"TBCONTROL: TUBERCULOSIS INCIDENCE FORECASTING SYSTEM IN BANAYBANAY, DAVAO ORIENTAL USING LINEAR AND SEASONAL TRENDS"

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BITER, GRAZELLE E.

GUARDARIO, JEAN MAE M.

ABOS, JEPHANIE ANNE A.

Adviser

QUINDOYOS JR, RUBEN L.

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APPROVAL SHEET

This capstone project entitled **"TBCONTROL: TUBERCULOSIS INCIDENCE FORECASTING SYSTEM IN BANAYBANAY DAVAO ORIENTAL USING LINEAR AND SEASONAL TRENDS''** Prepared and submitted by **GRAZELLE E. BITER, JEAN MAE M. GUARDARIO AND JEPHANIE ANNE A. ABOS** has been examined and is hereby recommended for approval and acceptance.

Endorsed by:

RUBEN L. QUINDOYOS JR.
Adviser

APPROVED by the Capstone Project Committee on oral examination with the grade of _________.

NEIL A. MUTIA, MIT
Chairman
06/23/2022
Date

WILJONE E. CAPA
Member
06/23/2022
Date

DR. JOHN M. BAGCAL
Member
6/23/2022
Date

ACCEPTED as a partial fulfillment of the requirements for the degree of **Bachelor of Science in Information Technology.**

DR. EDNA B. BAGCAL
Campus Coordinator - BEC
6.30.22
Date

DR. ROSELYN V. REGINO
Director for Instruction
07.06.2022
Date

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ABSTRACT

GRAZELLE E. BITER, JEAN MAE M. GUARDARIO AND JEPHANIE ANNE A. ABOS. "TBCONTROL: TUBERCULOSIS INCIDENCE FORECASTING SYSTEM IN BANAYBANAY, DAVAO ORIENTAL USING LINEAR AND SEASONAL TRENDS" (IT Capstone Project). Davao Oriental State University Banaybanay Extension Campus. May 2022

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"TBCONTROL: TUBERCULOSIS INCIDENCE FORECASTING SYSTEM IN BANAYBANAY DAVAO ORIENTAL USING LINEAR AND SEASONAL TRENDS" Tuberculosis remains as one of the health problems in Davao Region (SunStar, 2018). At Banaybanay, Health Center, Davao Oriental, there are 1,307 cases in all ages from the years 2011–2021. There were 55.70% cured and 44.29% not cured. The death rate is 26.85%, with a 73% survival rate. There were several studies conducted in other countries that are similar about tuberculosis incidence forecasting, but it has not been conducted in Davao Oriental. In this case, the researchers uncover a proposal to develop a system for forecasting tuberculosis cases. This system has 3 modules that focus on the administrator, medical staff and guest users. The researchers choose linear regression in the study of TB incidence forecasting. Although it is an underestimated algorithm, as evidenced by the findings of existing research, linear regression has been used and may produce good results, showing that it is not outdated. As a result, the accuracy is 83.9% and the MAPE (Mean Absolute Error) is 16.81%. The result shows that the study provides a good result that can help to forecast the future number of tuberculosis cases.

CHAPTER I
INTRODUCTION

Tuberculosis is found all throughout the world. The WHO South-East Asian Region had the newest TB cases in 2020, accounting for 43 percent of new cases, followed by the WHO African Region with 25 percent and the WHO Western Pacific with 18 percent (Tuberculosis, 2021). India, China, Indonesia, Philippines, Pakistan, Nigeria, Bangladesh, and South Africa have accounted two-thirds of new TB cases. The likelihood of an individual becoming infected and developing the disease is determined by a number of variables, including socioeconomic determinants of health and social inequities that influence Latin America and, as a result, the country (Santos FLD1, 2021). The spread of tuberculosis is a major problem. To accomplish TB extinction, more investment in TB prevention, detection, and treatment is needed (Centisa, 2017)

For global TB prevalence rates, behavioral characteristics and demographics such as occupation, age, cigarette and alcohol usage, poor nutrition, and household are significant (Lytras, 2017). In the Philippines, tuberculosis is the seventh-largest cause of illness and mortality (Holohan, 2006-2011). Many of the multimillion-dollar programs that were developed have improved its diagnostics, medicines, and vaccinations. These were managed under the name of the Stop TB Partnership and are now receiving significantly more support (Jamison et al., 2006). Further, many extensive studies have looked into the costs, efficacy, and cost-effectiveness of various TB control strategies.

Tuberculosis remains to be a health problem as presented by the Department of Health (DOH) in Davao Region (SunStar, 2018). Data obtained from the DOH-Davao showed that there were 12, 890 tuberculosis cases noted as of February 2017, where 742 cases were children while 2016 has 13, 501 cases with 916 children.

There were several studies conducted in other countries that are similar about tuberculosis incidence forecasting, but it has not been conducted in Davao Oriental. In this case, the researchers uncover a proposal to develop a system for forecasting tuberculosis cases. The researchers choose linear regression in the study of TB incidence forecasting. Although it is an underestimated algorithm, as evidenced by the findings of existing research, linear regression has been used and may produce good results, showing that it is not outdated.

One of the existing studies is entitled "Pandemic coronavirus disease (Covid-19): world effects analysis and prediction using machine-learning techniques". In this study, the research forecasted the number of cases in COVID-19 in 2020. The machine learning methods used in this work include Naive Bayes, Linear Regression, and SVM. The Naive Bayes Mean Absolute Error is 488806.7492, which is lower than the Linear Regression's 648733.0991 and the SVM's 718150.1344, which has a large number of errors (Dimple, 2021) . Another study is "Forecast COVID-19 development and trend" in which Support Vector Machine, Linear Regression, and Holts Winter Model Prediction are among the machine learning approaches used in the said research (Gothai, et al., 2021). The results of each algorithm were compared to total confirmed cases in 2020. In 2020, there were 67,199,309 real instances, which was compared to the outcomes of each algorithm. The Holt's Winter Model forecast was ranked first since it was practically identical to the true outcome at 58,850,358; linear regression was second at 44,885,167; and the SVR was third with a total number forecast of 24,290,160.

In this present study, it uses the data of tuberculosis patients from Banaybanay Health Center in Davao Oriental. Some information about patients, like names and other personal data, are not included in order to ensure privacy, confidentiality and safety. The data from 2011–2021 was gathered and used as a foundation in this study. There are 1,307 cases in all ages, 55.70% are cured and 44.29% are not cured. The death rate is 26.85%, with a 73% chance of survival. Data is used to analyze and undergo some processes and algorithms to create a forecasted result. The algorithms that are used are linear and seasonality trends.

1.1 Purpose and Project Description

The purpose of this research is to assist the health center or any other organization in forecasting tuberculosis disease rates for the future year. It is important to forecast the possible rate in order to prepare for and avert an increase in tuberculosis disease rates. This approach would forecast the rate and number of expected tuberculosis cases in the coming year. Medical professionals can utilize the technology to forecast the rate based on historical data available in their facility and to quickly determine the number of probable cases.

1.2 Objectives of the study

The general objective of this research is to develop a system that can help users forecast the incidence of tuberculosis disease.

Specific Objectives

In line with the general objective, this research has specific goals which are the following:

- **To forecast tuberculosis disease incidence case numbers in every barangay in Banaybanay, Davao Oriental using Linear and Seasonal trends.**

  The linear and seasonality trends under the time series algorithm would be used to forecast the possible cases of TB in each barangay in Banaybanay, Davao Oriental. When data changes over time, the seasonality trend line will be used to illustrate and to determine if the data is moving up or down. By aggregating all of the cases in each month for all years, the seasonal pattern may also be utilized to estimate future possible incidents. For example, all the January cases would be added from the data's ten-year history. As a result, linear and seasonal trends would be able to create an analysis of data and forecast the possible number of incidents that will happen in the coming year.

- **To present the location of tuberculosis disease cases by barangay using leaflet, a JavaScript library for interactive maps.**

To present the location of tuberculosis cases, the variables that should be used are the name of each barangay and the number of cases from the historical data. This map would help medical staff and end-users easily identify the location that has the possible highest or lowest case of tuberculosis disease. Users can choose the range when viewing the cases; it's either the overall history or a custom range. Overall, this means they can view all cases depending on the data imported, and with custom, they can customize what year they want to view.

- **To generate a graphical representation of the forecasted incidence number of Tuberculosis disease using line graph chart**

The forecasted result can be displayed by this system using a graphical chart, which is a line graph. The line graph is the common chart that would display the results to help medical staff and end-users easily understand the results. It is a simple presentation that would elaborate on the result and give the users an insight into it. It has an x and y axis that depicts the relationship between two variables: the number of cases and the year/months.

- **To introduce a system to capture the data of the concerned agency that will be used to forecast the number of tuberculosis cases.**

This system can capture data from an organization and forecast the number of TB cases for facilities such as hospitals or any other health facility. To collect data from the agencies, they must use the format provided by this system. This can be used as a pattern to generate a forecasted data collection by capturing huge amounts of data. This data set provides insight into future situations, particularly for medical personnel, allowing them to plan ahead of time based on the expected outcome.

1.3 Significance of the Study

The system would be helpful to the following:

1.3.1 To the medical staff

Medical staff have the advantage of being able to quickly add, edit, update, and remove new Tb case data. Also, they can easily keep track of the present number of cases and the forecasted number of TB diseases in the following year, allowing them to prepare ahead of time. In addition, they can immediately see which locations have the most instances of TB cases, so they can focus their efforts there.

1.3.2 To the guest users

Patients, guests, and Banaybanay residents can observe a possible occurrence of TB disease and in this way, they can be aware of the number of instances and can prepare themselves to prevent contracting the disease. They could look at the analytic page, which shows the forecast result and the heatmap, which shows the different barangays' number of instances in order for them to be updated.

1.3.3 To the future researchers

This strategy could be used to lead further forecasting projects in the future and can be used as basis for future research studies. In that way, they would have a better idea of where to start. If they wish to improve the system, they must first obtain permission from the researchers. This will help future researchers understand the project's forecasting system in terms of tuberculosis incidence and case numbers.

1.4 Scope and Limitation

The data from tuberculosis positive patients at Poblacion, Banaybanay Health Center in Davao Oriental was the focus of this study. The eleven-year period from 2011 to 2021 would be covered by the historical data. Tuberculosis cases per year, age, gender, barangay, wellness, and the life status of tuberculosis patients in Poblacion, Banaybanay, Davao Oriental were used as variables.

Only those who have been diagnosed with tuberculosis would be included in the study. Because of factors that are not available from our sources, our system would be able to forecast tuberculosis incidence. This system is intended for laptop and computer users only and not for Androids.

CHAPTER II
REVIEW OF RELATED LITERATURE AND SYSTEM

This chapter provides the researchers' findings on relevant literature and studies that supported the development of this project.

2.1 Review of Related Literature

2.1.1 Pandemic Coronavirus disease (COVID-19): World effects analysis and prediction using machine-learning techniques.

Researchers and medical groups all around the world have urged for alternative prediction approaches and rapid screening protocols to prevent the pandemic since the COVID-19 pandemic. Machine learning and artificial intelligence are highly valued by healthcare firms. As a result, the researchers employed machine learning techniques such as Nave-Bayes, SVM, and Linear-Regression to anticipate the outbreak's future growth and effects on the COVID-19 real-time dataset. The presentation demonstrates that Nave Bayes outperforms and predicts better-COVID-19 confirmed instances than Regression and SVM with the lowest MAE and MSE value. Whereas SVM produces higher MAE and MSE values, Linear Regression produces lower MAE and MSE values and predicts better. The Nave Bayes predictions are almost identical to the actual verified Coronavirus cases. As a result, future forecasting of COVID-19 instances using Nave Bayes is more reliable than SVM and Regression (Tiwari, 2021).

2.1.2 Prediction of COVID-19 growth and trend using machine learning.

The overall goal of the proposed research is to apply supervised machine learning algorithms to assess worldwide COVID-19 data and forecast the total number of global reported cases in the future. (Thamson, 2021). When compared to the LR and SVR algorithms, this work provided a time series forecasting Holt's winter model that has better accuracy in predicting future data. In addition, this study utilized Python libraries to analyze and reflect the current trend of COVID-19 in the world using visual representation and to observe the curve depending on the disease's monthly trend internationally. We aim to expand our operations in the future to include real-time deployment.

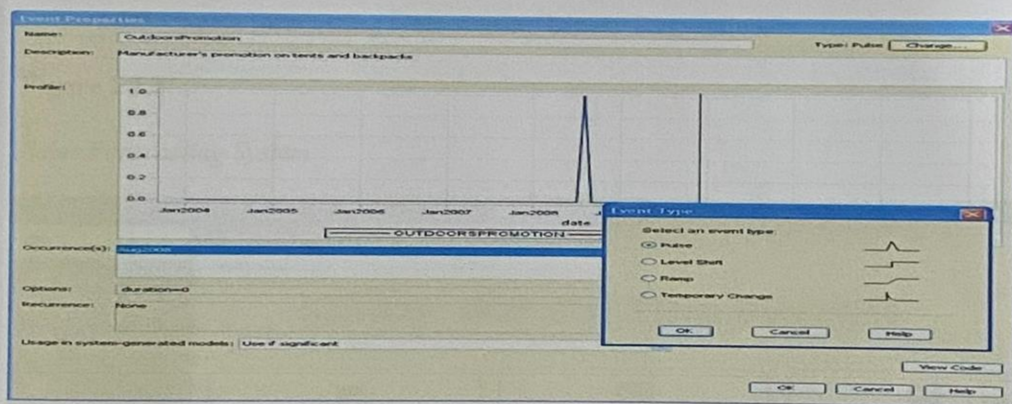
Review of Related Systems

The following are the relevant systems that the proponents used to develop the system.

2.2 Desktop Forecasting for Small and Midsize Businesses

Figure 2.2.1

Desktop View



Users may use SAS Forecasting for Desktop to create forecasting projects, execute automatic forecasting, and find exceptions. If desired, users can overrule forecasts and build their own models. (SAS Forecasting, 2022) . Top-down, middle-out, and bottom-up forecast reconciliation are provided by the system to facilitate hierarchical forecasting procedures.

The New Project Wizard leads the analyst through the last, optional step of selecting extra forecast parameters once the fundamental components of a forecasting project have been specified, variable roles assigned, and events produced.

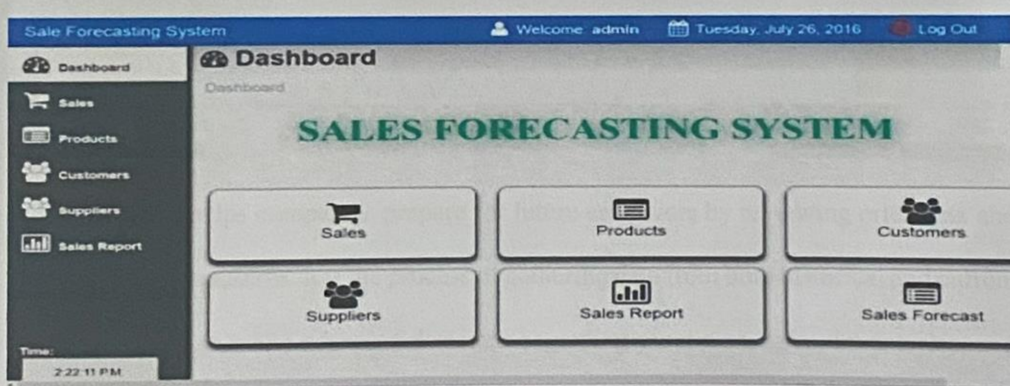
SAS Forecasting for Desktop combines the capability of SAS forecasting with the ease of use and affordability of a desktop application. It uses a user-friendly GUI to offer beginner forecasters with SAS' time series diagnostics, model construction, and automatic forecasting capabilities. Advanced users can access more complex features using the GUI's options.

2.2.2 SAS or other software can be used to publish forecasting findings or perform extra analysis (such as Microsoft Excel). SAS Forecasted for Desktop stores all forecasting data in SAS data sets.

2.2.3 Sales forecasting system using Linear Regression.

Figure 2.2.2

Sales Forecasting System



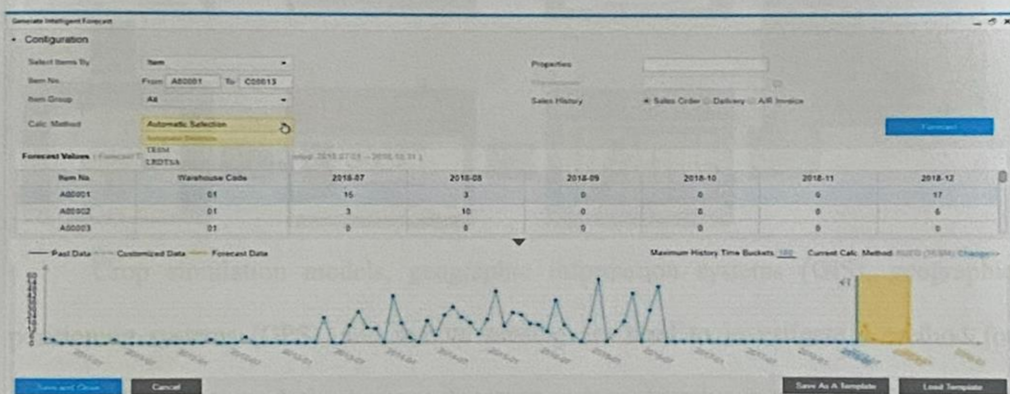
"Sales Forecasting System" is a sales system that uses point of sale (POS) technology to achieve its sales, accounting, and linear regression model for forecasting sales. Supplier registration and management, product management, user management, customer management, sales report, receipt printing, and sales forecasting are all part of the system (Sales Forecasting, 2022)

The purpose of this research was to expose several weaknesses in typical sales forecasting management systems. An accountant must do forecasting calculations on a regular basis using a certain sales model formula. Because forecasting takes a long time, regardless of whatever model the sales manager, accountant, or financial consultant uses, using these old approaches throws substantial limits on sales forecasting.

2.2.3 Forecasting for manufacturers with intelligent ERP software

Figure 2.2.3

Forecasting for manufacturers with intelligent ERP software



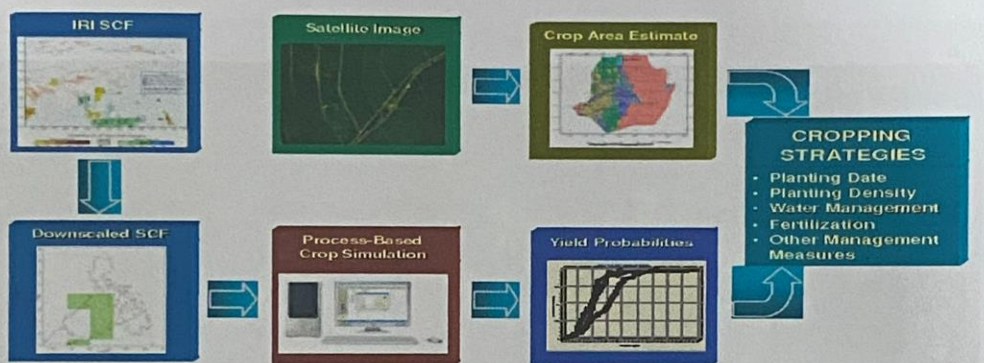
Forecasting helps companies prepare for future endeavors by reviewing prior data and identifying trend patterns. It is the process of gathering data from both historical and current sources in order to make educated decisions regarding purchases, sales, inventories, and other matters (Intelligent Forecasting, 2019). Traditional forecasting is rarely accurate, which leads to deficits and new company problems. Past performance will never be able to predict or reflect the future of a company.

2.2.4 Every contemporary firm aspires to increase operational capacity, cut costs, and increase profits. Trend models, segmentation, regression, exponential smoothing, and moving average are more accurate than historical forecasting methods such as traditional time-series forecasting, so it is a good idea to replace traditional forecasting with smart, precise, and mature predictive models based on sophisticated technology. It encourages educated and detailed future decision-making.

2.2.5 Developing a Crop Forecasting System in the Philippines

Figure 2.2.4

Crop Forecasting System in the Philippines



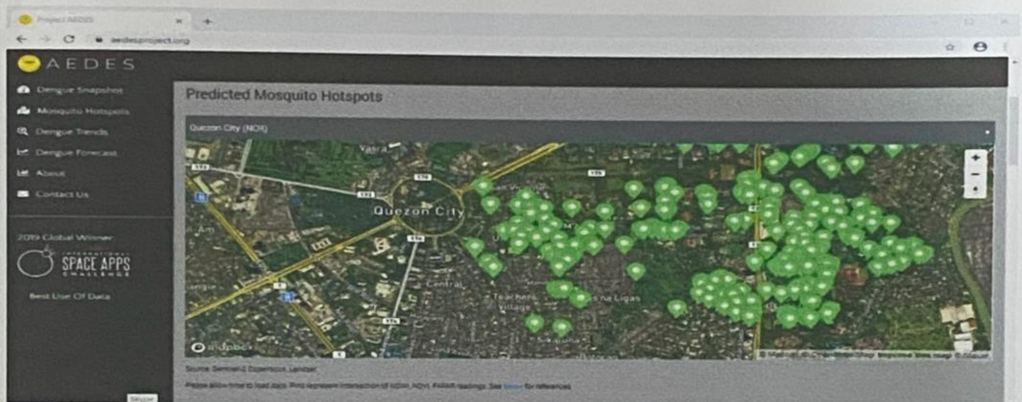
Crop simulation models, geographic information systems (GIS), geographic positioning systems (GPS), and remote sensing are used to investigate a method for producing accurate and timely crop forecasts using objective systems analysis-based procedures and methodologies that rely on advances in information and communication technologies, as well as the use of systems tools like crop simulation models, GIS, GPS, and remote sensing (Lansigan, 2007). A knowledge-based crop forecasting system (KCFS) may be used to estimate crop production using advanced seasonal climatic information. The KCFS involves four activities: (1) seasonal climate outlook analysis and downscaling; (2) crop yield calculation utilizing climate data; (3) cropped area determination; and (4) distribution of crop forecast information.

To obtain better resolution, a downscaled seasonal climate prediction for the province is employed (daily weather data). A locally verified crop simulation model uses synthetic sequences as inputs. To identify the area sown to the crop more precisely, remote sensing and GPS technologies are used.

2.2.6 Pinoy-Made Dengue Case Forecasting System

Figure 2.5

Dengue Case Forecasting System in Philippines



Dengue fever is an infectious illness carried mostly by the mosquito Aedes aegypti. It is one of the country's most critical health issues. Last year, the Department of Health (DOH) declared dengue fever a nationwide pandemic. The World Health Organization (WHO) reported 271,480 dengue illnesses and 1,107 fatalities in the nation from January 1 to August 31, 2019. With this in mind, a group of Pinoy technologists set out to harness space data to help limit the spread of the fatal disease, an endeavor that won them a berth in the 2019 NASA International Space Apps Challenge (Francisco, 2020).

Data from the Sentinel-2 Copernicus and Landsat 8 satellites, climate data from the Department of Science and Technology-Philippine Atmospheric, Geophysical and Astronomical Services Administration (DOST-PAGASA), and Google search trends (for keywords like 'dengue,' 'dengue symptoms,' 'dengue fever,' and 'dengue medicine') are compared to existing data on dengue cases and deaths. This data might be used by AEDES to identify areas that could become mosquito breeding grounds and highlight potential dengue hotspots via a web interface.

CHAPTER III
METHODS AND MATERIALS

This chapter elaborates the technologies that were utilized to achieve the desired output. Specifically, it presents the algorithms that would be used to achieve the study's purpose.

3.1 Details of the Technologies and Algorithms being used

In the development of this system, the primary process is using laptops to assist the proponents in performing actions and functionalities in the system. We also access the internet via Wi-Fi connection. The most important are the algorithms that serve as foundation for achieving systems objectives.

3.1.1 Seasonality Trend

Seasonality is a trend that shows up in time-series data at regular periods. This is in contrast to conventional cyclic patterns, such as the increase and fall in TB case numbers, which occur on a regular basis but have no fixed duration.

3.1.2 Linear Trend

Linear trends are characterized by constant, straight-line gains or falls, with the trend-line pointing up or down, with the angle ranging from severe to shallow. The idea describes linear trend forecasting's aims and uses, as well as the fundamental components needed to achieve it.

3.1.3 Visual Studio 2022

Visual Studio.NET gives developers quick access to underlying server functionality, like message queuing and event monitoring, as well as a range of designers from the Visual Studio.NET environment. (William, 2002). Designers are important personnel of Visual Studio.NET since they help developers through the intricate construction of individual components. XML Data Designer, Web Services Designer, Windows Forms Designer, and Web Forms Designer are some of the designers that make it simple to access created code based on class frameworks. The developer has access to the created code, which he or she may alter or contribute to.

3.1.4 Asp.Net Core Blazor Server

Blazor is a new web framework that expands the capabilities of.NET online applications. It is also a C#-based client-side web UI framework rather than JavaScript. Blazor provides full-stack web development with.NET when used in conjunction with.NET operating on the server. Blazor and ASP.NET Web Forms have a lot in common (Nish, 2020). For example, having a reusable component model and a straightforward method of handling user interactions. It also leverages on.NET Core's fundamentals to give a contemporary and high-performance web development experience.

3.1.5 MongoDB

MongoDB was created with scalability in mind. Its document-oriented data paradigm allows data distribution across different servers easy. MongoDB balances data and load throughout a cluster automatically, redistributing documents as needed, and directing user requests to the appropriate servers. This lets developers to concentrate on the application's programming rather than its scalability (Chodorow, 2013).

3.1.6 C# Programming Language

C# is a high-level language that is related to Java and C++, as well as Delphi, VB.NET, and C to some extent. C# is an object-oriented programming language. (Dimitrov, 2013). They are made up of a collection of definitions in classes that include methods, and the methods themselves contain the program logic - the instructions that the machine follows.

3.1.7 Docker

Docker adds an application deployment engine on top of a virtualized container execution environment which is quite easy to be used (Turnbull, 2017). It is intended to provide a lightweight and fast environment for running your code, as well as an efficient workflow for moving that code from your laptop to your test environment and finally into production.

3.1.8 Microsoft Excel 360

Excel workbooks are a convenient way to store and organize data, but Excel is capable of much more. You may simply do a range of calculations using the built-in tools, from simple tasks like totaling to complicated financial computations (Lambert & Frye, 2021). Excel can display information such as the current date and time, the maximum value or number of blank cells in a data collection, and the cells that fulfill specified criteria, as well as utilize this data when doing computations.

3.1.9 Bootstrap v5.0

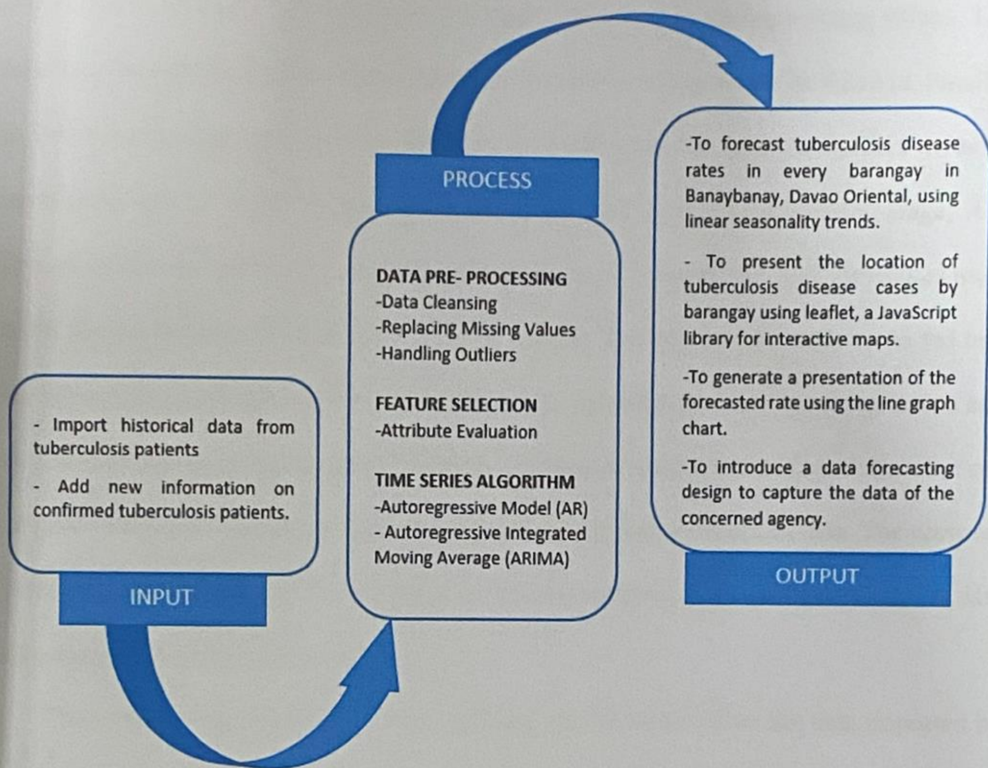
Bootstrap includes a number of jQuery components that are known to be stable in modern browsers and compatible with your current jQuery version. Furthermore, the style is consistent across your project (Lett, 2017).

3.1.10 Chart.js

Chart.js is an open-source library developed by the community that makes it simple to visualize data using JavaScript. Chartist and Google Charts are comparable. It has eight distinct chart kinds which include bars, lines, and pies among others all of which are responsive. To put in another way, we only need to set up our chart once, and Chart.js will take care of the heavy lifting and ensure that it is constantly readable (Ahlin, 2017).

Figure 3.2

Conceptual Framework



The concept and flow of this system are shown in the diagram above. It is divided into three categories in order to facilitate the completion of this capstone project. The first step is input, where historical and new data of TB patients would be entered into the system and stored in the database. The data are derived from health organizations that include information about the patients with tuberculosis diseases. This information is used as a foundation for forecasting. This historical data can help in generating new forecasting results.

The next step is the process. Entering the data into the system would go through several stages. First is the preprocessing. It includes data cleansing to remove all the unnecessary data that is not useful in this study. Second is replacing missing values. The data must be complete and without gaps, so any missing values would be filled in. Finally, in order to forecast tuberculosis diseases, it is necessary to remove outliers or non-correlation data in order to focus only on useful data. In the preprocessing stage, it is important to select a relevant attribute that can be used to attain the goal. Attributes must be fit for use in forecasting to get an accurate result. The data is now ready to be fed into the algorithm after preprocessing. The time series algorithm features linear regression and seasonality trend forecasting patterns that can be used to build a forecast result line that can be used to comprehend the upwards and downwards or stable pattern of data. The seasonal is then used to construct a future forecast result by studying seasonal cases from the data sets during the first eleven years.

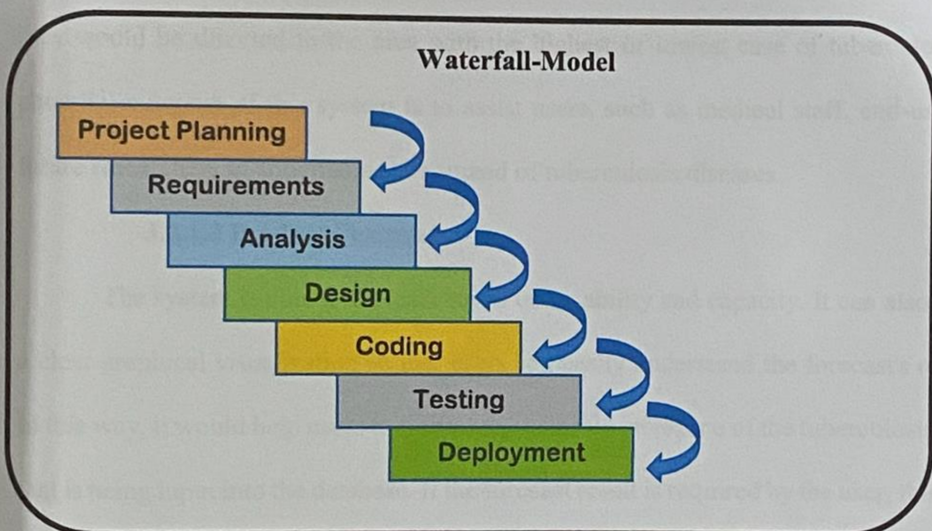
The output is the final stage; it can produce an output based on the data imported by following the steps from input to process. If the first and second phases are completed successfully, the process would be complete. The study's objectives would be met once all of the procedures were completed. These are the key characteristics of this system that would assist users in meeting their requirements. This research would focus on using historical data to anticipate tuberculosis disease rates and apply this approach to all of the requirements.

3.2 Software Methodology

In order to build this system, the proponents use waterfall as a method. This technique consists of a series of steps that must be followed in order to achieve a more ideal general construction of the developed system.

Figure 3.3

Waterfall Process



The waterfall model is a conventional and arguably "out-of-date" project management technique in software engineering. Because it is linear and sequential, it is termed a waterfall. It always goes ahead, without taking a single step back, much like a waterfall. Each waterfall phase follows the other and has well defined goals and timeframes. The waterfall method's main objective is to gather and clarify all needs up front, preventing development from continuing "downhill" without the ability to make adjustments.

3.2.1 Requirements Specification

To construct this tuberculosis disease forecasting system, information is gathered and evaluated before being correctly constructed to achieve the system's goal. It should perform in accordance with the expected results.

3.2.1.1 Product Perspective

This system allows users to forecast tuberculosis diseases. It would assist in the creation of a simple graphical chart that shows the forecasting results. Using a heatmap, they would be directed to the area with the highest or lowest case of tuberculosis. The potential outcome of this system is to assist users, such as medical staff, end-users, and future researchers in anticipating the spread of tuberculosis diseases.

3.2.1.2 Product Features

The system is able to forecast based on its ability and capacity. It can also provide a clear graphical visualization so that users can easily understand the forecast's outcome. In this way, it would help users to foresee the possible incidence of the tuberculosis disease that is being input into the database. If the forecast result is required by the user, this system can provide a copy if the administrator has approved the request to print out a copy.

3.2.1.3 User Classes and Characteristics

a) **ADMINISTRATOR-** It would be in charge of the entire system, from data monitoring to user management. The administration would add medical personnel and data into this system. Further, it is the responsibility of the administration to safely keep the information of the medical staff for their privacy and confidentiality.

b) **MEDICAL STAFF-** They can enter data and request forecasting to learn more about when tuberculosis disease outbreaks are likely to occur. They can plan ahead of time or devise a strategy to reduce the number of cases in tuberculosis disease if they notice that it is increasing.

c) **END-USERS-** They can view the results to gain an understanding of the most prevalent tuberculosis diseases in their area. Patients play the role of viewers who are concerned about the spread of tuberculosis diseases in their area.

3.2.1.4 Operating Environment

The researchers used various system development software tools, concepts, and technologies to help launch the system.

3.2.1.5 Software Components

The system would develop using the following methods by the system's proponent.

Table 3.1

LOCAL SERVER	Asp.Net Core Blazor Server
DATABASE	MongoDB
DESKTOP APPLICATION EDITING TOOL	Visual Studio
PROGRAMMING LANGUAGE	C# Programming Language
DIAGRAM TOOL	SMART DRAW
IMAGE EDITING TOOL	ADOBE PHOTOSHOP

Software Components

The table presented here lists the software components that would be used in this system development. The Asp.Net Core Blazor Server, which functions as a local server, would be the first piece of software used in this study. It would be used to run the program and verify its functionality before it is officially released. The database, MongoDB, acts as a data repository, storing data and allowing queries to be run. Another is the C# Programming Language, which would be used as a coding language. This could be used as a tool to assist the developer in developing the system's concept. Smart Draw would be used for editing to create an entity diagram and additional diagrams for this project. Because all types of forms are accessible, it is simple to use. Finally, Adobe Photoshop is used to modify photographs in order to make them more realistic for the system.

Hardware Components

The following hardware would be used in the development to implement the system.

Table 3.2

Hardware Components

DESKTOP APPLICATION	INTEL(R) CORE™i3-713OU 2.7GHz, 3MB L3 Cache)
	4Gb DDR4L MEMORY
	64-bit operating system, x64-based processor
	64-bit operating system, x64-based processor

The hardware components that would be used in system development are listed in the table above. The Corei3 laptop would be used. It has multiple speeds ranging from 2.7 GHz to 3.50 GHz and a 3 MB cache. The Core i3 processors are dual-core, having two cores. However, a selected few high-end Core i3 processors are quad-core featuring four cores. This laptop is capable of running all of the applications and software required for the development of this system. It is important to first check the capacity of the hardware before planning the development process.

3.2.1.6 Design and Implementation Constraints

This system is accessible via laptops and computers. The design is simple enough for anyone to understand. In this case, we would provide a manual guide on how to use this system so that users are not confused by its functionalities in order to enable them to use it properly.

3.2.1.7 User Documentation

The proponents would provide a user manual so that the user could understand how to use the system. The documentation includes screenshots of system pages and functions that users can utilize to learn its usage.

Other non-functional requirements

The proponents provide different requirements to establish authentic information about the tuberculosis disease rate forecast to make sure that the user is safe in dealing with this system.

Performance Requirements

Table 3.3

Performance Requirements

Requirements	Description
PO1	The system may be able to handle a user's request and process it in accordance with its functionality.

The table above displays the performance that was accomplished by this system. The objectives must be met in all of the processes and all of its features must function properly. The main goal of this study is to enable them to produce a system that is useful and capable for the users to ensure satisfaction. The requirements outlined above would direct our efforts toward developing a system capable of forecasting the prevalence of tuberculosis diseases.

3.2.1.8 Operational Requirements

Table 3.4

Operational Requirements

Requirements	Description
DO1	The system links to the database, which holds all of the information in all of the system's input data.
DO2	The system must have authorized personnel to manage the information and operation.
DO3	To prevent unauthorized access to the system, the system provides a username and password.

The table above gives descriptions of each condition that must be met. The data would be stored in a database and be obtained during the request for forecasting which is one of the requirements in Description One, or DO1. To complete the operation, the system must connect to the database. The DO2 system requires an authorized individual to handle the entire system and to keep track of who has access to it. To prevent unauthorized access to the system, DO3 would have a security feature that requires users to provide a unique login and password. In this way, the data and other vital information in this system can be safeguarded.

3.2.2 Analysis

3.2.2.1 Technical Feasibility

A system for forecasting the rate of tuberculosis diseases is feasible in solving the problem of informing users ahead of time in the case of tuberculosis disease. It is not a costly project since the hardware and software components are available and not paid for. This system's timely process would be taken into account to ensure better performance and quality. This project's development would be estimated based on its functionality, features, and objectives which would take more time to complete.

When a problem occurs during development, the developer must find other ways to continue this project. If the software components have a problem with how it is used, then there are still a lot of available software to use. When the hardware components are unable to perform a function or run an application, the developer would inspect them and prepare its usage with alternative computers or laptops.

3.2.2.2 Economic Feasibility

This project has no trouble budgeting money for funding. It is a project in which all materials are available for free and no employees need to pay. It is a project in which our team provides all the materials needed. What is more essential are the time and effort needed to be spent in the whole duration of this capstone project. Thus, it requires full-time development and planning to successfully finish this project.

This project allows the developer to contribute positive effects by ensuring that it is useful and helpful to the users in terms of their forecasting needs. In this way, it is a pleasure to assist health facilities and medical personnel in easily monitoring tuberculosis disease cases through forecasting.

3.2.2.3 Operational Feasibility

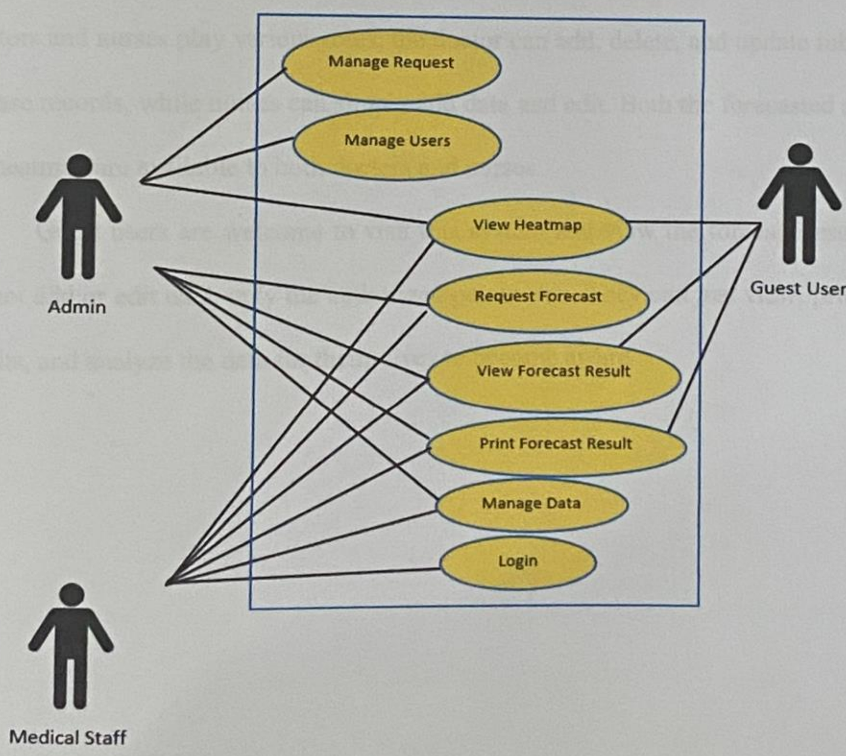
In this project, the intended organization, which is the Health Center in Poblacion, Banaybanay, Davao Oriental is expected to show support and allow the team developers to use the historical data of the patients that have tuberculosis disease in order to come up with more reliable data and information. The genuine acceptance of the request from the organization can help in developing a system.

3.2.3 Design

3.2.3.1 Use Case Diagram

Figure 3.3

Use Case Diagram



The above diagram depicts each user's role. They perform a variety of system functions. As seen in the diagram, one cannot do something which the others can. It provides a system that categorizes their responsibilities and benefits to meet the necessary requirements.

Medical personnel and guest users can be managed by the administrator's positions. The administrator would register every medical staff member that was assigned to a tuberculosis case. In registering the medical staff, they have user roles and permissions. Doctors can add a case, delete a case, and update a case, while nurses can only add a case and cannot delete any case. The administrator can also add, edit, update, and view forecast results.

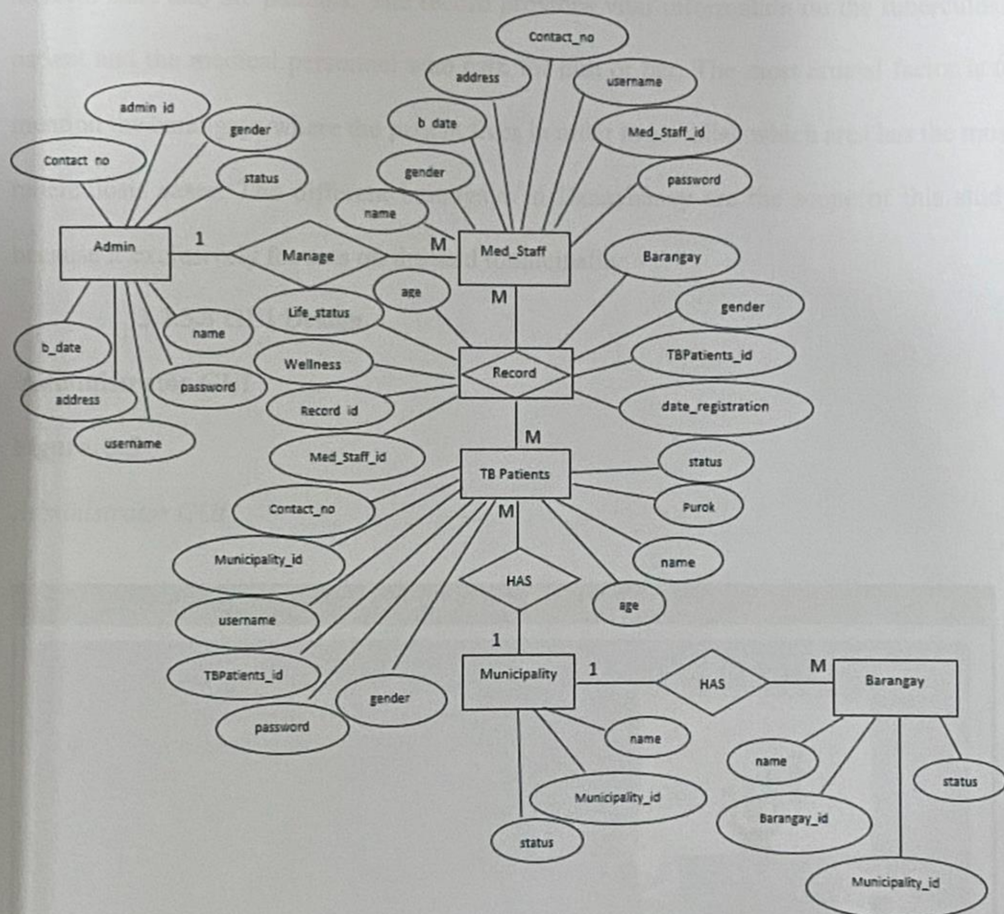
The medical personnel must first be registered by the administrator, after which the administrator would provide them with a username and password to log into the system. Doctors and nurses play various roles; the doctor can add, delete, and update tuberculosis disease records, while nurses can simply add data and edit. Both the forecasted result and the heatmap are available to both doctors and nurses.

Guest users are welcome to visit this system and view the forecast results. They cannot add or edit data; only the authorized person can. They can just view, print out the results, and analyze the data for themselves to become aware.

3.2.3.2 DATABASE DESIGN

Figure. 3.4

Entity Relationship Diagram (ERD)



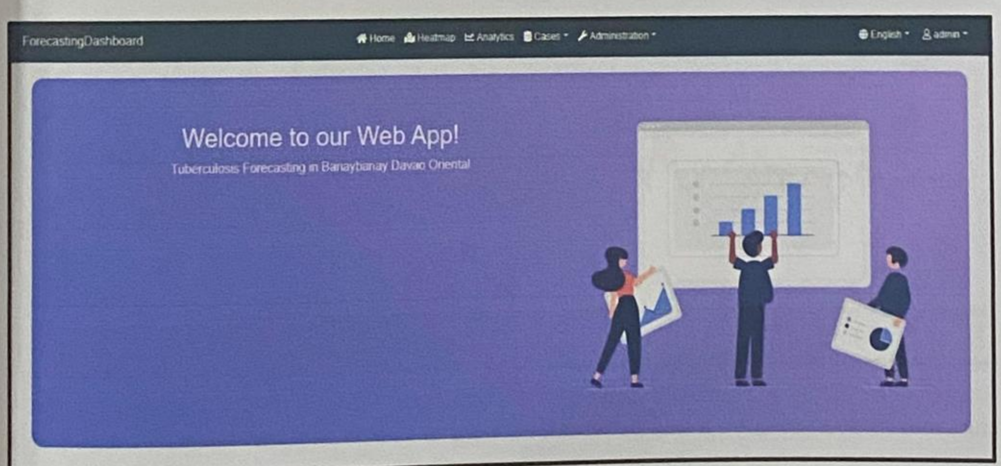
In the diagram below, the relationship between each one of them is shown. It explains how the various components of the system interact with one another and how they are connected. It also describes the database's content, such as entity attributes that would be stored. All entities and attributes would be visible in the database due to the compression of all data by this system. As shown in the diagram, the flow begins with the administrator who can manage the medical staff. This system only has one administrator but it can manage a large number of medical staff. The medical staff can then manage a large number of patients, and a large number of patients can manage a large number of medical staff. In this section, a new table called records was created. This contains all the records of the medical staff and the patients. The record provides vital information on the tuberculosis patient and the medical personnel who care for him or her. The most crucial factor is to mention the barangays where the patient lives in order to establish which area has the most tuberculosis cases. The different barangays in Banaybanay are the scope of this study because it exclusively focuses on the said municipality.

3.2.3.3 GUI Design

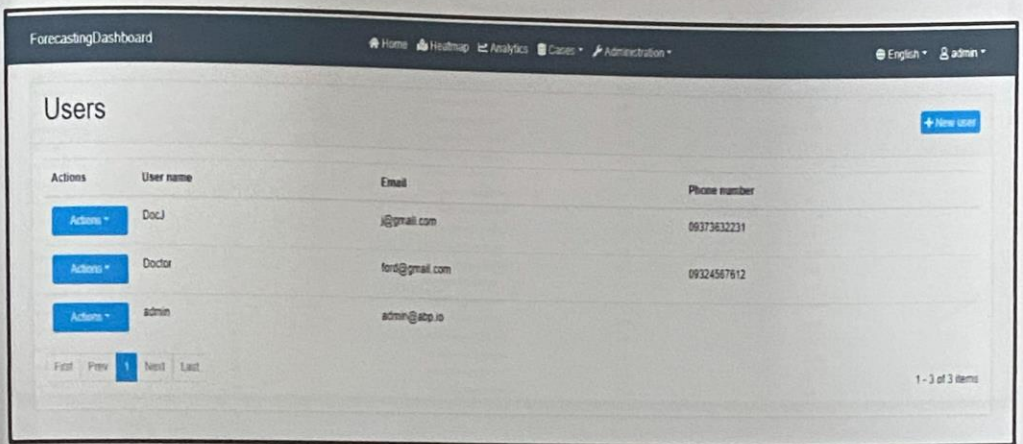
Administrator GUI

Figure. 3.5

Administrator GUI

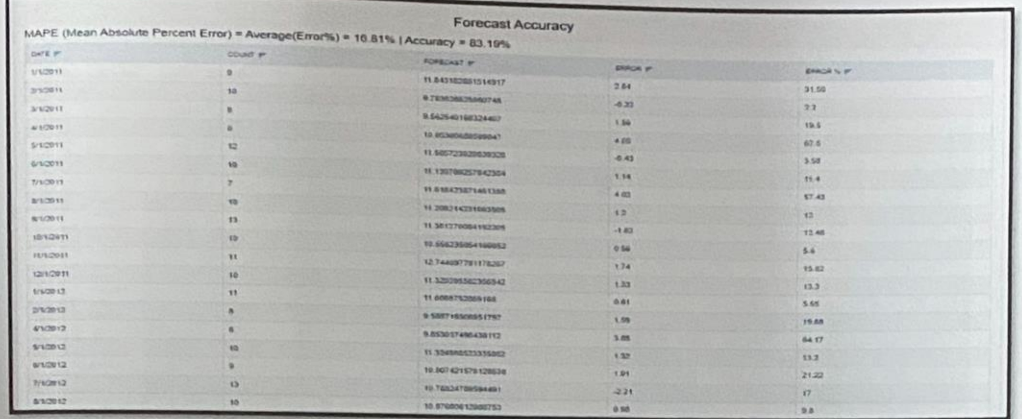


This is the administrator's home page where any menu bar component may be clicked by the administrator to function.



The administrator can create, update, and delete new users inside the health center, such as medical staff and other personnel. The new user's username and password should be made by the administrator and will be handed to them.

The forecast result is visible to the administrator, and it contains a chart that can be used to examine the number of cases for the future year. The linear trend is depicted by the yellow-green line, the actual data is blue, and the forecast result is red.

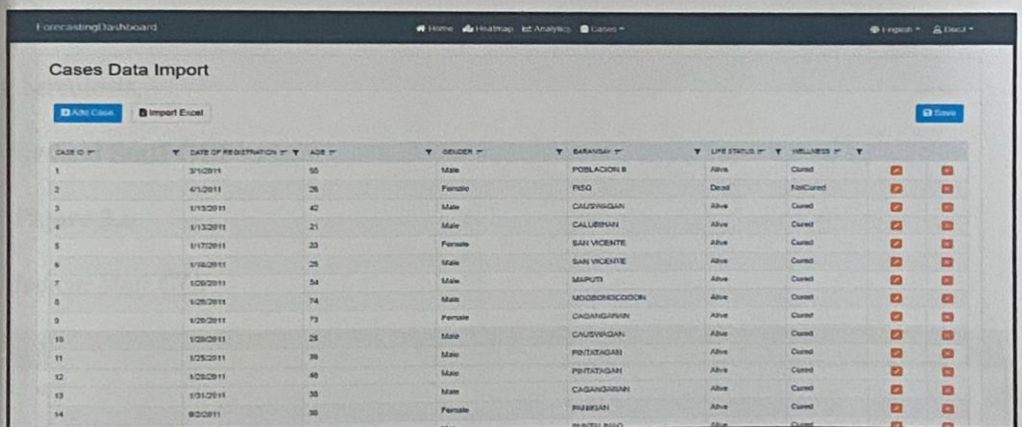


Forecast Accuracy

MAPE (Mean Absolute Percent Error) = Average(Error%) = 16.81% | Accuracy = 83.19%

DATE	COUNT	FORECAST	ERROR	ERROR %
1/1/2011	9	11.843182881514917	2.84	31.56
2/1/2011	10	9.789638825960748	-0.21	2.1
3/1/2011	8	9.562540188324407	1.56	19.5
4/1/2011	6	10.053806085999047	4.05	67.5
5/1/2011	12	11.565723920639328	-0.43	3.58
6/1/2011	10	11.139708257842304	1.14	11.4
7/1/2011	7	11.018475871461388	4.02	57.43
8/1/2011	10	11.208214231663505	1.2	12
9/1/2011	13	11.381279084192305	-1.62	12.46
10/1/2011	10	10.556239854166052	0.56	5.6
11/1/2011	11	12.744097781178287	1.74	15.82
12/1/2011	10	11.329295862356342	1.33	13.3
1/1/2012	11	11.6088752869168	0.61	5.55
2/1/2012	8	9.588716506951797	1.59	19.88
4/1/2012	6	9.853017486438112	3.85	64.17
5/1/2012	10	11.324986523335862	1.32	13.2
6/1/2012	9	10.907421579128638	1.91	21.22
7/1/2012	13	10.788247885944491	-2.21	17
8/1/2012	10	10.978806129900753	0.98	9.8

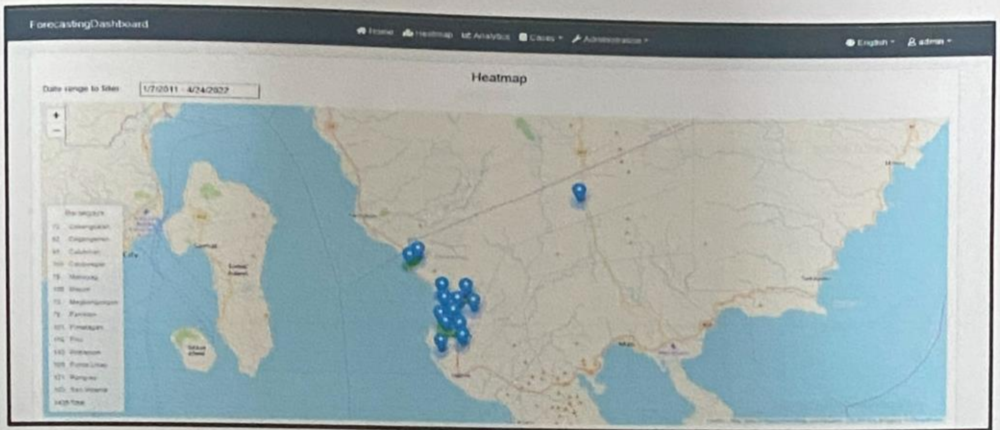
Below the graph, the administrator can see the summary of the results. The accuracy and margin of error are also given so that the outcome can be easily understood.



Cases Data Import

CASE ID	DATE OF REGISTRATION	AGE	GENDER	BARANGAY	LIFE STATUS	WELLNESS
1	3/1/2011	55	Male	POBLACION B	Alive	Cured
2	4/1/2011	26	Female	PISO	Dead	NotCured
3	1/13/2011	42	Male	CAUSWAGAN	Alive	Cured
4	1/13/2011	21	Male	CALUBIHAN	Alive	Cured
5	1/17/2011	23	Female	SAN VICENTE	Alive	Cured
6	1/18/2011	25	Male	SAN VICENTE	Alive	Cured
7	1/20/2011	54	Male	MAPUTI	Alive	Cured
8	1/26/2011	74	Male	MOGBONGCOGON	Alive	Cured
9	1/20/2011	73	Female	CAGANGANAN	Alive	Cured
10	1/20/2011	25	Male	CAUSWAGAN	Alive	Cured
11	1/25/2011	36	Male	PINTATAGAN	Alive	Cured
12	1/28/2011	46	Male	PINTATAGAN	Alive	Cured
13	1/31/2011	38	Male	CAGANGANAN	Alive	Cured
14	8/2/2011	38	Female	PAJUBAN	Alive	Cured

The administrator can import data from the historical data of patients who have tuberculosis. The data can also be edited, updated, and deleted depending on the situation of the patient's record.

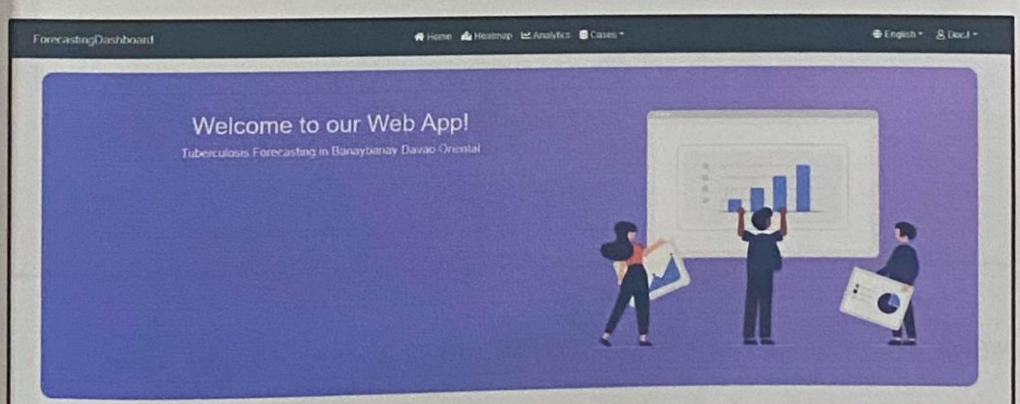


The administrator can see the heatmap, which shows the direction of each barangay in Banaybanay, Davao Oriental. Depending on the period range selected by the administrator, it displays the location of the barangay and the number of incidents of tuberculosis.

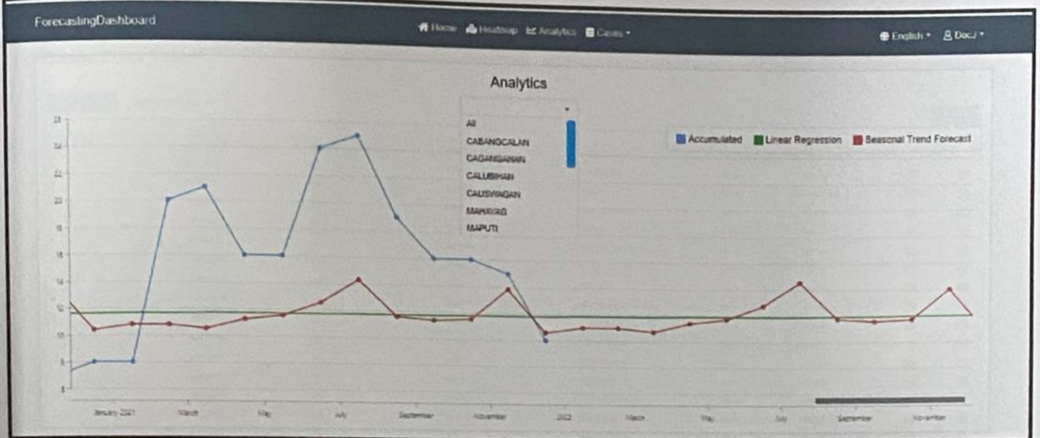
Medical Staff GUI

Figure 3.6

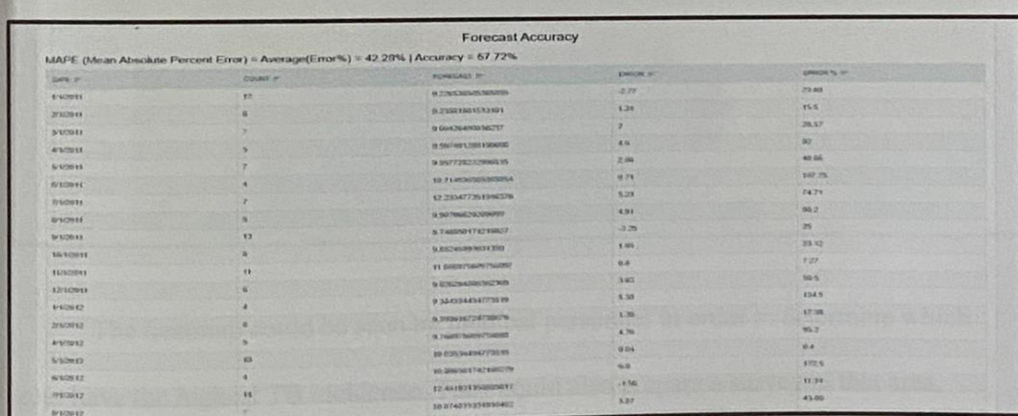
Medical Staff GUI



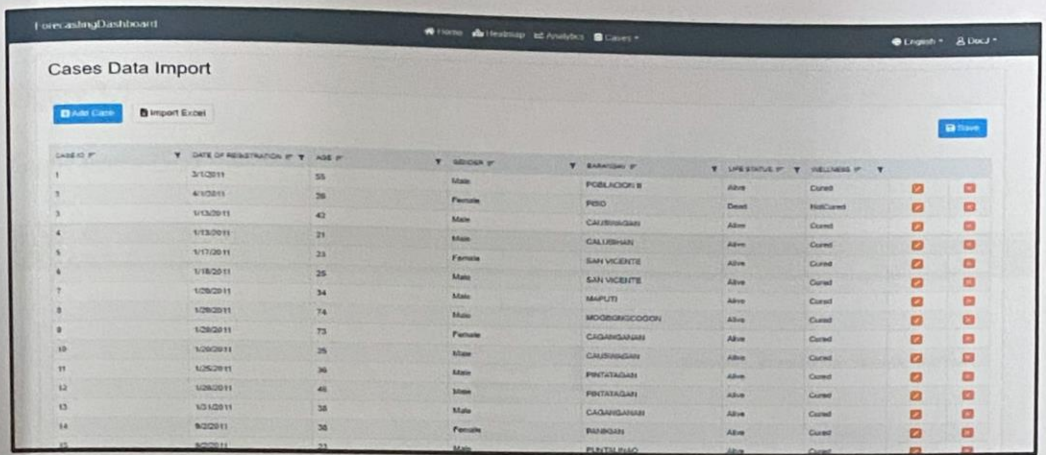
This is the medical staff homepage, and all of the elements in the menu bar can be clicked to perform their respective functions.



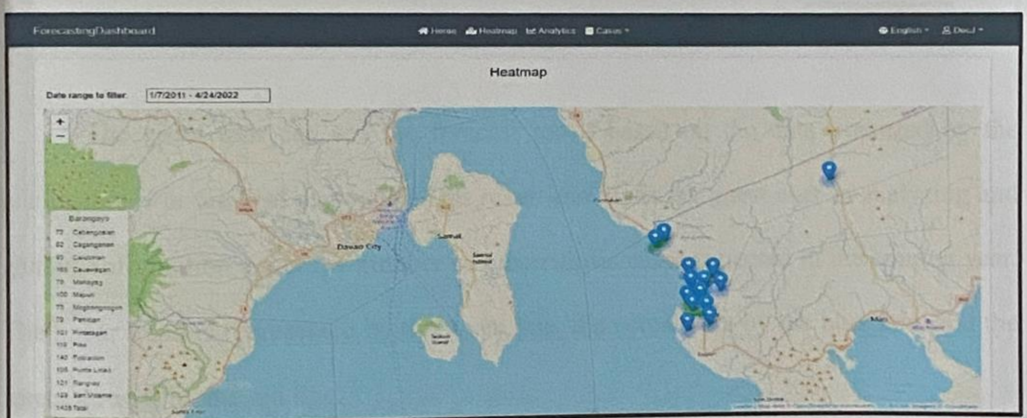
Medical staff can analyze the outcome right away and make plans based on it. To make the process more understandable, the result was shown as a line graph. The yellow line indicates the linear trend, the blue line shows the actual data, and the red line shows the forecast result.



The accuracy and margin of error, which reveal how well the algorithms analyse past data to develop a forecast result, can be provided below the line graph so that medical professionals can simply understand it.



Medical personnel can import and update TB patient data. Editing, updating, and deleting are also allowed.

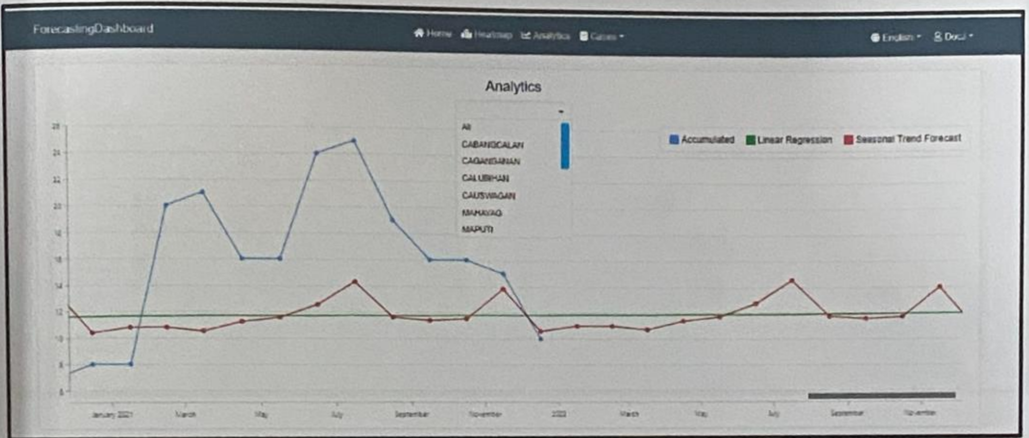


The heatmap could be seen by medical personnel in order to determine which areas have the highest TB incidence. They could also prepare a survey in that area.

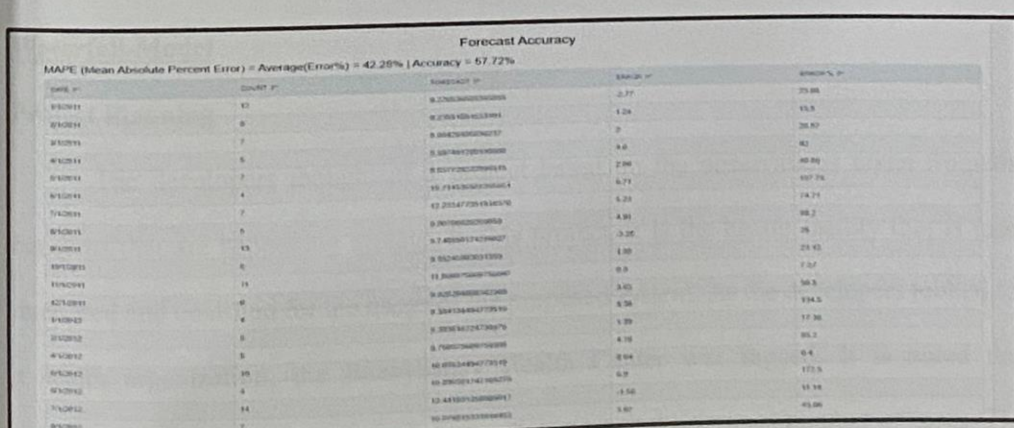
Guest Users GUI

Figure 3.7

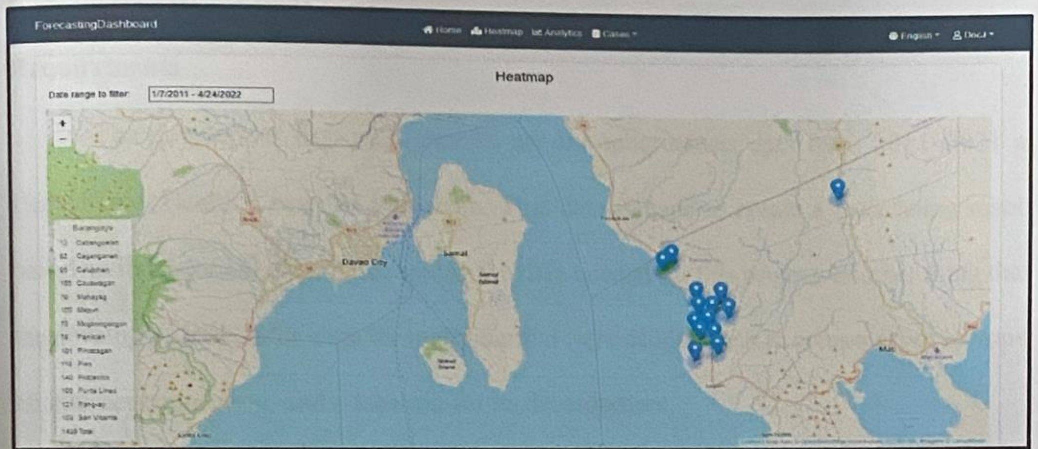
Guest users GUI



The guest user can see the forecast result based on the data imported by the administrator or medical personnel. This result can assist the guest user in analyzing and gaining information about the number of tuberculosis cases expected in the coming year. The linear trend is represented by the green line, the actual data by the blue line, and the forecast result by the red line.



The summary of results, including the accuracy and margin of error, is also available to the guest user for them to understand how to achieve the forecast result.



The heatmap can be viewed by a guest user so that they can immediately see which areas have the most TB cases. A date range can also be selected by a guest user based on what they prefer to see.

3.3.4 Development and Testing

The development and testing of tuberculosis incidence forecasting is based on the researchers' chosen software methodology.

<u>Waterfall-Model</u>

Project Planning

The developers thought of a project based on the observations taken from the concerns that are happening around. In this project, it is the health facility that is most interested and qualified for the usage of the proposed system. As the developers looked for a health organization, the Banaybanay Health Center was tagged. It is noted that tuberculosis was in fact the most common disease with the greatest number of cases. The idea of creating a system that would help solve this problem has come to be. Forecasting tuberculosis incidence was created to help medical staff forecast the possible number of cases for the coming years.

Requirements

The developers' first requirements are the tuberculosis data from 2011–2021 at Banaybanay Health Center in Poblacion. This data is used to create a forecasting result based on its historical data. After having the data needed for this project, another thing that the developers looked for were the materials that were needed such as computers or laptops, an internet connection, and a location for its development.

The developers prepared the necessary software for the development of the system for forecasting tuberculosis incidence such as Visual Studio for building code, editing and debugging. Finally, there is the GitHub code repository.

Analysis

The developers started analyzing data and collecting ideas from the internet on what algorithm should be used in forecasting tuberculosis incidence. The most suggested algorithm is the seasonality trend. When it comes to forecasting any type of illness or disease, seasonality is important. As a result, the developers decided to use Seasonal Trend and Linear Regression to determine whether the cases were ascending or descending.

The developers decided the possible users in this system, such as the administrator, who is the one who would manage the entire system, the medical staff who has the responsibility of adding TB patients, and guest users who can see the forecast result.

Design

In this phase, the developers search for a design that meets all of the user's requirements. The layout is straightforward but not overly complicated. When it comes to usability, the importance of design plays a major role. This system was created in the same way that other health-care systems are.

It makes no difference what age the users are, because every part of the system is simple to grasp. When a person is unable to read, an icon representing the function is displayed.

Coding

The developers start coding in Visual Studio using the C++ language. The process of constructing a code is not easy, especially when there is an algorithm that needs to be followed. Every time there is an error, the developer looks on the internet for a possible solution to debug the error.

The flow starts with the log in form and continues through achieving all the objectives of this system. Reaching all the goals in this project consumes a lot of time because while the developers develop, the process of learning also occurs.

Testing

The developers performed the testing after completing all of the objectives and verified that there were no problems. The developers begin to test the system's functionality. The year 2022 outcomes were good as a result of the forecast. The mean absolute percentage error (MAPE) was 42.28 percent, and the accuracy was 57.72 percent. The data that was imported into this system was used to determine the accuracy of the forecast result. The greater the number of imported years, the higher the accuracy rate.

Deployment

The system would be deployed only after extensive testing and repairs. First and foremost, the developers would ensure competence and strength. Everything should be prepared and ready to be used in accordance with the organization's goals to avoid making errors and mistakes. As a result, the system may be both productive and beneficial.

CHAPTER IV
RESULTS AND DISCUSSION

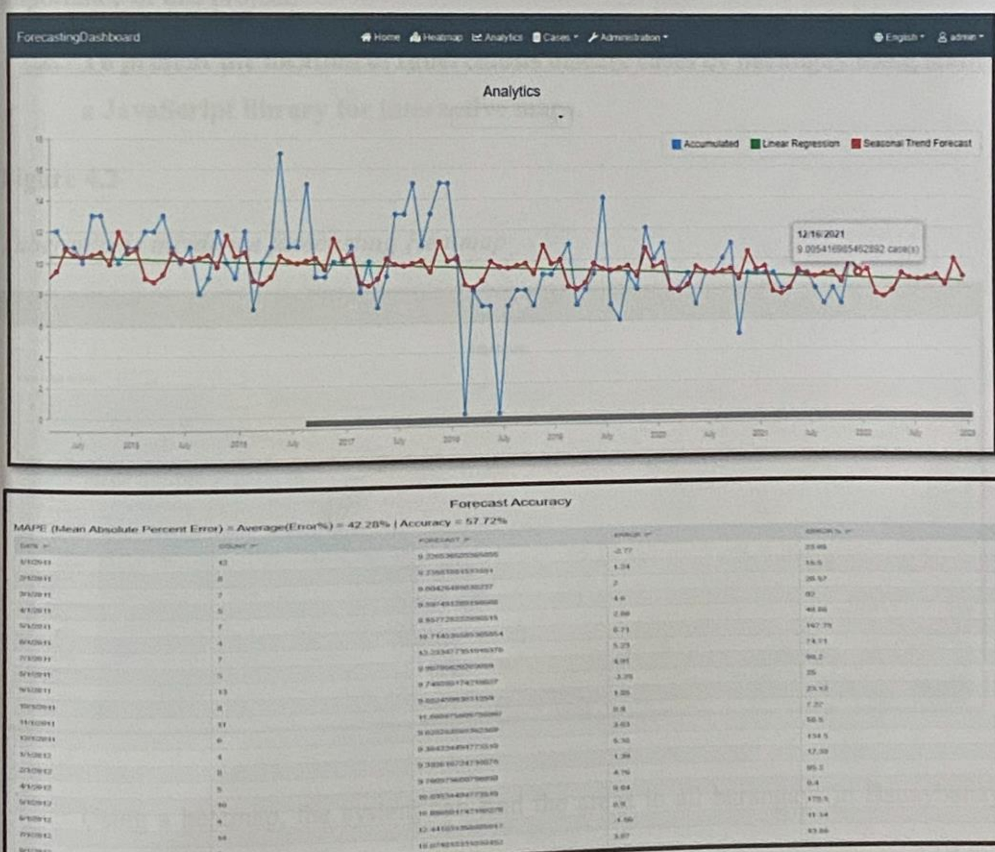
This chapter discusses the results and elaborated the outcomes of the project. Specifically, it includes the most important achievements taken for each objective presented in this project.

Achievement per objective

1. **To forecast tuberculosis disease rates in every barangay in Banaybanay, Davao Oriental using Linear and Seasonality Trends.**

Figure 4.1

Tuberculosis incidence Forecasting



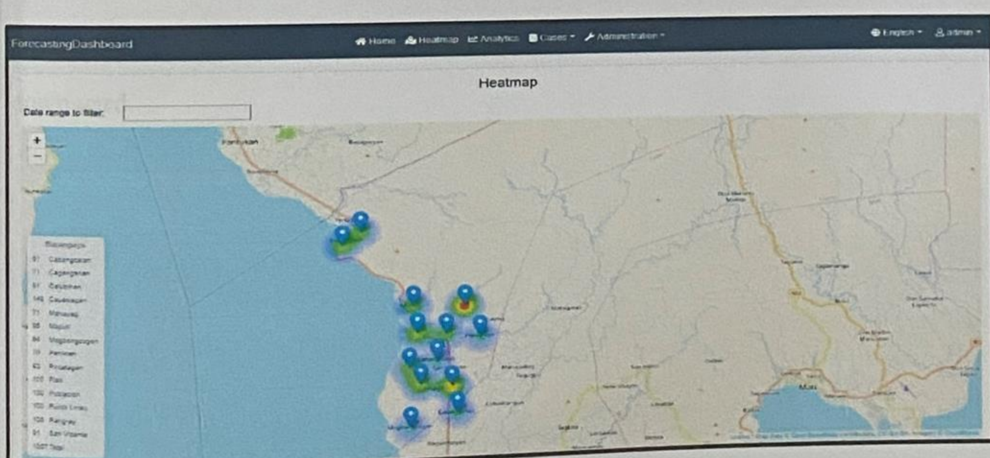
The tuberculosis forecasting system makes use of linear regression and seasonality trends. The formula in linear trend, x axis is the time period, every month per year then the y axis is the quantity of the number of cases. The formula in getting the slope is $b=\frac{\sum xy-n\bar{x}\bar{y}}{\sum x^2-n\bar{x}^2}$ the process of finding the rate of change of the value y (dependent variable) of the function changes with respect to that of the variable x (independent variable). The formula in getting the intercept $a=\bar{y}-b\bar{x}$ the it indicates the location where it intersects an axis. Forecasting formula $Y=a+bx$.

The result was based on the historical data imported into the system. The Mean Absolute Percent Error (MAPEH) and the forecast accuracy are displayed to show the importance of this project.

2. **To present the location of tuberculosis disease cases by barangay using leaflet, a JavaScript library for interactive maps.**

Figure 4.2

Tuberculosis incidence forecasting Heatmap

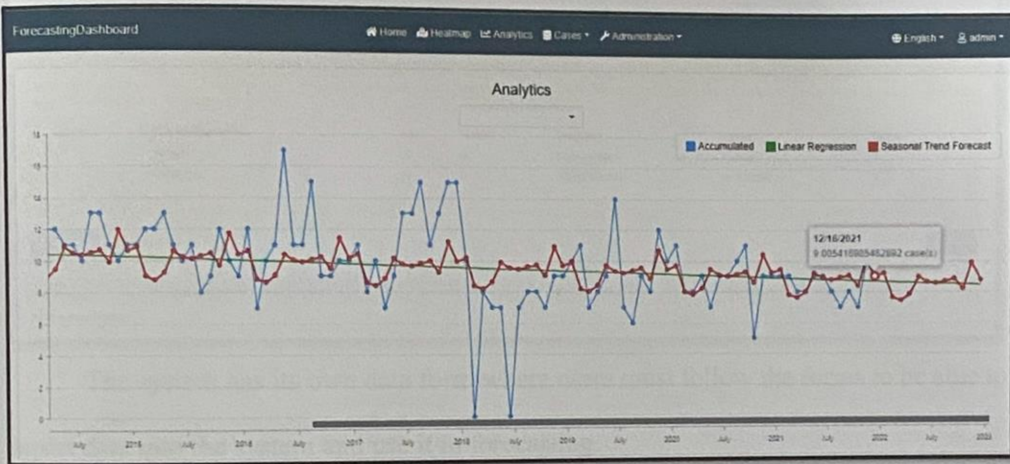


Using a heatmap, the system can find the areas in all barangays in Banaybanay, Davao Oriental. The number of instances is also mentioned so that you can see whether a location has the most or least instances. The user can also choose the range, either in its overall history or in custom.

2. To generate a presentation of the forecasted rate using the line graph chart

Figure 4.3

Line Graph

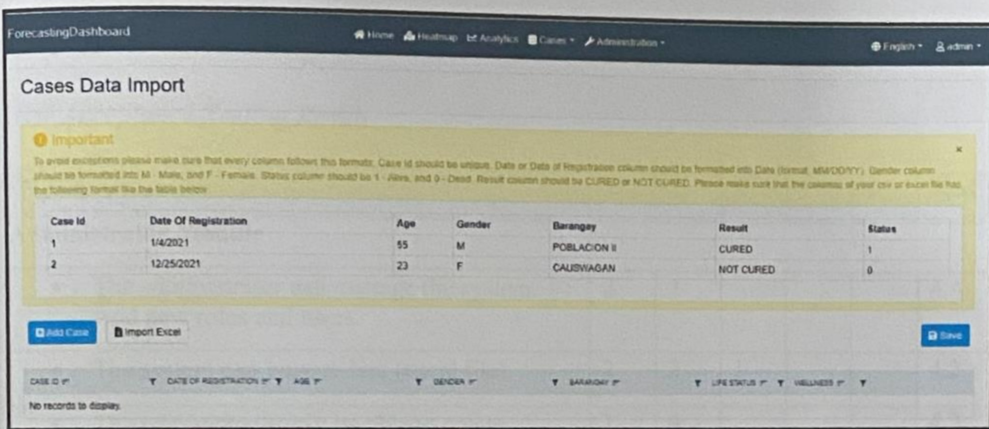


The result was shown as a line graph by the system. The user would find it simple and straightforward. It also emphasizes the result's direction, whether it is upward or downward.

3. To introduce a data forecasting design to capture the data of the concerned agency

Figure 4.4

Data Form



The system has its own data form where users must follow the forms to be able to import data into the system and use it in forecasting.

3.2 Testing/Implementation Results

The system's overall functionality is tested by the User Acceptance Testing rate.

3.2.1 User Acceptance Testing

Table 4.1

Likert Scale

Range	Scale	Adjective Interpretation
4.00-5.00	5	Excellent
3.00-3.99	4	Above average
2.00-2.99	3	Average
1.00-1.99	2	Fair
0-0.99	1	Poor

The researchers distributed a feedback form with a series of questions to various persons in order to assess the system. The total weighted mean is used in the following results.

User Module

Table 4.2

User Acceptance Testing Result

Criteria	5	4	3	2	1	WM
Administrator Module						
• The administrator can manage the system. Add new roles and users.	2	3				4.4
• The system can import data (excel file).	2	2	1			4.2
• The administrator can be able to create, update and delete the data.	1	4				4.2
• The administrator can view the forecasted result.	1	3	1			4
• The system can locate the exact location of each barangay with its number of cases.	3	2				4.6
• The system can print out a forecasted result.	4	1				4.8
Medical Staff Module						
• Medical staff can be able to log in using the username and password given by the administrator.	1	4				4.2
• The user will be able to import data (excel file).	1	3	1			4
• The user can be able to create, update and delete data.	3	2				4.6
• The medical staff can view the forecasted result.	1	3	1			4
• The system can locate the exact location of each Barangay with the number of cases.	2	2	1			4.2
• The system can print out a forecasted result.	4	1				4.8
Total Weighted Mean						4.3

4.3 Implication and Discussion Results

User Acceptance Testing is performed to determine the liability and legitimacy of the system. The researchers' total number of respondents was 5 which composed of medical staff. The survey is distributed to each member of the medical staff in duplicate. Based on the user evaluation results, the overall total weighted mean is 4.3, which implies the system's excellence. The users were satisfied and have approved the readiness of the implementation of the system.

CHAPTER V
SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter detailed the overall results of the study's summary, conclusion, and recommendations. It is an important section in which every part of the study is thoroughly discussed.

Summary

Table 4.1

Tuberculosis incidence Forecasting Result

Year	Month	Actual Case	Linear Trend Result	Seasonality Trend
2022	January		8.86	9.14
	February		8.84	8.37
	March		8.82	8.17
	April		8.80	7.71
	May		8.78	8.93
	June		8.76	9.39
	July		8.74	8.67
	August		8.72	8.55
	September		8.70	8.68
	October		8.08	8.29
	November		8.67	9.76
	December		8.65	8.88

LT= Linear Trend

ST= Seasonality Trend

Since we have gathered data from 2011–2021, then 2022 is the year to be forecasted. The number of cases presented is according to the calculation of the algorithms.

The seasonality trend indicates that there is a seasonal pattern in the number of TB cases with the maximum probable number of cases occurring in January, June, and November. Even if the number of instances is not as large as we thought, Tuberculosis is an infectious disease that can be transmitted to others, causing harm and death.

The tuberculosis incidence forecasting system is one of the most useful systems nowadays. It has the ability to capture historical data from health facilities to use as background data to formulate a forecast result. To be able to attain the forecast result, the seasonality and linear trend are the algorithms to be used. The forecasted result, which is the possible number of cases of tuberculosis in the next year, would give the users an insight on how to provide an action plan with regard to the cases stated in the result. This result would help the users to be aware and take care of themselves to avoid having this kind of disease. Users would be able to see the forecast result as well as the heatmap, which would help them locate the location of TB cases in each barangay. The forecasted result would be the guide of the medical staff in its drive to lessen the number of cases for tuberculosis.

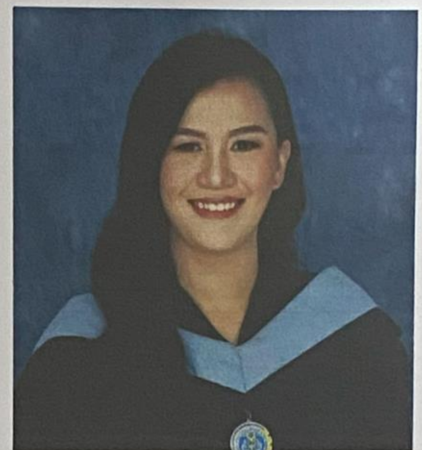
Conclusion

The tuberculosis incidence forecasting system in Banaybanay, Davao Oriental using linear and seasonality trends helps and improves the health field. This forecasting system would assist the users in forecasting the potential number of tuberculosis cases and would serve as a guide in reducing such cases. The accuracy would tell users how possible the forecast result would be. The rating sheets given to the users serve as the system rating to see how realistic and reliable the system is. The user module overall weighted mean is 5, which means that the functionality of the system is good.

Recommendations

These are recommendations that must be fulfilled in the system's future development. First, add the forecasted TB incidence case numbers into the heatmap. Second, multivariable can be used to broaden the scope of the study. Third, it can forecast TB case numbers for the next two or more years, giving users an insight into the potential cases. Lastly, include an additional page with information on how to avoid contracting TB.

GRAZELLE E. BITER



Purok 4, Poblacion, Banaybanay

Davao Oriental

(63) 909 390 7839

grazellebiter1@gmail.com

PERSONAL DATA

Date of Birth	:	November 27, 1999
Civil Status	:	Single
Citizenship	:	Filipino
Religion	:	Roman Catholic
Sex	:	Female
Height	:	5’2 feet
Weight	:	59 kls.

TECHNICAL SKILLS

- Multimedia
- Networking
- Data Processing
- Proficient in Microsoft Office Suite

JEAN MAE M. GUARDARIO

Purok 8, Rang-ay, Banaybanay

Davao Oriental

(63) 930 383 4224

jeanmaeguardario25@gmail.com

PERSONAL DATA

Date of Birth	:	November 6, 1999
Civil Status	:	Single
Citizenship	:	Filipino
Religion	:	Body of Christ
Sex	:	Female
Height	:	4'9 feet
Weight	:	44 kls.

TECHNICAL SKILLS

- Multimedia
- Networking
- Data Processing
- Proficient in Microsoft Office Suite

JEPHANIE ANNE A. ABOS

Purok 5-C, Poblacion, Banaybanay

Davao Oriental

(63) 963 942 7283

abosjephanieanne@gmail.com

PERSONAL DATA

Date of Birth	:	December 14, 1997
Civil Status	:	Single
Citizenship	:	Filipino
Religion	:	Roman Catholic
Sex	:	Female
Height	:	4'8 feet
Weight	:	45 kls.

TECHNICAL SKILLS

- Multimedia
- Networking
- Data Processing
- Proficient in Microsoft Office Suite