E-TONGUE: A SMART TOOL TO PREDICT THE SAFE CONSUMPTION OF GROUNDWATER

Project Id: 2020-164

Project Proposal Report

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B.Sc. (Hons) Degree in Information Technology Specializing in Software Engineering

Department of Information Systems Engineering

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DECLARATION

We declare that this is our own work and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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The supervisor/s should certify the proposal report with the following declaration.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor: Date

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ABSTRACT

Resourceful explanations for the water aspect are picking up significance with headway in information technology. Because of the quick improvement and urbanization, the nature of water is getting debase over step by step, and it prompts water-borne illnesses, and it makes a terrible effect on living species. National Water Supply and Drainage Board (NWSDB) is the national foundation for the arrangement of consumable water and the NWSDB has so far had the option to give 43.4% [1] of the populace with pipe-borne water. There are different types of water supply through country water plans run by local governments just as buyer social societies and hand siphons and so forth that represent an extra 25% of the populace. In that capacity, the absolute safe drinking water supply inclusion in the nation is nearer to 65% of the populace. The rest of the society consumes unsafe water which tends to vast outbreaks in the future. Out of safe water consumes most of them unaware of the safeness of the consumable water. There is no portable and accurate mechanism to check the safeness of water when and there except TDS meter which has a limited range of capability of measuring water quality. This research explores about groundwater safety checking mechanism based on the Internet of Things technology using pH, temperature, conductivity, turbidity and calcium sensors. The model created is utilized for testing water tests and the information transferred over the Internet and predict the safeness of water samples for the end-users with higher accuracy and location tracking. Also, an algorithm that can join these strategies to give an exact outcome alongside an alignment system that can lessen the lapse rate. The product has been planned with the goal that it tends to be utilized for applications and by a wide range of end-users.

Keywords - Total dissolved solids (TDS), Water quality, internet of things,

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LIST OF ABBREVIATIONS

Abbreviation	Description
IEEE	Institute of Electrical and Electronic Engineers
IDE	Integrated Development Environment
IoT	Internet of Things
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
LDR	Light Dependent Resistor
NWSDB	National Water Supply and Drainage Board
TDS	Total Dissolved Solids
WQI	Water Quality Index
WQP	Water Quality Parameters
WSN	Wireless Sensor Network
SMS	Short Message Service

1. INTRODUCTION

Water is one of the basic regular assets that has been talented to humankind. Be that as it may, the fast advancement of the general public and various human exercises speeded up the defilement and disintegrated the water assets. The water quality index (WQI) is constantly utilized so as to legitimize or order the degree of water quality. WQI goes about as a meaningful sign of water quality estimation through the assurance of parameters of groundwater [2]. It is imperative to gauge the degree of water quality before devouring or safe use for different purposes. For water quality characterization, a few physical, natural and synthetic parameters that have a critical effect on the water quality must be recognized.

The conventional approach for observing the water quality is with the end goal that the water test is taken and sent to the lab to be tried physically by expository strategies. Despite the fact that by this strategy the substance, physical, and organic particles of the water can be dissected, it comes with disadvantages. Right off, it is tedious and works escalated. Besides, the expense of this strategy is high because of the activity cost, work cost, and gear cost, and it is hard to detect analytical choices in real-time [2].

So as to guarantee the safety of the nature of water, it ought to be checked continuously. To make the way toward testing the constant nature of water basic and simple for everybody, ease and convenient water quality observing the device is structured and created. This a portable device implanted with several sensors to capture diversions in water formation. Mainly pH sensor, conductivity, temperature, calcium and turbidity sensors will be embedded in this proposed system. It is a user-friendly framework which much of the time can test the nature of water and sends an alert to the authorities if there should arise an occurrence of any variation in any parameter of the water which is not consumable by checking formation of water sample through the neural network after storing the initial data in the cloud.

Due to the absence of water safeness checking equipment in Sri Lanka which performs in real-time which stores the critical data in the cloud. Our research team aims to develop a piece of equipment to cater to this requirement which is beneficial mainly to the families in the north-central province.

1.1 Background & Literature survey

This is an enormous water amount and if 1% of water misfortune is spared it will be adequate to give water to 20,000 families. The related cost that the nation could be spared will be roughly Rs. 3,000 million every year. This sparing is adequate to build 1 km of interstates for every year. Along these lines, if more levels of water misfortunes can be wiped out the advantages are so high. Supply of consumable water is a costly issue and accordingly, the capital speculation required for the arrangement of consumable water surpasses Rs. 175,000 to 300,000 for each family. Consequently, the measure of cash required for water supply is enormous and this has gained the ground of providing water slower than usual. Simultaneously if the water created is utilized for expected purposes, without wastage and ill-advised utilization, the inclusion of the population can be expanded without going for additional speculations [1].

Our proposed approach, a possess collected Arduino microcontroller is utilized as the central controller of the system. When the code is transferred to the microcontroller. Right now, sensors are utilized to gauge the fundamental water parameters. As it was considered from the past looks into, the most fundamental water parameters should have been checked by the normal clients are water pH level, water turbidity (darkness), water temperature, conductivity, and the calcium level. Along these lines, Sensors' circuits are associated with the microcontroller and the tests of the turbidity, pH, conductivity and temperature sensors put inside the water. A waterproof temperature sensor is utilized to dodge any harm or electrical stun to the device and the end-user. All sensors read the water quality parameters and send the information to the microcontroller as electrical signs and it will be transmitted to the cloud server through the WI-FI module.

So there are several kinds of research regarding water quality management are conducted. We will elaborate on some of them. Quoi Tie-Zahn, 2010 [4] assembled up an online water quality checking entity dependent on GPRS/GSM. The transmission of data packets done through a GPRS enabled network, which assisted with checking remotely the WQP.

Actualized the WSN platform in the water observing mechanism. The SquidBee [5] which is a commonplace IEEE 802.15.4 ZigBee based bits were utilized as the WSN hubs. All sensor hubs were drifted on the seashore. It observed the water pH level and water temperature of the contemplated seashores. The device comprises three key parts; the sensor hub, cluster head hub, and network portal. The algorithm was written in C programming language to get the information from sensor hubs for each 5s of time interim. The approved end-user can screen the constant information of pH level, and water temperature.

This developed was a WQM [6] system based on WSN. The remote sensor was based on the Sigsbee network. WSN tested WQP and sent data to the Internet using GPRS. With the help of the Web, information was gathered at a remote server.

M.K.Khurana and his colleagues proposed a water quality observing device that can examine the nature of water and impart a caution signal to the authorities through Wi-Fi. If the water parameter is certainly not an ideal worth [7]. This platform gives an exact estimation of the water parameters since right now pH sensor is twofold aligned. Be that as it may, this is only capable of showing to the pH level of the water and no other water quality parameters.

N. Vijayakumar and R.Ramya concocted a thought for the constant water quality observing in the IoT (Internet of Things) condition. Their framework comprises a few sensors which can quantify some basic parameters of the water, for example, temperature, pH level, conductivity, turbidity, and the information can be seen on the web utilizing distributed computing. Center Micro controller implement here is raspberry Pi, its detriment is that it is run on LINUX utilizing the console. It requires the clients to include a command each time when they need to realize the sensors perusing [3].

A.S. Rao, built up a water quality observing framework utilizing Arduino Mega 2560 microcontroller and separate sensors to screen the temperature, conductivity, pH, broke up oxygen, light, and oxidation decrease capability of the water. Despite the fact that it comprises of complex wiring and requires a PC or an additional Beagle board XM ARM processor for correspondence interface and activity [4].

M Deqing, Z. Ying and C.Shangsong, in [8], utilized the Global System for Mobile Communications to detect the nature of water remotely. In their proposed framework, the basic water quality parameters, in particular, pH level, conductivity, dissolved oxygen, and turbidity are perused from the water through the individual sensors and it is then dissected by the controller and in the event that it is past the standard range, it is sent to relevant parties through an SMS, simultaneously. The information is also put away in a database and it is plotted to a graph for additional analysis. Be that as it may, this product is moderate for large water provider organizations or ventures since it comprises of costly parts.

2. RESEARCH GAP

In recent times safeness of water plays a vital role in Sri Lanka. The conventional strategy for water quality testing isn't pertinent any longer. To handle the issue, a few electronic-based water quality observing frameworks were created in the previous decade. However, as the greater part of these frameworks were examined, other than their qualities, every one of them has its own drawbacks. Therefore there is a clear gap remaining to be explore. So we try to come up with an optimal solution to outfit this problem. Table 2.1 will gives you and clear understanding of what to be considered to have a good quality product. From our research team's feasibility study, we discovered these areas to be carried forward for a better and accurate product.

Table 1.1 Comparison of existing systems

Attributes	Currently Available Equipment's	Proposed Solution
Basic Sensors	Yes	Yes
Calcium Sensor	No	Yes
Portability	Moderate	High
Size	Bulky	Small
Sensor Calibration	No	Yes
Cost	Moderate	Low
Accuracy	Moderate	High
Real-Time	No	Yes
Data Storage	No	Yes
Power usage	High	Low
Protection of data	Low	High

3. RESEARCH PROBLEM

The safety of water is a challenge due to the top wellsprings of contaminations. The fundamental driver for water quality issues is the overexploitation of characteristic assets. When the safeness of water decreases numerous harmful water-related diseases may arise. In Sri Lanka, the main resources of water are surface water and groundwater. While groundwater assets are limited to wells, tube wells, and Argo wells. Around 80 percent of this groundwater is being utilized for high-esteem farming and staying 20 percent for residential use including flushing requests of toilets in urban zones. There are more than 300 urban and provincial water supply plots across 23 areas under the NWSDB, 33% of them depend on provisions from shallow and deep groundwater sources.

There is a direct impact of quality water for the well-being of people in Sri Lanka. Currently, there is no mechanism provided to society to check the safeness of groundwater before consumption by the authorities. Due to this large number of humankind has water-borne diseases. So our research team had a feasibility study on this matter and has a solution we proposed to develop a portable IoT device to check safeness in groundwater in real-time. This will cater to the problem mainly the people facing in rural cities. This will be more beneficial in time to come to the Sri Lankan society.

4. OBJECTIVES

4.1 Main Objectives

The primary purpose of this component is to facilitate IoT enabled products to read fundamental water parameters through calibrated sensors and feeding collected data into the cloud server. Later on, this will help to predict the safeness of water by going through several algorithms.

4.2 Specific Objectives

- Implement a cost-effective water safeness measuring equipment.
- Improving the accuracy of sensor readings
- Portable solution for the end-user.
- Identity test combination of sensors to be implemented.
- Minimize the error rate of each sensor.

5. METHODOLOGY

Water safety estimating tool was proposed to implement, In my planned methodology, a nodemcu microcontroller is utilized as the fundamental controller of the system. Figure 1 shows the comparison of microcontrollers. It clearly depicts that nodemcu is ideal for this IOT implementation. Due to its inbuilt Wi-Fi capability and cost-effectiveness. As we are targeting this for normal end-users the device should be affordable. The framework capacities naturally and freely as per the code transferred to the microcontroller. In this system, five sensors are used to measure the fundamental parameters. As was contemplated from the past investigates, the most fundamental water parameters should have been observed [3][5] by the normal clients are water pH level, water turbidity (darkness), water temperature and turbidity to measure surface water. Here we were able to add an extra calcium sensor and the total dissolved solids sensor for the measurements of groundwater safeness. All sensors read the water quality parameters and transmit packets to the microcontroller as electrical signs.

Table 5.1 Comparison of microcontrollers

Parameters	Arduino Uno	Raspberry Pi B+	ESP-8266
Processor	ATMega328P	Quad-core ARM Cortex A53	-
GPU	-	Broadcom Video Core IV with 400 MHz	-
Operating voltage	5v	5V	3.3V
Clock speed	16 MHz	1.2 MHz	26 MHz - 52 MHz
System memory	2kB	1kB	<45kB
Flash memory	32kB	-	Up to 128kB
Communication supported	IEEE 802.11 b/g/n IEEE 802.15.4 433RF BLE 4.0 via Shield	IEEE 802.11 b/g/n IEEE 802.15.4 433RF BLE 4.0Ethernet Serial	IEEE 802.11 b/g/n
Development environments	Arduino IDE	Any Linux compatible IDE	Arduino IDE, Lua Loader
Programming language	Wiring	Python C C++ Java Scratch Ruby	Wiring, C, C++

From the past research findings, information from the industry personals gathered data and with the feasibility study of the researches. We were able to find the optimal sensors for this product. Anyway, we will have to find the best-suited combination out of these while calibrating all these sensors to a minimal error rate.

pH estimates measure of corrosive or base in the arrangement. Reversing Op-amp is utilized to help the voltage from mV to voltage go. pH sensor comprises two terminals which are reference anode and pH cathode otherwise called estimating terminal. At the point when put in the arrangement pH anode builds up a potential that is corresponding to pH level. The worth reaches from 0 to 14. The worthy scope of pH for drinking water is 6.5 to 8.5 [9].

Turbidity is a proportion of darkness in the water. Light is transmitted and reflected by suspended solids and reflected light is gotten by the sensors. An LDR is a high opposition semiconductor. On the off chance that light falling on the gadget is of high recurrence, photons consumed by the semiconductor give the bound electrons enough vitality to bounce into the conduction band [9].

The open-source Arduino Software (IDE) makes it simple to compose code and transfer it to the board. It runs on Windows, Mac OS X, and Linux. The earth is written in Java and dependent on Processing and another open-source programming. Essentially, the IoT device will be customized by utilizing the Arduino IDE.

Figure 5.1 shows the high-level diagram of the proposed system. Further, it displays the number of sensors we are using with an LCD screen to show the reading values. After getting initial values through the sensors, data packets will be transmitted to the cloud environment via the WI-FI module in real-time.

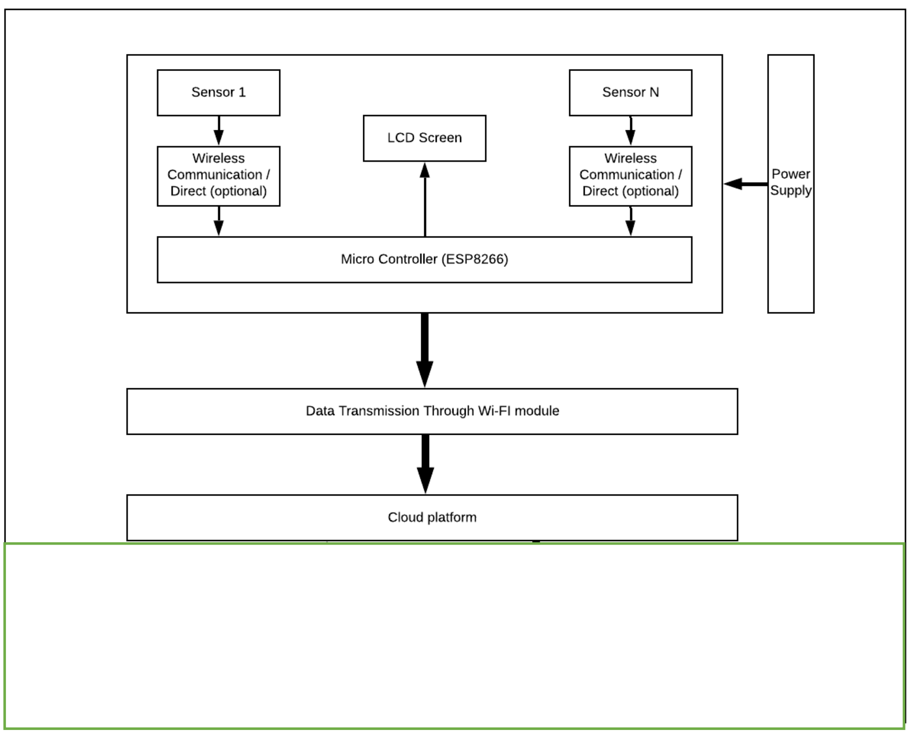

Figure 5.1 High level architecture of the proposed system

6. DESCRIPTION OF PERSONAL AND FACILITIES

Member	**Component**	**Description**
IT16175280 A.M.P.B.Alahakoon	Device Implementation and Technology	• Developing a smart IoT device for measure hardness of water • Developing data transmission media to transfer data • Calibrating sensors to give away readings with minimum error fluctuation • Implement an inception environment for the research team to test water samples

7. BUDGET

The following budget sheet shows the expenses that will be incurred in the development of the IoT device.

Table 7.2 Budget for the IoT device

Description	**Quantity**	**Amount**
Nodemcu ESP8266	1	1200
pH sensor	1	3000
Turbidity sensor	1	6000
TDS sensor	1	4500
Temperature	1	400
Soldering wires	1m	150
Rechargeable battery	1	500
Jumper Wires	50 pins	450
Miscellaneous		2500
Total		18,700.00

8. GANTT CHART

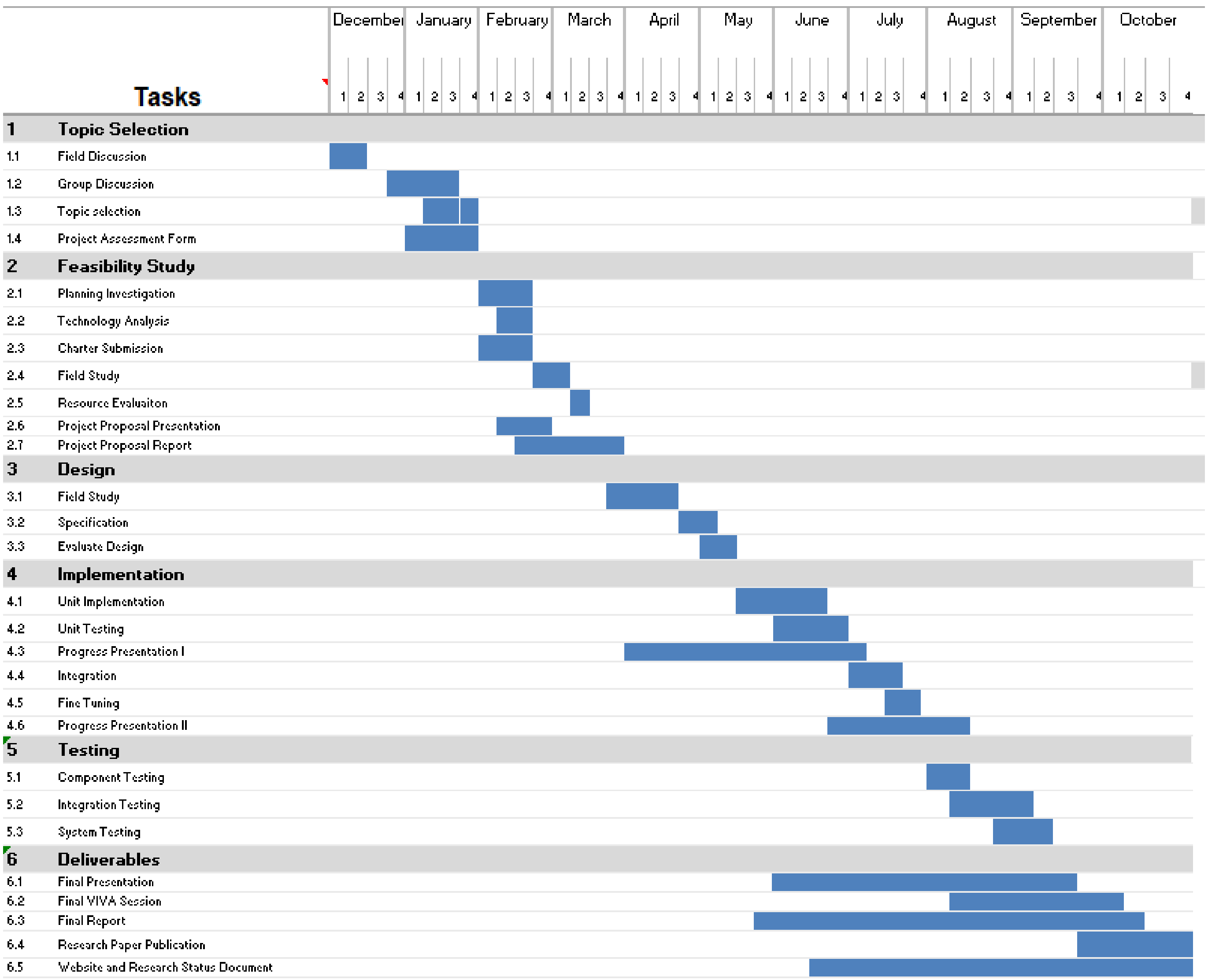

Figure 8.1 Gantt chart

9. WORK BREAKDOWN STRUCTURE

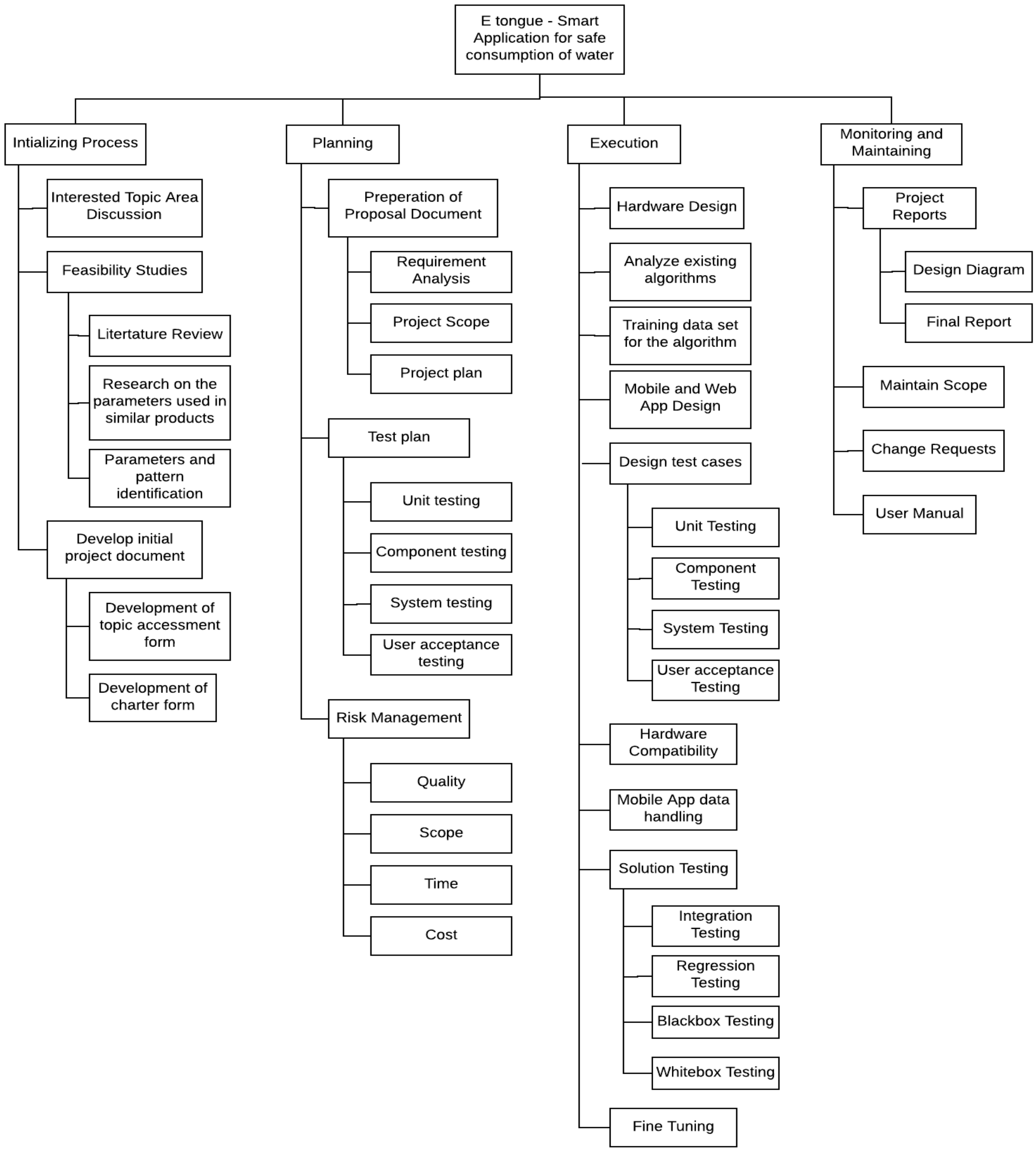

Figure 9.1 Work Breakdown Structure

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