Laboratory-Based Usability Test

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Abstract: *Usability is becoming a vital aspect of the spread and marketing of any website. The present research applied laboratory-based usability testing on Shura website. For this purpose, a laboratory was designed and equipped so that participants can perform the test under direct observation and supervision of the testing team. The Participants were recruited and selected by an online survey. Prior to the test, all participants responded to pre-questionnaire to understand their attitudes. Test tasks were designed to test two versions of the website in concern. As a result, the laboratory-based test proved to be effective in discovering the drawback of the website even with a little number of participants.*

Keywords: *User Centered Design, Website Usability, Software Usability, Ergonomics*

I. INTRODUCTION

Usability as a term describes the extent of ease of using a system, a website, software or any other product. It analysis the user's experience to find out the obstacles facing him/her and provide guidance to solve the problems encountered. Usability is vital for optimal use of a design that is designed in the first place to satisfy the user [1]. Recently, usability has been considered as one of the quality central concepts specifically for software. The usability researches are focusing on making the software easy to learn, easy to follow, able to correct errors, less confusable, and readable. Generally, when designing a website, the owner negotiates with the designer about the time and the cost. Then the website launched on the internet as soon as the design is done. Soon after, the customers start complaining and the number of visitors will not be as planned. In the website market, the common mistake is that the designers consider themselves as optimal users [2].

Usability is defined in ISO/IEC 9126 as a set of attributes that describes the effort needed for the use and on individual assessment of use by a stated or implied group of users [3]. On the other hand, IEEE Std.610.12 has defined usability as the ease in enabling the user to learn how to operate, prepare inputs, and interpret outputs of a system or components [4].

Typically, the usability test is the inclusion of user performance of a given task to test the ease and efficiency in the way the task is performed and later to test user's subsequent satisfaction on the product and their own performance [5]. During the test, quantitative and qualitative data related to the user's success, the speed of performance and satisfaction can be collected [6]. The usability test helps in discovering problems either in the user interface or in the design itself [7]. In addition, the usability test can be performed by many methods such as Automatic Evaluation Method, Conative Walkthrough, Heuristic Evaluation, Laboratory Testing, Think Aloud Testing, and Remote Testing [8].

Laboratory Usability Test

In most literature, usability laboratory testing method has been defined as an empirical usability testing. It is also considered the classic, most sophisticated and most logical usability testing method [9]. This method helps to know whether the program, website or even a home entertainment system is easy enough to use by observing some people while trying to use it and record the problems encountered, fix them and test again. Previously, this kind of test was very expensive due the need of usability laboratory equipped with a side room separated from the main testing room by a one-way mirror and at least 2 video cameras to record user's reactions and all other happenings. It requires also recruiting people to perform the test. Therefore, laboratory method was not applied so frequently because the high cost [2]. However, in many researches, laboratory-based usability tests used to be the main method. It was an acceptable and efficient method to discover usability problems of websites and other applications [10]. On the other hand,

concerning the number of participants that is enough to perform Lab tests, the conventional usability test was a formal process where the experimental design was implemented. And since tests used to be shown as research experiments that required 30 to 50 test subjects (participants), most companies were not able to bear the cost which led to a small number of works [16]. In the early 1990s, some studies showed that tests can be performed efficiently with less number of participants [17-20]. It was found that studies with a small number of participants covered 80-85% of the details used to be covered with studies with a bigger number [21]. Recently, a specific screen capture software is used for the laboratory testing. Keystrokes and mouse movement is also recorded by the same software [11].

II.   OBJECTIVES

The present research aims to perform direct observation tests of the users' performance (in laboratory) while using both versions (issues) of the tested website. In this test, we evaluated the Shura website; which is a remote project management platform; by two versions the present version (Alpha) and a suggested new version (Beta). The goal of this test is to compare and define usability problems in both versions by analyzing users' performance. Although the used test method is known for its high cost, it is believed that with the introduction of some modifications cost can be reduced. For example, Molich and Nielsen have provided a method to reduce the cost [12]. On the other hand, Kurg has developed a technique called lost-our-lease for usability lab tests [2]. Table 1 shows the differences between the conventional test, Kurg test and the present test developed by this study where the cost was reduced to 1/6 comparing to the lost-our-lease method.

Table 1. The differences between Kurg test, the conventional test [13], and the test suggested in this research.

	Conventional Test	Kurg Test	Our Test
Number of Participants	Typically more than 6 depending on the available budget	3 or 4 only	8
Recruiting Efforts	Keen selection is done until the targeted specimen is reached	Gathering some people. In principle, any person can use the web/program	As in the conventional way
Place of Test	Usability test equipped with all surveillance tools	Any office or meeting room	A laboratory was prepared with necessary tools
Who does the Test?	Specialist	Any person who is logic and patient	Anyone who was interested
Additional Planning	The test has to be done according to a fixed schedule. Enough time is left for recruiting participants	The test can be done at any time with less scheduling. Equipment are simple even Mobile camera is enough	As in conventional way
Cost	$5,000 to $15,000 (or more)	About $300 (a $50 to $100 stipend for each user and $20 for three hours	Participants were volunteers and the cost was simple
What happens after the test?	About 20 pages' report, which takes time. Then the development team does the necessary changes.	Notes are written on memo papers during the test and it is reported to the developing team on the same day.	As in the conventional way. But, the development team was noticed step by step using an interactive tools.

III.   METHODOLOGY

The used procedures in this study were driven from a technical guideline are as follow [14]:

1- Determine the goal of the test and the tasks that will be tested.
2- Writing down the scenario for the tasks, determining the tools and preparing the questionnaires.
3- Defining the participants and start recruiting them.
4- Performing the pilot test to validate the procedures and make the necessary modification.
5- Performing the test with the participants.
6- Analyzing the observation data that recorded audio-visually and the responses of the questionnaires.
7- Reporting and recommendations.

Recruiting Participants for Usability Test

Many studies used the term recruiting on the process of participants' selection [2, 13, 15]. A questionnaire is usually used in recruiting people for the usability test. However, to avoid wasting any time in analyzing the answers of the questionnaire, some researchers suggested using "screening questions" which make no chance to the respondents to know which answer is the one targeted by the questionnaire (the right answer) [15]. Other researchers suggested to screen respondents and classify them according to their experience into insufficient and expert by weighing the answers with points and stop the questionnaire when the person is not within the targeted group. Carol M. Barnum emphasized the importance of screening in recruiting participants [16]. In this study, an online questioner was designed using screening questions then distributed on social websites. A paper version of this questioner also distributed with the first question omitted. Table 2 shows the used questions with their marks. To evaluate the experience of the participants, only internet use skills were considered and classified as beginner, intermediate, and advanced. An expert performed the pilot test to find out any needed modification prior to the test starting date.

Table 2. Recruiting the participants questionnaire.

Introductory message: We need a number of volunteers to perform a test of a website. The test includes performing some tasks on the website. The place of the test will be at Usability Lab at Aleppo University. The test may take about one hour. If you wish to join, please answer the questionnaire.

1- Do you live now in Aleppo?
    a.   Yes (continue the test)
    b.   No (stop the test)
2- Do you usually browse websites at home/work?
    a.   Yes (continue the test)
    b.   No (stop the test)
3- Since when do you use the internet?
    a.   Less than 6 months (stop the test).
    b.   Between 1 and 3 years (1 point is given).
    c.   More than 3 years (2 points are given).
4- For how long do you use the internet weekly?
    a.   Less than 2 hours (stop the test).
    b.   Between 2 and 5 hours (1 point is given).
    c.   More than 5 hours (2 points are given).
5- Please define which of the following tasks do you perform? (multiple choice. No point is given if the number of selected choices is less than 2, 1 point is given if it is between 2 and 5 choices and 2 points are given if the number is more than 5)
    a.   Visiting scientific sites.
    b.   Updating/downloading programs.
    c.   Design websites.
    d.   Using e-mail.
    e.   E-shopping.
    f.   Login social media.
    g.   Add some personal touch to my PC and browser.
    h.   Other ……………………………………..

Responders were classified according to their score. The used classification is summarized in Table 3. The participants were selected randomly from each experience level, then contacted to select the test date.

Table 3. Scored points and level of expertise.

Points (Score)	Level
0	Novice
1-2	Beginner
3-4	Intermediate
5-6	Advanced
>6	Expert

Pilot Test

The tested tasks and scenarios were designed and then tested by pilot test. Some drawbacks were discovered and modified. Tables 4 and 5 show a list of the final tested tasks items for both Alpha and Beta version, respectively.

Table 4. Tasks for testing Alpha version of Shura

Task No.	Task content
1	Login using username: sah******** , and password: *******
2	Enter workgroup SMA
3	Use "Shura system" icon to surf the site. Then enter to: help file – Shura usability – Shura test 2
4	Edit the present page by writing the following: "Shura Lab Test". Make the font size 18, centralized text and color of your choice and finally save the change.
5	In the present page, answer the comment of Mr. X1. The answer can be any words.
6	In the present page, delete the answer you made to Mr. X1's comment.
7	Search the website for the word "management".
8	Enter the user profile and change the photo.
9	Return to home
10	Sign out

Table 5. Tasks for testing Beta version of Shura

Task No.	Task content
1	Enter workgroup SMA
2	Use the "Root" icon to surf the site. Then enter to: help file –Shura usability–Shura test 2
3	Return to Shura main menu/homepage.
4	Search the site for "project management" and open the document.
5	Enter the user profile and change the photo.
6	Sign out

Laboratory Design

There is a variety of Usability Laboratory design. The difference between each design lies in the tools and extra cost that the organization is able to offer. However, the basic requirements are similar. In all laboratory designs, it is needed to record and document all reactions of the user in a way that enables later analysis. In the present research, the Laboratory ergonomically within one room divided into three workstations. Figure 1 shows a detailed layout of the Lab.
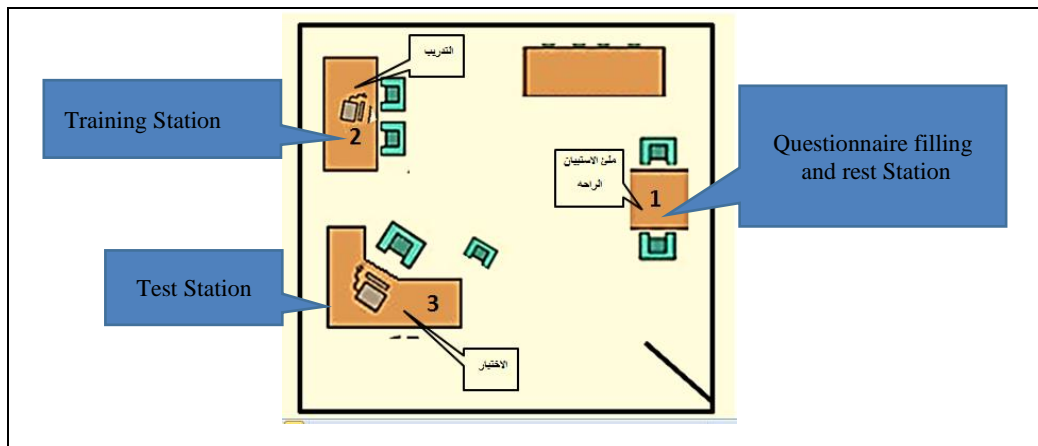
Fig. 1. Top view of Usability Test Lab layout.

Tools

The tools used during the test were:
1- Usability Studio Program.
2- 2 PCs, one for the training and the other for performing the test.
3- Internet connection Type DSL.
4- Pens and papers for the questionnaire.

Recorded Data

The types of data recorded during the test were:
1- Video recording of the computer screen.
2- Video recording to the face of the participant.
3- Mouse movement and clicks.

Questionnaire

During the test, pre- and post-test were used. The pre-test questionnaire collected the demographic data of the participants in addition to some personal information to understand the participants' attitudes and the way they deal with the tested website. Fig. 2 includes the pre-test questionnaire. Regarding the post-test questionnaire, a system usability scale (SUS) was adopted using the scale from 0 to100. Fig. 3 shows the 10 statements that formed this questionnaire.

Fig. 2. Pre-test questionnaire

Some non-native speakers may have a problem understanding some terms such as "cumbersome" in item no.8, so it has to be replaced with a word that is more common [22]. However, in our research, the post-test questionnaire was translated into Arabic to fit all participants and used terminologies were adjusted accordingly.

Fig. 3. Post-test (SUS) questionnaire [23]

Test Procedures

The participants did the test separately one by one. The participant was informed that he/she can stop the test at any time and the test is intended for the website and not at all targeting their abilities. The test procedures included the following:

1- Explaining the goal of the test, used tools and procedures.
2- Participant filled out the pre-test questionnaire. This step is done on worktable No.1.
3- Training the participant on task performance and explain how video recording will be done. This was done on worktable No. 2.
4- Perform the test on Shura website while the tester is observing and writing down notes. This step is done on worktable No.3.
5- After the participants finish the test on the Alpha version of Shura, they are asked whether they would like to proceed to test the Beta version.
6- After test is finished on both versions, the participants write the SUS questionnaire.
7- Show the participant the video that was recorded during the test to get his/her approval.
8- Thank the participants for their volunteer contribution, show them the video and get their permission to use the data.

Remarks on the Test

1- All notes were written on cards during the test.
2- The tester was neutral and did not show any reaction on the performance of the participants.
3- In case the participant felt confusion, he/she was requested to take a break.
4- If the participants asked any question during test performance, the tester answers were not included any judgment. The question and the answer had to be recorded on the card. Table 6 shows some samples of questions that were asked by participants during the test.

Table 6. Sample of questions asked by participants during the test.

Question by participant	Answer by tester
Am I doing right?	Sure.
Why search results did not appear?	Please behave as you do normally at home.
How can I know if the task is done?	Your personal estimate is the criteria. When you feel that the task is done then shift to the next task.

IV.   RESULTS

Participants' details

The number of participants was 8 (7 males and 1 female). For privacy reasons, only initials were used to identify participants. Table 7 shows the details of each participant.

Table 7. Details of each participant

Name Initials	Profession	Score (expertise level)
R.J	Engineer (Pilot test)	7 Professional
T.M	Engineer	4 Medium
A.D	Engineer	3 Medium
M.H	Student	5 Advanced
W.H	Accountant	4 Medium
R.H	Teacher	2 Primary
M.R	Engineer	5 Advanced
A.M	Student	2 Primary

Results of pre-test questionnaire

As mentioned before, the purpose of the pre-test questionnaire was to get more information about participants. The following figures show such details.
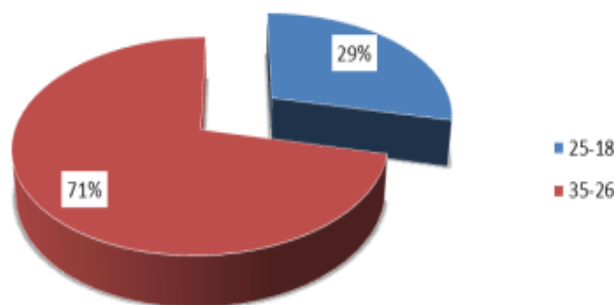
Fig. 4. Participants' age.
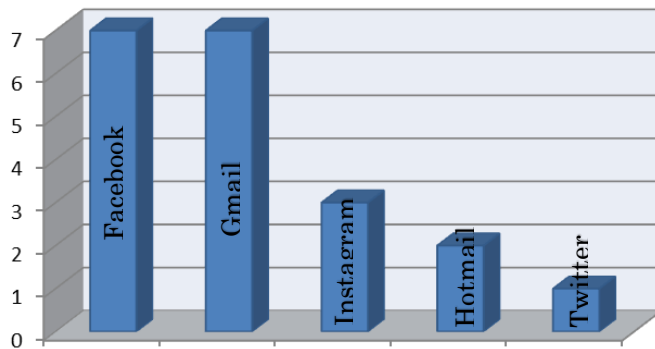
Facebook	7
Gmail	7
Instagram	3
Hotmail	2
Twitter	1

Fig. 5. Electronic accounts of the participants
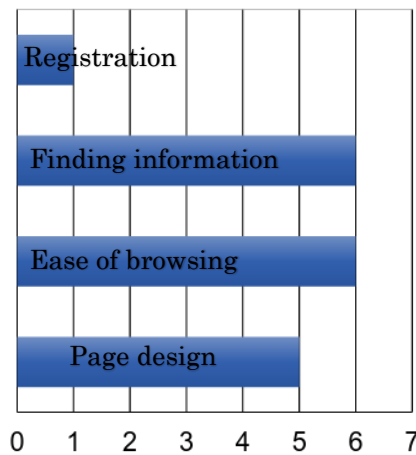
Page design	5
Finding information	6
Ease of browsing	6
Registration	1

Fig. 6. What most concern the participants when they brows a webpage.

Results of Lab test

Recorded videos were analyzed carefully along with the details about task performance, asked questions, and comments during the test. Table 8 shows an example of the performance of one participant during the testing Alpha Version of Shura.

Table 8. Example of the performance of one participant during the testing of the Alpha version of Shura

| Task	User Action	Time Min:Sec	Comments and remarks
1	Clicked "Enter" after writing username and password.	S 0:0 E 0:8	
2	Clicked SMA icon then clicked task ending after entering to the group.	S 0:8 E 0:43	
3	Clicked "Shura system" icon. Followed the path: Help – Shura Usability – enter the required page.	S 1:01 E 1:46	
4	Clicked "Edit page" icon, then tried font size 18, green color, right alignment, and finally clicked "save changes".	S 1:48 E 3:01	
5	Browsed to the bottom of the page, wrote a comment and the pressed "enter" on keyboard.	S 3:03 E 5:20	The reason for the long time spent on this task was that the participant took a long time to think about a

			proper comment.
6	Clicked "X" sign near comment box.	S 5:21 E 5: 26	
7	Wrote the word "Management" in the search box located at the top of the page and pressed "Enter Key" on the keyboard. When the "Leave Page" notice appeared, the participant read it and clicked "Leave this page". When noticed nothing happened the participant clicked "End Task".	S 5: 28 E 6:19	From the face of the participant, it was clear that he was surprised seeing the "Leave page" notice.
8	Clicked the icon that holds username then selected "Modify your profile" from the drop list. When the new page appeared, the participant clicked the "Change profile image" icon which is located below the profile photo.	S 6:20 E 7:42	
9	Clicked the "Shura system" icon which leads to browsing the content of the website. Then looked for a way to return to the main page. The participant clicked most of the contents of the page then wrote a comment. Finally gave up and wrote www.shurasystem.com and pressed the enter key on the key board.	S 7: 43 E 8:55	
10	Clicked the icon that hold username and selected "Logout" from the drop list.	S 8:57 E 9:02	

Table 9 summarizes the results for all participants and Table 10 summarizes the results for each task for Alpha version.

Table 9. Summary of the results of all participants (Alpha Version)

Task Participant	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9	Task 10
1	○	○	○	○	○	○	○	○	✕	○
2	○	○	○	○	○	○	✕	○	⊗	○
3	○	○	○	✕	○	○	✕	○	✕	○
4	○	○	○	✕	○	○	⊗	○	✕	○
5	○	○	○	○	○	○	✕	○	⊗	○
6	○	○	✕	○	○	○	○	○	⊗	✕
7	○	○	○	✕	○	○	⊗	○	✕	○
Success:○ Failure:✕ Abandonment: ⊗										

Table 10. Summary of each task (Alpha Version)

Task Result	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9	Task 10
Success%	100	100	86	71	100	100	28.5	100	0	86
Failure%	0	0	14	29	0	0	43	0	57	14
Abandonment%	0	0	0	0	0	0	28.5	0	43	0

Table 11 summarizes the results for all participants and Table 12 summarizes the results for each task for Beta Version.

Table 11. Summary of the results of all participants (Beta Version)

Task Participant	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
1	○	○	⊗	○	○	○
2	○	⊗	○	○	○	○
3	○	○	⊗	✕	○	○
4	○	⊗	○	✕	○	○
Success:○ Failure:✕ Abandonment: ⊗						

Table 12. Summary of each task (Beta Version)

Task Result	Task1	Task 2	Task 3	Task 4	Task 5	Task 6
Success%	100	50	25	25	75	100
Failure%	0	0	25	75	0	0
Abandonment%	0	50	50	0	25	0

Results of Post-Test Questionnaire SUS

Table 13 shows scores of the SUS questionnaire for the Alpha version.

Table 13. SUS score (Alpha Version)

Participant	SUS score
1	20×2.5=50
2	23×2.5=57.5
3	21×2.5=52.5
4	18×2.5=45
5	22×2.5=55
6	24×2.5=60
7	15×2.5=37.5
Ave.	20.428×2.5=52.8%

Table 14 shows the SUS scores for all participants for the Beta Version.

Table 14. SUS score (Beta Version)

Participant	SUS score
1	22×2.5=55
2	16×2.5=40
3	25×2.5=62.5
4	20×2.5=50
Ave.	20.75×2.5=51.875%

V.   DISCUSSION AND CONCLUSION

Task performance of present Alpha version

1- As for task 1 (login), task 2 (enter to the workgroup), task 5 (answer the comment) and task 6 (delete the answer), the success ratio was 100%.
2- Participant 6 failed in task 3 (browsing and entering into one page) because the clickability of the icon that classifies the subjects was ambiguous. The participant claimed to click the icon but it was not actually clicked. Eventually, the test supervisor clicked it in front of the participant.
3- The failure ratio for task 4 was 29%. Participants 3 and 4 wrote in the "comment" box instead of clicking the "Edit page". Figure 7 shows the wrong action done by participants 3 and 4 and the correct action. On the other hand, participant 7 failed in task 4 because he did not save the changes by clicking on the "save changes" icon after writing the necessary text.

Fig. 7. the wrong action done by participants 3 and 4 and the correct action.

4- In task 7, participants 2, 3, and 5 failed in it, while participants 4 and 7 abandoned it. Participants used the search box on the present page, while the correct action was to write in the search box on the site index page. Figure 8 shows the way used by almost all participants to search and the correct way which is by first moving to the "Shura system" content page then write the intended search words in the box there. Success ratio in performing task 7 was 28.5% where only participants 1 and 6 succeeded. Participant 1 succeeded because he insisted on doing the "search" task and tried many ways. When asked about the reason, he said that it is his nature not to give up.
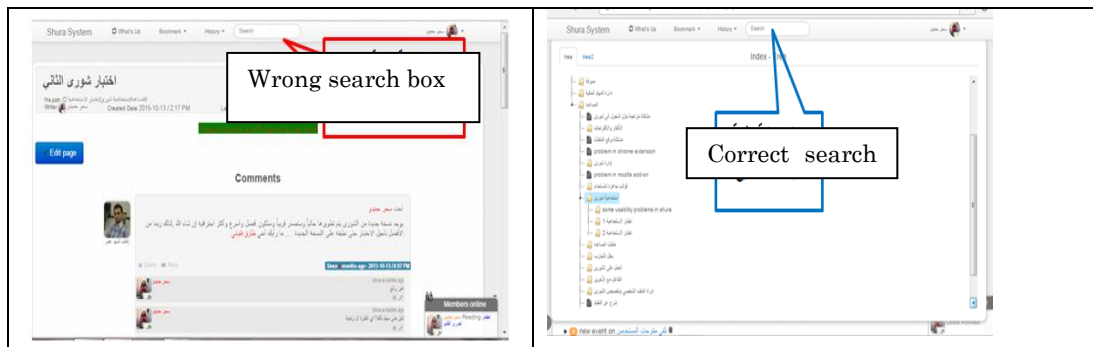

Fig. 8. The wrong (performed by almost all participants) and the correct search way.

5- None of the participants performed task 9 (return to the main page) as planned by the designers. Figure 9 shows the icon (indicated in blue) that has to be clicked in order to return to the main page and succeed in task 9. Most participants clicked the "Shura system" icon (indicated in red). Participants 1, 3 and 4 returned to the main page by keeping the main URL of the site in the URL box, removing all other subpages' indicators and then pressing "Enter Key" on the keyboard.
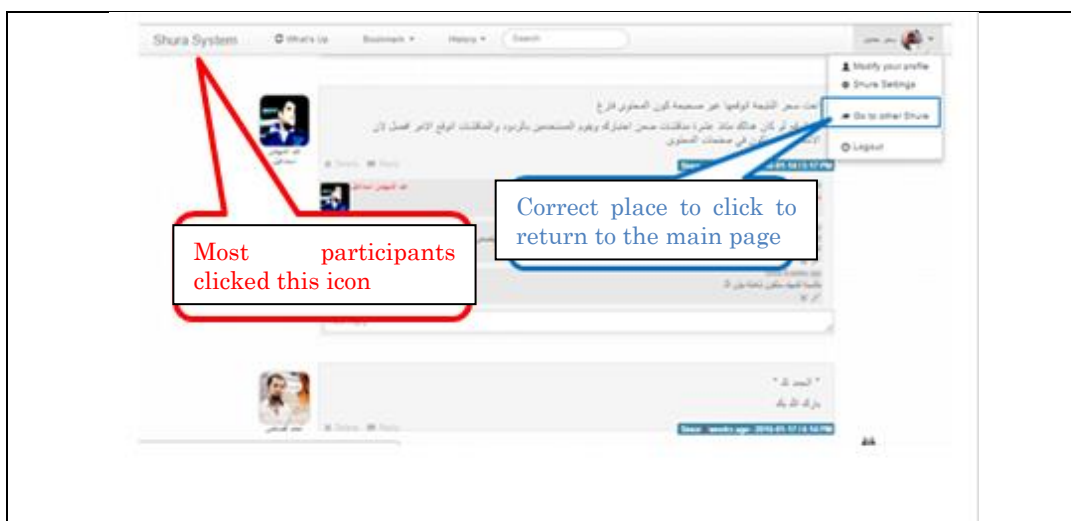
Fig. 9: Designers intended icon (in blue) and most participants-clicked icon (in red)

Task performance of Beta version

1- The success ratio for tasks 1 and 6 was 100%.

2- The success ratio for task 2 (browsing and entering one page) was 50%. On the other hand, 50% of the participants abandoned this task. Participant 2 abandoned the task after several trials to find the icon. Participant 4 also did not succeed in entering the designated page because the classification method of the subjects of the site was not clear.

3- For task 3 (return to the main page), the ratios of success, failure and abandonment were 25%, 25%, and 50%, respectively. Participant 1 abandoned the task because – as he said- did not want to waste time, as he did in the test for the Alpha version for a similar task. Participant 3 tried to find a way to perform the task. Eventually, after a few trials, he gave up. Participant 2 failed in performing the task and clicked the "go back" arrow of the browser.

4- Task 4 (search within the site). Participants 1, 2 and 4 failed in this task. They followed a similar method where they have put the search phrase in the search box of the present page, while the correct way was to write the search phrase in the search box of the "site content page". Only participant 3 succeeded in this task because accidentally he was in the "site content page" as a result of the previous task.

Usability problems in the present Alpha version

1- Clickability

For most participants, the icons were ambiguous. Some participants clicked randomly on the site or even clicked several times in the same position. For task 3, although the name of the site content icon "Shura system" was clearly mentioned in the instruction of the task, most participants made the search in the present page where they are browsing.

2- Search within the site

The process of "search within the site" was not effective. Participants failed and did not know the reason why. When asked this issue, some employees of the developing company replied that they found the correct search way by try and error method.

3- Lack of effective feedback

Except for the sign of page loading, the entire site does not include any signal or notice that notify the user about the success of action he performed. For example, participant 1 clicked many times in the same place while wondering whether the command was fulfilled or not. Participant 2 also clicked several times without noticing that the page is being uploaded. The same observed when participant 6 was surfing the site contents.

4- Ambiguity of icons

In the task of "editing the page", participant 3 did not notice the "Edit page" icon. Participant 7 did not notice the "save changes" icon.

5- Lack of consistency

Generally, the site had a big inconsistency problem. It uses Arabic in some pages and English on other pages to indicate the same topic.

6- Confirm the navigation window

People do not like to read much. Contradicting with the principle of reading laziness a window appears to confirm "leave page" action each time the user intends to leave a page and move to another page, figure 10. It was observed that the appearance of this window strayed the attention of the participants. For example, when doing a search, the surprised look appeared on the face of participant 2 when he saw the window. Participant 1 confused and selected the command "stay on this page". Participant 4 closed the window without reading its contents. It was clear that the problem lied in the choices within the window where most participants did not know the proper choice which was "leave this page" in order to fulfill the task.
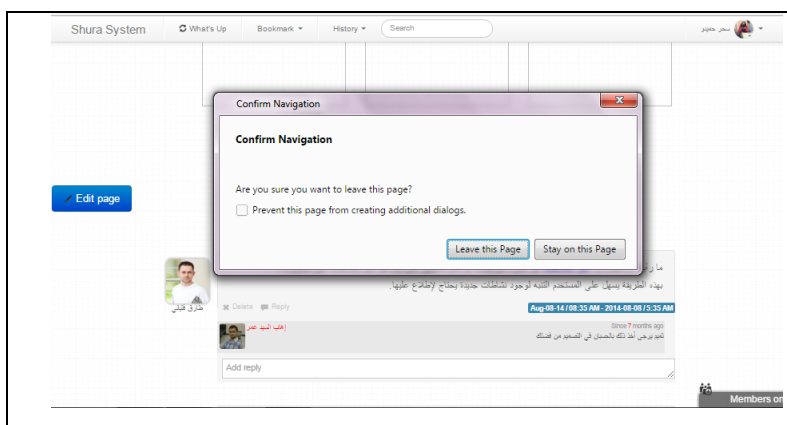
Fig. 10. "Leave page" confirmation window.

7- Lack of clear way to return to the main page of the site

Participants 1, 3 and 4 followed the way of deleting of sub details from URL address and kept only mail page address to return to the main page. "Shura system" icon deceived participant 1 where he clicked to return to the main page. "Shura system" icon was for browsing the contents of the site and not the main page.

8- Extra information

The website included much extra unnecessary information, figure 11. For example, the main page contained information about new pages created, comments, etc. When asked about the meaning of that information, participant 7 replied that he did not know because he did not read.
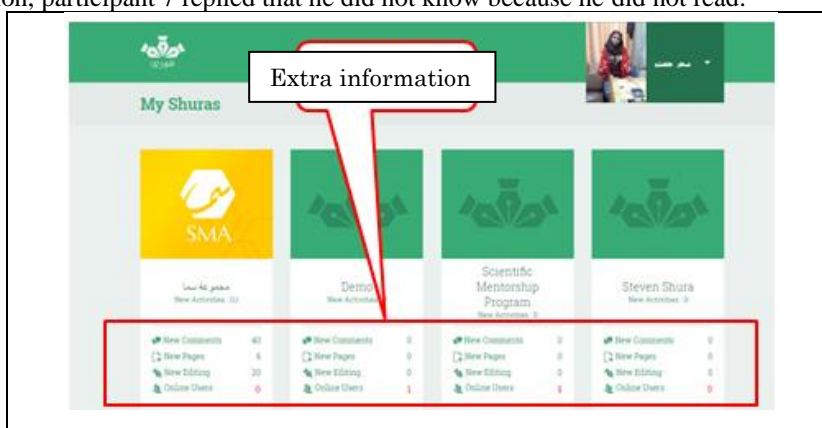
Fig. 11. Extra unnecessary information

The advantages in the present Alpha version were:
1- The ease in changing the page since it follows the typical way know to all participants.
2- The ease of logging out since it follows the typical way know to all participants.
3- The presence of two ways to perform "delete a comment".

Usability problems in Beta version

1- The ambiguity of the meaning of the icons and symbols:

The meaning of the symbols located at the top of the page was not clear, figure 12. The icons and

symbols did not give enough hint to the meaning intended by the designer. For example, the icon was meant to the classification of the content of the site. In task 2, there was an indirect indication of that but was not helpful in the fulfillment of the task.

Fig. 12. The ambiguity of the symbols at the top of the page.

2- The contrast:

Beta version interfaces used green hues backgrounds with a white-colored font. This reduced the readability of the content, the thing which was noticed clearly in the "search" task, where the search phrase written in the search box was not clear enough. The participants had to bent closer to the monitor to check whether the phrase was written or not.

Table 15 compares some aspects of both Alpha and Beta versions.

Table 15. Comparing both Alpha and Beta Versions

	Alpha	**Beta**	**Remarks**
Sign of Loading Page	Better	Ambiguous	
Browsing site content	Better	Ambiguous	In Beta, the participants could not recognize the sequence of browsing.
SUS usability indicator	Low	Low	It indicates the poor user experience.
Success ratio			It is not good to compare both versions from success ratio point of view, since the numbers of tasks and participants were different. It is better to compare similar tasks. For example, "search" task success ratio was low in both versions.

Finally, the laboratory-based usability testing adopted in the present research had proved to be effective method to be applied. The cost issue that was considered a disadvantage was solved. The presence of the tester and the participant in the same location helped overcome many difficulties and misinterpretations of results attributed to remote testing. Another drawback attributed to laboratory testing, that participants may not represent the entire intended community. This issue was almost overcome by recruiting process.

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