RICE PRODUCTION FORECASTING SYSTEM USING MULTI LINEAR REGRESSION ALGORITHM IN DAVAO ORIENTAL

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BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

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ABSTRACT

MACRIS JHISS TUMULAK AND GEMAR P. PETERE. "RICE PRODUCTION FORECASTING SYSTEM USING MULTI LINEAR REGRESSION ALGORITHM IN DAVAO ORIENTAL" (IT Capstone Project). Davao Oriental State University Banaybanay Extension Campus. May 2022.

Adviser: Mr. Ruben L. Quindoyos Jr.

Rice is the most important food crop of the developing world and the staple food of more than half of the world's population. In fact, rice production is reduced expectedly when climate change hitting farmers particularly in regions such as Southeast Asia (UN environment programme, 2019; Schonhardt, 2021; Ogasa, 2021). However, Davao Oriental lacks studies and development system that can predict and forecast the rice production for the future. It is critical to examine the impact of many factors on rice production and to ensure consistency in increase of rice output and provide solutions to the problem. The proponent aimed to conduct research and developed a system **"Rice Production Forecasting System using Multi Linear Regression Algorithm in Davao Oriental"** to forecast the rice production dynamically based on the previous data given to Provincial Agriculture Office XI (PAGRO). The proponent used multi-linear regression to generate the data and visualized the predicted and forecasted value. In this study, the proponent focused only the rice production. In addition, forecasting rice field could potentially benefit decision-making from national, regional, and local governments to local farmers. The proponents used methods and different materials to make sure the system reliable, innovative, and easy to use. However, the system consisted one module which the researchers gave 1 copy for the user only. As a result, based on the user evaluation results

the overall total weighted mean is 4.3 that implies system's Excellency. We concluded that this study "Rice Production Forecasting System Using Multi-linear Regression Algorithm" has a positive impact to the users and in the field of farming. Due to insufficient time, the proponents could formulate recommendation and that was the system will suggest what varieties to be used for the next cropping. The future researcher will provide a forecasted map of low production in every barangay, so that the municipality level of Department of Agriculture can initiate what intervention they need to do. The system could query specific location of barangays. Lastly, the future researcher will be needed to have a data for rice variety that can be used for variety recommendation.

CHAPTER I
INTRODUCTION

1.1 Rationale of the Study

Half of the world's population consumes rice (Oryza sativa L.). For instance, rice production is reduced expectedly when climate change hitting farmers particularly in regions such as Southeast Asia (UN environment programme, 2019; Schonhardt, 2021; Ogasa, 2021). However, rice produces different varieties. These varieties are inbred rice variety which is a pure line and hybrid variety which is a product of a cross between two genetically distinct rice parents (Jian Lu, 2020). In other words, upland rice is grown in rainfed, naturally well-drained soils without surface water accumulation. Moreover, lowland rice is grown in fields that can be flooded and they are either rain-fed or irrigated (PreethiVijayaraghavareddy, 2019). In fact, rice is grown in both highland and lowland areas, with irrigated lowland rice systems accounting for around 76% of global production (Marie-Noel, 2021). Indeed, rice yields produced 3–6 tons per hectare on average (AminouArouna, 2021).

In a global scope, South Asia has the largest food-insecure population in the world. Such factors account for more than 22% of rice yield losses in the South Asian (Jeetendra Prakash Aryal, 2019). Moreover, abiotic elements such as rainfall, drought, flooding, temperature, and sun radiation have a significant impact on rice yield at various phases of development (Sajid Hussain, 2020). With the purpose of accurate forecasting of the rice yields is very important for the organization to make a better planning and decision making (Harper, 2019).

The Philippines consumes above production numbers and rely on imports to meet their needs (Philippines Country Commercial Guide, 2021). However, Philippines is prone

from typhoon due to climate change. According to the Cabanatuan City Daily Inquirer, during the wet season, a lack of capital, as well as pests and diseases, have a significant impact on productivity (BORDEY, 2014; . That is why the rice production in this country is not sufficient to provide the needs. Furthermore, recent studies also reported that drought reduced rice yield production by 30% and that an increase (one degree Celsius) in global mean temperature would reduce global rice yield by 3.2 percent on average (Chuang Zhao, 2021). As a result, forecasting rice production under current climate change scenarios is important in order to feed the world's ever-increasing population (Joginder Kumar, 2021).

Provincial Agriculture Office XI, Banaybanay, and Lupon, Davao Oriental collaborated and stated that lack of personnel, capital, low price palay, pests and illnesses, weather, and a lack of postharvest infrastructure are all concerns that affect rice yield (Dagpin, 2021). Thus, forecast yield obtained is validated with actual yield of corresponding year to find the accuracy of developed model (Hoa Thi Pham, 2022).

Forecasting of rice production is applicable to all countries. Previous studies developed a system to predict and forecast the rice production using algorithms and methods to increase the rice production (Kiran Kumar Paidipati, 2021; Jackie D. Urrutia, 2019; SeungtaekJeong, 2022). Despite of prior discussion, Davao Oriental lack of studies and lack of development system that can predict and forecast the rice production for the future.

Moreover, it is critical to examine the impact of many factors on rice production and to ensure a consistent increase in rice output and provide solutions to the problem identified at the local level. As a result, the proponents have decided to conduct research and propose a system that forecast rice production using a multi linear regression

algorithm, particularly in Davao Oriental. (Province of Davao Oriental, 2020) Which has been adjudged as one of the country's top producers of rice yields, with an average yield of 4.51 metric tons per hectare.

1.2 Purpose and Project Description

The focus of the proposed system is to forecast the following rice yields based on the previous data on rice production. It has a graphical presentation of rice and its corresponding factors affecting its production. It also used Choropleth Map as a form of visual representation of data to specified areas.

Forecasting rice yield could potentially benefit decision-making from national, regional, and local governments to local farmers. The Davao Oriental province as named as the National Rice Achievers Awardee, wants to boost rice output and increase farmer income through its Rice Self-Sufficiency Plan (Provincial Information Office, 2020). In this regard, a computer program aligned to the Province's Rice Self-Sufficiency, a plan that was proposed to forecast rice Production in the specified Municipalities.

1.3 Objectives

This research had numerous specific targets, which are the following:

- **To create a system that would show the distribution rates of rice production in every municipalities of Davao Oriental.**

  The proponents of this research aimed to develop a web-based system that enables the intended end-user to monitor the previous rice production rates in the entire province. The system showed the overall distribution in every municipality of Davao Oriental.

- **To create a system that would show a production trend in every municipality together with the forecasted and actual values by cropping.**

  Graphic visual representation of information is a crucial component in understanding and identifying patterns and trends in the ever fluctuations flow of data in rice production. Graphical representation enables the quick analysis of large amounts of data at one time and can aid in making forecasting and informed decisions. The proponent decided to use line graph to visualize the trend of actual rice production value and forecasted value.

- **To create a system that would show forecasted metric ton unit of rice production per municipality.**

  In 2019, Davao Oriental was also proclaim as one of the Country's top rice producers. Whereas the province was able to contribute 0.38 percent to the country's total rice production, the Provincial Agriculture Office XI (PAGRO) used this objective to determine how much the production of Davao Oriental can contribute in the country in the future years using a graphical representation and the proponent used a bar graph.

- **To create a system that would allow Local Government Units to generate report in CSV, and important reports in a graph that can be exported to .png format.**

  Having a copy of a particular thing is important because it allow us to remember the data. The proponent decided to use the downloaded image in .png format of graphical predicted views and PDF or CSV for data through table, because it is good and easy to see, and convenient to carry out everywhere, and because of that you as a user of this system, you can help to others because it is easy to share for everyone.

- **To create a system that could show the forecasted production value through choropleth map.**

The advantage of using a choropleth map include: ease of preparation – simply color the map, easy perception – the color makes it easy for everyone to see the differences between areas, analytical abundance – may types of data placed in one picture in a comprehensible way.

1.4 Significance of the Study

The proposed system would be significant to the following:

- **Provincial Agriculture Office XI –** With the Province's rice self-sufficiency plan to maintain or possibly increase rice yields in the upcoming harvest, the system would help them keep track of rice production using a comprehensive graphical presentation that enable them to correlate data.
- **Farmers** - the proposed system were beneficial to rice farmers as it would offer them a user interface for online consultations and make them aware of the best solution there is for rice farming constraints. This would be somehow directly coming from agriculture sector experts and professionals from DORA-XI.
- **Future Researchers** - This project would broaden the researchers' understanding, allowing them to come up with new ideas and iterations of the project that have the same transaction mechanisms, which very useful in other projects.

1.5 Scope and Limitation

Forecasting rice production in Davao Oriental using a multi-linear regression algorithm is propelled by the Province's plan to rice production sustainability where comprehensive data reports based on ten years data from 2011 to 2020 were be shown using graphical presentation. Thus, enabling them to

efficiently monitor and keep track of factors affecting rice production.

Despite the several published types of research have claimed multiple determinants of rice production, the proponents were only following the data provided by the agricultural sector in the Municipalities of Davao Oriental. The data used were aligned with the data set present from the Department of Agriculture Regional Office XI among others are (1) ecosystem, (2) variety of rice, (3) number of farmers affected, (4) stage of crop development, and (5) yield loss. Also, the user allowed querying in every municipalities only, but could not able to query the specific location of its barangay and the system also could not give a decision what rice intervention to suggest and rice varieties.

CHAPTER II
REVIEW OF RELATED LITERATURE AND SYSTEMS

This chapter presents the related literature and studies conducted by a search which were done by the researchers. The materials and studies included in this chapter help in familiarizing information that is relevant and similar to the present study.

2.1 Review of Related Literature

2.1.1 Factors explaining variability in rice yields in a rain-fed lowland rice ecosystem in Southern Cambodia.

In this study, major parameters impacting yields in a rain-fed lowland rice environment in Cambodia were explored using both SRI and conventional management approaches (CMP). However, rice yields were measured in 70 plots with documented management procedures (36 under farmer's SRI and 34 under CMP). On the other hand, to find major determinants of rice yield variability, stepwise multiple regression analysis was used. The number of cattle (access to farmyard manure [FYM]), farmer's SRI methods, crop density, and soil organic carbon all played a role in yield variation (SOC). Furthermore, these four variables accounted for 39% of the variation in rice yield. Shifting from CMP to farmer's SRI methods boosted rice yields by 14 percent (458 kg ha1) while keeping other variables unchanged (Proyuth Ly, 2016).

We were inspired by this literature to do or construct a system to forecast rice production. This literature gave us the notion of how to exploit harvest in a variety of ways in the lowland rice habitat. It contributes to the reliability and utility of our research study and system.

2.1.2. Factors Influencing Productivity and Technical Efficiency of Rice Farmers in Isabela, Philippines

According to a student from Isabela State University's Department of Crop Science, College of Agriculture, cost of farm services and quantity of seeds, farm services, land area, the quantity of fertilizer applied, cost of pesticides, and farm services were the determining factors on rain-fed crops. When compared to irrigated rice farmers, rain-fed rice producers exhibited higher technical inefficiencies and worse returns on the scale in rice production. Furthermore, the pressing problems were insufficient finances, calamities, and soil and irrigation/water management. More capability building, technical, financial, infrastructure, and organization strengthening were recommended to improve the productivity and technical efficiency of rice farmers in both farm ecosystems (Cañete, 2017).

We obtained an understanding of what techniques could be applied and what factors influence rice yield from this literature. It made the research study more informative, and the growth of the system more organized.

2.1.3 Factors Affecting Rice Production

Primary and secondary data were employed in this investigation. Multiple Linear Regression Analysis was used to examine the data. The correlation coefficient (R2) is 0.955. This coefficient of determination indicates that 95.5 percent of rice production (Y) is explained by seed variables (X1), fertilizer (X2), pesticides (X3), and labor (X4), with the remaining 4.5 percent controlled by factors not included in the equation. Seed variables (X1), fertilizer (X2), pesticides (X3), and labor (X4), all with a significant value of F equal to 0,000, have a substantial

effect on the rice production variable (Y). Seeds and pesticides have a limited impact on rice production, whereas fertilizer and labor have no impact. There is no multicollinearity, heteroscedasticity symptoms, or regularly distributed regression models, according to the traditional assumption test (Nina Maksimiliana Ginting, 2021).

The notion we gained from this literature was about the various factors that could affect the rice producing ecology. As a result, knowledge about rice production characteristics made our research study more helpful and reliable. Furthermore, with the support of this aspect, we were able to manage our system development.

2.1.4 Multiple Linear Regression

In finance and investing, regression analysis is a typical statistical tool. One of the most used regression analysis approaches is linear regression. Several regression is a type of regression that includes both linear and nonlinear regressions that have multiple explanatory variables (Blokhin, 2021). MLR, also known as multi-linera regression, is a statistical technique for predicting the outcome of a response variable by combining many explanatory variables. The linear relationship between explanatory (independent) and response (dependent) variables is attempted to be represented using multiple linear regression. In other words, MLR investigates the relationship between numerous independent factors and a single dependent variable. The information on the many variables can be used to generate an accurate prediction of the level of effect they have on the outcome variable once each of the independent factors has been determined to predict the

dependent variable. The model generates a straight line (linear) relationship that best approximates all of the individual data points (Hayes, 2021).

With the help of this literature, we were able to understand the purpose of multi-linear regression as well as its flaws and limitations. As a result, we chose to adopt this algorithm since it closely matches the data we obtained from the Department of Agriculture XI; in fact, this algorithm is critical to the development of our system, particularly in terms of data accuracy.

2.1.5 The Impact of Climate Change on Rice Production in Nepal

The sensitivity of rice output in Nepal to change in climate variables, as well as the extent of future implications on rice productivity, were investigated in this study. Our findings highlighted the fact that the impact on rice output varies depending on which stage of rice development is impacted. During the ripening phase of rice, a 1°C increase in daytime maximum temperature improves harvest by 27 kg, according to our calculations. However, our findings implied that when the daytime maximum temperature exceeds 29.9°C, production decreases. Rice yield likely decrease with any future rises in maximum temperature because the average maximum temperature is already greater than this threshold. Rainfall appears to have a strong negative effect on yield if it occurs when rice plants are in the nursery stage. Overall, under a double CO2 scenario predicted for 2100, rice yield in Nepal is expected to drop by about 4.2 per cent relative to current production levels (Karn, 2014).

With the use of this literature, we were able to determine the impact of climate change on rice production in particular. As a result, we now understand the

significance of climate change, particularly in our rice field production. Indeed, this literature assisted us in making our research study more helpful and enlightening.

2.1.6 THE EFFECTS OF CLIMATE CHANGE ON RICE YIELD OF PAMPANGA

The goal of this research was to look into the effects of climate change on Pampanga's rice harvest. Therefore, effort to assist rice farmers in Pampanga in determining the right cropping calendar throughout the province the climatic and yield data used was for a 20-year period between 1998 and 2012 to the year 2017. Furthermore, the rice production in Pampanga showed an increasing trend within a twenty-year period. Therefore, the correlation of rice yield vs. rainfall and temperature was also examined. It was found out that there is no significant relationship between rice yield and temperature (r-value = - 0.083 and p-value = 0.463). While the relationship of rainfall and rice yield is inverse and significant (r-value = - 0.382 and p-value = 0.000) (Camille Anne U. Lacap, 2019).

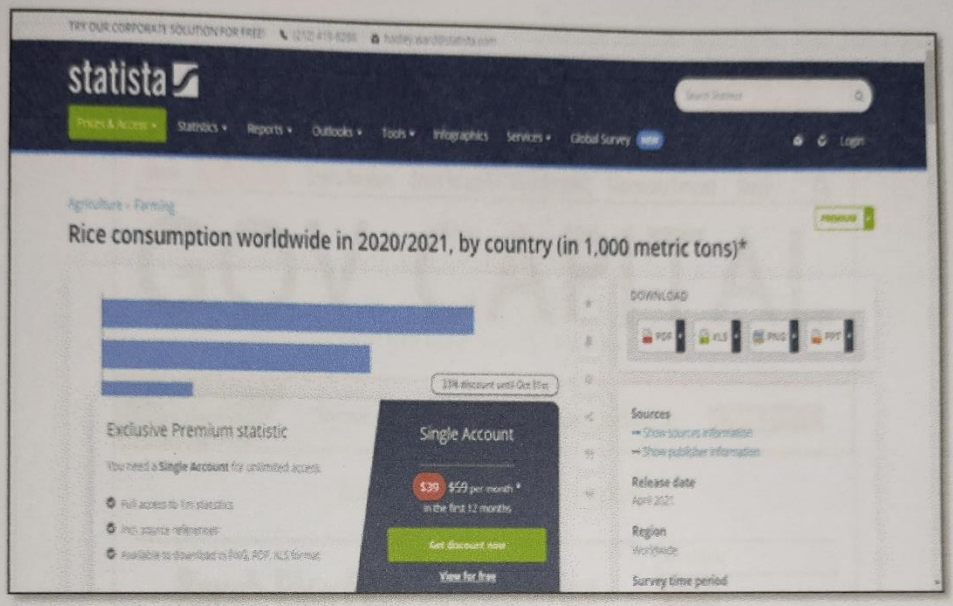
We learned about the impact of climate change on rice production through this literature. As a result, climate change is a significant influence affecting rice output, as climatic change is unpredictable at times. Indeed, this literature aided our research study in understanding the effects of climate change and can provide useful information.

2.2 Related Systems

The following are the relevant related system that was utilized by the proponents and were used as basis upon the development of the system.

Figure 1

Statista

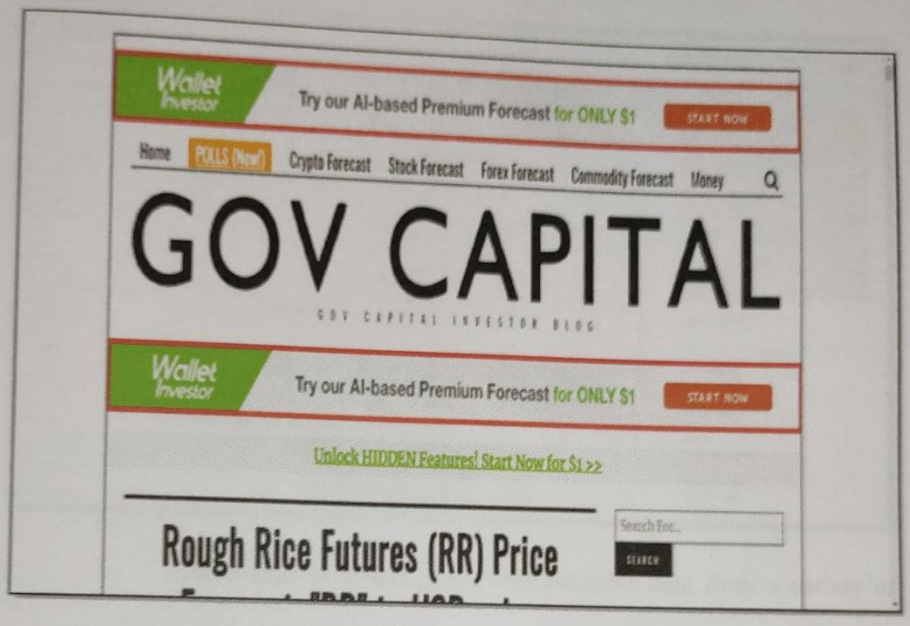


Statista provided its user any possible reports in analytics. Accessing reports required user credentials to validate the users' authenticity. Like any other websites and systems, users who do not have any valid credentials were first register and provide necessary information in order to gain access to the system. Statista enable to search analytics reports and other aspects available in terms of agricultural reports (Statista, 2022).

In its dashboard, its navigation bar contains options for statistics, reports, outlooks, tools, info graphics, services and global survey that integrate also in our system. Statistics menu provides you options in reports users want to select about sets of categories relating to analytic reports. Articles are also present in the system under report menu.

Figure 2

Gov Capital



Walletinvestor.com was founded in 2017 and offers technical forecasts for 3,400+ cryptocurrencies, 50,000+ equities, thousands of Forex pairs, 28,000+ US real-estate markets, over 10,000 funds, and the most essential commodities. The site provided both free forecasts for all visitors and additional features for subscribers. The forecasts were derived by a WalletInvestor-developed Machine Learning system (GOVPH, 2017).

The system has four subscription options in addition to the free functions. The monthly recurring charge is $8.99, however you get a discount if you subscribe for a longer period (3 months: $19.99, or $6.69 per month; 6 months: $34.99, or $5.99 per month; 12 months: $69.99, or $5.8 per month). And the method, like ours, provides a range of time to forecast ordered in a table.

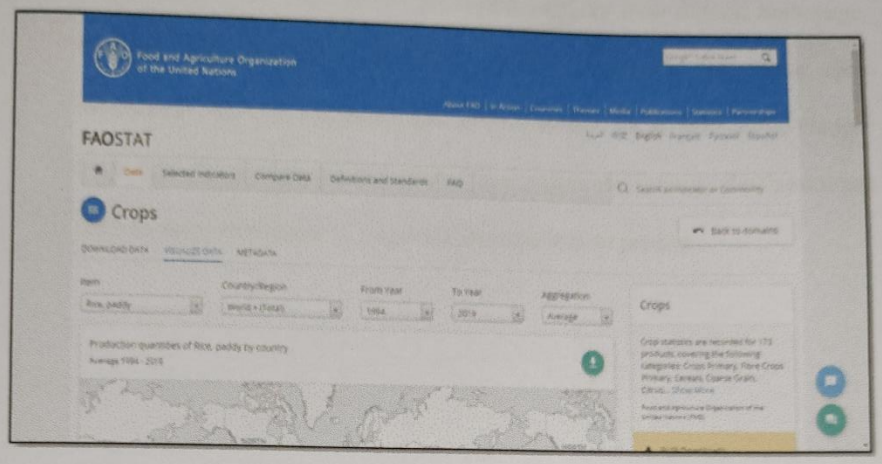
Figure 3

Index Mundi

IndexMundi is a data portal that compiles data from a variety of sources and presents it in easy-to-understand images. The system's goal is to transform raw data from around the world into actionable information for a global audience. It gathers facts that are scattered or otherwise concealed and presents them to visitors in the shape of user-friendly maps, charts, and tables, allowing them to grasp complex information at a glance (IndexMundi, 2021).

Figure 4

Faostat



FAOSTAT is a United Nations Food and Agriculture Organization project that collects crop statistics for 173 products in the following categories: Primary Crops, Fibre Crops Primary, Cereals, Coarse Grain, Citrus Fruit. The information is presented in terms of harvested area, production quantity, and yield. The goal is to cover all primary crop production for all countries and regions around the world. Cereals: Area and production data on cereals only apply to crops harvested for dry grain. As a result, cereal crops produced for hay or harvested green for food, feed, silage, or grazing are prohibited. The harvested area is represented by the area data (FAOSTAT, 2022).

The system has a navigation bar which allows its users to search for particular data. It contains metadata inside the downloadable data which allows users to visualize predicted data. Users of the system can also be able to use query commands to filter data according to their specified filters.

Upon browsing the site, users were redirected to their default page which contains prediction in agricultural crops as their default homepage. Features like pie graph for each country graphically presenting crop production for each country is also visible along with an interactive Google map. And the proponent were doing their system the same as the Faostat has such as map, and query to select the desired data to predict.

CHAPTER III
METHODS AND MATERIALS

This chapter presents the methods and materials that were used by the researcher to attain the functionality of the project system. These include the following below:

3.1 DETAILS OF THE TECHNOLOGIES BEING USED

The process of development of the project were basically use laptops and other computer units the proponents also used portable Wi-Fi connections to access the internet. Some gadgets like android phones that could be used as a tool for communications matter. The following are among the software to be utilized:

3.1.2 PostgreSQL Version 12.3

This software is the database storage that utilized for storing and managing information, and the proponent used PostgreSQL server to construct a safe database. The information gathered from the user's asset information, depreciation, and maintenance logs. PostgreSQL includes user authentication, which is extremely important for securing data created or stored by application software (Langford, 2010).

3.1.3 WEKA Version 3.9

WEKA is a software program intended for the data mining process. It employs a set of machine learning algorithms. These algorithms can be applied to data directly or called from Java code. Weka is a set of tools that can be used for regression, clustering, association, data pre-processing, and classification. It also converts the csv file from the training data source to .arff format after uploading it (Tutorialspoint, 2021).

3.1.4 Tableau Version 2022.1

Tableau is a visual analytics platform that is transforming the way we use data to solve problems by enabling individuals and companies to get the most out of their data. The analytics platform, which is the market-leading solution for modern business intelligence, makes it easier for users to explore and manage data, as well as find and share insights that may transform businesses and the globe. Tableau is the most powerful, secure, and versatile end-to-end analytics platform, from connection to collaboration (Tableau Software, n.d.).

3.1.5 Angular CLI Local Server Version 14.0.1

The Angular CLI is a command-line interface tool for launching, developing, scaffolding, and maintaining Angular applications from a command shell. By adding the.bin folder within your local node modules folder to your PATH, you can run ng commands straight from a locally installed version of the angular-cli. The node modules and.bin directories are generated in the directory where npm install @angular/cli was run after the install command completes (Angular, n.d.).

3.1.6. Plotly Library Version 4.10.0

The Python graphing library from Plotly creates interactive, publication-quality graphs. Line plots, scatter plots, area charts, bar charts, error bars, box plots, histograms, heatmaps, subplots, multiple-axes, polar charts, and bubble charts are all examples of how to make them (Plotly Library, n.d.).

3.1.7 Streamlit Version 1.4.0

Streamlit is an open-source app framework for teams working in Machine Learning and Data Science. Beautiful data apps can be created in a matter of hours.

Everything is written in Python (Sehmi, 2022).

3.1.8 Python 3.8

Python is a powerful general-purpose programming language. It is used in web development, data science, creating software prototypes, and so on. Fortunately for beginners, Python has simple easy-to-use syntax. This makes Python an excellent language to learn to program for beginners (Programiz, n.d.), and the proponent using python language to integrate into our end which is allow to use the desire algorithm.

3.1.9 Microsoft Excel 2021 (Professional)

Excel is a spreadsheet program for storing, organizing, and manipulating data. Tables, which are made up of rows and columns of small rectangular boxes or cells, are used to hold linked data. In all versions of Excel and other spreadsheet programs, you can save numerous spreadsheet pages in a single computer file (CFI, n.d.).

3.1.10 Visual Studio Code version 1.61

Blends the ease of use of a code editor with the features that developers require for their edit-build-debug cycle. It has lightweight debugging, a robust extension architecture, and lightweight interface with existing tools, as well as extensive code editing, navigation, and understanding assistance (Visual Studio Code, n.d.).

3.1.11 Jupyter Notebook Version 6.4.12

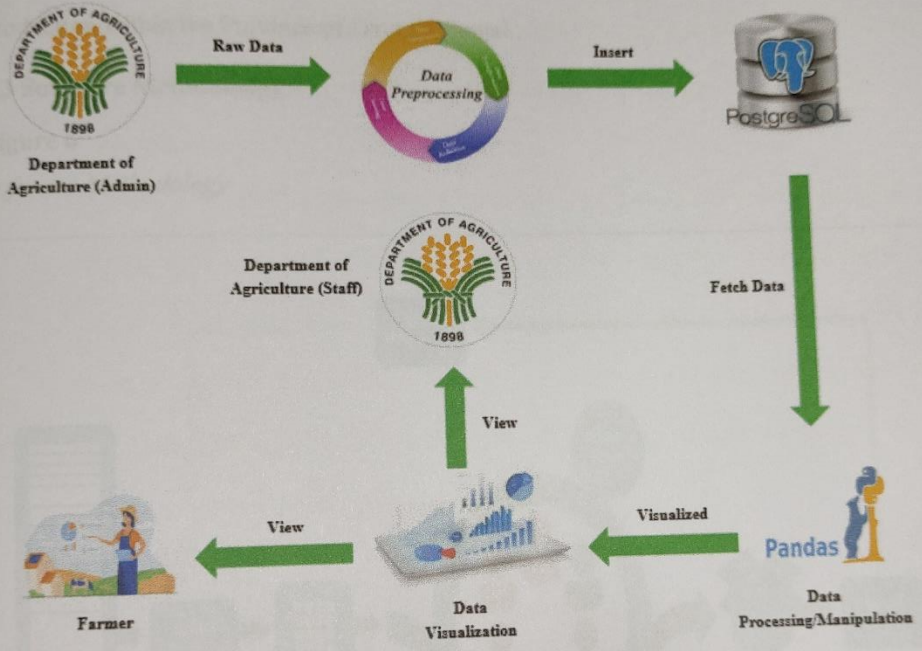
JupyterLab is the most recent interactive development environment for notebooks, code, and data on the web. Users can configure and arrange workflows

in data science, scientific computing, computational journalism, and machine learning using its flexible interface (Jupyter Home, n.d.).

3.2. Conceptual Framework

Figure 5

Conceptual Framework



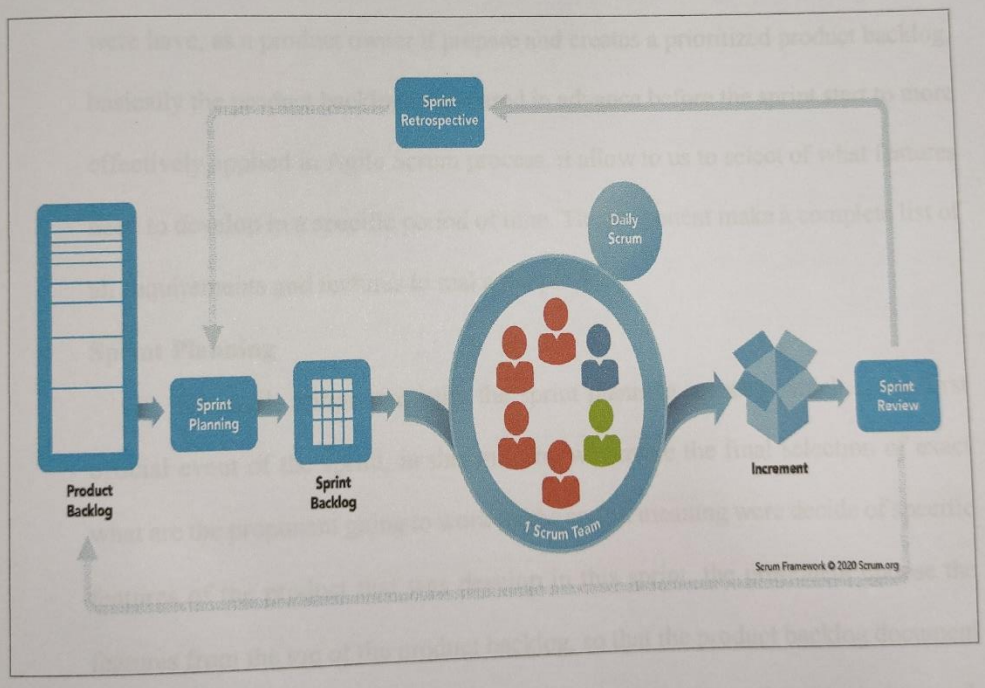
A conceptual framework process is a mechanism to help software developer plan, design and structure the development of software to solve a problem. Without a process to guide the structured evolution of a solution, it is extremely likely that at least some aspects of the resulting software were committed or incorrectly implemented. The figure above shows how our project processes to be used in the data analytics cycle. The above scenario showed that where the data come from and the outcome, the Department of Agriculture above serve as the source of our data, then from their department input and load to our

database so that our system can have a tool as a source of a data in order to have a visualization based on the data. Using the proposed algorithm, the data from database undergo processing and feed to our MLR algorithm and the system showing a visualized data by graphs to end users, but before visualization, the data need to manipulate through panda's python library. The visualized data are forecasted and actual value of rice production within the Province of Davao Oriental.

3.3 Software Methodology

Figure 6

Software Methodology



The proponent used methodology that adopted to agile specifically in scrum, which allow developing a system rapidly. Agile is the ability to create and respond to change. It is a way of dealing with and ultimately succeeding in, an uncertain and turbulent

environment. Agile is used for alternative approach to managing projects, specially created for managing projects in fast paced and constantly changing environments. Agile is famous for IT and software development, gaining popularity in non IT industries. Teams that adopt the agile methodology are able to complete work faster, adapt to changing project requirements, and optimize their workflow (Agile Project Management, n.d.). It is also has a flexible approach which allow the proponents to quickly adapt to situations and make changes, then to develop working software early and get it checked by the customer.

Product Backlog

Product Backlog is a set of plan of what are the requirements of the project were have, as a product owner it prepare and creates a prioritized product backlog, basically the product backlog is prepared in advance before the sprint start to more effectively applied in Agile Scrum process, it allow to us to select of what features need to develop in a specific period of time. The proponent make a complete list of all requirements and features to make the product.

Sprint Planning

The Agile sprint start with the sprint planning meeting which is our first official event of the sprint, in this meeting was make the final selection of exact what are the proponent going to work on the sprint, meaning were decide of specific features of the product that was develop in this sprint, the proponent choose the features from the top of the product backlog, so that the product backlog document had a hundred features, let say were making the five of them from the top to work on in this sprint.

Sprint Backlog

The proponent put those five features in the document called the sprint backlog, the sprint backlog is the document which contains the items that have selected for the sprint, these are the items that the development team work on and make them fully functional product features.

Development work or Activities

Once the sprint backlog has been created, the next stage were doing in the development work or activities perform the actual work to make the product, in other words the proponent developed the features of the product, this is include activities such as programming designing and quality assurance.

Daily Scrum Meeting

While doing this development work, also the proponent have a daily scrum meeting, this is the meeting which the development team discusses about the progress of our individual task and also what are the blocker the developer facing today, then discuss what are the developer going to work tomorrow .

Increment

Once the proponent completed the work were getting the outcome of the sprint, the outcome refers to the finished and completed product features that the proponent developed during this sprint, this is known as Increment.

Sprint Review Meeting

Also at this point the proponent were going to have a sprint review meeting. This is the meeting that demonstrate the progress of what the developer done, as the result of the product demonstration the proponent have a feed back to see if the development team had the right direction.

Sprint Retrospective

At the end of the sprint the developer found what is the skills need to be improved for the next sprint, and also to know about the performance during the sprint execution.

3.3.1 Requirements Specification

A product requirement specification establishes a bridge between product management and development. It defines a product in terms of stakeholder requirements, containing all those requirements that sensibly should be described explicitly and be available permanently. To develop this web-based system, gathering information were analyzed and formulated correctly to meet the requirements for the development of the system, and it should be properly in line with the desired output.

3.3.1.1 Product Perspective

The product requirements specification is the core instrument that (a) defines product management's response to stakeholder needs and demands, and (b) that communicates to development what shall be the product or the new features to be developed. Rice production forecasting system using Multi Linear Regression Algorithm in Davao Oriental were crafted tailored to the needs of agricultural sector. It were made for: (1) Provincial Agriculture Office XI which enable them to comprehensively view rice paddy statistical reports about yields in a specified period of time; (2) Professionals in the field of agriculture for the necessary intervention for factors affecting rice production and; (3) Rice Farmers as they can also use the system for free consultancy service from government professionals.

3.3.1.2 Product Features

Product features are discrete areas of new and upgraded functionality that deliver value to your target users. Evaluating, defining, and prioritizing features is a large part of the role. Rice production forecasting system in Davao Oriental to Provide Rice Self-Sufficiency using multi linear regression algorithm were using web browsers since it is a web-based application for the administrator's module, thus, any third-party applications to be downloaded that may greatly affect the total performance of a computer system and or any mobile or android phones are not needed.

The focus of proposed system was on forecasting the yield of rice in the succeeding harvest time using the data from the previous year. It was embedding Choropleth Map to comprehensively display rice production-related reports including the forecasting of rice production per specified area. Administrator of the proposed module were given an interface to select and specify scope of their view from the Choropleth Map and view reports based on that specified area. Farmers on the side note have their corresponding user interface to have direct contact with professionals in the field of Agriculture for free online consultation in terms of personal constraints in rice farming. Since Davao Oriental aspires to improve and maintain rice self-sufficiency, the proponents find it necessary to establish communication between agricultural experts and rice farmers to attain the Region's vision in agriculture.

On the other hand, in compliance with the availability of confidential information, in line with the emphasis of the CIA (Confidentiality, Integrity, and

Availability) triad, the system enforcing two-factor authentication to ensure that the information can only be accessed by authorized personnel.

3.3.1.3 User Classes and Characteristics

User classes may be differentiated based on frequency of use, subset of product functions used, technical expertise, security or privilege levels, educational level, or experience. The following are the users of the program.

Provincial Agriculture Office - XI

Having stated the product features and perspective in this chapter, Provincial Agriculture Office XI was the prospected administrator for this proposed system. The only requirement they needed to meet was to have workstation class desktops to access the proposed system using any web browsers.

Rice Farmers in the Province of Davao Oriental

Since the proposed system aimed to help the Province of Davao Oriental attain its goal, which is to provide self-sufficiency in rice farming, the proponents were crafting a user-interface at the grass-root level accounting rice farmers. Web-based application were embedded into a mobile application for rice farmers' use.

3.3.1.4 Operating Environment

The researchers used different system development software tools, concepts, and technologies that helped the system launched.

3.3.1.4.1 Software Specification

The proponent were using the following to develop the system:

Table 1

Software Specification

LOCAL SERVER	Angular CLI Local server
DATABASE	MySQL Server 5.0
DESKTOP APPLICATION EDITING TOOL	Visual Studio Code version 1.61, Sublime Text version 3.0
PROGRAMMING LANGUAGE	Python, Flask Python, Angular 10
IMAGE EDITING TOOL	ADOBE PHOTOSHOP
DATA CLEANING TOOL	WEKA
DATA VISUALIZATION TOOL	Tableau

3.3.1.4.2 Hardware Specification

The developers used the following hardware to implement this system.

Table 2

Hardware Specification

COMPUTER	AMD Ryzen 3 3250U with Radeon Graphics 2.60 GHz
	8GB (5.92 GB usable)
	64-bit Operating System, x64-based processor

3.3.1.5 Design and Implementation Constraints

This system is a web-based and fully responsive so that it works on any device that can search through online.

3.3.1.6 User Documentation

The proponent provided a user manual for the user to understand on how the system used. Manual contains screenshots of every page and its function that might be helpful for the users to follow on how to use it.

3.3.1.7 Other non-functional requirements

- Performance Requirements

Table 3

Performance Requirements

Requirements	Description
PO1	The system can be able to handle request made by the user and process requests.

The table shows the requirement on how the systems process and the request of the users as well as its entire functions of the system.

3.3.1.7.1 Operational Requirements

Table 4

Operational Requirements

Requirements	Description
DO1	The system was connected to the database that contains all information in all transaction within the system.
DO2	The system must have authorized personnel to manage the operation or transaction
DO3	The system was asking username and password to prevent the system from unauthorized access.

3.3.1.7.2 Other Requirements

Table 5

Other Requirements

Requirements	Description
RO1	The system was to be developed as a web application
RO2	The system used relational database to function as storage of data that would be used on the system search functionally.

3.3.2 Analysis

3.3.2.1 Technical Feasibility

Rice production forecasting System in Davao Oriental to Provide Rice Self-Sufficiency using a Multi Linear Regression algorithm was believed to be technically feasible in all aspect. Provincial Agriculture Office XI believed to hold computers in accomplishing daily tasks and reports which can be used for project deployment as well as trained IT professionals as IT supports in case of tech-related issues. The proposed system would not be requiring high-end computer specifications provided that the computer has a web browser and an internet connection in order to access the system.

3.3.2.2 Economic Feasibility

The proponents believed that the procurement of the system, as a whole, opposed to the cost it demands for the system to be deployed are prudent, thrifty, and could achieve maximum productivity with minimum wasted effort and or expense. The system would be only needing data for a certain time period and computer components - meeting the minimum

required computer specifications, needed to run the whole program.

3.3.2.3 Operational Feasibility

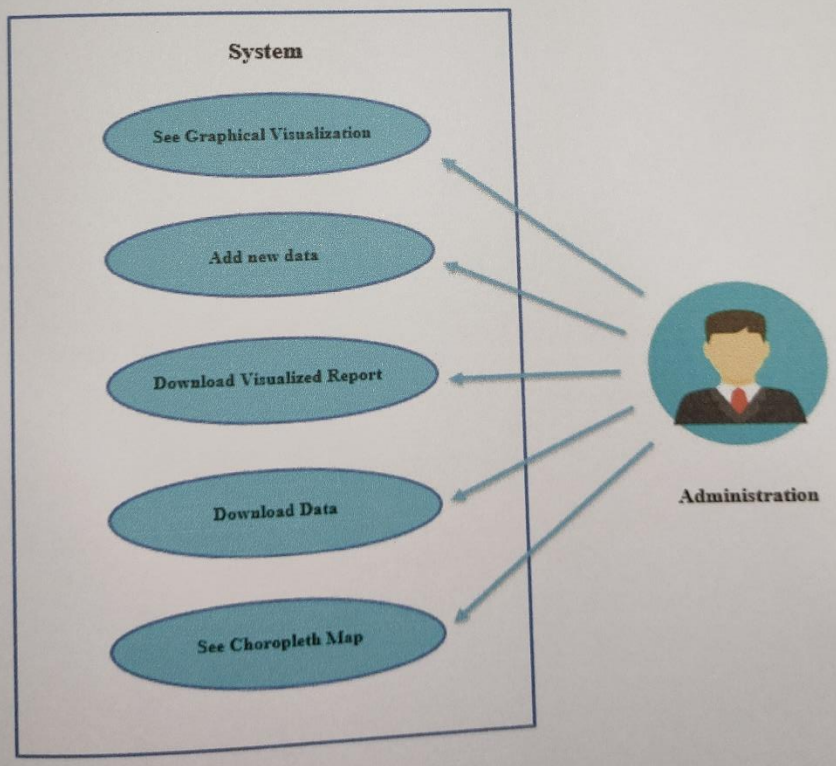
The proponents provided user-interface documentation and manual to be used as training or basis on how to develop system. The software development team (proponents) is still on the process of determining further solutions to further refine the usability of the product itself taking in full consideration the user interface and user experience factors.

3.3.3 Design

3.3.3.1 Use Case Diagram

Figure 7

Use Case Diagram



This figure shows the Department of Agriculture in municipality serve as the administrator of its project, can fully integrate the features of the system. Basically, can view the geographical and graphical representation of the data, and download report into csv file, and also would allow to integrate to select of what attributes he or she want to view.

CHAPTER IV
RESULTS AND DISCUSSION

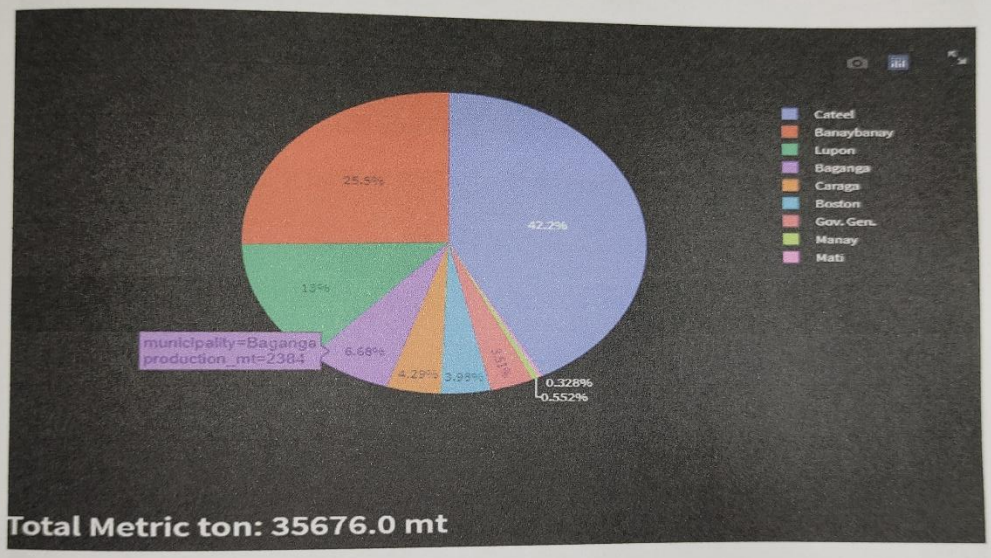
This chapter presents the results and discussion of the research study conducted by the proponent. Those include in this following below:

4.1 Achievement per objective

1. To create a system that would show the distribution rates of rice production in every municipality of Davao Oriental.

Figure 8

Pie Graph

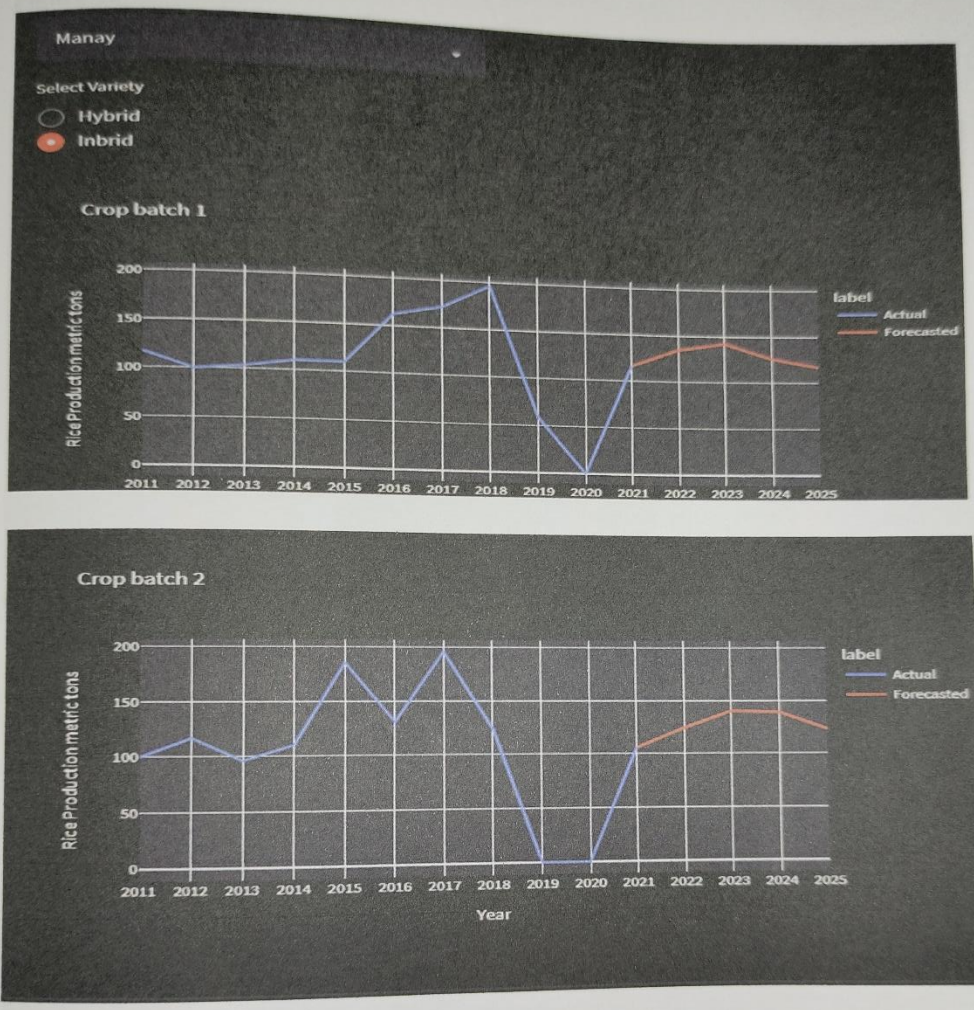


This figure shows the exact distribution of the production rates in every municipality together with the year and batch cropping.

2. To create a system that would show a production trend in every municipality together with the forecasted and actual values by cropping.

Figure 9

Line Graph

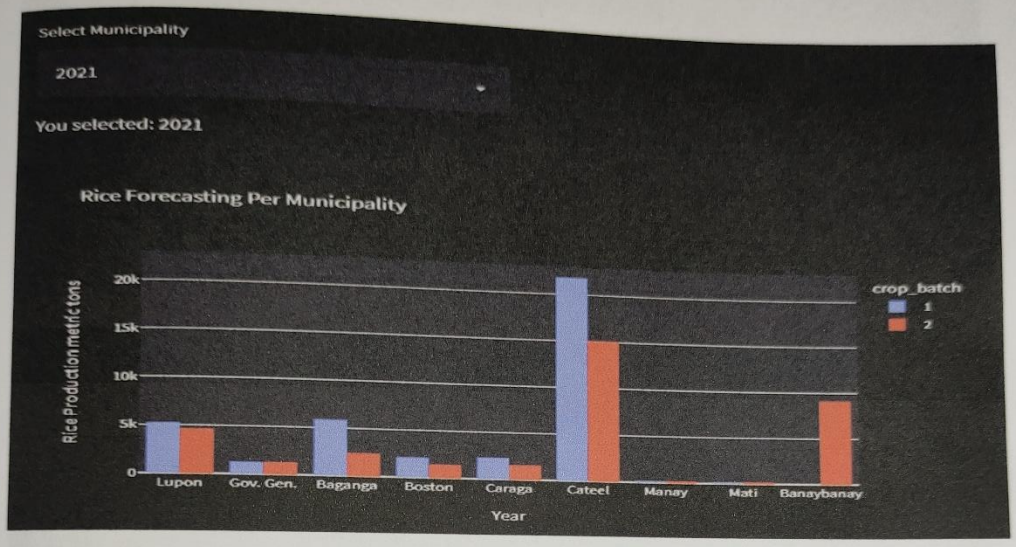


This figure shows that the user can select variety and municipality. The system automatically generated and visualized the rice production metric tons into two crop batch. Then the label beside indicated the actual and forecasted value and the graph line serve as decrease and increase in every year.

3. To create a system that would show forecasted metric tons unit of rice production per municipality.

Figure 10

Forecasted Metric Tons

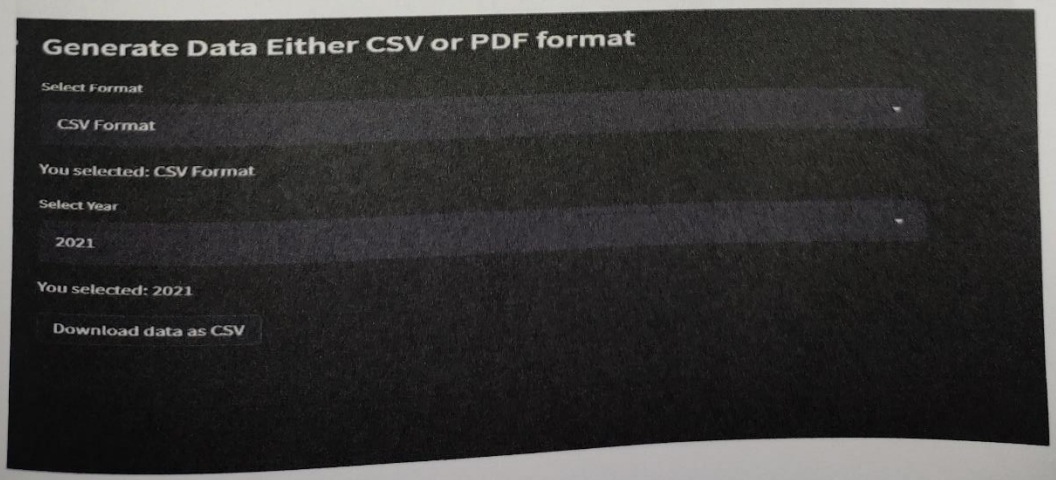


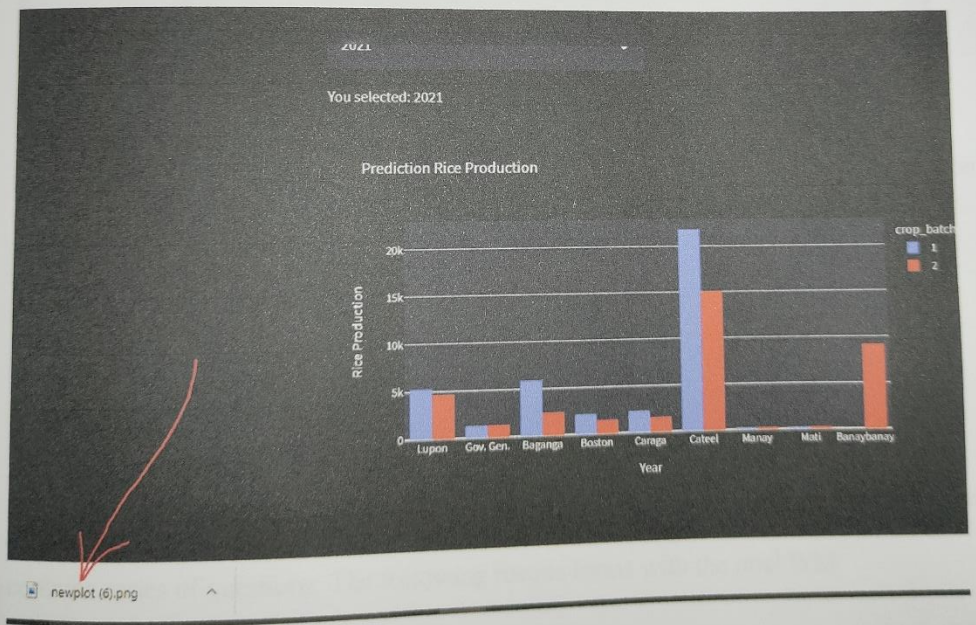
This figure shows that the user can select year to see the forecasted metric tons per cropping and municipality.

4. To create a system that would allow Local Government Units to generate report in CSV, and important reports in a graph that can be exported to png format.

Figure 11

Download Visualized Data and Generate Data



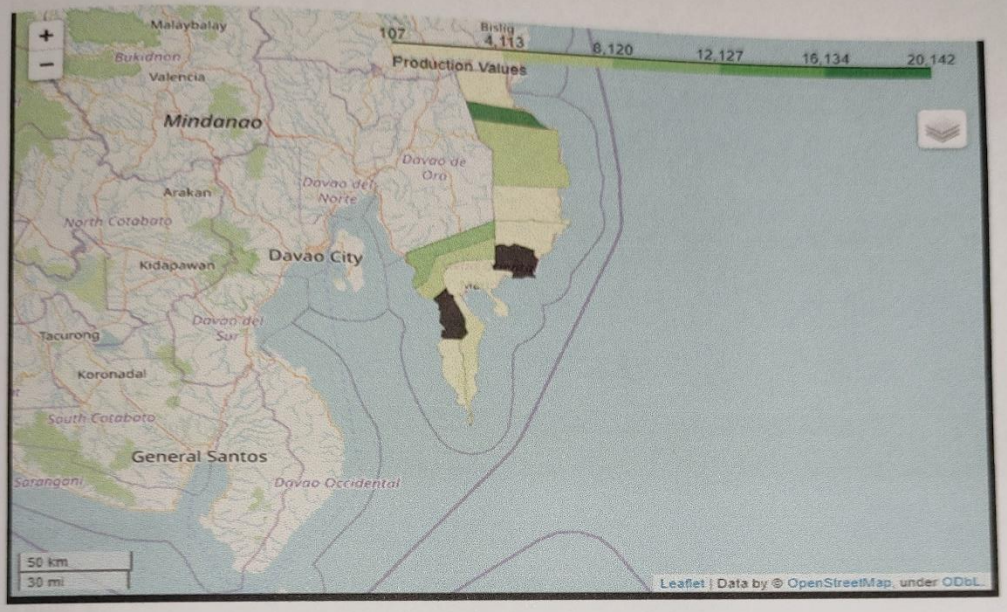


This figure shows that the user can download data in a CSV format and the user also can select year to see the prediction of rice production and the user can download report by clicking the button in a png format.

5. To create a system that can show the forecasted production value through choropleth map.

Figure 12

Choropleth Map



This figure shows the choropleth map that helps the user identify the production values in specific areas together with the color indicated and value presented.

4.2 Testing/Implementation Results

The User Acceptance Testing rate the overall functionality of the system.

4.2.1

To rate the system, the researchers gave a feedback form to various people which contains series of questions. The following results forms with the total WM:

Table 6

Likert Scale

Range	Scale	Adjective Interpretation
4.00 – 5.00	5	Excellent (of superior quality)
3.00 – 3.99	4	Above Average (exceed the minimum standard)
2.00 – 2.99	3	Average (meets the minimum standard)
1.00 – 1.99	2	Fair (does not meet the minimum standard)
0 – 0.99	1	Poor(needs improvement)

User Module

Table 7

User Acceptance Testing Results

Criteria	5	4	3	2	1	WM
U – 1 Rice Forecasting Interaction						
Importing data in CSV format.	5	3	1	1	0	4.2
Generate predicted data Report through PDF or CSV.	4	4	0	1	1	3.9
Download the visualized predicted data via image report.	5	2	3	0	0	4.2
Davao Oriental Municipalities are accurately located on the Choropleth Map.	4	3	2	0	1	3.9

U – 2 Rice Forecasting Accuracy						
Actual and predicted values are compared.	5	4	1	0	0	4.4
U – 3 Graph Visualization						
Comprehension of Actual Value (Visualization).	7	2	0	1	0	5.4
Comprehension of Predicted Values (Visualization).	6	2	2	0	0	4.2
The predicted production rate distribution by municipality (Pie Graph).	4	4	1	1	0	4.1
The X and Y axis values for the Bar Graph label.	5	5	0	0	0	4.5
Total Weighted Mean						4.3

4.3 Implication and Discussion Results

User Acceptance Testing was performed to determine the liability and legitimacy of the system. The researchers gave 1 copy for the user only. Based on the user evaluation results the overall total weighted mean is 4.3 that implies system's Excellency. Users were satisfied and approved that the system is ready to be implemented.

CHAPTER V
SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter is presented in three sections. The first section contributes to an overall summary of the study followed by the conclusions and recommendations.

5.1 Summary

This web-based system was being developed to provide simple interface for the Provincial Agriculture Office XI who would use it. The help of the current technology has been ameliorated the function. Through this, the Provincial Agriculture Office was able to download data in CSV format, can analyze forecasted data and input data to the system. Then, the system also would show the graphical data visualization to be readable for the user and easy to interpret. In fact, the farmers also can see the visualized predicted and forecasted data records and ask for request a copy of data from the Provincial Agriculture Office XI.

5.2 Conclusion

R-C Prognoz: Rice production forecasting system using a multilinear regression in Davao Oriental helps and improved the rice field. In order to prevent the low production of rice, R-C Prognoz was developed. By using a web-based system that was deployed in any web browser, this system would help see possible outcomes for rice production so that the Provincial Agriculture Office XI would be prepared if there is an intervention need to execute and also what kind of those interventions would be possible solutions for that matter. The rating sheets given to users serves as the system rating or how realistic and liable the system was. The user module overall weighted mean is 4.3 which tell that the functionality of the system is very good and users are satisfied with the system service. We can now conclude that R-C Prognoz has a positive impact to the users and to the field of

farmers.

5.3 Recommendation

The following are recommendations that the system needs to make it improved in future development and iterations. (1)The system will suggest what varieties to be used for the next cropping. (2)The future researcher must provide a forecasted map of low production in every barangays, so that the municipality level of Department of Agriculture can initiate what intervention they need to do. (3)The system can be able to query specific location of barangays. (4)The future researcher will be need to have a data for rice variety that can be used for variety recommendation.

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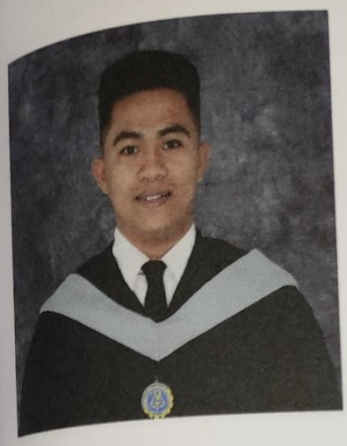
GEMAR P. PETERE



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Personal Details

Age:	24 years old
Date of Birth:	Oct. 10, 1997
Place of Birth:	Tagum, City
Citizenship:	Filipino
Civil Status:	Single
Weight:	62kg
Height:	5'2"

Objectives

Dedicated to work aiming for positive socio-economic mobility for family. Strongly focused with the ability to complete tasks efficiently in a fast-paced environment with conflicting deadlines.

Approachable, positive, goal and family-oriented person.

Continuously looking for professional and personal development.

Educational Attainment

Tertiary	Davao Oriental State University – Banaybanay Extension Campus Bachelor of Science in Information Technology Purok 6 Poblacion, Banaybanay, Davao Oriental 2021-2022
Secondary	Lupon Vocational High school Cambing Baratua st. Lupon, Davao Oriental 2014-2015
Primary	Mogbongcogon Elem. School Mogbongcogon, Banaybanay, Davao Oriental 2009-2010

Relevant Skills

Microsoft Office Word
Microsoft Office Excel
Microsoft Office Power Point
Encoding
Programming

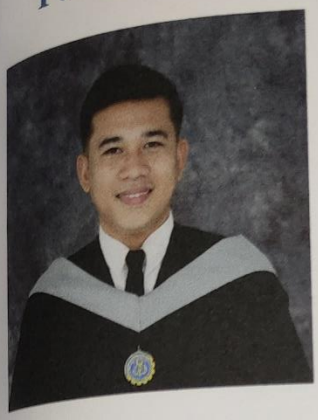
Seminars/Training Attended

Pre-Employment Seminar – 05/16/22-05/18/22

Character Reference

Mr. Ruben L. Quindoyos Jr. Davao Oriental State University
IT Instructor

MACRIS JHISS TUMULAK



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Personal Details

Age:	26 years old
Date of Birth:	Mar. 18, 1996
Place of Birth:	Cebu City
Citizenship:	Filipino
Civil Status:	Single
Weight:	70kg
Height:	5'6"

Objectives

To secure a challenging position in a reputable organization to expand my learnings, knowledge, and skills.

Educational Attainment

Tertiary	Davao Oriental State University – Banaybanay Extension Campus
	Bachelor of Science in Information Technology
	Purok 6 Poblacion, Banaybanay, Davao Oriental
	2021-2022
Secondary	Divino Amore Academy
	Lower Mohon, Talisay city, Cebu
	2012-2013
Primary	Panadtaran Elementary School
	Panadtaran, San Fernando, Cebu
	2008-2009

Relevant Skills

Microsoft Office Word

Microsoft Office Excel

Microsoft Office Power Point

Multimedia

Encoding

Programming

Seminars/Training Attended

Pre-Employment Seminar – 05/16/22-05/18/22

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