# Prediction on the Trend of Dengue Cases with Decision Support System Using Statistical Formula

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## EXECUTIVE SUMMARY

An accurate prediction model for dengue incidences months in advance of an impending outbreak could prove useful in enhancing decision-making for health establishments and reducing the morbidity and mortality rate of this tropical disease. Therefore, a prediction model was developed to predict the trend of dengue cases in the future based on historical epidemiology cases of dengue and using the statistical formula of mean+2 Standard Deviation, where mean is the average of all the past cases and standard deviation of all the number of past cases taken into factors for the prediction of the future trend of cases. The prediction model was able to draw alert thresholds using the statistical formula and was also able to predict with an acceptable level of accuracy using the actual data as a benchmark for the predicted value. However, the system cannot predict the anomalies or exceptional cases, rather serving as a guide for Digos City Health Center operatives to create preventive measures for this alarming tropical disease. In the conclusion of this study, using the model developed and taking historical epidemiology data as the basis for the prediction of a future trend could prove as a viable source for enhanced evidence-based decision support for the Digos City Health Center operatives.

Keywords: *prediction, mean+2SD, decision support, alert threshold*

## INTRODUCTION

Globally, infection rates of Dengue Fever-causing virus are on the rise in recent decades. The World Health Organization (WHO) estimates the number of infections worldwide to be 50 million per year. As this debilitating and sometimes lethal infection affects more and more people every year, science research is on notice and moving fast to catch up (Lobo, 2011).

The spread of dengue, especially in urban and semi-urban areas, has become a major international public health concern in recent years. Dengue fever (DF) is a common vector-borne viral disease in the tropics and subtropics and is primarily spread by the female Aedes Aegypti mosquito. In tropical and subtropical regions of eastern and South-eastern Asia, DF, and dengue hemorrhagic fever (DHF), outbreaks occur frequently. Various approaches have been attempted to control the spread of the virus, which includes reducing the population of Aedes aegypti in the field. Other methods such as Fumigation have been used to reduce mosquitoes, and the use of temephos was also utilized to reduce the larvae if not eradicated. To cure patients, treatment in hospitals is usually given in supportive care, which includes bed rest, antipyretics, and analgesics. (World Health Organization, 2012)

In the Philippines, dengue cases can occur and increase anytime, which is why different organizations implement various programs that will aid in the prevention of dengue cases. However, many organizations still encounter difficulties in monitoring dengue cases, especially in remote areas where its occurrences can be very rampant due to lack of information dissemination and support. With the aid of technology, everything can be a boundless portal and major concerns can be solved and managed effectively. Sufficient information and proper guidance are really important so that awareness among people can be strengthened and unity to promote a dengue-free community. (Elijorde, Clarite, 2016)

The primary purpose of this research is to create a system using the web interface for a dengue prediction system to predict the future behavior of the trend of dengue cases using historical dengue cases. Identifying future dengue cases would benefit the Digos City Health Center. This would give them ample time to make necessary decisions, plans, and actions to help safeguard the health of Digos City locals.

## PROJECT CONTEXT

Prediction on the Trend of Dengue Cases in Digos City with Decision Support System Using Statistical Formula provides a prediction of dengue cases in Digos City for the following months based on past dengue case reports. Using dengue case history, the system will predict future cases of dengue in individual barangays of Digos City. This set of predictions gives the Digos City Health center the ability to detect early warning signs of dengue case growth. It can be monitored and based on preventive measures that can be implemented immediately, reducing the risk of possible outbreaks and casualties brought upon this disease.

## PURPOSE AND DESCRIPTION

Dengue is widespread among Digos City's barangays, but there has been a lack of actions taken to counter the dengue issues occurring from time to time at an alarming rate. The severity of dengue cases in Digos City that caused harm and death has caught the researchers' attention that led them to create this system. The researchers' main purpose is to create a program to minimize the cases of dengue in our locality.

The researchers have come up with a solution which is through prevention. Thus, the Prediction on the Trend of Dengue Cases in Digos City with Decision Support System Using Statistical Formula system was created to help Digos City health agency's awareness.

This system is capable of analyzing the previous dengue cases to predict the future trend of dengue cases. The system draws a threshold using historical data of dengue cases to classify the high, medium, and low thresholds for all the recorded dengue cases as a guideline for the intended users, enabling them to conclude it. The system will also generate reports for predicted values and actual value of dengue cases of individual barangays.

## OBJECTIVE OF THE STUDY

Specifically, the project aims:

- To develop a system that predicts the trend of dengue cases of every barangay using historical dengue cases to identify possible rise or fall dengue threat in the future using statistical method.

- Develop a system that can draw thresholds from historical dengue cases and normalize all the data and warn users if cases have surpassed alert thresholds.
- Develop a system that generates reports from all the data gathered and guide Digos City Health's decision-making.

## TECHNICAL BACKGROUND

The Digos City Health Center Services is composed of a multi-disciplinary team of professionals committed to protecting public health. They do this by managing health risks to the community, using different approaches across the areas of influence in Digos City.

Employees of the Digos City Health center gather data provided to them by different medical facilities such as clinics, hospitals, etc., and consolidate all the cases into one comprehensive report (total infection no., location, morbidity, etc.) They can use these data to plot graphs and provide a visual report and draw conclusion from it.

The Digos City Health center operations for data gathering show the possibility of the lack of potential to fully use these data to maximize its usability.

To help maximize the Digos City Health center's efficiency to help minimize the epidemic of dengue cases, we, the researchers, have created a solution by creating a system that guides the health center by giving them a prediction of dengue cases. Prediction on the Trend of Dengue Cases in Digos City w/ Decision Support System Using Statistical Formula helps the health center with their decision making by providing a prediction on the future trends of dengue cases dengue case history. The system also warns the users if the cases have surpassed thresholds.

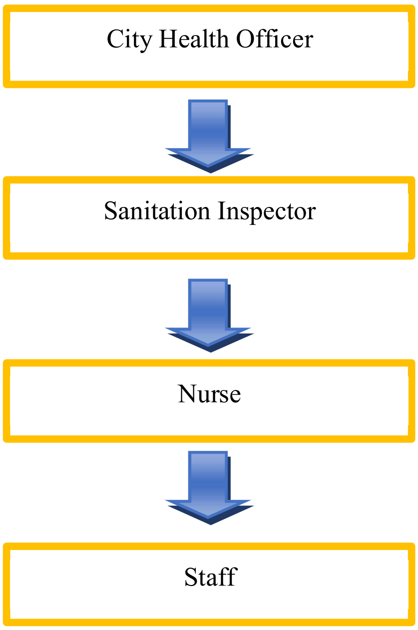
The system requires data from past monthly cases of dengue in individual barangays to be input into the system, thus requiring it to input at least a year's worth of dengue cases to draw thresholds for all the data input into it, classifying the high, medium and low incidence month based on the data that was input to it. Once data has been fed to the system, it automatically generates a prediction of the trend using the statistical formula, which is the mean+2SD.

The system requires to be connected to a local webserver to allow access for the users, aside from the admin, to view the system. XAMPP is required to be installed on the admin's PC as it makes it easier for the admin to create a local web server required by the system. Once XAMPP has been installed, the admin is required to launch the Apache server and MySQL Database from the XAMPP's dashboard to make the system's backend functional. The system's backend is run by PHP, JavaScript, and MySQL for the database, while HTML and CSS run its frontend for the user's interface and interaction with the system.

*Organizational Chart*

An organizational chart is a diagram that shows the structure of an organization and the relationships and relative ranks of its parts and positions/jobs. The figure below illustrates the organizational chart of the City Health Office. In the proposed research, we will be focusing on the Environmental Sanitation Services sector.

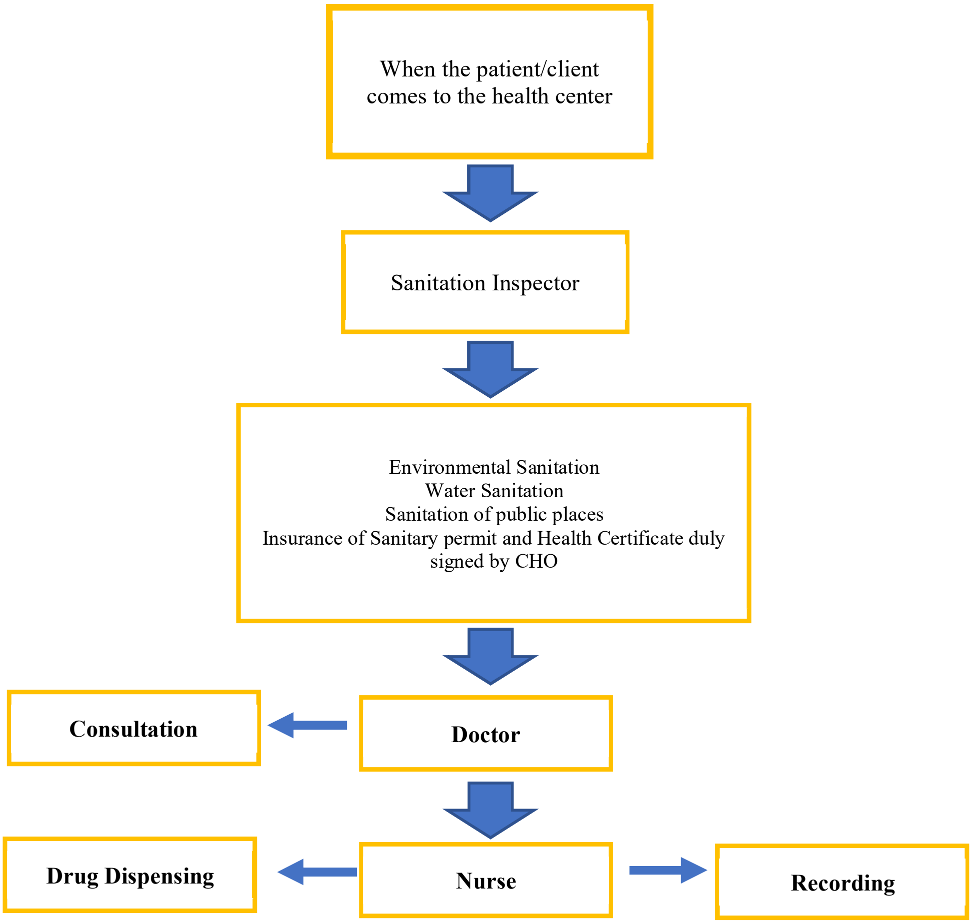
Figure 1 Organizational chart of Digos City Health chart




*Work Flow Diagram*

The illustration below describes Digos City Health’s flow/process of their work for the day-to-day operations.

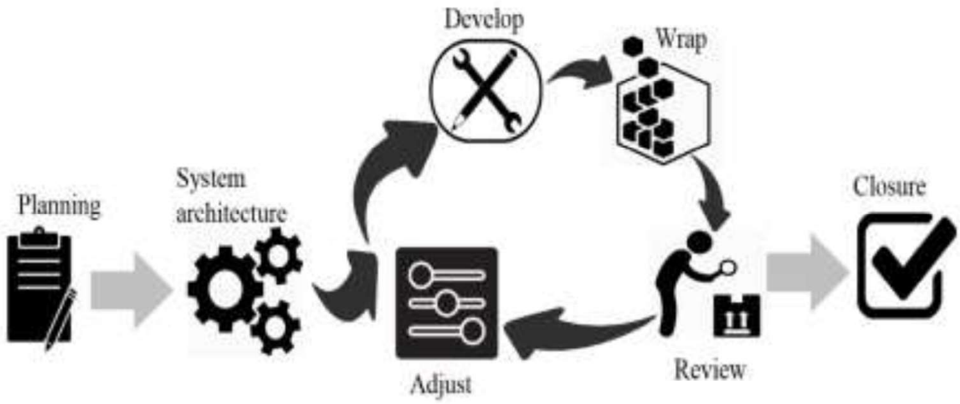
Figure 2 *Work Flow Diagram of Digos City Health center*




## METHODOLOGY

Scrum is an Agile Software development methodology which is an iterative and incremental methodology. This is intended for software projects and application development. Projects progress via a series of iterations called *sprints* which usually span 2-4 weeks long. The reason why the researchers chose this methodology is that the context is set by environment and controls. The primary cycle is moving the development forward. The researchers chose this methodology because the set of controls adapt and evolve to the environment.

Figure 3 The figure above is Scrum Model.




*Planning*

In this phase of the study, the researchers studied data flow in Digos City Health center (DCH) related to dengue. The study showed that data about dengue cases and incidences were passed on to the Sanitation Department headed by the Sanitary Inspector. The researchers then interviewed the Sanitary Inspector as to how they deal with the dengue epidemic. The study revealed that the flaws in their basis for decisions to counter the epidemic; the sanitation department did not have a system that guide's them in their decision making. The researchers proposed a system that could help the DCH, which gives them the ability to predict the future trend of dengue cases based on previous incidences over the past few years. This would give DHC a solid basis for their decision to help combat the epidemic and further protect the health of the locals of Digos city.

*System Architecture*

In this stage of the study, the researchers were given data about the previous cases. This was later used as the basis of the prediction of the system. The researchers were provided yearly total dengue cases spanning from 2010 – 2015. They were also provided with data from 2015 – 2016; only this time, the data was more detailed as it had total monthly cases for individual barangay.

*Development*

During the development stages of the system, the researchers went under two *sprints.* In the 1st sprint phase of the study, the researchers began to develop the system based on the architecture. The researchers used PHP, JavaScript as the backend of the system. This is where all the computation for the prediction happens. They then developed the frontend for the user's interface and interaction of the whole system run by HTML5 and CSS. The researchers based their prediction on a yearly based prediction to predict how many dengue cases would arise in the following years based on previous data. In the 2nd sprint phase of the development stage, the researchers then added improvements. They revised its prediction into a monthly prediction using the mean+2sd statistical formula, classifying the high, medium, and low incidence month of dengue cases and alert users and a report generating function for the system.

*Wrap*

In the 1st sprint phase of the study, the researchers wrapped up the back end and front end of the system to test its functionality. During the 2nd sprint phase of the study, enhancements to the system were then applied to the system. More functions were added.

*Review*

During the 1st sprint phase of the reviewing stage, the researchers immediately saw the system's flaws. In contrast, the system could predict how many totals of cases would appear for the following years, the system could not tell which months would be considered a high, medium and low incidence month making the prediction of the system less helpful for the basis of decision making. Due to the previous results of the initial sprint, the researchers fell back to a more stable prediction to predict the trend of dengue cases in monthly data. Further observation shows that giving them a monthly prediction gives them enough time to prepare for an impending epidemic. With the guide of the system, it helps minimize the casualties brought upon dengue.

*Adjust*

In this stage of the study, based on the 1st sprint phase of the review stage, the researcher decided to test the monthly data for 2015-2016 to see how efficient and accurate its prediction would be.

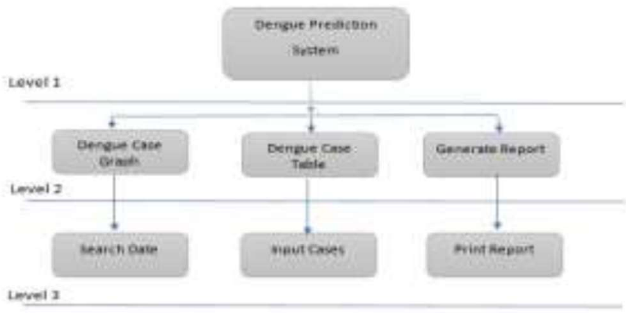
*Closure*

In this stage of the study, the researchers concluded that the system was ready to be deployed, and the documents were revised.

*Work Breakdown Structure*

It is a deliverable-oriented decomposition of a project into smaller components. A work breakdown structure is a key project deliverable that organizes the team's work into manageable sections.

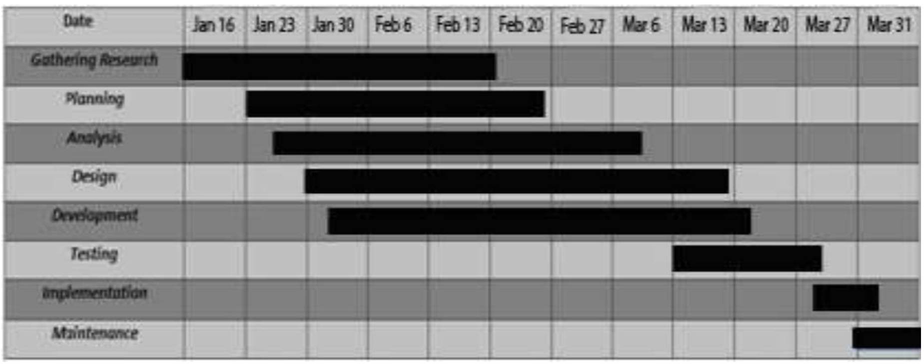
Figure 4 The figure above is Work Breakdown.




*Gantt Chart of the Development Phase*

This graphical illustration of a schedule illustrates the start and finish dates of a proposed project. It is useful as a project management tool for planning and scheduling projects. And it helps to assess how long a project should take, determine the resources needed, and plan the order in which you'll complete tasks.

Figure 5 Gantt Chart of the Development Phase




*Functional Requirements*

The Functional Requirements Specification documents the operations and activities that a system must be able to perform. It will illustrate the data to be entered into the system and who can enter the data, operations that will be performed, work-flows performed by the system, system reports, and other outputs, and how the system meets the applicable regulatory requirements.

***Interface Requirements***

***Admin***

The login credentials for the admin will be given and modified during the deployment phase. Data entry will be permitted as long as the admin credentials will be provided. Prediction reports will be view-able upon data entry.

***User***

User's do not require login credentials as they are strictly limited to the viewing of the overall report and the predicted values.

***Business Requirements***

Admin or Sanitation Inspector using the system will be trained by the developers.

***Regulatory/Compliance Requirements***

The system will limit access to authorized users.

***Security Requirements***

Data entry is restricted strictly to the admin for security purposes.

***Non-Functional Requirements***

It essentially specifies how the system should behave and that it is a constraint upon the system's behavior. It also states as a quality attribute for the proposed system.

*Usability Requirement*

The system shall allow the users to access the system from the web. The system uses a web browser as an interface. Since all users are familiar with the general usage of browsers, no special training is required. The system is user-friendly, and online help makes using the system easy.

*Availability Requirement*

The system is available 100% for the user and is usable 24 hours a day. The system shall be operational 24 hours a day.

*Accuracy*

The system will be 100% accurate by the time of deployment.

*Performance Requirement*

The prediction constantly changes when new data is entered to further enhance the predicted value for the succeeding month. Its performance in prediction/estimation heavily bases on the data gathered.

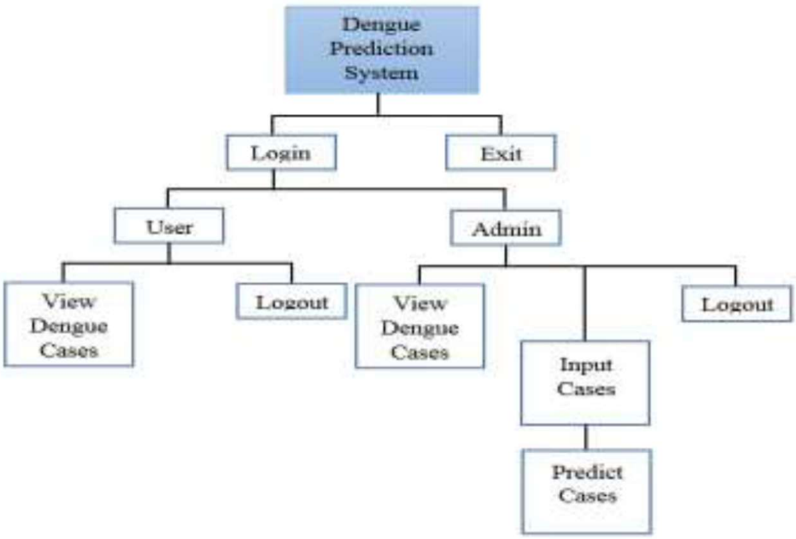
*Reliability Requirement*
The system has to be 100% reliable due to the importance of data and the damages caused by incorrect or incomplete data.

*Maintainability and Portability Requirement*
Changes (new user addition, password changes, and database changes) must be verified once per day. The system should automatically provide notifications to users on their accounts about the incoming election and election results.

*Design of Software Systems*
This topic provides the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. This could be seen as the application of systems theory to product development. This includes the HIPO, IPO, Manual Flow Chart, Proposed Flow Chart, Current Data Flow Diagram, and Proposed Data Flow Diagram.

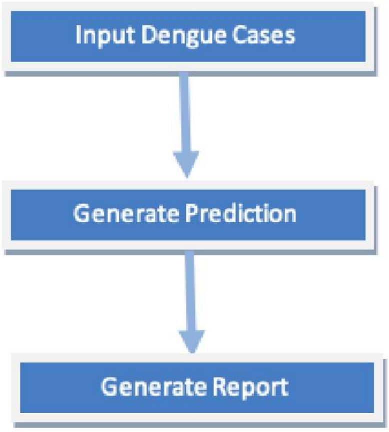
*Hierarchical Input-Process-Output*
The Hierarchical Input- Process- Output or HIPO is a documented model that shows the system's overall design.

Figure 6 Hierarchical Input- Process- Output



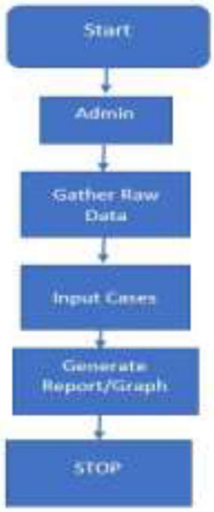
*Input-Process-Output*
A graphical representation for describing the structure of an information processing program or another process.

Figure 7 Input-Process-Output



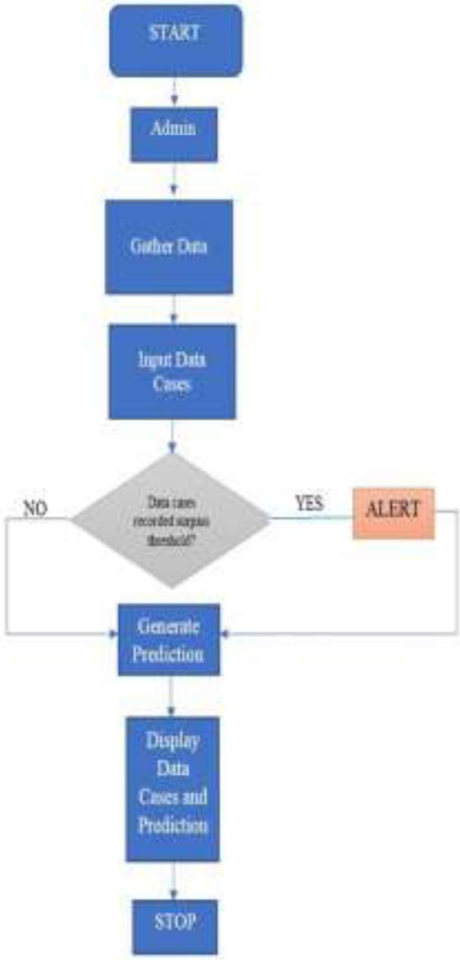

*Current Flow Chart*
The figure below shows the manual process for data gathering and report the conclusion of Digos City Health.

Figure 8 Manual Flow Chart



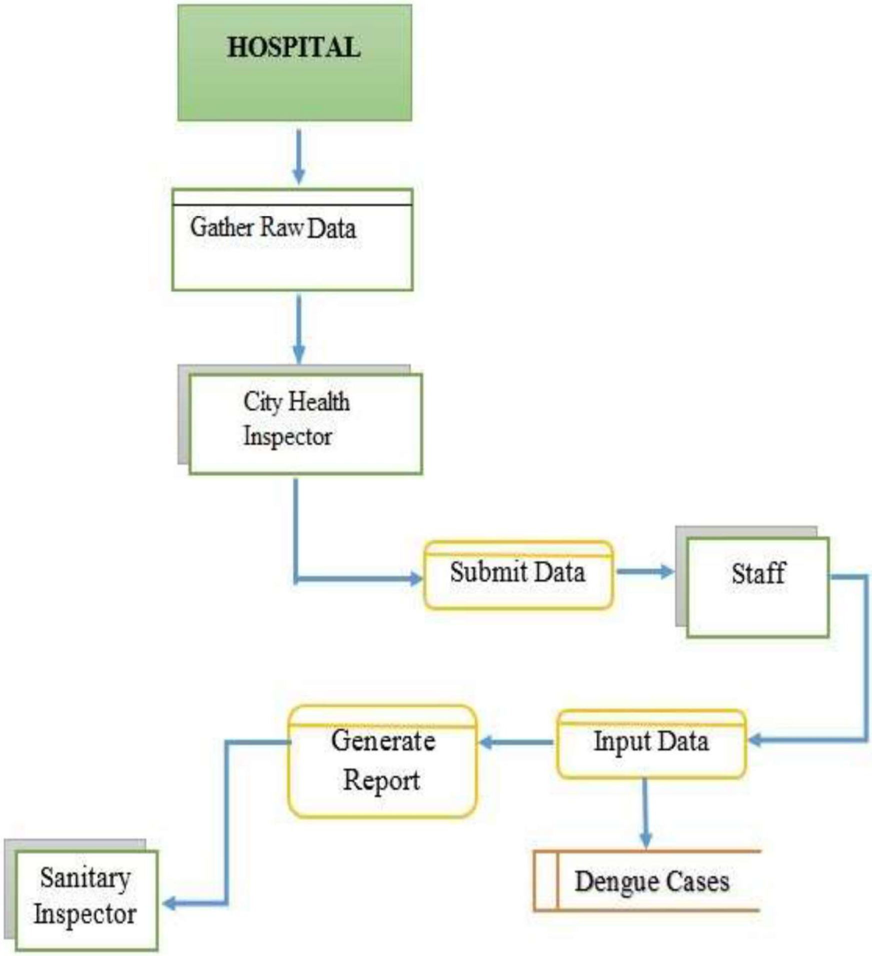
*Proposed Flow Chart*
The figure below shows the process of the proposed flow chart. The figure illustrates how the proposed flow of data maximizes the use of the data cases.

Figure 9 Proposed Flow Chart




*Current Data Flow Chart*
The figure below shows the current data flow in Digos City Health center and how these data are distributed and processed.

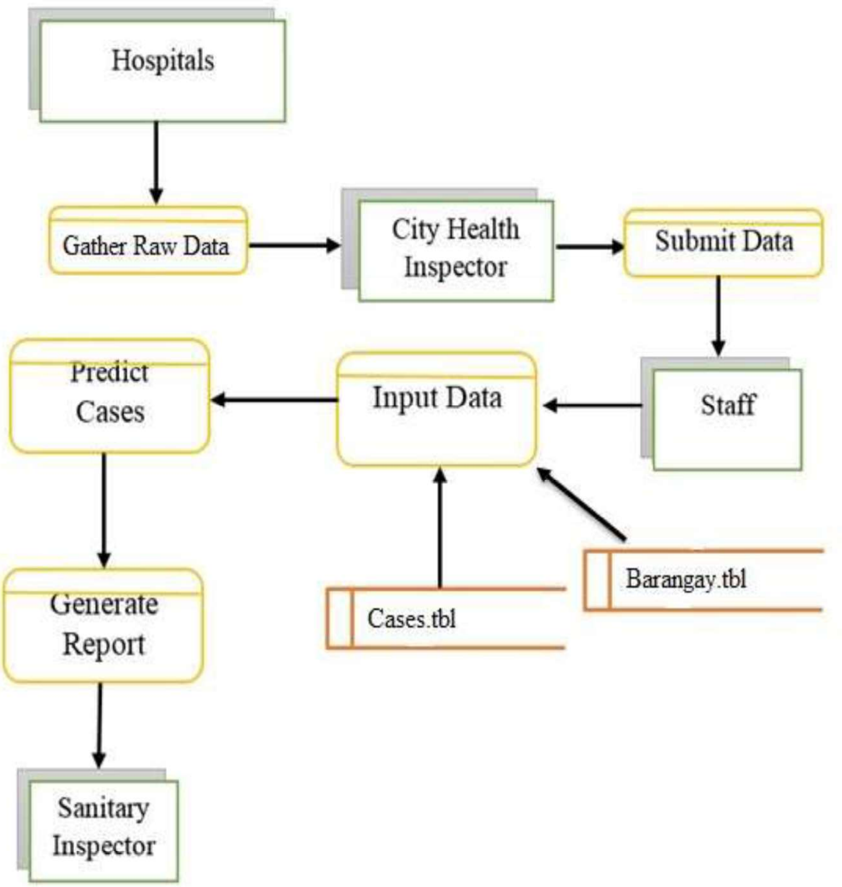
Figure 10. *Current Data Flow Chart*




*Proposed Data Flow Diagram*

The figure below shows the proposed flow of data. It illustrates how the system will integrate its output and contribution to the overall report.

***Figure 11**. Proposed Data Flow Diagram*




*Development and Testing*

The Development and Testing will focus on which the software life cycles and methods are part of the structure implemented while developing and creating the entire application. Testing is done to assess whether the application is ready to be promoted to the next level of production testing.

The developers will know by testing the application if it is already met the needs of the users. This kind of test is very important in any application to test its functionalities and test if it is working properly or not and if the user interface is accepted.

The researchers gathered as much data for dengue cases history as the basis for the prediction provided by Digos City Health center.
To find out the accuracy of the system's prediction, using the researcher's statistical model, they tested to see if the model's accuracy was acceptable by comparing the actual data versus the predicted data.

*Software used:*
a. Chrome
b. Xampp
c. Sublime

*Hardware used:*
a. PC
b. Laptop

## RECOMMENDATION

This section contains the recommendation regarding the created Prediction on the Trend of Dengue Cases in Digos City w/ Decision Support System Using Statistical Formula. The following are the recommendation of the researchers.

The proponents suggested that the researchers' system should be maintained for better usability and should have a back-up server so that all data will be protected. Future researchers must have additional functionaries to expand the usability and capabilities of the system. The system hasn't been perfected yet due to Digos City Health's limited data, which could have helped the system's accuracy, and results may vary a lot.

*Implementation Plan*
To use the proposed system correctly, the user must be computer literate. The user should be oriented on how the proposed system works.

To implement the proposed system with the user, they must first download and install a software called XAMPP as the system's database and place the system in XAMPP's directory folder. The users must then download and install a web browser; we recommend using the Google Chrome web browser.

The design made by the researchers should be maintained for user usability and efficiency. If applicable, there should be a back-up server so that all data will be protected. Thus, research information is best assured from not losing it. The proponents also recommend that the IT Department assign IT personnel who will assist and mandate the research personnel for excellent management and maintenance.

*Budget Recommendation*

The purpose of this is to view the total cost it requires for the system to work as intended. The researchers would recommend building a budget PC as the system does not require a powerful spec computer to run it.

***Table 2.*** *Hardware Requirements*

| Hardware Requirements | PRICE |
|---|---|
| CPU - AMD APU A5 Series processors | P 1,800.00 |
| Memory Modules – 2 GB ddr3 1333/1600/1866 mhz | P 1,000.00 |
| Motherboard – EMAXX Motherboard | P 1,800.00 |
| PSU – Deep Cool 600w Power Supply | P 1,700 |
| PC Case | P 1,000 |
| Display Monitor – Acer LED Monitor | 4,000 |
| Hard Disk Drive – SEAGATE HDD 250 GB SATA | P 1,640.00 |
| Router – TP-Link Router | P 1,020 |

*Software*

***Table 3.*** *Software Requirements*

| SOFTWARE Requirements | Price |
|---|---|
| Operating System – Windows 7 or 8 | 5,600 |
| XAMPP | FREE |
| Google Chrome | FREE |
| TOTAL | P 5,600 |
| **Grand Total** | **P 11,840.00** |

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