DCS
Power To Design The Desired
Summer Internship

INTRODUCING A LOW COST AND EFFICIENT,

SMART
WATER MANAGEMENT SYSTEM

Project Proposal

The Report

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Acknowledgement

Presentation, inspiration and motivation have always played a key role in the success of any venture.

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Abstract

Water is one of earth's most precious resources and is an integral part of he survival of life on the planet. Research shows that there are only very scarce quantities of potable water available and this results in great pressure on the resource and thus necessitates the need to protect and manage it properly. An increase in the competition of global land and water resources can be expected in the coming decades with much of the world's population currently experiencing water stress.

As technology improves, more solutions are being developed to meet such challenges. The use of technology in water management has taken many forms from the early days of “smart water usage metering" and more recently the use of “smart pipes" and entire metropolitan water management systems.

This report presents the design and development of a low-cost, water sensing, reporting, analytic and visualisation system for collecting various water data and presenting it in a form that allows for the administrators of the system to make more informed water management decisions. The primary system functional requirements include the ability to sense critical water data and securely upload this data to a cloud storage system and then subsequently present the stored water data visually.

Research conducted in this report shows the capabilities of the technologies as solutions for some of the challenges that are faced in the area of water management. The research reviews existing technologies and water management systems implemented by previous researchers and enterprise solutions so as to outline the benefits and challenges involved with such systems. Based on this research, a proposed water management system design was motivated so as to meet the shortfalls of the existing systems, within the project requirements.

The Smart Water System is implemented and the results from the water sensors and the insights drawn are shown throughout the report. The results show how the defined system requirements and specifications were met and the testing shows the performance and capability of the system to handle massive amounts of data.

The system designed met the proposed objectives and thus the conclusion was made that the overall project was a success.

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Chapter 1

THE PROBLEM STATEMENT

INTRODUCTION TO THE PROBLEM STATEMENT

As we all know that water distinguishes our planet from other planets. And we still waste so much water everyday. The average family can waste around 180 gallons per week, or 9,400 gallons of water annually, from household leaks. That's equivalent to the amount of water needed to wash more than 300 loads of laundry. Many people become ill because they do not use safe water for daily purposes. As a result they get fungal diseases due to dirty water. Household leaks can waste approximately nearly 900 billion gallons of water annually nationwide. That's equal to the annual household water use of nearly 11 million homes.

Water leakage is identified as one of the major contributors to the water scarcity that every country is facing. Leaking occurs due to old and corroded pipes, pipes getting damaged due to road excavations, bursting of pipes due to high pressures, etc. It is difficult to detect leakages as many times these pipes are underground. There is so much waste through such leakages that goes undetected.

Developed countries like the USA, UK, Europe, Singapore, etc. ensure that every household is accountable for every drop of water they use by charging the households. India being the second largest populated country in the world doesn't seem to be worried and is not wanting to take any precautionary steps for saving water in the households.

Conserving and saving water is a behavioral change that we all need to adopt. It is an essential change that we need to adopt sooner than to be sorry later.

OBJECTIVES OF SMART WATER MANAGEMENT

The primary objective of smart water management is reasonable and sustainable usage and recycling of water resources. Growing population, increasing environmental issues and pressure on the food and agriculture sector make water even a more precious asset

In this respect, water management technologies and activities pursue the following objectives:

1. Reduce wasting water used in high volumes in such areas as manufacturing, agriculture, power production. It implies the introduction of high-tech practices like precision farming, smart irrigation, and real-time water metering.

2. Improve water quality and prevent contamination by chemical waste and natural pollution such as acidification. In order to improve and maintain the quality of water, companies use sensor technology for real-time monitoring and control.
3. Enhance the efficiency of water systems such as water collectors, treatment plants, distribution mains, and wastewater recycling centers. Using IoT and data solutions for asset management, companies can keep important measurements such as water pressure, temperature, flow, etc. in sight, practice predictive maintenance, and avoid breakage and downtime.
4. Implement leakage control by using smart water management devices equipped with leak and moisture sensors. Considering that almost $3 billion are spent on fixing the damage caused by leakage yearly, leakage control is essential to keep water resources and budgets safe.
5. Practice consumption monitoring to optimize and keep under control the usage of water resources at different levels — in a household, industry, the country, or the whole planet.

MEASURING WATER LEVEL WITHIN THE TANKS

The major problem faced at every home is that people don't have an idea of how much water is left in a tank or when they need to refill the tank. So, we have put two sensors for this work to get precise data and send the data of water level in the tank to the user on the app developed by us. We use two Flow Sensors and an Ultrasonic Sensor for this work, both sensors send the data on our cloud server and after analysis of that data, the user will get the accurate information about the tank level. Water flow sensors are installed at the water source on pipes to measure the rate of flow of water and calculate the amount of water flowed through the pipe. And on the basis of that calculation, we decide the different water level of a tank. Also, the ultrasonic sensor will be installed inside the tank and we convert the distance of water from the sensor and decide the different water levels of a tank. In the last, the most precise data will be sent to you through the app.

READING WATER CONTAMINANTS

The water coming to our homes from various sources can not be declared safe and rid of all impurity. That's the reason we decided to check the water coming from the source if it's safe and pure then and there only before entering the building.We have put two sensors- a pH sensor and a turbidity sensor to check the pH and impurity of water respectively. We know that more acidic or basic water is harmful for us as well as for our clothes. The pH sensor solves this problem.

It generates a pulse and then converts it into volt and then converts it into pH value. It uses a pH meter for calculating the pH value. On the other hand, the turbidity sensor is used to detect the impurities in the water. The turbidity sensor will inform us that water is suitable for the use or not if it is not suitable then it gives an alert on the app. This data will be a deciding factor on whether the tank should be filled with that water or not. If the water is safe then only the water from that particular source will be filled. Also, this data will be displayed on the app so that the user can check individually that the water is safe to use or not.

MAKING WATER PUMPS TO RESPOND AUTOMATICALLY

Our team did a lot of research to find a suitable solution for this so that we can make the pump of the water tank smart to make it turn on or off automatically with respect to the water level data. We are using an Ultrasonic Sensor for this work. If the tank is empty then it will trigger the message to the relay and then the water pump will automatically start and after a certain level is reached the pump will automatically get turned off through the relay and also, a physical button is provided in the app to do this in case the sensor is not working. Thus, the user can turn on the pump physically from anywhere in the world just by one touch. Also, the motor state is always visible in the app developed by our team.

DETECTING WATER LEAKAGE

Due to leakage a lot of water is wasted and even if somehow the leakage is found, the time wasted in finding the leakage is very much and a lot of water goes to waste like this. Our team came up with a solution to this problem and our system can notify the user of the leakage if it occurs in the water pipe or water tank. We are using Flow Sensor for this work. Flow sensor calculates the amount of water that is flowing through the pipe so if the leakage occurs some amount of water will flow constantly even no one is using the water it will send the data to the server and after the analysis of that data, we will notify you that somewhere in your home there is a leakage problem and also if it's in the water tank or the pipes. By this, we will be able to save a lot of water and simultaneously we will be able to make the system more convenient for the user.

Chapter 1

HANDLING WATER WASTAGE

We use about 27% of water for bathing and toilet use. Approximately, a leaking faucet can waste 4,000 drops of water, which is equal to a litre of water. A flush of the toilet uses six and a half gallons of water. On an average one person wastes about 0-45 litres water per day. To understand it better, it is 30% of water requirement per person per day. 125 million litres of water wasted daily.

We did some research on this problem andt thought that we can use Infrared Sensor in busy taps like in the kitchen sink and washroom sink. This doesn't cost too much so the user also has an option for this. We are also handling the leakage problem by the Flow Sensor as we have discussed above.

REAL-TIME TEMPERATURE MONITORING

After doing a bit of research on temperature sensors we thought of using it to determine the temperature of the water to get the information if the water is pleasant for bathing and other use or not. By analysing the temperature data for several days, our mobile app will display that at what time the water will be pleasant for bathing and other activities. It is a low-cost sensor so it fits into the budget perfectly. We care about the people and we want them to use water when it's pleasant and by our predictive analysis and machine learning we were able to achieve this.

READING WATER CONSUMPTION ON A DAILY BASIS

Nowadays people are facing unnecessary bills and they don't even know if the water bill calculated is correct or not, we have tried to resolve this issue by using a Content management system (CMS) . It will help us to understand our bills, and to understand how we are consuming water. We can determine how much water people typically consume over a period of time by keeping a simple log. The content management system is an application that is used to manage web content, allowing multiple contributors to create, edit, and publish. Content in a CMS is typically stored in a database and displayed in a presentation layer based on a set of templates. By reading water consumption on a daily basis helps to prevent water loss.

STORING DATA FOR FURTHER ANALYSIS

We are storing our data on any of the two cloud servers named as IBM Watson Cloud or ThingSpeak platform for our analysis of data and storing it. As these two are the best cloud servers from our point of view as IBM Watson Cloud provides 100 MB/months which will be enough for us to store the data and ThingSpeak provides 4 channel support which will also be enough for receiving data and storing it. We use CMS for a more interesting way of data displaying. IBM Watson can do 5000 predictions per month in the free version of it which will be enough for our project as we are not using so much predictive analysis. We currently use this data but, in the future, we are thinking of making our own cloud server for this purpose only as it will be more secure and efficient for our project work.

ANALYSIS OF DATA

The received data from the sensors of individual houses will be systematically stored and observed for deciding whether to go with a linear or non-linear prediction model. Also, the data will be observed for understanding whether we need to remove insignificant features or there's a need to add some extra features for enhancing the accuracy of the model. Analysis and prediction will be solely based on the past record if there comes a situation where both linear or non-linear models are failing, then we will have to use a classification model and would have to divide predictions

ANALYSIS OF DATA

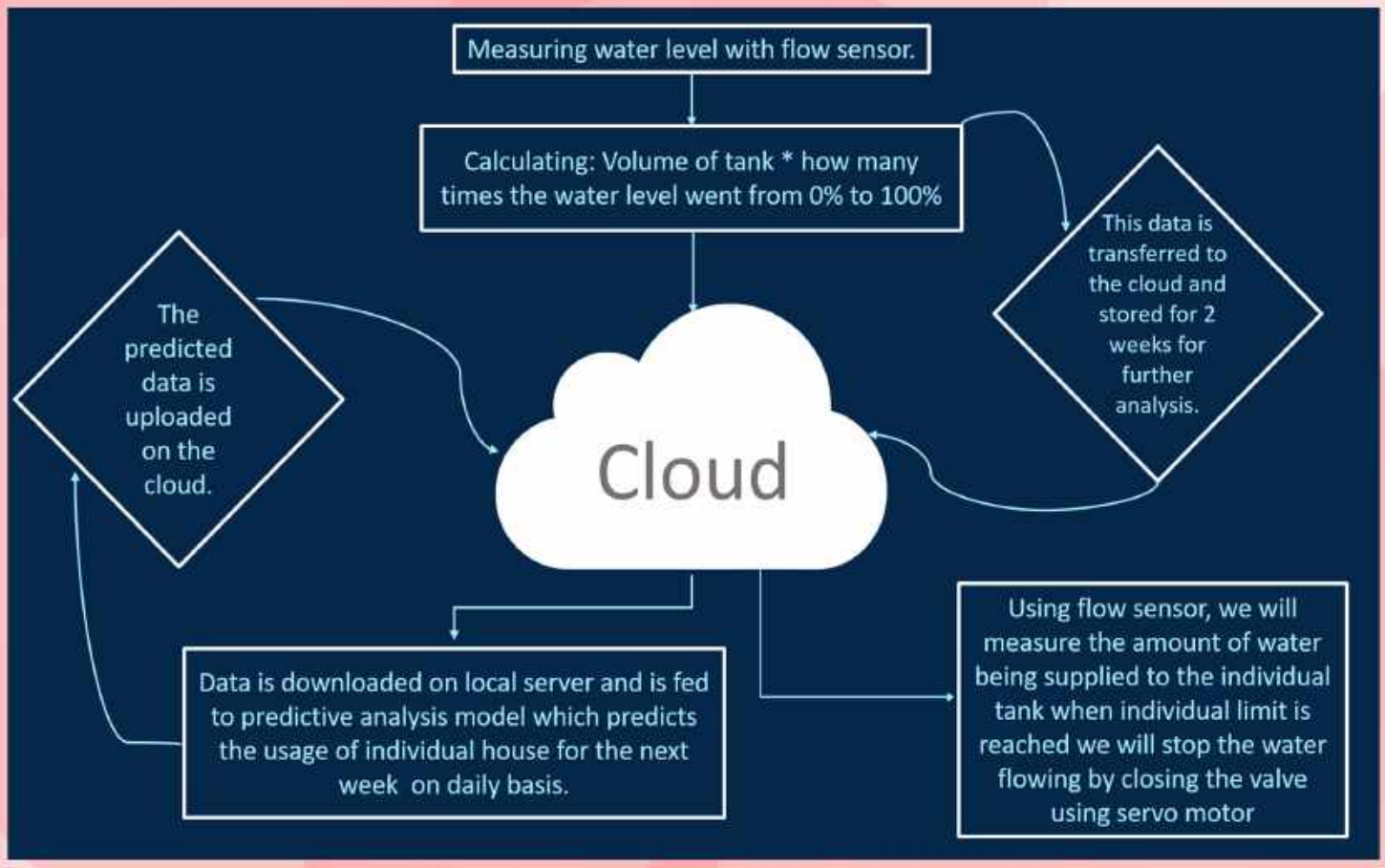

Fig. 2.1 to show the analysis of data in the form of a block diagram.

TRANSMISSION OF DATA

For this, we have done a lot of research about the microcontroller that can be used for effective data transmission and have a long-range and also available in cheap price to make a pocket-friendly budget. So, we finally reach the conclusion that we are using ESP-32 micro-controller. It comes at the price of 168 rupees which is very cheap compared to other microcontrollers. It has a range of 1 km which is enough for us to transfer the data and connect to the gateway. Microcontroller is used to transfer or receive the data between the cloud and sensors. It will work as an intermediate between cloud and sensors. For optimal utilization in the lowest resources for transmitting data from the microcontroller to cloud, we will be making clusters of received data and will transmit data from controller to cloud through a single channel if there will be the need, we can further divide the data transmission up to 4 channels for reducing latency.

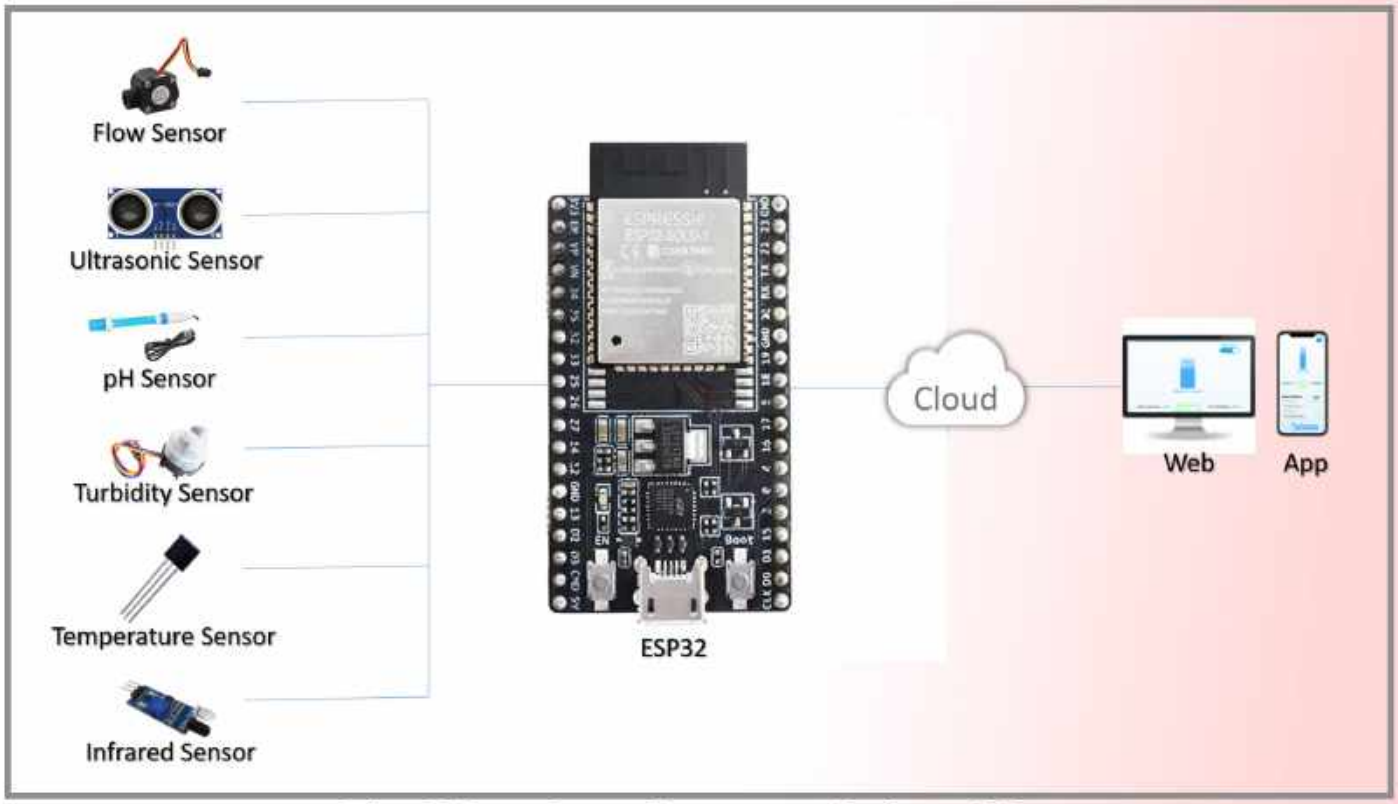

Fig. 2.2 to show the transmission of data.

The MODEL

Our model is for 1 building of the society. As in the given figure, we can see that two flow sensors are being used to calculate the water flow from motor to tank as well as the tank to in house. It will help in keeping records of water supplied and water used in the particular house. We use pH sensor and Turbidity Sensor near the main source of water so that we can give the data to all the buildings of the society. Then we use the ultrasonic sensor in the tank to measure the water level and make the water pump respond automatically. After that, we are using a temperature sensor which will tell you the right time to take a bath.

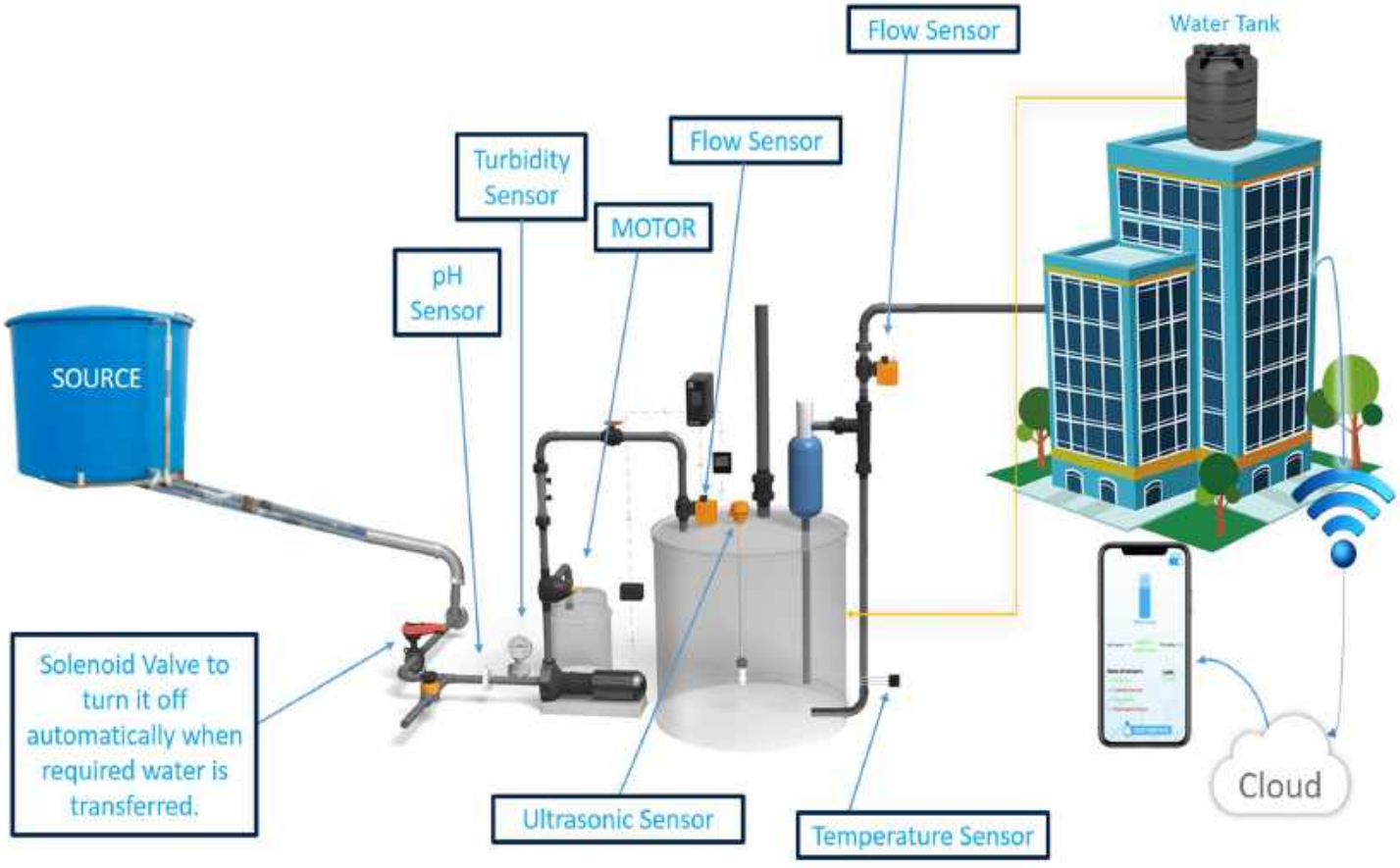

Fig. 3.1 The Model

Chapter 2

The APP

Our App contains so many things which will provide you and once you install our project to your home you will feel full comfort from the water management problem and this is only our aim to provide you full satisfaction with our work. Our App will contain one motor on/off button to turn on or off motor physically. It will show you the PH value, Turbidity value and also suggest you for the time to take a bath which makes it unique from others. It will also send an alert when there will be any leakage problem or if any sensor is not working. The state of every sensor will be shown in the app for the user so that he/she can find out which sensor is working and which is not working. It also contains a "request more water" button so that you can request more water when you find the need for it. It also contains the button of "customer support" when you just tap the icon a message box will appear and you can send your problem in that message box free of cost or normal message charge. And we are 24*7 available for your support.

POWER SUPPLY

The power supply is the primary source for our system, so we need to find out the cheapest and renewable sources, after searching a lot of components we came up with Lithium-ion batteries to give power supply to our system components, as it recharged hundreds of times and is more stable. They tend to have a higher density energy, voltage capacity and lower self-discharge rate than other rechargeable batteries, this makes for better power efficiency as a single cell has longer charge retention than other battery types. We need to charge these batteries by Lithium battery charging module- and also protects against over-voltage and reverse polarity connection (it will usually destroy itself instead of the battery), it has high charging accuracy with good protection performance and cheapest of all charging modules. And we are making use of a mini 5V Solar panel which is connected to a charging module to charge our lithium batteries with renewable energy. By using this method no electricity will be used so it is cost-effective and makes our system environment friendly.

Lithium ion battery

Lithium ion battery Charging module

Solar Panel

Chapter 3

THE BUDGET

REQUIREMENT

The requirement of the components varies with the number of buildings and the plan opted by the user. The requirement is also shown in the form of a table below.

S.No.	Name of the Component	Requirement	
		For 1 Building	For 8 Buildings
1	pH Sensor	1	1
2	Turbidity Sensor	1	1
3	Flow Sensor	2	16
4	Ultrasonic Sensor	1	8
5	Temperature sensor	1	8
6	Solar panel(atleast 5V)	1	9
7	ESP32	1	9
8	Lithium ion battery	1	9
9	Lithium ion battery charging module	1	9
10	Solenoid valve	1	1

Table 3.2 Requirement of Components

After doing the calculations keeping in mind the price of components and requirement, the total comes down to:

For 1 Building: **₹2538.26**
For 8 Buildings: **₹10398.26**

OTHER CHARGES

Other Charges like internet charges and electricity are also taken into consideration while creating the budget. Assuming we don't get access to the internet and including the minimal amount of electricity required only for solenoid valve as everything else will have its own power source and no amount of software charges are included as we are using the free benifits of Thing

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Internet	Electricity	Software
₹ 500	₹ 100	null

Table 3.3 Other Charges

Total Budget of the System: **₹10,998**

Chapter 4

THE PROPOSAL

USEFULNESS OF THE SYSTEM

According to a 2014 Government Accountability Report, 40 out of 50 state water managers expect water shortages under average conditions in some portion of their states over the next decade. The average family can waste 180 gallons per week, or 9,400 gallons of water annually, from household leaks. That's equivalent to the amount of water needed to wash more than 300 loads of laundry. Household leaks can waste approximately nearly 900 billion gallons of water annually nationwide. That's equal to the annual household water use of nearly 11 million homes. All these are major problems of our society. Considering all these problems we have designed our project that can save a lot of money. It can save water leakage and water wastage and also give the customer a fully developed app from which anyone can control everything related to your water management system. We are also making the taps smart at a very low cost compared to the market where tap water smart systems can cost up to 3000 rupees. And in a much lesser budget our team can make the tap water-smart. So not only that our project is doing a lot of things but also it will be pocket friendly.

PREDICTIVENESS IN THE SYSTEM

In this system, a lot of data will run through predictive analysis on the server to satisfy the customer's needs and to make this system truly smart. For example, we are using predictive analysis of machine learning so that it can predict whether the water is suitable for the bathing, etc. or not. We are also finding the leakage in any pipe through the predictive analysis. Similarly it will take data of 1 week and then another week and then do a lot of analysis and finally give a simple result on the app. With this, we will also show weekly consumption rate of the water of a particular house and also tell how many times the extra water has been requested in a week and then in a month.

Chapter 4

ADVANTAGES OF OUR SYSTEM

- Our system will provide the state of water beforehand only that whether it is useful for daily use or not with proper data on the app.
- Our System will notify each and very drop wastage in the house so there will be no wastage of water in future.
- As we use two flow sensors each for a building, our system will be able to calculate the amount of water flowing through it daily and give a record of water consumption on the app.
- We use an ultrasonic sensor and flow sensor with the help of which the sytem will notify by giving information about the stae of the tank whether it is full, half, or empty.
- More water can be requested from the municipality through our app.
- Our System will work according to the need of the customer and with the help of machine learning and predictive analysis programming it will me able to act as a fully automatic and a truly smart system.

BENEFITS FOR THE SOCIETY

- Transparency to the processes in the water supply chain.
- Real-time monitoring and the ability to immediately address detected issues.
- Automation and augmentation of human power.
- Sustainable practices thanks to reduced waste.
- Least amount of maintenance.
- Forward-orienting water conservation strategy based on data analytics and prediction algorithms.

APP BENEFITS

- Monitor everything.
- Never run short of water.
- Use safe water.
- Keep track of the sensors.

Chapter 4

OUR PROMISES

- No more leakage of water in your houses.
- Almost zero maintenance cost.
- Full control of the System in your hands.

THE COMPETITORS

KARIKALA the known Smart Water Management System by the company Casperon costs about 1-1.5 lakhs and our System with much more features will cost under 11000 Rs. which is a huge difference and every common household can easily afford our System. This is a factor where our System wins with a huge margin. More features with lesser price is clearly a winning deal. This point clearly proves that our system is better and cheaper than our competitors.

CONCLUSION

Our System can be used for measuring and monitoring the data captured and drawing real-time analysis of water testing in industries like manufacturing, energy etc. This System can also be used for public utility companies in the field. The readings are provided to the end users with the help of water testing meters and sensor devices. The end user can get information like pH level, turbidity, etc. This will help in accessing the real-time, accurate quantification of results and will also provide the ability to pinpoint the problem areas.

The system was able to achieve the functional requirements as proposed from the outset. The system was able to achieve the functional tasks within the scope of the system in a satisfactory manner. The System could stand better in every way to its competitors which concluded that it is indeed a success.