TITLE: SMART WATER MANAGEMENT SYSTEM

GROUP NO: 9

TEAM MEMBERS:

MANAV SHAH

ISHAAN PANCHAL

SHUBHAM JAITAPKAR

SHREEYA SATAV

COURSE CODE: SYSTEM ANALYSIS AND DESIGN MSIS 619

DATE OF SUBMISSION: 13TH DECEMBER, 2022

Table of Content

Brief Description of Project

Water is the most important substances on earth so it should be used wisely. In the era of automation and enormous development, we still find problems with the Water Pumping System, Tank Water-Level sensing and in the residential buildings. Sometimes due to carelessness of the security guard who is responsible for managing the water tanks, huge amount of water is wasted or is not utilized in a proper manner. So, to overcome this problem Smart Water management System lends a helping hand. It takes up the responsibility to fill up the Underground Tank and the Overhead Tank of the buildings by controlling the water pump. Smart Water Management System is also a great device which can be used to alert the society members by passing a message that water has not arrived from government so to use water efficiently. Smart Water Management will provide us with the Website which will be user informative and can be remotely accessed.

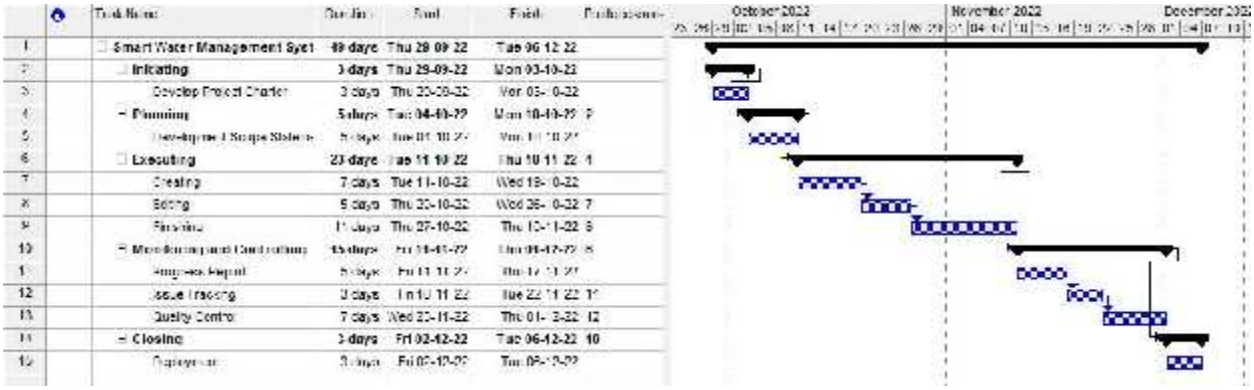
Smart Water Management System is an essential feature in the societies which will be working automatically and if the user want to manually make the changes then it can be done too. The aim of the project **"Smart Water Management System"** is to minimize the efforts of the security guards and the secretary of the societies and the purpose of the system is to create a convenient environment and east-to-use system for users. The project also aims at proposing a system that will be used for the betterment of the members. A responsive Website is also used to check the complete details of the system. The user can manage it by not being at home. The tank will be able to manage the water level in it and will automatically pump it in the houses.

Business Case

The focus of the system is on minimizing the water wastage and consuming it in an efficient manner.

Remote monitoring makes it easier as it would provide remote valve control and real-time insights on connected gadgets, and much more.

The earlier effort of turning the motor on and off by the person as per the customer needs is not a worry anymore since everything would be automated.



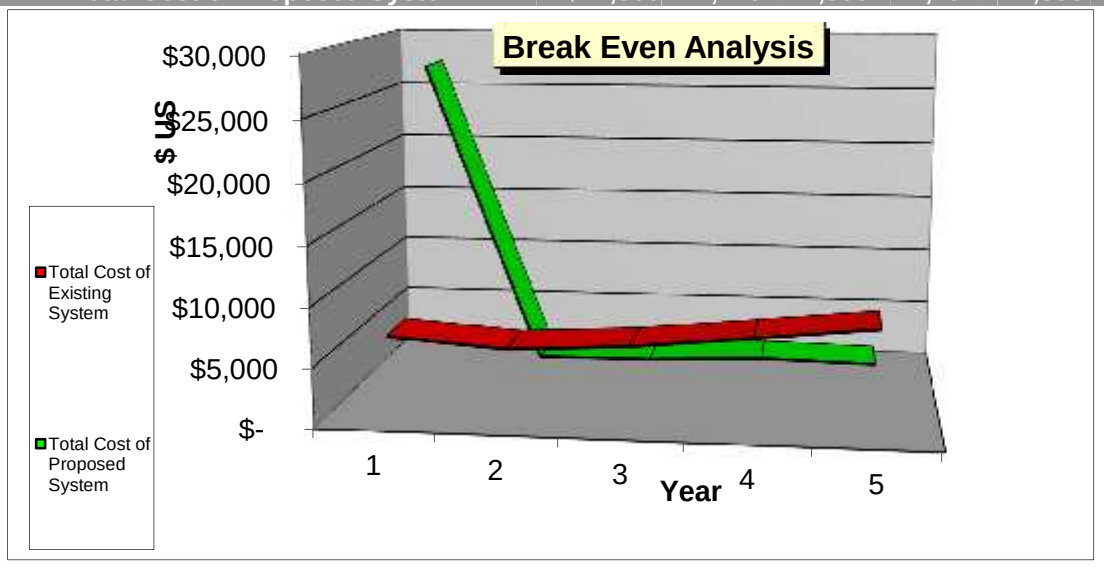
Economic Feasibility

Category	In $US
Cost reduction or avoidance	$ 2,500.00
Error reduction	$ 2,500.00
Increased flexibility	$ 7,500.00
Increased speed of activity	$ 10,500.00
Improvement in management planning and control	$ 25,000.00
Other	$ -
Total Tangible Benefits	**$ 48,000.00**

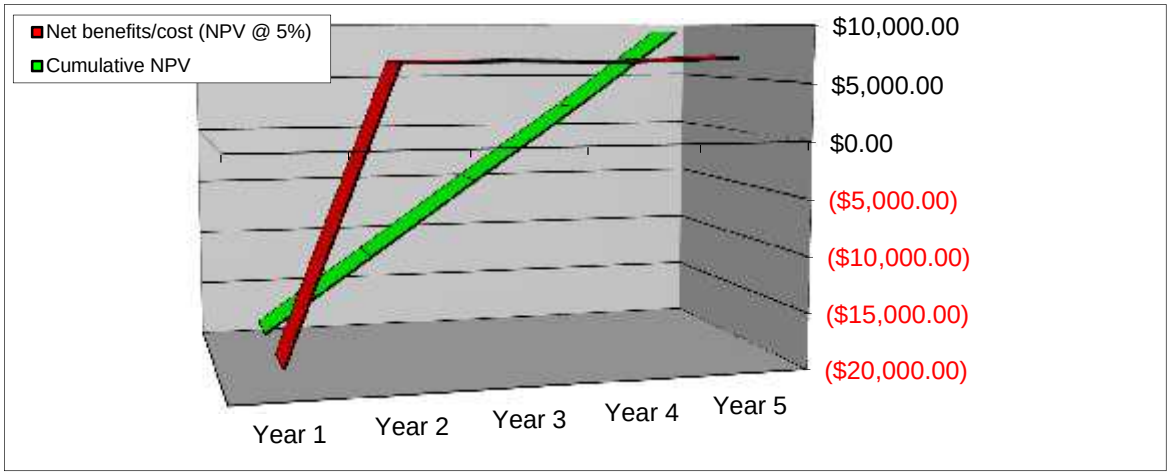
Tangible One-Time Costs	
Category	**In $US**
Development costs	$ 15,000.00
New hardware	$ 4,000.00
New software	$ 5,000.00
User training	$ 1,500.00
Site preparation	$ 2,000.00
Other	$ -
Total Tangible One-Time Costs	**$ 27,500.00**

Tangible Recurring Costs	
Category	**In $US**
Application software maintenance	$ 5,000.00
Incremental data storage required	$ 1,500.00
Incremental communications	$ 1,000.00
New software or hardware leases	$ 1,500.00
Supplies	$ 500.00
Other	$ -
Total Tangible Recurring Costs	**$ 9,500.00**

Break Even Analysis					
Costs of Existing System	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Development costs	$ -	$ -	$ -	$ -	$ -
Additional hardware	$ 3,000	$ 1,850	$ 1,970	$ 2,500	$ 3,000
Operation costs	$ 150	$ 158	$ 165	$ 174	$ 182
User time during development	$ -	$ -	$ -	$ -	$ -
Salaries	$ 3,000	$ 3,300	$ 3,630	$ 3,993	$ 4,392
Maintenance costs	$ 500	$ 575	$ 661	$ 760	$ 875
Total Cost of Existing System	**$ 6,650**	**$ 5,883**	**$ 6,427**	**$ 7,427**	**$ 8,449**
Costs of Proposed System	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Development costs	$15,000	$ -	$ -	$ -	$ -
Hardware And Software	$ 9,000	$ -	$ -	$ 300	$ -
Operation costs	$ -	$ 150	$ 161	$ 172	$ 184
User Training And Site Prep	$ 3,500	$ -	$ -	$ -	$ -
Salaries	$ -	$ -	$ -	$ -	$ -
Maintenance costs (Software + Hardware)	$ -	$ 1,120	$ 1,198	$ 1,282	$ 1,372
Total Cost of Proposed System	**$27,500**	**$ 1,270**	**$ 1,359**	**$ 1,754**	**$ 1,556**



Cost Benefit Analysis using Present Value (Purchasing Operations Support)					
Benefits of option	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Staff savings	$ 6,000	$ 6,300	$ 6,615	$ 6,946	$ 7,293
Water and electricity savings	$ 1,050	$ 1,155	$ 1,271	$ 1,398	$ 1,537
Preventing Motor Failures	$ 1,200	$ 1,320	$ 1,452	$ 1,597	$ 1,757
Total Benefits	**$ 8,250**	**$ 8,775**	**$ 9,338**	**$ 9,941**	**$ 10,587**
Costs of option	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Development costs	$ 15,000	$ -	$ -	$ -	$ -
Additional hardware and software	$ 9,000	$ -	$ -	$ 300	$ -
Operation costs	$ -	$ 150	$ 158	$ 165	$ 174
User training and Site Prep	$ 3,500	$ -	$ -	$ -	$ -
Maintenance costs	$ -	$ 1,120	$ 1,176	$ 1,235	$ 1,297
Total Costs	**$ 27,500**	**$ 1,270**	**$ 1,334**	**$ 1,700**	**$ 1,470**
Net benefits/costs	$ (19,250)	$ 7,505	$ 8,004	$ 8,240	$ 9,117
Cumulative benefits/costs	$ (19,250)	$ (11,745)	$ (3,741)	$ 4,499	$ 13,616
Net benefits/cost (NPV @ 5%)	($18,333.33)	$6,807.26	$6,914.16	$6,779.34	$7,143.47
Cumulative NPV	($18,333.33)	($11,526.08)	($4,611.92)	$2,167.41	$9,310.88



Break Even Period **1.39218968**

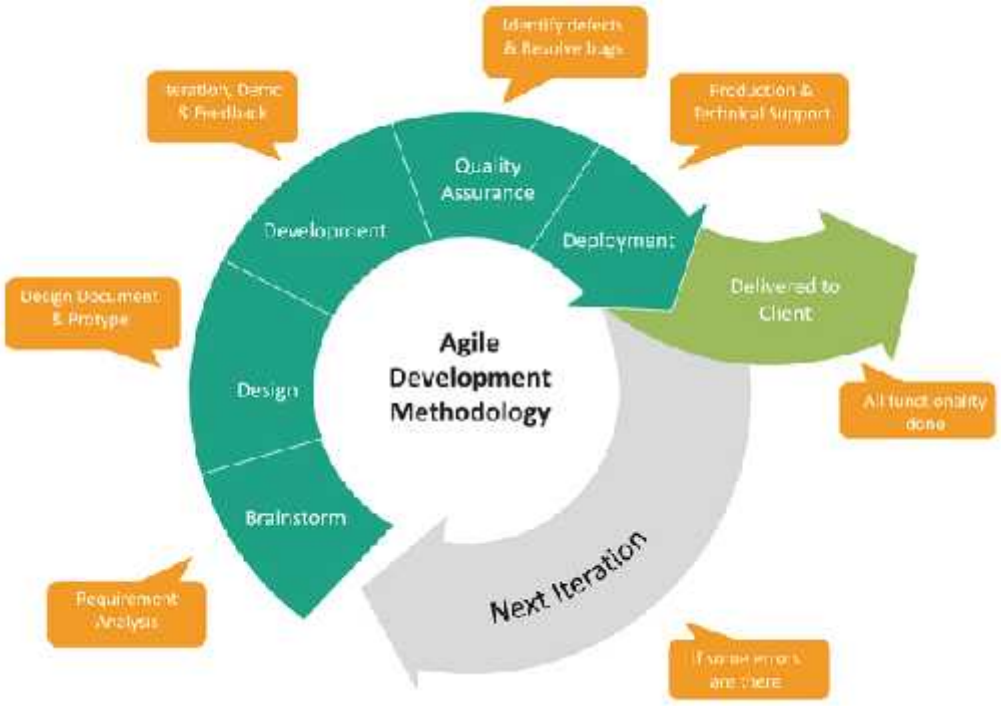
Revised Project Plan

We thought of implementing this project by Agile Methodology because of few reasons we know Agile can be helpful for our project.

It can accommodate changes at any time, also it is effective for the dynamic development environment.

It has also a very high satisfaction over the development process.

All these pros are very helpful while implementing our project.



Requirements

Requirement gathering process

Requirements gathering is the process of identifying your project's exact requirements from start to finish.

Smart Water Management System is the project where we require feedbacks and opinions about the people who are really experiencing the problem of water loss and other water related problems in the societies or building. So, to gather such kind of information we thought of approaching people and know about their problems and how they are suffering from it. We initially thought of two techniques to gather the required information from them.

Requirement gathering technique and rationale

Technique	Pros	Cons	Use-Case
Survey	Easy to evaluate, Easy to gather high volume data	Not specific questions, Sometimes fake surveys	Asking many societies and buildings at once
Shadowing	Real time data hands – on experience	Time consuming for the case study	High accuracy needed, Process improvement

These are the two techniques which we were thinking to carry-on with. Though after looking at the pros and cons of it, we thought of going with the surveys as it helped us majorly for the information we were looking at on a wider picture rather than just focusing on one small prototype.

We created a questionnaire and sent a google form to all the mature people who are interacting with the current water pumping system in the societies and buildings, so that we can get the proper idea of what they are facing and what solutions they are expecting.

List of functional requirements related to major business processes

- The Water Management System ensures the automation of the water system and prevention of water loss.

    - All the software and hardware components in this system ensures the full automated functioning of the system and this automation helps in preventing water loss in the societies.

- The system shall help all its user to have a good interaction with data as well.

    - The dashboard is quite easy to interact with as it makes sure that the UI/UX is very simple and understandable for the users using it.

- The system shall also maintain data records related to water purity and water loss.

    - The data of water level, purity of water and water loss is also maintained by the system so that it can be easy to analyze the data at the time of maintenance.

- The system shall be very flexible to use once it gets installed.

Once the whole system gets set up, it becomes very flexible for users and admin to use it, as the whole system will run very smoothly and seamlessly.

List of business policies

Private clouds: System uses private cloud for data storage. Resources for cloud computing are used only by one organization. Private clouds may be operated by a third-party cloud service provider or physically stored in an on-premises data center. Still, the cloud infrastructure is kept in a private network with dedicated hardware and software.

Following policies are involved for the data storage:

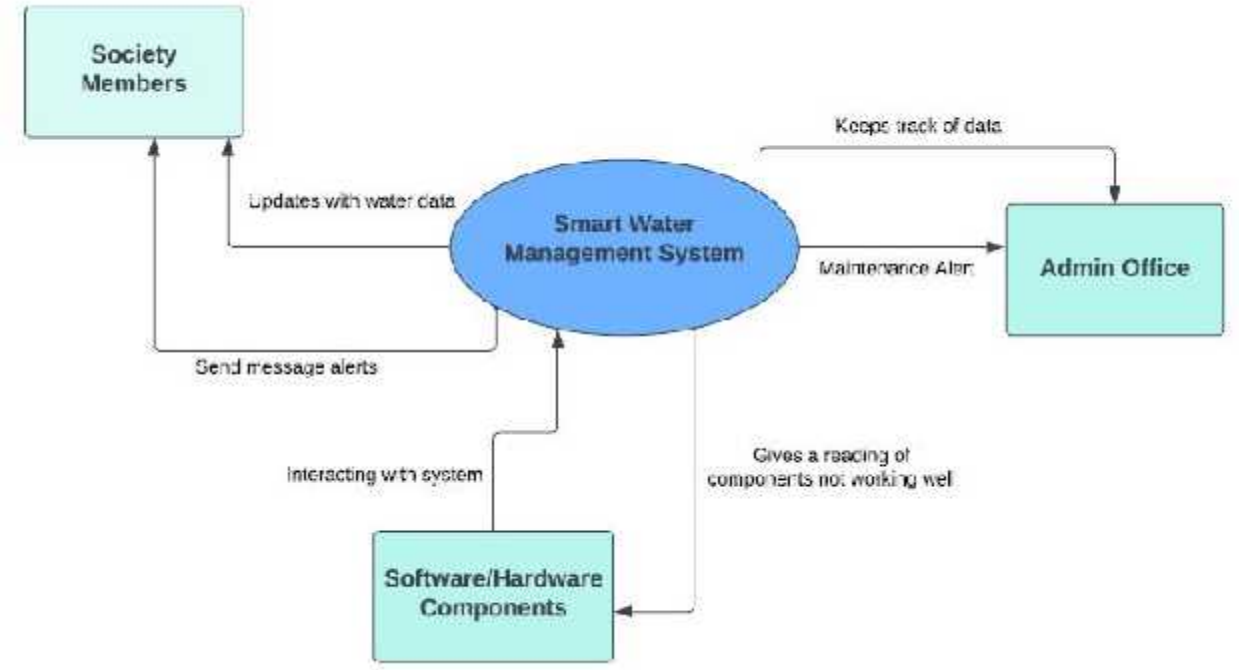
- Do not use cloud storage to store files containing information about individuals or other sensitive information.
- If you are using Cloud Storage for collaboration with others, either from within the society or elsewhere, only grant access to files or folders that are required for the collaboration to take place. Access to personal data should be given on a strictly need to know basis to comply with the Data Protection Act.
- You must ensure that there is a suitable level of encryption on any mobile or portable device used to download any data about individuals from cloud storage. Such a device must be password protected.

Multifactor Authentication Increases Security:

Multifactor authentication (MFA) involves securing access to your cloud with a combination of identifying measures. For example, in addition to entering a password, people may also need to input a code sent to their phone.

To store and process your online data, cloud providers and cloud storage services use a network of interconnected, secure data centers.

Context Diagram

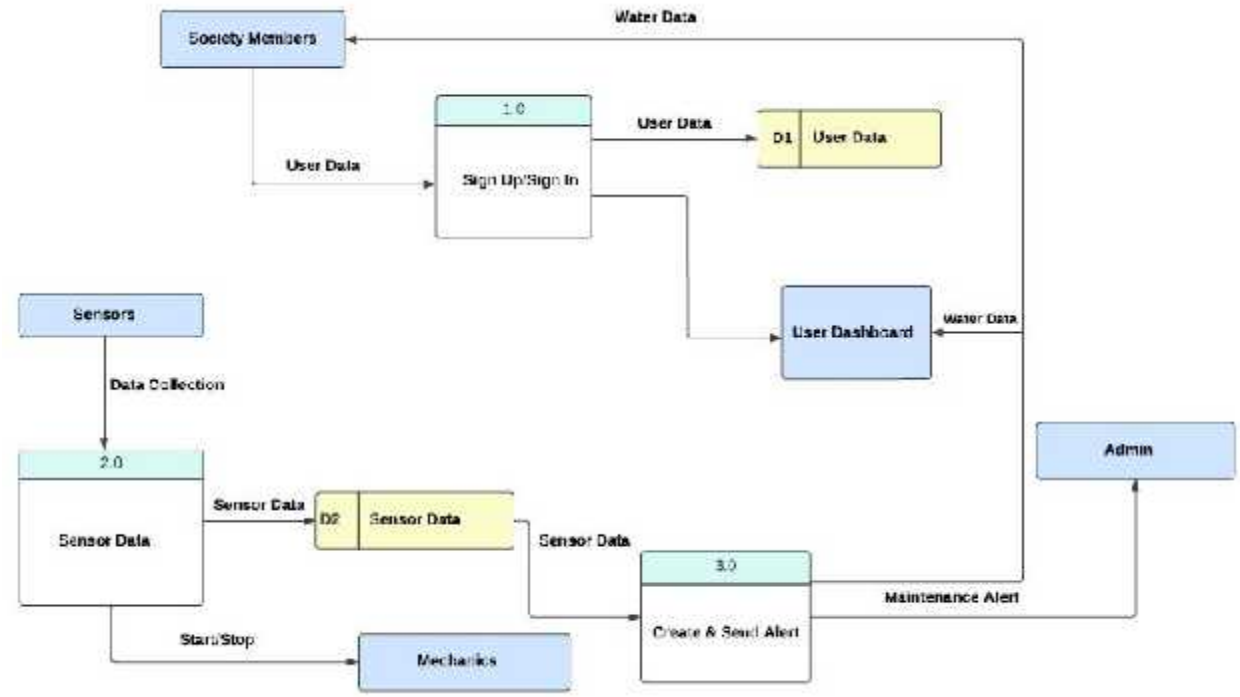


A context diagram outlines how external entities interact with an internal software system. It's primarily used to help businesses wrap their heads around the scope of a system. As a result, they can figure out how best to design a new system and its requirements or how to improve an existing system.

Here, society members, admin office and software/hardware components (sensors) are the entities in the context diagram which are interacting with the smart water management system. In this diagram, each entity interacts with the system regarding the updating, deleting and maintaining the data in the system.

Data Flow Diagram

Level 0 DFD

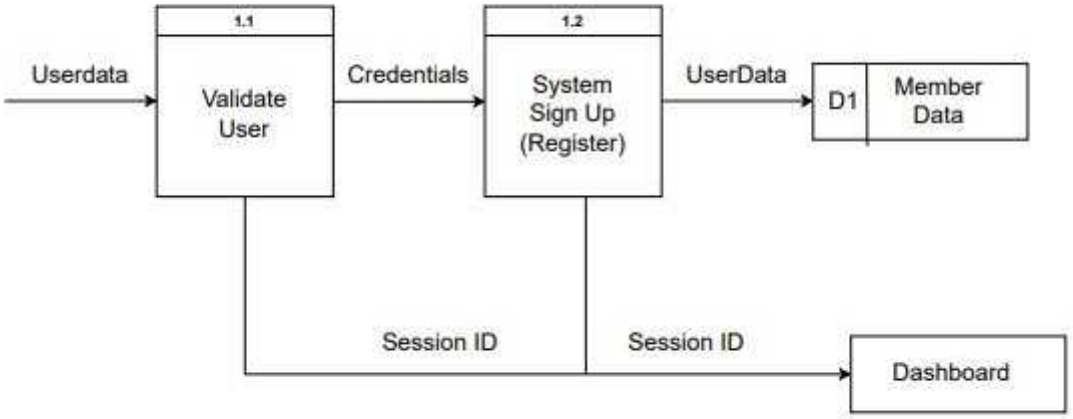


A data flow diagram (DFD) is a graphical or visual representation using a standardized set of symbols and notations to describe a business's operations through data movement. They are often elements of a formal methodology such as Structured Systems Analysis and Design Method.

DFD Level 0 is also called a Context Diagram. It's a basic overview of the whole system or process being analyzed or modeled. It's designed to be an at-a-glance view, showing the system as a single high-level process, with its relationship to external entities.

Here, sign in/sign up, sensor data and create & send alert are the three main processes of the system. User data and Sensor data are the data sets wherein all the data of their respective fields are kept secure. Also, society members, user dashboard, sensors, admin and mechanics are the entities here.

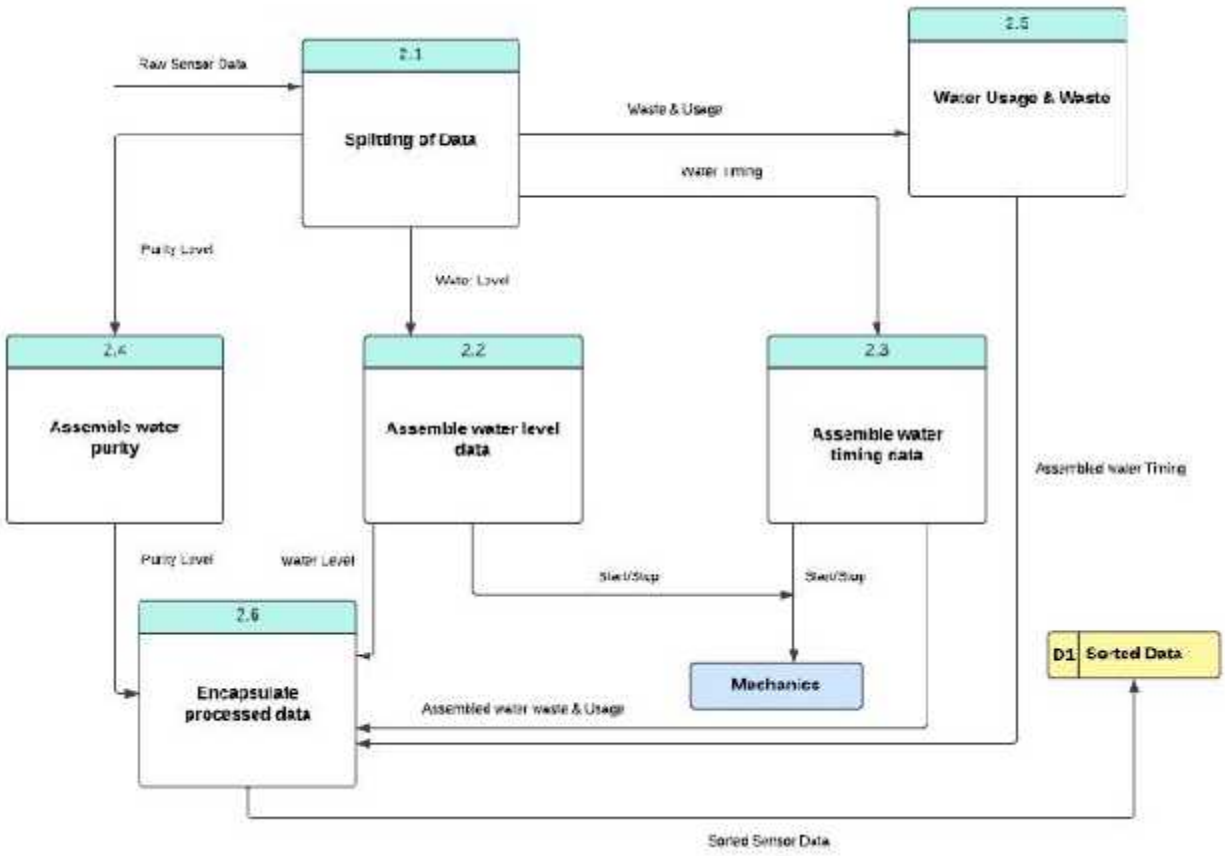
Level 1 DFD (Sign in/Sign up)



Level 1 DFDs are still a general overview, but they go into more detail than a context diagram. In level 1 DFD, the single process node from the context diagram is broken down into sub-processes. As these processes are added, the diagram will need additional data flows and data stores to link them together.

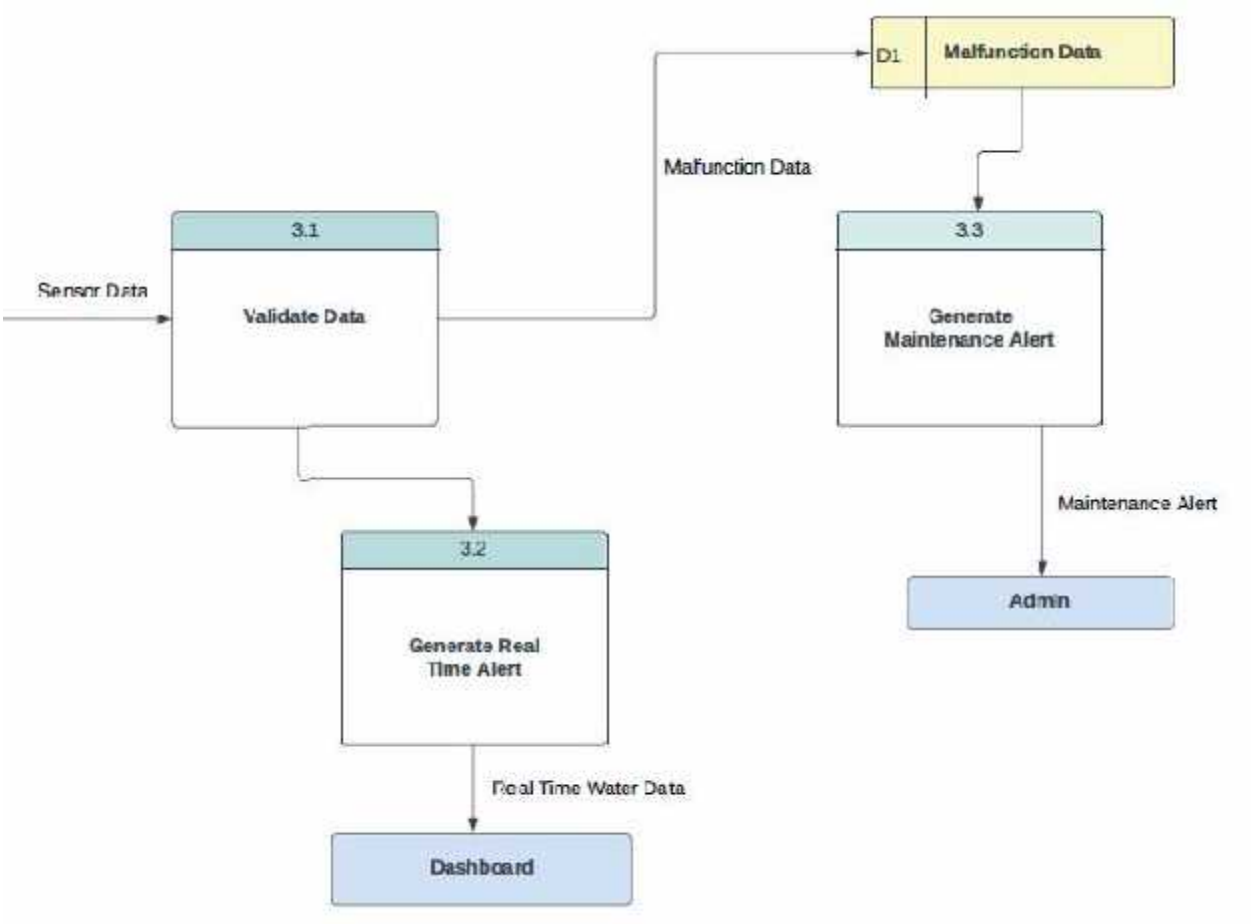
This is the sign up/sign in page for Level 1 DFD. Similarly to level 0 DFD this level 1 DFD also have the same attributes but into more detailed version of each of those.

Level 1 DFD (Sensor Data)



This is similar to Level 1 DFD, here there is a breakdown of sensor data in this diagram. There is only one data member i.e Sorted Data which has all the data of the sensors in the sorted form. Rest all the functions are similar to the previous Level 1 DFD.

Level 1 DFD (Create & Send Alert)

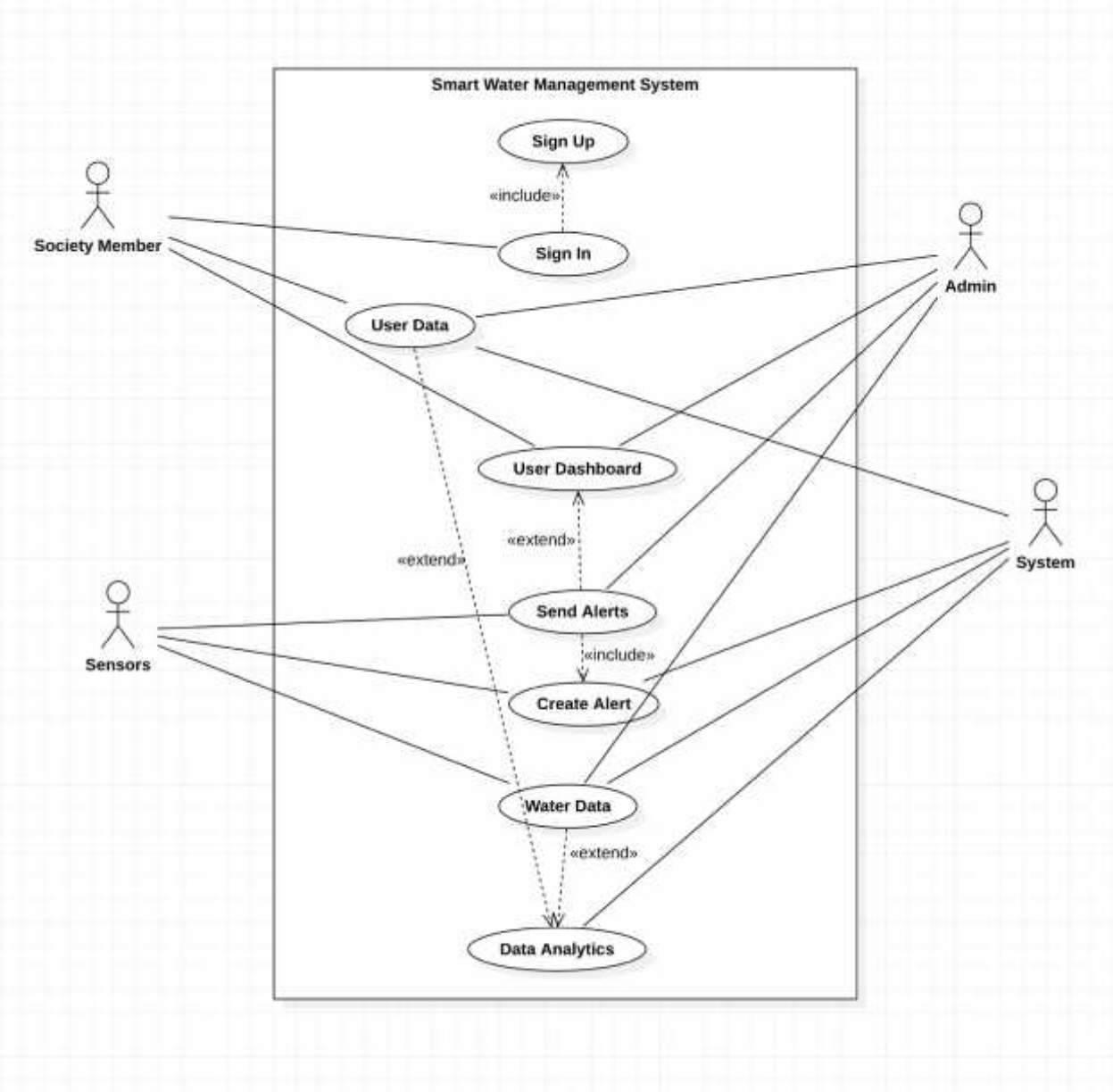


This is the last Level 1 DFD breakdown which is for Create and Send Alerts. Here, there are processes which validates data, generates real time alerts and generates maintenance alert. There are two entities admin and dashboard which interacts with the processes. Also, there is one data set called malfunction data which keeps track of all malfunctioned data in the process.

DATA DICTIONARY	
Source/Sink	Description
Society Members	People living in the housing colony, who will be on boarded on the system.
User Dashboard	All data will be visible to the user related to water.
Sensors	Source of Water data
Mechanics	All machinery (Motors, Relays, etc.)
Admin	The Main office of housing colony and their members.
Processes	Description
Process 1.0	Register for the system or sign into the system.
Process 2.0	Filtration and Splitting of sensor data according to its requirement.
Process 3.0	Creating and sending alerts according to requirements.
Process 1.1	Check If User exits or not
Process 1.2	If User Exists open Login page
Process 1.3	If New User open Registration Page
Process 2.1	Splitting of sensor data once received from sensors
Process 2.2	Assemble Water level data
Process 2.3	Assemble water timing data
Process 2.4	Assemble water purity data
Process 2.5	Assemble Water Usage and wastage data
Process 2.6	Encapsulate Processed data into one single sorted database.
Process 3.1	Check Data Parameters
Process 3.2	Create real-time water data alerts
Process 3.3	Create maintenance alert
Data Stores	Description
User Database	All information of registered users

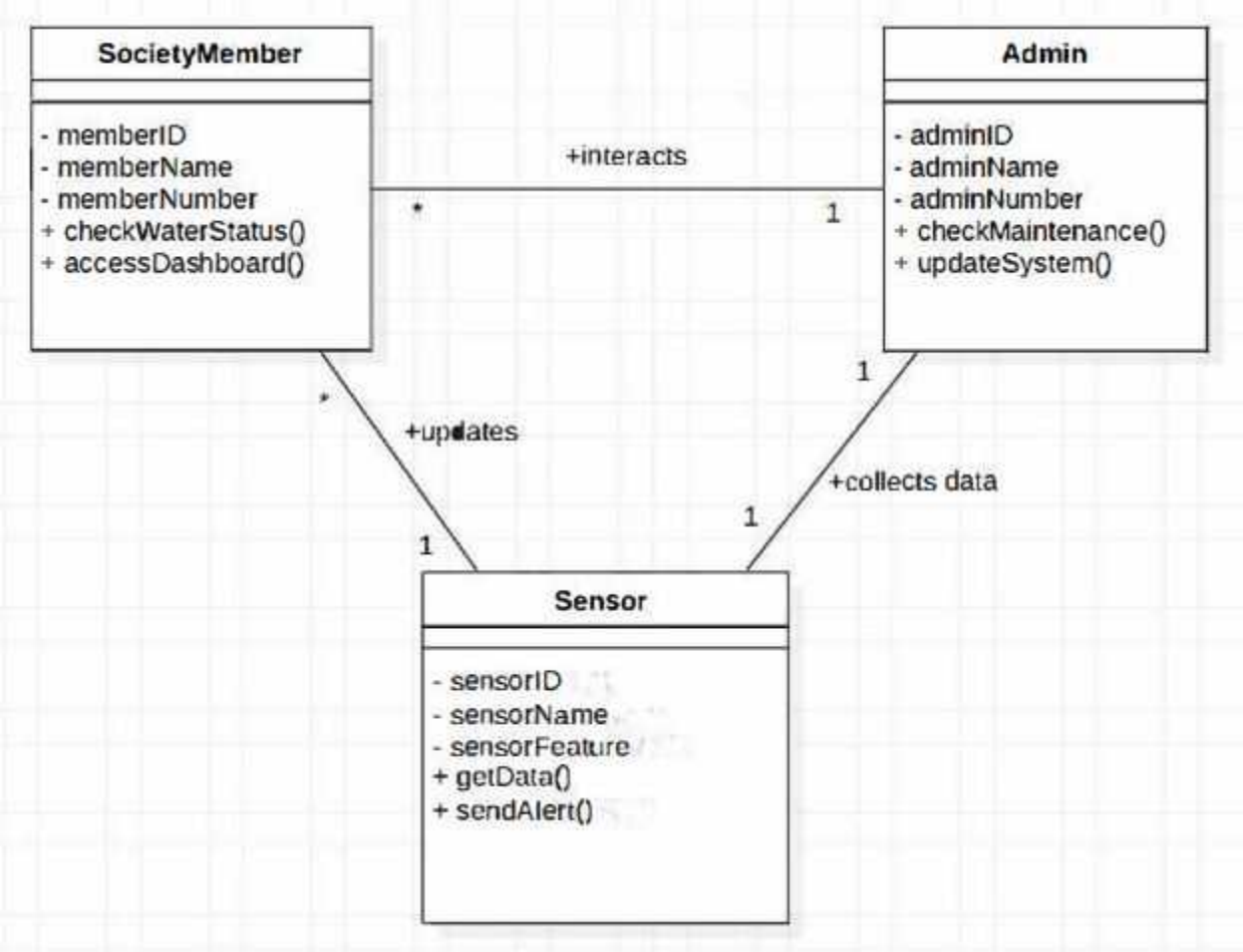
Sensor Database	Data coming from the sensor which is sorted and filtered.
Malfunction Database	All data related to machinery failure or sensor failure.
Data Flows	Description
User Data	The data entered by the user while registering or logging in
Raw Sensor data	Data coming from the sensor which is raw
Maintenance Alert	Alert sent to admin for maintenance.
Real-time water data	Data sent to dashboard for the users.
Stasrt/Stop	Command to start or stop the machinery.
User Credentials	Username and password of the user
Session ID	To display that particular users dashboard
Purity Level	Purity of water
Water Level	Level of water
Wastage and usage	water wastage and usage data
Water timings	Water released timing from the government
Malfunction Data	Data not according to set parameters
Real time water data	Real time data regarding water purity, timings, etc.
Assembled Water Level Data	Assembled data specific to water level
Assembled Water Timing Data	Assembled data specific to water timing
Assembled Water Wastage/Usage Data	Assembled data specific to water usage
Assembled Water Purity Data	Assembled data specific to water purity
Sorted Sensor Data	Data which was sorted according to requirements.

Use Case Diagram



A use case is a methodology used in system analysis to identify, clarify and organize system requirements. The use case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. Here, the members, admin, system and sensor are the actors and they interact with all the properties within the system.

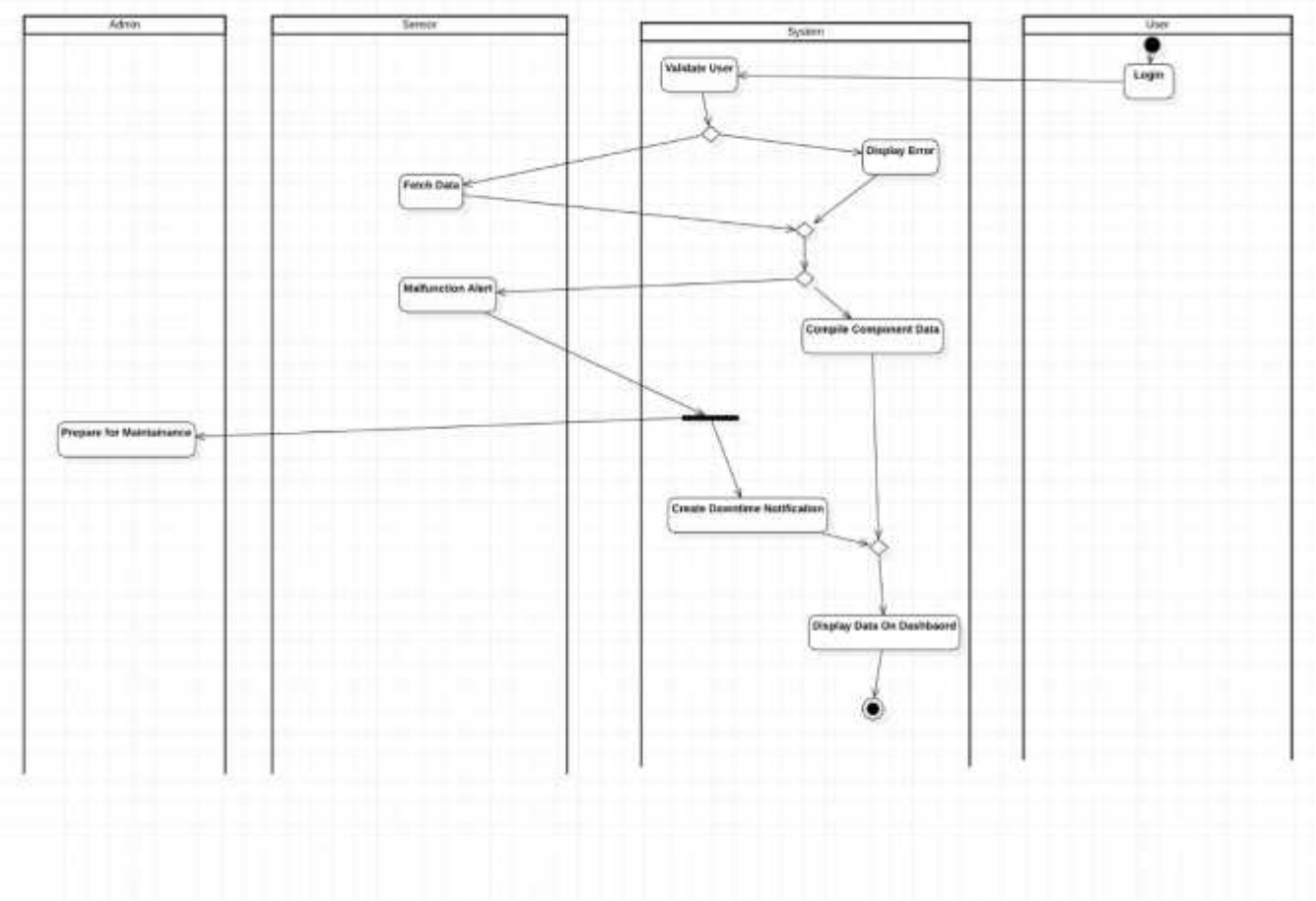
Class Diagram



Class diagrams are the blueprints of your system or subsystem. You can use class diagrams to model the objects that make up the system, to display the relationships between the objects, and to describe what those objects do and the services that they provide. Class diagrams are useful in many stages of system design. Here, society member, admin and sensor are the classes and they have attributes and operations which interact with one another within the class.

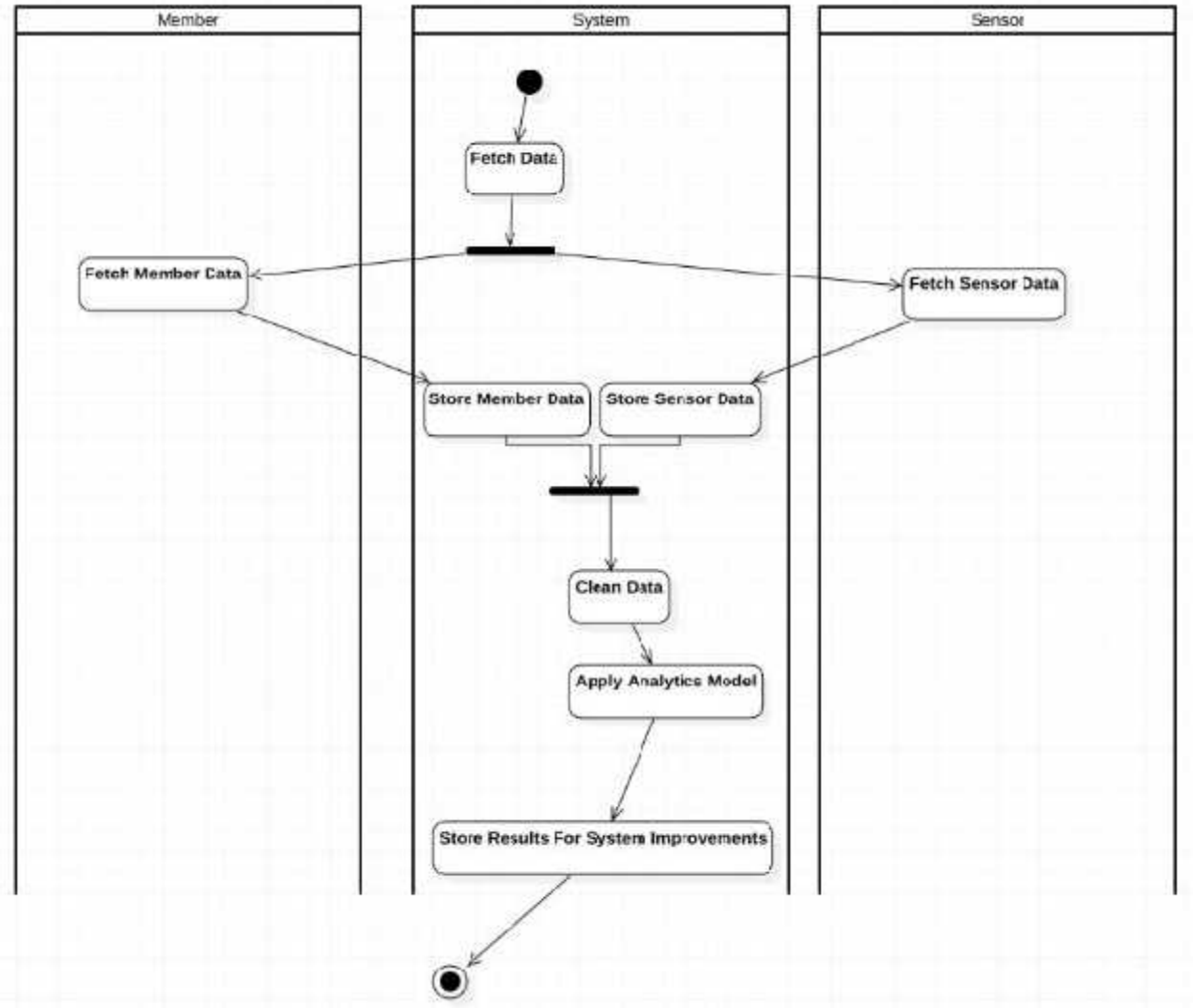
Activity Diagram

Activity Diagram 1



An activity diagram visually presents a series of actions or flow of control in a system similar to a flowchart or a data flow diagram. Activity diagrams are often used in business process modeling. They can also describe the steps in a use case diagram. Activities modeled can be sequential and concurrent. Here, there are four swim lanes including admin, sensor, system and user where the entities of one swim lane interacts with other to complete the flow of the process.

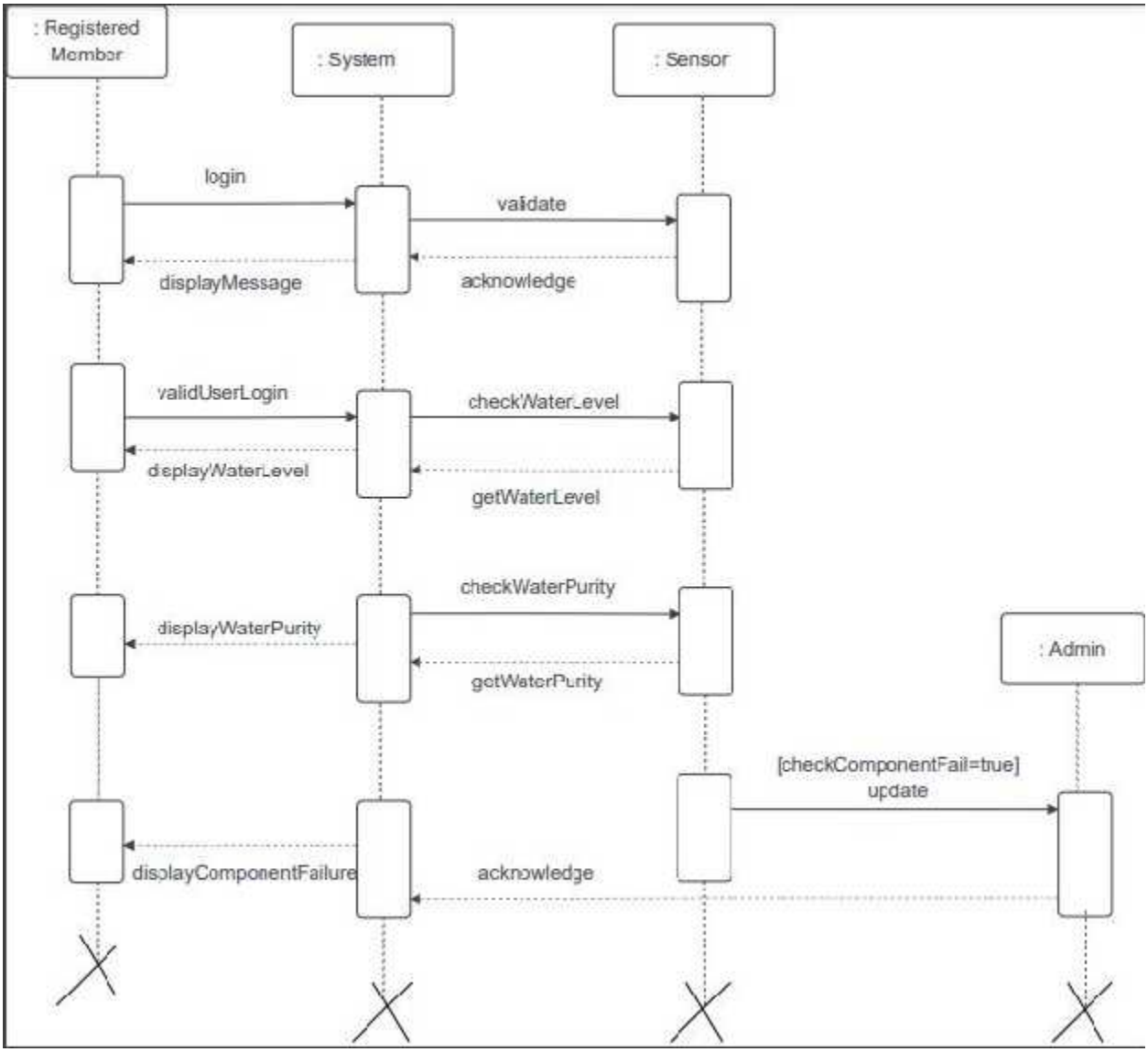
Activity Diagram 2



It is similar to the previous activity diagram. The only difference is, it has three swim lanes named member, system and sensor interacting with one another within the same project. As per our discussion regarding on us focusing on the core use cases for our project, we implemented the activity diagram for the data analytics in this case which perfectly aligns with our use case.

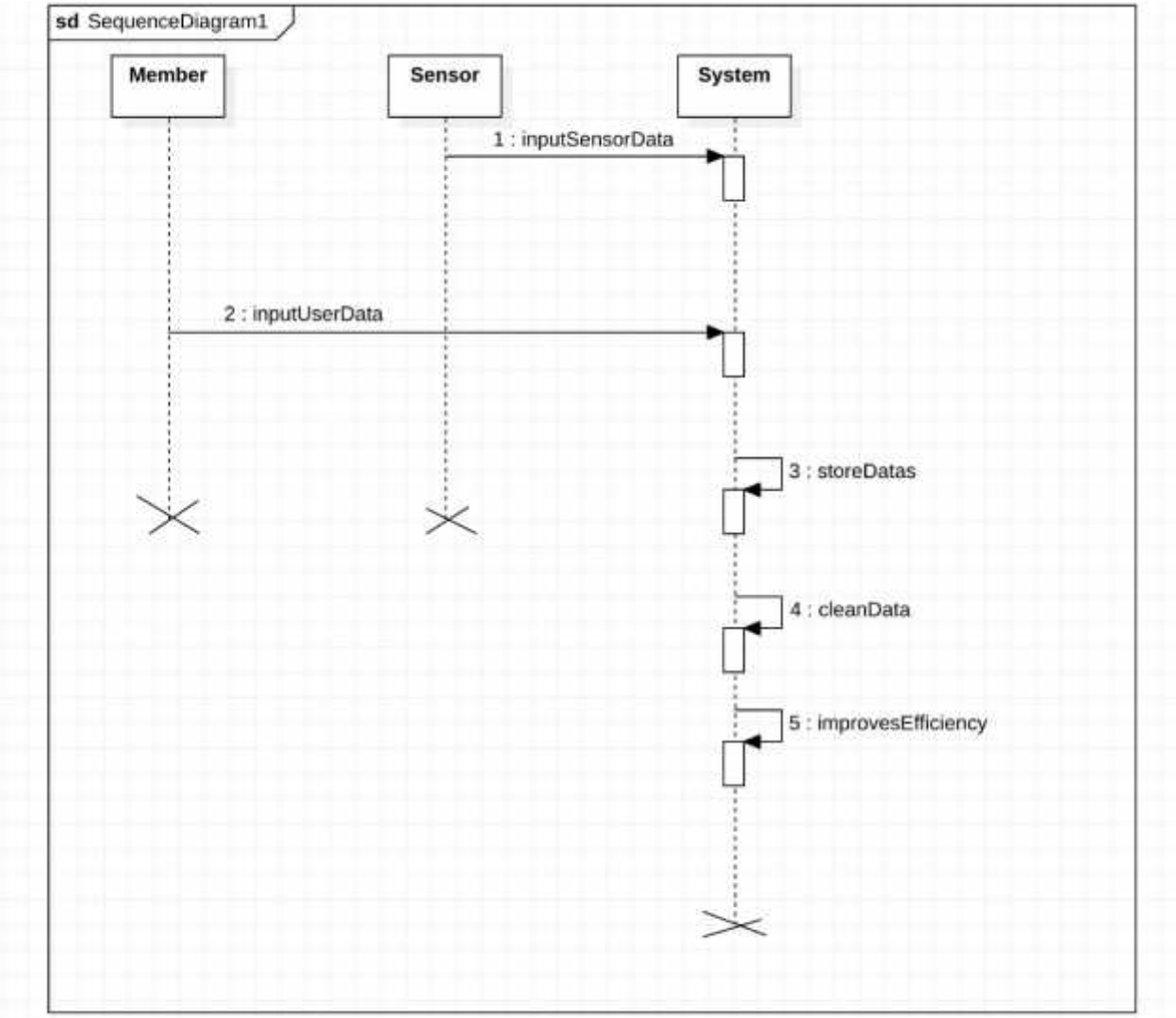
Sequence Diagram

Sequence Diagram 1



A sequence diagram consists of a group of objects that are represented by lifelines, and the messages that they exchange over time during the interaction. A sequence diagram shows the sequence of messages passed between objects. Sequence diagrams can also show the control structures between objects.

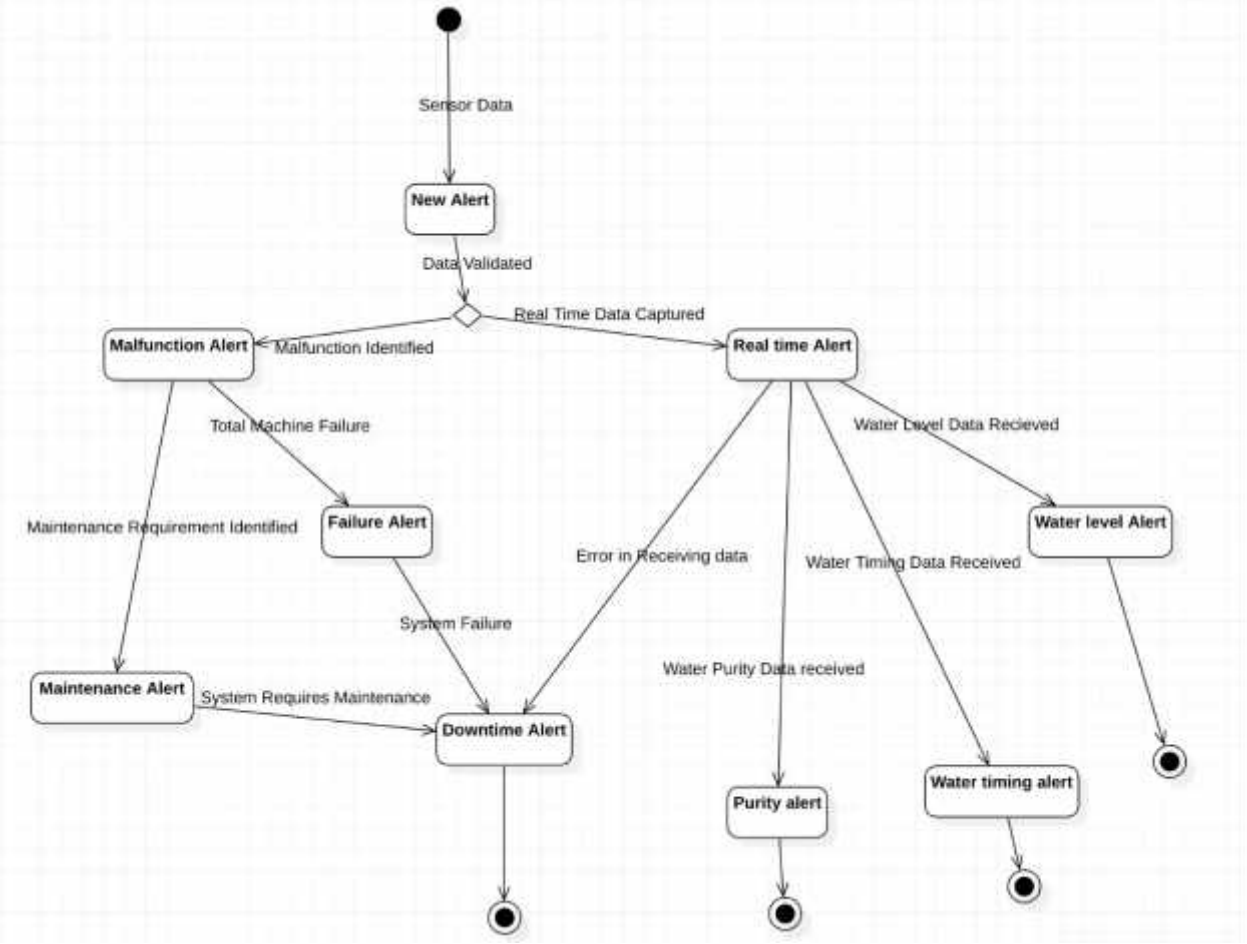
Sequence Diagram 2



Similar to the activity diagram 2 wherein we used data analytics as our core use case and drew the diagram, here for the sequence diagram we followed the same thing. Just to be specific regarding our core use cases and concepts we followed the same process.

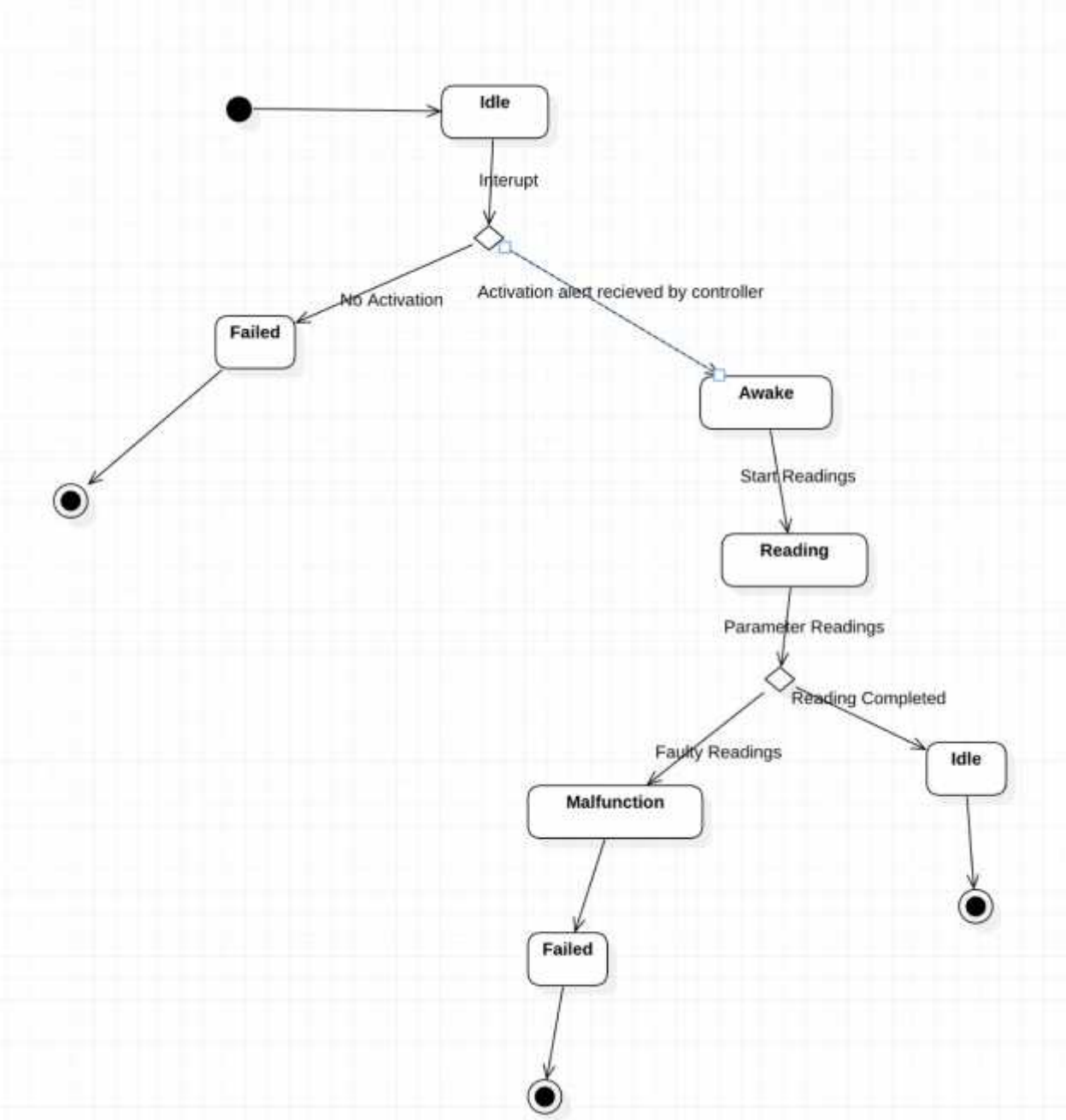
State Diagram

State Chart -1



A state diagram, also known as a state machine diagram or state chart diagram, is an illustration of the states an object can attain as well as the transitions between those states in the Unified Modeling Language or System Analysis and Design. Here, we implemented different states for the alerts in the system.

State Chart – 2



This is the another state chart diagram for the sensors which truly depicts their states after each action being performed.

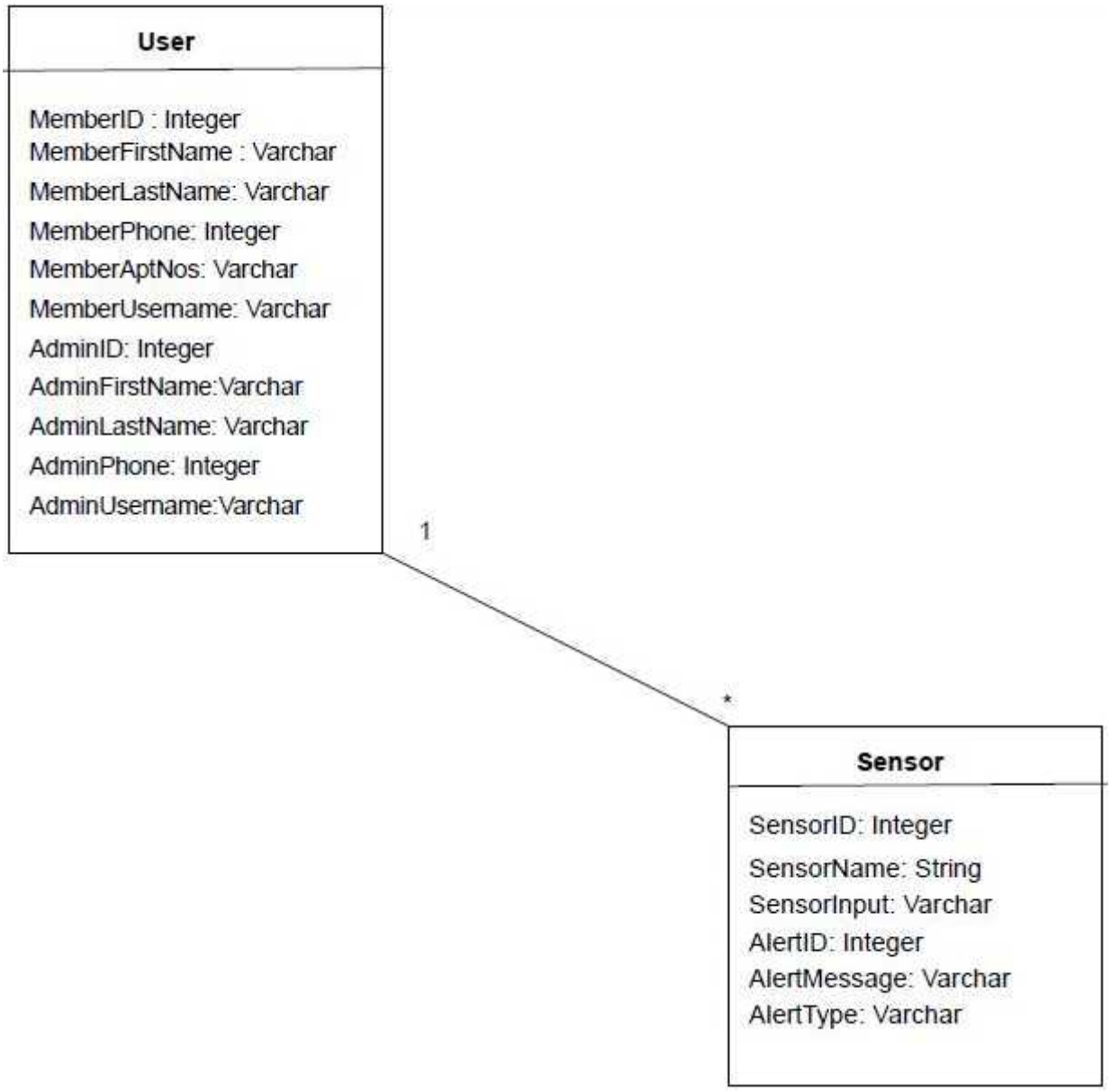
Data Model

Data Model 0-NF

The Data Modeling diagram is used to create or view graphical models of relational database system schemas including a range of database objects. The diagrams can be drawn at a logical or a physical level.

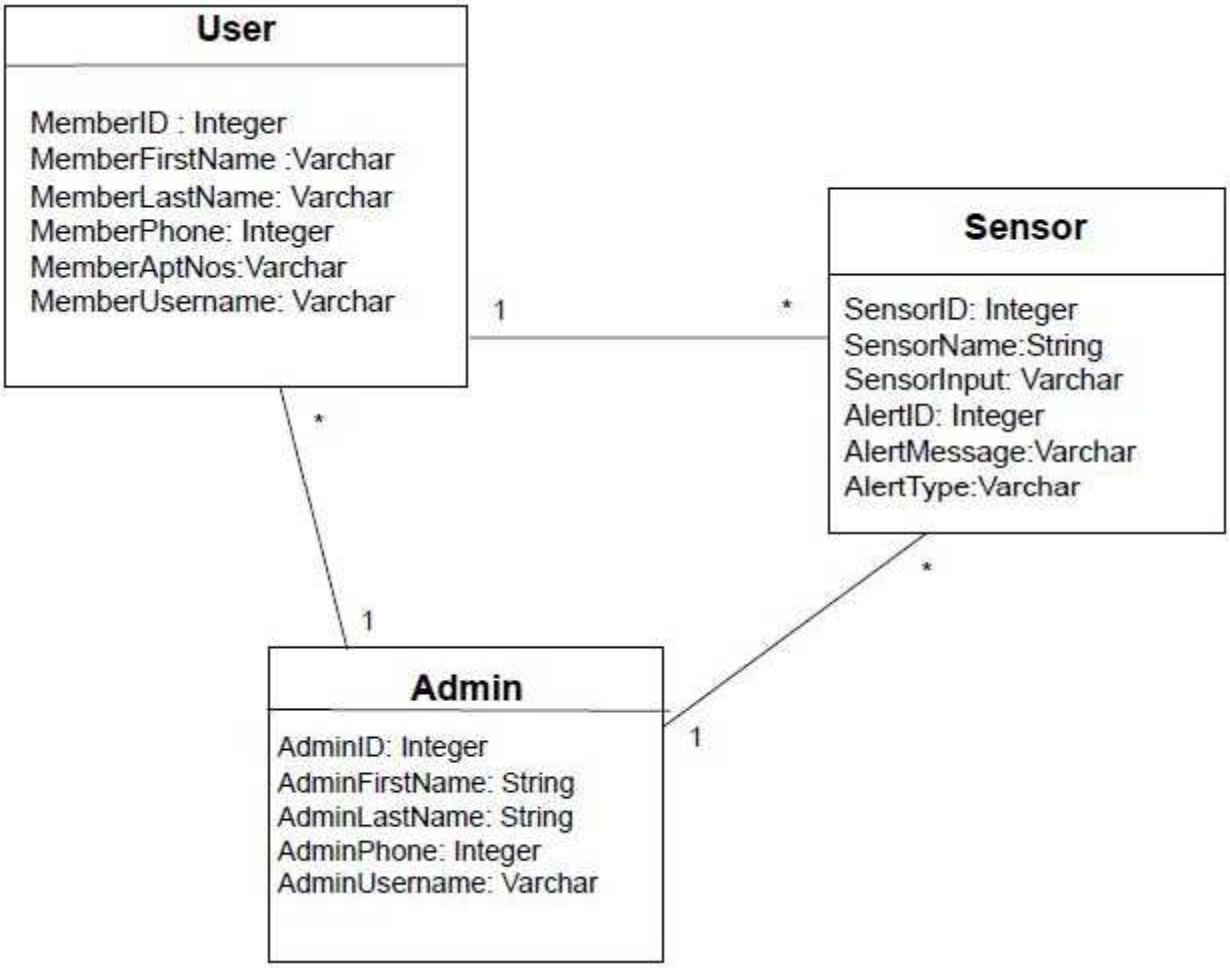
It is the simplest database model also known as non-first normal form or a 0-NF.A 0-NF model will suffer problems like data redundancy thus it lacks the efficiency of database normalization.

Data Model 1-NF



A relation is in first normal form only if the relational table doesn't contain any multivalued attribute but contains only single-valued attributes.

Data Model 2-NF

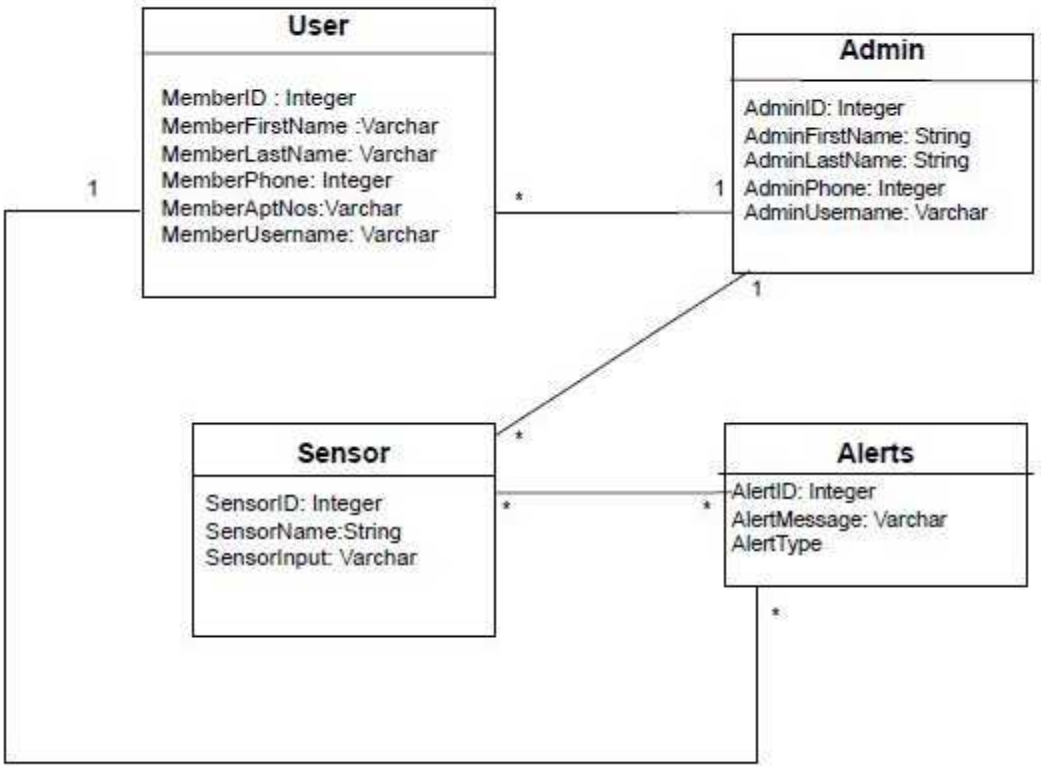


A relation is in second normal form if:

It is in first normal form or 1NF

It doesn't contain any partial dependencies. (It shouldn't have any non-prime attribute which is functionally dependent on any proper subset of the candidate key of the relation.).

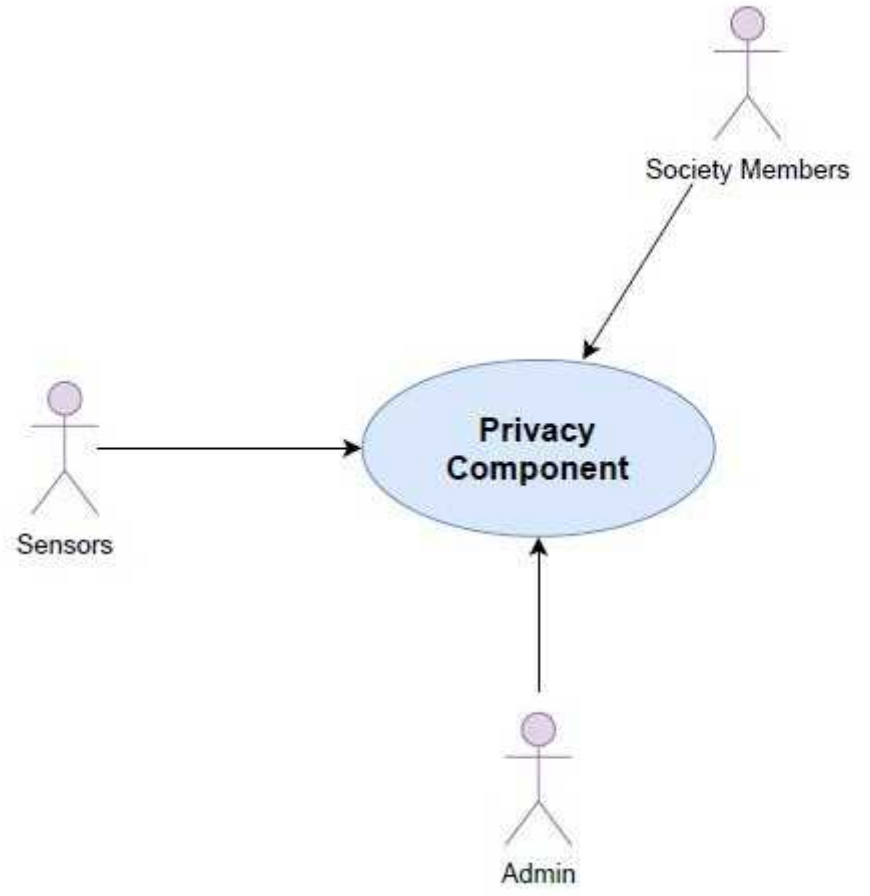
Data Model 3-NF



A relation is in third normal form, if there is no transitive dependency for non-prime attributes as well as it is in second normal form. Basically the relation which is in 2NF already if it doesn't contain any transitive dependencies then it will be in 3NF.

Privacy Component

Privacy Context Diagram

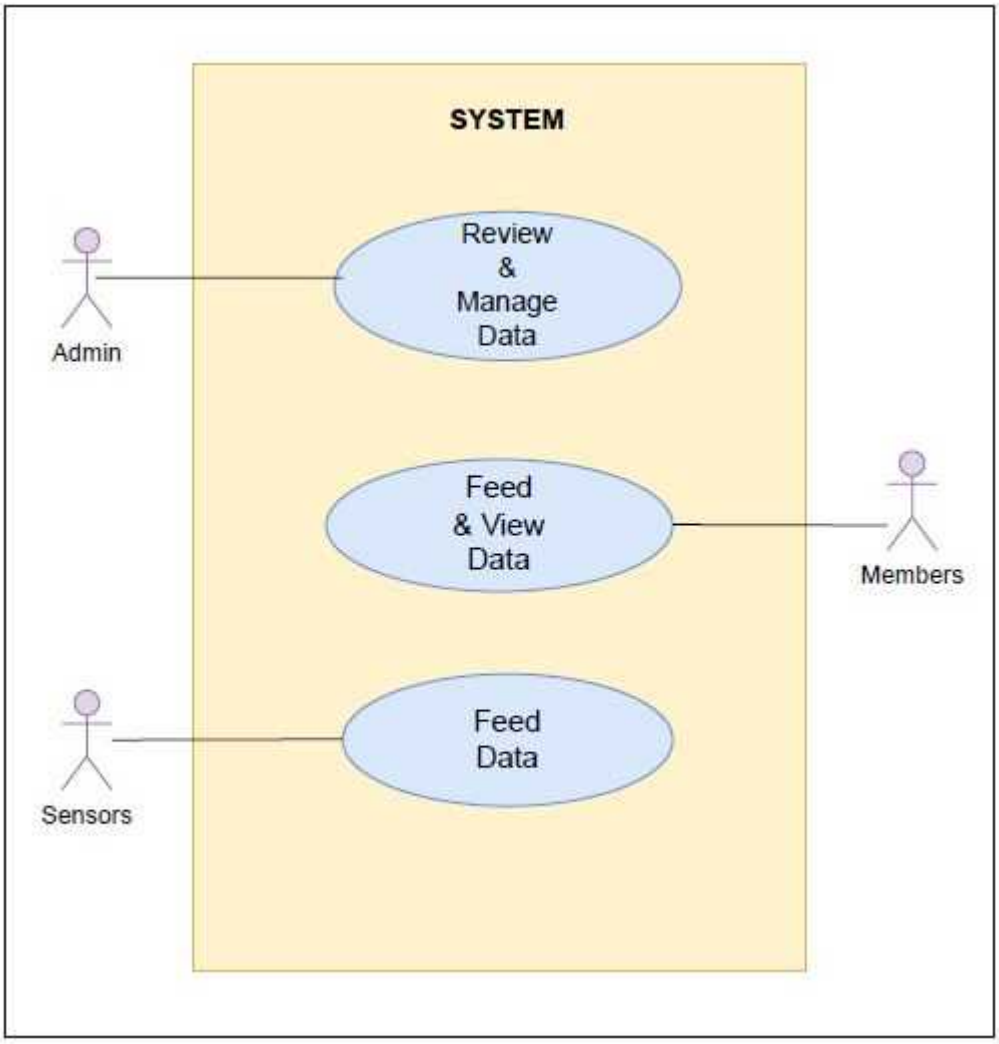


Privacy team members ensure that the privacy rules are entered into the metadata repository according to the privacy policies established.

The embedding system interacts with the privacy component via an application program interface (API).

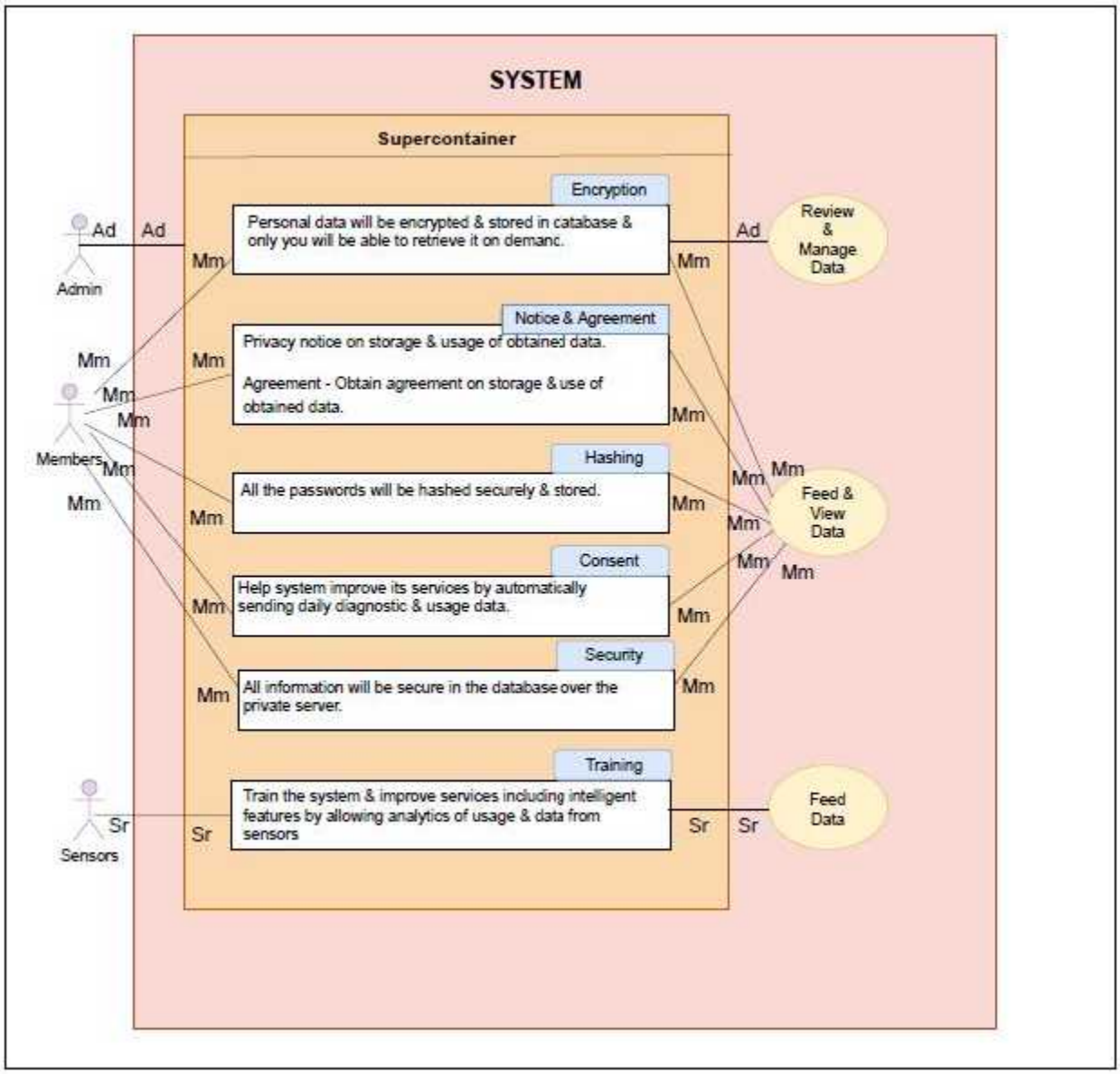
This is the context diagram for the privacy component.

Privacy Use Case -1



The above diagram is the gist of the next detailed privacy component use case diagram.

Privacy Use Case – 2



This diagram depicts the clear idea of how the proper privacy component use case looks like.

Wireframes

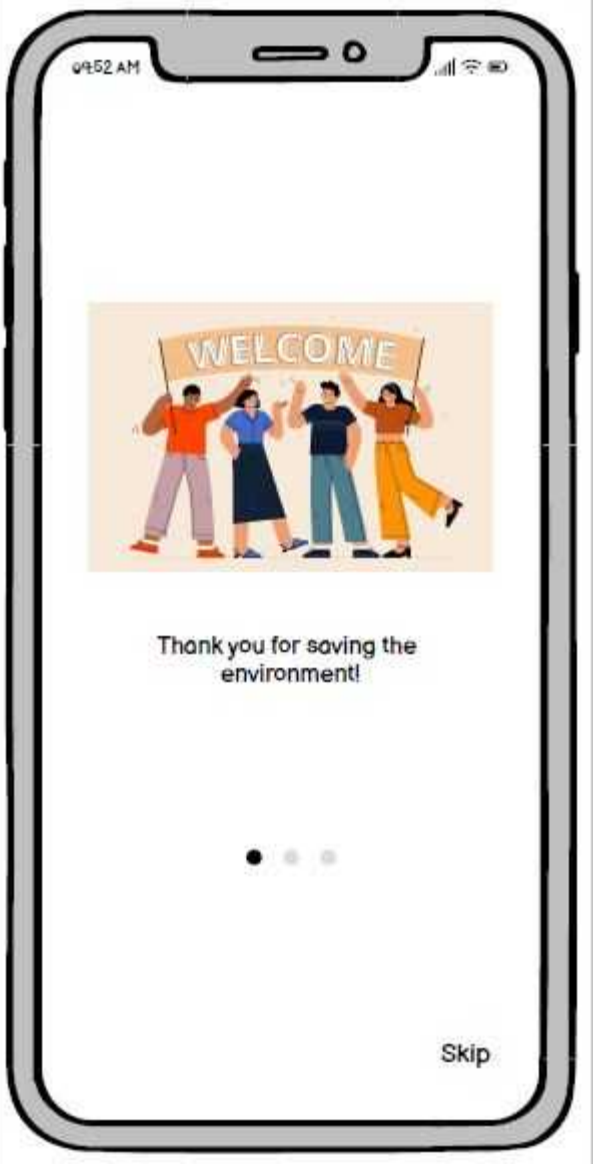
A website wireframe, also known as a page schematic or screen blueprint, is a visual guide that represents the skeletal framework of a website.

Balsamiq Wireframes is the industry standard low-fidelity wire framing software. It makes work fun.

Balsamiq Wireframes is a user interface design tool for creating wireframes (sometimes called mockups or low-fidelity prototypes). You can use it to generate digital sketches of your idea or concept for an application or website, to facilitate discussion and understanding before any code is written.

Balsamiq Wireframes is a rapid low-fidelity UI wire framing tool that reproduces the experience of sketching on a notepad or whiteboard, but using a computer. It really forces you to focus on structure and content, avoiding lengthy discussions about colors and details that should come later in the process.


09:52 AM
Water Management System


09:52 AM
WELCOME
Thank you for saving the environment!
Skip

3 / 11

09:52 AM

Explore the stats of water you use!

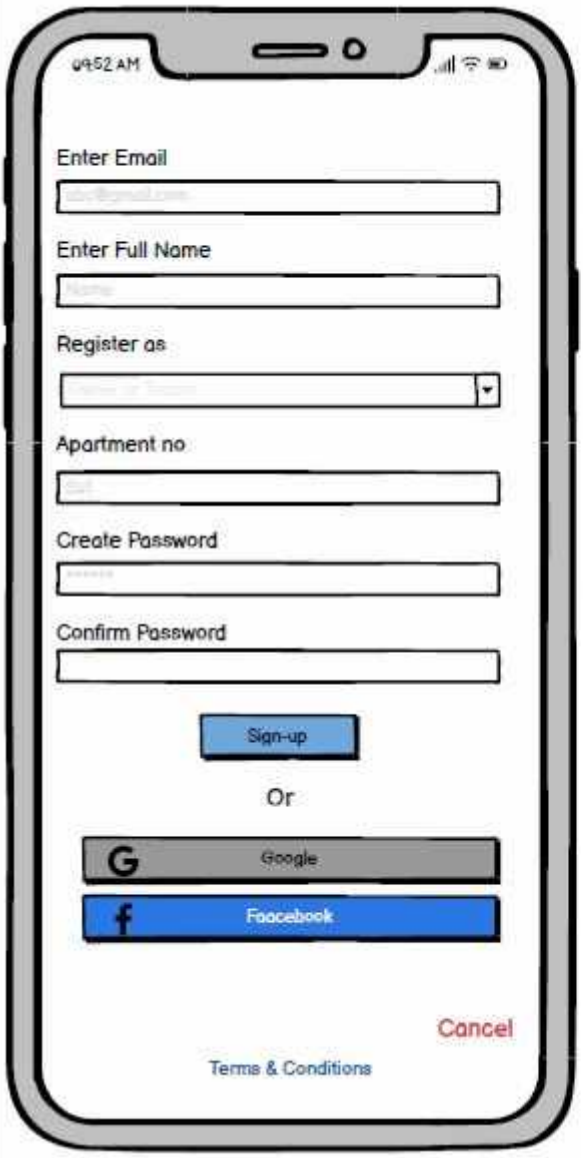
Skip

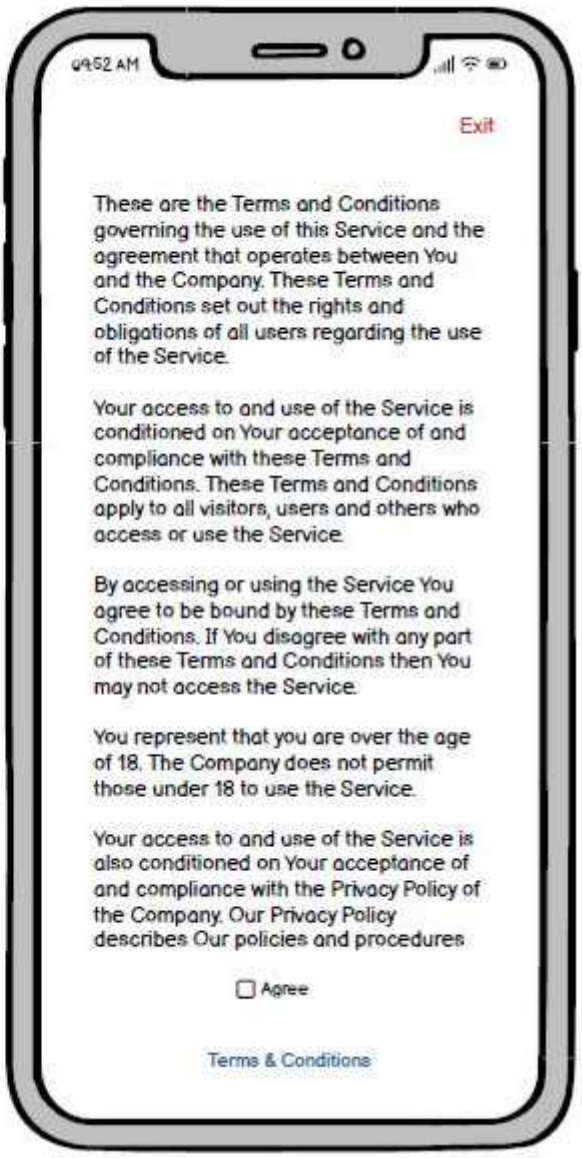
4 / 11

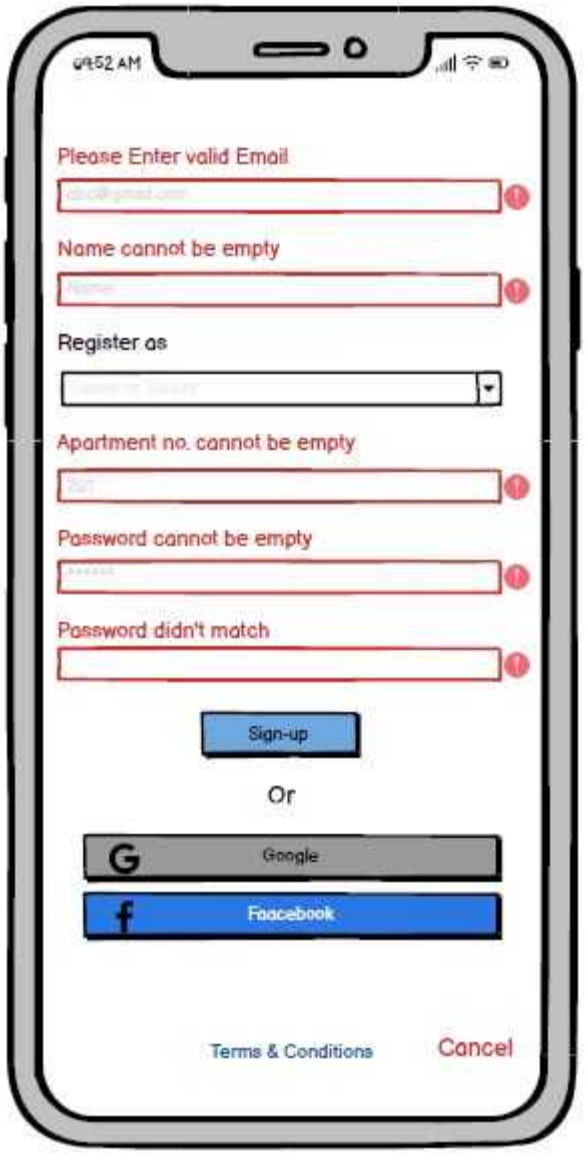
09:52 AM

If there is magic on this planet, it is contained in water.

Skip


9:52 AM
Enter Email
Enter Full Name
Register as
Apartment no
Create Password
Confirm Password
Sign-up
Or
Google
Facebook
Cancel
Terms & Conditions


9:52 AM
Exit
These are the Terms and Conditions governing the use of this Service and the agreement that operates between You and the Company. These Terms and Conditions set out the rights and obligations of all users regarding the use of the Service.
Your access to and use of the Service is conditioned on Your acceptance of and compliance with these Terms and Conditions. These Terms and Conditions apply to all visitors, users and others who access or use the Service.
By accessing or using the Service You agree to be bound by these Terms and Conditions. If You disagree with any part of these Terms and Conditions then You may not access the Service.
You represent that you are over the age of 18. The Company does not permit those under 18 to use the Service.
Your access to and use of the Service is also conditioned on Your acceptance of and compliance with the Privacy Policy of the Company. Our Privacy Policy describes Our policies and procedures
Agree
Terms & Conditions


09:52 AM
Please Enter valid Email
Name cannot be empty
Register as
Apartment no. cannot be empty
Password cannot be empty
Password didn't match
Sign-up
Or
Google
Facebook
Terms & Conditions
Cancel


09:52 AM
User Name
Password
Forgot Password ?
Remember Me
Login
Terms & Conditions


09:52 AM
Invalid User Name
Incorrect Password
Forgot Password ?
Remember Me
Login
Terms & Conditions


09:52 AM
Dashboard
Manav, Apt 204
54.5%
Underground Tank
40%
Overhead Tank
80%
Water Purity
200 L
Water Supplied
Supply Time : 9:00 to 9:30 Am
Wastage : 10 L
Usage : 34 L


09:52 AM
Dashboard
Manav, Apt 204
54.5%
Underground Tank
40%
Overhead Tank
Alert
Are you sure, you want to logout?
No
Yes
Purity
Supply Time : 9:00 to 9:30 Am
Wastage : 10 L
Usage : 34 L

Technical Recommendations

Hardware Requirements

- Processor: 1.4GHz 64-bit quad-core ARMv8 CPU
- Raspberry Pi 3 Model B+
- RAM: 1 GB RAM
- Hardware Platform: Linux
- Hard Disk: 16 GB (Class 10)
- Ultrasonic Sensors (SL-HC 5V)
- Turbidity Sensor
- Submersible Water Motors
- 4-channel Relay Module

Software Requirements

- Operating System: Raspbian Stretch Lite
- Front End: HTML, CSS
- Back End: Python, Sqlite3

Feedback Table

Date	Assignment no	Feedback from Instructor	Response
September 27	1	Good work. I have deducted 2 points because you will still have to edit the entire report based on the feedback you will receive for other assignments. Keep up the good work. Good work. Consider the feedback provided in the case submission as you revise these. For the final report, please modify the Gantt chart as per the activities that you understand for each phase. For instance, DFD, use cases, requirement gathering, etc.	We worked on the Gantt Chart and updated it on the very next day of the feedback which included everything which was mentioned in the feedback and again confirmed it with the professor.
October 18	2	The chart you showed indicates/makes a case for implementing the proposed systems. How did you collect the requirements? Good job on the policy for user data. How long will the data be stored? Where are you storing the information? If it is on the cloud, then look into their policies that might Good job on processes at level 0. Do you see a process	We eliminated the survey result from the slides and report, as we had two options after talking to the professor either delete it or give dummy data to it. Though we gave a clear idea about it to the professor and worked on DFDs to make it more core use case oriented, we also worked on user registration and user validation as suggested by professor.

		or need for generating any kind of reports? Level 1 dfd is steps rather than processes. I would say simply "user registration" and "user validation."	
November 15	3	Your simple class diagram is appreciated, but I doubt it represents your system. You are dealing with alerts. I would have imagined alert as one of the main objects. Another one could have been sensor, since I think you will have multiple sensors. I am not sure what your system has to do with society members' data. Again the activity diagrams do not represent the core functionalities of the proposed system. Same is true for the sequence diagram. I would have assumed to present the process that was the motivation to design the project in the first place. Although state model representation is correct but again this is not how a user is validated. Your system is also not about user registration. Now that you have modeled state chart for sensors,	Overall for this feedback we understood that we were lagging the core processes though we had clear knowledge about the diagrams and its rules. We brainstormed every diagram from then on, and re-designed each model for the project to be more goal-oriented.

		you do not have object for that. Anyway, ensure the attribute whose state you are modeling are present in the corresponding object in the class diagram.	
December 6	4	No feedback was given.	Everything was executed well.

Extra Relevant Information/Suggestion

We are looking forward to work on the future scope for this project.

- The features to be integrated in future can be a water detection sensor, which is capable of detecting the water i.e. hard water or sweet water and accordingly segregating it.
- There will be a login page developed in the website so only the authorized user can have access to it and security can be assured.
- There will be a LED screen provided in the cabin of the security guard that will show the status of the current water level in the tank.
- We will have a complete analysis of the water that have been used in every months and can accordingly tell the user to use the water efficiently and thus can save water.
- Further the scope of this system is not only meant for the betterment of the societies, it can also be implemented on several other agricultural projects and help in the ease of work for people.