EARLY WARNING FOR PRE AND POST FLOOD RISK MANAGEMENT

2021-124

Project Proposal Report

Mohamed Fazil Mohamed

BSc (Hons) in Information Technology Specializing in

Information Technology

Department of Information Technology Sri Lanka Institute of Information Technology

Sri Lanka

February 2021

EARLY WARNING FOR PRE AND POST FLOOD RISK MANAGEMENT

2021-124

Project Proposal Report

BSc (Hons) in Information Technology Specializing in

Information Technology

Department of Information Technology Sri Lanka Institute of Information Technology

Sri Lanka

February 2021

DECLARATION

I declare that this my our own work and this proposal does not incorporate without acknowledgement 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 acknowledgement is made in the text.

NAME	**REGISTRATION NUMBER**	**SIGNATURE**
Mohamed M. F.	IT18003406	

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

Signature of the supervisor: …… Date:……

ABSTRACT

Flooding and landslides have been a very treacherous situation in Sri Lanka where many areas are flooded for the slightest rain. As of today, flooding is more frequent in most of the areas in Sri Lanka specially the rural areas due to various human activities. Due to such incidents people lose their properties, affect in their agriculture activities, their business and lead to loss their lives.

Flooding happens due to various reasons such as human and natural reasons. So, we renowned 3 main points under this circumstance such as continuous heavy rains causing flooding, new constructions and landfills causing flooding, landslides.

To address these situations, we propose to develop an early warning structure to minimize the devastating destruction that could be caused. Since this solution provides very critical information which includes real-time weather analysis and predictions, Data Mining based weather predictions and also implements crowdsourcing data gathering mechanisms and third-party API utilization on current weather, it is must to carry-out following analysis during requirement gathering and feasibility study phases of this project, Comprehensive study on utilizing IOT devices for weather prediction and forecasting, providing a suitable solution for non-subscribed user to get weather information, to provide a constant service on data transmission from the IoT device to the system.

With this study we hope to make the life easy for the public during adverse weather conditions and hope that this system structure will be of very much use to the state authorities to plan and be in readiness to face the situation.

Table of Contents

List of figures

List of tables

1 INTRODUCTION

1.1 Background & Literature Survey

Natural disasters are one of the main threats we as Sri Lankans face. Among the natural disasters flooding is once the main threats faced by humans in there day to day life. Even for a slightest rain a threat of flooding is expected because of various points. Such as due to constant climate changes taking place in the atmosphere, due to human activities such as constructions & landfills etc.

Flooding is caused mainly due to the inappropriate use of land to full fill the human requirements. In this research we will be providing warnings by monitoring the rainfall and the water levels and providing data of other weather components. By this our main ambition is to provide a flood risk management method which will be useful to reduce the economic loss to the state and human.

In many parts of the world monitoring weather data facts are in a weak stage whereas monitoring the flood situation is affected the most. Therefor to avoid such overwhelming issues effecting the environment and mankind providing accurate and real-time data should be shared to the public on the arising of the water level due to the heavy rainfall within their living area which could also lead to a flooding situation which could cause major damages.

The world is evolving fast towards the day to day evaluating technology. And all people despite of the age group is used to use the modern technology systems to make their lives easy and productive. We will be using suitable information technology practices to analyze all factors related to cause of flood and have an early warning structure to overcome all flooding situations well prepared in a timely manner.

1.2 Research gap

We have considered some sample research projects with regarding to the Flood prediction and monitoring. Majority of those research project have considered on the below points.

1. Flood tracking and the monitoring
2. Flood prediction
3. Monitoring the weather factors with the use of IoT devices

Gathering some of the available research papers, “Smart IoT Flood Monitoring System” research has being mainly focused only on the ultrasonic sensor where as they will be giving an alert notification to the residents around a certain circumference by the user of LED notification and a buzzer alarm. But in case of a network failure or any person is to enter that area has no method to get details or either get a notification until that person enters the relevant border. Also, this research will not be monitoring the rainfall amount which has a chance having late warning as in the alert notification will only be given to the stakeholders once certain amount of water level has already augmented.

Whereas you could see Research on “Design of Information Monitoring System Flood Based Internet of Things (IoT)”, “Computer Vision and IoT-Based Sensors in Flood Monitoring and Mapping: A Systematic Review”, “Flood Detection and Water Monitoring System Using IOT” has used a rainfall monitoring sensor to monitor the rainfall capacity and monitor the water level increase due to the rainfall intensity. All these gathered data from IoT sensors has being passed on to the system for users to view and get information for them analyze etc.

But with comparison with our proposed solution we will not be monitoring only the water level and the rainfall intensity whereas we will be monitoring all basic weather factors such as Temperature, Humidity, Water level, Rainfall intensity with the help of various relevant sensors will be monitored and data will be gathered and transmitted to the system. Also apart from this we will be having a solution where non other research papers did have is we will be also be providing details of weather data if user

who requests who has not subscribed to our system or either who has no internet connection.

Also in case of a power interruption in the area the IoT device will not be able to connect to the internet therefore there will be a disturbance in data transmission from the IoT device which will interrupt entire future process of prediction and data validation etc. in the system. Therefore, to bridge this gap we have proposed to us a mesh network method where the IoT device will have maximum minimization of disruption in data transmission to the system.

Research Paper	Usage if IoT devices		Other Sensor types	Solution for non-subcribed users	Solution for incase of network distructions
	Ultrasonic Sensor	Water droplet sensor			
Smart IoT Flood Monitoring System	✓	×	×	×	×
Design of Information Monitoring System Flood Based Internet of Things (IoT)	✓	✓	×	×	×
Computer Vision and IoT-Based Sensors in Flood Monitoring and Mapping: A Systematic Review	✓	✓	✓	×	×
Flood Detection and Water Monitoring System Using IOT	✓	✓	✓	×	×
Proposed Solution	✓	✓	✓	✓	✓

Table 1: Comparison with existing studies

1.3 Research problem

Natural disasters have devastating situation in many parts of the world such as flooding, landslides, eruption of volcano earthquakes etc. Flooding and landslides have been a very treacherous situation too in Sri Lanka where many areas are flooded for the slightest rain. As of today, flooding is more frequent in most of the areas in Sri Lanka specially the rural areas. Due to such incidents, people loss their properties, affect their agriculture, their businesses and lead to loss their lives.

Below figure will give a deeper study on the amount people who has faced natural disasters in their day to day life.

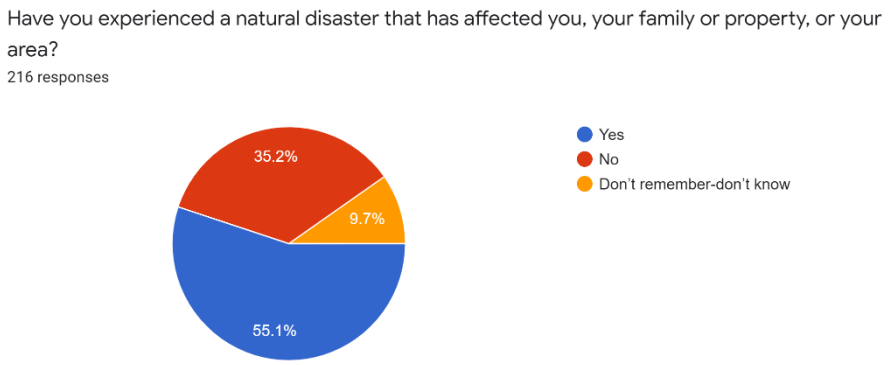

Figure 1: Survey on the amount of people being affected by Natural disasters

When an excess rainfall takes place there is most likely and chance of a flooding situation with the result of the arising of water level. At times due to the sudden arising of water level sudden evacuation measures could not be taken. This is due to the unavailability of pre warnings therefore we need to face many damages and losses in many instances.

Below survey results will show the number of victims face due to heavy rainfall and flooding situation in Sri Lanka.

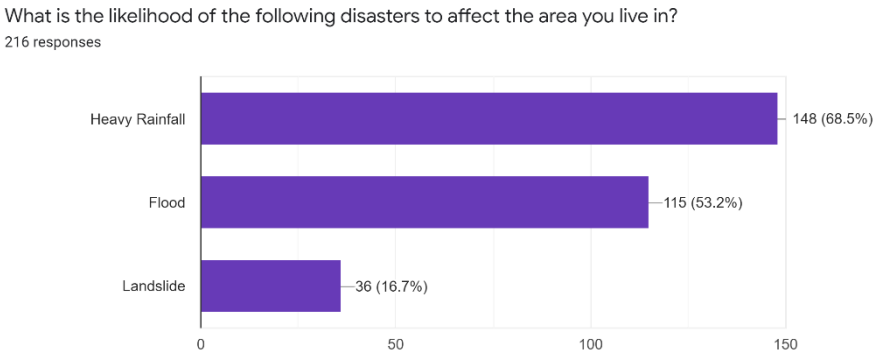

Figure 2: Amount people being affected by Rainfall and Flood situations

Therefore with the help of the modern technology we will be implementing a pre warning method and solution to overcome these situations by providing all the necessary details in a timely manner we will be able to overcome the delays in information transmitting delivering by the respective authorities.

Due to the unavailability of an early warning system many countries face costly incident regarding natural disasters. Therefore, as a main component we will be predicting many weather factors and collecting live data through IoT devices (amount of Rainfall, water level, Humidity, Temperature etc.) and visualizing to make the tool more accurate and feasible.

As in per our scope in the Research we will be providing an Early warning for flooding whereas we will be using historic gathered data and live data gathered from IoT devices. Whereas IoT will be playing a major role in the scope of this project with providing all real time being gathered with related to the rainfall and flooding situation. To move ahead on this project, we identified 2 main issues which we will be fulfilling to make this project a success.

1. Weather data to be shared to non-subscribed users (at request).
2. IoT device to be able to transfer data despite of the power or network interruption.

By observing the factors of weak communication regarding the flood warning situation we recommend designing an early warning tool to handle and mitigate the loss and damages caused due to the flooding situation.

2 OBJECTIVES

2.1 Main objectives

To the disruptions taking place when data is transmitted from the IoT device to the system and any user (subscribed and non-subscribed) can get data information from our system

- Any type of user (subscribed and non-subscribed) to be able to use the system also if they do not have an internet connection.
- Even though the IoT is unable to connect to the internet not to have disruptions in the data transmission to the system which will hold other processes in the system.

2.2 Specific sub-objectives

1. Design an IoT device to monitor all weather factors

To gather all weather data factors such as temperature, humidity, rainfall intensity & the water level an IoT device will be designed to gather the above-mentioned factors. All the gathered data factors will be sent to our system by the use of a Wifi method in the IoT device which will be used for other processors in the system.

2. Solution for any type of user to be able to use our system

We will also be giving a solution to the users who have not subscribed our service in terms where users who aren't using our mobile application or either our web portal to get weather data. Whereas the non-subscribed users will be able to get weather data

out of our system by sending a text message where our system will transmit a limited amount off significant data will be transmitted to the user on the same platform

3. Minimize disruptions on data transmission at any weather intensity

At server weather conditions there is a high chance of power disconnection and network interruption due to natural reasons as well as safety reason. In such cases our system will come to a halt where other processors will not be able to proceed on their tasks and responsibilities. So, we will be using a mesh network technology in order to fulfill this requirement.

3 METHODOLOGY

This planned early warning system has an ability and the capability of having the below functions,

- Detect the amount of rainfall and the water level
- Detect the humidity and temperature
- Provide weather data to non-subscribed users
- Plan for data transmission even though in extreme weather conditions.

IoT will be playing a major role in this project as in all live data factors will be gathered by the help various types of sensors which are unique for their responsibilities where these gathered data will be used for various models in this project.

Relevant sensors to monitor the rainfall intensity and the water level will be used monitored by the help of an ultrasonic sensor. For a flood prediction system monitoring the rainfall amount and the water level is key activity in the IoT device as in all real time data will be passed on to the system for other procedures.

Another weather factor which aligns with the flood prediction and rainfall intensity measurement is the humidity and temperature therefore we will be gathering live data with regard to the temperature and the humidity also and the same will be passed on to the system for other relevant procedures such as validation and prediction purposes.

When it comes to the perspective of usage some users may use our mobile application/Web site some may not use due to various reasons. But we will also be providing a solution for such users to get details via our system. This will be done where the user will have to send a request to our system via sms and the user will be able to get limited important details via the same mode.

Also, it has come to notice that at extreme weather conditions there is most likely a chance of having a power interruption due to safety reasons and power breakdowns. In such cases if we expect to have disruption in our data transmission, we will not be able to provide be able to transmit live gathered data to the system so that it could process on the other functionalities. Therefore, to overcome this situation we will be using a mesh network technology which will help us to overcome this situation and provide a constant information service to our users.

3.1 System architecture

The system architecture is shown as below.

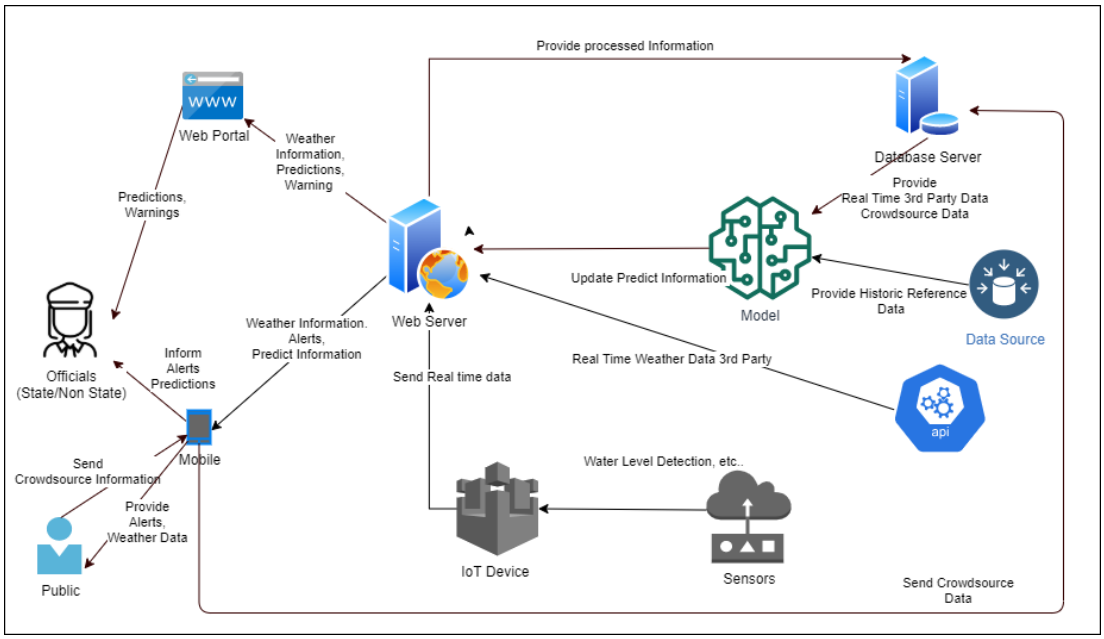

Figure 3 System Architectural Diagram

3.2 High Level Component Diagram

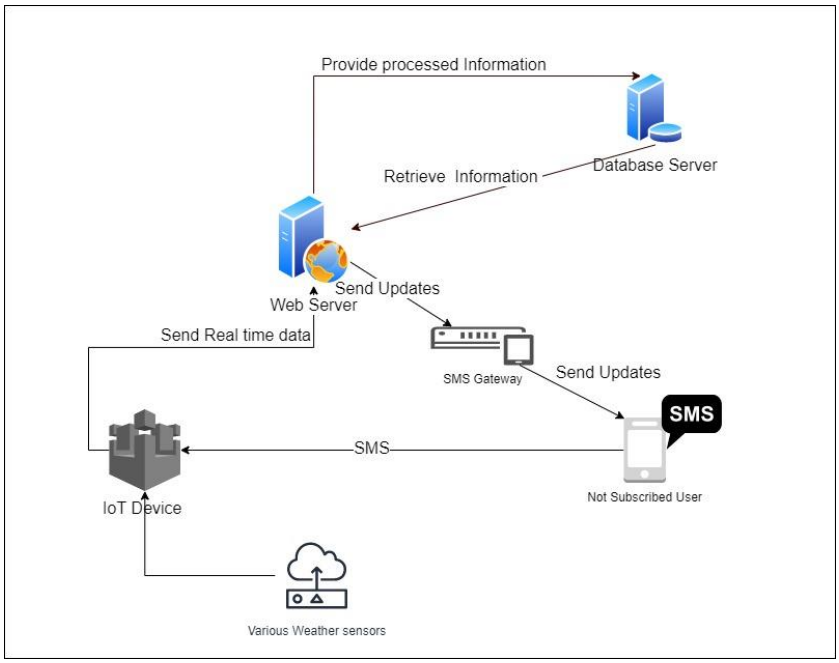

Figure 4: High Level Component Diagram

3.3 Hardware solution

The Hardware Solution is shown as below.

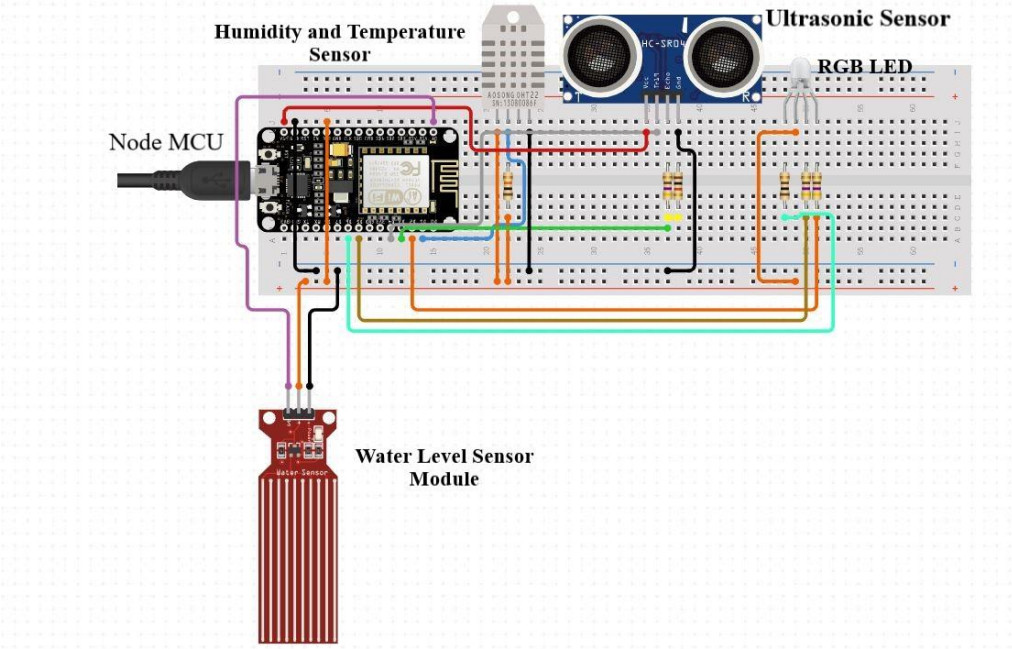

Figure 5 Hardware Architecture Diagram

3.4 Requirement Gathering and Analysis

Requirement gathering and analysis is done by using techniques such as conducting surveys, by using questionnaires, using reports that previous researchers have done, existing documents, and prototyping. After investigating the reports and information that has collected the research team gathered important factors about flooding situation and what are the reasons to cause floods and heavy rainfall. For an example, which part of the year that the selected area gets heavy rainfalls, in that period how critically people will get affected by flooding and heavy rainfall in that area.

Gap analysis is done by reviewing the researches and reports that has been done previously and using existing documents. Prototyping is an experimental process where design teams implement ideas into touchable forms from paper to digital. Teams build prototypes of different degrees of fidelity to capture design concepts and test on users. Prototyping the solution is used to build an initial version of the solution before it gets approved and then adding additional requirements, changes will be done according to user friendliness of the system because it will be directly interacted with the general public.

Feasibility Study

A feasibility study is an assessment of the practicality of a proposed project or system. The research team have found by doing a feasibility study, that below mentioned factors should consider before implementing the project.

- **Schedule feasibility**

  Schedule Feasibility is defined as the probability of a project to be completed within its scheduled time limits, by a planned due date.

  The proposed early warning structure should be done, and the outcome should be handed over to the stakeholders right on time. To do that the team have to complete each stage of the project maintaining the period and considering the due date of the project.

  Economic feasibility

  Economic feasibility is a kind of cost-benefit analysis of the examined project, which evaluate whether it is possible to implement it or not. It consists of market analysis, economic analysis, technical and strategic analysis.

  The proposed system should be done using the approved budget. Also, the final Outcome of the project should be performed without any errors and the quality of the system should be up to the standards. The materials, information's and technology should be fully utilized and should maintain a minimum cost and a

high quality. The goal of the team is to provide an outcome with higher quality and low cost.

- **Technical feasibility**

  A technical feasibility study evaluates the details of how you plan to deliver a product or service to customers. Materials, labor, transportation, information, where your business will be located, and the technology that will be necessary to bring all this together.

  The knowledge about the electronics and about IOT devices are needed to complete the proposed early warning structure. The team should know the latest data mining and prediction techniques required to build the prediction model of the proposed early warning structure.

3.5 Implementation of the proposed solution

The proposed system will consist of the above-mentioned technologies and methodologies as well as various other technologies also. The final production of this project will give users a mobile application together with a web application.

- Web Application Development

  The final harvest will provide a detailed dashboard of all-weather factors validated. We will be using HTML, CSS for the front-end development and Java will be used as the programming language.

- Mobile Application Development

  We will be considering the usability and user friendliness when building the mobile application to gain more user usages in the mobile application. We will be using Android application as our IDE and Java will be our programing language.

- Arduino IDE

  We will be using this IDE to get our required processors run an implemented on the IoT device. C++ will be used as our language to implements the necessary functions in the IoT device.

4 DESCRIPTION OF PERSONAL FACILITIES

1. Select the most suitable IoT board and the related sensors which will support each other.
2. Decide on a suitable structure to build this IoT device to ensure that no circuit breakdowns take place due various reasons.
3. Deciding a method to make the data transfer faster to improve the accuracy of the system.
4. Check on a suitable GSM model to use to provide a service for the non-subscribed users.
5. Do a study on the implementation of a mesh network and its challenges

4.1 Functional requirements

- Data transmission to the system
- Gather data via sensors
- Provide weather data to non-subscribed users
- Data transmission via mesh network at special instances (power failures, network failures etc.)

4.2 Non-functional requirements

Below is a list of non-functional requirements we identified

- Availability
- Usability
- Reliability
- Scalability
- Compatibility

5 WORK BREAKDOWN STRUCTURE

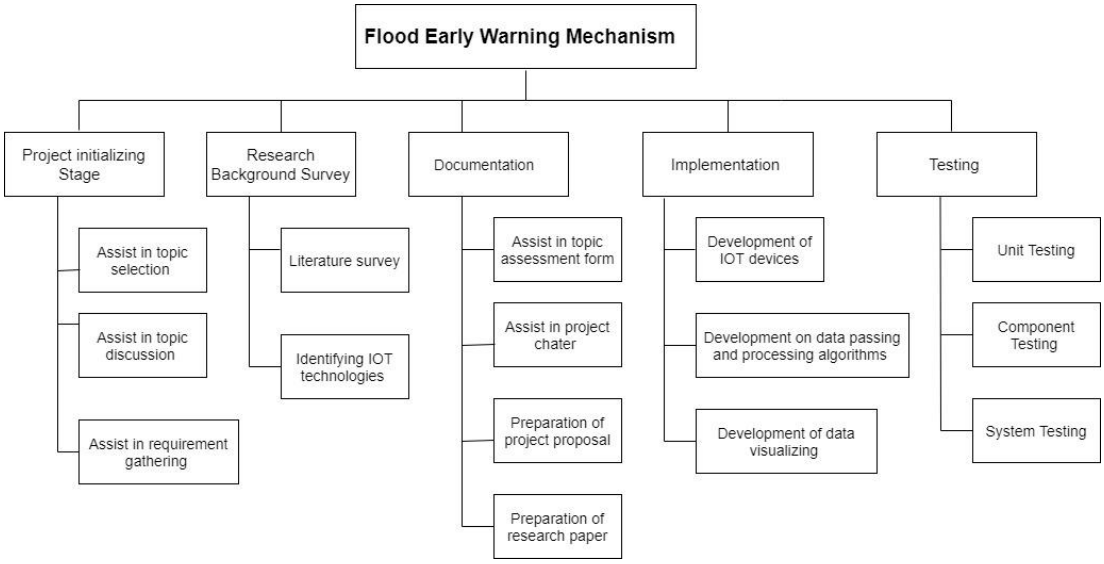

Figure 6: Work breakdown structure

6 GANTT CHART

Task	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct
Project Initiation										
Project Planning										
Documentation										
Implementation										
Testing										
Final Product/Viva										

Table 2: Gantt Chart

7 BUDGET

Component	**Amount (LKR)**
Variable Cost (Per IoT Device)	
NodeMCU	LKR 925.00
DS18B20 1-Wire Temperature Sensor	LKR 390.00
DHT22/11 Humidity and Temperature Sensor	LKR 760.00
Ultrasonic Sensor - HC-SR04	LKR 250.00
Water Level Sensor Module	LKR 110.00
BreadBoard	LKR 250.00
Ublox NEO-6M GPS Module	LKR 1,350.00
Total	**LKR 4,035.00**
Fixed Cost (Annual)	
Domain Name Registration	
Hosting	
Total	**LKR 4,035.00**

Table 3 Budget

REFERENCE LIST

[1] A. B. De Aguiar and P. R. Pinheiro, “Innovative Algorithms and Techniques in Automation, Industrial Electronics and Telecommunications,” *Innov. Algorithms Tech. Autom. Ind. Electron. Telecommun.*, no. June, 2007, doi: 10.1007/978-1-4020-6266-7.

[2] B. Arshad, R. Ogie, J. Barthelemy, B. Pradhan, N. Verstaevel, and P. Perez, “Computer vision and iot-based sensors in flood monitoring and mapping: A systematic review,” *Sensors (Switzerland)*, vol. 19, no. 22, pp. 1–28, 2019, doi: 10.3390/s19225012.

[3] S. Binti Zahir *et al.*, “Smart IoT Flood Monitoring System,” *J. Phys. Conf. Ser.*, vol. 1339, no. 1, 2019, doi: 10.1088/1742-6596/1339/1/012043.

[4] P. Cardullo and D. Roio, “Mesh Networking,” no. November, 2019, doi: 10.31219/osf.io/tepgc.

[5] P. Cardullo and D. J. Roio, “Mesh Networks,” *Blackwell Encycl. Sociol.*, no. April, pp. 1–3, 2020, doi: 10.1002/9781405165518.wbeos1547.

[6] A. A. Ghapar, S. Yussof, and A. A. Bakar, “Internet of Things (IoT) Architecture for Flood Data Management,” *Int. J. Futur. Gener. Commun. Netw.*, vol. 11, no. 1, pp. 55–62, 2018, doi: 10.14257/ijfgcn.2018.11.1.06.

[7] D. Kumari *et al.*, “Study on IOT Based Early Flood Detection & Avoidance,” *SSRN Electron. J.*, no. Icaisc, pp. 1–3, 2020, doi: 10.2139/ssrn.3652362.

[8] M. Roy, P. Pradhan, J. George, and N. Pradhan, “Flood Detection and Water Monitoring System Using IOT,” *Int. J. Eng. Comput. Sci.*, vol. 9, no. 07, pp. 25113–25115, 2020, doi: 10.18535/ijecs/v9i07.4499.

[9] T.-U.-I. Saha, Sajeeb. Uzzal Kumar, Acharjee. Md, “A Survey on Wireless Mesh Network and its Challenges at the Transport Layer,” *Int. J. Comput. Eng. Technol.*, vol. 5, no. 8, pp. 169–177, 2014, [Online]. Available: file:///C:/Users/Naktal/Downloads/ASURVEYONWIRELESSMESHNETWORKANDITSCHALLENGESATTHETRANSPORTLAYER.pdf.

[10] E. Samikwa and E. Samikwa, “Edge Computing Flood Prediction System Using IoT Edge Computing,” 2020.

[11] J. Sathiamoorthy, T. N. College, B. E. Ece, and V. E. College, “A Role of SMS Gateway Server in Mobile Communication,” vol. 1, no. 2, pp. 1–5, 2015.

[12] D. Satria, S. Yana, R. Munadi, and S. Syahreza, “Design of Information Monitoring System Flood Based Internet of Things (IoT),” no. May, pp. 337–342, 2018, doi: 10.1108/978-1-78756-793-1-00072.

[13] C. Science, R. T. Morris, T. Supervisor, and L. A. Kolodziejski, “Efficient Flooding for Wireless Mesh Networks,” no. 2001, 2012.