THE QUEST Journal of Multidisciplinary Research and Development
ISSN 1908-3211 (Online) | ISSN 1908-322X (Print)
P-ISSN: 1908-322X and E-ISSN: 1908-3211
https://neust.journalintellect.com/quest

Development and Assessment of Online Platform for Crop Production with Decision Support System

Allen Paul L. Esteban and Ruth Ann G. Santos
Graduate School, Nueva Ecija University of Science and Technology

This study was designed and developed to assist the young generation of farmers from the Philippines through data science. It aims to give them informative way of farming with the processes of crop production, to make a place for collaboration of knowledge and helping each other, to encourage the youth to stay in farming, and to increase their agricultural productivity through decision support and prediction algorithms. The system has been developed to keep track the farming timeline activity, expenses, and weather information. With the growing population and demands to improve crop productivity, there is a reason to make available sustainable resource practice that serves better both the communities and the nation. In satisfying this need, a web-based application which contains informative and insightful agricultural education was developed to aid decision making in agro-processing, stimulate the farmer's climate information and provide useful information required to enhance crop productivity, especially in the rural areas. The Decision Support System with agricultural timeline and weather information will be a huge advantage to farmers at large and is expected to impact positively on the present economy situation of the nation through increase in smallholder's productivity. To test the quality of the application, the researcher used the ISO/IEC 25010 criteria as evaluation tool [1].

Keywords: *Decision Support System, Crop Production, Farming Timeline Activity, Agricultural Education, Decision and Prediction System, Online Portal*

I. INTRODUCTION

"Once in your life you need a doctor, a lawyer, a policeman, a preacher, but every day, three times a day, you need a farmer" (Brenda Schoepp, 2012). In life, nothing worth having comes easy. One of the researcher learned it at a very young age when most of his friends had the pleasure to play anytime and anywhere while together with his siblings he would go to the farm and help his grandfather to work under of the sun. Farming plays a vital role in the development of the economy. In fact, according to World Atlas' Website, the Philippines is the 3rd largest rice producer in the world in 2017, it contributes 5% of global rice production [2]. In 2017, the total paddy rice output reached 93% of the country's annual requirement (Department of Agriculture Philippines). But establishing the country's food security is a constant challenging struggle [3]. One of these alarming factors and struggle is the aging population of farmers in the Philippines. Based on the previous research conducted by the Department of Agriculture during Innovation Olympics 2018 and published in Philippine Star on June 2018, the average age of Filipino farmers ranges from 57 – 59 years old, which are just few years away to becoming senior citizens and eventually retire from the farming industry [4]. This data showed that young generation of Filipinos are reluctant in pursuing a career in farming. In 2016, the Bureau of Agricultural Statistics showed that the annual average income of farmers was about P20,000 only, which was less than P2,000 a month [5]. It showed that those children experienced first-hand poverty on farming is working in cities or migrating abroad because that is the only resort to getting out of it. Based on my observation, parents themselves encourage their children to study hard and don't settle in farming because they believe that when they become farmer they'll only get poorer as they get older.

As a result, children grow with little or no idea about farming. Therefore, millennials and Gen Z must be encouraged to get involved in farming. These are the reasons why the researchers pursue the study which is TubongPinoy. This is the best way to motivate and educate the youth to engage in crop production. Since millennial and gen Z of today are more interested on technology based products and services, it's a good idea that we have an online portal that will introduce a much better way of revolutionary farming, the practical and smart way of crops farming especially rice production. Under this program, it is planned to make centralized system where new generation of farmers, suppliers, traders, concerned institutions and agricultural crop experts can make their individual account to meet in one portal and help each other to create sustainable agriculture. They are now called "Collaborators". It is also built-in with a 45-day weather forecast from openweathermap.org [6] and Department of Science and Technology (DOST) thru API especially designed for cropping season. There's also a unified marketplace where farmers can buy farming supplies such as fertilizers, pesticides, seeds, etc. monitored by Department of Agriculture (DA) with regulated price. It helps the market to remove the additional fees in agricultural products added by middle man. With this system, every farmer has the chance to know the best seeds available at the market based on their location, season and land type and that will yield more harvest. They have the chance to know the latest technology, machine and new techniques available for farmers and most importantly through the use of this system, everyone has the equal opportunity to learn more about new generation farming shared by agricultural crop experts.

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II. EXPERIMENTAL AND COMPUTATIONAL DETAILS

A. Theoretical and Conceptual Framework

The researchers used the Agile Method to designed and developed this system. Iterative approach is taken and working software build is delivered after each iteration. Each build is incremental in terms of features; the final build holds all the features required by the customer. This conceptual framework is divided in different stages and each stage has requirement. These stages are from Agile Model. It has six (6) phases and it will be used to design, develop and test the quality of the system.

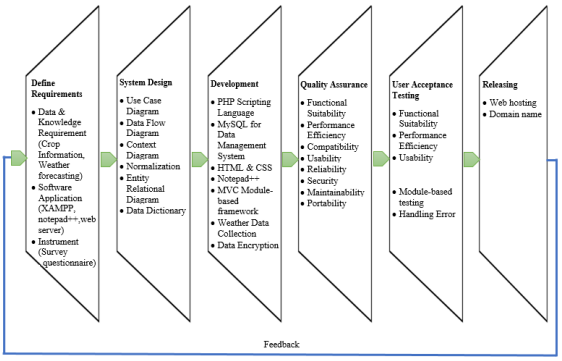

Fig. 1. Conceptual Framework

Fig. 1 shows the conceptual framework of the system. The details on define requirement box are needed to create this system. Divided into three categories to start the building information infrastructure, the data and knowledge requirements, software application and the instrument. Data, knowledge, software and instrument requirement was based on previous thesis of the researcher. Data and knowledge requirement contains data about new farming strategies, crop production techniques, agricultural statistical data, continuous weather forecast data thru API, crop information and the instrument. If these data and knowledge satisfy the development of the system, the software application are needed to process those collected data. System design will help to avoid conflicts and flaws. Starting with User Interface for front-end interaction. Normalization, Entity Relational Diagram and Data Dictionary for back-end database design. Inside development box, XAMPP application will be used to run and test the development of the system. It has PHP and MySQL integration. The programming code is generated during development stage. Inside the quality assurance box is the ISO/IEC criteria, it will use to evaluate the portal or system based on international standards. It has eight (8) criteria and each criterion has sub-criteria. The criteria will be needed to create a system anchored in international standards. The testing stage is usually a subset of all the stages as in the modern Agile models, the testing activities are mostly involved in all the stages of Agile. The selected ISO/IEC criteria will use to evaluate the acceptance testing of the portal. The researchers selected only three (3) criteria because it is the only criteria that the user can answer and assess. These criteria are Functional Suitability, Performance Efficiency, and Usability. Once the product is tested and ready to be deployed it is released formally in the appropriate platform.

B. Defining Requirements Phase

The researcher used the Gantt chart as a guide for monitoring the timeline and collected the necessary requirements to start the development of the system on time. A Gantt chart is a type of bar chart, developed by Henry Gantt in the 1910s, that illustrates a project schedule. Gantt charts are a great tool for planning, rescheduling and visualizing your projects. It shows the start and the finish dates of the different required elements of a project.

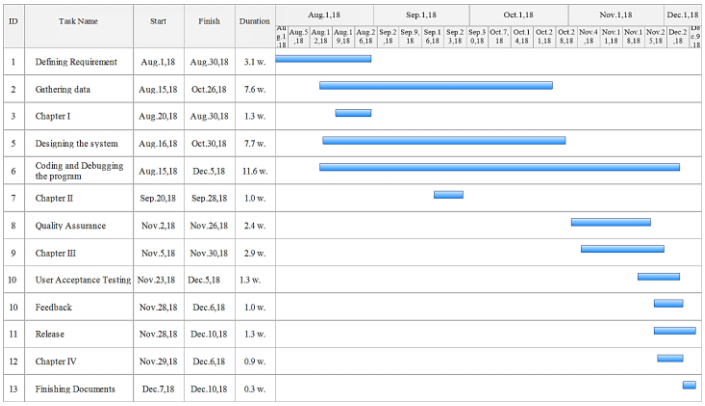

Fig. 2. Gantt Chart

The implementation of the system was handled by the Nueva Ecija University of Science and Technology and it was started last January 2019.

C. System Design Phase

The step of designing takes over, which is basically building the architecture of the project. This step helps remove possible flaws by setting a standard and attempting to stick to it. Design phase dealt with the Use Case, Context Diagram, Data Flow Diagram, Normalization, Entity Relationship Diagram, and Data Dictionary. The Use Case Diagram was needed to capture what the system is supposed to do. Context Diagram is needed to defines the boundary between the system, or part of a system, and its environment, showing the entities that interact with it. Data Flow Diagram is used to create an overview of the system without going into great detail, which can later be elaborated. To organize tables in a manner that reduces redundancy and dependency of data, the researcher used Normalization. While Entity Relationship Diagram is used to design or debug relational databases.

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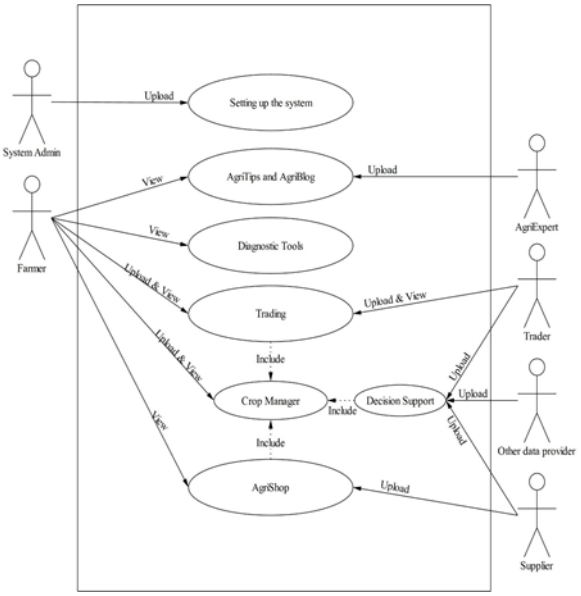

Fig. 3. Use Case of TubongPinoy

It is a graphic depiction of the interactions among the elements of a system. The researcher used the use case as a methodology for system analysis to identify, clarify, and organize system requirements. There are six (6) users in the portal which is Farmer, Supplier, Trader, AgriExpert, Price Controller and Other data provider. Farmer can access the AgriTips posted by the AgriExperts. Diagnostic Tool for decision support system, Trading System for negotiations and deals from Traders, AgriShop for agricultural supply posted by the Supplier and Crop Manager. Crop Manager is the primary features of the portal, because it will guide the farmers how to work with farming industry from buying and choosing seeds up to harvesting.

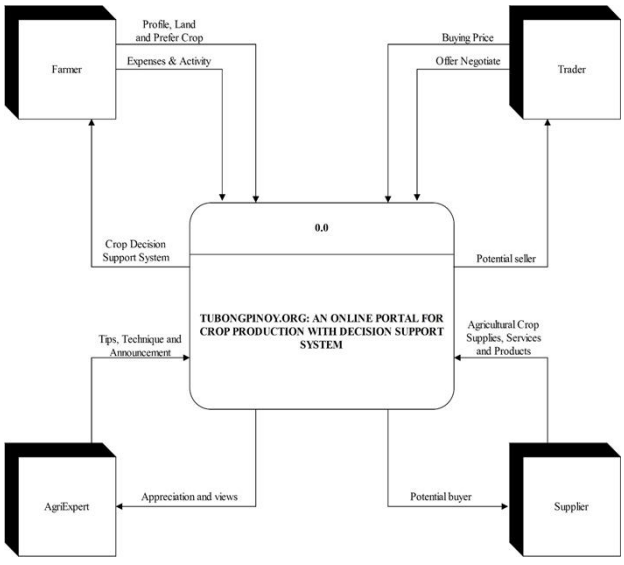

Fig. 4. Context Diagram of TubongPinoy

Fig 4. is the boundary between the system, or part of a system, and its environment, showing the entities that interact with it. This diagram is a high-level view of a system. This involves identifying how each of the areas included within the scope will be investigated. This could be by interviewing users, providing questionnaires to users or clients, studying existing system documentation and procedures, observation and so on. Key users are identified and their specific roles in the investigation are agreed upon.

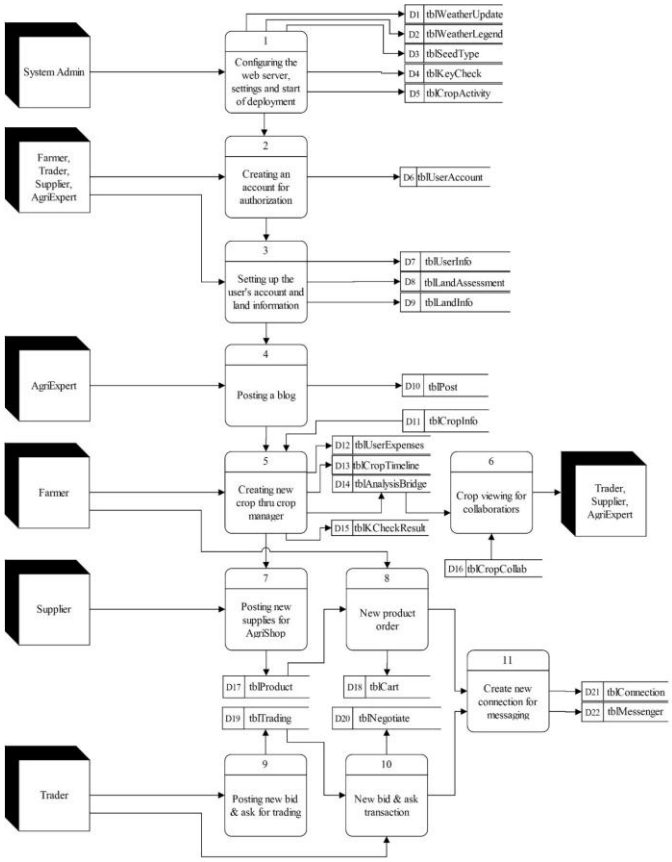

Fig. 5. Level 0 Data Flow Diagram of TubongPinoy

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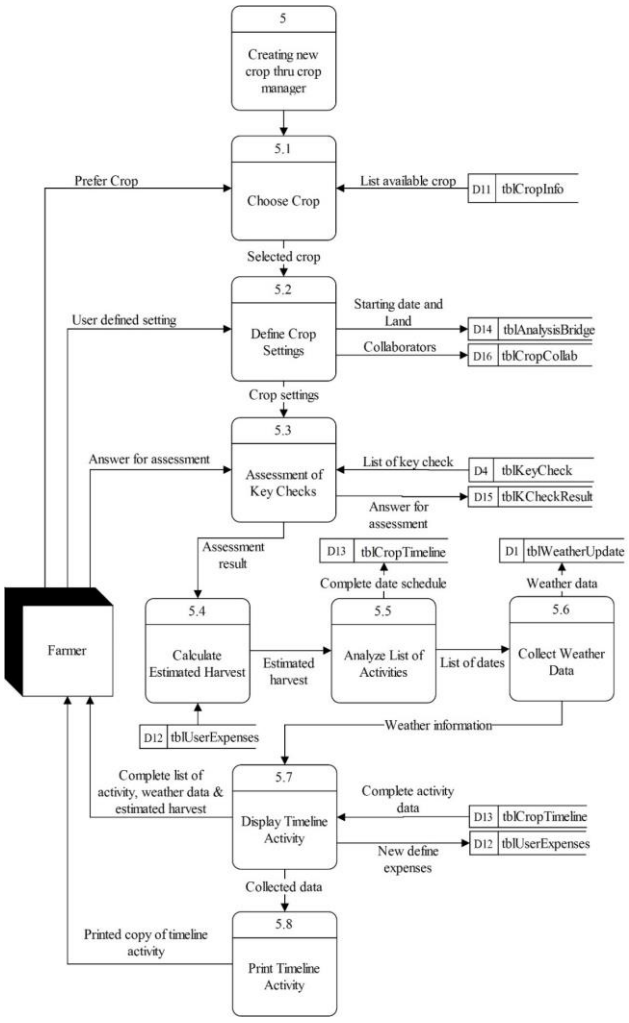

Fig. 6. Level 1 Data Flow Diagram of Decision Support and Prediction System

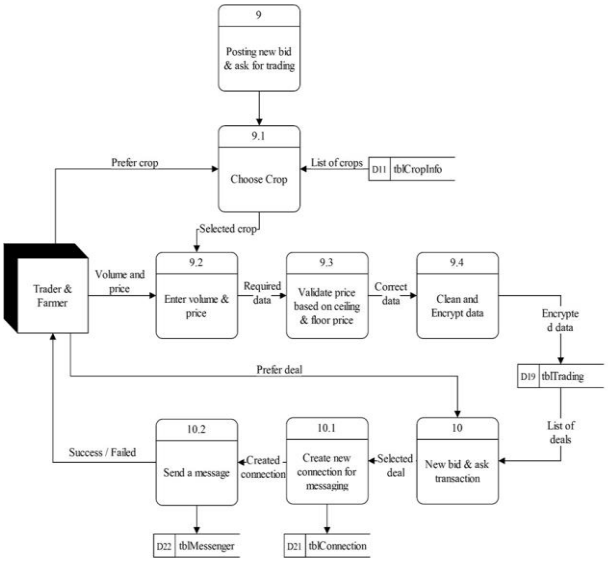

Fig. 7. Level 1 Data Flow Diagram of Trading

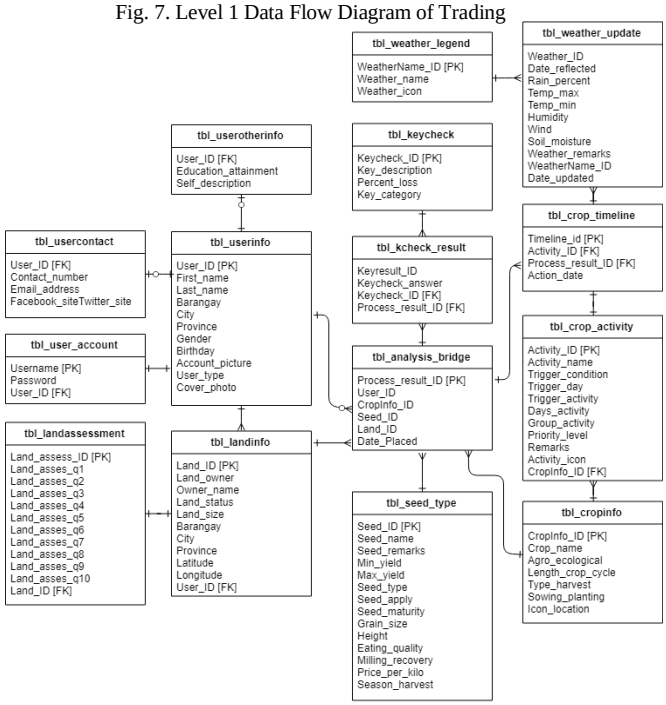

Fig. 8. Entity Relationship Diagram – Decision Support and Prediction System

D. *Development Phase*

In the development proper, the researchers used HTML, PHP and MySQL thru XAMPP and his own-made Model-View-Control(MVC) Module-based framework to design and construct the portal. The researchers also used AJAX (Asynchronous JavaScript And XML) for real time processing data without reloading the page. Primarily, it was used in Messaging and Trading System. Here is how AJAX worked in TubongPinoy.

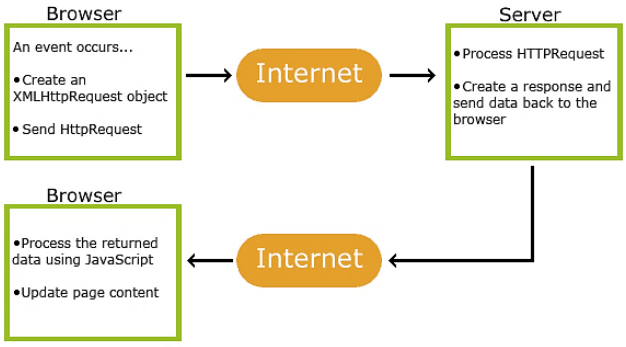

Fig. 9. AJAX Flow

From the browser, the user sends a request to the server thru internet and the server processes the requested data and displays the output to the browser of the user without reloading the page.

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For sending and retrieving the process, the researcher created his own Model-View-Control (MVC) module-based framework. MVC is an architectural pattern that separates an application into three main logical components: the model, the view, and the controller. Each of these components is built to handle specific development aspects of an application. Here is how MVC worked in TubongPinoy.

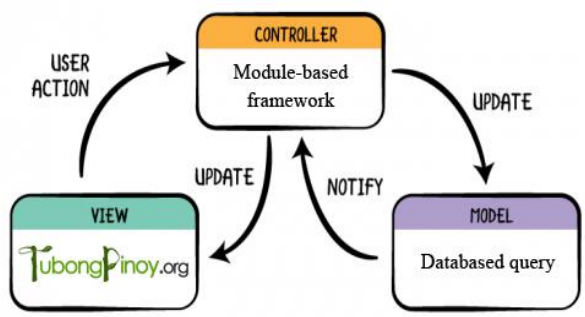

Fig. 10. Model-View-Control Module-Based Framework

"View" was created by HTML and CSS. It displays the requested data with graphical presentation. The "Controller" routes the requested data thru the portal. Controller is the one who responsible for interaction and communication of "View" and "Model". For database processing, the "Model" is the only one who allowed to communicate with database using query.

For data and information encryption security, the researcher used openssl_decrypt() and openssl_encrypt() with his own passphrase or password for better encryption. OpenSSL is a robust, commercial-grade, and full-featured toolkit for the Transport Layer Security (TLS) and Secure Sockets Layer (SSL) protocols. It is also a general-purpose cryptography library. OpenSSL is licensed under an Apache-style license, which basically means that you are free to get and use it for commercial and non-commercial purposes subject to some simple license conditions. Here is how encryption worked in TubongPinoy.

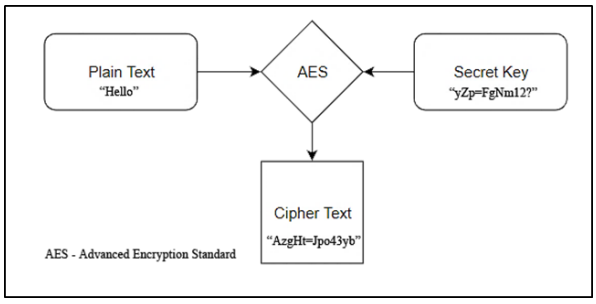

Fig. 11. Advanced Encryption Standard for Sensitive Data

Encryption helps the portal to secure the data and information. From plain text, the AES create a secured process that make the text encrypted.

For weather forecasting, the researcher used API (Application Programming Interface) integration to collect data from weather data providers such as OpenWeatherMap.org, AgroMonitoring.com, and NOAH of University of the Philippines.

Here is how weather data retrieving worked in TubongPinoy.

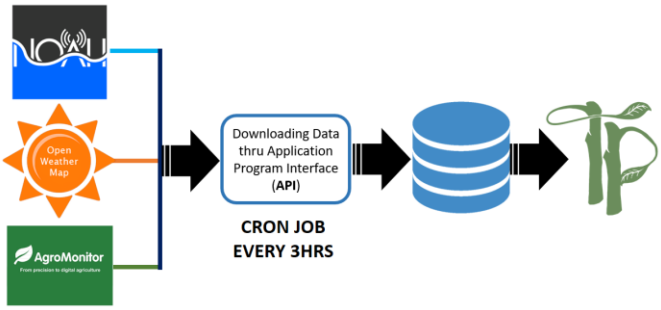

Fig. 12. Collection of Weather Data from Providers

With three (3) weather data providers, there is a high chance to collect the accurate data from weather forecast. The researcher created a CRON job that runs or executed every 3 hours.

E. Quality Assurance

The quality model is the cornerstone of a product quality evaluation system. The quality model determines which quality characteristics will be taken into account when evaluating the properties of a software product.

The quality of a system is the degree to which the system satisfies the stated and implied needs of its various stakeholders, and thus provides value. Those stakeholders' needs (functionality, performance, security, reliability, etc.) are precisely what is represented in the quality model, which categorizes the product quality into characteristics and sub-characteristics. The product quality model defined in ISO/IEC 25010 comprises the eight quality characteristics shown in the following figure:

Fig. 13. ISO/IEC 25010 Criteria

F. User Acceptance Testing

The testing stage assesses the software for errors and documents bugs if there are any. The researcher tested the

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fully integrated system in the internet to check how components interact with one another. The system is also tested thoroughly to verify that it meets the technical and functional specifications.

Users test the actual application to make sure it can handle required tasks in real-world scenarios, according to specifications. Here is how the testing phase applied to TubongPinoy.

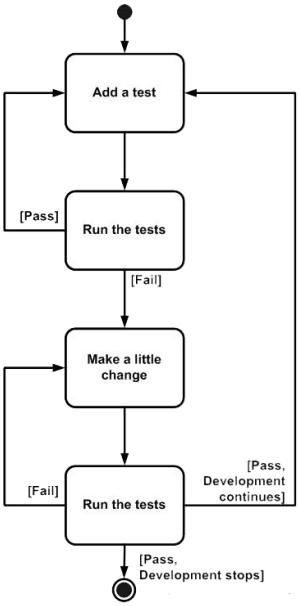

Fig. 24. Flow Chart of Testing

All functions of the system were tested based on the flow chart above. Starts with the system trial and if there is a bug, the developer will make a little change to debug and run the test again. If passed, the testing will continue to other function. If fail, the debugging will start again and run the test.

G. Releasing

The system was fully tested and no high priority issues remain in the web application. The system is ready for full implementation.

III. RESULTS AND DISCUSSION

A. Designing and Development

The researcher designed and developed the Online Platform for Crop Production with Decision Support System using Agile Model shown in Fig. 1, so that the farmers have a portal with complete crop production including the decision support, weather forecast, crop manager, and trading system. It also encourages the youth to go in farming without restrictions. Both system developers and stakeholders alike, find they also get more freedom of time and options than if the software was developed in a more rigid sequential way. Having options gives them the ability to leave important decisions until more or better data or even entire hosting programs are available; meaning the project can continue to move forward without fear of reaching a sudden standstill. When new changes are needed to be implemented. The freedom agile gives to change is very important. New changes can be implemented at very little cost because of the frequency of new increments that are produced.

Here's the sample user interface design of TubongPinoy.

Fig. 15. Landing Page

Fig. 16. Home Page with Farmer Account

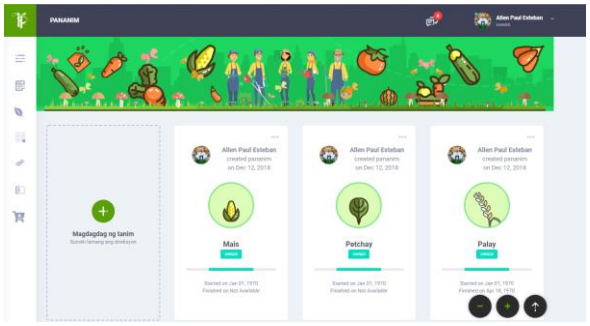

Fig. 17. Crop Manager

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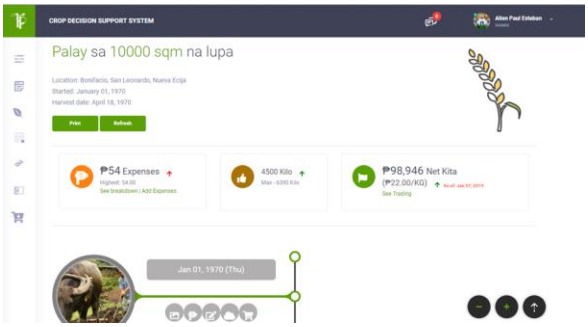

Fig. 18. Crop Output

Fig. 19. Timeline Activity

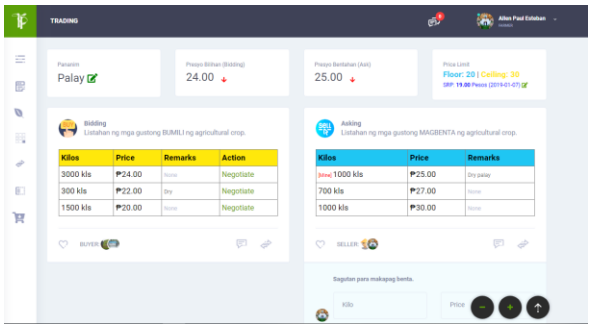

Fig. 20. Trading System

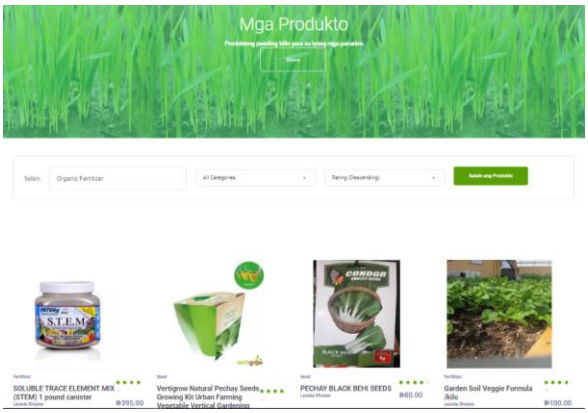

Fig. 21. AgriShop

B. *Quality Assurance and Standard*

To facilitate the User Acceptance Testing and Quality Assurance of the system, the researchers used international standards criteria as shown in Fig. 13 for the evaluation of the system. The total respondents (n) of this study was sixty (60) composed of two hundred (200) users and twenty (20) IT Expert with 9% margin of error (E) and a confidence level of 90% calculated by raosoft.com [9].

TABLE 1. RESPONDENTS

Respondents	n
Users	
Generation Z	85
Millennial	90
Trader	10
Supplier	10
AgriExpert	5
Subtotal	200
IT Expert	
Programmer	10
MIS Supervisor	1
Designer	3
Quality Assurance	5
ICT Officer	1
Subtotal	20
Total sample size *(n)*	220

A purposive sampling procedure was used for selecting the participants in this study. The respondents were chosen based on their characteristic and traits (age and field of work). The age classification in this study is 15 to 38 years old. Programmer, Encoder, IT Head, Designer, Quality Assurance, Data Controller and ICT Officer are included in the classification of field of work. Questionnaire and interview techniques were utilized as tools in gathering data for evaluating the online portal. The questionnaire was developed based on ISO criteria.

The data that the proponent collected from the field was analyzed. Statistically weighted mean was used in answering the research questions. The response options in the instrument was weighted as shown below:

TABLE 2. SCORING SCALE

Response	Scale	Verbal Description
4	3.25-4.00	Very Functional, Very Efficient, Very Compatible, Very Usable, Very Reliable, Very Secured, Very Portable
3	2.50-3.24	Functional, Efficient, Compatible, Usable, Reliable, Secured, Portable
2	1.75-2.49	Needs Improvement
1	1.00-1.74	Poor

The acceptance point for the items will be 2.50 and any mean below 2.50 will be regarded as rejected, needs improvement and as unpopular view.

Based on the evaluation of IT Experts, the application successfully met the qualifications of standard quality assurance. The Functional Suitability, Performance Efficiency, and Usability are the only criteria that the user can assess and evaluate because of technicalities. The table below shows the summary of the overall evaluation of Users and IT Experts.

Table 3. Summary of Evaluation

Criteria	IT Expert	User	Total Mean	Verbal Description
Functional Suitability	3.50	3.51	3.51	Very Functional
Performance Efficiency	3.60	3.48	3.54	Very Efficient
Compatibility	3.50	-	3.50	Very Compatible
Usability	3.57	3.52	3.55	Very Usable
Reliability	3.52	-	3.52	Very Reliable
Security	3.50	-	3.50	Very Secured
Maintainability	-	-	-	-
Portability	3.63	-	3.63	Very Portable

Table 3 shows that the TubongPinoy successfully meet the User Acceptance Testing and Quality Assurance of all criteria in ISO/IEC international standards except maintainability. The researcher didn't include the maintainability in evaluation because there is a third-party institution or organization will handle the maintenance of the system.

It implies that using international standards for quality of the software, the TubongPinoy was successfully passed the Quality Assurance which was one of the phases of Agile Model. Majority of the overall evaluation result was "Very Acceptable". It means that the system was successfully met the objective and criteria of the study. It was deployed and ready for accepting request from client.

IV. Conclusions

In summary, TubongPinoy was successfully designed and developed based on the Agile methodology. It was tested and evaluated by IT experts and Users based on ISO/IEC international criteria. Majority of the overall evaluation result got the highest score. It means that the system was successfully met the objective and criteria of the study. It was deployed and ready for accepting request from client.

The results from 200 users and 20 IT experts showed that the functionality, performance, compatibility, usability, reliability, security and portability of the system was very acceptable. Based on their evaluation, the system was successfully met the qualifications of standard quality assurance. Evaluation of the portal was limited only on designing, development and quality assurance. Likewise, maintainability of the portal was not included in the evaluation because there is a third-party institution that will handle its maintenance.

Acknowledgment

This work was supported by the Nueva Ecija University of Science and Technology (NEUST) and by the National Research Council of the Philippines (NRCP).

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