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pataBanana: A Web-Based Decision Support Application for Calculating the Fertilizer Amount Based on Soil Test Result

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ABSTRACT

In the Philippines, the banana industry is one of best agricultural products and become a source of income for local Filipino farmers and foreign exchange earners for the country. In the Regional Research Agenda 2011-2016 issued by the National Economic Development Authority (NEDA), suitability of specific fertilizers on land/soil classes for varieties of bananas is one of the priorities. Researchers found out that agriculturists from Bureau of Soils and Water Management agency manually compute the fertilizer recommendation for a certain crop. The study aims to develop a web - based decision support application to assist agriculturists in calculating the exact amount of fertilizer by automating the computation process for fertilizer recommendation. The general formula given by the Bureau of Soils and Water Management (BSWM) serves as the algorithm for calculation. Decision Support System is used for predicting the number of banana herbs to be planted and the number of hands and fingers to be harvested. Descriptive development method using Iterative process model was utilized in the study. The application was developed using PHP Laravel 5.3, semaphore API for the SMS feature and black box for testing procedure.

Keywords **—** Decision Support System, Fertilizer Recommendation, Information Technology, Iterative Development Model, Philippines

INTRODUCTION

Banana, a monoecious monocotyledonous plant belonging to the family Musacea is the largest herbaceous plant in the world. The Philippines, along with

other Southeast Asian countries, is one of the centers of banana diversity and domestication. The most commonly known banana is the Cavendish variety, which is the one produced for export markets (Memorian & Vuylsteke, 2011).

According to John Dela Cruz in the Manila Trade Website posted in 2016, in the Philippines, the Banana Industry is one of the best and important agricultural products (Dela Cruz, n.d.), as it has become a source of income for local farmers and a foreign exchange earner for the country.

As stated in the Regional Research Agenda 2011-2016 that was issued by the National Economic Development Authority (NEDA), one of the research priority areas of the Banana Industry Cluster is the suitability of specific fertilizers on land or soil classes for a different variety of bananas. As the researchers gathered data and studied more about this research priority, they found out that there are a lot of things to consider when planting banana. One of this is the number of fertilizers needed for the soil or land to ensure that a particular variety of banana can be planted in it (Tropical permaculture, 2018).

The exact amount of fertilizers to apply to the land/soil in which a particular variety of banana will be cultivated, agriculturists from Bureau of Soils and Water Management agency manually compute the exact amount of fertilizer for the land/soil based on its lab results. Computing the amount of fertilizer for a land/soil from its analysis requires basic arithmetic. This process can lead to incorrect computation of fertilizer amount and is also time-consuming on the part of the agriculturist. To achieve good banana production, it is important that all factors in the cultivation are considered (Kabunga, Dubois, & Qaim, 2014). Applying the improper amount of fertilizer might affect plant growth, its quality, and the environment. Nutrient management itself can be the cause of a number of serious environmental problems. The improper use of fertilizers can lead to six main types of negative environmental impacts: nutritional disorders of plants, reduction in yield quality, decreased tolerance of crops to diseases and pests, increased acidification of acidic soils, accumulation of NO3-N in freshwater resources (lakes, rivers), and nutrient accumulation (Eutrophication) in natural water resources (lakes, rivers) (Investopedia, 2018).

In today's generation, the standard of living has improved significantly because of technology. Technology has played a big role in developing the agricultural industry. Modern agricultural technology allows a small number of people to grow vast quantities of food in the shortest period of time. Farmers use technology in their own ways, some farmers use applications to help compute the amount grass available in the field while others use it to create fertilizers.

Technology has turned farming into a real business (Ramey, November 24, 2012).

The web today is a growing universe of interlinked web pages and web application. The Web is a highly programmable environment that allows mass customization through a direct deployment of a large and diverse range of applications, to millions of global users. Over the past years, the web has been embraced by millions of people as a low-cost network for communication and information exchange.

Decision support systems (DSS) are interactive, computer-based systems that aid users in judgment and choice activities. DSSs include knowledge-based systems. In general, Decision Support Systems are a class of automated information system that helps decision-making (Information Builders, 2018).

Short Message Service (SMS) messaging or more popularly known as text messaging is a service that allows for short messages to be sent from one mobile phone to another (Taylor, & Vincent, 2005). Through SMS, people can receive information from various industries on spot.

With the advent of technology and the existing issues concerning the computation for the correct amount of fertilizers, the researchers conceived the idea of creating a web-based application entitled "pataBanana: A Web-Based Decision Support Application for Calculating the Fertilizer Amount Based on Soil Test Result". This application can help agriculturists identify what is the exact amount of fertilizers needed for the land/soil in which a certain commercial variety of banana will be cultivated.

OBJECTIVES OF THE STUDY

The main objective of this project is to develop a web-based application that will help agriculturists in the Davao Region in producing the fertilizer recommendation by identifying the fertilizer amount needed based on the soil test results for the land/soil in which a certain commercial variety of banana will be cultivated. Specifically, the application is capable of: 1) generating the fertilizer recommendation automatically by computing the nutrient requirements based on soil test results by using the general formula given by the Bureau of Soils and Water Management (BSWM); 2) suggesting the number of banana trees to be planted in a certain area (hectare) and the number of hands and fingers to produce based on how many banana trees is planted in a certain area; 3) allowing agriculturists from the Bureau of Soils and Water Management (BSWM) to add lists of soils, the Bureau of Plant Industry (BPI) to add the list

of banana varieties, and the Fertilizer and Pesticides Authority (FPA) to add lists of registered fertilizers. Also, this application allows administrators to add other administrators; 4) allowing agriculturists from the Bureau of Soils and Water Management (BSWM) to send their fertilizer recommendation to the farmer via SMS and email; 5) printing the fertilizer recommendation; 6) allowing the three (3) administrators to update their profiles and 7) letting the farmers view the site, search for banana types and view lists of banana varieties, kinds of fertilizers and soil varieties as well.

FRAMEWORK

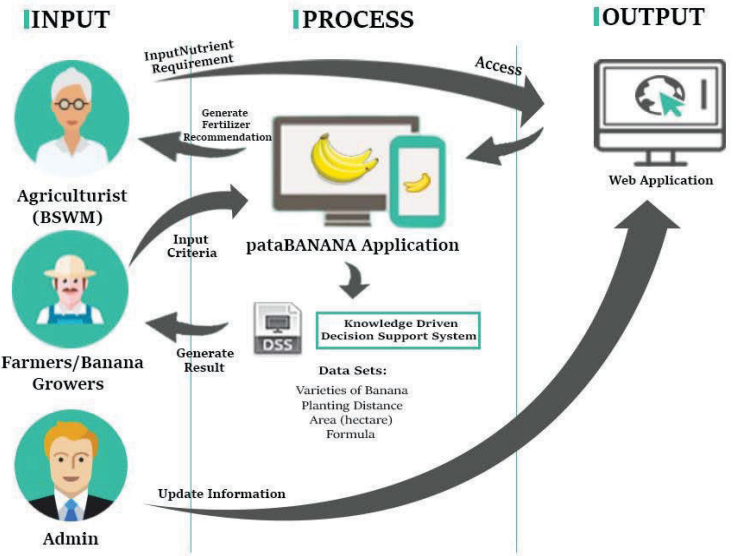

Figure 1. Conceptual Design (General)

As shown in the figure, the farmer or banana growers and agriculturists from Bureau of Soils and Water Management (BSWM), Bureau of Plant Industry (BPI), Fertilizer and Pesticide Authority (FPA) can use the application through a computer since it is a web-based application.

Agriculturists from the Bureau of Soils and Water Management (BSWM) inputs the different criteria based on the nutrient requirements from the issued soil test result of a specific soil in which a class of banana will be cultivated. After the different criteria are inputted, the application processes the different criteria

under an algorithm which is the formula given by the Bureau of Soils and Water Management (BSWM), after this process, the application now produces the combination of fertilizer and the exact amount needed. The agriculturist can pass the result of the computation called the Fertilizer Recommendation to the farmers/banana growers through an email or an SMS if the farmers/banana growers do not have an email account.

On the farmers and banana growers side, farmers and banana growers input the different criteria such as the banana type, area (hectare) and the planting distance. After inputting the criteria, undergoes processing using Knowledge Driven Decision Support and generates the number of banana trees to be planted in a certain area and the number of hands and fingers that will be harvested based on the number of banana trees planted in an area.

The three administrators from different government agencies who are the agriculturist from Bureau of Soils and Water Management (BSWM), Bureau of Plant Industry (BPI) and the Fertilizer and Pesticides Authority (FPA) can update the data which are stored in the application. Administrators from the Fertilizer and Pesticide Authority) (FPA) can update the list of registered fertilizers, the Bureau of Plant Industry (BPI) can update the list of commercial varieties of banana with images, the planting distance, and other criteria which are needed for the DSS and the Bureau of Soil and Water Management (BSWM) can update the list of soil with images.

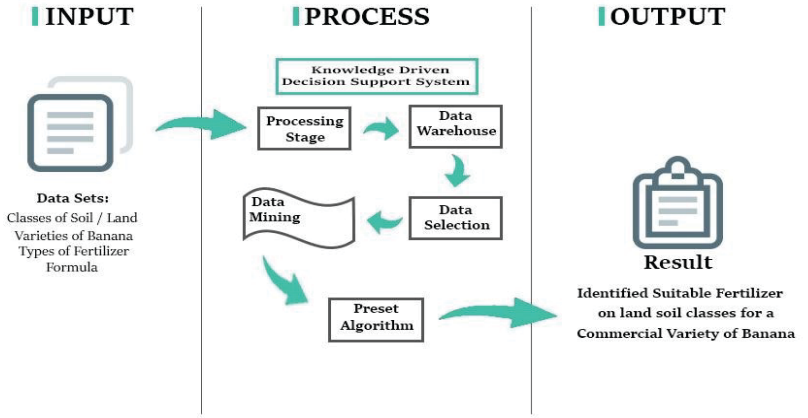

Figure 2. Conceptual Framework (Knowledge Driven)

The researchers gathered data from the different government organizations that are involved in this study. The researchers collected data about the different commercial varieties of banana, the classes of soil or land and the formula in computing the fertilizer application rate. These datasets will be integrated and pre-processed under the preprocessing phase. After this, the cleaned and prepared data from the pre-processing phase will be stored in the data warehouse. Before the data sets are mined in the data warehouse for discovering knowledge, part of the data will be selected and customized in the data selection phase. Then the selected data will be analyzed and will undergo a set of algorithms and generates results about the number of banana to be planted in a certain area and the number of hands and fingers. This formula given by the agriculturist in computing the amount of fertilizer served as the algorithm and this is discussed under the methodology section. A KD-DSS is a knowledge driven decision support system. The KD-DSS can give suggestions or recommendations based on several criteria. Advanced analytical tools like data mining can be integrated with the KD-DSS to find hidden patterns. Data mining is the process of sifting through large amounts of data to produce data content relationships. Knowledge-driven DSS can store and apply knowledge for a variety of specific problems/ tasks that would otherwise be resolved by a human expert. The generic tasks include classification, configuration, diagnosis, interpretation, planning, and prediction (Hamad, & Qader, 2014).

METHODOLOGY

The researchers used the constructive research method. This research method is based on theories, hypothesis and case studies. The objective of the constructive research is to solve practical problems while producing an academically valued theoretical contribution.

Each phase guided the researchers in solving the solution to the practical problem and contributed to the completion of the research procedure.

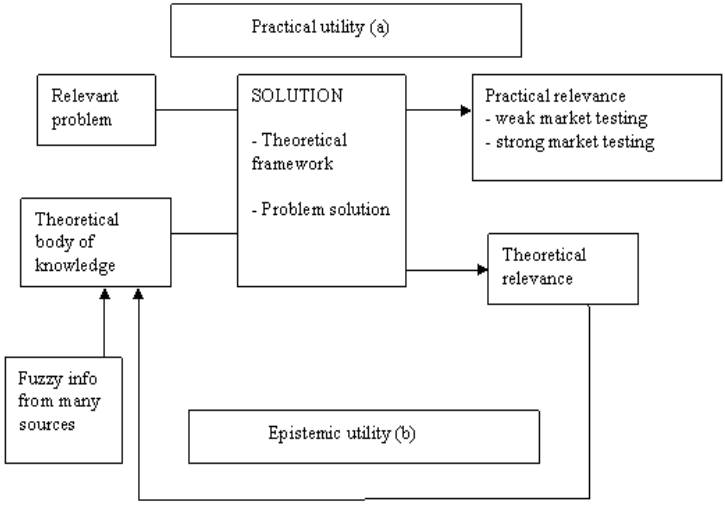

Figure 3. Constructive Research Diagram

Finding a Relevant Problem. In this phase, the researchers searched for relevant problems with the use of the internet. Aside from the internet, the researchers also paid particular attention and observation to find possible important problems in their community. This helped researchers evaluate such problems and their research potential. The researchers discovered an existing relevant problem among agriculturists at the Bureau of Soils and Water Management (BSWM) with regards to the manual computation of the nutrient requirements to produce the fertilizer recommendation based on soil Test Result. The researchers also found out that most of the farmers have a difficulty in getting the results of the soil test from Bureau of Soils and Water Management (BSWM) because some of them are from provinces and they need to travel to get the soil test result.

Concept of Computation. The formula for the amount of fertilizer to be applied in the land or soil that the particular commercial variety of banana will be cultivated will depend on its soil analysis but the Department of Soil and Water Management has a default formula for computing the amount of fertilizer to be applied this is called fertilizer recommendation. Fertilizer recommendations are given in amounts of

nutrients. Commercial fertilizer indicates only a percentage of nutrients or fertilizer elements contained in the bag. The general formula is:

No. of bags fertilizer = Kgm. Nutrients Recommended/Kgm. Nutrient per bag

Obtaining a General and Comprehensive Understanding of the Topic. The researchers continued to research to gain a comprehensive understanding of the research problem and its context which is computing the fertilizer amount based on the soil test result. The researchers conducted an interview with respondents such as the farmers or local banana growers, agriculturists from the Bureau of Soils and Water Management (BSWM), the Bureau of Plant Industry (BPI) and the Fertilizer and Pesticides Authority (FPA) to fully understand and assess the problem. These respondents had to be interviewed because they were the persons experiencing the existing problem found by the researchers in the Regional Research Agenda 2011-2016 that was issued by National Economic Development Authority (NEDA). The outcome of interviews and gathered data were the basis for the researchers to determine if the problems need to be solved. This is when the topic was analyzed to come up with a good proposal. The researchers examined the data, sources, and problems and started thinking of possible solutions.

Innovate. Through the gathered data, the researchers were able to understand their topic along with other issues relating to it. The gathered data had been the guide of the researchers in creating an application to solve the problem. As a result of the gathered data, the researchers came up with an idea of solving the problem by creating a web-based application entitled "pataBanana: A Web-based Decision Support Application for computing the Fertilizer Amount Based on Soil Test Result". Through this application, the agriculturist from Bureau of Soils and Water Management (BSWM) was able to compute the fertilizer amount and produced the fertilizer recommendation automatically based on soil test result. Iterative Development Model was used by the researchers in building the web-based application.

Iterative Development Cycle

Iterative Development Model is a way of breaking down the software development of a large application into smaller chunks. Feature code is design, develop and test in repeated cycles. With each iteration,

additional features can be designed, developed, and tested until there is a fully functional software application ready to use for the customer (TechTarget, 2018). The Unified process groups increments/iterations into phases: inception, elaboration, construction, and transition.

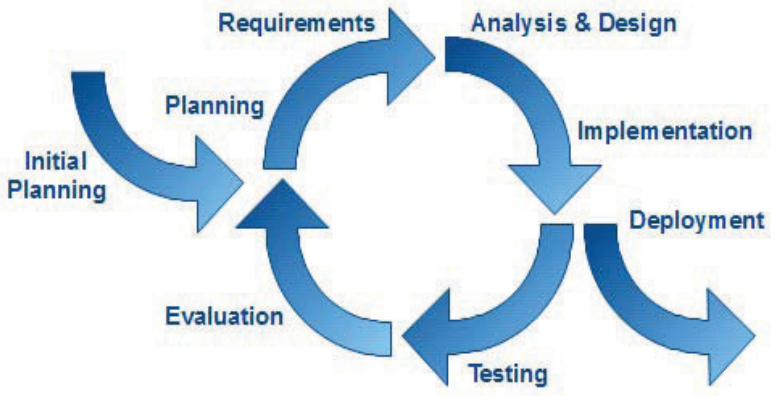

Figure 4. Iterative Development Model

Design Procedure

Initial Planning Phase. In this phase, the researchers created blueprints using the conceptual framework. The functionality of the application as a whole was listed by the researchers. This serves as a guide for the team member's participation in developing the web application.

Planning and Requirement Phase. During this phase, the participation of the technical consultant was important to guide the researchers in developing the web application. The researchers and technical consultant studied the possible topics that were relevant to the proposed application and conceptualized it. The researchers chose to create a web-based decision support application for computing the fertilizer amount based on soil test results.

Requirements Phase. The researchers gathered data from the different organizations that are involved in the creation of the proposed application. The researchers also searched for applications and literature which were related to the proposed application and downloaded software and tutorials that were useful to the implementation of the application. The researchers provided their own computer in creating the application.

Analysis and Design. In this phase, the technical development of the application was started. It was based on the conceptual framework and the gathered data, the researchers enumerated the design plan accordingly:

1. The database of the application covers the list of banana varieties, fertilizer, soil types (Sandy, Sandy Loam, Loam, Silt Loam, Clay Loam, and Clay), planting distance, fruit production, administrator/agriculturist and administrator's information.
2. The design phase for the farmers where he/she can view the list of banana, fertilizer, and soil. The farmers can also receive the result of the soil testing and the fertilizer recommendation via email, moreover, the farmers can also receive SMS that contains the fertilizer recommendation. For sending the email, Postmark API was used while in sending SMS the Semaphore API was modified to attain the functionality. The Decision Support System (DSS) Result and login page of the administrator/ agriculturist are also part of this phase.
3. The design phase for the administrator of Bureau of Soils and Water Management (BSWM) that had sample list of soil and can update data. Calculating the amount of fertilizer based on soil test result and generated a result with print and can send email and SMS to the farmers are also included in this phase.
4. The design phase for the administrator of Bureau of Plants Industry where he/she could view a sample list of banana and can update data.
5. The design phase for the administrator of Fertilizer and Pesticides Authority (FPA) where he/she could view a sample list of fertilizer and update data. Every design plan of the application as enumerated above was translated into code by using a programming language that had been indicated in the technical background under the system development.

Testing. The application was developed and tested by the researchers to check if it was functional, identified what are other features to add and be able to detect errors before subjecting the application for evaluation. The researchers used Black box testing in the application. The Black box testing is mainly applicable to higher levels of testing. Black box testing does not require programming knowledge and implementation knowledge. The researchers identified the testers in the city of Davao. After the testing is being conducted, the researchers identified the errors and functionalities that were never met by the system.

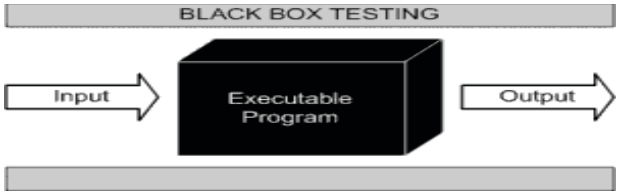

Figure 5. Black-Box Testing Flow

Testing Procedures. To test and validate the functionalities of the "pataBanana" application, the researchers made a formal letter and randomly selected respondents from the farmers or local banana growers in Davao City. On the other hand, the researchers also made a formal letter to the selected agriculturist from Bureau of Soils and Water Management (BSWM), Bureau of Plant Industry (BPI) and lastly the Fertilizer and Pesticides Authority. The procedures are as follow:

The researchers explained first the concept of the application, how did it work and its different functionalities. The respondents have given a permission to use the application with the assistance of the assigned researchers. They were required to answer the test cases given by the researchers and asked to put suggestions and recommendations to strengthen the application.

During the testing of the "pataBanana" application particularly in the administrator side, there were total of three (3) respondents tested the application from different government agency. This covers the Bureau of Soils and Water Management (BSWM), Bureau of Plants Industry (BPI) and the Fertilizer and Pesticides Authority (FPA). Each government agency had only one (1) representative participated that's why there is only one (1) test case result for every agency acquired by the researchers.

RESULTS AND DISCUSSION

During the development of this project, the researchers conducted User Acceptance Testing (UAT) on the identified respondents of the pataBanana application which covers the Agriculturists from Bureau of Soils and Water Management (BSWM), Agriculturists from Bureau of Plant Industry (BPI), Agriculturist from Fertilizer and Pesticides Authority (FPA) and the farmers or banana growers. They were asked to answer the User Acceptance Test (UAT)

form after the presentation of the concept of the research project. One of the researchers has elaborated the concept and procedures of the capstone and let the said respondents test the functionalities of the web-based application using the laptop provided by the researchers; particularly on the computation side of the agriculturist, the decision support user interface for number of plants to be planted by the farmers or banana growers and suggest estimated number of hands and fingers to be harvested. She also oriented the respondents especially the agriculturist from Bureau of Soils and Water Management that they can send soil test result and fertilizer recommendation through SMS and email.

Moreover, during the testing of the farmers or banana growers, one researcher was assigned to assist the farmers or banana growers for the testing of the application. He instructed first the farmer about the overview of what they can access. Then, the farmers were allowed to click the view button to get the list of soil, banana, and fertilizer. Moreover, the farmer also accesses the decision support functionalities and allows them to input the different criteria such as the type of banana, land area and the planting distance of the banana. The rest of the two researchers also took note of the encountered errors, respondents involved on the test, the time duration of the test, their position or designation of the said application.

There were five (12) respondents from different user's category that have participated the User Acceptance Test (UAT) that the researchers made. There were two (2) agriculturists who tested the said application and able to access their accounts. The agriculturist from Bureau of Soils and Water Management view the list of Soil, access the computation functionality and send the soil test result and the fertilizer recommendation via SMS and Email.

Moreover, the agriculturist from Bureau of Plant Industry viewed the list of banana, list of banana production and the list of different planting distance. In addition, there were ten (10) farmers or banana growers tested the application and able to access the farmer interface. In each User Acceptance Test (UAT), each respondent consumed ten (10) to twenty (20) minutes to test the web application, and to answer the test questionnaires.

One (1) out of one (1) or 100%, the agriculturist of Bureau of Soils and Water Management agreed that some functionalities of the application are working properly during the test except for the update profile and Update Soil functionality. The researchers identified the cause of the error and found out that update profile functionality cannot update the personal information of the

Bureau of Soils and Water Management (BSWM) administrator simultaneously same as the update soil functionality.

One (1) out of one (1) or 100%, the agriculturist of Bureau of Plant Industry (BPI) agreed that some functionalities of the application were working properly during the test except for the update profile and Update Soil functionalities.

Ten (10) out of ten (10) or 100%, the farmers or Banana Growers agreed that all functionalities of the application were working properly during the test except the SMS and DSS functionalities. The DSS functionality does not generate the result of a number of bananas to be planted and the estimated number of hands and fingers to be harvested due to some missing codes while the SMS functionality does not work because there is no available internet. The researchers gathered some comments and suggestions of the stated above respondents of the pataBanana application from the 12 or 100% respondents. These are as follows: For the Agriculturist from Bureau of Soils and Water Management (BSWM), she had commented that split application, liming and foliar spray with copper, manganese, zinc, and boron for micronutrient should be added to the calculation.

For the Agriculturist from Bureau of Plant Industry (BPI) she had suggested that the FHIA-2, FHIA-1 should be deleted from the list of a commercial variety of banana also Pisang Ceylan, Williams and Lakatan's estimated number of hands and fingers should be changed. Include citations or references in every data displayed and change button labels specifically the List of Planting Distance and List of Production.

The pataBanana application was developed based on the objectives that were specified. The researchers chose to address the objectives per user role. The application has two (2) types of users such as the administrators coming from Bureau of Soils and Water Management (BSWM), Bureau of Plant Industry (BPI) and Fertilizer and Pesticides Authority (FPA) and the farmers, banana growers and banana plantations. As to our case, the main consideration is the three (3) administrators coming from Bureau of Soils and Water Management (BSWM), Bureau of Plants Industry (BPI) and Fertilizer and Pesticide Authority (FPA) which plays an important role to our application. First, the researchers created a login form that sets the level of user accessibility to the application since this functionality is the starting point for other objectives to be completed. In allowing the agriculturist from the Bureau of Soils and Water Management (BSWM), Bureau of Plants Industry (BPI) and Fertilizer and Pesticide Authority (FPA) to login and have full access to the application, the researchers created

a login functionality that sets the level of users' accessibility in the web portal. To achieve this objective the Laravel 5.3 make:auth functionality was used and modified.

In allowing the three (3) administrators from Bureau of Soils and Water Management (BSWM), Bureau of Plants Industry (BPI) and Fertilizer and Pesticides Authority (FPA) to add another administrator to access the application the researchers held on an idea to create another Laravel 5.3 make:auth functionality to attain this objective, the researchers modified this function to enable the registration of administrator to the application. To set the level of user accessibility in the application, the researchers modify the user role section of each type of administrator.

In allowing the administrator from Bureau of Soils and Water Management (BSWM), Bureau of Plant Industry (BPI) and Fertilizer and Pesticide Authority (FPA) can edit his/her personal information and profile picture, the update profile functionality was created to achieve this objective.

During the creation of edit profile functionality, the researchers encounter difficulties in merging the edit info form and update profile picture form, to get rid of the errors the researchers find alternative ways in merging the two forms by applying jQuery file upload script. After the researchers achieved the similar functionalities of the three (3) Administrators, the researchers started to classify and develop the unique functionalities of each administrator interface.

For the administrator from Bureau of Soils and Water Management (BSWM):

- adds and update the list of soil with the picture;
- computes the nutrient requirement;
- generates the fertilizer recommendation;
- sends fertilizer recommendation through SMS; and
- sends the soil test result and fertilizer recommendation through email.

In allowing the administrator from BSWM to add and update the list of soils to the application, the CRUD functionality was created to attain this objective.

In the development of the CRUD functionality, the researchers used Laravel 5.3 codes instead of AJAX. In updating the information and the image simultaneously, the researchers added a jQuery update image script to the code. In computing the nutrient requirements from the issued soil test result and generating the fertilizer recommendation, the general formula from Bureau of Soils and Water Management (BSWM) was used by the researchers to come up with the right amount of fertilizer needed for the land or soil and generate the

fertilizer recommendation automatically. This formula serves as the algorithm for computing the nutrient requirements. The application produced a computerized tabular form of a soil test result, the original form of soil test result was basically created in excel table but to meet the objective of the application, the researchers converted the normal excel table to a computerized tabular form. The researchers used HTML basic table and input type designs and combined it to make a tabular form that can be filled in with data.

After creating the soil test result table, the researchers formed the table for the fertilizer recommendation. The result of the calculation, as well as the other inputs such as the legends, placement of fertilizer and notes from the soil test result table, will be transferred in this tabular form.

The researchers used the general formula to be the algorithm the researchers also used if and switch statement to create conditions for the computation. The If statement was used for classifying what is the lowest value to undergo computation first while the switch statement was used for choosing what kind of fertilizer to use for calculation.

For sending the result through SMS and email functionality, the researchers use semaphore API for sending SMS and Postmark API for sending the result via email to attain this objective. The input contact number modal was created to allow the agriculturist from Bureau of Soils and Water Management to input the contact number of the farmer that will serve as the receiver of the fertilizer recommendation result. On the other hand, the input email address modal was created to allow the agriculturist from Bureau of Soils and Water Management to input the email address of the farmer that will serve as the receiver of the detailed result of soil test result and fertilizer recommendation.

The researchers used the Semaphore API for the send result functionality of the application since it is the cheapest text messaging API. For the send result through email functionality, the researchers used Postmark API to attain this objective since it is a free API for sending transactional emails. However, the Postmark API requires an internet connection to send the result to the emails of the receivers. Sending result via SMS and email was created to address the current problem of the farmers in getting the result from the Bureau of Soils and Water Management (BSWM) agency. The farmers have difficulties in claiming the result of a soil test and the fertilizer recommendation to the BSWM office because some of them are from provinces. The said functionality helps the farmers receive the fertilizer recommendation and soil test result easily without exerting effort to go to BSWM office.

For the administrator from Bureau of Plant Industry (BPI), the administrator is capable of adding and updating the list of banana with the picture, list of different planting distance and the list of banana production by type.

To allow the agriculturist from BPI to add and update the list of banana, list of planting distance and the list of banana production per type, the CRUD for this functionality was created to achieve this objective. Below are the figures that represent the CRUD functionality for this administrator. The CRUD functionality was used to attain this objective, the researchers used jQuery upload file script to resolve the errors. The data that will be inputted and stored in this functionality will be the basis for the decision support functionality.

For the administrator of Fertilizer and Pesticide Authority (FPA):

In allowing the agriculturist from FPA to add and update the list of fertilizer, the CRUD functionality was created to attain this objective.

For Farmers/Banana Growers/Banana Plantation:

- Input type of banana, land area (hectare) and planting distance
- Generate number of banana tree to be planted in a certain land area and estimated number of hands and fingers to be harvested based on the number of banana tree to be planted
- View list of soil, fertilizer, and banana.

In allowing the Farmers, Banana Growers, and Banana Plantations to know how many numbers of bananas to be planted in a certain land area (hectare) and the estimated number of hands and fingers to be harvested, the decision support functionality was created to attain this objective. Type of banana, land area and planting distance are inputs that served as the basis for the DSS to generate results such as a number of bananas to be planted in a certain land area (hectare) and the estimated number of hands and fingers to be harvested. The data coming from the inputs from Bureau of Plants Industry (BPI) administrator are fetched and used to come up with the DSS result. The researchers used a knowledge driven type of decision support since KD-DSS can give suggestions or recommendations based on several criteria.

In allowing the Farmers, Banana Growers, and Banana Plantations to view the list of banana, list of fertilizers and the list of soils, the view functionality was created to attain this objective. The data coming from the inputs from the three (3) different administrators are fetched and displayed to the farmer's interface to achieve this objective.

CONCLUSION

Through automating the process of calculating the nutrient requirement to produce the fertilizer recommendation and the significant use of the Semaphore SMS gateway API and Postmark API, the researchers concluded that the pataBanana: A Web Based Decision Support Application for Calculating the Fertilizer Amount Based on Soil Test Result is a tool to reduce the work of agriculturist from Bureau of Soils and Water Management (BSWM) in calculating the nutrient requirements of a certain land or soil based on the soil test result and in sending the result of the soil test and fertilizer recommendation to the farmers.

RECOMMENDATIONS

During the development and testing of the application, both the respondents and the developers have suggested some recommendations for the improvement of the application. The researchers gathered some recommendations from the respondents of the pataBanana application and these are as follows:

For the Agriculturist from the Bureau of Soils and Water Management (BSWM), it was recommended it includes a split application for computing the nutrient requirement and include foliar spray with copper, zinc, manganese, and boron for calculating the micronutrient. For the Agriculturist from Bureau of Plants Industry, it was suggested that more data must be added to the system especially with regards to the productions of different types of banana because the production of banana differs to how a banana tree is fertilized. She also recommended that we must remove FHIA-2, FHIA 1 and Pisang Ceylan to the list of a commercial variety of banana because these types of banana do not belong to the list and she also said that we must add citations or references in every data or list displayed in our application.

The researchers who tested the application suggested that the researchers must improve the UI to make more text readable, fixed SMS layout, make the application more easy to use for non-techie users such as the farmers, the application must have a delete functionality for the lists, add archiving of the generated results and implement alternative solution such as reference number query in case SMS and Email functionality are not available.

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