

Original Research Paper

Assessing Students' Perceptions of Mobile Applications Usability using System Usability Scale

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Abstract: The purpose of this study is to explore the usability level of the mobile application from the perspectives of students at higher education institutes by using the most used measure of perceived usability, namely, the System Usability Scale (SUS). Furthermore, the study investigated the effect of some of the students' demographic attributes on mobile application usability. Results revealed that the system usability scale score is 63% which indicated that the mobile application usability is inadequate and requires more attention. Moreover, the results indicated that there is a significant impact of students' gender on system usability scale scores; while other demographic attributes such as study level, department, usage experience, and device type, did not have impacts on System Usability Scale scores. The results of the study will be helpful to policymakers, top management, and mobile applications developers, in designing mobile applications with high quality in terms of its usability.

Keywords: Usability, Assessment, Systems Usability Scale (SUS), Mobile Application, Higher Education

Introduction

Mobile application is a program that is developed to operate on tiny, wireless computing machines, such as smartphones and tablets, rather than laptops and desktops (Goel *et al.*, 2018; Weichbroth, 2020). Mobile applications have widespread in different sectors, including banking, healthcare, e-commerce, tourism, and education, (Weichbroth, 2020; Lumor *et al.*, 2020). The invention of mobile applications for the mobile computing environment presented a new method to the service domain since mobile applications are designed to achieve a particular task. For instance, in higher education, mobile applications are employed not just for enhancing the education process but also to allow stakeholders access to academic resources and academic services (Lumor *et al.*, 2020). Mobile Apps allow faculty, students, and staff to carry out their tasks wherever they are. Despite the abundance of mobile applications that have been spread in many sectors, it still faces numerous challenges that have attracted the attention of academia and software developers.

Mobile application usability is one of the major challenges that has gained the attention of researchers and mobile application developers (Weichbroth, 2020),

(Lumor *et al.*, 2020; Parsazadeh *et al.*, 2018). The concept of usability is defined by ISO 9241-11 as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (Weichbroth, 2020; ISO, 2018; Moumane *et al.*, 2016). In software engineering, usability is considered one of the important software quality attributes, that evaluates how easy user interfaces are to use (Weichbroth, 2020).

Several studies have shown that usability difficulties of programs caused issues related to software quality such as lower efficiency and effectiveness, as well as leading to the failure of applications and products. Moumane *et al.* (2016); Nielsen and Molich (1990); Nielsen (1994); Brooke (1996); Kumar and Goundar (2019); Nielsen and Molich (1990), proved that software with good usability enhanced productivity and revenues, and improving the usability for E-commerce applications leads to an increase the income by 10-35%.

Due to the advancement in technology the usage of mobile applications has become common in today's era. This highlights the importance of assessing the usability of mobile applications to determine the level of acceptance by its stakeholder, discover the major issues that face the stakeholder of those applications, and gain

feedback about the design. Many methods are presented for evaluating mobile application usability (Weichbroth, 2020; Kortum and Sorber, 2015; Jake-Schoffman *et al.*, 2017; Fabil *et al.*, 2015; Harrison *et al.*, 2013; Parsazadeh *et al.*, 2018; Moumane *et al.*, 2016; Az-zahra *et al.*, 2019; Al-mayyan and Al-Refai, 2020; Kaya *et al.*, 2019; Hoehle and Venkatesh, 2015), where different models are used. Moreover, Assessment has an essential role in processing the usability difficulties of mobile applications.

Therefore, the current study attempts to consider this gap by evaluating the usability of mobile applications in higher education institutes and studying the impact of some factors on perceived usability. Moreover, the study will give feedback about the problems that face users of mobile applications at higher education institutions. As well as providing mobile application developers and policymakers in higher education with insights that help them in developing mobile applications with high quality.

The objectives of the current study are, First, to determine the usability level of the PSAU mobile application from the perception of the students in the College of Business Administration (CBA) at Prince Sattam Bin Abdulaziz University in Saudi Arabia, utilizing SUS survey adapted with an adjective rating scale; the second aim is to explore the impact of the features of students on SUS resultant. The study attempts to answer the following research questions:

1. What is the usability degree of PSAU mobile applications from the perception of students in the College of Business Administration at Prince Sattam Bin Abdulaziz University in Saudi Arabia, as measured by the SUS score
2. Do the demographic features of students influence the overall SUS scores

Many Studies were presented to examine the usability of different software or tools, they vary in assessing the usability of many applications in different domains.

Weichbroth (2020) presented a systematic literature review of the usability of mobile applications. The study covered 790 documents from 2001 to 2018. The researcher presents three major findings about the usability of mobile applications. The first contribution was about the usability definition, where the author found that the most popular definition was presented in ISO 9241-11 and was used by 85% of the covered documents. The second contribution was related to usability attributes, where 75 usability attributes were identified by researchers. The most frequent attributes were as follows: Efficiency (70%), satisfaction (66%), and effectiveness (58%). Subsequently, the less frequent are learnability (45%), memorability (23%), cognitive load (19%), and errors (17%). The last two concern simplicity (13%) and

ease of use (9%). The last contribution concluded that the most frequently used methods for the evaluation of usability in mobile applications were survey-based and controlled observation, however, eye-tracking, thinking aloud and interviews were hardly used, but are employed as support tools to collect additional data. The produced results of this study suggested that is a need for further research on the usability of mobile applications.

The study by Kortum and Sorber (2015) describes the usability of mobile apps for mobile phones and tablets across two operating systems. The authors used SUS as a survey instrument to measure mobile application usability. The study was performed on more than nine mobile applications and more than 3000 users participated in the study. The results revealed that the average SUS rating of all applications was 77.7.

Moumane *et al.* (2016) conducted an empirical study for evaluating the usability of mobile applications that operate on different operating systems such as iOS, Android, and Symbian. The software Quality standard ISO 9126 for mobile environments was used. The main findings revealed that some mobile usability issues must be taken into account during the development stage of the mobile application to enhance its usability of mobile application (Moumane *et al.*, 2016).

Kumar and Goundar (2019) used a heuristic method for evaluating the usability of mobile learning applications. The suggested method was drawn from (Nielsen, 1994) whose tool was used to evaluate the usability, based on a prepared list of criteria and then checking their availability. In this study, new heuristics approaches were proposed to extend (Nielsen, 1994) heuristics to support the heuristic evaluation of mobile learning applications. The study was carried out on two applications at the University of the South Pacific. The outcomes showed that using newly developed heuristics allows evaluators to discover more usability issues while evaluating mobile learning applications. Goal Question Metrics (GQM) are another way to evaluate the usability of mobile applications suggested by Fabil *et al.* (2015). Its major objective was to assess usability to determine the main issues in the user interface that may lead to human errors during interaction with the mobile application. The PACMA model was used which was applied to evaluate two mobile applications for two university portals (mobile version); University Sains Islam Malaysia (USIM) and OUM portal. Researchers (Az-zahra *et al.*, 2019) utilized the PACMAD usability model for evaluating the usability of three mobile applications used in Indonesia; Tokopedia, Bukalapak, and Shopee. The assessment was performed on seven aspects as in PACMAD, which include Effectiveness, efficiency, learnability, Memorability, Errors, Satisfaction, and cognitive load. The outcomes showed that Bukalapak was good in all aspects, then Tokopedia and Shopee.

Parsazadeh *et al.* (2018) proposed a usability assessment model with the insertion of timeliness to evaluate the usability of mobile learning applications; the study aimed to create and validate a usability assessment for the mobile environment. A questionnaire was used as a data collection method. Al-mayyan and Al-Refai (2020) presented a study that aimed at measuring the usability of the My U app in the Higher Institute of Administrative Service in Kuwait within the educational community. The SUS survey was used and the total number of students who participated in the study was 209 students in the second semester of the academic year 2019. The SUS score was calculated using the method developed by Brooke (1996) and the obtained score was 60.75. Afif (2021) used the PACMAD usability model to evaluate the usability of the PSAU mobile application. The evaluation was performed for seven aspects as in PACMAD, which included Effectiveness, efficiency, learnability, Memorability, Errors, Satisfaction, and cognitive load. A survey-based methodology was used for collecting data from a random sample size of 137 enrolled students in the College of Business Administration at Prince Sattam Bin Abdulaziz University. The results demonstrated that the state of usability attributes of the PSAU mobile application is acceptable. The major difference between the current study with the previous study presented by Afif (2021) is the model used in the current study which is SUS; furthermore, the presented study investigated the impact of demographic information on usability.

To the researcher's best knowledge, no studies have been conducted at Prince Sattam Bin Abdulaziz University to evaluate the usability of mobile applications by using the SUS model; further, the current study explored the impacts of the characteristics of the participants on usability. To achieve the study goals the following hypotheses were developed.

H_1

The PSAU mobile application used by the students at the College of Business Administration at Prince Sattam Bin Abdulaziz University students has a high level of usability.

H_2

The gender of students at the College of Business Administration at Prince Sattam bin Abdulaziz University has a significant effect on the usability of the PSAU app.

H_3

The demographic characteristics of students at the College of Business Administration at Prince Sattam Bin Abdulaziz University have a significant impact on the SUS score.

Materials and Methods

This is a survey study in which data were collected and analyzed following three phases. First, a questionnaire was designed based on the SUS instrument which was designed and developed by Brooke (1996) and used by Kaya *et al.* (2019); Hoehle and Venkatesh (2015); Finstad (2010). The survey was split up into two segments, namely, segment A and segment B. In particular, part A contained 5 statements designed to collect data about the respondents like the study level, department, gender, usage experience of mobile application, and type of smartphone. Section B discovers the views of the College of Business Administration students on SUS on issues affecting their usability of the university PSAU mobile application (PSAU App). A five-point Likert scale was employed in this part and the participants were needed to state the range to which they agreed or disagreed with each sentence. The survey was published via the web using google forms to the College of Business Administration students utilizing a simple random sampling. The sample of the study comprised 352 College of Business Administration students enrolling for the academic year 2020/2021 at Prince Sattam Bin Abdulaziz University in Saudi Arabia. Second, a pre-processing phase includes preparing the data for processing, calculating the SUS score, and developing the rules to predict the grade and adjective rating for each respondent. During this phase, the collected data was cleaned by removing incomplete data and unsuitable responses, after that, data were encoded by replacing the words with numeric values according to the Likert scale (Strongly Disagree: 1, Strongly agree: 5. etc.). Then, the SUS scores and adjective rating scales were calculated; Scores are calculated according to Brooke's guidelines (Brooke, 1996); by adding the scores on each of the 10 elements. For odd elements 1, 3, 5, 7, and 9, one point was subtracted from the produced score. While, elements 2, 4, 6, 8, and 10, five points were subtracted from the produced score. The overall usability scale value calculates by multiplying the total of all scores by 2.5. Rules were developed by using Excel 365 software for predicting the grade and adjective for the processed data according to the rules suggested by Bangor *et al.* (2008) and used by other researchers (Bangor *et al.*, 2009; Brooke, 2013). In the third phase, descriptive analysis, and statistical tests were applied to find out the major indicators of the collected data.

Results and Discussion

The presented study employed the SUS survey for assessing the usability because it has high reliability and validity for usability assessment, which are verified by the literature, where Cronbach's alpha found frequently was larger than 0.80 and in most of the investigate papers even beyond 0.90 as in (Al-mayyan and Al-Refai, 2020; Kaya *et al.*, 2019; Hoehle and Venkatesh, 2015;

Finstad, 2010; Alhadreti, 2021; Lewis, 2019). The SUS survey contained ten statements. It comprised ten positive and negative alternative statements for which a participant provides a subjective assessment of a system's usability. Thus, the SUS's special attributes were proved as an ideal tool for evaluating the usability of PSAU mobile applications in the present study. The SUS questionnaire was distributed to College of Business Administration students at Prince Sattam University. The total number of students who responded to the questionnaire was 352 students in the academic year 2020-2021; however, 336 responses from the total number were valid. Table 1

demonstrates the characters of the respondents which included gender, department, level of study, usage experiences of mobile, and type of smartphone they use. As the table displays, 69% were male and 31% female. Regarding the departments, most of the students in the public preparation and Law departments represented 34 and 27% respectively. Regarding mobile usage, most of the students 49% used their mobiles for more than 7 years. In terms of the type of smartphones used, most of them (i.e., 89%) used iPhones. MS Excel 365 and SPSS 25 were used for processing and statistical analysis of the collected data.

Table 1: Sample attributes

Factors or attribute	Answers	Frequency (%)
Gender	Male	233 (69%)
	Female	103 (31%)
Department	General	114 (34%)
	Law	87 (27%)
	Accounting	71 (22%)
	HR	36 (10%)
	Finical	13 (4%)
	MIS	15 (3%)
Level	First year	85 (25%)
	In the second year	67 (20%)
	In the third year	94 (28%)
	In the fourth year	90 (27%)
Usage experiences with mobile	Less than one year	22 (7%)
	Between 1-3	73 (22%)
	Between 4-6	75 (22%)
	More than 7	166 (49%)
Type of mobile	iPhone	301 (89%)
	Samsung	18 (5%)
	HUAWEI	15 (4%)
	Other	5 (1%)

Table 2: Descriptive statistics for SUS statements

St. No	Means	Median	Mode	Stdev	Skewness	Kurtosis
S1	3.7	4	4	1.10	-0.73	-0.06
S2	2.8	3	3	1.10	0.30	-0.46
S3	3.8	4	4	1.10	-0.70	-0.40
S4	2.1	2	1	1.20	0.90	-0.11
S5	3.1	3	3	1.10	-0.04	-0.07
S6	3.1	3	3	1.20	0.12	-0.08
S7	4.0	4	5	1.00	-0.74	0.05
S8	2.4	2	2	1.10	0.75	0.12
S9	3.5	4	4	1.10	-0.50	-0.30
S10	2.5	2	2	1.10	0.50	-0.05
All	3.1	3	4	0.04	0.12	-1.00

Table 3: Results of usability in terms of SUS scores and Rating

Grade	Number	Ratio	Value of SUS	Adjective
A	47	14%	Greater than 80.3	Excellent
B	81	24%	Between (68-80.3)	Good
C	0	0	Equal 68	Okay
D	125	37%	Between (51-68)	Poor
F	83	25%	Less than 51	Awful
SUS score	336	63	Grade D	Acceptable

Table 4: Results SUS scores and rating for males and females

Grade	Male			Grade	Female		
	Number	Ratio	Adjective		Number	Ratio	Adjective
A	31	13%	Excellent	A	16	16%	Excellent
B	47	20%	Good	B	34	33%	Good
C	0	0	Okay	C	0	0	Okay
D	86	37%	Poor	D	39	38%	Poor
F	69	30%	Awful	F	14	13%	Awful
Score	233	61	Poor	SUS	103	68	Okay
G		D	Acceptable	Score	G	C	Acceptable

Table 5: Results of SUS scores and user experiences

Experiences	Grade	Number	Ratio	Adjective
Less than one year	A	3	14%	Excellent
	B	5	23%	Good
	D	5	23%	Poor
	F	9	40%	Awful
SUS score	D	22(7%)	60.5	Poor
One to 3	A	6	8%	Excellent
	B	13	18%	Good
	D	37	52%	Poor
	F	15	21%	Awful
SUS score	D	71(21%)	61.3	Poor
Between 4 To 6	A	9	12%	Excellent
	B	24	32%	Good
	D	26	35%	Poor
	F	16	21%	Awful
SUS score	D	75(22%)	64	Poor
Greater than 7	A	29	17%	Excellent
	B	39	23%	Good
	D	57	34%	Poor
	F	43	26%	Awful
SUS score	D	168(50%)	63.4	Poor

Table 6: Descriptive Statistics of SUS score and its average

	N	Means	Std. deviation	Std. error mean
SUS score	336	62.121	17.78	0.9699
AVESUS	336	03.100	00.38	0.0210

Table 7: Statistical t-test Results for SUS score and its average

	t	df	Sig.(2-tailed)	Mean difference	Test value
SUS score	-23.59	335	0.000	-22.870	85
AVESUS	-92.08	335	0.000	-1.907	5

Table 8: Descriptive Statistics about the Gender with SUS

	N	Means	Std. deviation	Mini	Maxim
SUS score	336	62.1210	17.780	0.0	97.5
Gender	336	0.6900	0.462	0.0	1.0

Table 9: Mann-Whitney statistical test Results

SUS Score	Gender	N	Mean rank	Sum of ranks	Mann-whitney U	Wilcoxon W	Z	Asymp. Sig (2-tailed)
	F	103	194.9	20072	9283.0	36544.0	-3.31	.001
	M	233	156.8	36544				

Table 10: Results of Statistical testing for SUS Scores versus factors

Factor	df	Kruskal-wallis H	Sig	Notes	
Level of study	3	18.22	0.000	First and third levels found the p-value less than .005	P<0.005
Usage years	3	2.56	0.464	No impact	P>0.005
Device type	2	3.78	0.151	No impact	P>0.005
Department	5	21.09	0.001	Only departments 1 Versus 2 and 6 have an impact on perceived usability	P<0.005

SUS Score Range	Grade	Percentile Range
84.1-100	A+	96-100
80.8-84.0	A	90-95
78.9-80.7	A-	85-89
77.2-78.8	B+	80-84
74.1-77.1	B	70-79
72.6-74.0	B-	65-69
71.1-72.5	C+	60-64
65.0-71.0	C	41-59
62.7-64.9	C-	35-40
51.7-62.6	D	15-34
0.0-51.6	F	0-14

Fig 1: Usability Scale (SUS) score ratings-Source (Bangor *et al.*, 2008)

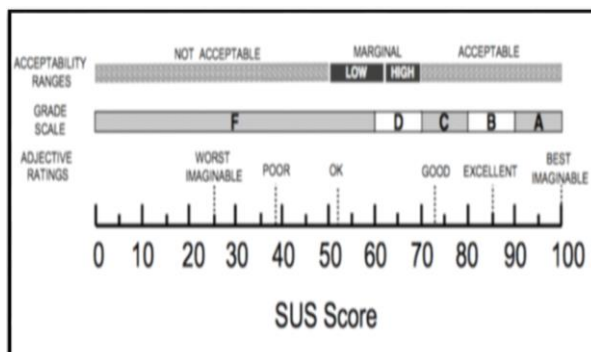


Fig. 2: The Sauro/Lewis curved grading scale (Lewis, 2019)

Table 2 reveals the descriptive statistics of the ten items of the SUS measure, which includes the mean, median, mode, standard deviation, skewness, and kurtosis. The mean for the items was between 2.1 and 3.8, the median of the items ranged between 2 and 4, while mode values were in the range between 1 and 5. The standard deviation of the items ranged between 1.1 and 1.2 and the skewness and kurtosis values were between 0.74- 0.9 and -0.46- 0.12 respectively. The last row lists the overall values of all measures; the highest value was for the mode and the lowest value was for Kurtosis.

Tables 3,4 and 5 reported the obtained results after calculating the SUS score and rating it according to (Bangor *et al.*, 2008) suggested rules. Bangor *et al.* (2008), proposed usability ratings based on mean SUS scores as illustrated in Fig. 1 and 2. Figure 1 demonstrates three ratings, namely, acceptability ranges, grade scale, and adjective ratings, all based on SUS score ranges. A SUS score of less than 50 indicates poor usability, while a score between (50-70) indicates marginal acceptability, and a score greater than 70 indicates an acceptable level of usability as in Fig. 1 and 2.

Table 3 reveals the obtained results of students' perceptions of usability which includes the grade, number, ratio, value of SUS score, and the adjective. Regarding grade scale and adjective rating, 14% of the respondents scored their usability as grade A, 24% rated

it as grade B, and 37% considered usability as grade D, while 25% of them rated the usability as Awful (grade F). The overall SUS score that was obtained is 63 with a D grade, which is an acceptable level of perceived usability. The outputs indicated that 75% of the respondents gave positive responses that ranged from (A to D); while 25% of them selected the F grade. Thus, the findings proved that the level of usability for the PSAU mobile application is acceptable, but it still needs to be enhanced. The main contribution of this section is stated as the level of usability for the mobile application used by the students at the College of Business Administration at Prince Sattam Bin Abdulaziz university is acceptable with a need for improvement.

Table 4 illustrates the findings of the effect of students' demographic data on their perceptions of the usability of the PSAU mobile application such as gender and user experiences. As displayed in the table, the overall SUS score for females is 68 with grade C, while 61 for males with grade D. The obtained findings prove that there were differences between males and females in their perception of the usability of the PSAU mobile application. The differences between males and females may be due to disparate capabilities, knowledge, skills, and understanding. Females usually have a good level of knowledge and understanding abilities. Thus, the major contribution of this part can be defined in the significant differences between males and females in perceived usability; in other words, females have more understanding regarding perceiving usability.

Table 5 presents the results of usability based on user experiences. The outcomes of the SUS score for all levels of experience were in the same grade which is D. The maximum SUS score was 64 for users who used the mobile between 4 and 6 years, after that the users with more than 7 years with 63.4 for SUS score, while 61.3 and 60 were the SUS scores for other experiences levels. The obtained results demonstrated that user experiences did not have any impact on the perception of usability of the PSAU mobile application.

Statistical Tests and Hypotheses Examination

Statistical tests and analyses were performed to explore the differences in average between SUS scores according to the study hypotheses. Table 6 and 7 demonstrate the descriptive statistics of the SUS score and average. The P value obtained is less than 0.05 and this means that the H_1 hypothesis which was "The PSAU mobile application used by CBA students has a high level of usability" is rejected and therefore accepting the alternative hypothesis which reads as: "The PSAU mobile application used by CBA students has an acceptable level of usability."

Table 8 reveals descriptive analysis for the groups and Table 9 presents the results of the Mann-Whitney test. It proves that there is a significant difference ($Z = -3.31$,

$p = 0.001$) between the two groups: Males and females. There is a positive impact of gender on College of Business Administration students' perceptions of the usability of PSUA. The P value indicated that significant difference, which leads to accepting the H_2 hypothesis which says: The gender of students at the College of Business Administration has a significant effect on students' perceptions of the usability of the PSAU mobile application.

Kruskal-Wallis Test was used to explore the influence of demographical data on students' perceptions of the usability of the PSAU mobile application. Table 10 demonstrates the results of the statistical test including factor, df, Kruskal-Wallis H, significance, and notes about the significant details. As listed in the table, two factors have significant effects, the p-value was less than 0.005, while the others were greater than 0.005. This means that the first and third levels have a positive impact on perceiving the usability of PSUA mobile applications, while other levels don't have any impact on perceived usability. Furthermore, departments 1, 2, and 6 have a positive impact on perceiving the usability of PSUA mobile applications; other factors' p-value is greater than 0.005 and this indicates that there is no impact of these factors on perceived usability. This leads to rejecting the H_3 hypothesis that "the demographic characteristics of students at College of Business Administration have a significant impact on the SUS score and accepting the alternative hypothesis by restating it as "The demographic characteristics of students at CBA do not have a significant impact on the SUS score".

From all analysis and discussions, the following conclusions can be summarized:

- The usability level of the PSAU app is acceptable but still needs to be enhanced
- Gender influences the output of SUS, while other demographic information such as study level, department, experiences, and device type does not have any impact on SUS; with some exceptions concerning the study level; first and third levels, as well as students in department 1 verses 2 and 6, all have a positive impact on perceived usability
- Usability is relative or subjective; in other words, the results differ from one person to another may be due to factors that affected the perception of usability for a given mobile application, such as the capabilities of the person as the skills, knowledge, and understanding, as well as the mobile application and the usability model used
- The current study collected feedback from users about the current level of usability, and it is useful in highlighting the major issues in perceiving the usability of mobile applications in higher education institutions in Saudi Arabia. Furthermore, it provides feedback to policymakers and mobile application

designers, and developers regarding the issues that need to be enhanced and improved. This feedback will be valuable for smartphone application designers, and developers, in designing mobile applications with high quality in terms its usability

- Finally, the research provides to enriching the literature on perceiving the usability of mobile applications at higher education institutions in Saudi Arabia

Conclusion

The PSAU mobile app in use at Prince Sattam Bin Abdullaziz University in Saudi Arabia has an insufficient degree of usability and requires to be enhanced due to SUS. These results are supported by objective analysis and statistical testing. In addition, other contributions of the study are represented by the postulating the significant effect of the gender of the students on perceiving usability due to the SUS score. The other demographic information of the students such as (study level, specialist, usage experiences, and device type) do not have any effect on perceiving usability based on SUS score. Furthermore, the results of this study supported the idea that usability is a relative measure, as it is disparate from one user to another according to user abilities in understanding, knowledge, and skills. Moreover, this research adds to the literature on the usability evaluation of mobile applications at higher education institutions in Saudi Arabia. In addition to this, the results of the study presented insights into the usability issues related to mobile application usability. It will be beneficial for policymakers such as the ministry of education, the institutes' top management, and developers of mobile software in designing mobile applications with high quality in terms of usability. Further studies are recommended to be conducted on other various samples and different colleges with different usability evaluation models as well as developing new methodologies to evaluate usability.

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Ethics

I undersigned that this article has not been published elsewhere. The authors declare no conflict of interest.

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