Developing and Implementation of Research Grant Management System for Research Office, Haramaya University, Ethiopia

Tilahun Shiferaw[1], Wesenu Mohammed[2,] Tariku Mohammed[2], Zekarias Teferi[2]
Department of Information Science, College of Computing and Informatics, P.O.Box 138,
Haramaya University, Dire Dawa, Ethiopia
Email: shiferaw.tilahun@gmail.com, mwesenu@gmail.com, tarestat@yahoo.com, zekarias25@gmail.com

Abstract—In this work, we have developed a research grant management system in Haramaya University. The main aim of this project was to automate the manual working system in order to facilitate grant application process, improve time efficiency, save manual cost, improve the flow of information among researchers, and eliminate work delay. In the process of developing the system, researchers conducted a survey research which helps to identify the stakeholders and experts view. Delphi technique was used to identify the view of stakeholders. Whereas a questionnaire was used to collect data from purposely selected researchers to undertake user acceptance test. Finally, we adopted an iterative and incremental method. For the design, we used the UML Modeling language and PHP, JavaScript, Jquery, Json, Bootstrap and CSS used for the implementation. The user acceptance test found the system is acceptable with an average of 94.45%. Through all this process the system was successfully developed, tested and deployed.

Index Terms—Research grant management system, Research grant framework, Blended system development approach, Haramaya University research grant.

I. INTRODUCTION

Haramaya University is currently undertaking thousands of researchers and project works to enable it to meet its obligations of delivering quality and equitable researches to the population. To achieve this objective a viable and efficient Research grant management system (RGMS) has been identified as key. More than five decades ago, traditional paper-based research proposal submission had introduced various problems to research office and researchers [1]. The work processes from proposal to finally completed research submission is very often a tedious activity. Excel software had introduced to use as data storage, processing, management, preservation, and retrieval. Whereas, manual paper as a solution towards proposal and documents' submission. However, many cases of errors occur very often highlighting problems related to organizing, managing, retrieving and storing research grant data that leads the system is time-consuming and inefficient [2]. Thus, we have proposed a web application research grant management system that limits the errors of the manual system. Developing RGMS for Haramaya University allows a research office to eliminate the work delay, facilitate the review process, minimize wastage of resource (save cost), minimize loss of documents, improve administrative reporting, improve response time, facilitate the research grant application process and improve the flow of information among research communities [3]. The system will also able to make the easy way of proposal submission, track any updates and status of submitted research proposals, notifications for any updates, easy reporting, and review process. With the use of a system, research office can be able to manage the overall flow of proposal submission to final research reporting activities in a more organized manner [4]. Researchers go through a proper procedure to create a proposal and this ensures the proposal consists of all required details before submission for approval. For the design, we insightfully draw a combination of survey research; choose of system development method, user acceptance test and stakeholders' participation as the keystone to developing a responsive system for the identified problems. The analysis of information obtained from in-depth interviews made with key informants, formal and informal discussions, focused group discussions, and own experience revealed that a blended approach is imperative for developing an efficient & effective system.

System problems, required feature, new ideas and system requirements to improve efficiency in the organization were easily identified through surveying [5]. These are mostly ignored procedures by system developers during system development, that is why system feasibility is under not known. We are facing a period where software projects have a huge dimension involving small resources, high risk and a wide range of available approaches. In this scenario the Software Development Methodologies (SDMs) was chosen is achieved by defining a scale that goes from total satisfaction to no satisfaction, with an intermediate level

of partial satisfaction that is applied to a set of keys [6]. Then SDM for this project was identified by ICT office software development experts who provide weights based on criteria regarding the project in which the SDM will be used and previous experiences. Accordingly, iterative & incremental is used. Finally, knowing stakeholder's participation in all system development process is an asset that admits system developers to value a diversity of domain experts and appreciate multiple procedures, which in turn enable them to provide an efficient, effective and user-focused system. Put differently, a synergy of survey research, system development method, user acceptance test, and stakeholders' participation enable system developers to develop a quality system. We shall remind the very concept of synergy that, "The whole is more than the sum of its parts [7] & [8].

II. Objectives of the System

The aim of the paper is to quantify the importance of automated electronic grant management system for organizations having complex work process and emphasizing the approaching to be followed during development of applicable systems.

A. General objectives

The main objective of the study is to develop the research grant management system for Haramaya University.

B. Specific objectives

✓ To convert the current paper-based research grant proposal submission and approval process into a system to system submission and electronic approval routing process
✓ To minimize wastage of time in the current manual working system
✓ To supply the archive with the electronic and digital resource management system
✓ To enhance proposals progress tracking for reporting and management
✓ To show blended system development approaches

III. Methodology

Delphi technique was used to elicit input from the view of stakeholders to identify business domain, stakeholders concerns and requirements, business priorities, and technology constraints [9], [10] & [11]. This technique is adapted to gather system input and clarity about research grant management system from research office directorates of Haramaya University. The observation made by [12], [13], [14] & [15] reported, Delphi method is a well suited for consensus building by a serious of questionnaires delivered using multiple iterations to correct data from respondents [16]. The objectives of research grant management system developers team are to identify" what could be/should be" not "what is", that's why a need for choosing Delphi research techniques [17] & [18].

Delphi iteration processes were determined continuously to achieve the desired goal. Accordingly needed information is gathered and reached on consensus in most cases. Two round-table discussions appropriately as follows, in round 1: participants were provided with a set of proposed system features and possible futures of the proposed modules and requested to identify system business processes and core system functionalities for the proposed research grant management system. They are also requested to itemize any additional functionality and features that they felt should be considered along with justifications. In the 2nd round, participants were provided with a set of revised core functionalities, modules and features of the system for further review, and requested to rank. Moreover, structured questionnaires for 20 software developers and system analysts and 40 researchers were involved to select system development method and conduct system acceptance test. Furthermore, own experience as a subtheme leader of computing and information technology for more than 3 years was also helpful in substantiating information obtained through different data.

IV. Results and Discussions

The study adopted a two rounds Delphi technique. In the first round of the Delphi technique, participants were provided with a set of required roles and features/functionalities of the system that must be fulfilled and requested to identify core features/functionalities and major stakeholders with their roles. They were also invited to add new functionalities along with justifications. Accordingly, 32 functionalities/roles were identified and prepared for the second round for research group directorate director to revise and rank the must needed features/functionalities of the system. Subsequently, we developed a framework (see fig. 1.) to properly design and develop the system.
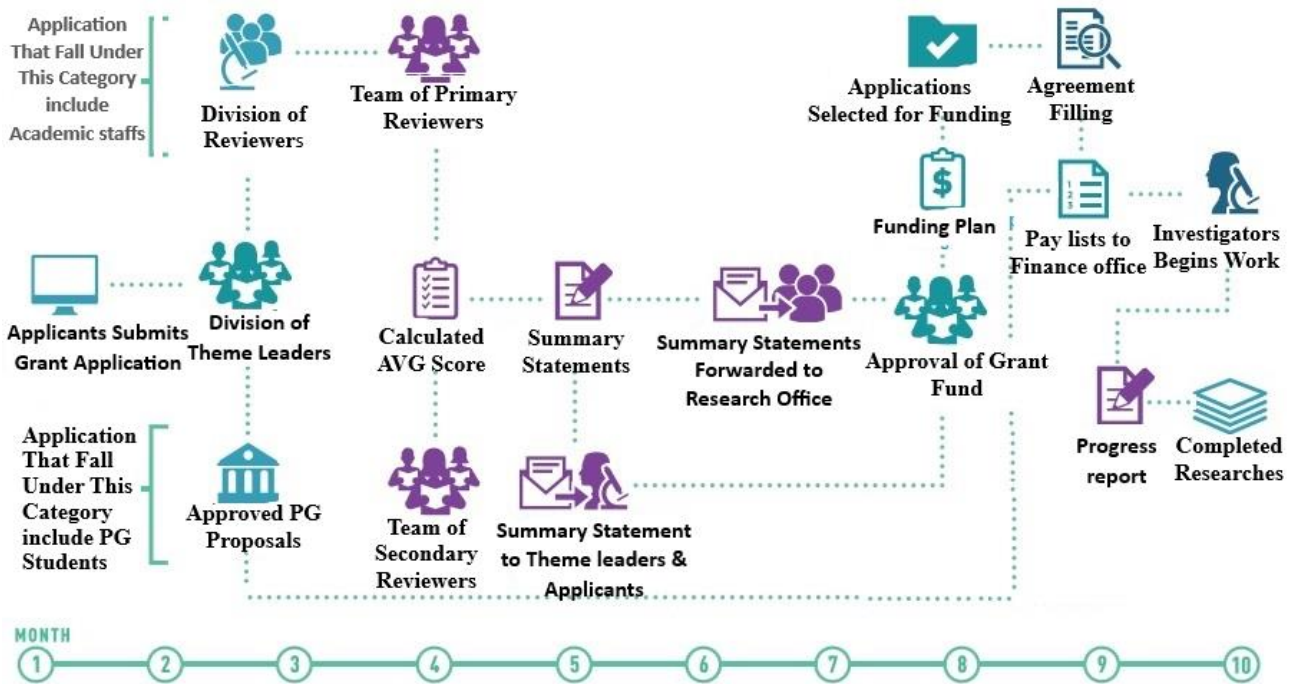
Fig.1. The proposed research grant management system framework

A. Proposed Framework of the system

The presented framework contains not less than 17 steps/layers. The following conditions needed for the application to final reporting of the research project. The system has a user-friendly interface. So that after registering to the system, the end user can log in to the system through privileges-based login and will provide with privileges-based menu through which they can access the system. Upon successful submission of the application, researcher receives a Tracking Number that can be entered online to check the status. After reviewers get lists of documents for review, they reviewed and give marks to the documents and submit it back to theme leader. The system calculates the average marks of reviewers, and then theme leader decides grants that can accept for the second review based on the university research grant evaluation standards of pass or fail criteria. A workshop will have organized for secondary evaluations/review for grant proposals passed the primary review, the evaluators/reviewers result should be filled to the system by reviewers and submitted to theme leader. The system calculates the average results of reviewers and generates summary statements of the review report. After reviewers submitted their review report and the system generates the summery of reviewers result both theme leaders and grant applicants can view the summary result. The grant applicants get only the report of his/hers' but theme leader will get all applicants report under their theme. At the end of review report summary report of accepted lists of applicants is to be submitted to research office, and then a team of theme leaders set together including research office makes a recommendation for approved applications at the theme level. Once an application was approved, research office develops its funding plan and post list of grant winners. After grant winners are identified the system fill the agreement form by retrieving data from needed tables, then researchers download activated agreement form from their profile and submit it to research office for signature. Then research officer sends a list of grant winners who filled the agreement for to finance office for research fund processing. Finally, researcher/investigator start doing their research and regularly submit their progress report online. Clearance can be processed after final research report is submitted and approved by both research office and theme leader.

Postgraduate students use the system to register their proposals, after that research office processes funding. Finally, they have to submit their research report for clearance.

B. Use case diagram

Based on the framework, the system designers draft the business logic and categorized the system features into five basic modules such as researchers, theme leaders, reviewers, research officer and postgraduate students. Required roles of researcher, reviewer, theme leader and research officer depicted by the panel of experts were indicated as the use case in Fig. 2. below.
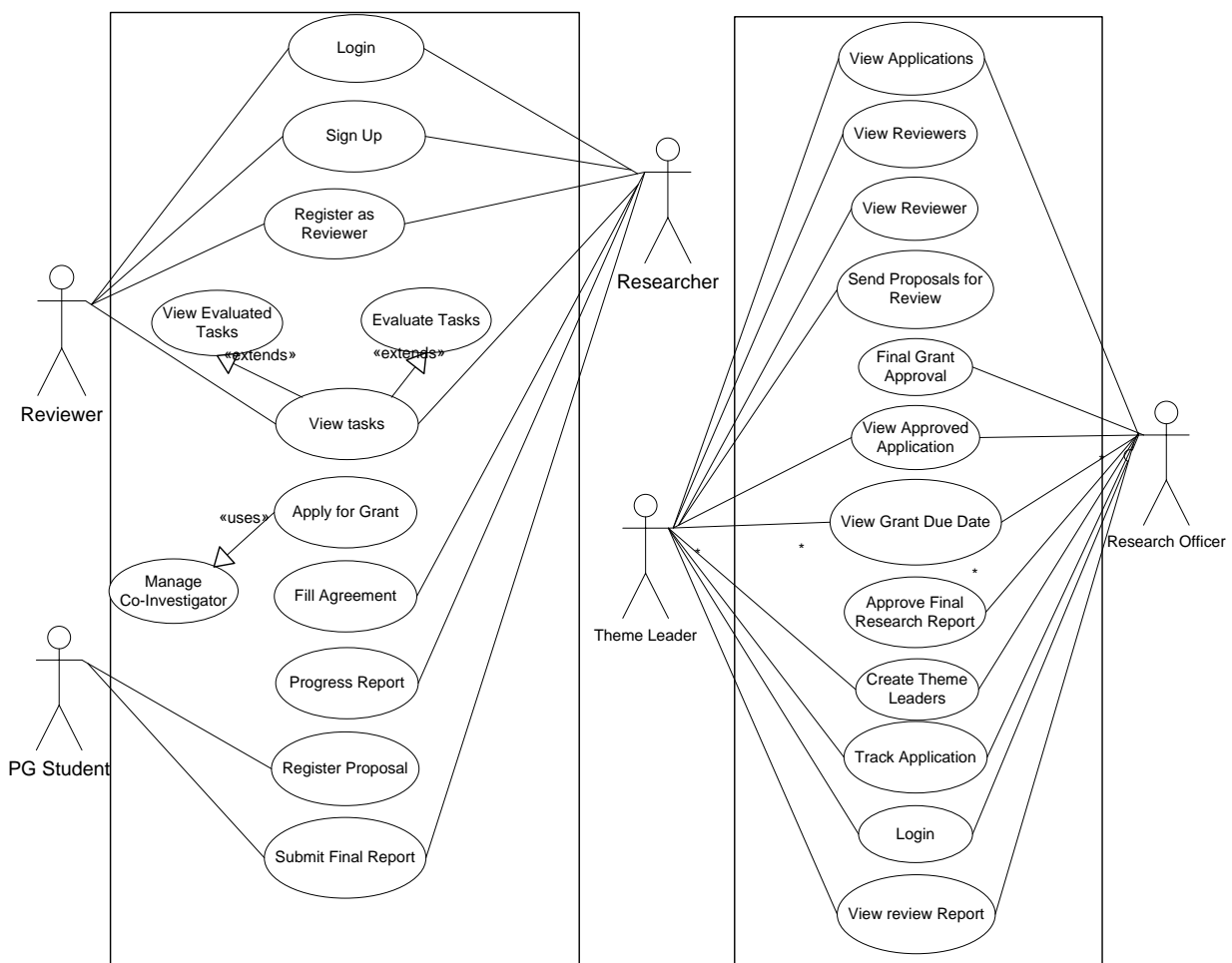
Fig.2. Identified actors of the system with their activities/actives

C. User Interface Description

All forms of the system follow a consistent theme, standard color, and clear structure. In order to minimize the occurrence of errors and text size, combo-boxes, checkboxes, and radio buttons are incorporated [19], [20]. Appropriate error messages are also prompted for the user that tells the error occurred and suggests the possible error correcting mechanisms [21], [22]. The client-side scripting language is used in order to check the correctness of the data before submission. The system provides the users with a feedback form to leave comments and ask questions through built-in messaging feature. Information displayed using tables in a clear and structured manner. If there is a system error, it provides the target module or method where an error occurs and suggests some tips for maintenance measure. Actors of

research grant management system with their level have interfaces and privileges to manage information [23], [24], [25], [26] & [27]. For example, the research officer has full privilege on the researchers', theme leaders' and reviewers' information.

The user interface was remodified after user acceptance test. So that all research communities of Haramaya University must register by using their university ID after providing all required information the system automatically generates user password then a user can change or modify their password for security purpose.

Once users registered to the system, they can log in to the system through privileges-based login and will provides with privileges-based menu through which they can access the system.
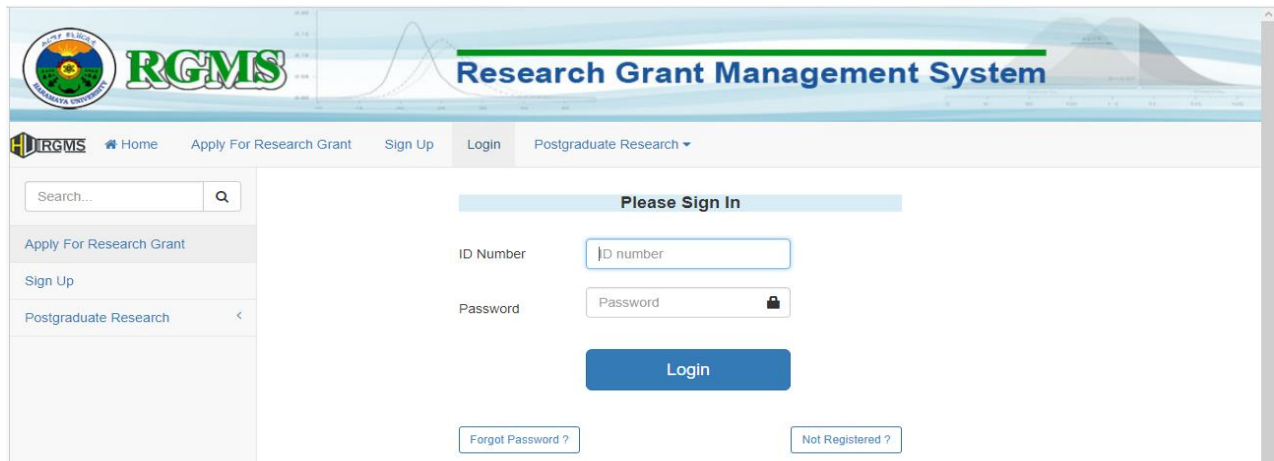
Fig.3. Researchers community login interface

When registered as a researcher to apply for a research grant, one needs to move to the left sidebar and click a drop-down menu "apply for research grant" that has a drop-down menu of research grant types (regular, women's, innovative and knowledge transfer) at Haramaya University. When a user clicks on one of this category, an application form will be displayed. After filling all required proposal submission information and click on submit button, the system automatically generates a project id like HUKT_2018_05_02_27 which indicates university, year, type of grant, theme number, sub-theme number and two-digit random number. Then click next button to add involved co-investigators and students. Once researchers completed filling of the form the system automatically generates application summary in pdf form that to download. In case if there need to add or delete involved co-investigators in a particular project it is possible by using Manage co-investigator menu. Any researcher can apply as a reviewer in any sub-themes by navigating to the left sidebar and click on "register as reviewer" link but it is theme leaders to approve reviewer's application. The other greatest feature of the system is tracking research status of each project that applied and completed projects involved as principal and co-investigator in summarized table form having the information of project ID, title, investigators start and end date, budget and status/progress. The researcher can fill an agreement form by clicking on "agreement" link when the final approval is made by the research officer. Once project work is started the researcher should frequently send a project report through "progress report" link. Finally, after completion of the project work, the researcher can submit his final report including final research report, manuscript and policy brief using "submit final report" link. Notification of any updates and news, profile update, and private messaging service is developed for all types of users.

Fig.4. Researchers' working interface

Theme leaders are immediate supervisors who control every activity under their theme. First, a theme leader can view grant application under his/her theme through "view applications". Reviewer applicants get approval or termination by the theme leader via "reviewer applicant" link and also, he/she can see approved review list by clicking on "approved reviewers" link. A theme leader can send proposals for respected reviewers to be evaluated by them through "send proposals to reviewers" link. Also, the evaluated proposals with their respective individual and average mark results both for primary and secondary screening can be accessible by the theme leader on "Evaluation result" and "Average Result" links respectively. Besides a theme, leader can track and view the list of researchers who passed the primary screening, secondary screening, approved for the fund, on progress and completed grants under his/her theme via "track applications" link and also it is possible to download this reports for further processing both in pdf and excel format. Likewise, he/she can also see the researcher's progress report under his/her theme on "progress report" link. Lastly, a theme leader can apply for a research grant and act as a researcher without leaving his theme leader account via" apply for research grant" link.
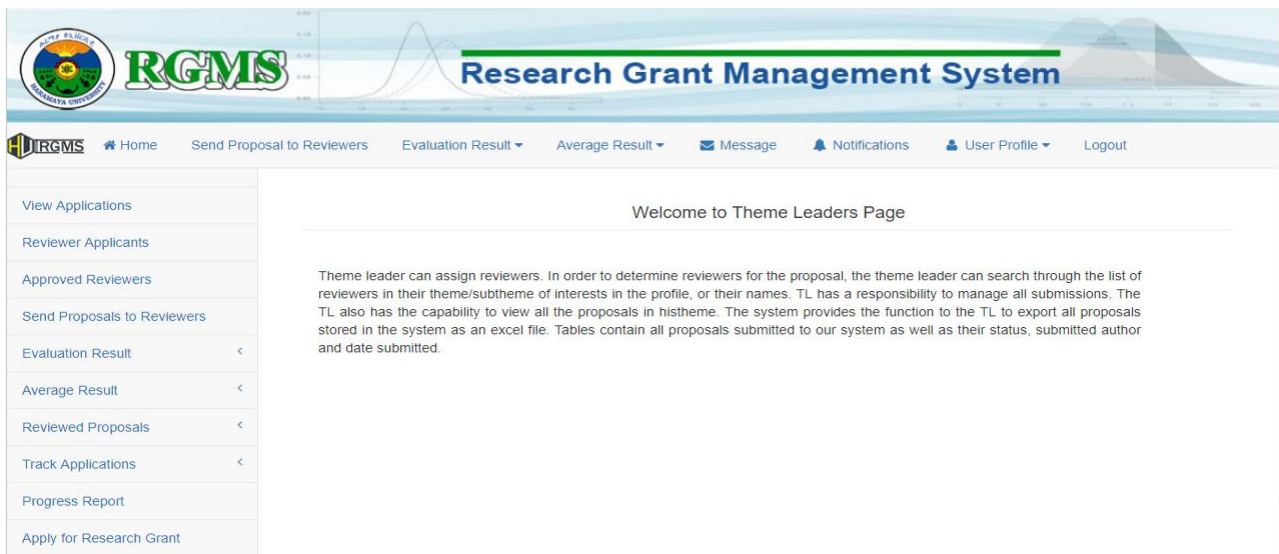

Fig.5. Theme leaders' page

To play a reviewer role, the account must be activated by the theme leader. After login, the reviewer can view assigned tasks for both primary and secondary screening from "view task" link. To evaluate the assigned proposals, he/she have to click on "evaluate tasks" link. Also, the evaluated tasks will be visible on the "view evaluated tasks" link. Next, to this, the reviewer can apply to be a reviewer in another sub-theme by following "register in other sub-theme" link. Finally, the reviewer can apply for a research grant and act as a researcher without leaving the reviewer account via" apply for research grant" link.

Fig.6. Reviewers' user interface

An actor who plays administrator role is research officer. What makes research officer differ from theme leader is, a theme leader has restricted access to his/her theme information whereas research officer can control every activity carried out under varies themes. First, he can view the list of grant applicants under all themes using "view application" link. In addition, approved reviewer applicants by the theme leader are available on "reviewers" link. The primary privilege of this actor is, he/she can make final approval by modifying the budget requested, which makes the applicant winner of the grant via "final approval" link. Furthermore, once the researcher completed every activity of the project, it gets final completion approval by the research officer and allows them to submit their final report through "confirm final report submission" link.

This account also allows viewing due dates of each and every granted project under "view due dates" link. Alike the theme leader, research officer can also track and view a list of researchers who passed a primary screening, secondary screening, approved for a fund, on progress and completed grants under all themes via "track applications" link and it is also possible to download a and cooperative agreements, including review, negotiation, award, administration, and the interpretation of grants policies and provisions [22 & 23]. Reviewing grant applications budget from a management point of view for conformity to funding and financial policy.

Fig.7. Research officers' interface

D. System Acceptance Test

The type of questionnaires distributed for feedback collection from the evaluators was close-ended questionnaires focusing on easiness, attractiveness, time efficiency and accuracy of the research grant management system (RGMS). The evaluators were allowed to rate the options using checkbox questions. The options of the checkbox questions are excellent, very good, good, fair and poor with values of 5, 4, 3, 2 & 1 respectively. The table below indicates the feedback obtained from the domain experts (evaluation) on systems, interaction as calculated based on the given scale.

The evaluators were requested to use the developed system and given an itemized Likert scale questions to evaluate the system. Descriptive statistics presented in Table 1 show that respondents said the system is excellent in its ease of accessibility and user-friendly interface with Mean values 4.97 & 4.94 respectively. The second most response scale was the efficiency of the system in terms of time, the accuracy of the system in analyzing facts for decision making and Significance of the system for easily managing research grant were also scaled excellently with mean values 4.82, 4.90 and 4.98 respectively. The findings agree with [28] study on the theory of software testing. Similarly, [29] investigated in his work that user acceptance testing incorporates formal testing with respect to user satisfaction, the simplicity of use, and timely response for queries must fulfill whether or not to accept the system by users. On the other hand, incorporating manual and user helps and Accuracy of the system in providing explanation and recommendation were answered very well with values 4.20 & 4.25 respectively. This finding is in agreement to [30] who stated that user acceptance testing (UAT) has widespread implications in the software community. It involves quality assurance of system accuracy, significance & user manuals, and helpful tips. The overall average of user acceptance test becomes 94.45%.

Table 1. RGMS performance evaluation using visual interaction

S. No	Evaluation Parameters	Central tendency				
		X	Median	Mode	SD	Decision
1	Easy accessibility of the system	4.97	5	5	0.87	E
2	User friendly interface	4.94	5	5	1.01	E
3	The efficiency of the system in terms of time	4.82	5	5	1.22	E
4	Accuracy in analyzing facts for decision making	4.90	5	5	1.14	E
5	Incorporating manual and user helps	4.20	4.5	5	1.33	V.G
6	The accuracy of the system in providing explanation and recommendation	4.25	4.5	5	1.12	VG
7	The significance of the system for easily managing research grant	4.98	5	5	1.15	E

Scale: 5=Excellent (E), 4=Very Good (VG), 3=Good (G), 2=Fair (F), 1=Poor (P)

E. Graphic user interface (GUI) testing

One of the mechanisms used to examine the user friendly of designed user interface questions were asked to 105 researchers who apply a grant proposal by using the system.

To find out the user's perceptions about the quality of GUI they were asked to give their opinion about the quality of GUI. The results presented in Table 2 show that the most of response were strongly agreed and agreed for the questions related with the similar appearance of font type and size use all over the application, colors and style guide of the product confirm the specification, input fields are of proper size, all icons are designed in one style, navigation is intuitively clear, tool tips for unknown fields in UI, good security, and help Users recognize, diagnose and recover from errors with mean values 4.6, 4.7, 4.2, 4.9, 4.8, 4.6, 4.2 and 4.8 respectively. This finding is in agreement to [31] who stated that usability and security must be considered in a manner which allows users to make suggestions to the developers on interface design they find comfortable so that they can enjoy the user interfaces and securely use the information systems.

Table 2. Respondents' opinion about the quality of GUI Summary of the response of the respondents

GUI quality indicator checklist	Central tendencies				Decision
	X	Median	Mode	SD	
The same font type and size is used all over the application	4.6	4	5	1.15	SA
Standard colors and styles	4.7	5	5	1.2	SA
Input fields are of proper size	4.2	4	5	1.14	A
All icons are designed in one style	4.9	5	5	1.31	SA
Navigation is intuitively clear	4.8	5	5	1.19	SA
Tool tips for unknown fields in UI	4.6	4	5	1.28	SA
Good security	4.1	4	5	1.12	A
Help Users Recognize, Diagnose and Recover from Errors	4.8	5	5	1.32	SA

Scale: 5=strongly agree (SA), 4= agree (A), 3= medium (M), 2=Disagree (DA), 1=strongly disagree (SDA)

V. CONCLUSION AND RECOMMENDATION

The study concluded that a list of multi procedures used to develop research grant management system is discussed. Likewise, a synergy of doing research, choosing the best system development method, conducting user acceptance test and stakeholders' participation enable system developers to come with the quality system in the contemporary organization's landscape. Moreover, the proposed framework for RGMS is meant for universal conceptualization. Other system developers can adapt the proposed framework to their system development realities. Our solution of the dynamicity problem is very simple. The study also concluded that participating stakeholders in every process of system analysis and design activities is highly important. We successfully developed and tested the presentation and business modules within eight months, as per client requirements, and delivered an integrated application for user acceptance testing. It has been shown that the system effectively automat research grant work processes with parental information, easily retrieves information about a researcher and generates the required reports, and we heard a lot of positive feedback from users.

The choice between software development methodology was based on which model best reduces risk, increases productivity and improves quality while achieving the goals of the project.

We believe that the freedom afforded to software architects, analysts or developers to tailor the software development process according to business needs and project characteristics is a crucial factor in successful project completion.

The study recommended that with the consultation of Haramaya University research affairs other higher institutions can adopt the system. Then they will think to integrate their system by applying metasearch technology and plagiarism detection tools. This, in turn, enables universities to protect plagiarism, easily reporting of research productions in higher educations, ranking of universities based on their research outputs.

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Authors' Profiles

Tilahun Shiferaw is a Lecture at Department of Information Science, College of Computing and Informatics in Haramaya University, Ethiopia. He is a member for some of the international organization e.g. IEEE Computer Society, Association of Information Systems (IS), and Institute of Advanced Engineering and Science (IAES). He has published several research papers in reputable journal publication and one of this is in the International Journal of Information Technology and Computer Science under MECS Publisher. His research interests include cloud computing, deep learning, data science and semantic web.

Wesenu Mohammed is earned his BSc. and MSc. in Information science and Information and Knowledge Management respectively from Jimma University. He is a lecturer of the Department of Information Science under College of Computing and Informatics of Haramaya University, Ethiopia.

Tariku Mohammed is a Lecturer at the College of Computing and Informatics. He is currently working in the Information Science department the Haramaya University. He graduated from Jimma University, Ethiopia earned MSc. In Information & Knowledge Management. His research interests include information & Knowledge management, data mining, multimedia systems and Software Development.

Zekarias Teferi is received his BSc. in Information science and MSc. In Computer Networking from Jimma University. He is currently working as Lecturer and head department of Information science under the college of computing and Informatics of Haramaya University, Ethiopia. His research interest includes wireless sensor networks (WSN), Internet of things (IOT) and Data science.