

GETMOSYS: A Plant Pathologists' Geotagging And Monitoring System For Infected Banana Plant

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Abstract: Technology sets new record as people discover novel ideas of the application of technology. Some of these innovations paved a way to give solutions to the problems in various fields especially in agriculture. The identified problem is that plant pathologists use different applications such as Google Earth and Microsoft Excel in managing the data given by the growers that will lead to disorganization of location data. Moreover, handling large amount of data with the GPS coordinates as the only identifier on the map can be tedious and consumes significant effort when retrieving the specific data or information needed. In order to address the issues, a plant pathologists' geotagging and monitoring system for infected banana plant was designed and developed as a remedy to the problem of the plant pathologist's recording, monitoring of sample with diseases in the vast hectares of banana plantations. It is called GETMOSYS. The GETMOSYS application has two parts: a website that is specifically created to be used by the Pathologist and the mobile application that is created to be used by the growers for their grower representatives. Prototyping predictive model was used as the system development method in developing and implementing the software. Black box testing was used for the software testing functionality of the website and mobile application. One plant pathologist and 24 personnel of a banana plantation evaluated the system usability using the User Experience Questionnaire (UEQ). The system shows excellent results in Attractiveness, Perspicuity, Efficiency.

Index Terms: Banana Plant, Plant Pathologist, Geotagging, UEQ, Davao, Philippines

1. INTRODUCTION

Innovation establishes new precedent as individuals find original thoughts of the utilization of innovation. A portion of these developments cleared an approach to offer answers for the issues in different fields particularly in farming. In many tropical countries, banana is a staple food [1]. Consequently, the lives of the people depend on banana production. Even with years of agricultural research, diseases, pests, and weeds still get in the way of agricultural productivity [2]. The most significant constraints that affect the production and utilization of banana are diseases. Diseases may directly reduce yield, quality or storage of life of the fruit or indirectly affect these attributes by reducing the health of the fruit bearing plant [3]. As plant pathology is the scientific discipline that focus in plant diseases that are caused by pathogens, infectious organisms, and other environmental conditions or physiological factors and the identification of the said pathogen [4], the monitoring of these plant diseases is the main concern of a plant pathologist [5]. The utilization of current technology to help the agricultural industry is greatly supported by many experts [6], [7]. Geographic information systems are presently utilized for land use planning and arranging, utility administration, environment and landscape assessment, transportation and infrastructure planning, advertise investigation, visual effect examination, offices the board, charge evaluation, land examination and numerous different applications [8]. One example are the Geographic Tagging systems; these systems provide a substantial benefit specifically in the agricultural or environmental research [9]. Geo-tagging is the process of adding geographical information to various media in the form of metadata, which usually consists of coordinates like latitude and longitude, but may even include bearing, altitude, distance and place names. As per the definition of geo-tagging, plant pathologists utilize the specific functionality of Google Earth that enables a user to input latitude and longitude to pin point the location of an infected banana. This mapping method helps guide the plant pathologist for monitoring the infection of banana plant diseases that also helps them in drawing research conclusions. [10]. The identified problem is that plant pathologists use different applications such as Google Earth

and Microsoft Excel in managing the data given by the growers. This approach may eventually lead to data disorganization as plant pathologists plot the locations in Google Earth and the rest of the data is stored in Microsoft Excel. Moreover, handling large amount of data with the GPS coordinates as the only identifier on the map can be tedious and consumes significant effort when retrieving the specific data or information needed. Especially, when the plant pathologists want to view the specific infection rate of a particular banana disease. To provide a system that can accommodate the specific needs of plant pathologists efficiently guided the developers to develop the GETMOSYS as an IT solution.

1.1 Objectives of the study

The general objective of the study is to develop a Plant Pathologists' Geo-Tagging and Monitoring System for Infected Banana Plant, named GETMOSYS. Specifically, the researchers aim to develop a system that can receive and manage the information of sample submitted by the growers to the pathologists. The system must also record and analyze the laboratory findings and results. It must also provide a map showing the geographic location of the infected banana plant with its description using geotagging. The system must generate frequency reports in banana. The system will be tested and evaluated using the White-Box Testing and User Experience Questionnaire (UEQ).

1.1 Scope and Limitations of the Study

The scope of the system is to record the samples' data given by the farmer, to provide a map that shows the location of infected banana plant. Developing a mobile application for the growers to be able to send the samples' data to the pathologist. The pathologists will be using a web-based application to receive and view the data. The pathologist will be able add the laboratory results after the samples' laboratory tests. From the laboratory results, the system utilizes the findings and view reports such as: viewing the disease trends, yearly infection rate, and disease infection rate. As for the limitation of the system, GETMOSYS is not an image

processing system that analyzes the image provided and detects the disease associated in the image. In the system, the plant pathologist inputs the laboratory results after conducting the appropriate laboratory test. The system is also not a Decision Support System; instead of relying solely on the external symptoms inputted, the plant pathologist should input the disease associated with the sample verified after conducting the laboratory test.

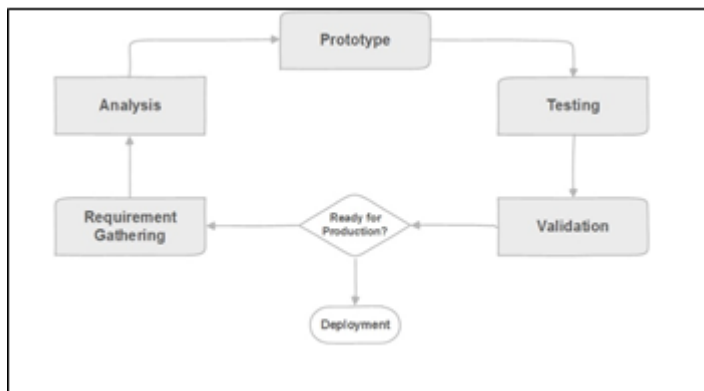


Fig 1. Prototyping model used in system development

2 METHODOLOGY

2.1 Systems Planning

In the systems planning phase, the developers started with environmental scanning. In the environmental scanning, the developers looked for potential clients that still perform business transactions using manual processes. The developers handed a formal letter to three different organizations, inquiring permission to ask questions or information related to the works or transactions of the company. After the letters have been signed for approval, the developers then conducted interviews with some of the personnel. Once the developers have gathered information from the different organizations, the developers formulated three titles to propose for the title defense: Academic Information Management System in La Paz National High School, Purchase Request Monitoring System in Procurement of Municipality of Carmen, and GETMOSYS: A Plant Pathologists' Geo-tagging and Monitoring System for Infected Banana Plant. In the end of the title defense, the GETMOSYS: A Plant Pathologists' Geo-tagging and Monitoring System for Infected Banana Plant was chosen for the developers to develop for the capstone project. After the title defense, the developers had to meet the client again. The developers had two meetings with the client to discuss further the business process of the pathologist and to define the system requirements. Thereafter, the developers constructed a Gantt chart containing the task that the developers have already rendered and the tasks to be performed in the future as part of the development of the system. Regular meetings of the project team are essential so that the team may be able to cope up with the expected time frame of the system development of the project. The project team established financial management in order for the development team to survive in the financial aspects. Development Method. The developers used prototyping. Prototyping involves a repetitive sequence of analysis, design, modeling, and testing [12]. In

prototyping, user input and feedback are essential at every stage of the systems development process [11]. Also, prototyping allows users to examine a model that accurately represents system outputs, inputs, interfaces, and processes. The prototype is evaluated by the panel of critics in a defense to determine if the system guarantees quality and ensures that it has a clear and concise documentation. The cycle of requirement gathering, the analysis of the result of the gathering, coding a prototype, testing and validation does not stop until the prototype meets all the requirements of the system objectives.

2.2 Systems Analysis

The analysis phase discusses the flowchart of the existing business process, which focuses in the current process when the system is not yet developed. In addition, the system requirements, which deals with the functional and non-functional requirements that the developers need to achieve in order to satisfy the client are also discussed in this phase. Use case diagram and use case description, which covers the interaction of the user(s) to the system. Context Data Flow Diagram and Diagram 0 Data Flow Diagram defines the flow of the data with the system and its process. There are the system flowcharts for the web and mobile applications that illustrate the software flow. During the conduct of an environmental scanning and interview, the following findings were defined: the plant pathologist receives the banana sample and its information such as type of sample; GPS coordinate of the plant, identified symptom, descriptions or comment of the sender, and the image of the infected plant; the plant pathologist conducts laboratory test to the sample; the plant pathologist will then input the result in the spreadsheet, and writes an email to notify the farmer of the result. The problem in that existing process is that the tedious effort needs to exert in tagging the GPS coordinate associated in a sample when handling too much data. The inefficiency of finding the specific sample with the tag is a serious problem and it is also time consuming when specific reports are needed to be ascertained from the bulk of data in the spreadsheet.

2.2.1 Use-Case Diagram. The use case diagram depicts the interaction of the actors to the system [13]. In order to access the functionality of the system, the actor named pathologist and the actor named grower need to register an account first. After the account registration, the users can log in. However, the grower can only log in after a plant pathologist approves the account. The plant pathologist will be the one receiving the banana sample and adding the laboratory result into the GETMOSYS. Both of the users can view the laboratory result, the map that contains the location of the sample delivered, and the data of the banana sample. Only the plant pathologist can view information generated by the system such as disease infection report, yearly information report, and disease trend report; and search information such as the other plant pathologists, diseases, and growers.

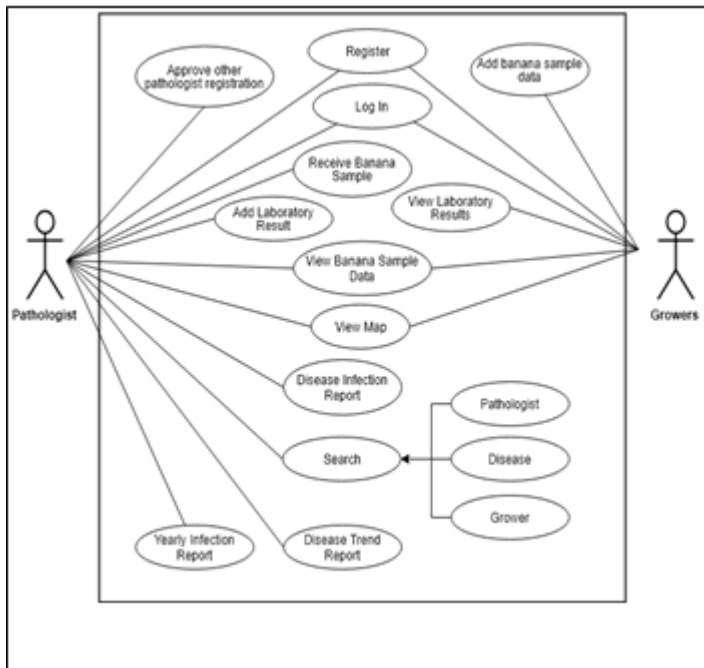


Fig 2. Use Case Diagram of GETMOSYS

2.2.2 Data Flow Diagram. A Data Flow Diagram is a graphical representation of the flow of data through an information system. A DFD shows what kind of information will be input to and out from the system, where the data will come from and go to, and where the data will be stored. In the first process, Plant Pathologist Registration, the data will be inputted by an external entity called Plant Pathologist. This is where the plant pathologist wishes to register an account. The entity plant pathologist will input the following: Pathologist Type, First Name, Last Name, Email Address, and Password. The data will then be included in the next process, which is the second process called Approved by a Registered Pathologist, wherein a registered plant pathologist user will accept the account pending for acceptance. All the data entered by the entity Plant Pathologist for the account registration, only after receiving a confirmation, will be stored in a data store called Plant Pathologist Record. The grower's account registration occurs in the third process wherein the data that will be entering will be coming from an entity called Growers. The entity will input the following: Grower name, contact number username, password, farm address, grower representative. The data will flow into the fourth process called Approve Grower Registration in which a registered plant pathologist user must first put an approve status to the account of the grower. All the data inputted by the entity grower will be put inside a data store called Grower Records. In the process number 5, Add Banana Sample Details, the data will be coming from the entity Growers then into the data store named Banana Sample Records. The data contains symptoms, image, infected count, infection radius, sampling date, and description. In process 6, Receive Banana Sample, the plant pathologist shall input a banana sample status indicating whether the banana sample is already received or not. The data called banana sample status will also be included in the data store Banana Sample Records. In process 7, View Banana Sample, the data named as Sample details will be coming from the data store called

Banana Sample details to be viewed by the entity Plant Pathologist. In process 8, laboratory results, the data is inputted by the entity Plant Pathologist which will then be stored at the data store Banana Sample Records. In process 9, the data will be coming from the data store banana sample records which will be viewed by the entity plant pathologist. The following diagram visualizes the flow of the data in the GETMOSYS application.

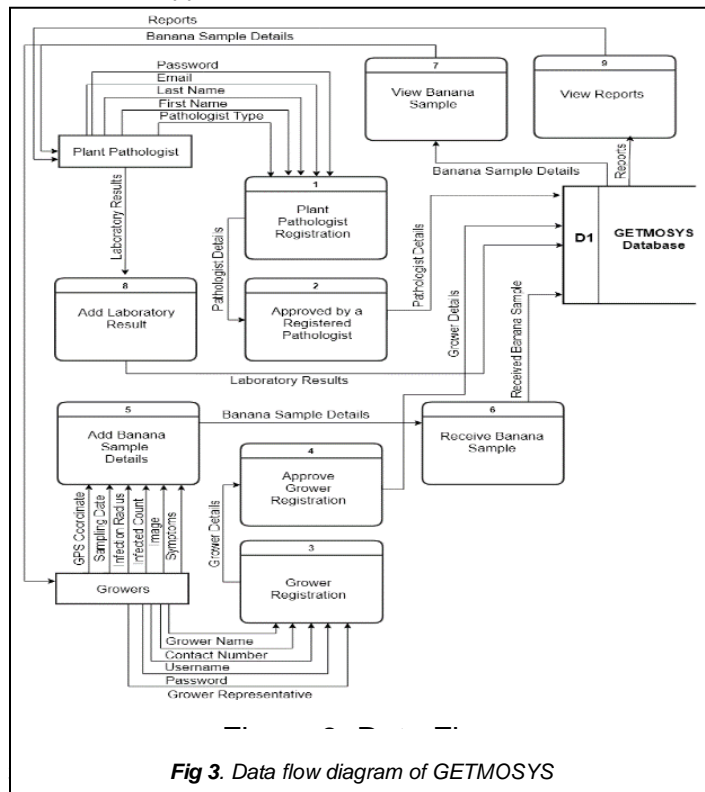


Fig 3. Data flow diagram of GETMOSYS

3.1 Technologies and Tools

PHP Laravel framework was used as a backend framework by the developers of the software. Vue. JS helps conserve the 25,000 number of reload in the page so that the it will not violate the open source constraint that the Google Maps. For the mobile application of the system, IONIC framework was utilized in its development. In GETMOSYS, the mobile application serves as the farmer's access to the system which enables the farmer to register in the mobile app and wait for the sample to be entered so that the farmer can view the sample sent and can also view the laboratory result that the Pathologist entered when the laboratory test is done. For mapping the banana plants with infection or disease, the Leaflet JS and OpenStreet Map was utilized. The Leaflet library utilizes the OpenStreetMap as a map provider since leaflet does not provide map on its own [14]. OpenStreetMap is described as 'open data' [15] which means, there is no limit in usage unlike Google Map API that there is a limit with the number of load in a day, and also OpenStreetMap is widely supported by its community and users that contribute to each other for the enhancement of the technology in the field of mapping. In figure 4, shows the map generated using the Leaflet js library in the GETMOSYS application.

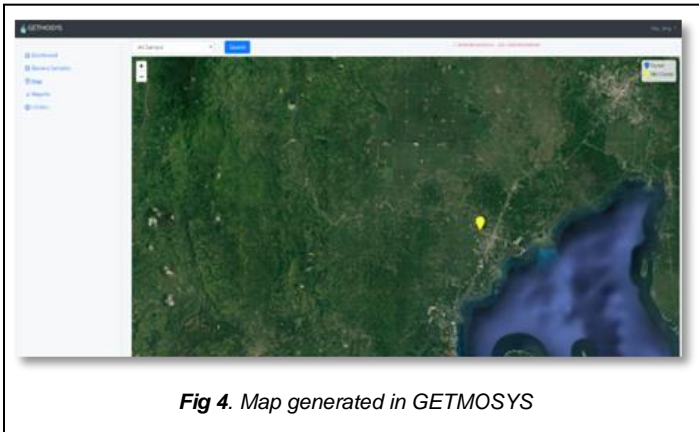


Fig 4. Map generated in GETMOSYS

The Chart JS library was used in the development to produce the report needed by the plant pathologist that helps them to assess of what disease they should focus on studying. In figure 5, shows the sample chart as report on disease trends which was generated using Chart JS library. Axios provides a great help in rendering the markers in the map without reloading the page, and also handles in some areas of the system so that the reloading and front-end page rendering is efficient.

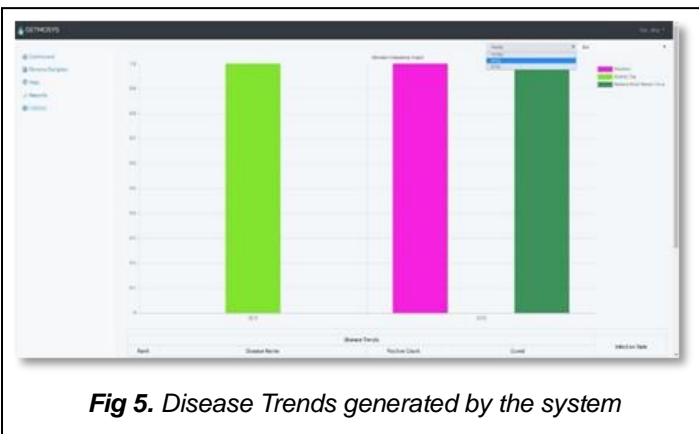


Fig 5. Disease Trends generated by the system

In the development of the web and mobile application, open source software was utilized. Open sources technologies do not need any license purchases. Pertaining to the previously mentioned technology, the developers used Leaflet with open street map, Laravel Framework for the backend, Bootstrap 4 and Vue Js Framework for the front end, and Ionic framework for the mobile application. In figure 6, shows the mobile application view of the GETMOSYS.

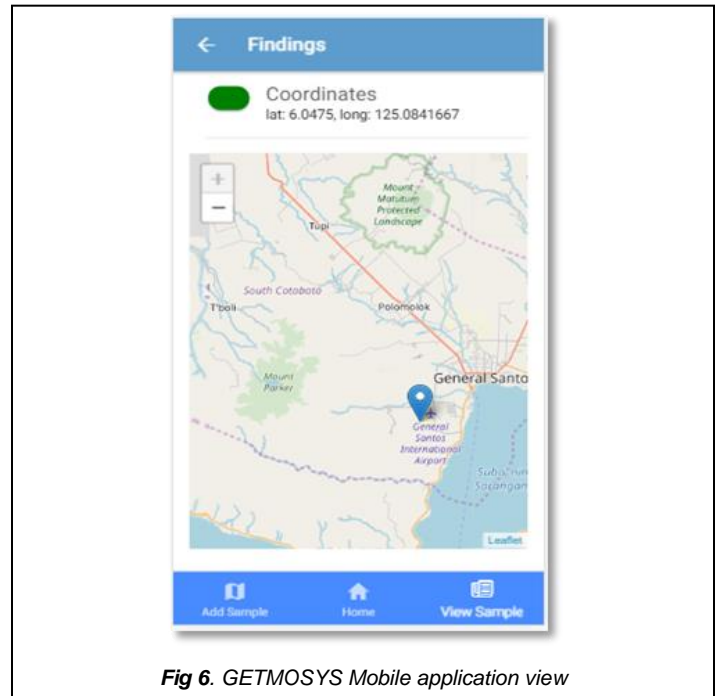


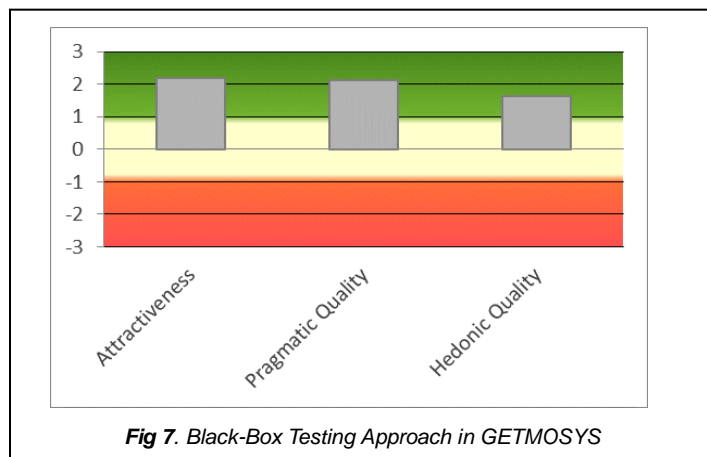
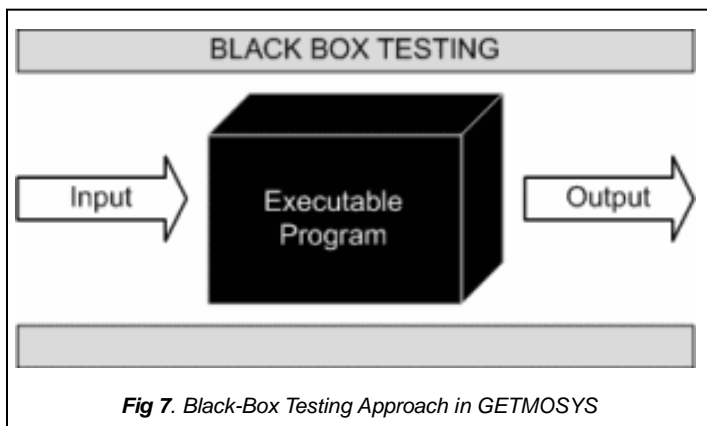
Fig 6. GETMOSYS Mobile application view

3.2 Implementation

Before conducting the implementation of the project, the system was first presented to the panel of critics for evaluation, correction, and recommendation. After accomplishing the panel recommendation, the developers then started preparing for the deployment of the system. The deployment began on February 13, 2019 until March 27, 2019. GETMOSYS has two types of end-users: the plant pathologist for the web application and the growers for the mobile application. Since the data for this line of business are typically considered as classified, the developers were advised to use enumeration. The developers of the system have eventually corrected those errors through debugging and have presented the iterations of the prototype until there are no errors experienced by the users.

3.2 Software Testing and User Testing

The software functionality was evaluated and tested using the Black-Box Testing. This kind of software testing is an approach in which it tests and examines the functionality of an application without looking into its internal structures, codes or workings of the software [16]. During the software testing phase, test cases was developed in order to assess the functionality of the software. These test cases was also based in the objectives and scope of the web and mobile applications. The software testing was successful and the result yields a positive feedback, it shows that 100% of the functionality of the software meets the functional and non-functional requirements which was based in objectives and the scope of the system. In figure 7, shows the approach of a black-box testing in the GETMOSYS application.



The web and mobile application was used and evaluated for usability testing by one (1) legitimate plant pathologist and by twenty-four (24) personnel and the owner of a banana plantation in Brgy. Cebulano, Carmen, Davao del Norte. the User Experience Questionnaire (UEQ) was utilized in the usability testing. UEQ The user experience questionnaire contains thus 6 scales with 26 items: Attractiveness (Overall impression of the product), Perspicuity (Familiarity of the product), Efficiency (Solving tasks without unnecessary effort), Dependability (Feel in control of the interaction), Stimulation (Exciting and motivating), and Novelty (innovative and creative) [17]. Table 1 shows the mean results and the variance after the usability testing. The results shows that perspicuity scale has the higher mean than any of the other areas. This means that users of the GETMOSYS have experienced easy familiarity of the functionalities with the application.

TABLE 1
UEQ Mean Result and Variance

Scale	Mean	Variance
Attractiveness	2.180	0.38
Perspicuity	2.260	0.35
Efficiency	2.120	0.34
Dependability	1.960	0.38
Stimulation	1.960	0.36
Novelty	1.300	0.39
Average Mean	1.963	0.37

The scales of the UEQ can be grouped into attractiveness, pragmatic quality (Perspicuity, Efficiency, Dependability) and hedonic quality (Stimulation, Originality). Pragmatic quality describes task related quality aspects, hedonic quality the non-task related quality aspects. Below the mean of the three pragmatic and hedonic quality aspects is calculated. In figure 8, shows the representation of the UEQ scales group results and it shows that Attractiveness and Pragmatic Quality has a slightly greater mean value than Hedonic quality.

3 CONCLUSIONS AND RECOMMENDATIONS

As banana holds a very important role in certain countries, monitoring the diseases that may affect the production is the crucial duty of a plant pathologist. Relying only in the basic functionality of Google Earth such as pinpointing the location of the infected banana plant and storing the rest of the data in Microsoft Excel may result into data disorganization and inefficiency in retrieving a specific data or information for the plant pathologist. Hence, the web and mobile application, GETMOSYS was developed. It is a plant pathologists' geotagging and monitoring system for infected banana plant. GETMOSYS combined the functionality of Google Earth and Microsoft Excel utilized by the plant pathologist. With the use of the system, GETMOSYS, the plant pathologist can simply input the GPS coordinates and the data of the sample and those inputted values eventually will be reflected in the map. Monitoring the cured and infected banana plants and retrieving a particular sample will now be much easier for the plant pathologist. Also, the system alleviates the tedious transaction between the pathologist and the growers in giving and receiving the sample's laboratory result, respectively. Moreover, the system generates reports through graphs which may inform the plant pathologist about diseases trends, disease infection rate, and frequency of yearly infection rate. The GETMOSYS application also passed the black-box testing process. Based on the result of the usability testing and evaluation using UEQ, the system obtained a grand average weighted mean of 1.963 which means it is satisfactory with the users. Therefore, the GETMOSYS project had successfully met all requirements of the system objectives and its scope. GETMOSYS can potentially be advanced by following these recommendations: (1) can be used to forecast certain events, such as endemic diseases or territorial diseases, using machine learning algorithms since the GETMOSYS stores banana sample data inputted by the growers and the laboratory findings. The example and the most common laboratory findings includes Panama, Moko and Sigatoka. (2) can implement image recognition for the mobile application to determine the symptoms or the possible diseases that the banana plant could possibly be possessing.

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