Investigation of the different Influences of Software Usability Quality Evaluation for Systems at Umm Al-Qura University

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Summary
Building software systems with quality in mind has been a focus for software engineering community over the past years. Therefore, many have introduced their approaches and tools to develop software systems with quality attributes [1]. One of these quality attributes of software systems is usability. In order to measure this quality attribute, approaches such SUS, SUMI, and other approaches have been introduced. This paper aims to employ SUS and other usability evaluation approaches in order to evaluate 4 software systems of Umm Al Qura University (UQU) and to investigate factors that might influence the results of such approaches. Three factors have been considered in the investigation namely gender, training, and pervious experience with similar software systems. The main findings show a noticeable influence of the factors on usability evaluation of the 4 systems of UQU. It was found that Females evaluates usability of the systems more positively. Similarly, evaluators with no previous experience with similar software systems tends to evaluate usability of the systems more positively.

Key words:
software engineering, software quality attributes, SUS, usability evaluations.

1. Introduction

Software requirement is an expression that describe a feature or a function which stakeholders need or expect to be in the system [2], [3]. Software analysts employ several requirement elicitations techniques, such as interviews, observations, questionnaires etc., in order to gather them from the clients [4]. Software requirements are generally divided into two categories which are functional and non-functional requirements. Non-functional requirements are also known as quality requirements [4].

Quality Attributes are features or characteristics that affects a system quality. In other words, Software Quality attributes are special requirements gained from stakeholders during requirement engineering [3], [5]. In this research the non-functional requirements are considered, the quality attribute of Usability.

Usability is can be defined as the level of effectiveness, efficiency, and satisfaction to achieve goals of a software system by intended users. Usability also known as a quality of a user-friendly which are required in a software system [6], [7]. Furthermore, Human Computer Interaction (HCI) principles allow designing software systems with usability in mind by offering guidelines for usability as well as approaches for evaluating usability.

This research aims to investigate the factors that might affect usability evaluations have. The investigation will be conducted on four software systems in Umm Al Qura University (UQU) [8]. UQU has several integrated software systems which facilitate the administrative work. In this research, four interactive systems (Masar - ETickets - MySite – EduGate) have been chosen for the investigation purpose of this study.

Masar [9] is the main paperless system which is an Administrative Communication System that is used to aid transaction within the UQU departments. In addition, ETickets [10] is a software system which has been developed to facilitates and enhance the work procedures in Deanship of Faculty Members and Employees Affairs which was originated for at the first place before applying this system to all departments and deanships.

EduGate [11] is a software system that encapsulates all academic services offered to the students and academic staff such as a Request for Apology for Study, a Request for Postponement of Study, a Request for Re-Enrolment for the Semester, a Request for Changing a Major, an Entry of the Students' Absence, and a Students Marks registrations. In addition, MySite [12] system offers integrated services for faculty, staff, and departments to manipulate their webpages and information in these pages.

Brooke [13] has introduced System Usability Scale (SUS) which is an approach for evaluating usability for software systems. It has become a worldwide industry standard approach for system usability evaluation [14]. It is a reliable approach which offers a 10-items questionnaire that allow qualitative measure of usability, learnability and satisfaction of system's users [15]. In addition, Software Usability Measurement Inventory (SUMI) [16] is a usability evaluation approach that relies on 50-items questionnaire with 3-points scale as (agree, undecided, and disagree) [17]– [19]. Several other approaches are introduced such as SUPR-Q [20], SUPR-Qm [21] QUIS [22], [23]. In this research, SUS has been employed in the investigation of the usability of the four software systems of UQU. This is due to the simplicity and shortness of questionnaire.

Many researchers have studied some of the factors that might have influenced on the SUS scores. One of these

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factors is User Experience which they showed that it can affect SUS scores. It is claimed that experienced users tend evaluated the average SUS evaluation score up to 15% higher [24]– [26]. They refer to User Experience as the level of familiarity of users to the system as users who see the system for the first time are counted as unexperienced. In addition, culture and language are claimed [25], [27] to be factors affecting the usability evaluations.

This research aims to consider the user experience from different point of views. First, point of view the official training of users on the systems. Second, the experience with other similar systems to the one under considerations. By focusing on these two points, user experience factor can be covered broadly. Another point of view which this research aims to focus on is the gender.

The Importance of this research is to highlight other factors that might have an impact on usability evaluations. Studying usability helps increasing productivity and minimizing costs [1]. However, studying the factors that might affect the results of the evaluations is essential in order to have the goal of usability evaluation achieved. In addition, studying the factors allows further interpretations of the evaluation results, consequently, it allows better use of usability evaluation approaches.

2. Related work

Kamran et al. [28] have introduced an expert evaluation approach that combine SUS technique and heuristic technique of Web Content Accessibility Guidelines (WCAG) 2.0 evaluation of usability. This approach was examined by trying to measure the usability of two mobile apps namely Accessible Qatar and LinkedIn. The aim was to evaluate interfaces for visually impaired users. The authors found that visibility and recognition heuristics are most violated.

Samuel et al. [29] have investigated the factors that affect the usability evaluation of a healthcare chatbots called WeightMentor which is a mobile app that helps users maintain weight loss. The authors found that simplicity of interfaces and the number of evaluators is factors that influence the usability evaluation scores (SUS). In addition, they suggested the number of 26 users to have a reasonable and realistic score.

Dowding et al. [30] have developed a domain specific dashboard for care nurses. In addition, SUS and QUIS have been adopted in order to measure the usability of this dashboard. Furthermore, 20 nurses were recruited in the evaluation process. The authors found that the users work experiences and knowledge of nursing impact positively the usability evaluation.

Desolda et al. [15] introduced a model which allow end users to intervene in customizing the Internet of Thing (IoT) objects in some smarts environments using End-User Development (EUD) paradigm. In addition, a visual web-based graphical interface has been designed for this model. Furthermore, SUS has been used in order to evaluate the usability of the model. The authors believe that many factors might affects the generality of the results. Some of these factors are the user experience, age, system types.

Abd Wahab et al. [31] have investigated the factors that influence the quality attribute evaluation of techno-spiritual application. The authors employed Post-Study System Usability Questionnaire (PSSUQ) which consists of 3 sections and 19-items to evaluate Effectiveness, Efficiency, and Satisfaction. The focus was on techno-spiritual application on mobile apps. The authors show that the purpose of the application impact positively the usability evaluations. In addition, the authors highlight that the operating system might impact the evaluation. Furthermore, the location where the user use and evaluated the application have influences on the usability evaluations.

Brown et al. [32] introduced Health IT Usability Evaluation Model (Health-ITUEM) which is a usability evaluation framework that combines several evaluation theories. The authors employed the Health-ITUEM in order to evaluate the usability of mobile health (mHealth) technology. The authors stated that device used for the applications might affect the usability of the application and the usability evaluation.

Thimthong et al. [33] have introduced a new usability evaluation approach called Net Easy Score (NES) which is based on Net Promotors Score (NPS) [34]. NES aims to obtain an early evaluation on user interfaces and the used design patterns before the final release. In addition, it divides the evaluation into two categories positive and negative. Furthermore, authors have addressed the effect of visualization on the evaluation of usability of the design patterns.

Suominen [24] has conducted a usability evaluation on a video conferencing service provided by Polycom for Metso company's employees. SUS approach has been used in order to conduct the usability evaluation on current users who are the employees. The author expected that after years of using the service the usability evaluation score would be higher than the average which is 68. The results were below the average. Although, difference of results to the average was not significant, this highlighted that the experience of user with systems might affect their usability evaluation of these systems with years.

McLellan et al. [25] investigated the impact of user experiences factor when evaluating the usability of systems. The usability evaluation was conducted using SUS on two versions of two systems of oilfield company. One of the systems was desktop and the other one was a web-based system. The authors found that the more experienced participants with the systems tend to evaluate the systems with higher scores of SUS. In addition, authors highlighted

other factors that might impact the usability evaluation such as cultural and language diversity.

Mansor et al. [19] have adopted Software Usability Measurement Inventory (SUMI) for evaluating the usability of WebCost software which is a cost estimation tool. SUMI is a 50-items questionnaire for usability evaluations. The authors have found that the WebCost has a good and easy interface and provides corrects outputs. However, authors have paid attention to the influence of the user experience and training factors, therefore, they aimed to specify the respondents to the questionnaire to be experienced people from companies like IBM, HeiTech, and other companies. This highlights the experience and training factors which might influence the evaluation of usability. However, the authors have not investigated these factors in their study.

3. Research questions

This research outlines three research questions which focus on the factors that affects the usability of evaluations for software systems.

***RQ1. Does gender affect the usability evaluation of a* system?** In order to answer this question, participants should reveal their gender type. This will allow classify the participants into two groups, then, calculate the responses accordingly to have an average of SUS score based on gender. Thereafter, it is possible to compare the SUS score and draw conclusions.

***RQ2. Does the technical background of similar* systems influence the usability evaluation of the system?** In order to answer this question, participants will be asked two related questions which will indicate their experience with other similar systems to the ones under considerations.

***RQ3. Does the usability evaluation affect user* training on the system?** In order to answer this question, participants will be asked a related question which will indicate their experience with the systems under considerations as if any official trainings have been given to participants in advance.

4. Methodology

In this research the survey methodology was employed. This is due to the efficiency and effectiveness of data collection that this methodology provides. Consequently, 4 identical questionnaires have been designed for each system under investigation namely Masar, ETickets, MySite, and EduGate. The questionnaires were circulated online via emails and social media to 120 respondents. 76 participants have completed the questionnaires with response rate of 63.3%. It is important to mention here that the respondents were of specific domain which is the Umm Al Qura University society namely faculty members, administrative staff, and technical staff.

Following the ethical manner of scientific research, respondents were informed that the collected data is confidential and is used for research purposes. Thereafter, they have been asked to provide their consent to participate and they were able to withdraw at any stage of the process. The participants were assured that their privacy is protected and respected

Each questionnaire consists of 3 parts. The first part is concerned about the general information about the participants. This information is the name, gender, job title, and qualifications. The second part adopted the Software Usability Scale (SUS) 10-items questions. SUS tool is a widely known for evaluations of usability [35], [36], [13]. SUS was adopted to allow comparison between the 4 systems. In addition, a question of 7-point adjective scale (1 Worst Imaginable, 2 Awful, 3 Poor, 4 OK, 5 Good, 6 Excellent, 7 Best Imaginable) was in second part of the questionnaire [35]. This is to allow further investigation on the usability of systems under considerations. Furthermore, Reichheld's [34], [37], [38] 11-point (0 to 10) likelihood recommend question was included in this part of the questionnaire in order to investigate the loyalty of the systems users. The third part of the questionnaire composed of 3 questions that of the type of Likert scale (5-point 1-5). The 3 questions are related to the research questions of this research namely RQ2 and RQ3.

Out of the 76 respondents 57.89% were male participants, whereas 42.11% were female participants. The majority of respondents are faculty members as 56.58%, whereas 35.53% are Administrative staff and 7.89% Technical staff. There are a variety of qualifications among respondents as the majority of 75.00% are Postgraduate, and 22.37% are Bachelor holders. Respondents holding qualifications of diploma and High School Certificate count as 1.32% and 1.32% respectively.

5. Results and discussion

In this section the main findings are shown and discussed. first final outcomes of the study will be shown in favor of the SUS score and its interpretation of each system under consideration namely (Masar - ETickets -MySite – EduGate). In addition, for each previously named system, the Adjective test score will be shown with an attempt to simplify the result by classify the responses into 3 categories namely (positive – neutral – negative). Furthermore, the Loyalty test score will be shown and discussed. Next, a summary on all SUS score based on each factor mentioned in the research questions of this study will be provided in order to compress the results in one place. Finally, a conclusion will be drawn.

5.1 Evaluation of usability systems under considerations

As it can be seen from Fig 1, the four systems vary in the SUS score. From Fig 1, EduGate seems to be the one with the highest SUS score at 75.12, whereas ETickets comes in the second place with the score of 66.81. both Masar and MySite comes in the range of 50s. In general, there is a difference in the result, given that the respondents are the same, but the systems are different and their interaction with them is what determines the results. Therefore, it has been an assumption that the results will be different, but the aim of this research was to investigate the factors that might impact the results.

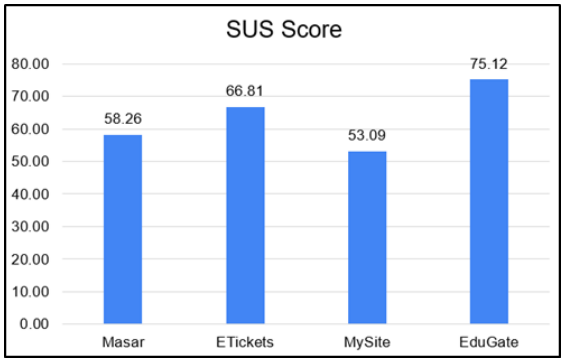


Fig. 1 SUS Score based on average results

Obviously, more meaning for these scores are needed. Therefore, acceptability and grade interpretations were employed in order to do so. Table 1 illustrates each SUS Score for each system based on interpretations of Banger et al. and Jeff Sauro [35], [36], [39] meaning of SUS sores. It can be seen that EduGate is an acceptable system with a B grade. In addition, ETickets system is a competing system with the grade C, whereas Masar and MySite systems gained a D. however, apart from EduGate, all the three systems are in a marginal area of acceptability.

Table 1: Detailed SUS Score based on average results with Acceptability and Grade

System	SUS Score	Acceptability	Grade
EduGate	75.12	Acceptable	B
ETickets	66.81	Marginal	C
Masar	58.26	Marginal	D
MySite	53.09	Marginal	D

Adjective scale allows respondents to identify the system with a word that reflects their opinion about the system. seven words are shown to the respondents with the Banger et al tool. Fig 2 shows the results for each of the system under consideration with comparison to each other. It is obvious from Fig 2 that the density of responses is in the OK area. However, from the figure that EduGate has very high score, compared with other system, in the Excellent adjective. In addition, it gained the lowest score in the Good adjective with comparison to other systems.

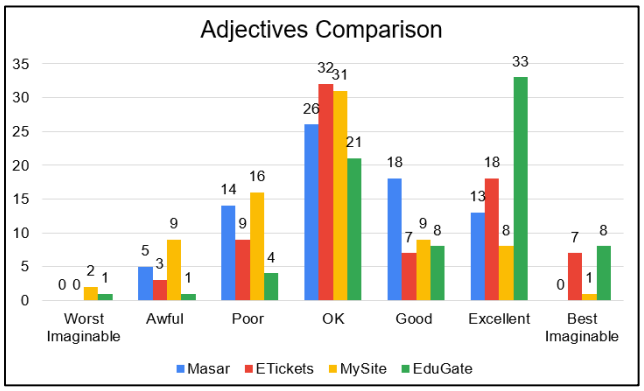


Fig. 2 Adjectives Score based on count of responses

In order to simplify the above shown result in Fig 2, the seven adjectives have been classified in to 3 categories which are positive, neutral, and negative. This will allow more readability for the adjective scale by gathering the results of the three words which are Good, Excellent, and Best Imaginable into a category of Positive. Furthermore, category of Negative will gather the responses on Poor, Awful, and Worst Imaginable. Last the Neutral category will only gather the responses of OK.

By undertaking such a simplifying way for the adjective scale, readability can be more effective as shown in Fig 3. It is clear that EduGate system attained 64% as positive responses and it was the lowest system, with comparison to others, in the negative responses. While ETickets and Masar systems obtained almost same responses of positive with 42% and 41%, MySite obtained the highest negative responses with comparison to other systems by 36%.

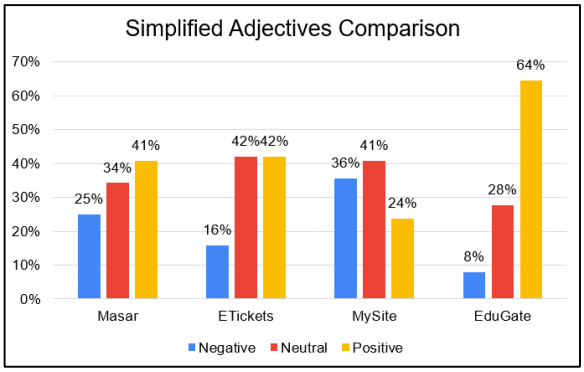


Fig. 3 Simplified Adjectives Score based on count of responses

Reichhelds [34], [37], [38] loyalty test was part of this study for the four systems of UQU. The test is to ask the

respondents a question to rate from 0 to 10 their likelihood to recommend each system to other people in UQU. The interpretations for the results were based on Sauro [40] and other researchers works [41], [42] where respondents' answers are classified as follows: result from 9-10 as "Promoters" and from 7-8 as "Passives" and from 0-6 as "Detractors". Next, Net Promoter Score is calculated by finding the difference between the percentage of the "Promoters" and "Detractors". Fig 4 demonstrates the NPS as the EduGate system has the highest score of 79% which indicates an exceptional level of reliability and satisfaction, whereas ETickets comes in the second place with NPS of 55.26% as a good score according to Florea et al and others [41], [42].

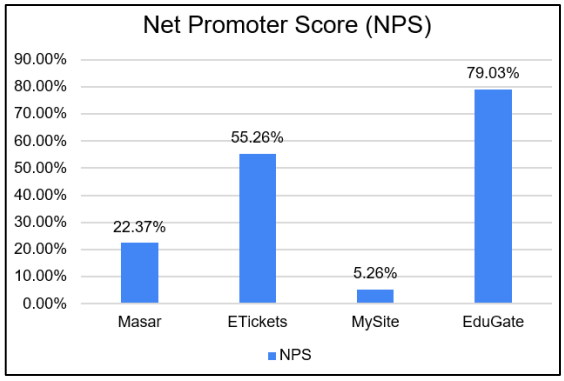


Fig. 4 Loyalty Score based on average

However, Masar and MySite are in a safe area of NPS as they are scoring above zero. It is important to mention here that NPS ranges from -100 to +100. Table 2 shows the details of the data that each system obtained from respondents. Passives responses are not part of the formula of NPS as it counts as the neutral opinion.

Table 2: Net Promoters Score Details based on percentage of respondents

System	NPS	Promoters	Passives	Detractors
Masar	22.37%	43.42%	35.53%	21.05%
ETickets	55.26%	64.47%	26.32%	9.21%
MySite	5.26%	31.58%	42.11%	26.32%
EduGate	79.03%	82.26%	14.52%	3.23%

5.2 Usability evaluation differences based on factors impacts

This study identified three research questions which highlight three factors that might impact the usability evaluation of software system. Previously, the usability evaluations of 4 systems of the UQU were shown and discussed. in this subsection, usability evaluation differences based on impacts of factors will be shown and discussed with comparison between the systems under considerations.

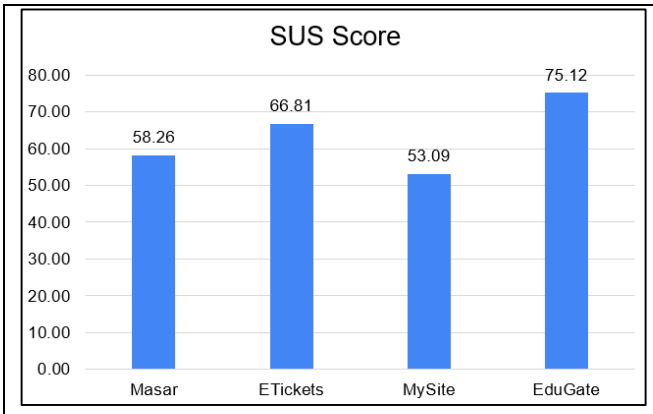
As discussed in the research questions, gender, training, and previous experience with similar software systems are the factors which this research aims to investigate the impact of them on the usability evaluation of 4 systems of UQU. In order to do so, respondents were asked to specify their gender in the general information section of the questionnaire. In addition, respondents were asked a closed question of whether received a training on the systems. Finally, they were asked another closed question to specify whether they believe that previous experience with similar software systems influence their usability of the systems.

Fig 5 illustrates the differences in the SUS usability scoring for the 4 systems of UQU based on each factor. Fig 5(A) shows usability scoring (original) for all the systems under consideration with neglect to factors, whereas, Fig 5(B) highlights the difference based on the gender factor. Considering both figures, Fig 5(A, B), for instance, it can be seen that EduGate system in the UQU obtained 75 in the SUS score which comes to the grade of B. However, Female respondents have evaluated EduGate system positively with a score of 84.20 which come to the grade of A+ as can be seen in Table 3. Relatively, it seems that Females SUS evaluation scores for the other 3 systems of UQU are higher than the score of the systems in Fig 5(A), as Males SUS evaluation scores for the 4 systems of UQU are lower than the score of the systems in Fig 5(A). finally, it can be concluded that gender factor has an impact on varying the SUS evaluation scores of usability of the 4 systems under considerations of UQU.

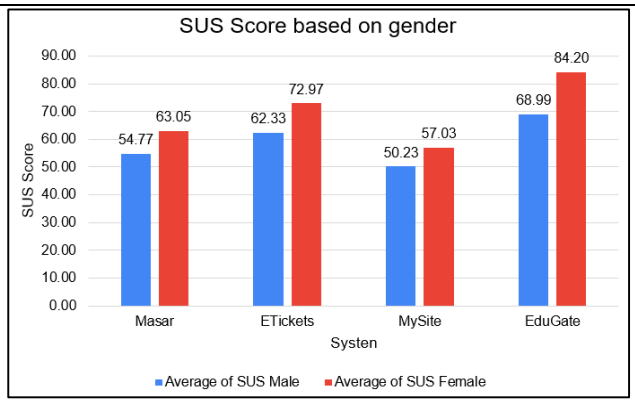
Fig 5(C) highlights the differences in SUS score based on the Training factor. As can be seen in Fig 5(A, C) and Table 3, Masar and MySite systems gained higher score based on trained respondents, whereas, EduGate gained similar score to the original score in Fig 5(A). However, surprisingly, ETickets system were evaluated by not trained respondents slightly higher than the trained respondents and the original SUS score for the ETickets in Fig 5(A). Finally, it seems that that training factor has a slight impact on SUS evaluation score of usability of the 4 systems under considerations of UQU.

Previous experience on similar system was considered in this study. Fig 5(A, D) and Table 3 shows a comparison of SUS evaluation scores of usability of the 4 systems under considerations of UQU based on this factor. It is obvious that Masar and EduGate was usability evaluated noticeably higher by respondents with no previous experience on similar systems. Additionally, the scores were higher than the original in Fig 5(A). However, while, MySite system was usability evaluated higher by respondents with previous experience with similar systems, ETickets system was usability evaluated by respondents with previous experience with similar systems with a score close to the original in Fig 5(A). Finally, it might be regarded that

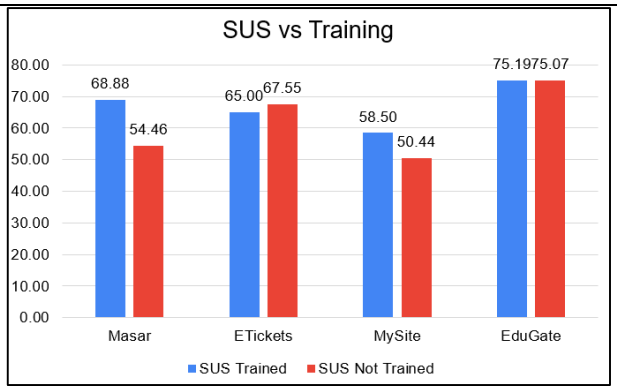
having no previous experience with similar systems might impact positively the evaluation of usability of software systems.



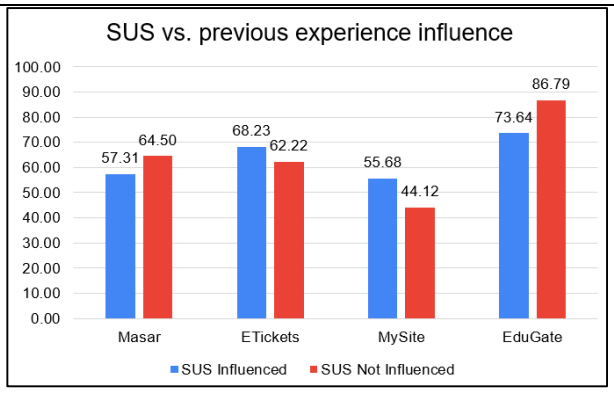
(A): SUS general Score for UQU systems



(B): SUS Score based on gender for UQU systems



(C): SUS Score based on training for UQU systems



(D): SUS Score based on Experience influence for UQU systems

Fig. 5 Comparison of SUS score among 4 UQU systems based on different factors

Table 3: Detailed Comparison of SUS score among 4 UQU systems based on different factors

Factor	System		SUS	Acceptability	Grade
Gender	Masar	Male	54.77	Marginal	D
		Female	63.05	Marginal	C-
	ETickets	Male	62.33	Marginal	D
		Female	72.97	Acceptable	C+
	MySite	Male	50.23	Not Acceptable	F
		Female	57.03	Marginal	D
	EduGate	Male	68.99	Marginal	C
		Female	84.20	Acceptable	A+
Training	Masar	Trained	68.88	Marginal	C
		Not Trained	54.46	Marginal	D
	ETickets	Trained	65.00	Marginal	C
		Not Trained	67.55	Marginal	C
	MySite	Trained	58.50	Marginal	D
		Not Trained	50.44	Not Acceptable	F
	EduGate	Trained	75.19	Acceptable	B
		Not Trained	75.07	Acceptable	B
Experience with similar systems	Masar	Influenced	57.31	Marginal	D
		Not Influenced	64.50	Marginal	C-
	ETickets	Influenced	68.23	Marginal	C
		Not Influenced	62.22	Marginal	D
	MySite	Influenced	55.68	Marginal	D
		Not Influenced	44.12	Not Acceptable	F
	EduGate	Influenced	73.64	Acceptable	B-
		Not Influenced	86.79	Acceptable	A+

6. Conclusion

In conclusion, in this research, the factors that might affect usability evaluations have been investigated. These factors are gender, training, and pervious experience with similar software systems. In order to investigate the impact of the aforementioned factors, SUS approach was used to investigate the usability evaluations on 4 software systems of UQU. These systems are Masar, ETickets, MySite, and EduGate.

The main findings of this research are that gender has an impact on usability evaluation. This is shown as females evaluate usability of the systems higher than males. In addition, user experience, from the point of view of experience with other similar software systems, has impact on the usability evaluation as those with no previous experience with similar systems evaluate the usability of systems higher than those with experience with similar systems. Finally, a minor difference in usability evaluation has been noticed between the users who received an official training on systems and who have not as the former indicated the higher scores of usability evaluation.

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