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Development of Geospatial Asset Management System for Higher Education

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Abstract: The integration of Geographic Information System (GIS) for asset management was addressed in this study. Geographic Information System (GIS) as a decision support system was integrated within the process of asset management to strengthen the monitoring of tangible assets within the organization. The main objective of this study is to design and develop a Location-Based Asset Management Application System. A waterfall model was utilized to create the system. GeoJSON was used to represent geographical features or attributes of the data gathered. A standardized adapted evaluation form was used to determine the Functionality, Performance, Robustness, and Workmanship of the developed application and interpreted using descriptive analysis. The analysis shows that the developed system is excellent in terms of Functionality, Performance, Robustness, and Workmanship. Based on the study's findings, the developed spatial asset management system is an effective way of monitoring and delivering asset management information and resources to its various constituents. It is highly recommended that a designed system should be utilized and use the developed systems to proactively respond and adapt to the modern world in delivering and managing resources.

Keywords: GIS, Location-Based System, GeoJSON, DSS, Waterfall Model.

I. Introduction

Asset management is the process of maintaining assets cost-effectively. It is commonly used in different firms, companies, and various institutions. It is a system that helps keep track of all their assets, such as physical assets, which is utilized for their operation. Government agencies, non-profit organizations, and companies must provide comprehensive reports on how they acquire, use, and dispose of assets. To ease the reporting process, a majority of them record their asset information in a central database. In such a way, when they need to compile the reports at the end of their fiscal year, they can easily access all the information they need. In instances that exist where lost, damaged, or stolen assets are still recorded on the books. With a strategic asset management plan, the firm's owners will be aware of the assets that have been lost and not record them in the books. By keeping tabs on a company's assets throughout their life cycle, a firm owner can improve their technique of acquiring and using the assets.

Geographic Information Systems (GIS) have revolutionized the world of mapping. GIS allows linking endless amounts of information to a specific geographic location and helps in answering questions and solving problems by looking at data in a way that is quickly understood and easily shared [6]. GIS integrates with the top facilities management software and consulting firms, making it easier than ever to extend the life of FM data. GIS can be used throughout the facility's life cycle, from deciding where to build up to maintenance. It helps streamline asset information collection, dissemination, support, and use, expedite planning and analysis, and share information in and out of the field more efficiently [9]. GIS-based management and information systems proved to be the most effective "all-in-one," and thus, indispensable tools to perform a wide variety of tasks in the most informed, time-saving, and convenient manner through desk work [4]. According to [8] Geographic Information System. (GIS) applications are hardly manageable and replicable and strongly depend on outsiders' skills and facilities.

In the digital era, geospatial technologies are revolutionizing the policy-making and economy of individual institutions. In this regard, reliable geospatial data will also enable policymakers, civil society, and others to have better insights into the distribution of needs and ways to optimize development planning and develop better policies In general, the advent of geospatial technology inspires researchers to apply geospatial technologies in different fields of technology most specifically to asset management [14]. Furthermore, geospatial technology used in asset management will help to advance data accessibility through web service, which adds value to the information that already exists and can geo-locate the different assets where it is situated, giving accurate, new insights to managers and administrators in the organizations. In connection with this, asset management with the geospatial component is very timely to be developed, adopted, and implemented in government agencies and institutions like Universities to strengthen the monitoring of tangible assets such as buildings, facilities, and others. This study will also provide techniques for mining information needed to reform the institutional process, specifically in asset management.

Research Objectives

This study aimed to design and develop a Geospatial Asset Management System in Southern Leyte State University. Specifically, it sought to establish and answer the following questions:

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1. Design and develop different features for a Geospatial Asset Management System in Southern Leyte State University;

2. Implement and evaluate the proposed system and determine its efficiency during the deployment stage;

3. Determine the performance of the developed system in terms of:

    3.1 Functionality

    3.2 Performance;

    2.3 Robustness; and;

    2.4 Workmanship.

Conceptual Framework

The proposed system passes the following steps: the web application interface will start communicating the system through users (employees, guests, etc.). The user enters a query about the location through the system's first phase, which is the web application. The web application associates the GIS application to search for the area. The GIS application sends the query to the database, starting to find the location and sending it back with the coordinates. The GIS plots the coordinates on the map in the web application and submits the area to the user.

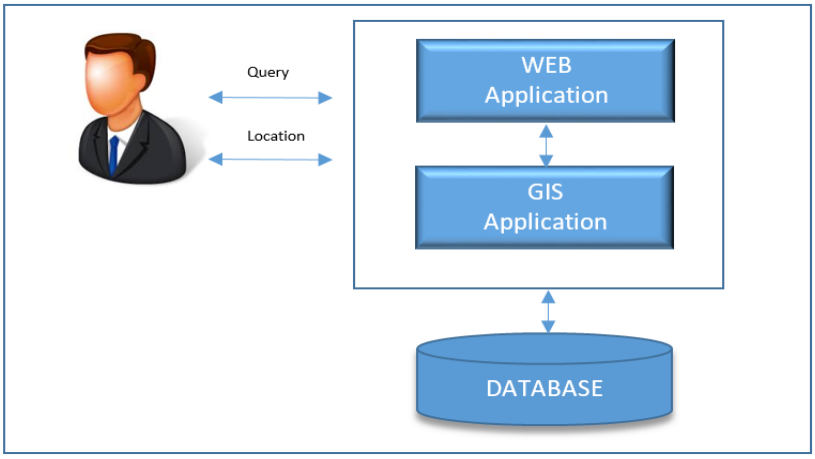

Fig. 1 Conceptual Framework of the Study

II. Methodology

Research Flow

Figure 2 shows the research flow of the study. It gives the critical step-by-step outlined and procedure of the study.

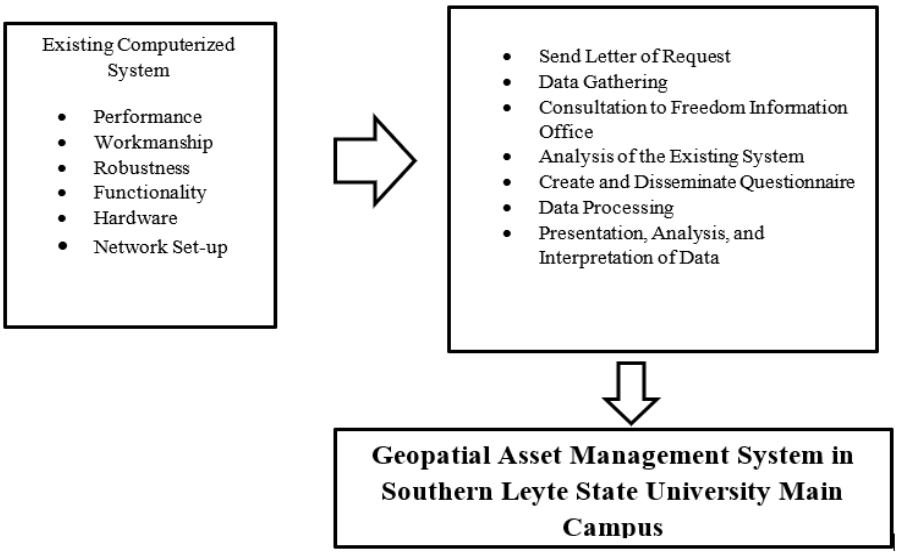

Fig. 2 Research Flow Chart

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To ensure the developed system is fully functional this study applies Software Development Life Cycle (SDLC) Waterfall Model [2] which is majorly used in several engineering and industrial fields such as systems engineering, software engineering, computer science, computational sciences, and applied engineering [12]. The Software Development Life Cycle Waterfall Model will undergo the following phases: (1) Requirement Analysis, (2) System Design, (3) Implementation, (4) Testing, (5) Deployment and (6) Maintenance it covers the entire life cycle of the system from Conception analysis to maintenance [5].

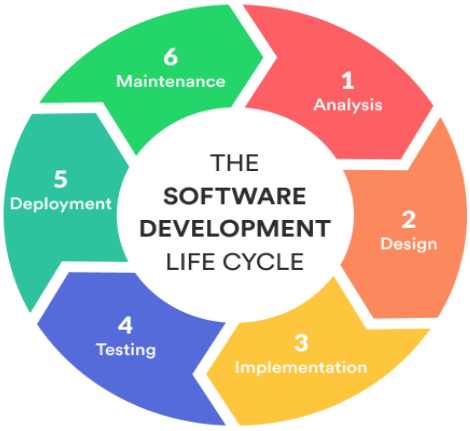

Fig. 3 SDLC Waterfall Model

Research Design

This study will use instructional development also known as developmental research: "the systematic study of designing, developing and evaluating instructional programs, processes and products that must meet the criteria of internal consistency and effectiveness" [10]. Developmental research seeks to create knowledge grounded in data systematically derived from practice. It is a pragmatic type of research that offers a way to test "theory" that has been only hypothesized and to validate practice that has been perpetuated necessarily through unchallenged tradition. It is a way to establish new procedures, techniques, and tools based on a systematic analysis of specific cases.

Research Environment

The research was implemented in Southern Leyte State University, Barangay San Roque, Sogod, Southern Leyte, Philippines. The University has various facilities and buildings in both academic and administrative endeavors such as Admin Buildings where the administrative offices and function is settled, student center where the student's services are offered and accessed and various buildings for academic classes and purposes.

Research Respondent

In this study, IT professionals and related experts evaluated the system as Functionality, overall Performance, Robustness, and Workmanship; all their inputs and suggestions carried in to improve the system. The researcher used a purposive sampling technique in choosing the respondents of the study. They will be invited to evaluate the developed application program.

Table 1: Respondents of the Study

Evaluators	No. of Evaluators
IT Professional/Expert	5
TOTAL:	5

Research Instrument

The standardized adapted-evaluation form from Rochester Institute of Technology in New York, USA was used as an instrument in this study shown in Appendix B. It is used to determine the Functionality, Performance, Robustness, and Workmanship of the development application program; the evaluators used the following scale:

Table 2: Research Instrument

GRADE	INTERPRETATION	REMARKS
A+	96.1-100	
A	93.1-96	Superior

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A-	90.1-93	
B+ B B-	86.1-90 83.1-86 80-83	Above Average
C+ C C-	76.1-79 73.1-76 70-73	Average
D+ D D-	66.1-69 63.1-66 60.1-63	Below Average
F	<60	Failing

Data Gathering

First, the researcher sent a request letter for approval from the University President to ask permission to conduct the study. The researcher will distribute the questionnaire to the respondents to test the Functionality, Performance, Robustness, and Workmanship of the system using the Adapted-Evaluation Form. The answers will be collected, tabulated, analyzed, and interpreted. Using descriptive analysis, the researcher will interpret the results of the proposed Spatial Asset Management System in Southern Leyte State University-Main Campus.

Data Analysis Procedure

The data gathered was treated with proper statistical treatment and tabulation of data according to the sample. The mode is obtained from the data collected from the respondents to get the likelihood of the developed system. The researcher followed the assessment method used by the Rochester Institute of Technology in New York, USA. It is an Engineering Design Guide and Environment (EDGE) software method to support project developers and development teams. The researcher believes that the material is adequate for the evaluation of the developed system. The form involves grading the developed applications software from A+ (96 percent and higher) being the highest to F (60 percent and lower) being the lowest. It assesses the various factors such as Functionality, Performance, Robustness, and Workmanship of the system. Comments and recommendations from the expert addressed to ensure the overall efficiency of the system is guaranteed. Using the evaluative analysis, the researcher will interpret the results of the proposed system software.

III. Results and Discussion

Design and Development of a Location-Based Asset Management Application

The developed University Spatial Asset Management System is organized into three types of accounts. Super Admin, Admin, and Guest user. The Super Admin account has the overall control of the system; different type of accounts is filtered through this Super Admin account. This was accountable for performing all the features of the system such as managing users' accounts, managing limitations of access and information to be disclosed for the users, viewing registered users in the system, managing the user's accounts changing passwords editing accounts, and removing user, add and update assets in the system and view assets of the campus. The super admin is the one manager in the supply office in the University, the one whose function is to oversee and manage the physical assets of the organization. The second type of user is the Admin account. It has a flexible function and control of the system but cannot manage the user's account as the super admin is capable of doing. Adding new assets encored in the organization, updating assets of the new location of the specific asset, and who has the new responsibility of overseeing such assets. The last type of user is the guest; this user is any person in and outside the organization permitted by the super admin through online registration. This is to ensure that the organization's critical information cannot be disclosed to an unauthorized person. Its viewing capability is limited only to the campus map and its primary data of the different buildings such as building picture, building name, and the officer in charge.

Login page

Super Admin, Admin, and Guest use the same page to login to the system. This can be done by typing the URL http://spatialassetmgt.test/ to the browser. Figure 6 below shows the index page.

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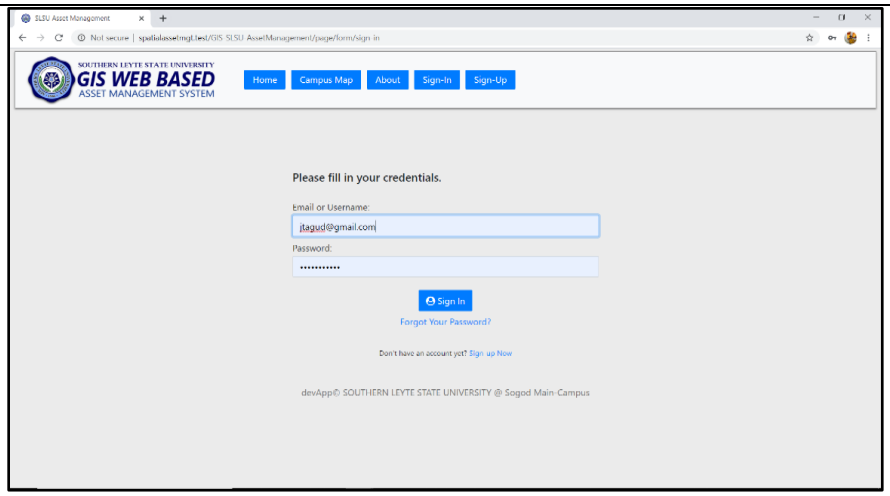

Fig. 4 Log-in Page

Campus Page

The figure below displays the campus map; the user can choose which base map he/she is going to use in searching a specific building or asset in the search box.

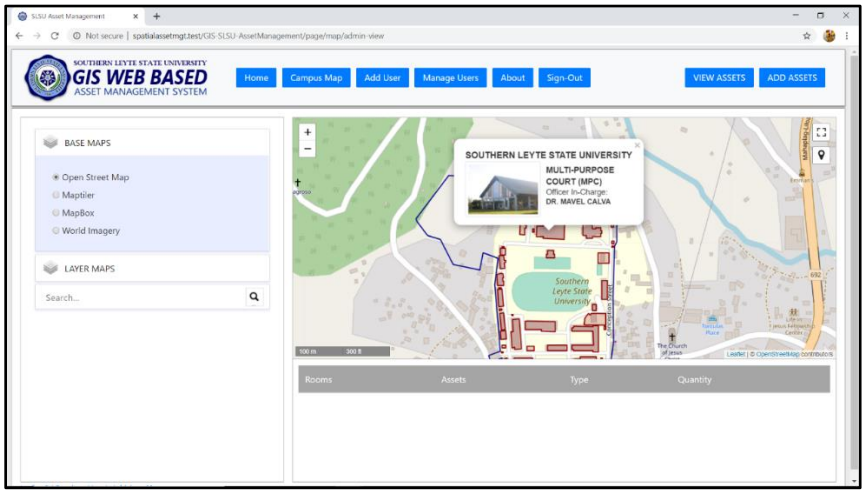

Fig. 5 Campus Page

Manage User Page

On this page, the super admin can manage the user's account; it can edit the user type and can delete the user's account. The password is seen in a hash form to protect password privacy.

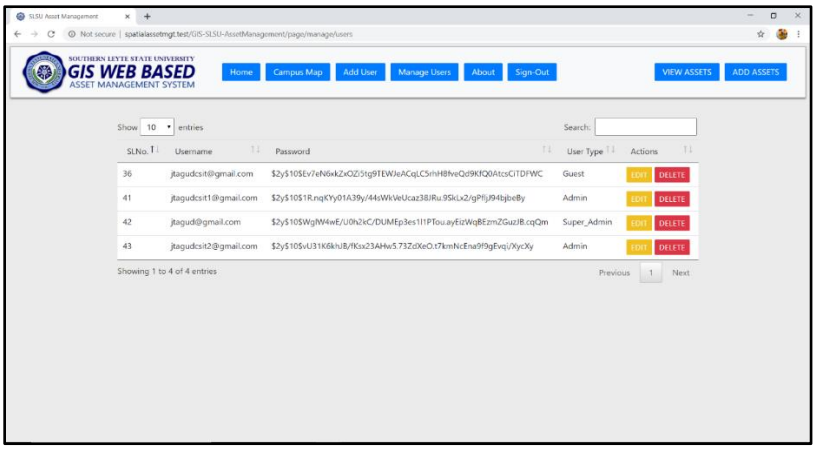

Fig. 6 Manage User Page

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View Assets Page

In this page, the super admin and the admin user can view the asset; it also allows us to edit and drop a particular asset.

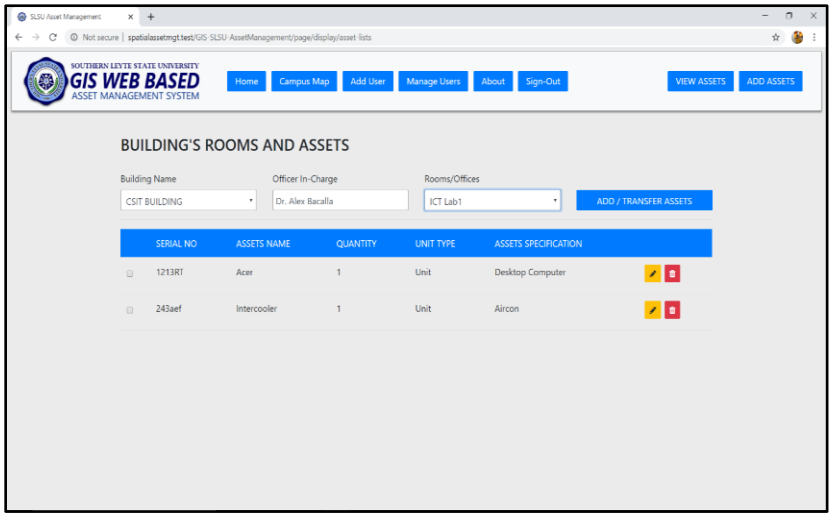

Fig. 7 View Asset Page

Add Asset Page

This page allows the super admin and admin user account to add assets like building name rooms and assets within a place with the following information gathered, serial number, Asset Name, Quantity, Unit Type, Asset Specification, and date received or encoded.

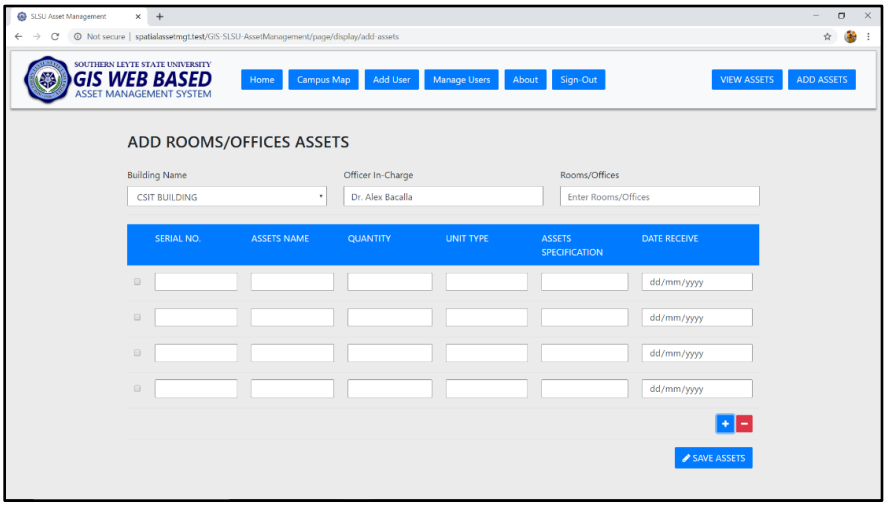

Fig. 8 Add Asset Page

Efficiency of the Developed Spatial Asset Management System of Southern Leyte State University-Main Campus.

Efficient means the system uses inputs in the right way and produces a desirable output with the highest productivity [1]. The system's efficiency was guaranteed by considering and applying the comments and suggestions raised during the evaluation and deployment stage. During the deployment stage, three of the five experts suggested the following: First, there must be a UPS or Uninterruptable Power Supply so that uncertain data loss can be prevented and provide power surge protection. Second, provide a dedicated network connection for the system, to reduce data traffic and internet connection loss, and ensure that it is always available. Lastly, a firewall or security software protects against malware to detect strange behavior in the computer system. And constant protection from malicious hackers and Ensure the overall access control of the system.

Performance of the Developed Spatial Asset Management System of Southern Leyte State University-Main Campus.

The performance of the developed system was determined in terms of Functionality, Performance, Robustness, and Workmanship. The data were gathered during the system testing, and the respondents were asked to answer some of the questions regarding of the developed system in terms of Functionality, Performance, Robustness and Workmanship adaption of Rochester Institute of

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Technology in the United States evaluation form insures that the system follows the standards in developing IT-related applications.

Functionality

Table 3: Performance of the Proposed System in terms of Functionality

Items	Frequency					Modal Response
	SU	AA	A	BA	F	
Does the system have all the functionality required?	4	1				Superior

Legend: 5-Superior, 4-Above Average, 3-Average, 2-Below Average, 1-Failing

The quality of being functional and the range of operations that can be run on a computer or other electronic system [7]. Table 3 shows the performance of the new system in terms of its functionality. As shown, out of 5 respondents, 4 of them answered that the system worked properly at the superior level; all controls used were responsive, and expected outcomes were delivered. During the testing, the functionality of the developed application was verified by the experts in the field. When the system was tested, all functionalities were run and functional at a superior level. One (1) out of 5 respondents answered that the developed system's functionality runs above the average. The database was checked during querying (adding, deleting, searching, and updating). This entire feature generates the desired output as required by the experts. As reflected, majority of the respondents evaluated the functionality of the proposed system as superior.

Performance

Performance refers to a class of software tools that allows the IT operations group to monitor and control infrastructure stacks [11]. Table 4 shows the performance of the newly developed spatial asset management system as perceived by the respondents. The assessment of the newly developed system in terms of how it manages time effectively was interpreted as Superior, which is five out of 4, and 1 out of 5 answers the systems performs at the above-average level. The system responds immediately to every action the end-user performs, and it operates at the maximum level of accuracy and preciseness at all times. Generally, most of the respondents answered that the performance of the proposed system meets the desired requirement at the superior level.

Table 4: Performance of the Proposed System in terms of Performance

Items	Frequency					Modal Response
	SU	AA	A	BA	F	
Does the performance of the system meets desired it requirements?	4	1				Superior

Legend: 5-Superior, 4-Above Average, 3-Average, 2-Below Average, 1-Failing

Robustness

Software is robust, if any exception raised during its execution, in any architecture and with an initial state, is caught by some exception handler [3]. Table 5 shows the Robustness of the developed spatial asset management system. Three (3) out of 5 respondents answers that the system runs at its superior robust. And Two (2) believed that the system run in an above-average manner. The application can adapt to both mobile and desktop environments. Once installed, users will be notified if an update of the system is available online. Overall the result further implies that the proposed system is superior in terms of robustness since it operates repeatedly without adjustment or repair.

Table 5: Performance of the Proposed System in terms of Robustness

Items	Frequency					Modal Response
	SU	AA	A	BA	F	
Does the robustness of the system operate repeatedly without adjustment or repair?	3	2				Superior

Legend: 5-Superior, 4-Above Average, 3-Average, 2-Below Average, 1-Failing

Workmanship

The workmanship is a human attribute relating to knowledge and skill at performing a task. It is also a quality imparted to product creation [13]. Table 6 below displays the workmanship of the newly developed spatial asset management system. The table shows that on the processing time, the system immediately responds to the user needs and checks and validates first the data being

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entered before the next transaction happens. Based on the respondent's response, four (4) believes that the workmanship of the system indicates a superior response, and 1 out of 5 answered above average for the workmanship of the system. Generally, based on the modal response on the data gathered, it shows that it is preferable to use the developed system as it meets the demands of the users and satisfies the expectation of the users.

Table 6. Performance of the Proposed System in terms of Workmanship

Items	Frequency					Modal Response
	SU	AA	A	BA	F	
Does the system show quality workmanship?	4	1				Superior

Legend: 5-Superior, 4-Above Average, 3-Average, 2-Below Average, 1-Failing

Generally, based on the overall data presented on the performance of the developed spatial asset management system in terms of efficiency, functionality, performance, robustness and workmanship it shows that the system performed at its maximum level of accuracy, precise at all times, operates repeatedly without adjustment or repair and the users satisfies the expectation of the users.

IV. Conclusion

The spatial Asset management system was developed using PHP and MySQL; GeoJSON is used to represent geographical features. All respondents are IT professionals and working people in the academe and practice in the industry as a freelance worker in IT-related jobs. The performance of the developed spatial asset management system in terms of functionality is functional at a superior level. As for the Performance, the majority of the respondents agreed that it performs well. In its Robustness, respondent's remarks above average that the system works in robust. Both of the respondents agree that during the testing phase, bugs and errors were comprehensively examined, which made the system error-free somehow, and therefore it performed well on its workmanship. Generally, most of the respondents agreed to use the developed system as it meets the expert's demands and satisfies the users. Based on the summary of the opinions of the respondents and from the findings of the study, the researcher concludes the development of a spatial asset management system in SLSU Main Campus is an effective way of monitoring and delivering university asset management information and resources to its various constituents. The performance of the newly developed system in terms of Functionality, performance, Robustness, and Workmanship showed that the system is an excellent platform to use.

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