

System for Managing research and publication: Model-View-Controller Approach

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Abstract: Without a proper record system, it becomes difficult for the Research Management Centre (RMC) of higher institutions to monitor the progress of the research project in terms of budget used, percentage of completion and output from the research. It also became difficult for the RMC to gather accurate information to produce reports for Malaysia Research Assessment (MyRA) and Rating System for the Malaysian Higher Education Institutions (SETARA) rating. In a simple sense, efficient and orderly management is of utmost importance (Aminah et al., 2021; Azlisham et al., 2021; Saadiah et al., 2021; Firkhan et al., 2021; Ishak et al., 2021; Ashari et al., 2021). Efficient management is also capable of standardizing the administration and collection of important documents (Norazmi et al., 2019; Fauziyana et al., 2020; Norazmi, 2020; Zaid et al., 2020; Zaid et al., 2021; Mustafa et al., 2021). In addition, organized management also facilitates researchers or users to obtain accurate and fast resources (Mohd Norazmi et al., 2021; Rosnee et al., 2021; Roszi et al., 2021; Nik Nurhalida et al., 2021; Een et al., 2021; Yusaini et al., 2021)

1.0 INTRODUCTION

Research activity is among the core output of any higher institution besides producing quality students. Every year there will be a lot of research funds offered by the institution itself, the Ministry of Higher Education or various government and private agencies. Output from the research will be the publication. At the end of the year, the number of research and publications will contribute to the part of measurement values of academicians' performance evaluation (Suryani et al., 2013).

Without a proper record system, it becomes difficult for the Research Management Centre (RMC) of higher institutions to monitor the progress of the research project in terms of budget used, percentage of completion and output from the research. It also became difficult for the RMC to gather accurate information to produce reports for Malaysia Research Assessment (MyRA) and Rating System for the Malaysian Higher Education Institutions (SETARA) rating. In a simple sense, efficient and orderly management is of utmost importance (Aminah et al., 2021; Azlisham et al., 2021; Saadiah et al., 2021; Firkhan et al., 2021; Ishak et al., 2021; Ashari et al., 2021). Efficient management is also capable of standardizing the administration and collection of important documents (Norazmi et al., 2019; Fauziyana et al., 2020; Norazmi, 2020; Zaid et al., 2020; Zaid et al., 2021; Mustafa et al., 2021). In addition, organized management also facilitates researchers or users to obtain accurate and fast resources (Mohd Norazmi et al., 2021; Rosnee et al., 2021; Roszi et al., 2021; Nik Nurhalida et al., 2021; Een et al., 2021; Yusaini et al., 2021).

Given the above problems, a new digitalized system named Sistem Penyelidikan Universiti (SPU) was developed as one of the Total Campus Management System (TCMS) modules. The main objective of the development of the SPU system is to synchronize the whole process of research and publication in the institution into a digitized platform. It will benefit all stakeholders involved in the research processes. They are:

1. Research Management Centre
The centre will have an updated record of all research progresses in the institution. Information on past research projects will also easily be accessible by the centre. Besides that, any recommendation and approval process will be through the SPU system thus making it faster and paperless.
2. Researchers.
By updating their research and publication regularly together with their research progress, researchers can avoid the last minutes of preparing updates when asked by RMC. At the same time, RMC can easily monitor any research-related activities such as progress, Intellectual Property registration or a Memorandum of Understanding done by the researchers. Any advance requisition or claim will be done through the SPU system

- thus making it easier for the researchers to keep track of the application without having to contact the relevant departments.
3. Faculties.
Faculties will be benefited from the SPU system where they can progressively monitor the Key Performance Index of its staff regarding the research section. Faculties can also prepare needed reports using the SPU system as compared to manual preparation done previously.
 4. Corporate Governance and Quality Assurance (CGQA) unit.
The task of the CQGA unit in compiling reports and information regarding research to be submitted to SETARA will be faster and more accurate.
 5. Treasury office.
With no more manual checking and approval steps needed with the introduction of the SPU system, the communication between the treasury office and the researchers or RMC will be more effective. By updating process claims through the system, any feedback will be automatically triggered to the researchers or RMC through the system and email.
 6. Human resource department.
The department can easily access the system to review any research and publication produced by all staff for the current and past years. With the digitalized SPU the department can check by themselves for any supporting documentation needed to approve staff application for attending a conference, eligible leave for attending conference or meeting and much more.

This project was looking for a software development approach or framework that enable sharing, reusing, integrating, and monitoring all the coding for the system. After a long study, finally, the project team decided to go for the MVC approach. MVC approach has been widely used for designing interactive software system architectures (Mensah, 2018). The MVC method works are to separate three main components such as data manipulation (model), display/interface (View) and the process (Controller) so that it is more neat, structured, and easily developed for integration (Andri Sunardi and Suharjito, 2019). The MVC approach is best for software framework such as Laravel (Olanrewaju et al, 2015).

2.0 LITERATURE REVIEW

Facilitation of research, dissemination of knowledge through education, imparting training and contribution to society are some of the goals set by the Institute of Higher Learning (IHL) for its research and development department (Pandey & Pattnaik, 2016). Hence, most IHL commits to the development of a system specifically focusing on achieving these objectives.

The research management system is essential for IHL. This is due to the needs of having accurate records of research at any time for supporting IHL operations. Some researches related reporting are mandatory for the Ministry of Higher Education or other third parties for evaluation of the IHL. Zambonini (2016) highlighted functions of the research management system as to:

- i) discovery and capture of information, data and evidence.
- ii) organization and management of information.
- iii) coordinate people and processes
- iv) measurement and monitoring.

For this project, a research management system named *Sistem Penyelidikan Universiti* (SPU) will be developed using a Laravel based system which will be integrated with the current financial and human resource system for the IHL. The main objectives of the system are to allow the management of research grants and publications. Laravel has been chosen as the development tools for this project due to its development efficiency compared to traditional web design. Some of the Laravel capabilities include standardization of development process, a non-business logic relationship that is processed automatically and its scalability (Parkar et al., 2016).

Laravel is based on the Model View Controller pattern which is shown on the following diagram:

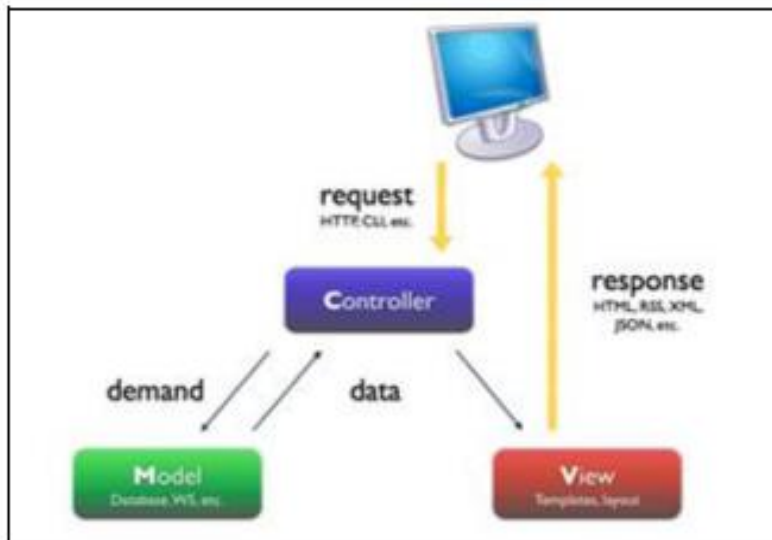


Fig. 1 The MVC pattern (Glorfindel, 2019)

MVC pattern is divided into several roles which are Planning, Requirement Elicitation, Requirement Analysis, System Design, System Development, and finally System Verification and Validation. It allows for low code development where roles for development taken by an experienced programmer (Al, 2007). In producing the MVC approach, the user plays a decisive role and participates in the formation of preparing requirements and system or prototype development (Al-Husseini & Obaid, 2018).

3.0 METHODOLOGY

To elicit exact and complete requirements from the users, a series of focus group interviews have taken place periodically face-to-face and online. The face-to-face approach is utilizing physical meeting and presentation. Online meeting utilizes video conferencing tools such as Microsoft Teams, Google Meet, and Zoom especially in the times of Movement Control Order enforced by the Malaysian government due to the COVID-19 pandemic. Video conferencing technologies that run on Voice over Internet Protocol via synchronous communication is a powerful and nowadays a well-accepted avenue for meeting interviewees or respondents (Lacono et al., 2016). The method is timesaving, at the comfort of home or workplace, and supports meeting recording that enables playback useful for reference and proof. Focus group interview is a methodology of data collection that depends on the interaction of group members to collectively formulate answers toward researchers' questions in pursuit of acquiring knowledge, experiences, perceptions, opinions, and feelings (Rosenthal, 2016). In the case of SPU, the focus group interview refers to the interviews targeting expert users who are currently in charge of the research management activities. Experienced users are also engaged in this interview owing to their invaluable past knowledge and insights. They contribute by introducing new processes, detailing or simplifying existing processes, and recommending innovative solutions among others. The group of Assistant Registrars, Assistant Administration Officers, Finance Officers, and academicians are the main input collectors of SPU as they are the frontlines of research management activities at the university. During the interview, documents related to the processes were collected for document analysis and reference in understanding and designing the system.

The users' inputs gathered out of the interviews are interpreted, analyzed, and formalized into a controlled versioning document called User Requirements Specifications (URS). Among key findings in the URS of SPU are the business functions diagrams of research stakeholders in the company with the process flowcharts of their research management activities. These are drawn by the open-source diagrams.net software which was formerly known as draw.io. All these artefacts are presented back to the users including the descriptions of their roles and the details of research management processes for evaluation, finalization, and approval. Apart from tackling issues arising at the early stage, this exercise was to ensure all the requirements collected for the preparation of a subsequent document named System Requirements Specification (SRS).

Six stages of development will be employed that are: Planning, Requirement elicitation, Requirement Analysis, System Design, System Development and System Verification and Validation. Figure 2 organizes the entire development process of SPU.

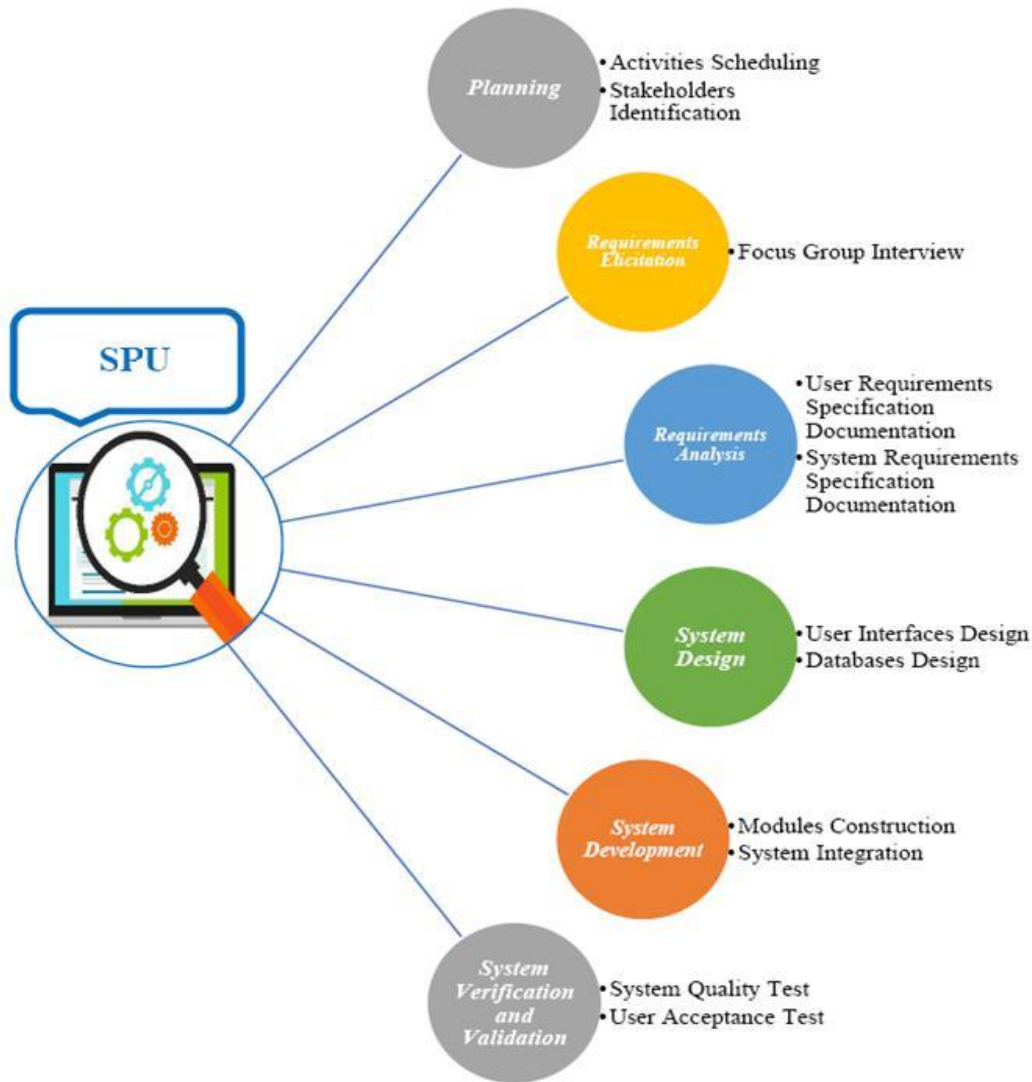


Figure 2: Development process of SPU

4.0 DATA COLLECTION AND ANALYSIS

The data collection was designed to cover university needs related to managing research records especially in providing reports to external stakeholders MyRA and SETARA. The data collection team consists of one business architect and one senior programmer. The data collection took around 6 months to complete provided the tasks conducted in parallel with other current operational tasks assigned to the team. The advantage of the data collection team is that the business architect is also a researcher and academican in the university that has been went through research processes such as research grants applications, applications for conferences, applications of extension of grants, submission of research progress, submission of change leader/members and retrieval of research key performance indicator.

The data collection of this project was conducted from 6 internal units in the university, which work with RMC as mentioned earlier. A total of 12 staffs involved from the 6 internal units. The focus group protocol was set in

advance and set of questions was drafted to guide the sessions. Meanwhile, business architect who conducted the interview sessions set the date, time, and venue of the sessions according to stakeholder preferences. Probing was also used to get the desire result. Field notes was used to jot down the requirements and for further references later. Relevant documents such as forms, standard operating procedures (SOP), sample of letters and sample of reports was collected for analysis of requirements and references.

Few times or cycle of iterations was conducted with each group. This is to ensure Business Architect get good understanding of the input, processes, and output of the system. The field notes and documents were referred and translated into user interface design and database design using Model View and Controller (MVC) approaches: **Model** (data storage, integrity, consistency, queries & mutations), **View** (presentation assets & code), **Controller** (receive, interpret & validate input; create & update views; query & modify models).

5.0 RESULTS AND DISCUSSION

The current business functions through a business function modelling diagram of managing research has been divided into four main categories that are:

- a) **Research Information Data Entry**
Collect various form of research information (various publications, conference, awards, pattern, commercial, know-how, intellectual property, spin-off and research collaboration)
- b) **Research Grant Applications**
Automate internal research grant applications and record important information for external research grant applications. Include grant application evaluation process.
- c) **Managing Research**
Manage the process financial allocations and grant progress status. Managing research groups. Application for conference presentation. Application for extending research duration.
- d) **Generate Report**
Main reporting will be MyRA and SETARA reporting. Other than that every stakeholders will be having their own set of searching and reporting.

Users of SPU are from various post and units in the university and have specific roles in the research management system processes. The list of SPU users and their roles is as listed in Table 1.

Table 1: List of SPU Users and roles in SPU

Users	Description of roles in SPU
Administrator	An administrator is a user who manages the authority of a user account
Researcher	Researchers need to record, update and monitor the progress of activities or application process, review and approval related to the research conducted. .
Assessor of grant application	Grant application evaluator is a researcher appointed to evaluate and refine the researcher's grant application. The evaluator will comment on the application for improvement of the application.
RMC	RMC needs to review, monitor and update research information based on the current status of ongoing activities and processes. RMC also needs to gather information on research, edit and issue MyRA reports.

Director of RMC	The RMC Director can view grant information and approve applications for advances, adjustments and purchases not exceeding RM2999. For a total grant application of RM3000 and beyond, the RMC director may or may not support the application. The RMC Director will also support grant applications as well as applications for presentation of academic results.
Deputy Vice Chancellor (Academics, Research and Industry Networking) (TNCA)	TNCA can view research advance application information and approve advance applications, adjustments and purchases starting from RM3000 and above. TNCA may also support applications for presentation of academic results.
Treasurer's office	The Office of the Treasurer (research division) needs to review the documentation requirements of advance applications, adjustments, purchases as well as applications for presentation of academic results supported or approved by the RMC director. Completed forms and documents will be processed according to the next process flow for approval. After approval is obtained from RMC/TNCA/NCP/Treasurer, the treasurer's office will make a final review before payment is made..
Treasurer	The treasure will review and approve payments related to advance applications, adjustments, purchases as well as applications for presentation of academic results that have been approved by RMC/TNCA/NCP.
Faculty	The Dean/Deputy Dean of Research and Postgraduate/Head of Department must support the application for the Smart research grant as well as support the application for the presentation of academic results. The research administrator at the faculty, namely the Deputy Dean of Research and Postgraduate or the appointed staff must issue a report on the researcher for the respective faculty according to the department and researcher.
Deputy Director of Corporate Governance Unit, Office of Governance and Quality Assurance @ Corporate Governance and Quality Assurance (CGQA).	These users need to obtain research information from RMC and issue a research - related SETARA report.

Researcher Dashboard

The Model-view-controller (MVC) ARCHITECTURE is mapped and co-responded with the business process. The sample page for the Research Interface is shown in Table 2 which depict the actual process that takes place in the intended system.

Table 2: Researcher Dashboard

MVC ARCHITECTURE	REQUIREMENTS DETAILS
VIEW (User interface/Form)	User Interface : Research Validation: NIL

<p>CONTROLLER (process – to complete user action and manage business logic)</p>	<p>This page will enable the researcher to do the following:</p> <ol style="list-style-type: none"> 1. Add new record 2. Edit the existing record 3. Delete the record 4. Exit from the form. <p>Other processes involved:</p> <ol style="list-style-type: none"> 1. The page will load the list of specific researcher information and relevant research information that are (menu): <ol style="list-style-type: none"> i) Research Information (Head and members) ii) Other research information (Publications, Awards, Patents, Commercials, Know How, Intellectual Property, Spin Offs, Joint Research) 2. Research Information contain link to research information and finance information 3. Other research information contains tabs to display all of the information
<p>MODEL (business logic & properties)</p> <p>(Note: for repetitive identical model, do not repeat, just write the referral page number on the requirements details column)</p>	<p>Work registration data Dashboard link to table: Staff, Publications, Awards, Patents, Commercials, Know How, Intellectual Property, Spin Offs, Joint Research</p>

6. CONCLUSIONS

Research and managing publications are some of the central outputs of any higher education institution. It becomes challenging for higher education's RMCs to track the success of research projects in terms of expenditure spent, percentage completed, and research production without a proper record system. It is more difficult for the RMC to gather reliable data to generate reports for MyRA and SETARA) rating systems. The fundamental goal of the SPU system's creation is to transform the current institution's research and publication phase into a digitized platform that would be beneficial to all stakeholders.

Decision of developing the SPU using MVC approach is contra from traditional designing system using system analysis and design approach. It is simpler and shorten the process of logical design. Anyhow, as a newcomers to MVC, the team has facing challenges to change from traditional approach to MVC approach, especially for senior software development team that has been working with traditional approach.

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