USABILITY EVALUATION OF MOBILE ACCESS TO INSTITUTIONAL REPOSITORY

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Abstract:

This paper investigates the usability of the core functionalities of an Institutional Repository on mobile devices. An EPrints-based repository (Covenant University Repository) was used as case study. The core functionalities of the Institutional Repository were modelled using the Unified Modelling Language and tested on five different mobile devices. Questionnaires were designed and administered to users of the repository based on known usability attributes and the results were analysed using SPSS software. Reliability and convergent validity of the questionnaire was estimated by Cronbach's alpha and produced a result of 0.771, which is above 0.7 - the minimum recommended. Also, the results from the analysis of the usability attributes show that for all the attributes considered, each scored well above 4.00 on a scale of (1-5) which represents good usability. In essence, the results show that the current web version of the repository provides good usability when accessed from a range of mobile devices. The novelty of this work is that it presents a case study of mobile access to Institutional Repositories in an elegant and repeatable way.

Keywords: EPrints, Institutional Repository, Mobile devices, Mobile Web, Usability

1. Introduction

The World Wide Web as we know it is fast becoming accessible to portable and wireless devices such as tablets, and smart phones. For the first time in 2008, access to the Web via mobile devices superseded desktop computer-based access[1]. This shift is being catalyzed by the introduction of smart devices with touch features and large screens. This has helped to improve the browsing experiences of the users. It has also necessitated the need to build mobile-friendly web applications. Three key techniques for achieving this include: building the mobile version for every web application. The downside of this is duplication of efforts as there would be two distinct sites to maintain. In addition, there is the issue of varying screen sizes[2]. Creating the content once and adapting it to the various devices is another technique. Adaptation can occur at three levels of a web application namely[3]: the client, the middleware and the

server. The third possible technique is the use of World Wide Web Consortium (W3C) Web standards such as Extensible Hypertext Markup Language (XHTML), Cascading Style Sheets (CSS), Asynchronous JavaScript and XML (Ajax), Extensible Markup Language (XML), Extensible Stylesheet Language Translator (XSLT). Many Web applications (including Institutional Repository[4]) today are built using the W3C standards. An Institutional Repository is essentially a digital library specifically designed to capture, curate and share the intellectual output of an institution (i.e. University[5], government or research institute) in digital formats[6-8]. Institutional repositories being web applications are becoming the focus of research efforts aimed at deploying them to the mobile web[9-10].

The developers of the Greenstone Digital Library software have been working on porting the platform to mobile devices running iOS. To do this, they implemented Greenstone Digital Library Software on an iPod[11]. The implementation was carried out in such a way that the archives of the repository were accessible locally on the iPod device shutting out the need for Internet connectivity. As a result, the iPod's storage was used to store the repository materials.

Though the materials are readily accessible on the device without the need for Internet connectivity, the approach is not ideal for institutional repositories that need to be accessible to a large user base over a network.In another work[12] still considering Greenstone, the authors investigated the feasibility of a system for accessing Greenstone using WAP handsets. Although the work provides an interesting discuss, it was carried out at a time when smart phones were not yet wide spread. As of today, smart phones running different mobile operating systems now exist and are gradually replacing WAP handsets.

In recent times, attention has also been given to creating a mobile interface for D Space - leading repository software managed by Dura Space Foundation[13]. However, of all the popular institutional repository software platforms, only the developers of Greenstone have done considerable work on providing a mobile interface to their software. Mention is made of the possibility of having a mobile version of EPrints[14] but no work had been done in this regard as of the time of this writing.

It is this gap that has motivated us to reconsider institutional repositories as web applications and test out their core functionalities on different mobile devices – without necessarily building mobile versions. This is based on the argument that repositories are built according to standards such as XHTML, JavaScript and CSS and as such they are able to adapt to different screen sizes[15]. We also go a step further to evaluate the usability of the repository when accessed from different mobile devices in use today.

2. Research Questions and Methodology

Although mobile versions of web applications – in particular, Institutional Repositories - are beginning to emerge, we believe that there may be no need to create separate versions for the mobile Web. This has led us to pose the following research questions:

RQ1: What will be the result of accessing the current Web version of a typical Institutional Repository on contemporary mobile devices?

RQ2: What do users think about Institutional Repositories on mobile devices?

To address these questions, we began by elucidating the core functionalities of a typical Institutional Repository with the aid of the Unified Modelling Language[16]. It entailed coming up with a use case diagram and sequence diagram. In addition, a model of the software architecture was evolved. Next, an Institutional Repository was deployed for Covenant University using EPrints – open source institutional repository software. It is hosted on a managed server outside of the university in order to reduce the energy consumption that could come from having to host it in the university[17]. After setting up the repository, its main features were tested out on a variety of mobile devices. The results obtained from the tests answer RQ1.

Furthermore, we evaluated the usability of the repository. To achieve this, questionnaires were designed and administered to the users of the repository based on the usability attributes gleaned from Information Services and Technology[18]. This was to harvest their perception thereby providing answers to RQ2. The rest of this paper is organized in the following way. Section 3 models the core functionalities of a typical Institutional Repository based on EPrints. We then test the core functionalities of the repository on different mobile devices in Section 4. The usability attributes for harvesting users' perception is put forth in Section 5 as well as the results from users. The results from Section 5 were discussed in Section 6. The conclusions drawn from this work are given in Section 7.

3. Modelling the Core Functionalities of an Institutional Repository

To get a better perspective of the inner workings of a typical EPrints Institutional Repository, we produced the following with the aid of Microsoft Visio 2007: Use case diagram, Sequence diagram, and Software architecture.

3.1 Use Case Diagram

This visually captures the interaction of users (also known as actors) with a given system[19]. The use case diagram for our repository is given in Figure 1.
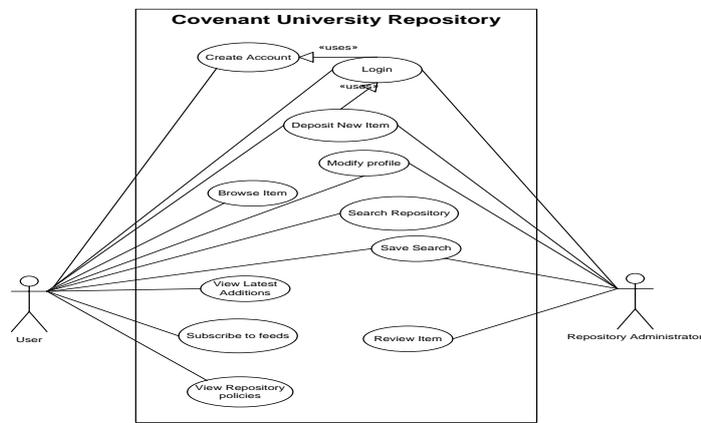

Figure 1. Use case diagram for Covenant University Repository.

3.2 Sequence Diagram

Sequence diagram is an interaction diagram that visually depicts how processes work with one another as well as the order in which this is done[20]. Figure 2 shows sequence diagram for Covenant University repository:
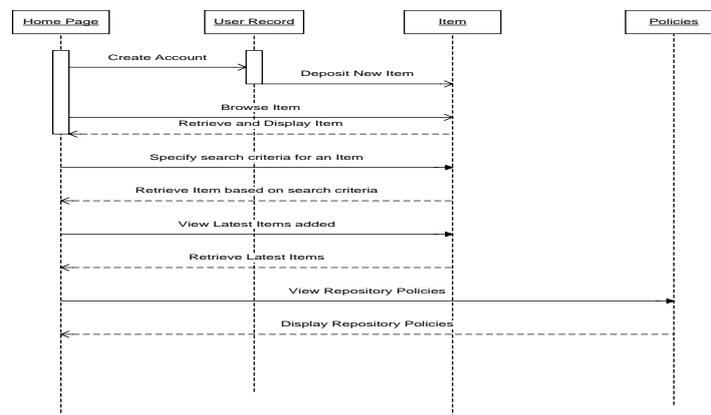

Figure 2. Covenant University Repository Sequence Diagram.

3.3 Conceptual Model of Repository Software

Covenant University Repository has a 3-tier client-server architecture design. It comprises of client interface, middleware and database. It is given in Figure 3.
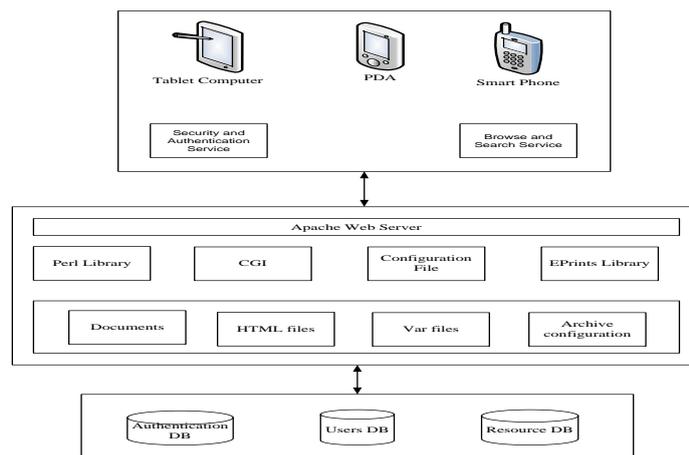

Figure 3. Conceptual Model of Covenant University Repository.

4. Testing the Core Functionalities on Mobile Devices

The core functionalities of Institutional Repository that we considered include the following: Search an Item; Create Account; Browse Item; Login; View Latest Additions; Deposit Item; Review an Item; Download Item; Save Search and Modify Profile The devices on which we carried out the test include: a Nokia Xpress Music phone (running on Symbian OS); a Coby Kyros MID 7024 tablet (with 800 x 480 pixels, 512MB RAM and 1GHz processor running Android v2.2); an iPad 1 (with 1024 x 768 pixels, 1000MHz and 16000MB built-in storage); an iPod Touch (with 960 x 640 pixel screen) and a BlackBerry Curve 2 phone (with 320 x 240 pixel screen and 512MHz processor).

4.1 Create Account

Before a user is able to deposit item in the repository, s/he must be registered with a user name and password. With the create account link in the repository, a user is able to create an account with which to login to the repository and make deposits. From all of the mobile devices used, this functionality of the repository could be accessed on all the mobile platforms considered.

4.2 Login

After creating an account, a user can access the authentication user interface by clicking the hyperlink labelled "Login" on the index page of the repository. Of the five mobile platforms considered, three of the mobile platforms were able to login successfully into the repository. They include: the Android tablet, the iPad and the iPod Touch.

4.3 Deposit Item:
Depositing an item to the repository is hinged on a user's ability to successfully create an account and login to the repository. There are five steps involved in depositing an item into an EPrints repository. The first step involves elucidating the kind of material to be archived. It can range from journal articles to postgraduate dissertations/thesis. The next step entails uploading the actual file to the repository. The third step involves filling the required metadata about the material being captured. In the fourth step, the item is classified using standard classification (Library of Congress Classification) and in the fifth step the item is deposited.

This function was performed successfully on the Android tablet and the iPod Touch only.

4.4 Download Item:
Due to the large size of files stored on the repository, it was difficult to download materials from the repository using the mobile devices.

4.5 Search an Item

One can perform search in the repository by using the search box feature located at the top-right position of the repository index page. A refined search can be conducted by clicking on the Search Repository hyperlink. This opens

an advanced search page that allows a user give detailed description of the item to be downloaded. The user can also opt for the simple search that contains fewer search fields.

The search function was performed successfully on the repository using all of the mobile devices.

4.6 Browse Item: Browsing in the repository can be done by year, by subject area, by division and by author. All of the mobile devices were able to perform the browse function successfully.

4.7 View Latest Additions: This link allows a user to view recently deposited items in the repository. The function was easily performed by all the mobile device platforms considered.

4.8 Review an Item: This function allows users with editorial privileges to login and review items submitted by other users and also decide whether or not to accept it into the repository. Except for the Nokia and BlackBerry devices that found it difficult to complete the login process, all of the other devices could easily be used by repository editors to review items to be deposited to the repository.

4.9 Modify Profile: This functionality allows a user to modify his/her profile on the repository. This functionality requires logging in to the repository as a result the function could not be completed on both the Symbian phone and the BlackBerry phone.

4.10 Save Search: This functionality allows a user to save a search term that returns results that the user finds interesting and may want to refer to at a later time. Again the only exceptions to accessing this functionality were the Symbian phone and the BlackBerry phone. After testing the repository's functionality on the mobile devices earlier mentioned, the findings are summarized in Table 1.

Table-1. Summary of Repository Feature Test with Mobile Devices.

Repository Feature	Nokia Phone	Android Tablet/Phone	iPad	iPod Touch	Blackberry Phone
Create Account	√	√	√	√	√
Login	X	√	√	√	X
Deposit Item	X	√	X	√	X
Download Item	√	X	√	√	X
Search an Item	√	√	√	√	√
Browse Item	√	√	√	√	√
View Latest Additions	√	√	√	√	√
View Repository Policies	√	√	√	√	√
Review an Item	X	√	√	√	X
Modify Profile	X	√	√	√	X
Save Search	X	√	√	√	X

Legend

√   Feature is accessible from mobile device

X   Feature is not accessible from mobile device

5.   USABILITY ATTRIBUTES AND EVALUATION

The usability attributes used to evaluate the Covenant University repository was gleaned from Information Services and Technology[18]. They include: simplicity, navigation, memorability, hypertext structure, consistency, completeness and self evidence.

Simplicity: How easy it is for users to comprehend and make use of the repository

Navigation: How easy it is to browse or surf the repository

Memorability: The ease with which users can return after a period of time away from the repository and re-establish proficiency?

Hypertext Structure: The dexterity with which essential information is structured on the repository.

Satisfaction: The satisfaction of its users in its ability to complete tasks in a few steps thereby saving time

Consistency: The extent to which the layout remains unchanged when navigating from one page to another

Completeness: The extent to which users are satisfied with the basic features of the repository and the appropriateness of the error messages prompted during errors Self Evidence: The level to which the repository tabs and links are descriptive and self informing to a user The questionnaire that was administered consisted of two sections. The first section captured the category of the would-be participants (Covenant University staff and students) and their skill/experience with computer software. It also captured the type of devices they used to access the repository. The second section captured information on the participants' perception of the repository based on each of the usability attributes earlier elucidated.

The questionnaire requested respondents to indicate the degree to which they agreed with each item. Participants interacted with the repository through mobile devices that could access the Internet. The person who administered the questionnaire only intervened when a participant indicated that s/he was done or could not follow the process through to conclusion. The questionnaires were administered immediately after each task to improve the accuracy of participants' response.All data were collected using a five point scale from "1", being "Strongly Disagree" to "5" being "Strongly Agree".For the first part of the questionnaire, 19 out of the 20 respondents filled in all the required information. Therefore Tables 2, 3 and 4 are based on the 19 persons that responded appropriately.

Table 2. Skill level of respondents.

	No. of respondents	Novice	Average	Good	Expert
Experience of respondents in the use of computer software	19	0%	5.26%	52.63%	42.12%

Table 2 indicates that the participants had at the very least average experience/skill in the use of computer software. In other words, none of the participants was a novice in the use of computer software. Table 3 shows the distribution of the devices used by the participants to access the repository. 10 (52.63%) of the participants used Android-enabled devices, 3 (15.79%) used Blackberry devices, 5 (26.32%) used laptops. One of the participants used an iPad while another used an iPod to access the repository.

Table 3. Devices used by the participants to access the repository.

	No. of participants	Android	Blackberry	iPad	iPod	Laptop
Devices used to access the repository	19	10	3	1	1	5
		52.63%	15.79%	5.26%	5.26%	26.32%

A total of 20 persons participated in the second part of the questionnaire, which was the usability study. The population count that was used is as suggested by Faulkner[21]. For all respondents, an overall score was computed for each of the usability dimension by averaging all the ratings on the questionnaire that was used. With the aid of Statistical Package for Social Sciences (SPSS) we generated the frequency distribution, mean, standard deviations and variances as well as all the relevant charts for the rating of each attribute. This is shown in Table 4.

Table 4. Descriptive Statistical Analysis of Questionnaire Data.

Attributes	Average	Standard Deviation	Variance
Simplicity	4.55	.484	.234
Navigation	4.30	.616	.379
Memorability	4.40	.447	.200
Hypertext Structure	4.40	.503	.253
Satisfaction	4.18	.694	.481
Consistency	4.40	.575	.332
Completeness	4.25	.618	.382
Self Evidence	4.45	.484	.234

The reliability estimates from the data gathered in the questionnaire was calculated. Reliability and convergent validity was estimated using Cronbach's alpha and produced a result of 0.771, which is above the recommended 0.7 given by Sauro and Kindlund[22]. It points out the reliability of the questionnaire results. Cronbach's Alpha coefficient theoretical maximum is usually set at 1.0. The reliability statistics and the Cronbach's alpha value are shown in Table 5 and Table 6 respectively.

Table 5. SPSS Test Cases.

	N	%
Valid	20	100.0
Excluded(a)	0	.0
Total	20	100.0

Table 6. Cronbach's Alpha.

Cronbach's Alpha	N of Items
.771	8

6. Discussion

The average rating for "Simplicity" was 4.55 out of 5. It indicates that the users found the repository easy to use and understand. The frequency graph is shown in Figure 4.
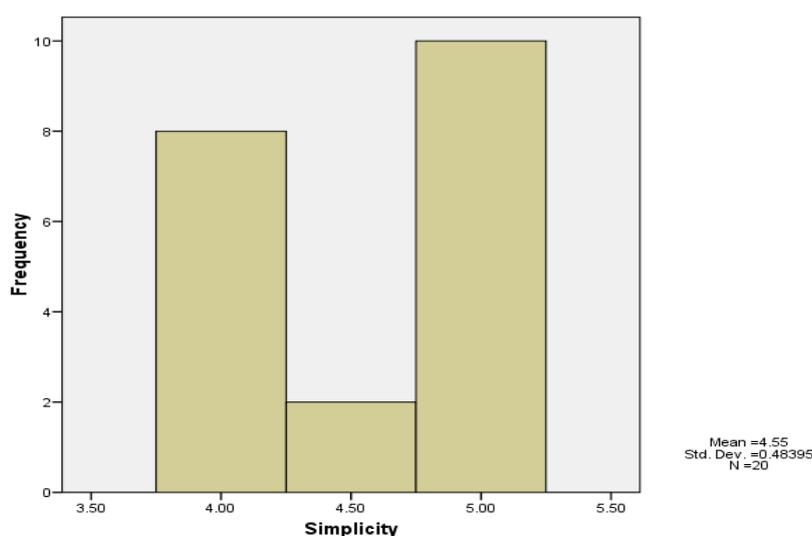
Figure 4. Frequency graph for the rating of Simplicity by participants.

A mean score of 4.30 for "Navigation" points out that many of the users did not have difficulties with browsing through the repository even from their mobile devices. Figure 5 shows the frequency graph of participants' rating of the repository's navigability.

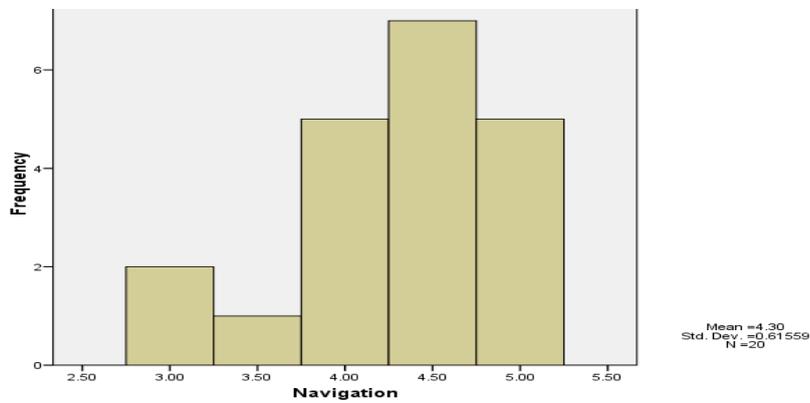Mean =4.30
Std. Dev. =0.61559
N =20

Figure 5. Frequency graph for the rating of Navigation by participants.

Memorability is an attribute that deals with how easy it is for respondents to recall how to complete a given task in the repository after a period of time. We measured this attribute by asking the respondents to revisit the repository and try to recall how to perform certain basic tasks in the repository after a period of two weeks. It was after this period that we asked them to rate this attribute on the questionnaire and the result was a mean rating of 4.40, which shows that system functions are easy to remember. The frequency graph for memorability as rated by the participants is given in Figure 6.

Mean =4.40
Std. Dev. =0.44721
N =20
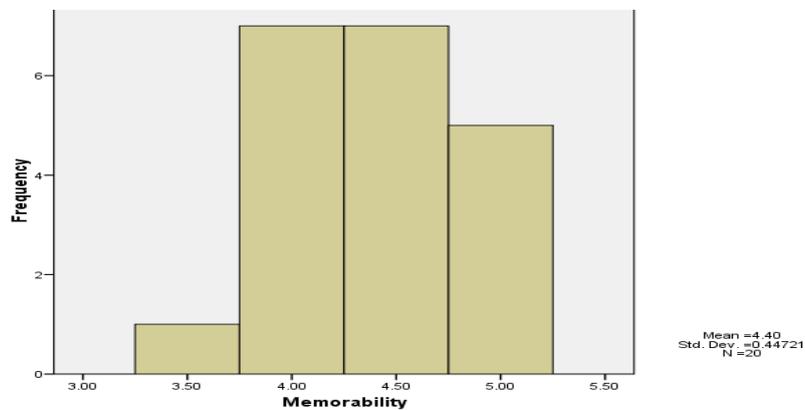
Figure 6. Frequency graph for the rating of Memorability by participants.

"Hypertext Structure" which is a measure of how well structured information about the repository's features are shares the same mean rating (4.40) with Memorability. The frequency graph is given in Figure 7.
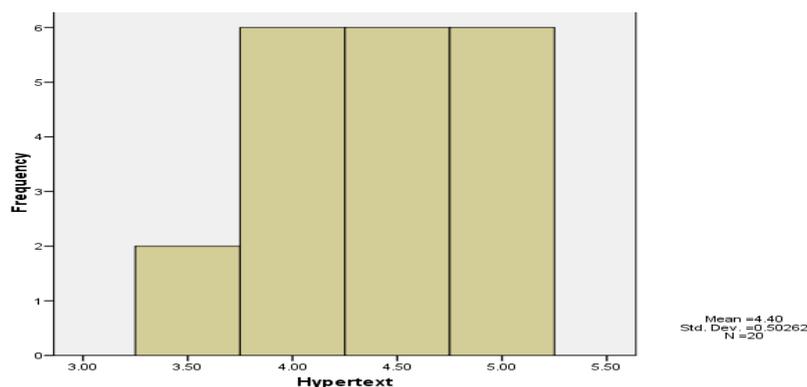

Mean =4.40
Std. Dev. =0.50262
N =20

Figure 7. Frequency graph for the rating of Hypertext Structure by participants.

For the "Satisfaction" attribute, most of the respondents were of the opinion that the repository required few steps to complete any task thereby saving time. The average score therefore was 4.18 out of 5. The frequency graph is given in Figure 8.
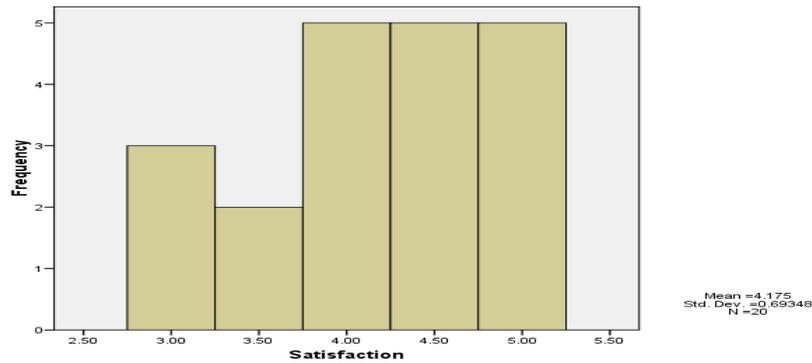

Figure 8. Frequency graph for the rating of Satisfaction by participants.

A number of the respondents were of the opinion that the repository had a good layout that was consistent as they navigated from one page to the other. The average score for Consistency was 4.40 out of 5. The frequency graph is given in Figure 9.
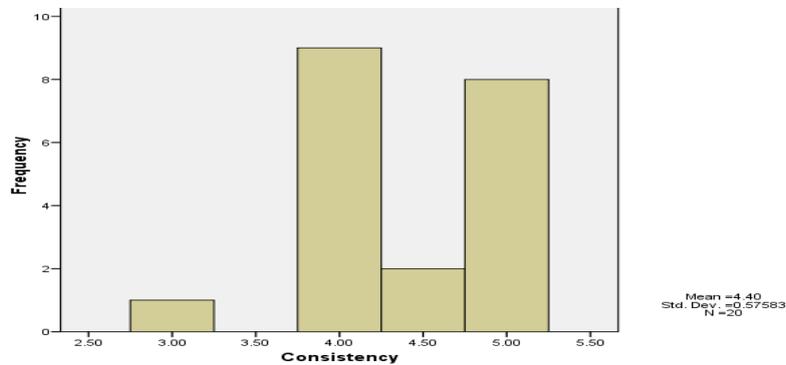

Figure 9. Frequency graph for the rating of Consistency by participants.

The mean rating for "Completeness" - the attribute that measures the extent of users' satisfaction with the basic features of the repository and the appropriateness of the error messages prompted during errors was 4.25. The frequency graph is shown in Figure 10.
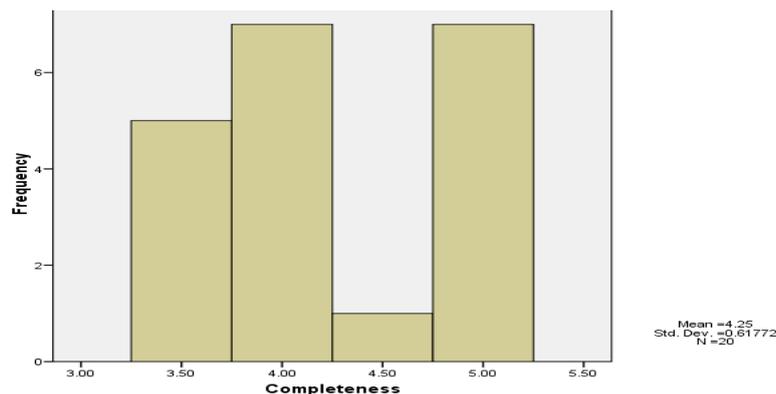

Figure 10. Frequency graph for the rating of Completeness by participants.

The average score of "Self Evidence" was 4.45. It points out the fact that the repository was structured in such a way that it was self-informing – there were relevant tabs and links to important pages and information on the repository. The frequency graph for participants' rating of Self Evidence is shown in Figure 11.
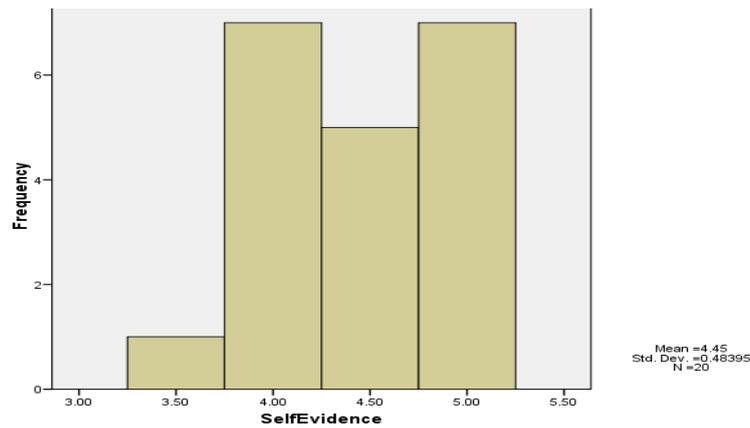

Figure 11. Frequency graph for the rating of Self Evidence by participants.

A number of studies in usability have reached a consensus on what "Good Usability" should be for a given system. For a scale of 1-5 the mean rating should be 4 while on a scale of 1-7, the mean rating should be 5.6[22]. We adopted scale 1-5, and conclude that the repository had "Good Usability" on mobile devices based on the average rating of each attribute shown in Figure 12. The graph shows that all the attributes exceed the minimum pass mark of 4 out of 5.
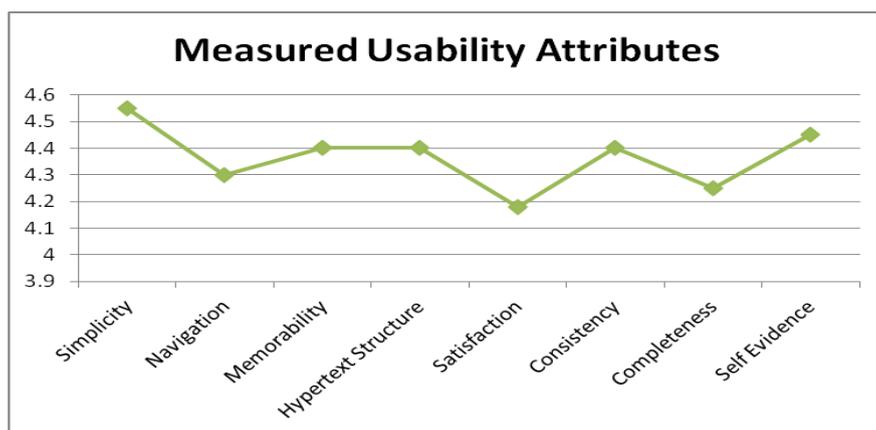

Figure 12. Graphical Summary of the Usability Attribute Ratings.

7. Conclusion

This paper set out to answer two research questions as put forth in Section 2. Research question (RQ1) was answered in Section 5 when the key features of an EPrints were tested out on five mobile devices with a summary table presented in Table 1. Research question (RQ2) sought to get feedback from users of the repository on the usability of the repository on mobile devices. This was executed through questionnaires and the results were reported in the Discussion Section.

Although this research has shown that by using Web standards an institutional repository can have good usability score on mobile devices there is room to extend the work further. This is discussed as follows:

The fact that some of the functionalities of the repository could not be accessed call for more research as to what could be the cause and possible solution of the problem With the emergence of frameworks (e.g. Apache Cordova formerly referred to as Phone Gap) that allow you to write a single code and compile it to several mobile platforms, this can be explored in building mobile interfaces for repositories. In conclusion, artificial intelligence techniques (e.g. fuzzy logic) can be employed in order to further analyze the degree of usability of the repository.

Acknowledgements

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