

Descriptive Analytics and Interactive Visualizations for Performance Monitoring of Extension Services Programs, Projects, and Activities

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Abstract—Providing universities with high technology-enabled automation tools to support the administrative decision-making processes will enable them to achieve their objectives. For an institution to succeed in its everyday tasks, it should come up with the emerging and modernized management services constituted, among others, by cloud, mobile, and business analytics technology. With this, the institution's operations and management efficiency are ensured. This study aims to develop a system with descriptive analytics named as MET Online Services that will automate and optimize the monitoring of extension services key performance indicators (KPIs) in order to help the institution in making better, data-driven decisions. The dashboards and interactive visualizations of the developed system will provide quick access to real-time progress of the extension services programs, projects, and activities. Results interpretation depicted that the developed system is indeed feasible for implementation, proven to be fully-functional and passed the quality software standards of a Certified Software Quality Assurance Specialist. As the developed system satisfied the users' expectations and requirements, it would be an effective tool for the institution, extension services unit, and community, to make better strategic decisions and continuously deliver quality services to the community.

Keywords—Business analytics; descriptive analytics; dashboards; interactive visualizations; extension services; monitoring; key performance indicators; KPIs; community

I. INTRODUCTION

Managing an institution and bringing together departments and campuses to achieve the vision and quality objectives are always a big challenge for the university management. Providing universities with high technology-enabled automation tools to support the administrative decision-making processes enable them to achieve their objectives. And for an institution to succeed in its everyday tasks, it should cope up with the emerging and modernized management services [1] constituted, among others, by cloud, mobile, and business analytics technology. It is supported by [2, 3], that Higher education institutions are expanding ICT-driven projects in both developed and developing nations to improve quality services in education and increase efficiency and effectiveness. With this, the institutions' operations and management efficiency are ensured.

An effective management system can help an organization use its resources more efficiently and improve its financial performance, risk management, protection of people and the environment, and ability to provide consistent and better services and products. This makes the organization more valuable to its customers and other stakeholders [4]. And to facilitate better flow of information, management system with the use of data analytics within an organization can aid in decision-making that is more strategically oriented, more effective, and maximizes performance [5, 6].

According to [7], management system is the process through which a company oversees the interdependent elements of its operations in order to achieve its goals. These goals may have to do with a variety of things, such as the continuous improvement of the products or services, operational effectiveness, performance, health and safety at work. In the Philippines, State, Universities, and Colleges are expected to extend their academic and community services to the community in accordance with the Commission on Higher Education's (CHED) directives along with instruction, research and production [8]. The office's main goal is to establish a sustainable partnership with public and private organizations with the purpose of reducing poverty. As [9] explicates that there are concerns about implementing extension programs where academic institutions must closely monitor and assess the results of their grassroots community engagement in order to attain development goals.

In this study, a monitoring system with descriptive analytics was developed and will serve as a tool in providing the users with beneficial information to do the extension activities effectively and efficiently that will allow the extension services unit team plan, implement, analyze (at both tactical and strategic levels) and administer all extension services procedure as a mechanized system in the operational level. It will automate and optimize the monitoring of extension services key performance indicators (KPIs) in order to help the institution in making better, data-driven decisions through dashboards, interactive visualizations, and reports. The study also aims to pass in the technical evaluation of a Certified Software Quality Assurance Specialist and determine the level of satisfaction and acceptance of the end-users towards the developed system.

II. RELATED WORK

A. Extension Services

According to [10], extension is a relatively new phenomenon and is defined as the intentional transfer of skills and the organized exchange of information. Extension service is a community-based educational opportunity offered by academic institutions [11], with the primary objective of establishing long-term partnerships with both public and private organizations working toward poverty alleviation. The office is in charge of carrying out the university's program for outreach and community development. It makes it simpler to put into action policies and programs that are intended to empower communities, especially those who have been underserved. As [12] stated that the educators from various universities came together and developed community and extension programs in the university. Serving the community is one of an organization's key principles.

The Philippine Higher Education system's objectives include improving the quality of life for Filipinos, adapting effectively to changing societal requirements and circumstances, and offering answers to issues at the local, regional, and national levels, according to [13]. As a core responsibility of universities and colleges, Extension services have been measured or evaluated in several state, universities, and colleges' assessments, including SUC Levelling, the Annual Major Final Outputs of SUCs, CHED's Institutional Sustainability Assessment, and the Accrediting Agency of Chartered Universities and Colleges (AACUP) Institutional and Program Accreditation [14].

According to [15], extension services unit should encourage, motivate, and elevate beneficiary awareness, participation, and satisfaction, especially for low-rated program services. By developing and improving its extension services to be more responsive to the community, the Philippine Higher Education Institutions (HEIs) participated in the discussion of the 2017-2022 Philippine Development Agenda (PDA). [16] explains that the government will create a strong national environment for innovation and knowledge creation, which is necessary for the nation's engagement in the global knowledge economy. It will make investments in: (a) improving the research capabilities of college and university faculty, research staff, and graduate students; (b) building the capital and institutional infrastructure needed for knowledge production and innovation; and (c) building up, retraining, and retaining a sustainable stream of new researchers.

Similar to this, the government will support formal collaborations between HEIs and community, commercial, and industry stakeholders. The intention is to integrate "informal" community-based learning and innovation with "formal" academic research and innovation as a means of accomplishing this goal. Policies and procedures will be developed for the operationalization of extension as part of applied research engagement as well as for the normative and appropriate distribution of hours for teaching and research.

B. Key Performance Indicators (KPIs)

A performance indicator, also known as key performance indicator (KPI) is an approach of measuring performance [17].

It examines the extent to which an organization was successful in carrying out a program, a project, a product, or some other initiative in which it was involved [18].

There have been many companies that have used inappropriate measurements; as a result, metrics of this kind should not be labeled performance indicators. According to [19], the majority of businesses that are regarded as having a genuine control system make use of key performance indicators. This is the reason why there are accountants, company executives, and consultants who have appropriate knowledge and experience regarding Key Performance Indicators.

One simply cannot place an adequate amount of emphasis on the significance of key performance indicators (KPIs) to the overall success of an organization. Key performance indicators (KPIs) are metrics that evaluate how well a firm is currently doing in relation to its overall goals [20].

Key performance indicators focus on the improvement of strategic and operational levels, which provide an analytical framework for decision-making, and raise knowledge and interest in many areas [21]. KPI plays an important role because it receives timely and accurate information by comparing current performance to a goal that is necessary to satisfy business needs and goals. This allows KPI to play an instrumental role in ensuring that business needs and goals are met. Alignment with corporate goals, active monitoring, report accuracy, and timeliness are all recommended KPI selection techniques [22]. KPI reporting and dashboards are automated to keep all stakeholders on the same page.

The process of managing utilizing key performance indicators also includes the steps of establishing goals (the expected level of performance) and evaluating progress toward those goals. According to [23], to have good KPIs the organization should perform the following, (a) provide objective evidence of progress towards achieving a desired result; (b) measure what is intended to be measured to help inform better decision making; (c) offer a comparison that gauges the degree of performance change over time, (d) track efficiency, effectiveness, quality, timeliness, governance, compliance, behaviors, economics, project performance, personnel performance or resource utilization; and (e) balance the leading and lagging indicators.

Key performance indicators serve to specify a predetermined set of values that have been established. The author in [24] refers to these unprocessed groups of numbers as indicators since they can be used to feed data aggregation systems. Measuring key performance indicators (KPI) can take either a quantitative or qualitative approach. A quantitative measurement compares facts to a standard and uses facts that have a specific objective numerical value. While the qualitative, denoting conformity to a standard that is not quantifiable or an interpretation of one's own feelings, preferences, beliefs, or experiences

C. Descriptive Analytics

Business analytics finds patterns and trends in massive data sets to improve decision-making and performance. In corporate reports and dashboards, descriptive analytics is used to produce

key performance indicators (KPIs) and metrics. Among the various sorts of analytics, descriptive analytics was recognized as the one that was the most fundamental and the one that was utilized the most [25]. Reports, key performance indicators (KPIs), and other business measures that allow businesses to monitor performance and other trends can be generated using descriptive analytics.

Four categories are frequently used to classify analytics technologies [26]: (i) descriptive (what happened), (ii) diagnostic (why did it happen), (iii) predictive (what will happen next), and (iv) prescriptive (what should be done about it). Academic institutions usually place a strong emphasis on the potential benefits of technology that makes use of sophisticated modeling in order to be either prescriptive or predictive [27, 28, 29, 30]. The majority of adopting companies' sales and marketing teams frequently employ descriptive analytics and straightforward dashboards for key performance indicators (KPIs) [31, 32, 33].

Descriptive analytics are utilized in numerous facets of a business by companies in order to assess the quality of their operations and determine whether or not they are on track to achieve their organizational objectives and used in various ways, particularly in reports, visualizations, and dashboards.

D. Reports

Management Information System Report is an umbrella phrase that describes a group of reports that give a picture of what goes on in an organization on a daily basis, which enables the functions of your firm to be studied. MIS Report is an acronym that stands for Management Information System [Futrlı]. They are a great tool for evaluating the performance of a firm and making decisions that are based on accurate and up-to-date information. They comprise of numerous separate reports that cover various areas of a business.

E. Visualizations

According to [34], The visualization of data through the use of charts, graphs, and maps, which can indicate trends in data as well as dips and spikes in a fashion that is obvious and easily accessible to the audience, is an excellent choice for providing a suitable outlet for presenting descriptive analysis. It is supported by [35] make information easier to perceive and understand. Data visualization involves the process of incorporating facts or information into a pictorial or graphical environment, like charts, maps, or other visual formats.

F. Dashboards

On a consistent basis, dashboards provide a quick overview of key performance indicators (KPIs) that are pertinent to a certain objective or organizational system (e.g., income, marketing, human resources, or production). In real-world usage, the terms "progress report" and "report" can sometimes be referred to as "dashboard" [36].

Regularly, the "dashboard" is shown on an internet page that is connected to a database. This connection makes it

possible for the document to be continuously updated. The term "dashboard" originated from the instrument panel seen in automobiles, where the driver can see, at a glance, the most critical functions displayed on the instrument cluster [37].

Managers can monitor the contributions of varied departments using digital dashboards. Digital dashboards can catch and record distinct information points from every department to provide a "snapshot" of overall performance. Benefits of using digital dashboards include visual presentation of overall performance measures, ability to identify and correct negative tendencies, degree efficiencies/inefficiencies, ability to generate precise reports showing new traits, ability to make more informed decisions based on accumulated business intelligence, align techniques and organizational goals, save time compared to walking a couple of reviews, and benefit total visibility of all measures.

G. Classification of Dashboards

Dashboards can be broken down according to position, and they combine strategic analysis with informational, analytical, and operational perspectives according to [38]. Strategic dashboards are a useful tool for managers at any level in an organization, and they give the concise evaluation that decision makers require in order to monitor the health of the business as well as its potential opportunities. These kinds of dashboards focus on high-level measurements of overall performance as well as forecasts. Static snapshots of data (daily, weekly, monthly, and quarterly) that are not constantly changing from one moment to the next are an advantage for strategic dashboards [39].

Dashboards for analytical purposes frequently include greater context, comparisons, and records, along with subtler overall performance evaluators. Analytical dashboards usually assist interactions with the data, along with drilling down into the underlying information. When dashboards were first introduced, its primary function was monitoring; but, as technology has advanced, their use has expanded to include more analytical tasks. Dashboards are currently being used in a way that incorporates scenario analysis, drill down capabilities, and flexible presentation format options [40].

III. METHODOLOGY

This section highlights the technical system architecture and explains the composition of the developed system as well as the roles involved for the utilization of the system functionality.

A. MET Online Services Technical System Architecture

Fig. 1 shows the technical system architecture of the developed system, which consists of the roles of the actors, business services, business processes, application services, technology services, and technology components.

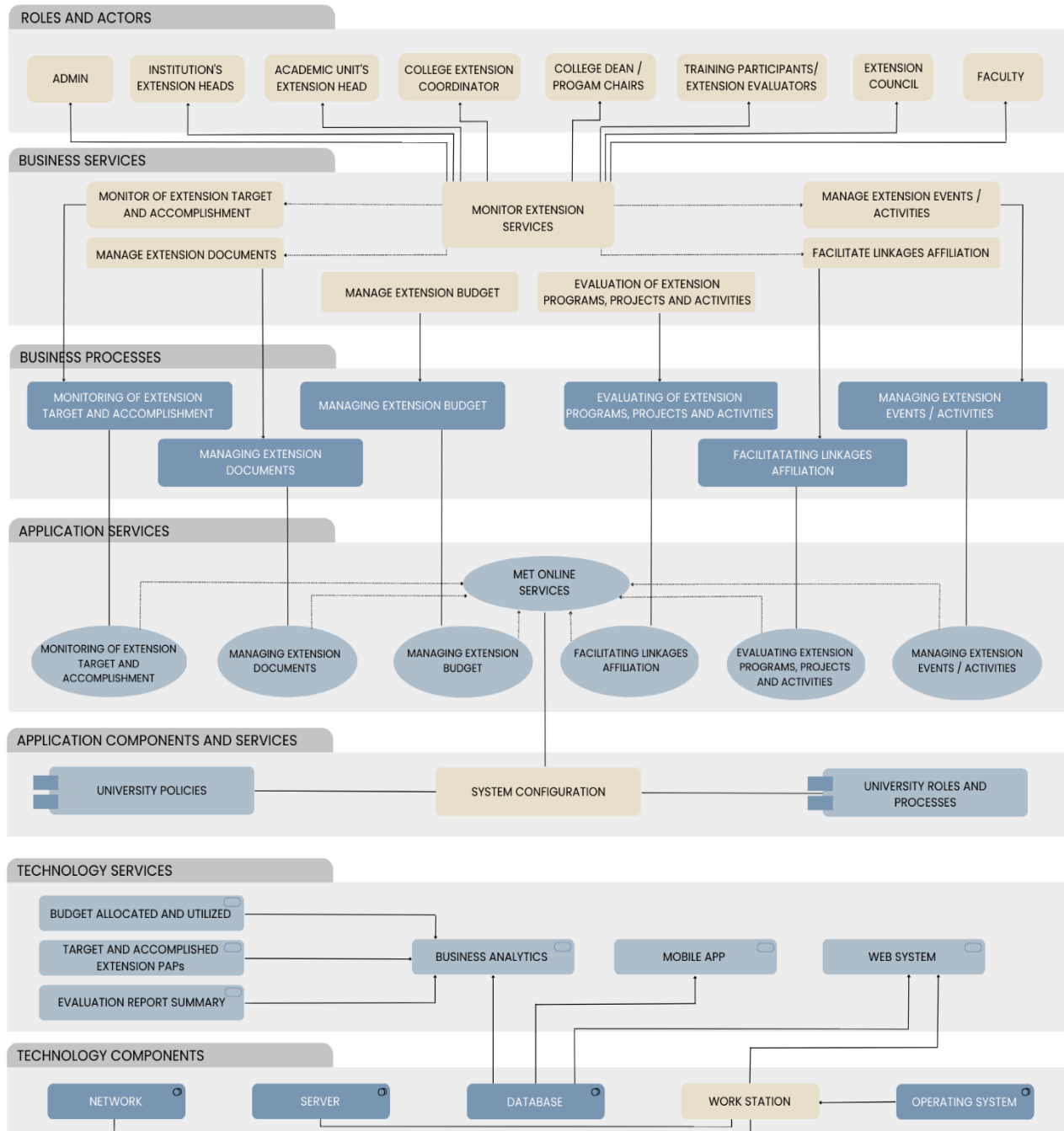


Fig. 1. Technical system architecture

B. Roles and Actors

In order to make the most of and maximize the usability of the system, it displays its contents and components that are employed. MET Online Services is composed of eight (8) major roles and actors to wit: System Administrator, Institution's Extension Head, Academic Unit's Extension Head, College Extension Coordinators, College Dean / Program Chairpersons, Training Participants, Extension Council, and Faculty. The following users have a corresponding role in order to utilize the system.

C. Business and Application Services

The business services / processes; and application services of MET Online Services has six (6) major components embedded in the extension services unit, these are as follows: (a) monitoring of extension programs, projects, and activities (PPAs) target and accomplishment, (b) managing extension services documents, (c) managing extension budget, (d) evaluating the extension programs, projects, and activities, (e) facilitating linkages affiliation, and (f) managing extension events / activities.

D. Technology Services and Components

For the technology services, the developed system is supported by business analytics, mobile application and web service. The business analytics is comprised of target and accomplished extension PPAs, budget allocated and utilized and evaluation report summary, where in technology services of the developed system it is the main feature along with the mobile application and web service.

In order to utilize the functionality of the developed system, the management must provide a secured network, normalized database, and an operating system that is suitable for the system.

IV. RESULTS AND DISCUSSIONS

This study developed a system with descriptive analytics named as “MET Online Services” that will automate and optimize the monitoring of extension services key performance indicators (KPIs) in order to help the institution in making better, data-driven decisions. The dashboards and interactive visualizations of the developed system will provide quick access to the extension activities’ real-time progress. The study is mainly focused on the business analytics of different operations and activities in extension services unit to systematize decision-making in order to upkeep real-time responses. During the development phase, it follows the dashboard development process [41].

The system employs a configurable Key Performance Indicators (Fig. 2) in developing the executive dashboards and interactive visualizations where extension services unit track and monitor their actual accomplishments on annually and quarterly basis. Since the system can be configured for all Philippine Association of State Universities and Colleges (PASUC) institutions, the researchers adopted the standard Major Final Output (MFO) for Extension Services of [42], particularly the key performance indicators, such as: (a) Number of trainees trained; (b) Number of trainees weighted by the length of training; (c) Number of extension programs organized and supported consistent with the SUC’s mandated and priority programs; (d) Percentage of beneficiaries who rate the training course/s and advisory services as satisfactory or higher in terms of quality and relevance; and (e) Percentage of persons who receive training or advisory services who rate timeliness of service delivery as good or better.

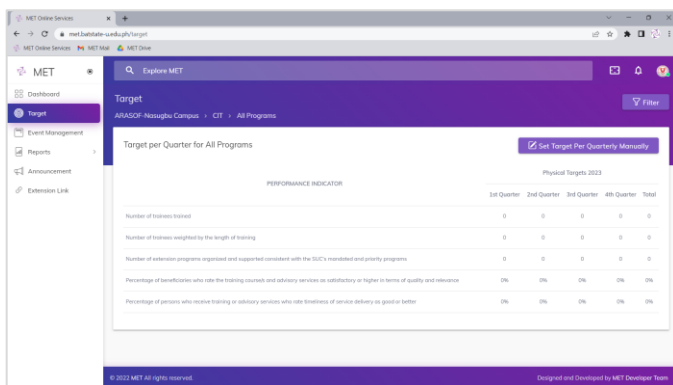


Fig. 2. Configurable key performance indicators

The executive dashboard and visualization features with filtering function [43] as shown in Fig. 3 to Fig. 5, provides the Extension Council, Institution and Academic Unit Heads along with the College Deans and Program Chairpersons with a high-level overview of the state of the extension services in their respective institutions/units/sectors. The system also generates beneficial reports on the extension services indicators which serve as a useful reference for the Office/Individual Performance Commitment Rating (OPCR/IPCR), Performance Based Bonus (PBB) and SUC leveling of the university.

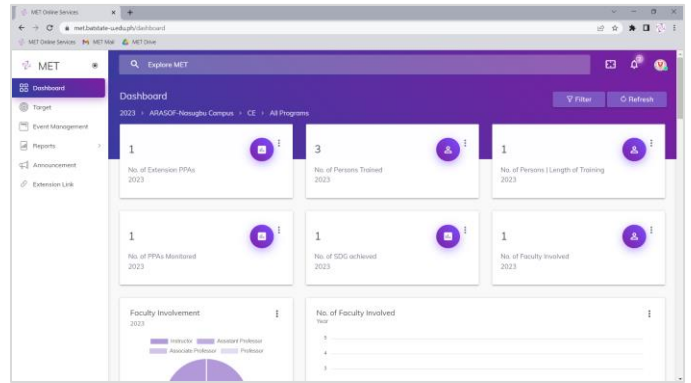


Fig. 3. Dashboards and interactive visualization (scorecards of extension key performance indicators)

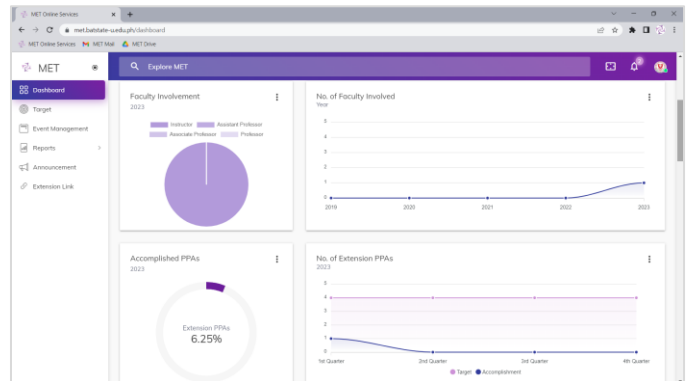


Fig. 4. Dashboards and interactive visualization (charts and graphs of faculty involvement and accomplished PPAs)

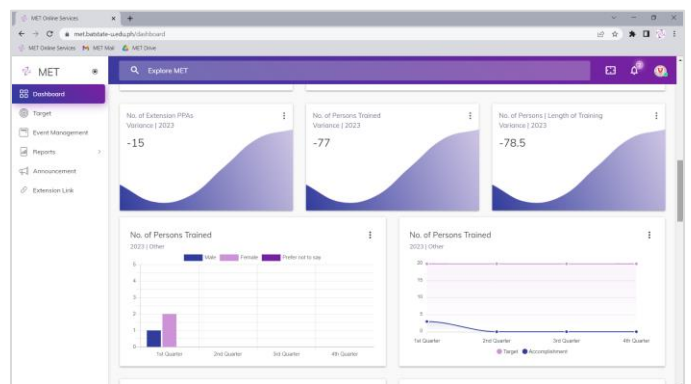


Fig. 5. Dashboards and interactive visualization (charts and graphs of variances and number of persons trained)

In addition to analytics part of the developed system, the following modules are incorporated to simplify the operations in the extension service unit: account management, target monitoring, event management, reports, announcement and extension links.

A. Account Management

The Account Management module grants authorized users the rights to use the various services of the developed system by dividing them into groups and defining their privileges. The administration part of this module not only refers to the administration of the management system but also the administration tasks and information of the extension services unit task force.

Since MET Online Services is applicable also to other extension services unit of any State Universities and Colleges, the administration part of this module as shown in Fig. 6, is capable of configuring the following: information of the extension services unit, name of university with logo, campus/es, college/s, program/s, designation, employment status and academic rank of designated extension service task force, sustainable development goal, and type of community extension service.

Key Performance Indicators and evaluation questions and other settings are also configurable through the system administrator account. This is to fully utilize and accommodate different State Universities and Colleges (SUCs) with an end goal of improving their extension services, operations and transactions.

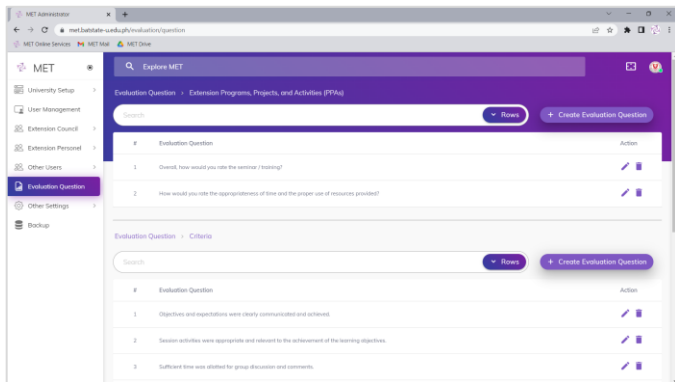


Fig. 6. Administrator account management.

B. Target Monitoring

The Target Monitoring module involves managing and setting performance indicator targets. These transactions are processed by the institution and academic unit's extension heads along with designated college extension coordinators. The system provides a tool for the computation of key performance indicator in setting the target for the number of persons trained weighted by length of training with the corresponding legend for the weights of training (1) and percentage of beneficiaries who rate the training course/s and advisory services as satisfactory or higher in terms of quality and relevance, and timeliness (2).

$$a = b \times d \quad (1)$$

where, a is the number of persons trained weighted by length of training; b is the number of persons trained; and d is the weight of training.

Weights:

Length of Training	Weight
< 8 hours	0.50
8 hours (1 day)	1.00
2 days	1.25
3-4 days	1.50
5 days or more	2.00

$$y = (m/n) \times 100 \quad (2)$$

where, y is the percentage of beneficiaries who rate the training course/s and advisory services as satisfactory or higher in terms of quality and relevance, and timeliness; m is the number of trainees who rate the training course/s and advisory services as satisfactory or higher; and n is the total number of trainees surveyed.

C. Event Management

The Event Management allows the institution and academic unit's extension heads as well as the college extension coordinators to manage all the extension services events / projects or activities. It includes electronic scheduling and task management of different extension activities. The status of each extension projects is automated and accessible on the web and mobile. There will be three (3) projects' status to wit: (a) For Implementation, (b) Ongoing, and (c) Implemented. These stages/statuses are dependent on the duration of the extension projects. It must be noted that once the project is implemented, it will be automatically added to the actual accomplishment. Different forms relevant to the extension services unit processes can be generated from this module, particularly the extension proposal, narrative report, monitoring proposal, and progress monitoring report.

D. Reports

The Reports module is capable of generating monitoring and evaluation reports from the data entered from all the modules of the system including the android application used by the extension participants that evaluates the extension project. This module can be accessed and downloaded by the extension council, institution's extension head and academic unit's extension head, college dean / program chairperson and college extension coordinators (Fig. 7).

E. Announcement and Extension Links

The announcement and extension links page will all the institution and academic unit heads to post and disseminate information to all extension services task forces relative to their regular functions and operations.

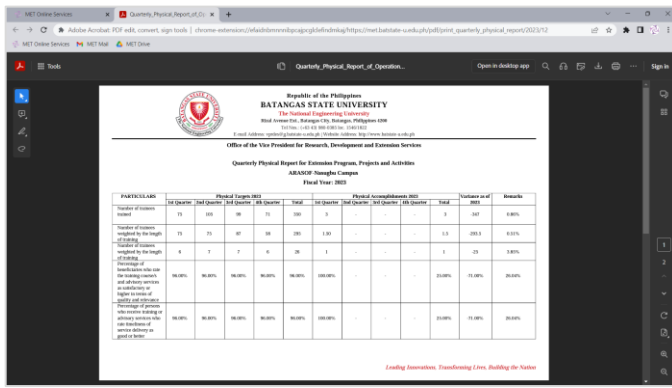


Fig. 7. Sample generated report using the prescribed template of the university

After the system development, a series of test cases and technical evaluations were carried out by a Certified Software Quality Assurance Specialist in order to ascertain, whether the developed system complies with the specified requirements. Software quality assurance (SQA) employs a methodical approach to identify trends and the necessary steps to enhance development processes. Unintended effects might result from finding and resolving coding problems; it is possible to solve one issue while also breaking other features and functions [44]. It can be gleaned from the test cases and technical evaluations as shown in Table I that the developed system is indeed feasible for implementation, proven to be fully-functional and passed the quality software standards set by the software quality assurance specialist.

TABLE I. TEST CASE AND TECHNICAL EVALUATION OF THE DEVELOPED SYSTEM

<p>Test Run Information: Tester Name/s: A.Z. Leynes and J.R.M. Ruiz Date(s) of Test: September 9-13, 2022 Location/server being used: N/A</p>	<p>Software Versions: Application: MET Online Services Browser [used & those COTS supports]: Google Chrome version 76.0.3809.132 (64-bit) Database: mySQL Operating System: Windows 10</p>
<p>Notes and Results: Overall, we can say that this is a big help for all the extension coordinator. In this module you can monitor all the extension services key performance indicators with ease through dashboards and interactive visualizations. The user can also provide the status of each extension services what is the upcoming services, the on-going and implemented. The system can also provide reliable and consistent reports if each college coordinator hit the target accomplishment. On the other hand, the head of the extension services can also monitor all the college coordinator which is hassle free, the head of the extension coordinator will just login filter what college he/she can monitor what is the status of each college coordinator. And for reports the system provides printable reports that can use for documentation.</p>	
Modules	Passed / Failed
Account Management	Passed
Dashboard	Passed
Target Monitoring	Passed
Event Management	Passed
Reports	Passed
Overall Evaluation	Passed

As the system passed the software quality assurance, it is also clear as reflected from Table II that the developed system highly satisfied the users' expectations and requirements in terms of efficiency, functionality, reliability, usability, and security. The satisfaction of the end-users determines that the developed system is acceptable [45] and indeed feasible for implementation. It is also an indicator that the information system is effective when the users are satisfied with its functions and requirements [46, 47].

TABLE II. LEVEL OF SATISFACTION OF THE RESPONDENTS ON THE DEVELOPED SYSTEM

	Criteria	Weighted Mean	Verbal Interpretation
1	Efficiency	4.32	Highly Satisfied
2	Functionality	4.43	Highly Satisfied
3	Reliability	4.30	Highly Satisfied
4	Usability	4.57	Highly Satisfied
5	Security	4.32	Highly Satisfied
	Overall Weighted Mean	4.39	Highly Satisfied

The developed system automates the process of evaluation of the Extension Programs, Projects, and Activities (PPAs) as shown in Fig. 8. By using their mobile devices, the extension participants can evaluate online and raise their suggestions and comments based on the performance of the extension program conducted. It can be gleaned from Table III that the mobile application was highly accepted by the end-users in evaluating the extension programs, projects, and activities.

TABLE III. LEVEL OF ACCEPTANCE OF THE RESPONDENTS IN THE MOBILE APPLICATION OF EVALUATING THE EXTENSION ACTIVITIES

	Criteria	Weighted Mean	Verbal Interpretation
1	Ease of Use	4.30	Highly Acceptable
2	Usefulness	4.32	Highly Acceptable
	Overall Weighted Mean	4.31	Highly Acceptable

In case that the participants don't have mobile devices, the designated college extension coordinators and staff will be tasked to provide and assist the participants in evaluating the extension PPAs using the university's mobile devices or laptop provided by a unique evaluation code which is system generated. Another concern is the Internet connection, since the said developed information system required internet access for the evaluation, the researchers recommend that extension service office assisted by the Information and Communication Technology (ICT) office to provide laptop computers during the activity for the computerized evaluation and once there is already internet connection, the designated college extension coordinators will be the one responsible to sync the encoded evaluation answers to generate the evaluation results and update it online. Hence, there will be a fast and accurate evaluation results immediately after the online evaluation done by the extension participants.

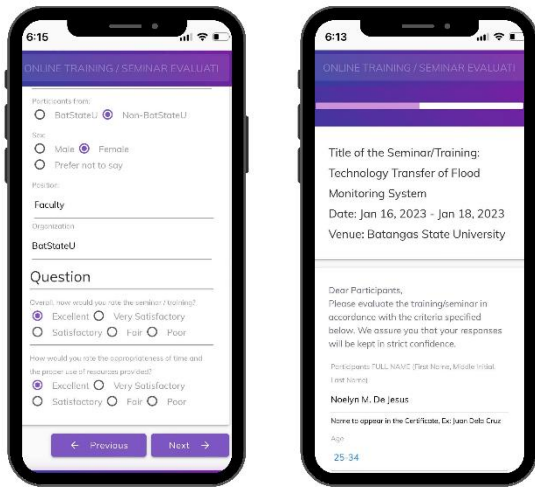


Fig. 8. Mobile evaluation of extensions activities.

V. CONCLUSION

Most Extension Services Unit of SUCs used the manual process of managing, monitoring and evaluating their extension projects. This, most of the time, results in problems related to documents handling/archiving, timely monitoring and evaluation reports, poor management of budget allocation and utilization. The significance of this study is resolving those issues and challenges encountered in the extension services unit of the university by automating its operations and providing quick access to real-time progress of its activities through dashboards, interactive visualization, and reports.

The developed system is indeed feasible for implementation, proven to be fully-functional and passed the quality software standards of a Certified Software Quality Assurance Specialist. As the developed system satisfied the users' expectations and requirements, it would be an effective tool for the institution, extension services unit, and community, to make better strategic decisions and continuously deliver quality services to the community.

VI. FUTURE WORK

It is suggested that future research should incorporate the evaluation for faculty involvement in extension which can be significant in the evaluation and promotion of faculty using the Qualitative Contribution Evaluation (QCE) instrument of the National Budget Circular (NBC) No. 461.

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