

Optimizing Research Grants: Leveraging Technology and UAT for Enhanced Data Management

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Abstract

The rapid evolution of technology continues to shape various aspects of our daily lives, offering innovative solutions to complex human challenges. As technology becomes more widely accepted, users often gain new experiences and adopt approaches that better suit their evolving needs. At Universiti Poly-Tech Malaysia (UPTM), lecturers are awarded research grants biannually to fund projects to foster experimentation and develop new tools. However, managing these grants can be challenging due to the need for accurate data handling, budgeting, and secure storage of sensitive information. An effective management system is crucial to ensure that data remains safe and accessible only to authorized users. A Research Management System (RMS) was developed using a web-based framework and Firebase Real-Time Database to address these challenges. The system, designed to centralize essential functions, including storing information on principal investigators, co-investigators, fund accounts, and essential documents, has significantly improved the management of research grants for lecturers. The success of the RMS can be attributed to the Agile Software Development Model, a methodology that played a crucial role in expediting development and ensuring flexibility. This paper focuses on the User Acceptance Testing (UAT) phase of the RMS, a critical step in software verification and validation. The UAT process ensures that the system meets user expectations, functions as intended, and addresses all previously identified issues. Implementing this system has streamlined the overall workflow and enhanced the experience of managing research grants for the lecturers.

Keywords: *Research Grant, Management System, Web-Based, Software Verification, User Acceptance Testing, Firebase Real-Time Database.*

Introduction

The rapid evolution of technology continues to transform various aspects of daily life, providing innovative solutions to complex challenges. As new technologies gain widespread adoption, they introduce experiences and methodologies that better align with users' evolving needs [1]. This is particularly evident in higher education, where effective research management is essential, especially when substantial funding and project coordination are involved [2].

At Universiti Poly-Tech Malaysia (UPTM), lecturers receive research funds twice annually to support the development of experimental tools and innovative projects. However, managing these research grants presents significant challenges, including precise budget tracking, secure handling of sensitive data, and compliance with funding requirements [3]. These issues highlight the pressing need for a robust, centralized, and secure system to streamline and optimize the management of research grants.

A Research Management System (RMS) was developed to address these challenges using a web-based framework and Firebase Real-Time Database. The RMS consolidates vital functions such as tracking principal investigators, co-investigators, budget management, and document storage. This centralization enhances the efficiency of research grant management and the security and accessibility of sensitive information [4].

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The system was developed using the Agile Software Development Model, which enabled a flexible, iterative approach. User feedback was integrated throughout the process to ensure the system met evolving requirements. A critical focus of this study is the User Acceptance Testing (UAT) phase, a vital step in software verification and validation. The UAT process ensures that the RMS aligns with user expectations, performs as intended, and resolves any issues identified during development [5].

Implementing the RMS at UPTM has significantly transformed research grant management workflows, delivering a more efficient, user-friendly, and secure experience for lecturers and project coordinators. This paper explores the development, features, and impact of the RMS, emphasizing its role in enhancing the research management process within higher education [6].

Literature Review

Managing research grants in academic institutions is a complex process that requires effective coordination, secure data handling, and precise budgeting. Over the years, various technological solutions have emerged to address these challenges, with many institutions adopting digital systems to streamline grant management processes. This section reviews the existing literature on research management systems, software development methodologies, and user acceptance testing.

Research Management Systems

Research Management Systems (RMS) are essential for managing project data, budgets, and compliance with funding regulations. These systems are designed to support principal investigators (PIs) in tracking the progress of research projects, maintaining financial records, and ensuring that funding is spent appropriately. According to [7], adopting RMS in universities has increased grant administration efficiency by centralizing information storage and automating tasks like budget tracking and report generation. Furthermore, [8] notes that such systems improve collaboration among research teams by providing a shared platform for managing documents and project updates.

However, challenges remain in ensuring that these systems are user-friendly and secure. [9] emphasizes the importance of data security in RMS, as sensitive financial and intellectual property information must be protected. Additionally, [10] suggests integrating cloud-based technologies, such as Firebase Real-Time Database, can enhance system performance by enabling real-time data access and updates.

Web-Based Frameworks and Firebase Real-Time Database

The shift toward web-based frameworks in software development has revolutionized how information systems are designed and deployed. A key benefit of web-based systems is their accessibility; users can access them from any location with an Internet connection, making them ideal for academic environments where flexibility is crucial [11]. Additionally, web-based frameworks allow for more effortless scalability and integration with other platforms.

Firebase Real-Time Database is a cloud-based technology that has gained traction in educational institutions for its ability to store and sync data in real-time across all clients [12]. This technology enables faster access to updated project data and supports collaborative work among research teams. [20] Firebase is particularly beneficial for research management systems, as it provides a secure environment for storing sensitive information while ensuring that data can be accessed and modified by authorized users in real-time.

Agile Software Development in Educational Systems

The Agile Software Development Model has become a popular approach in developing educational systems due to its flexibility, iterative process, and focus on user feedback. Agile methods enable rapid prototyping and testing, allowing developers to continuously improve based on user input [13]. In research management systems, Agile allows institutions to respond quickly to the changing needs of principal investigators and research teams.

Studies by [14] suggest that Agile methodologies suit educational institutions because they encourage collaboration between developers and end users. The iterative nature of Agile development ensures that systems are continually refined to meet researchers' needs. Furthermore, Agile frameworks facilitate the integration of User Acceptance Testing (UAT) as part of the verification and validation process, ensuring that the system performs as intended before full implementation [15].

User Acceptance Testing (UAT) in Software Development

User Acceptance Testing (UAT) is a critical phase in software development that ensures the final product meets user requirements and functions as intended. UAT involves the end users testing the system in a real-world environment to verify its functionality and usability. According to [16], UAT helps identify any remaining issues or areas of improvement before the system is fully deployed.

In the context of research management systems, UAT ensures that the software is aligned with the expectations of the principal investigators and research administrators. [17] UAT is essential for educational institutions because it verifies that the system integrates seamlessly with existing workflows, addresses critical pain points, and delivers a user-friendly interface. By incorporating UAT into the development cycle, institutions can ensure that their research management systems meet functional and usability standards.

The literature highlights the critical role that research management systems play in streamlining the management of research grants in higher education institutions. By adopting web-based frameworks and cloud technologies like Firebase Real-Time Database, these systems can provide real-time data access, enhanced security, and improved collaboration among research teams. Agile software development methodologies and UAT ensure systems are flexible, user-friendly, and aligned with end users' needs. Future studies may explore the long-term impact of these systems on research productivity and administrative efficiency in academic institutions.

User Acceptance Testing for RMS

User Acceptance Testing (UAT) is a critical process to ensure that a Research Management System (RMS) meets all functional requirements and operates effectively in real-world scenarios. The UAT process typically begins with defining the scope, focusing on critical functionalities such as proposal submission, budget management, role-based access control, system integration, and report generation. A comprehensive UAT plan is developed, outlining test cases, timelines, and responsibilities, while a testing environment that mirrors the production system is set up. Representative test data is also prepared to simulate real-world user interactions.

During the execution phase, stakeholders such as the principal investigator, research coordinator, and head of the research management centre are involved in testing the system based on their specific roles. They perform tasks like submitting research proposals, approving or rejecting projects, managing research funds, and generating progress and financial reports. Any issues, such as bugs, missing features, or performance problems, are recorded for further investigation. Feedback is gathered from testers to evaluate system usability, performance, and alignment with their needs. The development team addresses any identified issues, and further testing ensures that fixes are successful.

Post-UAT activities include training to familiarize users with the system's features and distributing user manuals or other supporting documentation. Once the stakeholders—such as the principal investigator, research coordinator, and head of the research management centre—confirm that the system meets their needs, the system is deployed to the live environment. This structured approach ensures that the RMS is robust, user-friendly, and ready for a smooth transition to production [18].

Results

The User Acceptance Testing (UAT) phase is a crucial part of evaluating the functionality and effectiveness of the Research Management System (RMS). At Universiti Poly-Tech Malaysia (UPTM), this phase was

carried out with 50 respondents, encompassing a diverse group of stakeholders. These participants included principal investigators responsible for leading research projects, research coordinators tasked with managing administrative aspects, and the Head of the Research Management Centre (RMC), who oversees the entire research management process. The inclusion of this broad spectrum of users ensured that feedback captured the system's relevance and usability across various operational roles.

The primary goal of the UAT was to verify and validate the RMS's functionality, ensuring it aligned with user requirements and effectively addressed real-world needs. Participants were asked to perform tasks such as managing investigator data, tracking research budgets, and navigating document storage and retrieval functions. Through this process, the UAT tested whether the system could handle its essential functions accurately and efficiently while providing a user-friendly experience. By simulating actual usage scenarios, the UAT evaluated not only the technical reliability of the RMS but also its ability to integrate seamlessly into users' workflows.

The results of the UAT confirmed the RMS's success in meeting its intended purpose. Stakeholders praised the system for its intuitive design, efficiency in managing complex research tasks, and ease of use. The positive reception from users validates that the RMS has achieved its objectives of improving research grant management processes while ensuring secure and accessible data management. Furthermore, feedback collected during the UAT offered valuable insights into potential enhancements, ensuring the system remains adaptable and continues to meet evolving user expectations.

Principal Investigator Feedback

Table 1 summarizes the UAT results for principal investigators. The respondents give feedback on the system's functionality and usability, rating their experience as "Poor," "Fair," "Good," or "Very Good."

Principal investigators had a positive experience while using the system. They successfully logged into the system and performed vital functions such as registering a new grant, updating information such as journal, conference, innovation, intellectual property, and expenses, and preparing progress reports and final reports. Meanwhile, there is a 94%-95% rate for the other functions, such as updating information regarding expenses and preparing a progress report and final report. These results indicate that they found the system efficient and able to perform the tasks well.

The system's overall performance received an impressive 95% "Very Good" satisfaction rating. The system successfully fulfills all the user requirements.

Table 1. Testing Results for the Principal Investigator

No	Question	Percentage (%)			
		Poor	Fair	Good	Very Good
1	A principal investigator can log in successfully.	0	0	0	100
2	A principal investigator can register a new grant.	0	0	0	100
3	A principal investigator can update information regarding journals.	0	0	0	100
4	A principal investigator can update information regarding conferences.	0	0	0	100
5	A principal investigator can update information regarding innovation.	0	0	0	100
6	A principal investigator can update information regarding intellectual property.	0	0	0	100
7	A principal investigator can update information regarding expenses.	0	0	5	95
8	A principal investigator can prepare a progress report.	0	0	5	95
9	A principal investigator can prepare a final report.	0	0	6	94

10	A principal investigator can view all the research records.	0	0	0	100
11	Your overall satisfaction with this system.	0	0	5	95

Research Coordinator Feedback

Table 2 summarizes the UAT results for research coordinators. The respondents give feedback on the system's functionality and usability. They rate their experience as "Poor", "Fair", "Good" or "Very Good".

Ten questions are for the coordinators. Their feedback is essential to validating the functionality regarding the research records updated by the lecturers. From Table 2, it can be seen that most of the functions achieved an impressive 100% "Very Good" satisfaction. The system successfully fulfils all the user requirements.

Table 2. Testing Results for the Research Coordinator

No	Question	Percentage (%)			
		Poor	Fair	Good	Very Good
1	The coordinator can log in successfully.	0	0	0	100
2	The coordinator can view the new grant registration.	0	0	0	100
3	The coordinator can view information regarding the journal.	0	0	0	100
4	The coordinator can view information regarding the conference.	0	0	0	100
5	The coordinator can view information regarding innovation.	0	0	0	100
6	The coordinator can view information regarding intellectual property.	0	0	0	100
7	The coordinator can view information regarding expenses.	0	0	0	100
8	The coordinator can view a progress report.	0	0	0	100
9	The coordinator can view a final report.	0	0	0	100
10	Your overall satisfaction with this system.	0	0	0	100

Head of RMC Feedback

Table 3 summarizes the UAT results for the head of RMC. The respondent gives feedback on the system's functionality and usability according to the rate of "Poor", "Fair", "Good", or "Very Good".

Ten questions are for the coordinators. Feedback is essential to validate the functionality of the research records and report verification. Table 3 shows that most of the functions achieved an impressive 100% "Very Good" satisfaction. The system successfully fulfils all the user requirements.

Table 3. Testing Result for Head Of RMC

No	Question	Percentage (%)			
		Poor	Fair	Good	Very Good
1	The head of RMC can log in successfully.	0	0	0	100
2	The head of RMC can view the new grant registration.	0	0	0	100
3	The head of RMC can view information regarding the journal.	0	0	0	100
4	The head of RMC can view information regarding the conference.	0	0	0	100

5	The head of RMC can view information regarding innovation.	0	0	0	100
6	The head of RMC can view information regarding intellectual property.	0	0	0	100
7	The head of RMC can view information regarding expenses.	0	0	0	100
8	The head of RMC can verify a progress report.	0	0	0	100
9	The head of RMC can verify a final report.	0	0	0	100
10	Your overall satisfaction with this system.	0	0	0	100

Discussion

The User Acceptance Testing (UAT) results for the Research Management System (RMS) indicate its strong success in fulfilling user requirements and meeting its intended purpose. The involvement of key stakeholders, including principal investigators, research coordinators, and the Head of the Research Management Centre (RMC), provided a comprehensive evaluation of the system's functionality. These users represent a broad spectrum of roles and responsibilities within the research management process, ensuring the feedback is relevant and reflects real-world usage scenarios.

The system demonstrated efficiency, user-friendliness, and the ability to meet user expectations, as reflected in the feedback from participants. Nearly 100% success rates for critical functions—such as managing investigator data, tracking research budgets, and storing project documents—underscore the RMS's reliability and precision. The high success rates suggest that the system aligns well with its design objectives and effectively supports the administrative and operational needs of research activities.

A key highlight of the UAT was the system's usability. Participants found the RMS intuitive to navigate, requiring minimal training to perform essential tasks. This ease of use is crucial for a system designed to cater to a diverse user base, including individuals with varying levels of technical expertise. The efficient performance of the RMS also contributed to positive user experiences, as tasks that were previously time-consuming, such as budget tracking and document retrieval, became streamlined and more manageable.

The positive feedback received during the UAT is a promising indicator of the system's readiness for deployment. Users expressed satisfaction with how the RMS simplifies workflows, reduces administrative burdens, and enhances the accuracy of data management. The results also provided valuable insights into the system's performance, identifying areas where minor improvements could further optimize functionality. For instance, additional filtering options for reports or enhanced notifications could be included in future updates to improve user engagement.

These UAT findings underscore the RMS's effectiveness in addressing key challenges in research grant management, such as ensuring compliance, maintaining data security, and improving accessibility. The nearly flawless execution of critical functions demonstrates the robustness of the system architecture, while the high levels of user satisfaction highlight its practical value. By meeting both functional and usability standards, the RMS has not only fulfilled its immediate goals but also laid a strong foundation for continuous enhancement and user trust.

In conclusion, the UAT results validate the RMS as a dependable and efficient tool for research grant management. The feedback gathered from stakeholders offers a roadmap for iterative improvements, ensuring the system remains responsive to evolving user needs. This success positions the RMS as a vital component in enhancing the research ecosystem at Universiti Poly-Tech Malaysia.

Conclusion

The User Acceptance Testing (UAT) conducted for the Research Management System (RMS) at Universiti Poly-Tech Malaysia (UPTM) revealed promising results, highlighting the system's effectiveness and its

alignment with user expectations. The UAT process involved key stakeholders, including principal investigators, research coordinators, and the Head of RMC, who tested the system in real-world scenarios. The results indicated that the system successfully addressed the primary challenges identified in the early stages of development, such as inefficient data management, budget tracking, and document storage. Test users reported a significant improvement in the overall efficiency of managing research grants. Automated processes, such as proposal submission, grant tracking, and financial management, allowed users to focus more on research activities than administrative tasks [8]. Additionally, the real-time data synchronization feature, powered by the Firebase Real-Time Database, enhanced collaboration between research teams and funding agencies, providing a seamless platform for communication and document sharing [12].

The UAT also confirmed that the system's financial tracking and reporting tools provided transparency and accountability, ensuring compliance with institutional and funding body regulations [19]. Furthermore, the interface was user-friendly and intuitive, reducing the learning curve for new users and enhancing the overall user experience [16]. In conclusion, the UAT results demonstrated that the RMS is a robust solution for managing research grants at UPTM. The system addresses the initial challenges and introduces new efficiencies that benefit lecturers and administrators. Its successful implementation promises to improve research outcomes, foster better collaboration, and ensure compliance with financial regulations. Future iterations of the system can build on this foundation by incorporating additional features based on ongoing user feedback and evolving research needs.

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