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Information management system for research of Don Mariano Marcos Memorial State University–South La Union Campus

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ABSTRACT

This study aimed to develop an information management system for research (IMSR) for the South La Union Campus of Don Mariano Marcos Memorial State University. The descriptive-developmental research design was applied, and the rapid application development model was used in the system development. An interview was conducted and ISO/IEC 25010-based questionnaire was employed. Respondents consisted of 37 faculty members and five (5) research office personnel. The researchers were able to develop the intended IMSR and were able to check its acceptability revealing that the system was very acceptable based on the measurement criteria of the ISO/IEC 25010 as to the following characteristics: functional suitability, reliability, usability, efficiency, maintainability, portability, compatibility, and security. The overall result was found that the IMSR is a deployable functional information management system in enhancing the research operations.

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1. INTRODUCTION

Throughout the years, higher education institutions have encountered social and economic conditions that have shaped research, innovation and extension. Under republic act 7722, an act forming the Commission on Higher Education specifies that the information society or knowledge economy characterize the university as a source of knowledge, cultural transmitter, as educator of young minds and as a significant agent of economic development [1]. Research is one of the University's four-fold roles recognized in the 1997 higher education reform act (RA 8292) in terms of intensifying academic facilities along with extension and higher education, to provide better quality education and middle and high-level workforce growth. This act also promotes the establishment of the State, Universities and Colleges (SUC) research centers to facilitate growth. Higher education institutions in the Philippines tend to face challenging problems at various stages of academic enterprise. One of the concerns is upgrading their physical resources and research infrastructure. With this situation, the need for the development of an information system is necessary to facilitate and manage SUC's research data.

Data grow in terms of volume, variety, velocity, and value. As a possible result, data is anywhere and requirements change then data design changes. Therefore, suitable approach with new paradigm and methods of data modeling needs to be enhanced to solve the problems in the real world [2]. The role of information management is also central to the increasing effect paradigm, with a body of information for various stakeholders that is rapidly growing and reconfiguring [3]. In generating economic and social growth, research and development (R&D) plays an important role. Research is a central operation within higher

education and constitutes a substantial revenue source for many institutions. Their study introduces a web-based software framework that supports institutional research management, built on Java technologies and provides decision support to HEI faculty members [4]. Information systems in research are very important for higher education institutions in collecting and storing big data on research activities and outputs of researchers. It is also valuable to research institutions to connect their research activities with the global, providing opportunities for regional, national and international sharing and benchmarking [5]. With the big volume of data, information may easily be extracted through proper data analytics which conventional analytics and business intelligence solutions may not be able to handle. The big data analytics thus minimizes the accompanied computing workloads which may be time consuming and energy and resource inefficient [6].

Recently big systems have consisted of several servers and terabytes of information. To assist administrator's appraisals, information system (IS) displays precise data. Information technology and information system have been widely applied in science research such as health science, biology, agriculture [7]. Likewise, information systems could provide quality to different institutions and organizations to improve the quality of research information [8]. At Don Mariano Marcos Memorial State University (DMMMSU), the campus research office is responsible for consolidating research reports for submission to the university from all its six (6) colleges. It also manages the University's R&D projects and activities in compliance with the implementation of the approved research programs and the objectives of the various colleges. However, it normally takes a long time to generate the necessary reports because there is no current information system, and most of the reports and data are stored in printed copies. Therefore, there is a need to build an information management system to provide accurate, complete, and usable information. Using this tool, the information and data required by the campus research office are efficiently retrieved and report generation is facilitated.

The 2030 agenda for sustainable development claims that Information and communication technologies (ICTs) can accelerate the development progress of human beings, and may bridge the digital gaps. They could be the key catalysts to all of the above sustainable development goals. Several studies have been implemented that are able to produce significant benefit to the economy such as the study on the spatial-decision-support system techniques based on geographic information systems which is a useful software tool to the developing countries as cited in Wu *et al.* [9]. This falls under the dimension of economic and technological development in the sustainable development goals (SDG) and pertains to sustainable industrialization and foster innovation. Relatively, the development of Information management system for DMMMSU-SLUC research office could serve as a great tool in providing innovation in the research unit of the university thereby improving its operations as to data management.

This research study aimed at achieving the following: (1) to develop an information management research system using rapid application (RAD) model, and (2) to determine the level of acceptability of the developed information management system using the International Organization for Standardization /International Electro-technical Commission (ISO/IEC) ISO/IEC 25010 Standards, as to functionality; reliability; usability; efficiency; maintainability; portability; compatibility and security. The evaluation utilized the calculation of the quality aspect with reference to international standards of measurement. ISO/IEC 25010 as a measurement quality model has a complete measurement dimension including functional suitability, reliability, performance efficiency, and other quality measurement criteria [10], [11].

2. METHOD

2.1. Research design

The researchers used descriptive and developmental research designs in completing the study. The researchers conducted interviews to identify the functional and non-functional requirements. On the other hand, developmental research is unique in its emphasis on designing, creating, and testing instructional products and processes [12]. For the development of the system, the researchers employed the rapid application development (RAD) model as identified by Fatima *et al.* [13] as the finest model in the development sector. They also mentioned that it involves a fast prototype generation approach that requires minimal planning with more customer satisfaction and less time consumption. The RAD model, adopted from James Martin (1991), served as the guideline in the development of the Information Management System as shown in Figure 1. This is a method used for structuring, organizing and managing the process of designing an information system. The product quality model defined in ISO 25010 includes eight (8) quality characteristics which are functional suitability, reliability, performance Eeficiency, usability, maintainability, security, compatibility, and portability, and 31 sub-characteristics as shown in Figure 2.

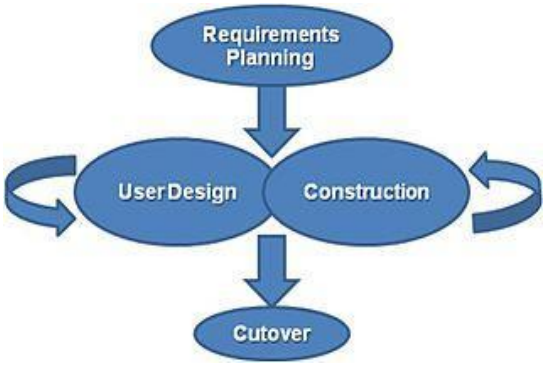

Figure 1. The RAD model by James Martin (1991)

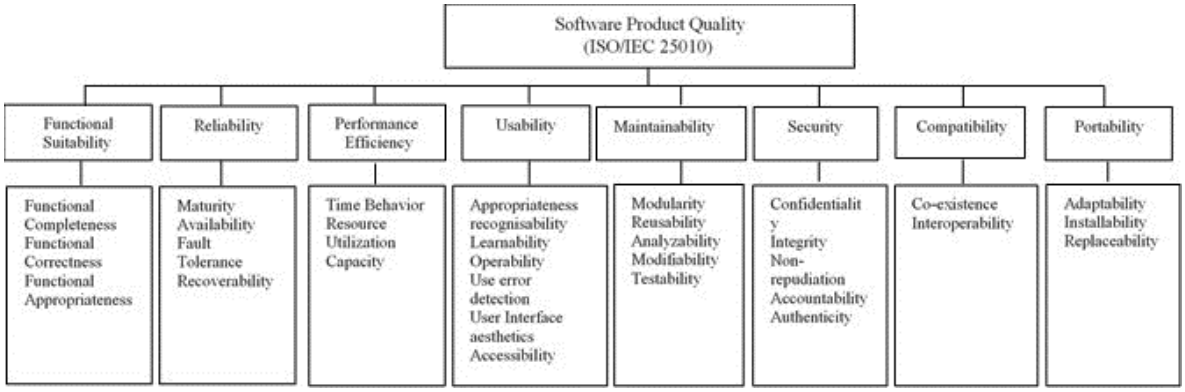

Figure 2. ISO/IEC 25010 for internal and external quality

A study states Franca and Soares [14] that functional suitability refers to the extent when the system is able to provide the users their needed functions, while, efficiency in performance is based on the amount of resources used compares to the output produced. They also defined compatibility as a degree to which a product can exchange information with other products and/or perform its required functions while sharing the same hardware or software environment. Usability refers to the degree to which a given product or program is able to achieve its defined goals with effectiveness, performance and satisfaction, while reliability is the extent to which a product performs its functions under specified conditions. Security is the degree to which a product maintains information and data such that the degree of data access is sufficient to their category. Maintainability refers to the degree of quality of the product such that it can be changed to enhance, correct or adapt to changes. Portability to the possibility of the product to be transferred from one hardware, software or other operational or usage environment to another.

2.2. Participants

This study was conducted at the campus research office of Don Mariano Marcos Memorial State University – South La Union Campus in Agoo, La Union. Table 1 presents the distribution of respondents. The researchers considered thirty-seven (37) faculty members and five (5) non- teaching research personnel from the research office as respondents. The faculty members are with completed research and with or without ongoing research. The researcher employed surveys through social media platforms and Google forms to facilitate distribution, retrieval and easier evaluation of the system.

Table 1. Distribution of respondents

Respondent group	Number of respondents
Faculty member	37
Research office personnel	5
Total	42

2.3. Materials and procedure

The RAD model used in the system development consists of four (4) phases: planning specifications phase, user design phase, construction phase, and cutover phase.

a. *Requirements Planning Phase.* All of the system's necessary specifications were defined in this process. The researchers conducted an interview with the Research Head and staff to identify the difficulties encountered and suggested a solution by getting the necessary information and desired specifications of the system.
b. *User Design Phase.* At this point, the researchers designed the system and data requirements in system development. The researchers conducted a patent search to look at the different features necessary to build the system in this process. They also specified the design, configuration and approaches of the system that should be followed to meet the stated requirements of the client.
c. *Construction Phase.* This process was when programming and creation of software, coding, unit-integration and system testing took place. The researchers applied PHP, CSS, Bootstrap, and JavaScript as their front end and MySQL as the backend that served as a tool for storage, security, and easy information retrieval to track the faculty researches submitted.
d. *Cutover Phase.* This is the implementation phase that includes data conversion, testing, and changeover to the new system, as well as user training. It is when all final changes are made while the coders and clients continue to look for bugs in the system.

The data collected in this study was interpreted and analyzed using frequency count and median. With this, the researchers came up with more detailed information that served as their guiding principle in taking the different steps towards the completion of the analysis. The researchers used a five-point Likert scale to assess the acceptability level of the proposed system.

3. RESULTS AND DISCUSSION

3.1. The developed IMSR

The researchers developed an information system named as information management system for research (IMSR) of South La Union Campus of the Don Mariano Marcos Memorial State University. The system will facilitate report submissions and monitor research of the different colleges. This system will provide services to research facilitators, faculty researchers and non-teaching personnel and administrators. The system features were based on the data consolidated during interviews including the process flow provided by the Research Head.

There are three (3) users of the system: the research head being the administrator, the college research facilitators, and the faculty researchers. The research head being the administrator is able to i) improve content of the system by posting updates and announcements; ii) secure and manage account users; iii) assist guest requests; and iv) track research proposals and status. By these functions, both the system administrator and researchers will be updated every time they use the system. While, the college facilitators can: i) inform researchers for updates and ii) track the progress of researches based on the submitted reports or documents by the faculty researchers, useful in generating reports submitted in the campus research office. Lastly, the faculty researchers can: i) submit and upload research outputs and required reports to the facilitator and ii) monitor the status of their research.

3.2. Level of acceptability of IMSR

Table 2 presents the level of acceptability of the developed research information system based on ISO/IEC standards. Overall, the median rating of 4.00 indicates that the system is acceptable. A study states Sekhon *et al.* [15] acceptability as an essential to measure the effectiveness of an intervention, although not sufficient. The successful implementation depends on the acceptability of the intervention to both intervention deliverers (e.g. developers, researchers) and recipients or users.

Functionality measures the functional completeness, correctness and appropriateness of the developed system. Based on the median rating of 5.00 the system developed has very acceptable functionality. The services of the campus research office were covered and designed for specific processes to facilitate accurate completion of tasks. In these times when most use the Internet and get into online communication, online communication replaces face-to-face communication. The findings in a study on health information web sites [16] show that the users give a higher priority to functionality and its factors. This functionality is an essential consideration in a system.

Reliability measures the maturity, availability, fault tolerance and recoverability of the developed system. The median rating (4.0) obtained indicates that the IMS has acceptable reliability. The respondents as system users found that whenever they request information concerning the research process, they also expect to receive a response. In a study where deep neural networks in healthcare applications were used [17], it emphasized that reliability should be remarkably high, because even a small error in the applications can lead

to injury or death, similarly, a low reliability in the system may cause a not so good result. While, availability was acceptable (4.0) because the system included the services offered by the research program of the University. Fault tolerance was likewise very acceptable for user-respondents due to the presence of services that could create strategies in case of failure on hardware and software. And, recoverability measures the ability of the system to recover in cases of interruption and failures. The developed system has very acceptable recoverability indicating that the system has met these criteria of ISO/IEC standard.

Table 2. Level of acceptability of the IMSR

Characteristics	Sub-characteristics	Median rating	Descriptive rating
Functional suitability	Functional completeness	4.0	Acceptable
	Functional correctness	5.0	Very Acceptable
	Functional appropriateness	5.0	Very Acceptable
	Sub-median	5.0	Very Acceptable
Reliability	Maturity	4.0	Acceptable
	Availability	4.0	Acceptable
	Fault Tolerance	4.0	Acceptable
	Recoverability	4.0	Acceptable
	Sub-median	4.0	Acceptable
Usability	Appropriateness recognizability	4.0	Acceptable
	Learnability	4.0	Acceptable
	Operability	4.0	Acceptable
	User error protection	4.0	Acceptable
	User interface aesthetics	4.0	Acceptable
	Accessibility	4.0	Acceptable
	Sub-median	4.0	Acceptable
Efficiency	Time behavior	4.0	Acceptable
	Resource Utilization	4.0	Acceptable
	Capacity	4.0	Acceptable
	Sub-median	4.0	Acceptable
Maintainability	Modularity	4.0	Acceptable
	Reusability	4.0	Acceptable
	Analyzability	4.0	Acceptable
	Modifiability	4.0	Acceptable
	Testability	4.0	Acceptable
	Sub-median	4.0	Acceptable
Portability	Adaptability	4.0	Acceptable
	Installability	4.0	Acceptable
	Replaceability	4.0	Acceptable
	Sub-median	4.0	Acceptable
Compatibility	Co-existence	4.0	Acceptable
	Interoperability	4.0	Acceptable
	Sub-median	4.0	Acceptable
Security	Confidentiality	4.0	Acceptable
	Integrity	4.5	Acceptable to Very Acceptable
	Non-repudiation	4.0	Acceptable
	Accountability	5.0	Very Acceptable
	Authenticity	4.0	Acceptable
	Mean	4.0	Very Acceptable
	Grand Mean	4.3	Very Acceptable

Usability measures the appropriateness recognizability, learnability, operability, user error protection, user interface aesthetics, and accessibility of the developed system. Based on the respondents' evaluation, the developed information system was acceptable in terms of appropriateness recognizability. It indicates that users have recognized the services that are appropriate for their needs through a service description. While, the user-respondents' acceptable rating on learning criteria suggests that the developed system contains a service feature that facilitates understanding of its operation. In the case of operability criteria, the acceptable rating indicates that the developed system consists of a service containing web services description language (WSDL) that allows document exchange messages between services. The developed system features a user error protection, which obtained a very acceptable rating. Both criteria on user interface aesthetics and acceptability were rated very acceptable by the user-respondents. Overall, the developed IMSR system has a very acceptable usability based on ISO/IEC standards. Though it is difficult to develop interactive computing systems that meet all user specifications, usability is still very important to be considered [18]. A study on cloud storage states that usability is regarded as the key performance indicator based on user's satisfaction [19]. It is then very important that a system has a good usability result.

Efficiency of the developed system was evaluated based on time behavior, resource utilization and capacity criteria. Based on the ratings obtained, the developed system features time in request processing and in returning a response. The system used services and resources to access information. The developed system has n adequate capacity that is able to remain working even with a simultaneous access at the same time.

Maintainability measures the modularity, reusability, analyzability, modifiability, and testability. Based on the ratings obtained in this criterion, the developed system is found to be acceptable. It is important that system maintainability is taken into consideration as several studies [20]-[22] regard this characteristic as a technical requirement or as a system quality attribute. Portability measures the adaptability, installability, and replaceability of the developed system. Based on the results, the developed system has an acceptable rating. The services can run on a server even when the platform changes. Compatibility measures the co-existence, interoperability and confidentiality. The developed system features different composite services where the users can share the same operations and allow services along interaction through the use of interfaces.

Security measures the systems confidentiality, integrity, non-repudiation, accountability, and authenticity. Activities like data sharing or data transferring are done online nowadays. This however, puts the users and data in some security concerns. The information transferred via a wireless network is prone to attack. The need for security therefore has increased with the increase of the need to transfer data [23]. Security concerns are important in an information system, both at technological and organizational levels [24]. Information security is a critical problem for individuals and organizations because it leads to great financial losses [25], and other possible losses, that is why, solutions to security through adopting mechanisms is very appropriate. In the developed IMSR, only authorized clients or users can access the information shared by the system. The system services are developed for unauthorized access or modification of data. Strategies were integrated to prove that the information has been delivered to users. The developed system is found to be acceptable along this characteristic.

4. CONCLUSIONS

It could be noted that the developed IMSR is achievable using the rapid application development (RAD) model in software development with consideration to the functional, non-functional and user requirements; and that said IMSR is an acceptable functional information management system that can facilitate the coordination, submission, monitoring, and report generation on research, which could enhance the research system of the Campus.

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