Water Level Sensing and Warning Device with Short Message Service (SMS) Notification

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Abstract: This study aimed to design and develop a warning device when water level rises. Specifically, it aimed to design a Water Level Sensing and Warning Device with Short Message Service (SMS) Notification; estimate the cost of supplies and materials needed for the construction of the project; construct and assemble the device; and test and evaluate the safety and functionality of the finished project. The project development was designed for the benefits of the community, establishments and households living near lakes, seashore, river and those living in low lying areas where water can be easily built-up.
Keywords: water level sensing, relay and sensor, short message service.

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Introduction

Unusually high rainfall in many parts of the world is a result of climate change. Floods are the most frequently occurring natural disasters, and south-east Asia is particularly vulnerable. According to Quivenco (2015), climate change and variability are expected to bring about increased typhoon activities, rising sea levels and off-season monsoon rains in south-east Asia and other regions. These can cause devastating floods in countries like Cambodia, Laos, Pakistan, Vietnam, Thailand and Philippines. The Philippine government faces huge challenges in rebuilding roads, public buildings, infrastructure and natural resources destroyed or polluted by the flood.

The Philippines ranks third among countries most at risk for disasters, including floods, storms, and earthquakes. In the past 30 years, more than 360 disasters struck the Philippines, with a total death toll of 33,000 people which affected 120 million people. Typhoons and floods are the most devastating in terms of their economic and social impact, accounting for 80 percent of all deaths, 90 percent of the total number of affected people, and 92 percent of the total economic impact (Navasca, 2017). Due to its geographical location, the Philippines is highly prone to natural disasters resulting from earthquakes, volcanic eruptions, tsunamis and tropical cyclones. Metro Manila lies along the flat alluvial and deltaic land extending from the mouth of the Pasig River in the west and the high rugged lands of the Marikina valley and the Sierra Madre Mountains in the east. Due to its geographical location and urban setting, Metro Manila suffers greatly from the impacts of hydrometeorological (e.g. tropical cyclones and floods) and geological hazards (Bautista, 2014).

For decades, floods caused by heavy rains have repeatedly inundated critical areas in Metro Manila, which prompted the Philippine government to establish a flood management system consisting of both structural and non-structural measures. However, most of the operational flood mitigation infrastructure was proven inadequate during the onslaught of typhoon Ondoy. The storm brought rains that exceeded the rainfall intensities of the country's previous typhoons (Gilbuena *et al.,* 2013). The Philippine Atmospheric, Geophysical and Astronomical and Services Administration (PAG-ASA) stated in the Flood Risk Analysis, Metro Manila is highly vulnerable to flooding, as demonstrated by the events of Tropical Storm Ondoy last 2009, and more the enhanced monsoon rainfall (*Habagat*) events of 2012 and 2013. This report details a flood risk analysis for the Pasig-Marikina Basin which is the major river system in Metro Manila (Santillan *et al.*, 2013).

Based from the mentioned occurrence of floods in the Philippines, the researchers intended to develop a device in which can help to monitor the water level. The study would contribute significantly to the community living near the river, sea shore and to those in the flood prone (NDRRMC) to easily locate areas where water level is rising. This project can be also installed in households, establishments and public places for water level monitoring.

The main objective of the study was to design and develop a Water Level Sensing and Warning Device with Short Message Service (SMS) Notification. Specifically, it aimed to: design water level sensing device to monitor the water level specifically to flood prone areas; construct and develop a warning device that can notify the authority in the status of the water level through SMS; test and evaluate the functionality of the project.

Methods and Materials

In order to develop the device, the researchers used the Input-Process-Output (IPO) that can be seen in Figure 1. The problems identified were floods and as well as the materials, tools and equipments used in developing the device. The researchers followed the following processes: designing, constructing, developing, testing, and evaluating.

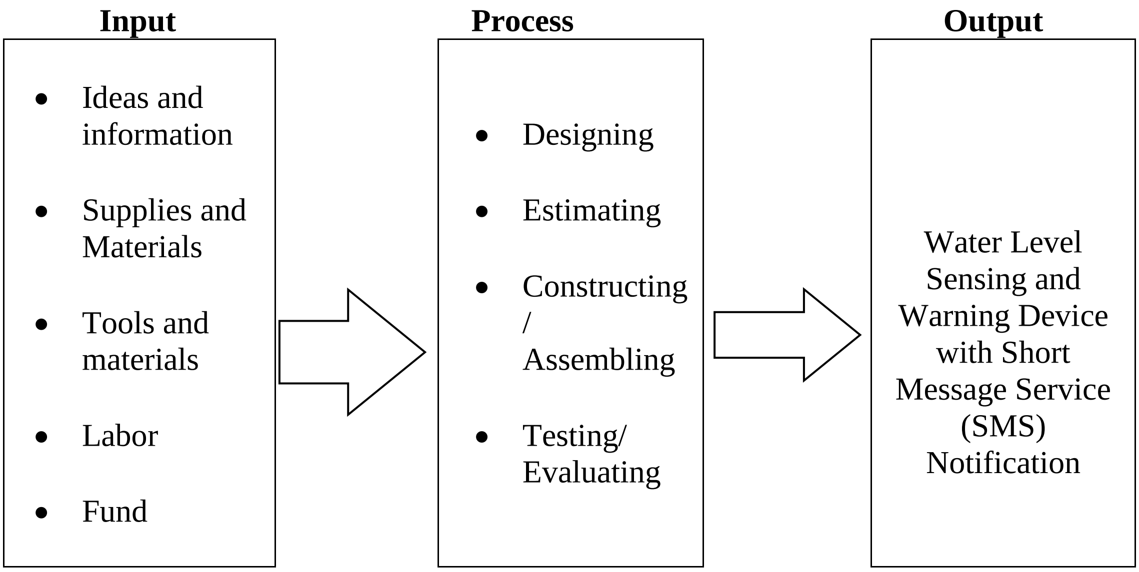

Figure 1. Conceptual Paradigm of SMS Water Level Sensing and Warning Device

Table 1 presents the work sequence of activities and time allotment for the study. It took two weeks to come up with the design of the alarm system. Then the researchers estimated the

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materials for a week and bought all materials for the construction of the project. The constructing and installing activities as well as testing were done for five weeks.

Table 1. Work Sequence of Activities and Corresponding Durations

Work Activities	Number of Weeks							
	1	2	3	4	5	6	7	8
Designing								
Estimating								
Constructing/Assembling								
Testing/Evaluating								

Design Stages and Development

Several stages were used to complete the project. Figure 2 shows the design stages and development of the study. The following processes were discussed based on how designing, estimating, constructing and assembling, testing and evaluating are being executed in the stages and development of the project. These processes requires proper execution to attain the max efficiency of project.

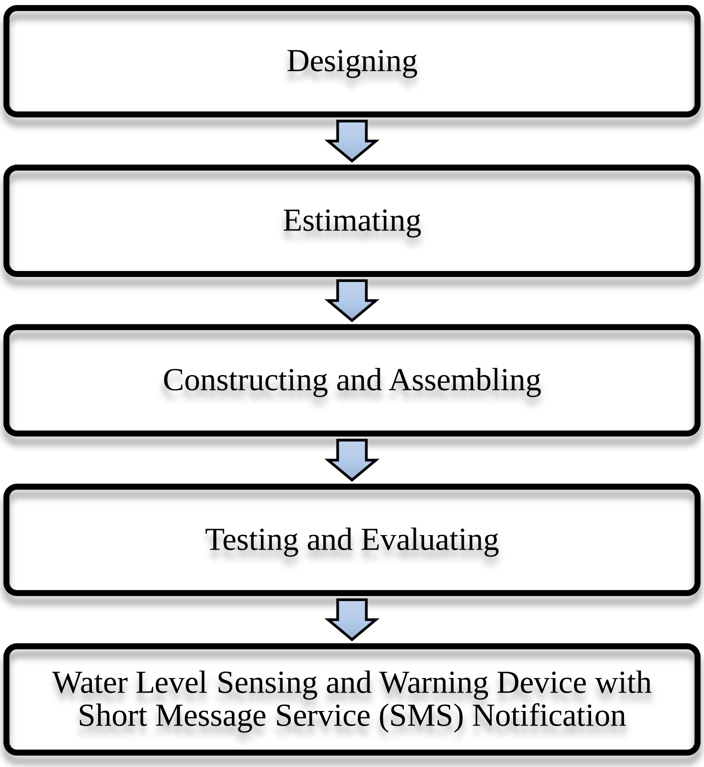

Figure 2. Design Stages and Development of the Study

Designing: The researchers gathered ideas and information from different sources in order to come up with the design of this project. The materials used were properly selected for the realization of this project development. The design of the project focused on constructing a water level alert capable of sending warning through SMS. Moreover, light indicator will be enabled when the level of water risen, meaning flood could be expected.

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Estimating: The list and cost of supplies and materials used in the project were made in this process. The researchers selected the parts based on their uses and conducted a canvas in different hardware stores. High quality materials were chosen to ensure the functionality of the project.

Constructing and Assembling: In this process, the project study was constructed and assembled. All parts and materials were assembled providing the necessary materials specification and following the prescribed design. Proper dimensions and measurements were observed to ensure the quality of the project.

Testing and Evaluating: After the construction of the project, the researchers will test and evaluate the project in order to measure the capabilities and limitation of the Water Level Sensing and Warning Device with Short Message Service (SMS) Notification.

Supplies and Materials

The materials presented below are the supplies and materials needed in the project. The availability of materials have been checked and found to be available in the market. Table 2 shows the cost of supplies and materials used in this project.

Table 2. Cost of Supplies and Materials

Qty.	Unit	Description	Unit Price	Total Price
3	pcs.	capacitive sensor	Php 500.00	Php 1500.00
1	pc.	light emitting diode	5.00	5.00
2.5	meter	tubular stainless bar 1x1x	300.00	300.00
30	meter	Marshall telephone cable	50.00	1500.00
1	roll	stranded wire #16	400.00	400.00
20	pcs.	bolt and nut 5/32 x	1.00	25.00
3	pcs.	sand paper (1000& 100)	5.00	15.00
20	pcs.	set off screws 1x1/8	1.00	15.00
5	pcs	welding electrode (6013)	15.00	45.00
8	pcs.	relay (24V) 14 contacts	190.00	1520.00
1	pc	PLC (OMRON)	12000.00	12000.00
2	pc	Siren	350.00	350.00
3	units	GSM mobile phone	400.00	1200.00
Total				**Php18,875.00**

To obtain financial viability of the project, the total cost of the components was projected in Table 3.

Table 3. Total Cost of the Project

Project Expenses	Variable Cost
Supplies and Materials	18,875.00
Miscellaneous Expenses	1000.00
Total Cost	**Php 19,875.00**

Construction Procedures

This part covers the different processes undertaken in the construction of the Water Level Sensing and Warning Device with Short Message Service (SMS) Notification. The procedures that follow show how the project was developed.

1. Prepare the tools and materials needed in the construction of the project. Tools should be properly positioned so they can be picked up easily and ready for use

2. Layout and construct the steel footings and the boom. Footing must be welded using stainless steel and the boom holds the sensor for a strong foundation of the project

3. Weld the sensor holder on the side of the boom. Holder must be bent downside and the sensor face must be in a downward position

4. Weld the siren holder to the top of the boom. Siren must be on the top facing the shore so that the people living near the flood area can easily hear the sounds

5. Clean the welded portion of the boom and the sensor holder. This is to done to ensure a tight and mounting angle for a better stand of the device

6. Install the wire for the sensor and for the siren. Wires should be inside the boom and must be connected tightly using the soldering iron

7. Install the siren to the siren holder. Proper wiring should be done to make the siren functional during emergency

8. Install the power supply going to the sensor, PLC, relay and siren. Ensure that the connections are tight and correct according to the polarity

9. Connect the mobile phone to the controller. The mobile phone is set to the signature text that cannot be erased for every SMS sent.

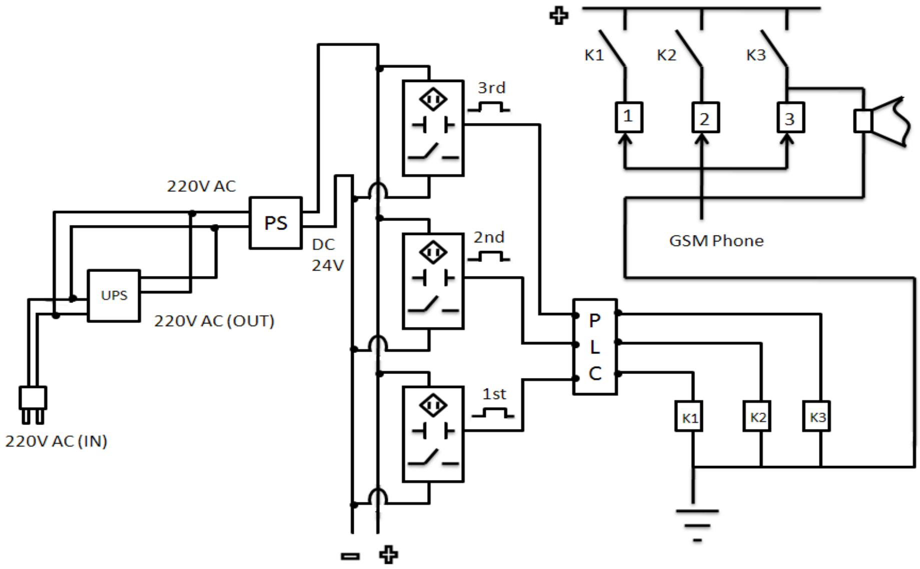

Figure 3. Schematic Diagram of the Water Level Sensing and Warning Device with Short Message Service (SMS) Notification

Figure 3 shows the schematic diagram of Water Level Sensing and Warning Device with Short Message Service (SMS) Notification which is a useful tool for a skilled technician to interpret the electronic symbols and detecting the possible reasons of a problem. The schematic diagram is comprised of relay application, sensor connection, power supply assembly and siren. The sensor detects the water level and the signal feeds it to PLC and then to the relay and the last is the mobile phone. The controller processes the signal given by the sensor and the processed signal results to message alert.

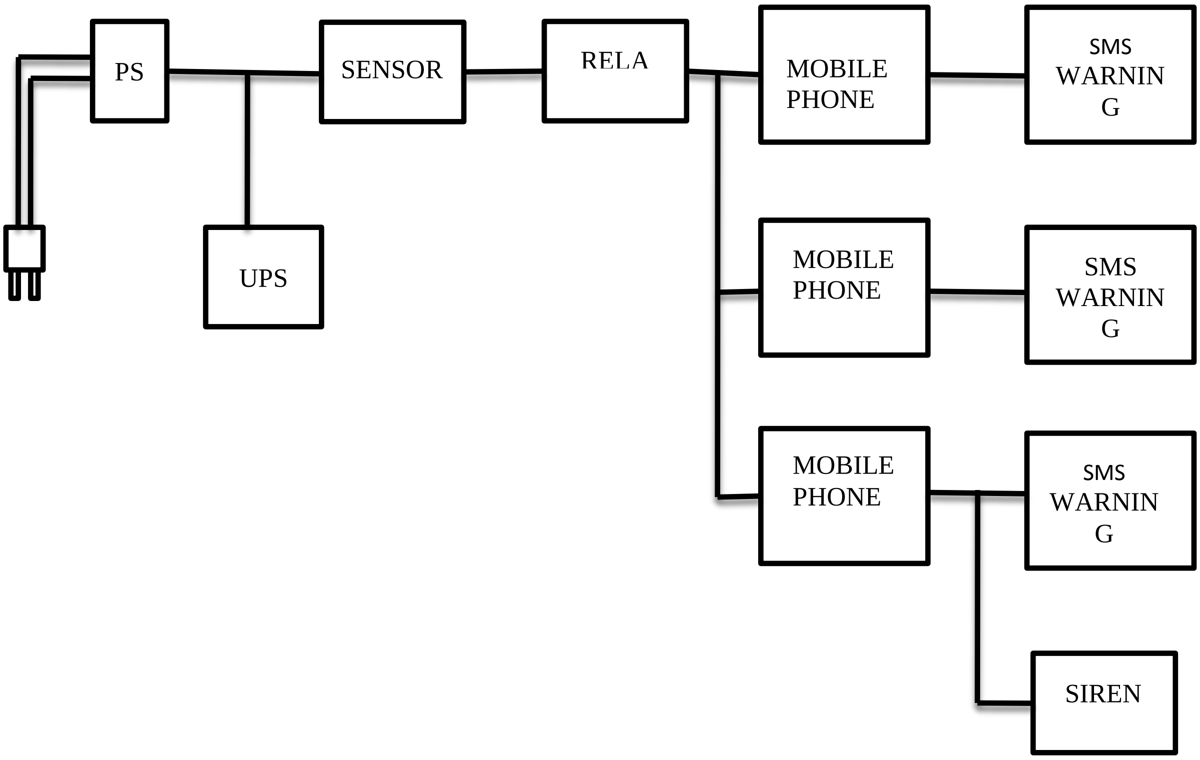

Figure 4. Block Diagram of Water Level Sensing and Warning Device with Short Message Service (SMS) Notification

Figure 4 shows the flow of each component. Power supply as the main source of current is plugged to 220V AC and converts it to 24V DC that supplies power to the whole circuit. Attached is the UPS that supports the device in case of power loss. The output of the sensor feeds to the relay that gives signal to the mobile phone. Mobile phones simply send warning message to the community after the water reached the last sensor and the siren.

Figure 5 shows the structure of the finish project. The device was composed of materials systematically assembled to make the design for SMS Water Level Sensing and Warning Device. Then major components were connected according to their function. The main body of the project was made of stainless steel prepared for all kind of water submerging. Screws and nuts were used in the assembly of parts and in installing PLC, relays, switches, siren and power supply inside the casing. The system was operated by a 220V AC to 24V DC power supply. Push button switches were used to activate the power supply. The controller was assembled inside the computer casing to ensure proper mounting. Wirings were properly soldered and relays were well mounted to its holder to avoid spark. Mobile phones were positioned in the upper portion of the case to make sure that the signal was free from electromagnetic effect caused by the AC voltage inside.

Figure 5. Finished Project

Test and Evaluation

After all the parts were assembled and checked, testing was made in order to measure the capabilities and limitation of the Water Level Sensing and Warning Device with Short Message Service (SMS) Notification. The researchers tested the program downloaded and installed to the PLC. They tested the actuation of outputs in accordance to the signal by observing the response of the sensor when water reached the sensor face. After testing the program, relay and mobile phone has been connected to ensure its functionality. At first the coordination of the sensors to PLC components was not reliable. Incorrect wiring was observed which might damage the PLC. In order to correct the problem rewiring with proper polarity was observed, applying enough amount of current to the unit and checking of wire connections of power supply to the PLC were done.

Results and Discussion

The components used in this project were not intended for high voltage. The input of the device is 220V and the output is 24V DC. The unit has also Uninterruptible Power Supply (UPS) in case of lost of power. The developed project has three capacitive sensors to detect the water level. A five feet tall that is divided into three sensors which provides alerts in every level. The project was limited for water only even though the sensor used was applicable to different type of liquid. Flood could be easily detected by the sensor face making and the threshold to react and give signal to the controller. And also, it was limited to normal type of water like sea and river water where it usually goes up by level due to rain and abnormal earth movement.

After constructing, testing and evaluating of the project, the following findings were drawn: the Water Level Sensing and Warning Device with Short Message Service (SMS) Notification is easy to use and operate; the materials used for the completion of the device are available in the market; the functionality of the completed project may be achieved through proper testing and evaluation.

Based on the evaluation, it was proven that proper coordination of the components, proper timing, and adequate power supply lead to a smooth operation of the device. It took time to come up with a good wiring of each component, good program and proper mounting of input and output devices, but enough knowledge about the project may lead to a successful and useful Water Level Sensing and Warning Device with Short Message Service (SMS) Notification.

Table 4. Commissioning

Type of water	Reaction of sensor after sensing different types water
Flood	Rapid Reaction
Sea water	Rapid Reaction
River water	Rapid Reaction
Tough water	Rapid Reaction
Lake water	Rapid Reaction

Table 4 shows the commissioning process of Water Level Sensing and Warning Device with Short Message Service (SMS) Notification. It includes the type of water used for the sensor to react. It also shows how the project reacts rapidly in different types of water. Trial and error procedure was carried out to achieve the efficiency of the functions. Commissioning of the project was done in order to determine if it was working based on its design. The completed project was tested to find out the limit and functionality of the project.

However, high temperature liquid like lava or high temperature liquid that might damage the sensor face and wiring inside the device. It was not intended for viscous type of liquid like molasses, bitumen and oil because might block the passage of liquid going to the sensor face.

Likewise, grease and other types of oil may also affect the project since it has the capability to create fire.

Conclusion and Recommendation

Based on the findings, the following conclusions were drawn: the designed of the Water Level Sensing and Warning Device with Short Message Service (SMS) Notification was simple and easy to operate; the developed device can be used to notify the authority in the status of the water level through SMS; the device was tested and evaluated and proved its the functionality. The total cost of the project is nineteen thousand seven hundred eighty-five pesos (Php 19,785.00). It is recommended to use the project and design a mitigation program that will show some improvements and monitoring that are derived from the experiences of the Filipino people in terms of flood.

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