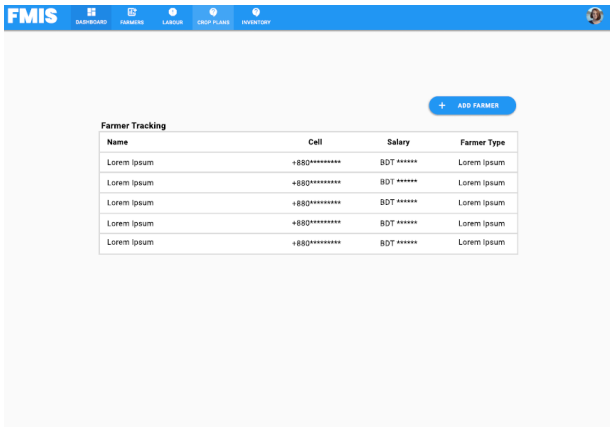


Figure 3.9: Add farmer page

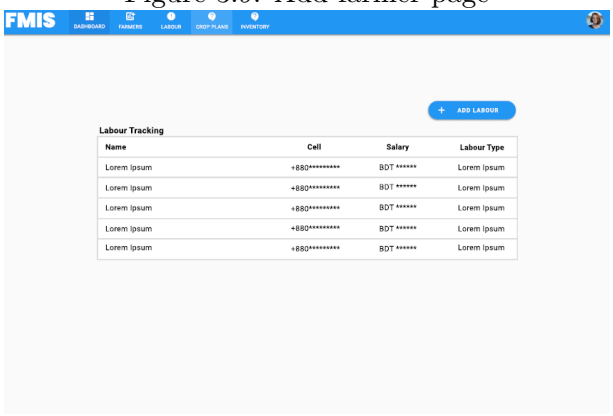


Figure 3.10: Labor tracking page

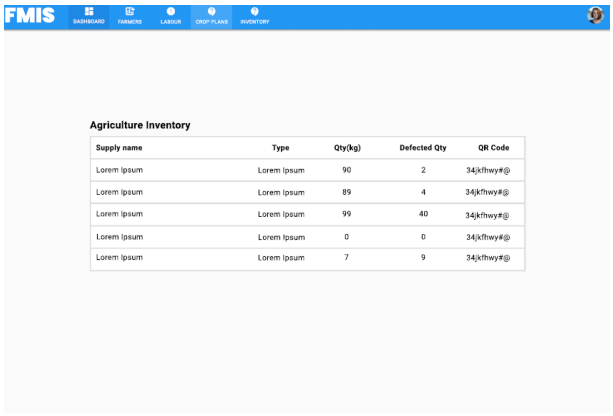


Figure 3.11: Agriculture inventory page

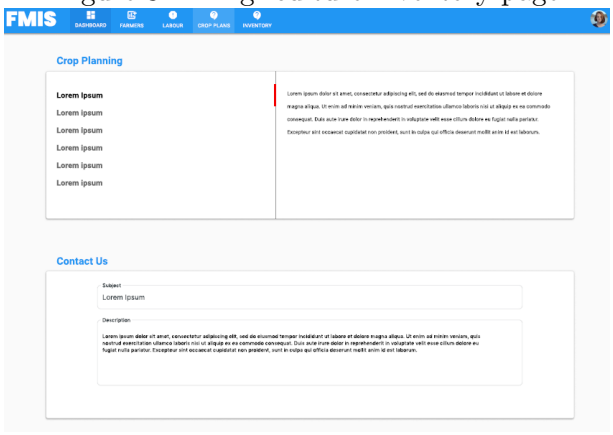


Figure 3.12: Crop planning and contact us dashboard page

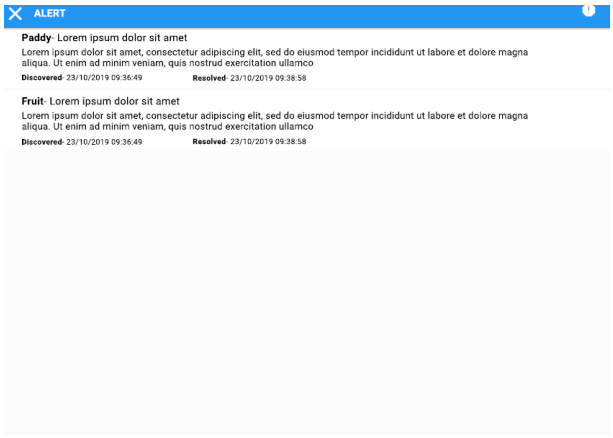


Figure 3.13: Alert page

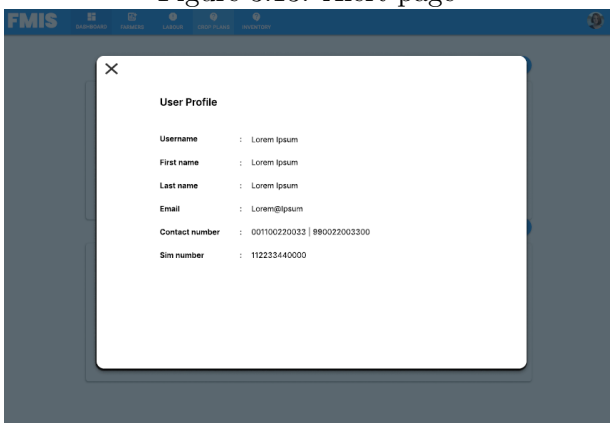


Figure 3.14: User profile page

3.2 Detailed Methodology and Design

Waterfall Model (Plan Based)[11]

- REQUIREMENTS: Define the problem. Identify the scope of the problem and develop a plan/strategy to solve the problem.
- ANALYSIS: Investigate the problem to define the requirements necessary for solving it.Define "what".
- DESIGN : Design a solution based upon the requirements. Define "how".
- CODE: Implement (program) the design. TEST Test the program to ensure the requirements have been satisfied.
- MAINTENANCE: Fix or improve applications based upon use or changes in the environment.

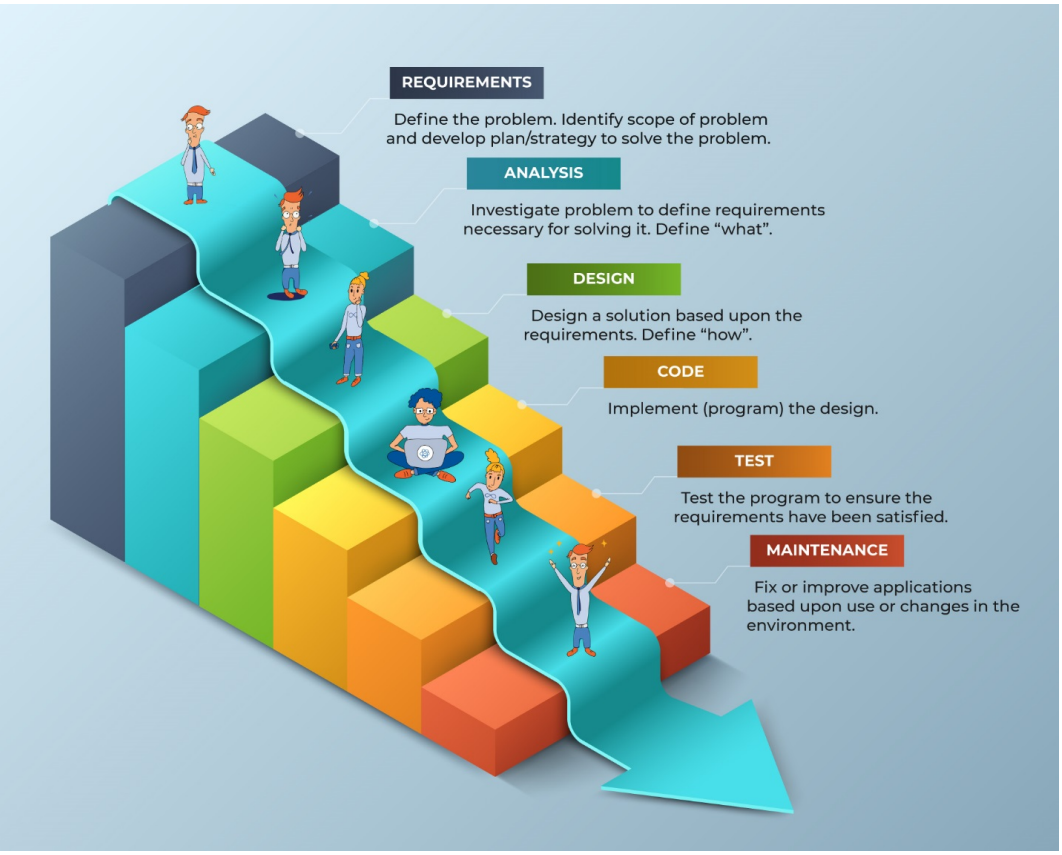


Figure 3.15: WaterFall Model (Plan Based)

Our project's Methodology and Design

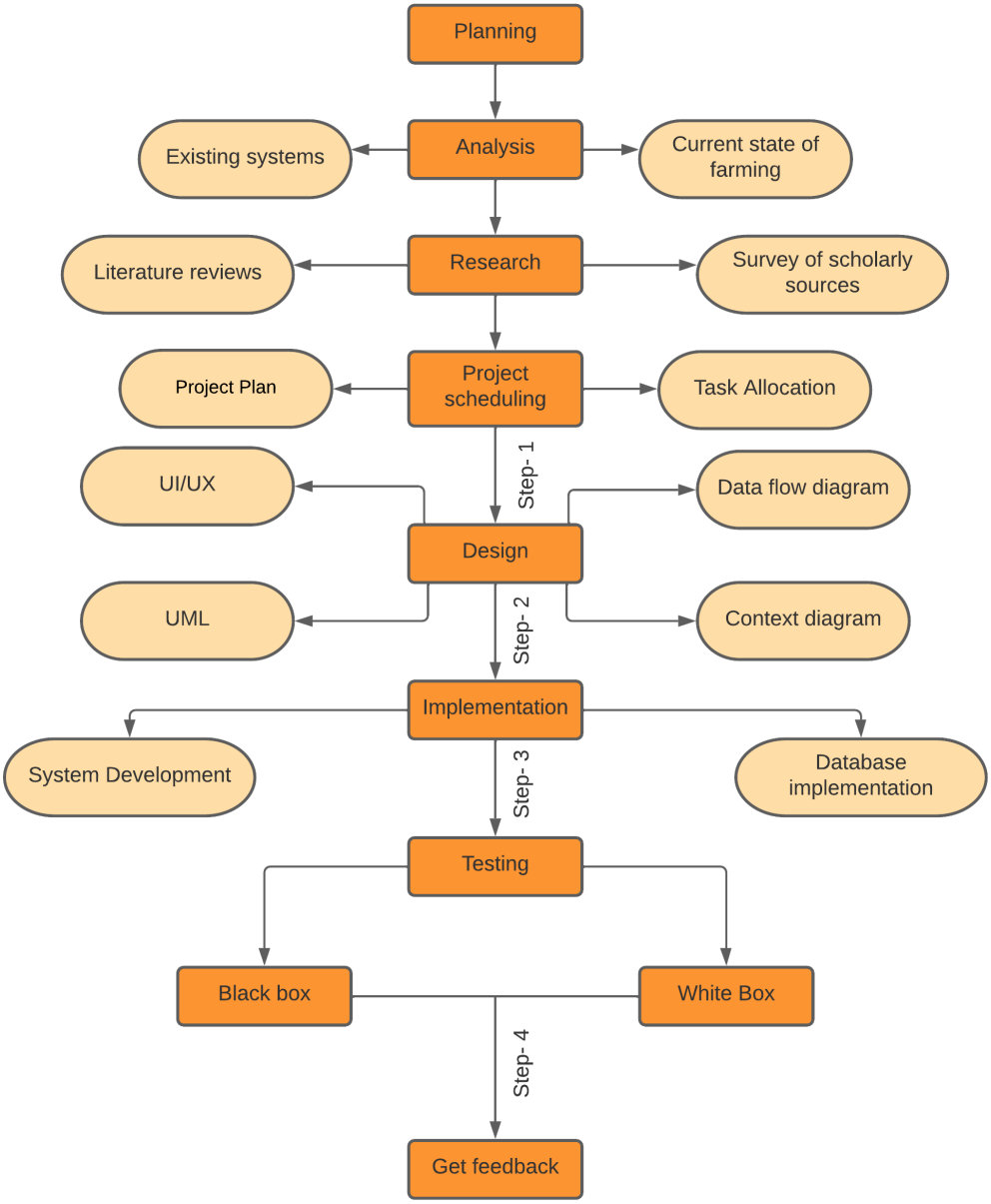


Figure 3.16: Detailed Methodology and Design

3.3 Project Plan

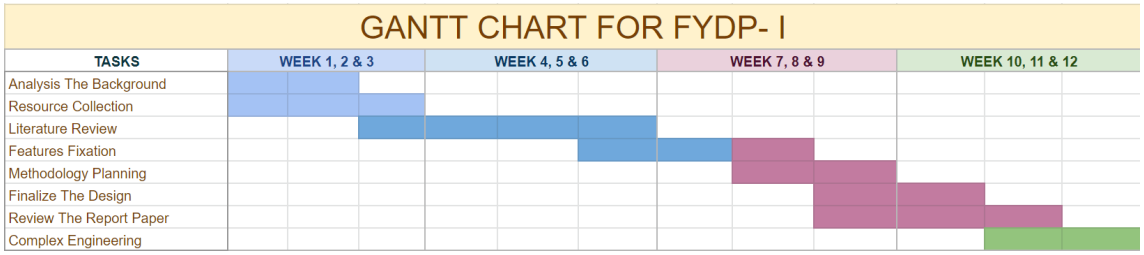


Figure 3.17: Project plan for FYDP 1

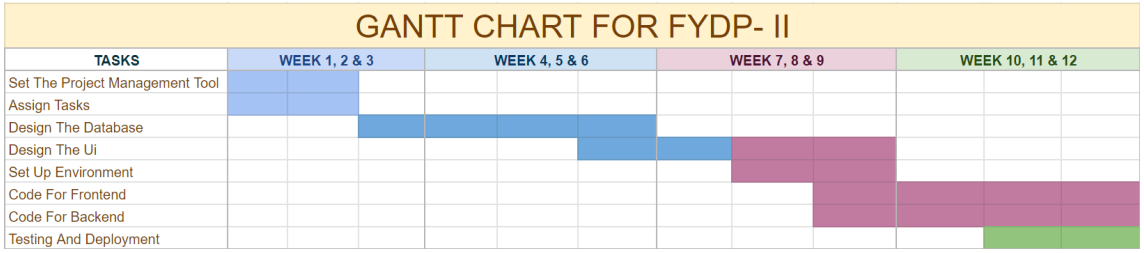


Figure 3.18: Project plan for FYDP 2

3.4 Task Allocation

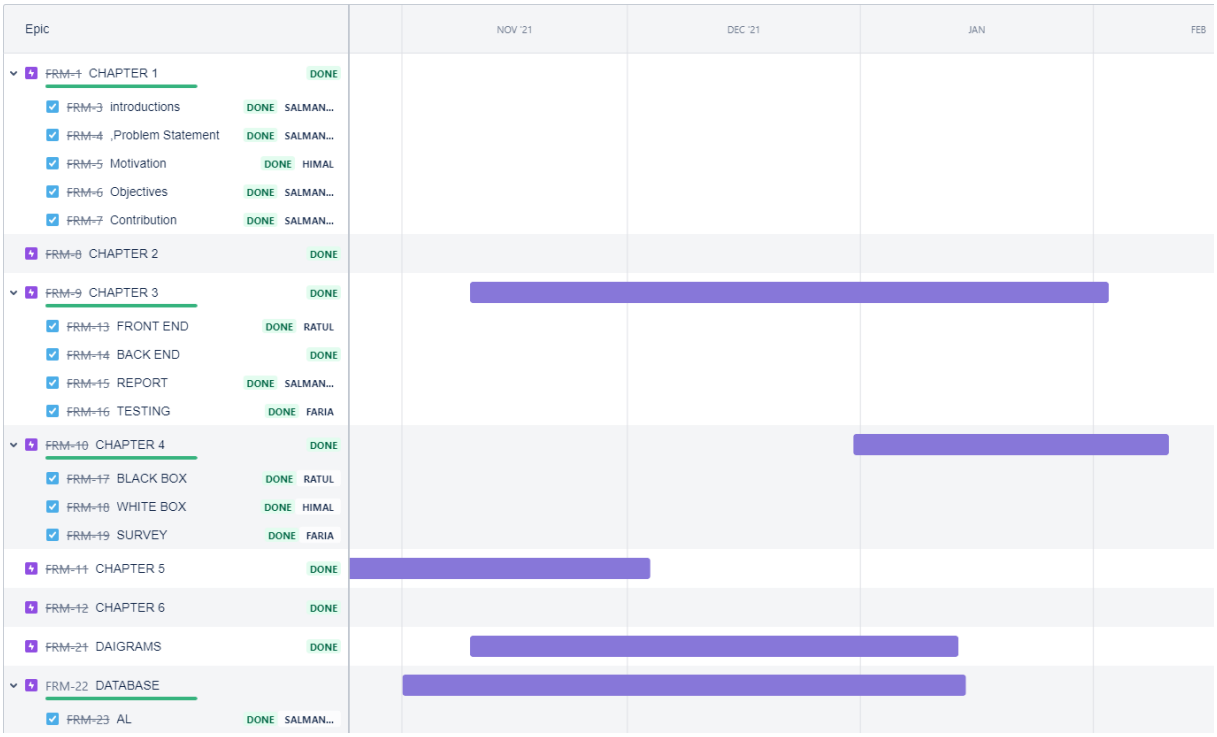


Figure 3.19: Road map of the entire project.

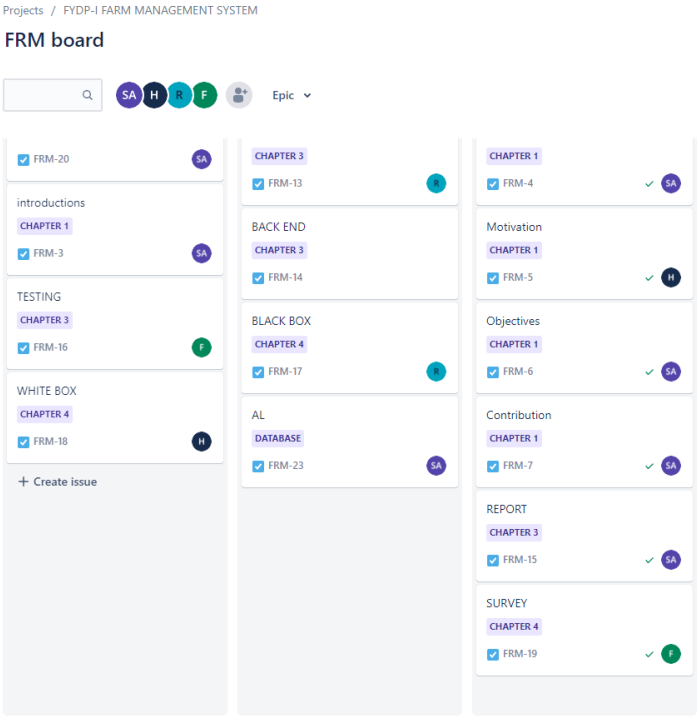


Figure 3.20: FRM board of our project.

3.5 Summary

This chapter presents a summary of how we design our projects so far. Functional and non-functional requirements consist of different credentials such as user login, user registration, post type facility, etc. It is also designed with analysis of some related research, a thorough benchmark study, and the gap analysis regarding current farm management information systems.

Chapter 4

Implementation and Results

4.1 Environment Setup

- Development:
  - **Front End:** HTML, CSS, JavaScript
  - **Front End Framework:** Bootstrap and React JS
  - **Back End:** JavaScript
  - **Back End Framework:** Node JS
- Database and Others:
  - **Database:** MongoDB Firebase
  - **Design Guideline:** Material UI
  - **Design Tool:** Figma, Server OS ,Cloud Linux (Shared Hosting)
  - **Integrated Development Environment (IDE):** VS Code, WebStrom
  - **Version control:** System: Git, **Repository management tool:** GitHub
  - **Project Management:** JIRA - An agile project management tool
- Platform : Cloud Linus OS (Shared Hosting), VS code for script editor

- **Some screenshots of script writing:**

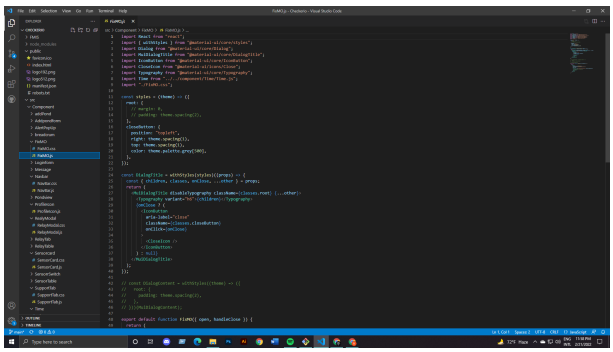


Figure 4.1: ScreenShots no. 1

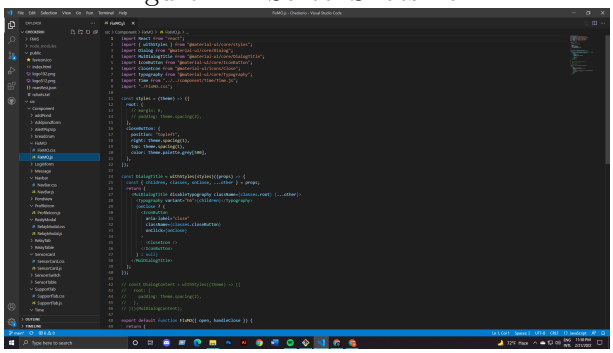


Figure 4.2: ScreenShots no. 2

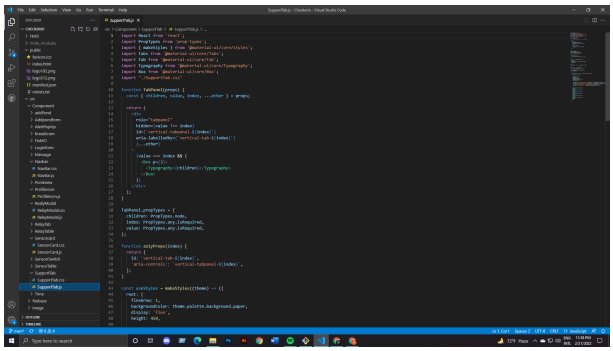


Figure 4.3: ScreenShots no. 3

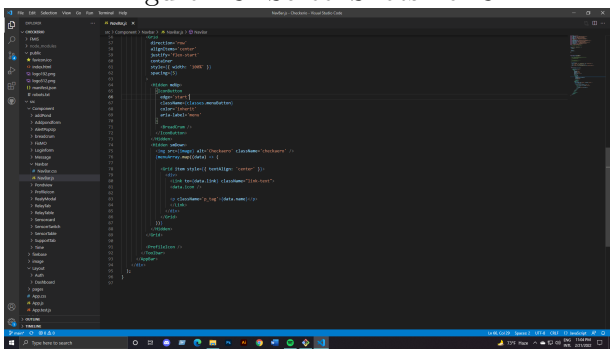


Figure 4.4: ScreenShots no. 4

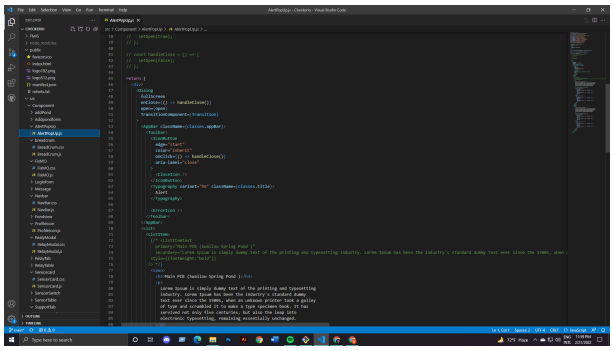


Figure 4.5: ScreenShots no. 5

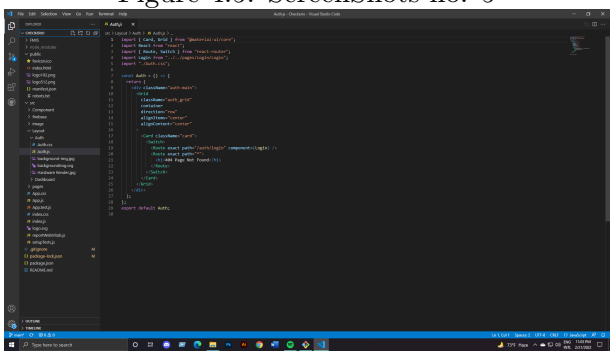


Figure 4.6: ScreenShots no. 6

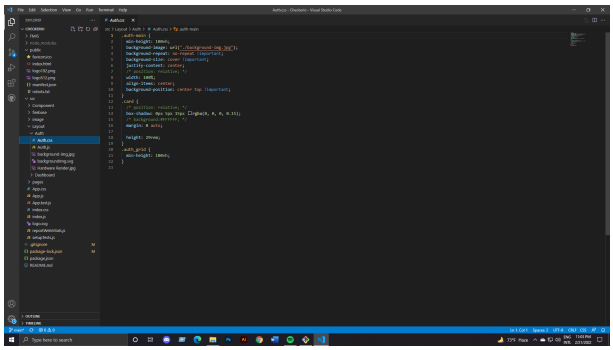


Figure 4.7: ScreenShots no. 7

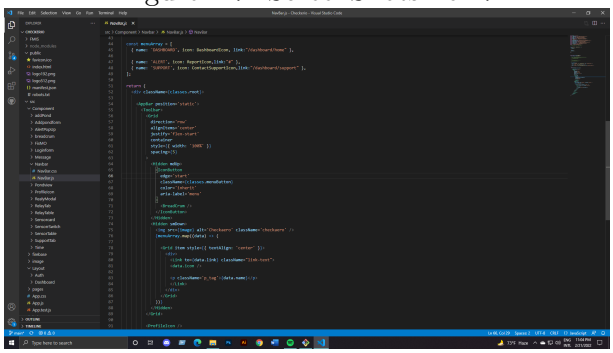


Figure 4.8: ScreenShots no. 8

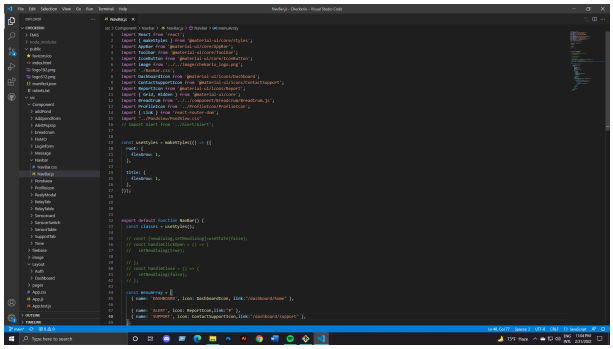


Figure 4.9: ScreenShots no. 9

- **Some screenshots of Version control:**
  Github Repository link: `https://github.com/RJRatul/FYDP.git`

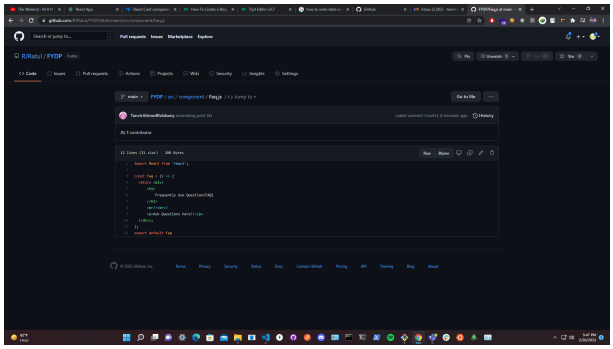


Figure 4.10: ScreenShots no. 1

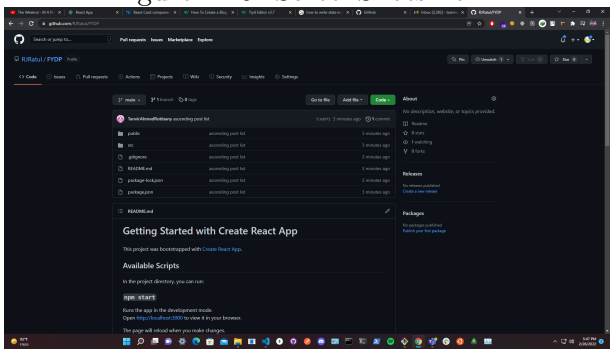


Figure 4.11: ScreenShots no. 2

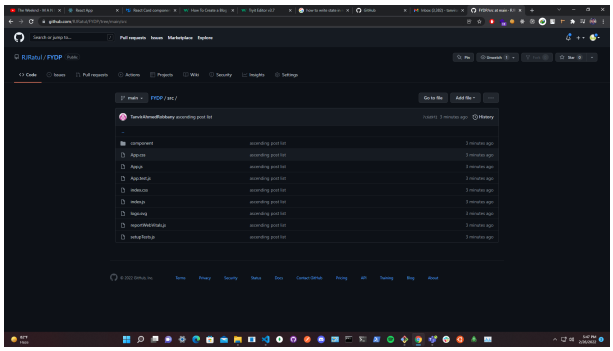


Figure 4.12: ScreenShots no. 3

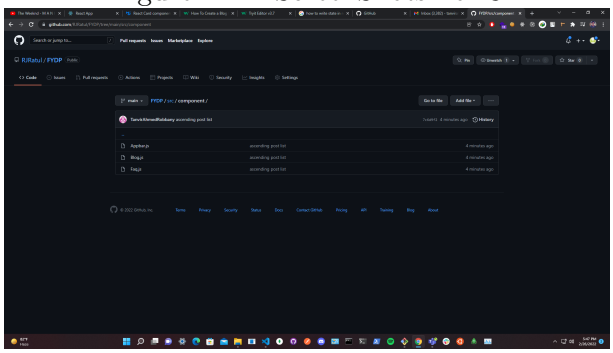


Figure 4.13: ScreenShots no. 4

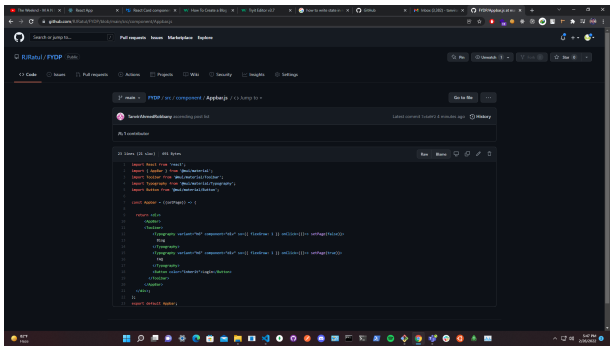


Figure 4.14: ScreenShots no. 5

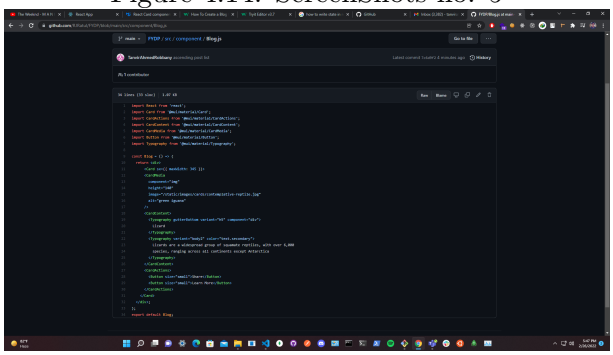


Figure 4.15: ScreenShots no. 6

4.2 Testing and Evaluation

- **Unit Testing:** All the Methods and functions are checked if expected output is generated given the specific input. In this testing only modules are checked. We have done unit testing for both our front end and back-end modules.
- **Integration Testing:** This test is to see if all the modules in a system are working correctly and collaboratively to produce the expected outcome as a system.
- **Requirement Testing:** The basic requirements of the website such as log in, log out, registering, posting, commenting, rating are ensured to be existent.
- **Functionality Testing :**
  - Link Testing:
    * Outbound links are tested.
    * Internal links are tested
    * Cyclic links are checked and removed.
    * Email links are tested
    * Broken links are checked and updated.
  - Form Testing:
    * Input data validity are tested
    * Allowed values for input data fields are tested
    * Invalid values for input data fields are also taken into the consideration
    * Form reset options are also checked
    * Form submission functionalities also checked
- **Compatibility Testing:**
  - Platform testing: How website functions on different OS on both desktop and mobile has been tested.
  - Browser testing: How website functions of different browsers of different vendors such as Firefox, Chrome has also been tested.

4.3 Summary

In this section, the core functionalities of our website has been defined as well as these have been tested. We focused on using popular technologies to build our website. For testing purpose, we've used only those tests that are crucially related to the basic functionalities of our website. Our website passed all those tests.

Chapter 5

Standards and Design Constraints

5.1 Compliance with the Standards

Standards are important as they allow the combination of products from different vendors. Without standards only hardware and software from the same vendor could be used together. A standard user interface can be beneficial for efficiency. As our project is an information management system for farms, we need to follow specific standards as well.

5.1.1 Software Standards

The management system we intend to develop is mainly a web-based system and we are willing to create the user interface following some guidelines. Software standards we are looking forward to following are:

i. **Common Gateway Interface (CGI):** This is a specification that allows web services to execute external programs or user requests.

ii. **ECMAScript:** This specification ensures the interoperability across different web browsers. JavaScript is an implementation of this specification.

iii. **Hyper Text Transfer Protocol (HTTP):** This protocol is used for transmitting hypermedia documents. This protocol is designed to establish connection between web browser and web servers.

iv. **Unicode:** We might need to use Bengali language to make it more user friendly. In this case, to use Bengali characters we will need Unicode for character encoding.

v. **Unified Modeling Language (UML):** It is a general-purpose modeling language in software engineering. It provides standard ways to visualize the design of a system.

vi. **Material:** This is a guideline for user interface design. We will use this guideline specifications for our user interface design.

5.2 Design Constraints

Constraints are conditions in the form of limitations that must be met while designing the system. For development of a farm management information system, there exist some constrains.

5.2.1 Ethical Constraint

(a) System design must respect patents and intellectual rights.

(b) System design must provide information security and privacy for the owners.

5.2.2 Social Constraint

(a) System must not be cause unemployment.

5.2.3 Sustainability

(a) System makes it easier to manage workers and workloads.

(b) System design improves record-keeping.

(c) System must have an easy-to-use graphical interface.

(d) System must be extensible. So that it supports future updates and upgrades.

(e) System must be easy to learn.

(f) System must be easily maintainable.

5.3 Complex Engineering Problem

Reasons that our project is a complex engineering problem: For a problem to become a complex engineering problem it must satisfy P1 and some or all of P2 to P7 from the Complex Problem Solving table and some or all of the Engineering Activities table. Our project fulfills compulsory as well as other additional criteria to be considered as a complex engineering problem. The rationale with proper visual representation is given below.

5.3.1 Complex Problem Solving

Table 5.1: Mapping with complex problem solving.

P1 Dept of Knowledge	P2 Range of Conflicting Requirements	P3 Depth of Analysis	P4 Familiarity of Issues	P5 Extent of Applicable Codes	P6 Extent of Stakeholder Involvement	P7 Interdependence
✓				✓	✓	✓

Table 5.2: Mapping with Knowledge profile for P1

K1 Natural Sciences	K2 Mathematics	K3 Engineering Fundamentals	K4 Specialist Knowledge	K5 Engineering Design	K6 Engineering Practice	K7 Comprehension	K8 Research Literature
		✓	✓	✓	✓	✓	✓

P1 (Depth of Knowledge): Our project requires in-depth engineering knowledge in several domains for successful completion. For P1 to be satisfied, K3, K4, K5, K6, and K8 must be satisfied from the Knowledge Profile table (Table 5.2).

* **K3(Engineering Fundamentals):** To make our project we will need knowledge of some theoretical engineering fundamentals.

  `Networking`: For reliable, accurate, and fast data transactions, we will need knowledge of Networking.

  `Database`: We will need databases for storing information. Both OLTP and OLAP types of databases are going to be required. So, in-depth knowledge of databases will also be required.

  `System Analysis and Design`: To develop our project in a proper orderly step-by-step process we will need in-depth knowledge of system analysis and design.

  `Web Technologies`: Clear knowledge of web technologies will be needed.

  `Data Structure and Algorithm`: Knowledge of data structure and algorithm is going to be required to make the system efficient and reliable.

* **K4 (Specialist Knowledge):** To implement our system, we will be using different tools and technologies. We will require specialist knowledge of tools and technologies such as MongoDB for database, React.JS for front-end development, Node.js for back-end development, Firestore (fire-base as a whole), Material UI for design guidelines, git for version controlling and collaboration.

* **K5 (Engineering Design):** Before the implementation, our project will go through the design phase. We will have to design architecture for our system along with different UML diagrams. For structure diagrams, we will design class diagrams, component diagrams, deployment diagrams. For behavioral diagrams, we will design use-case diagrams, sequence diagrams, activity diagrams, etc.

* **K6 (Engineering Practice):** Different engineering practices will be required for the project work. As it is a team project, we will need collaboration technologies such as GitHub. For project management, we will use Jira software. For documentation, we will use latex.For UI design free version of Figma will be used along with MS Visio for diagram design.

  Other analytical tasks such as SWOT analysis, cost analysis, benchmark study, algorithm analysis, etc. are also necessary for our project.

* **K7(Comprehension):** Our project is related to farming which is an essential part of our culture and economy. If the digitalization of the farming sector can improve overall efficiency and profit, then a large number of people who are gradually walking away from farming due to rapid urbanization might feel interested in getting involved in this sector. This way farming will be able to make more contribution to our economy and we will have food sufficiency in our country.

* **K8 (Research Literature):** our project involves studying technical papers and journals related to building farm management information systems. There are various pieces of literature describing different aspects and problems with proposed solutions regarding farm management information systems. Analysis of current systems and suggestions to improve these systems are also available in the works of literature. Studying technical papers helps improve both qualities and functionalities for our project.

P5 (Extent of Applicable Codes): (From Table 5.1) As we are building a Farm Information Management System, there are some standards and guideline we will have to follow. There are software engineering standards and agricultural standards to follow for our project.

Software engineering standards:[12]
ISO/IEC software engineering standards
`https://www.iso.org/obp/ui/#iso:std:iso-iec:tr:19759:ed-2:v2:en`
Agricultural standards:
ISO standards for agriculture[13]
https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100412.pdf

P6 (Extent of Stakeholder Involvement):(From Table 5.1) Farm management information systems have different stakeholders.Individuals and entities such as farm owner, government, farm employee, administrator, suppliers etc.Here farm owner is main stakeholder and a direct end user.

P7 (Interdependence):(From Table 5.1) Our project is divided into different parts and these parts are interdependent.Software development goes through different phases. Our first part is to explore current systems. Based on the study we need to think of anything new we might add to the existing systems to make it better.Next task is to determine what purpose our system should serve and what functionalities should be included in the system. From this part we will be able to set our objectives. Then in the next part we will have to do various diagram designs for our projects. These diagrams will be used as blueprints and guideline for our implementation phase. In our implementation phase we will build our system using various tools and techniques. Finally, we will test our system to check if it meets all the required criteria.

5.3.2 Engineering Activities

Table 5.3: Mapping with complex engineering activities.

A1 Range of resources	A2 Level of Interaction	A3 Innovation	A4 Consequences for society and environment	A5 Familiarity
√			√	

A1 (Range of Resources): (Table 5.3)Our project needs resources from different sectors. Firstly, we need research papers to keep us well informed regarding various aspects of Farm management information systems. A lot number of online resources such as articles, standards and guidelines, tutorials are also required. We have our mentor and course teacher to always guide us in the right direction.We will need some field experience related to how a farm function. In this case, farm owners and farm employees can also provide us with necessary information.

A4 (Consequence for Society and Environment):(Table 5.3) A farm management information system can reduce the cost and increase productivity. It makes farm management easier. An improved farming sector will contribute more to the country's economy. We will have food sufficiency. We will be able to export foods and agricultural products. This will create job opportunities as well. More people will be involved in farming. So, a successful implementation of this project might have a huge positive impact on our socioeconomic standards.

5.4 Summary

A basic web-based farm management information system includes some common and widely used software standards. Design constrains varies depending on if it is a commercial or a project-based work. For a commercial variant, some more constraints such as economical constraints would be added. Design and implementation of a fully functional farm management information system is a complex engineering problem. It has been shown with well established points. A farm management information system is a system where engineering knowledge can be applied very significantly.

Chapter 6

Conclusion

The various components–services of the FMIS and their functionalities can be derived based on specifications of the user-centric information modeling of the agricultural tasks. The base for functional requirements will be low-cost implementations.

6.1 Summary

A basic web-based farm management information system includes some common and widely used software standards.It is also designed with analysis of some related research, a thorough benchmark study, and the gap analysis regarding current farm management information systems.We conducted a GAP analysis, that enabled us to see current obstacles and challenges of developing FMISs.We also discussed some possible solutions to overcoming these obstacles.In our project, we intend to build a system that would keep track of farming operation and production activities. The main focus is to reduce the workload of farm management in our country. Using this system, a farm will be able to increase its production with the efficiency of resources.

6.2 Limitation

Website should not have a delivery system for the initial stages as sometimes farm goods need to have efficient storage facilities. Building up such facilities is quite costly.
Any kind of fraudulent detection prior to any reported case is not quite possible. Layers of verification also involve some excessive costs and institutional setup. Which is not possible at the current stage of development.

6.3 Future Work

Implement Corpus Analysis [14] to collect 'real-life' language samples such as speeches, magazine articles, and text messages. Our goal will be to discern certain rules of language use, patterns, type of text serving as valuable resources for related fields.

Make a mobile application to access every data and fields related resource for marketing. For delivery purposes, the shortest route is generated by the ai agent with conditions. We look forward to integrating a delivery system using which a consumer will be able to buy from farmers via us. That will provide consumers a security from different types of frauds. And hopefully a lot of unexpected situations can be prevented this way.

References

[1] A. Kassahun B. Tekinerdogan J. Tummers. *Reference architecture design for farm management information systems: a multi-case study approach.* Precision Agriculture, 01 June 2020.

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