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E-xtension: A Progressive Web-Based Information Management System with Predictive Analytics for the Center for Community Development and Extension Services of Urdaneta City University

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Abstract *– This study presents the development of E-xtension: A Progressive Web-Based Information Management System with Predictive Analytics for the Center for Community Development and Extension Services of Urdaneta City University. The study aimed to address inefficiencies in the manual management of university extension services, particularly in planning, monitoring, evaluation, documentation, and reporting processes. A descriptive-developmental research design was employed, and the system was developed using the Extreme Programming (XP) methodology to support iterative development, continuous feedback, and stakeholder collaboration. The developed system was implemented as a Progressive Web Application (PWA) to ensure accessibility, responsiveness, and cross-platform usability across devices. The system integrates modules for project proposal management, extension activity monitoring, evaluation and feedback management, accomplishment reporting, and partner and linkage management. In addition, predictive analytics features were incorporated, including extension impact prediction, participation forecasting, sentiment analysis of beneficiary feedback, performance evaluation dashboards, and recommendation of future extension programs. Data visualization tools such as Sustainable Development Goals (SDG) analytics and trend analysis dashboards were also integrated to support data-driven decision-making. System usability was evaluated using the System Usability Scale (SUS) with 16 respondents, yielding a score of 90, interpreted as excellent usability. Findings indicate that the developed system improves efficiency, transparency, accessibility, and decision-making in extension service management. The integration of Progressive Web-based Application technology and predictive analytics provides a scalable, adaptive, and data-driven solution for improving university extension service operations and community engagement.*

Keywords *– Community extension services, Data analytics, Information management system, Predictive analytics, Progressive web application*

INTRODUCTION

Extension services are considered one of the core functions of higher education institutions, serving as a bridge between universities and communities through outreach programs, capacity building, and collaborative development initiatives. According to Commission on Higher Education Memorandum Order (CMO) No. 08, s. 2008, extension services play a vital role in improving the quality of life of Filipinos and addressing societal needs through community-oriented programs (CHED, 2008). Furthermore, CMO No. 46, s. 2012 emphasized that extension services are evaluated through institutional assessments and accreditation processes to ensure their effectiveness and impact on community development (CHED, 2012). In the study conducted by Sermona et al. (2020), State Universities and Colleges (SUCs) in the Philippines were found to provide various extension initiatives such as educational programs, livelihood training, health awareness, governance support, and environmental sustainability programs.

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Despite the importance of extension services, several institutions continue to encounter operational challenges due to reliance on manual and fragmented management processes. Manual procedures involving paper-based documentation, repetitive encoding, and physical record keeping often lead to inefficient data handling, delayed processing, inconsistent documentation, and coordination difficulties (Sermona et al., 2020). Similarly, De Jesus and Buenas (2023) emphasized that manual systems lack real-time monitoring and analytical capabilities, resulting in fragmented data management and limited support for effective decision-making.

Management information systems have become essential tools in improving organizational efficiency, coordination, and data accessibility. According to ISO 9001 (2021), a management system is a structured framework that supports planning, control, and continuous improvement within organizations. Effective management systems streamline operations, improve resource allocation, and enhance communication among stakeholders (Davis, 2021). Pastor (2020) further stated that the success of organizations often depends on how effectively information systems align with organizational objectives and operational processes. In the context of higher education institutions, integrating digital systems into administrative operations improves coordination across departments and enhances institutional performance (Al-Ababneh & Alrhaimi, 2020).

The adoption of web-based management systems and digital technologies has significantly improved operational processes in universities and public institutions. Advanced technologies such as cloud computing, business analytics, and mobile applications support administrative decision-making and improve organizational efficiency (Cabaleiro-Cerviño & Vera, 2020). Arago (2023) also emphasized that universities increasingly utilize management information systems to improve extension program coordination, stakeholder communication, and outreach management. These systems enhance transparency, monitoring, and sustainability of extension initiatives while supporting community engagement.

Studies also highlight the advantages of automation and analytics in organizational management. Digital platforms support real-time data processing, centralized information storage, and automated reporting, allowing institutions to improve efficiency and decision-making processes (Schildkamp, 2019). Automated systems minimize duplication of records and reduce operational errors through streamlined workflows and integrated communication channels (Liu, 2023). In addition, cloud-based technologies improve scalability and accessibility of information systems, supporting centralized and secure data management (Aydin, 2021). The integration of analytics and visualization tools further strengthens organizational monitoring by providing actionable insights and supporting evidence-based evaluation and planning (Doneva et al., 2022).

Recent technological advancements have also introduced predictive analytics and intelligent decision-support systems into information management platforms. Predictive analytics utilizes historical and real-time data to identify trends, forecast outcomes, and support strategic planning decisions. In educational and organizational settings, predictive analytics has been applied in performance forecasting, resource optimization, and behavioral analysis (Ramaswami et al., 2023; Sghir et al., 2022). Sentiment analysis techniques are also increasingly used to classify feedback responses into positive, neutral, or negative categories to improve service evaluation and user satisfaction analysis (Grimalt-Álvaro & Usart, 2023; Shaik et al., 2023). Furthermore, data visualization dashboards improve interpretation of organizational data through graphical representations of trends, patterns, and performance indicators, supporting decision-making processes (Susnjak et al., 2022; Chen et al., 2023).

Agile software development methodologies have become widely adopted in system development

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projects because of their flexibility and adaptability to changing requirements. Extreme Programming (XP), an agile methodology introduced by Beck (2000), emphasizes iterative development, continuous testing, stakeholder collaboration, and rapid feedback integration. XP supports incremental software releases and continuous refinement of system functionalities, making it suitable for projects that require close interaction between developers and users (Juric, 2000). Through continuous testing and user feedback, XP improves software quality, usability, and adaptability.

Unlike existing extension management systems that primarily focus on documentation and reporting, the developed system integrates predictive analytics, sentiment analysis, Sustainable Development Goals (SDG) visualization, and Progressive Web Application (PWA) technology into a centralized platform specifically designed for university extension service management. The integration of analytics-driven functionalities provides enhanced decision-support capabilities that improve planning, monitoring, and evaluation processes.

At Urdaneta City University – Center for Community Development and Extension Services (UCU-CCDES), extension service operations are currently managed through traditional workflows combined with basic digital tools such as spreadsheets, online forms, and manual reporting systems. Based on interviews conducted with key personnel, the current process involves printed project proposals, manual approvals, physical accomplishment reports, and separate online evaluation forms requiring manual consolidation and analysis. Monitoring activities are tracked using office whiteboards and manually maintained records, making it difficult to efficiently oversee multiple extension activities simultaneously. These limitations result in fragmented records, delayed reporting, and inefficient workflow management.

To address these challenges, this study developed E-xtension: A Progressive Web-based Information Management System with Predictive Analytics for the Center for Community Development and Extension Services of Urdaneta City University. The system integrates extension service processes including proposal management, activity monitoring, evaluation management, accomplishment reporting, partner and linkage management, and report generation into a centralized digital platform. In addition, the system incorporates predictive analytics functionalities such as extension impact prediction, participation forecasting, sentiment analysis of beneficiary feedback, performance evaluation dashboards, recommendation systems for future extension programs, and Sustainable Development Goals (SDG) analytics visualization.

The system was developed using the Extreme Programming (XP) methodology to support iterative development, continuous improvement, and stakeholder collaboration throughout the project lifecycle. Furthermore, the system was implemented as a Progressive Web Application (PWA), enabling accessibility, responsiveness, offline capability, and cross-platform usability across multiple devices. By integrating centralized information management, predictive analytics, and modern web technologies, the study aims to improve efficiency, transparency, and data-driven decision-making in university extension service operations while supporting sustainable community engagement initiatives.

OBJECTIVES OF THE STUDY

This study aimed to develop and evaluate E-xtension: A Progressive Web-based Information Management System with Predictive Analytics for the Center for Community Development and Extension Services of Urdaneta City University to improve the efficiency, accessibility, and management of extension service operations.

Specifically, this study sought to:

1. Identify the current processes, challenges, and limitations in managing extension services at the Urdaneta City University – Center for Community Development and Extension Services (UCU-CCDES).

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2. Design and develop a Progressive Web-based Information Management System with predictive analytics features for extension service planning, monitoring, evaluation, documentation, and reporting.
3. Evaluate the usability of the developed system using the System Usability Scale (SUS) in terms of effectiveness, efficiency, and user satisfaction.

MATERIALS AND METHODS

This section presents research design, software development methodology, system implementation, data collection procedures, respondents of the study, research instruments, and data analysis techniques utilized in the development and evaluation of E-xtension: A Progressive Web-based Information Management System with Predictive Analytics for the Center for Community Development and Extension Services of Urdaneta City University.

Research Design

The study utilized a descriptive-developmental research design. The descriptive aspect focused on identifying and analyzing the existing workflows, challenges, and limitations in managing extension services at the Urdaneta City University – Center for Community Development and Extension Services (UCU-CCDES). The developmental aspect involved the design, development, implementation, and evaluation of a web-based information management system intended to improve efficiency, accessibility, and decision-making in extension service operations. This design was appropriate because it allowed the researchers to systematically examine current operational conditions while simultaneously developing a technological solution that addresses identified problems.

Scope and Limitations of the Study

This study focused on the development and evaluation of E-xtension: A Progressive Web-Based Information Management System with Predictive Analytics for the Center for Community Development and Extension Services of Urdaneta City University (UCU-CCDES). The system was designed to support extension service operations including project proposal management, activity monitoring, evaluation and feedback management, accomplishment reporting, partner and linkage management, and analytics visualization.

The predictive analytics features of the system were limited to extension impact prediction, participation forecasting, sentiment analysis of beneficiary feedback, recommendation of future extension programs, and Sustainable Development Goals (SDG) analytics dashboards based on the available historical and evaluation data gathered during the study.

The usability evaluation of the system was limited to sixteen (16) respondents composed of the UCU-CCDES Director, Secretary, and Extension Coordinators. The study primarily focused on usability evaluation using the System Usability Scale (SUS) and did not include large-scale deployment testing, long-term performance evaluation, or comparative analysis with other extension management systems.

In addition, the study was limited to the operational processes and requirements of Urdaneta City University – Center for Community Development and Extension Services and may require further customization for implementation in other institutions.

Software Development Methodology

The system was developed using the Extreme Programming (XP) methodology, an agile software development approach emphasizing iterative development, continuous testing, simplicity in design, and close collaboration with stakeholders. XP was selected because of its flexibility in accommodating changing requirements and supporting continuous refinement throughout the software development lifecycle.

The XP process implemented in the study consisted of the following phases:

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- Planning Phase – Requirements gathering was conducted through interviews, observation, and document analysis involving the UCU-CCDES Director, Secretary, and Extension Coordinators. Existing workflows and extension service procedures were examined to identify system requirements.
- Design Phase – System architecture, database structures, workflows, and user interface prototypes were designed based on gathered requirements. Mockups and wireframes were created to visualize user interactions and system processes.
- Coding Phase – The system was developed using web technologies including HTML, CSS, JavaScript, PHP, and a relational database management system. The application was structured to support role-based access control and centralized information management.
- Testing Phase – Continuous testing, including functional testing and user acceptance testing, was conducted throughout development to identify issues and improve system performance and usability.
- Feedback and Iteration Phase – Stakeholder feedback was continuously incorporated into succeeding development cycles to refine system functionalities and ensure alignment with actual extension service operations.

System Implementation

The developed system was implemented as a Progressive Web Application (PWA) to provide accessibility, responsiveness, and cross-platform compatibility across desktop and mobile devices. The system supports centralized management of extension service operations including proposal management, monitoring, evaluation, accomplishment reporting, and analytics visualization.

The system was developed using a modern web technology stack consisting of the Laravel framework for backend development and React.js for frontend user interface development. Inertia.js was utilized to integrate the Laravel backend and React.js frontend, enabling seamless single-page application functionality without the need for separate API architecture. Tailwind CSS was used to design responsive and user-friendly interfaces, while MySQL served as the relational database management system for centralized data storage and retrieval.

For predictive analytics functionalities, TensorFlow and Linear Regression techniques were utilized to support participation forecasting, extension impact prediction, and analytics processing. These technologies enabled the system to generate data-driven insights and visualization dashboards that support evidence-based decision-making in extension service management.

Respondents of the Study

The respondents of the study consisted of personnel from the Urdaneta City University – Center for Community Development and Extension Services (UCU-CCDES), including the Director, Secretary, and Extension Coordinators. These respondents participated during requirements gathering, system testing, and usability evaluation. A total of sixteen (16) respondents participated in the System Usability Scale (SUS) evaluation of the developed system. The respondents were selected through purposive sampling based on their direct involvement in extension service operations and system utilization.

Data Collection Methods

Data collection was conducted using interviews, observation, document analysis, and survey questionnaires. Interviews and observations were performed to identify the current processes, challenges, and requirements of the extension service office. Document analysis was utilized to review forms, reports, evaluation instruments, and existing extension-related documents used by UCU-CCDES.

To evaluate the usability of the developed system, the System Usability Scale (SUS) questionnaire

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developed by Brooke (1986) was administered to selected respondents after system implementation.

Research Instrument

The primary research instrument used in evaluating the usability of the system was the System Usability Scale (SUS), a standardized 10-item questionnaire used to assess system usability in terms of effectiveness, efficiency, and user satisfaction. The SUS utilizes a five-point Likert scale ranging from Strongly Disagree to Strongly Agree.

Ethical Considerations

The study observed proper ethical procedures throughout the conduct of the research. Permission to conduct the study and gather necessary data was secured from the Urdaneta City University – Center for Community Development and Extension Services (UCU-CCDES). Respondents were informed about the purpose of the study, the procedures involved, and the intended use of the collected information prior to their participation.

Participation in interviews, observations, and system usability evaluations was voluntary. Respondents were assured that all information gathered would be treated with confidentiality and used solely for academic and research purposes. No personal or sensitive information unrelated to the study was disclosed in the research.

Furthermore, the researchers ensured that the developed system was used only for legitimate academic and institutional purposes and that collected data were properly managed and protected to maintain data privacy and integrity.

Data Analysis

Qualitative data gathered from interviews, observations, and document analysis were used to identify system requirements and extension service workflows. Quantitative data obtained from the System Usability Scale (SUS) questionnaires were analyzed to determine the usability level of the developed system.

The SUS score was computed using the standard scoring procedure wherein the adjusted scores for all ten items were summed and multiplied by 2.5 to obtain the final usability score ranging from 0 to 100. The resulting score was interpreted using established SUS interpretation scales to determine the usability level of the system.

RESULTS AND DISCUSSION

This section presents the findings gathered during the development and evaluation of E-xtension: A Progressive Web-Based Information Management System with Predictive Analytics for the Center for Community Development and Extension Services of Urdaneta City University. The discussion focuses on the identified problems in the current extension service management process, the developed system features, predictive analytics functionalities, and the usability evaluation results.

Current Processes in Managing Extension Services

Based on interviews conducted with the Director, Secretary, and Extension Coordinators of the Urdaneta City University – Center for Community Development and Extension Services (UCU-CCDES), the current extension service management process relies heavily on manual and semi-digital procedures. Planning and approval of extension activities involve printed proposals, manual endorsements, and repetitive documentation processes. Monitoring of activities is conducted using office whiteboards and manually maintained records, making it difficult to track multiple projects simultaneously. Evaluation procedures are facilitated using external tools such as online forms, requiring manual consolidation and interpretation of responses. In addition, accomplishment reports are manually compiled, printed, and archived, resulting in delays, redundancy, and inefficient retrieval of information.

Table 1. Identified Challenges in the Current Extension Service Management Process

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Identified Problem	Description
Manual Documentation	Reliance on printed proposals and reports
Fragmented Records	Separate storage of files and records
Delayed Reporting	Time-consuming report preparation
Inefficient Monitoring	Use of whiteboards and manual tracking
Manual Consolidation	Evaluation results processed manually

The planning phase of extension activities begins with identifying the target community and preparing the necessary project proposal documents. The proposal undergoes several approval stages before implementation. Figure 1 presents the existing planning process of extension activities at UCU-CCDES.

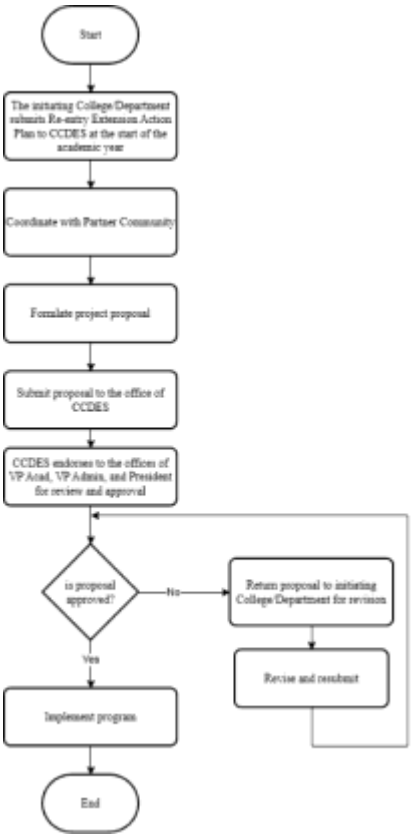

Figure. 1. Current Planning Process for Extension Activities

Monitoring of extension activities is currently conducted through manually maintained records and office monitoring boards. This process limits real-time tracking and efficient management of multiple extension activities. Figure 2 illustrates the current monitoring process implemented by UCU-CCDES.

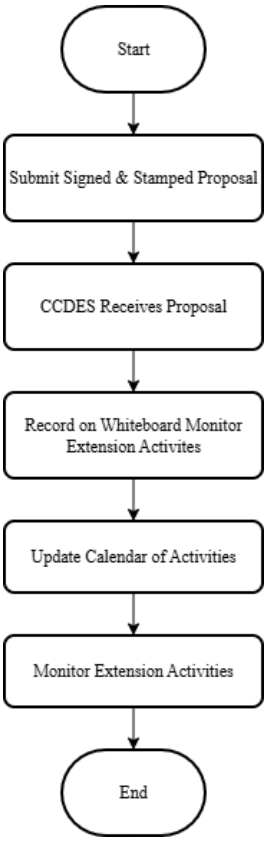

Figure. 2. Current Monitoring Process of Extension Activities

For evaluation procedures, beneficiaries are provided with online forms after the conduct of extension activities. Responses are manually reviewed and consolidated by coordinators to assess the effectiveness of conducted programs. Figure 3 presents the current evaluation procedure of conducted extension activities.

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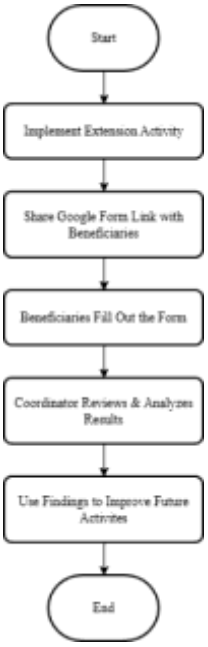

Figure. 3. Current Evaluation Process of Extension Activities

In terms of documentation and submission, coordinators manually compile accomplishment reports and supporting documents before submission to the CCDES Office. This procedure contributes to repetitive documentation and delayed retrieval of records. Figure 4 presents the current documentation and submission process.

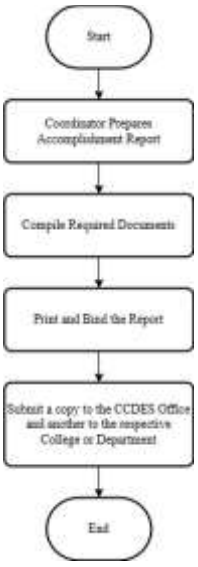

Figure. 4. Current Documentation and Submission Process

Developed System Features

To address the identified challenges, the study developed a centralized web-based management platform that integrates planning, monitoring, evaluation, reporting, and analytics functionalities into a single system. The developed system supports role-based access for administrators, secretaries, and extension coordinators, allowing users to efficiently manage extension activities according to their assigned responsibilities.

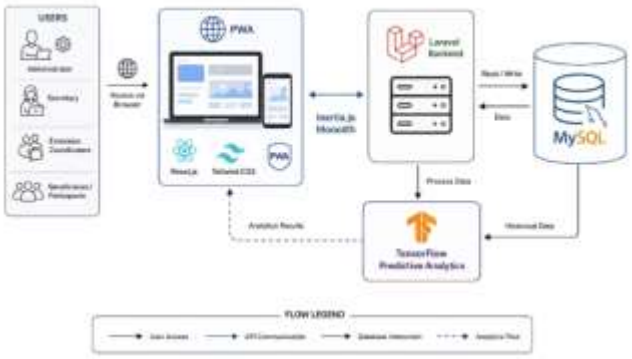

Figure. 5. System Architecture of E-xtension

The system includes modules for project proposal management, re-entry action plans, extension activity monitoring, accomplishment reporting, partner and linkage management, evaluation administration, and report generation. Through the implementation of a Progressive Web Application (PWA), the system provides accessibility across desktop and mobile devices while maintaining responsive and user-friendly interfaces. The PWA implementation also improves usability through faster loading performance, offline capability, and cross-platform compatibility.

Table 2. Major Functional Modules of the Developed System

Module	Function
Proposal Management	Handles proposal submission and approval
Monitoring Module	Tracks extension activities
Evaluation Management	Collects and analyzes feedback

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Report Generation	Generates accomplishment reports
Analytics Dashboard	Displays trends and insights
Partner Management	Stores partner and linkage records

Predictive Analytics and Visualization Features

One of the major enhancements introduced in the system is the integration of predictive analytics and data visualization tools. The developed analytics modules provide insights that support evidence-based planning and decision-making in extension service operations.

The Extension Impact Prediction feature analyzes historical evaluation results and feedback trends to estimate the potential effectiveness of future extension programs. This functionality assists coordinators in identifying activities with higher expected community impact.

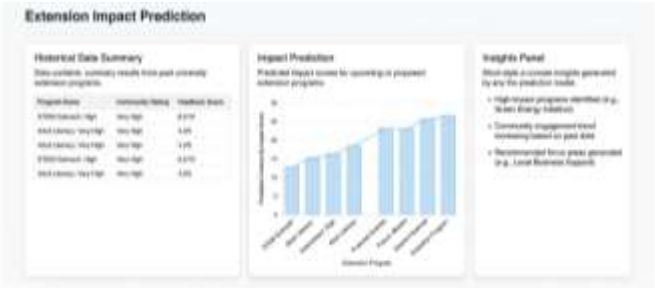

Figure. 6. Extension Impact Prediction Dashboard

The Participation Forecasting module predicts the expected number of beneficiaries for upcoming extension activities based on historical attendance records and participation trends. This feature helps coordinators allocate resources, personnel, and materials more effectively during project planning.

Figure. 7. Participation Forecasting Dashboard

The system also integrates Sentiment Analysis of Feedback, which processes open-ended beneficiary responses and classifies them into positive, neutral, or negative sentiments. This functionality enables administrators and coordinators to identify recurring concerns, measure participant satisfaction, and improve future extension activities based on community feedback.

Figure. 8. Sentiment Analysis Dashboard

In addition, the system provides a College and Department Performance Dashboard, which ranks colleges and departments according to impact scores, completion rates, and community satisfaction ratings. This dashboard promotes transparency and encourages continuous improvement among participating departments.

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Figure. 9. College and Department Performance Dashboard

The developed Recommendation System for Extension Programs utilizes historical project data and community needs assessments to suggest future extension activities that align with successful previous implementations and identified community priorities. This feature supports strategic planning and data-driven decision-making.

To strengthen institutional reporting and monitoring, the system includes Sustainable Development Goals (SDG) Analytics Dashboards and trend visualization graphs. These dashboards display the alignment of extension activities with specific SDG categories and provide graphical representations of activity trends, participation trends, impact scores, and evaluation results over time. The integration of visual analytics improves interpretation of data and supports institutional reporting requirements.

Figure. 10. Sustainable Development Goals (SDG) Analytics Dashboard

Usability Evaluation of the Developed System

The usability of the developed system was evaluated using the System Usability Scale (SUS) with sixteen (16) respondents composed of administrators, secretaries, and extension coordinators. The SUS is a standardized usability evaluation instrument consisting of a 10-item questionnaire that measures effectiveness, efficiency, and user satisfaction.

Table 3. System Usability Scale (SUS) Interpretation Scale

SUS Score Range	Interpretation
86–100	Excellent Usability
71–85	Good Usability
50–70	Average Usability
0–49	Poor Usability

The SUS score was computed by summing the adjusted scores of all questionnaire items and multiplying the total by 2.5 to obtain the final usability score ranging from 0 to 100.

Table 4. System Usability Evaluation Result

Evaluation Metric	Result
Number of Respondents	16
Average SUS Score	90
Interpretation	Excellent Usability

The evaluation resulted in an average SUS score of 90, interpreted as Excellent Usability. Respondents indicated that the system was easy to use, well-integrated, and efficient in supporting extension service operations. The high usability rating suggests that the system effectively meets user requirements and improves workflow efficiency.

The findings of the study demonstrate that integrating Progressive Web Application technology, predictive analytics, and centralized information management significantly enhances the efficiency, accessibility, and decision-making capabilities of university extension service operations. The developed system provides a scalable and adaptive solution that supports digital transformation in extension service management while promoting data-driven community engagement and institutional effectiveness.

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CONCLUSION AND RECOMMENDATION

The study successfully developed E-xtension: A Progressive Web-Based Information Management System with Predictive Analytics for the Center for Community Development and Extension Services of Urdaneta City University to address inefficiencies in the traditional management of extension services. Findings revealed that existing processes relied heavily on manual documentation, fragmented monitoring procedures, repetitive reporting practices, and separate evaluation systems, resulting in delays, inconsistencies, and difficulty in managing extension activities efficiently. These operational challenges emphasized the need for a centralized and technology-driven solution capable of improving workflow management, accessibility, monitoring, and decision-making.

The developed system integrated major extension service management functionalities, including project proposal management, activity monitoring, evaluation management, accomplishment reporting, partner and linkage management, and report generation into a unified digital platform. Through the implementation of Progressive Web Application (PWA) technology, the system provided a responsive, accessible, and cross-platform solution capable of operating efficiently across desktop and mobile devices. Furthermore, the integration of predictive analytics features such as extension impact prediction, participation forecasting, sentiment analysis, recommendation systems, performance dashboards, and Sustainable Development Goals (SDG) analytics enhanced the capability of the system to support evidence-based planning and strategic decision-making.

The utilization of the Extreme Programming (XP) methodology contributed significantly to the successful development of the system through iterative development, continuous testing, and stakeholder collaboration. The usability evaluation using the System Usability Scale (SUS) resulted in a score of 90, interpreted as Excellent Usability, indicating that the system is user-friendly, efficient, and effective in supporting extension service operations. The findings of the study demonstrate that integrating centralized information management, predictive analytics, and modern web technologies can significantly improve the efficiency, transparency, and sustainability of university extension service management.

Based on the findings of the study, the researchers recommend the continuous enhancement of the system through the integration of more advanced analytics and artificial intelligence capabilities. Future developers may incorporate machine learning algorithms for more accurate predictive modeling and automated decision-support functionalities. The integration of Geographic Information System (GIS) technologies is also recommended to support spatial visualization of partner communities and extension activity coverage areas. In addition, future studies may explore the incorporation of mobile push notifications, automated scheduling systems, and real-time communication tools to further improve coordination among stakeholders. Expanding the implementation of the system across multiple campuses and higher education institutions may also contribute to broader digital transformation initiatives in university extension service management.

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