Abstract

All higher learning institutions (HLIs) have a specified period of time for students to carry out field-based practices in companies which are relevant to their fields of study. As the number of students in Tanzanian HLIs become larger, coordination and allocation of students to relevant companies is becoming tougher. This study therefore intended to examine a better method to facilitate coordination and allocation of students to relevant companies through development of an online system. The general objective of this study was to develop a web-based system to integrate companies and higher learning institutions for effective management and coordination of field practices.
Specifically, the study sought to:

- Identify the user and system requirements
- Design and implement the system
- Validate the system for usability

This study was conducted in Arusha and Kilimanjaro regions which are located in the northern part of Tanzania. There are 10 universities and institutions which offer different fields of higher-level studies located in the two regions. Moreover, there are tourism, Information Technology and agricultural companies as well as government and non-governmental agencies which offer field attachment for students. The selected study area has a good number of target stakeholders with a perfect mix of variations of requirements based on fields of studies and companies core activities.

The study employed the following system design

- System Design

The solution design process involved the creation of a prototype. Since prototypes allow users to see how the final product will be, concepts can be approved and more importantly usability flaws can be uncovered early in the project lifecycle. The methodological approach used in this study was a mixed approach based on scrum. Scrum is a framework which involves use of various processes and techniques to come up with product of the optimum value. Scrum framework ensures the involvement of users in testing starting from the early development stages to continuously improve the product. Moreover, involvement of users in all stages of development not only exposes design issues at the early stages of development but also positively affects the usability of a system.

To allow major coverage of usability aspects, multiple methods were employed in this study. Quantitative usability metrics regarding effectiveness, efficiency, and satisfaction were established by applying user testing and questionnaires. User testing was preferred in this study because is the most useful usability evaluation method for the website since selected users execute some tasks while their performance and satisfaction are recorded.

- Interface Design

The collaborative prototype design is an innovative user-centred approach to system design that enables designers to involve more users in testing the tasks. Based on features suggested by users during interviews, observation and requirements workshop, web pages were sketched on paper. The pencil software was then used to translate the sketches into wireframe. Pencil software is a free and open-source prototyping tool that allows design of web pages and save them as clickable wireframe pages. The wireframe pages were finally used to create a prototype by linking pages and saving them as clickable web pages.

- Database Design

To accommodate all data required for a system to function, a database was designed and relationships between tables of data were determined prior to database implementation. The database was designed using MySQLWorkbench. MySQLWorkbench is a powerful data model development tool which captures only One-to-One and One-to-Many type of relationships between database tables. With MySQLWorkbench, Many-to-Many relationships are automatically converted into set of two One-to-Many relationships.

- Architectural Design

Not only a prototype but also an architectural design is a key approach to build the right product that accommodates all desired properties. Having information of all desired features and properties before the development of a system, led to both increased success rate and easy monitoring of the system development progress. In a process of coming out with a design which has information about all important features and properties of a system, an architectural design of layers was produced. FAMS architecture gave an overview of layers in which the system must be configured to accommodate the process model that allows flow of information among all stakeholders using both smart phones and computers.

To collect data, Key informant interviews were conducted to 62 students, 3 coordinators and 5 companies' representatives. Criteria for selecting students were based on inclusion composition of students who once attended field practices, students who were applying for the first time and those who have never either applied or attended field practices yet. Regarding, coordinators and companies, a number of respondents were relative to their availability in a research area.

Most of the interview questions were open-ended to allow informative answers from users. In order to identify the magnitude of the challenges, the participants were asked to give a picture of what would happen if no changes will be done to the current process. Moreover, participants were asked of what they will regard as a success after the introduction of the system that will facilitate the process. The proposed features from respondents were analysed and accommodated in the general prototype of the new system. For coordinators and companies, it was not possible to

perform quantitative analysis due to small size of dataset, thus only qualitative analysis was done. In analysing quantitative data, descriptive statistics were used by applying Ms Excel and SPSS. Qualitative data were analysed through content analysis and information was then integrated with quantitative information to provide more meaningful analysis.

Requirement's workshop employed in this study composed of 8 students was conducted for the aim of brainstorming the challenges that they are facing. A user story is defined as a statement which describes functionality that is of value to a user of a system. There are some variations in presentation of user stories but all have the same three basic components. Therefore, three basic components are helpful in knowing the requirements based on type of user as well as why a specified requirement is important. Through the workshop, user stories were identified and formulated considering those three components with exception of few stories which seem to have important requirement but user fail to give acceptance criteria. A number of system requirements were identified and finally included in the product backlog.

To make each participant feel comfortable and contribute in the session, the workshop guide was prepared and the aim of the workshop was well introduced. All stories were recorded on paper following the format. User stories helped to describe the features needed by users but not how to implement the features. To enable users to contribute to how they would want the features to be implemented, wireframes were prepared and prototyped for users' interaction.

- **System Development**

Agile software development using scrum framework involves various processes and techniques to continuously improve the product. Scrum is an effective framework especially in iterative and incremental software development since it ensures delivering products of the highest possible value by addressing complex adaptive problems through frequent inspection of progress to detect undesirable variances. Moreover, predicting and controlling the risks which may cause rejection of the final product is optimum in using Scrum, this is due to the fact that it employs an iterative, incremental approach.

- Approach

The development of a system was done in increments. List of functional requirements from product backlog analysed during requirements elicitation were given priorities based on their dependencies. The tasks were then categorized into sprints which were defined as time-boxes of two weeks to release an increment of the product. For each sprint, criteria for acceptance were defined by thoroughly investigating functional features of each task. For a task to be regarded as completed, the description that defines a specific task to be done was also set. The part of final product

backlog including acceptance criteria and definition of tasks to be regarded as done tasks is as indicated hereunder.

Product Backlog

Story ID	Tittle	User story	Priority	Sprint	Acceptance Criteria	Defination of Done	Status
1	Viewing posts advertisement	As a student I want to be able to get information of available organizations in the system and apply through the system	1	1	1. Being able to view available organizations 2. Being able to select an organization and send application to	1. Passes validation tests 2. Passess testing per acceptance criteria items 3. Able to show features in demo	Planned
2	Selection Feedback	As a student I want to be able to signup and registered in the system so that I can do follow up for the feedback	2	2	1. Accept new students login details and save 2. Generate success or failure message after processing 3. Student must be able to view selection status		Planned
3	Selection of post to apply	As a student I want to be able to see all available organizations so that I can choose one to apply	1	1	1. Display all available organizations 2. Able to choose one and apply		Planned
4	Reporting	As a student I want to be able to share my weekly reports to supervisor so that he/she can comment on my progress	5	5	1.Student should be able to fill daily report 2. Supervisor should be able to send a comment on the report		Planned

Figure: Part of the Product Backlog

The first sprint involved tasks which best understood in the first place. This helped to have a base of an intended product while continually gain understanding of the other ordered list of requirements that were needed in the product. For each sprint, a tracking sheet was prepared so as to monitor and evaluate the progress of an increment development. The tracking sheet was composed of a burn down chart which measures daily actual progress versus the ideal distribution of tasks in two weeks' time as indicated in Fig. 5. The estimated remaining time to complete a specific task in a sprint was recorded and used to monitor the progress. After completion of each sprint, a unit test was done based on definition of done and acceptance criteria of each task.

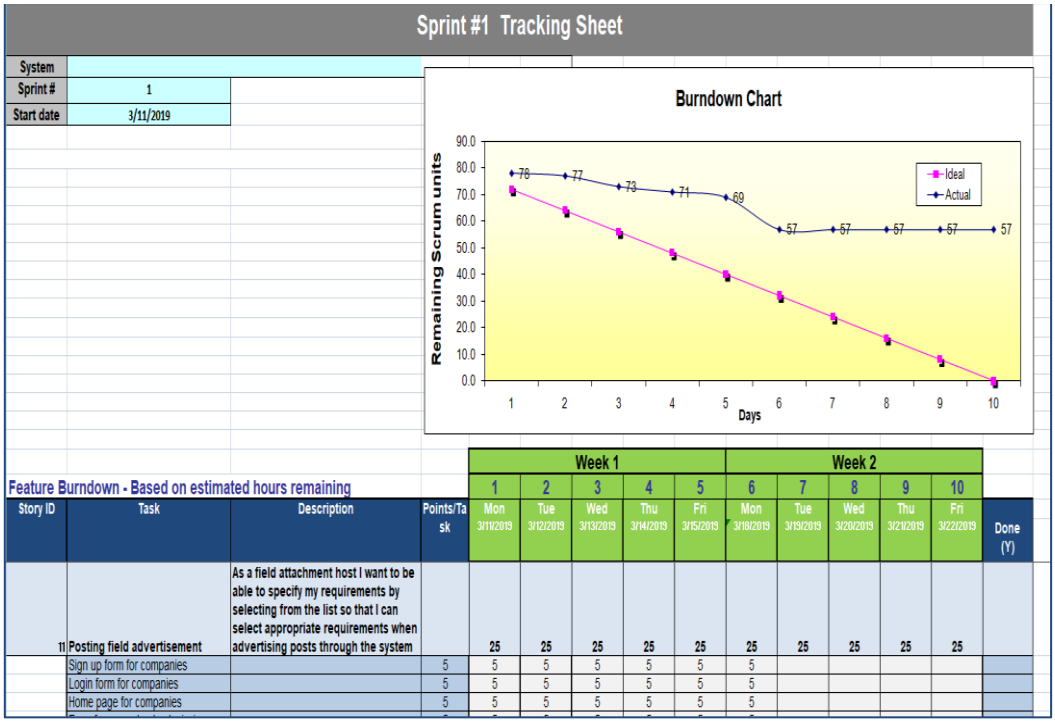

Figure 4: Sprint (Increment) Tracking Sheet

The above figure is a framework of a Scrum development approach that was employed to develop a field attachment system.

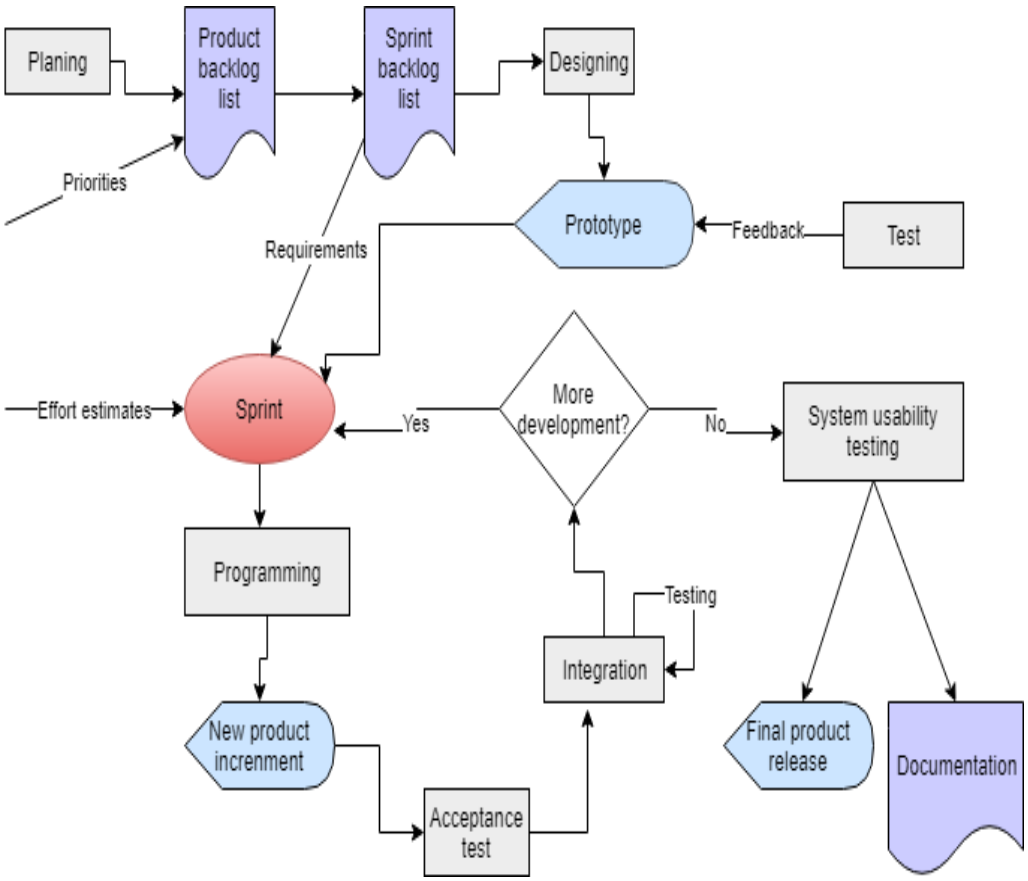

Figure 5: Scrum Development Approach

- **Tools**

WAMP server was used to develop the system. WAMP is a package of independently-created programs compatible with Microsoft windows operating system. It is composed of a web server called Apache, MySql as a database management system and PHP as a server-side scripting language. Java scripts were also used for rollover effects, roll out effects and graphics. Furthermore, the Integrated Development Environment (IDE) that was used as a code editor is NetBeans since it supports latest versions of programming languages including PHP 7.2.14 and has much functionality compared to counterparts like notepad++, notepad and eclipse.

System's interfaces were implemented by using HTML and CSS in separate files. HTML was used to describe the structure and contents of web pages while CSS was used to describe the web pages styles including layout, colours, and fonts. Maintenance of pages, sharing of style sheets across pages and tailoring of pages to different environments were made easy due to separation of HTML and CSS files. Responsive design is application of CSS to create web pages with dynamic layouts depending on size and structure of devices used to view them. All FAMS features were accommodated within the main system layout and formatted to meet responsive design needs. The responsive design allowed interface

In this study, the following were observed;

- Three stakeholders who are HLIs, students and companies were involved in the system's requirements determination. The stakeholders gave out their suggestions on what they will regard as a success after introducing a computer system to facilitate field attachment. The most suggested features were companies to be able to advertise available posts for field attachment, students to be able to register their profiles and make them available to companies and HLIs to be able to coordinate and supervise students during field attachment.
- The study came out with a computer system for effective coordination and management of the field attachment. As compared to similar systems, the ability to make students' profiles available to companies and the fact that companies, students and HLIs can be registered and linked is what makes the developed system unique.
- The developed system was finally tested for usability and found to pass with a high degree of acceptance. Consequently, FAMS was confirmed to improve field attachment process by enabling quick access of information about companies to students, easy follow-up and reports generation and other value-added advantages like open doors for more collaboration between HLIs and companies.
- The requirement's elicitation techniques that were used are key informant interviews, observations and requirements workshop.

Together with the usability metrics that were recorded, users who were involved in testing responded on the following questionnaires:

- Pre-test Questionnaire

The purpose of this questionnaire was to understand the type of user who is doing a test. Questions in this section were used to interpret whether the results of test are in one way or another depend on character of a user involved in testing. Users' information captured using pre-test questionnaire were on type of devices they use to open websites, frequency of using computers, sites they normally visit and experience on using online portals.

- Post-task Questionnaire

Post task questionnaire was prepared to get opinions of users on each task. Users involved in the testing were able to respond and give their experience on how did they find the process of completing a specific task using a developed system. They were further allowed to suggest some improvements.

- Post-test Questionnaire

At the end of the testing session, users were also given a post-test questionnaire. The aim of post-test questionnaire was to get the usability metrics of the entire system. All the responses were recorded in the form of ratings where respondents were allowed to rate different usability features from strongly agree (+2) to strongly disagree (-2).

Recommendations of the study

- Since the present findings has shown that there is no existing platform where companies information can be accessed by HLIs students and HLIs students' profiles can be accessed by companies, it is recommended that HLIs should, therefore, start using the developed system. This is because, the developed system has found to have addressed the current allocation challenges. To allow access of the system by all HLIs, the government through the responsible ministry or member-based institutions dealing with provision of services to HLIs like Tanzania Education and Research Network (TERNET) can adopt and host the system (FAMS). Furthermore, students, universities and companies can be given free access to the system and income can be generated through paid advertisements.
- Since this study had only focused on field attachment, further research is recommended to include more value addition features like analysis of feedback from companies to get information that can be used by HLIs in regular curriculum reviews.
- Some other additional features like internship and job finding can also be further researched for allowing more collaboration between companies and HLIs since HLIs are responsible for producing expatriates to work in companies. It is also recommended that further research should be carried out on HLIs which bear the responsibility to find and allocate students to field attachment to see whether there are any different needs.