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ORIGINAL PAPER

Elderly users' acceptance of mHealth user interface (UI) design-based culture: the moderator role of age

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Abstract
In the Arab world, mobile health (mHealth) applications are an effective way to provide health benefits to medically needy in the absence of health services. However, end users around the world use technology to perform tasks in a way that appears more natural, and closer to their cultural and personal preferences. Evidence from prior studies shows that culture is a vital factor in the success of a system or product. In view of this fact, this study investigated elderly Arab users' acceptance of mHealth User Interface (UI) design-based culture. The TAM model was used to shape the theoretical foundation for this study with a questionnaire as data gathering tool from 81 participants. The findings showed that perceived ease of use and attitude towards use had a significant positive influence on users' behavioral intention to use mHealth UI design-based culture. The impact of age on the relationship between ease of use, usefulness, and intention was significant. Overall, the findings showed that elderly Arab users found the UI design of mHealth acceptable due to its cultural significance. To enhance the design of mobile UI targeting elderly users, it is important to consider the cultural rules and their behavioral applications.

Keywords Technology acceptance · Elderly users · Mobile health applications · User interface · TAM · Culture · UI/UX

1 Introduction

Recently, there is a rapid growing in the number of elderly people worldwide. It is expected to be about 1 billion by 2030 [1]. In the European countries, for instance, the number of elderly people aged 60 and above years is predicted to rise 30% by 2020 [2]. The continuous increase in the aging population is believed to increase the use of technology among elderly people, particularly to learn about health and illness prevention. Hence, it seems that there is a need for a continuous effort to increase and support the active age of these elderly people who are more concerned about living healthy. This can be done not only by constant care, advices and support from their family, but also by the aid of technologies, which can assist elderly people in daily routine [3]. Recently, Mobile Health applications (mHealth apps) becomes more important as they are used increasingly in providing the necessary healthcare services such as managing medicines, monitoring diseases and other medical services [4–6]. The use of mHealth apps have an important effect on improving people's lives, especially older adult. It provides users with an easy way to access healthcare information at any time and at any place [7, 8].

Several studies have found that designing technology to meet the needs of older people is important in various domains [9, 10]. Most of the challenges reported in the literature regarding technology acceptance for elderly users were due to the design of User Interface (UI), navigability, and the complexity of functionalities [11]. Despite the fact that people interact with technology with regards to the cultural differences such as religion, ideas and customs [12], understanding people's use of UI design-based culture did not receive much attention in the context of acceptance [13]. Therefore, it is vital to take into account the challenges of developing acceptable and usable technologies for elderly users with regard to their cultural backgrounds. One aspect for consideration is embedding cultural values into the design of UI which has proven to play a significant role in promoting the usage behavior of the user [12]. Prior studies

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suggested that customization of mobile apps UI can improve user experience [14]. Thus, designing a culture-based mobile app UI may potentially increase users' satisfaction [15]. This is supported by Goodall, Ward [16] who claimed that a culturally different background can add an additional barrier to the older users' abilities to use technology and access information. In view of this, assessing the level of acceptance of culture into the design of mHealth UI among elderlies becomes an important consideration that developers and designers should consider in the future.

On the other hand, there is still a lack of empirical studies conducted in the Arab world concerning the influence of culture in interface design on the acceptance of elderlies. To our knowledge, there seems little evidence about the elderly users' intention to use Arabic cultural-based mHealh app UI. Findings from this study can help support designers of mobile apps in the Arab world based on the role of culture in the creation of interpretive products and experiences. This paper is organized as follows: the second Section describes the literature review of this study; the third Section presents the research methodology; the fourth Section presents the results and analysis; the fifth Section presents data analysis and results; the sixth Section presents conclusion and implications; and the seventh Section describes the limitations of the study.

2 Literature review

Due to age-related physical and health changes, older adults suffer from varying degrees of hearing loss, psychomotor impairments, poor vision as well as reduced attention, memory and learning abilities [11]. In addition, many elderly people encounter challenges when interacting with their mobile phones, particularly when they shift from a keypad to a touchscreen UI. Elderly users' preferences regarding the appearance of the interface is also linked to the declining physical abilities, cognitive and sensory changes. These changes affect movement, thus preventing elderly users to use technologies efficiently [17, 18]. The challenges of using technology faced by elderly users have been investigated in several empirical studies. For example, Leburu [19] conducted a study on elderly subjects in South Africa and found that memory problems, reduced mobility, and failing eyesight were preventing elderly people from using mobile phones as much as they would like to [19]. Charness and Holley [20] argued that physical challenges often affect the ability of elderly to do the tasks such as pressing buttons. Häikiö, Wallin [21] investigated users' use of smart mobile phones and found that trembling hands had considerable problems in pressing the right buttons. The literature also showed that most elderly users uses mobile to search for health-related information [22]. For instance, recent statistics show that the estimated number of mHealth apps download worldwide was 3.7 billion [23].

One of the justifications for the lack of mHealth apps and services targeting elderly Arab people is the lack of studies to design or suggest an appropriate design philosophy for mHealh UI [24]. As such, this study was conducted to examine elderly Arab users' acceptance of mHealh UI design-based culture.

The motivation for considering elderly Arab people in this study was due to the dramatical growth in the number of elderly people in the Arab world. For instance, in 2015, the total population of elderly Arab was 26.8 million and predicted to be 50 million by 2030. Currently, the percentage of elderly Arabs aged 60 years and above is constituted 6.7% of the elderly population with estimates showing growth to 9.5% by 2030 [25]. This rapid rise can be associated with the development in mobile system and services, which shows the essential need to develop health systems and applications acceptable by elderly users, particularly to support their health and improve their lives.

2.1 Culture and technology adoption

One of the main objections that is recorded on technology appropriation is deliberate to consider the influence of local factors in the design of UI such as culture and language [26]. Researchers have claimed that technologies industrialized in Western countries may not be appropriate to non-Western context because of the impact of these factors [27, 28]. Several prior studies have confirmed the influence of various cultural factors on the acceptance and use of technology (e.g., [29–31]). Culture is commonly defined as a custom, idea, belief, principle and practice that shapes a society and reflect the thinking of people living in a certain country.

Arab culture like every other culture has its own set of needs, expectations, and concerns that distinguish it from other cultures. The beliefs and principles of Arab culture are distinct and influenced by Islamic beliefs and traditions. These cultural beliefs and principles are usually unclear and new for Western cultures [32]. Based on this, it can be assumed that every word, symbol and image suitable for use in Western countries may be not suitable and acceptable for Arabic countries. Therefore, putting into consideration these differences in culture and the way that they impact upon the design of UI might be vital for the enhanced acceptance of technology [33, 34]. As such, the acceptance of mHealth UI design-based on Arab cultural was investigated as an attempt to improve elderly people's intention to use mHealth in the Arab world.

2.2 Development of research hypotheses

User acceptance of technology is considered an essential factor for the effective utilization of any technology, product, and process [35]. User acceptance is defined as a decision made by an individual at a particular point in time in order to use technology intentionally [36]. Utilization comes after the users have decided to accept the technology [36]. Several theories have been used to explain users' behavior of technology acceptance, such as Theory of Planned Behavior (TPB), Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Diffusion of Innovation, and Unified Theory of Acceptance and Use of Technology (UTATU). The studies carried out to investigate the acceptance and adoption of technology have been discussed in several contexts. In the field of technology utilization, both TRA and TPB theories have resulted in numerous studies, of which the most common appears to be related to information technology adoption and use. This include the use of TAM [37], with two extended versions TAM 2 [38] and TAM 3 [39]. Figure 1 shows the TAM model by Davis [37]. Davis defines perceived usefulness (PU) as the possibility that using a particular system would improve the user's job or work performance, while perceived ease of use (PEOU) defines the degree to which a person believes that using a particular system would be free of mental or physical effort. In addition, behavioral intention (BI) is defined as "the strength of one's intention to perform a specified behaviour" [40]. Attitude (AT) is defined as "an individual's positive or negative feelings about performing a target behaviour" [41]. Based on these, TAM was used for shaping the theoretical perspective for the present study.

2.2.1 The relationship between PEOU and PU

Davis [37] stated that perceived ease of use has a positive influence on perceived usefulness. Several previous studies also, such by Wen and Kwon [42] and Zhu, Linb and Hsu [43], have shown and confirmed that perceived ease of use has a positive influence on perceived usefulness in which an individual may feel comfortable doing the task with the least effort possible. Hence, this study proposed the following hypothesis:

H1 Perceived ease of use will have a positive effect on elderly people's perceived usefulness of mHealth UI design-based culture.

2.2.2 The relationship between PU and AT

According to Davis [37], PU is the degree to which a person believes that using a specific technique or system would improve his or her job performance or routine responsibility. Several studies, such by Yeh and Teng [44] and Pikkarainen [45], have confirmed perceived usefulness to be a very vital factor affect attitude for technology adoption. Hence, it is assumed that PU will positively influence elderly people's attitude. For example, if the benefit of mHealth UI design-based culture is positively perceived by users, then their attitude will be positive as well. Therefore, this study hypothesized that:

H2 Perceived usefulness will have a positive effect on elderly people's attitude to use mHealth UI design-based culture.

2.2.3 The relationship between PEOU and AT

TAM established that perceived ease of use has a direct positive impact on individual attitude towards using a system. This is supported by many previous studies [46–48] which have indicated that perceived ease of use is a major factor in effecting the attitude of a user towards the system. The more users perceive the system to be easy to use, the more positive attitude toward the technology. It is the same with mHealth UI design-based culture; as people perceive that mHealth design is easy to use, access and learn, their attitude to use mHealth apps will be more positive. Consequently, this study hypothesized that:

H3 Perceived ease of use will have a positive effect on elderly people's attitude to use mHealth UI design-based culture.

2.2.4 The relationship between PU and BI

According to Davis [37], Lemire, Paré [49], Wong, Yeung [50] and Yun and Park [51] there is a strong direct relation between PU and BI. This clarifies why people intend to use

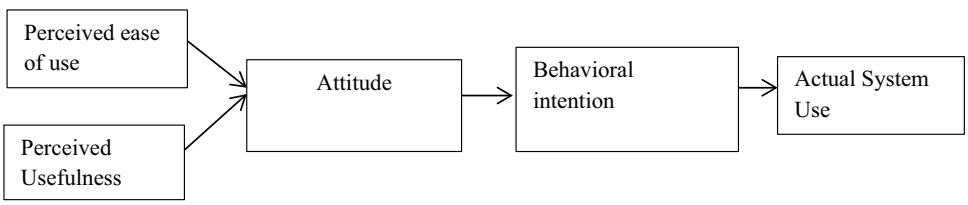

Fig. 1 TAM model by Davis [37]

technology. The more individuals think that the technology is useful, the more they would like to use it. In the case of this study, if elderly people perceive that mHealth UI design-based culture is useful to offer them with many healthcare services and enable them to improve their health status and functioning, they will likely use it more regularly. Hence, it can be assumed that the relation between perceived usefulness and elderly people's intention to use mHealth will be positive. Thus, this study hypothesized that:

H4 Perceived usefulness will have a positive effect on elderly people's intention to use mHealth UI design-based culture.

2.2.5 The relationship between PEOU and BI

The behavioral intention of individuals can be influenced directly by perceived ease of use [37, 52]. This is clarified by the fact that in technology usage decision, users intend to reduce their effort. Therefore, the easier the technology is to use, the greater the use of the technology will be [48]. This study defines perceived ease of use as elderly people's perceived learnability, memorability, simplicity and efficiency towards the overall usage of mHealth UI design-based culture. Then, it is assumed that variables related to perceived ease of use (learnability, memorability, simplicity and efficiency) can be positively related to the behavioral intention of users. Hence, the following hypothesis was formed:

H5 Perceived ease of use will have a positive effect on elderly people's intention to use mHealth UI design-based culture.

2.2.6 The relationship between AT and BI

Attitude is an important factor in the context of technology adoption and use. In the mobile adoption context, most users prefer to use mobile apps that offer information and services in all different categories. Hence, understanding users' attitude toward mobile apps will help us understand their usage behavior. Thus, attitude can be said to be a vital construct in predicting user behavior of information technology [47–49], which also represent elements of previous experience. Since attitude, as a factor, is associated with the users' feeling about the technology (like or dislike), it can be used to show how elderly people feel about mHealth UI design-based culture (positive or negative feeling). Several prior studies, such as that of Chan [47] and Wang and Liu [53], have reported that individuals' attitude toward technology can influence their intention to use it in the future. Based on these, the following hypothesis was shaped:

H6 Elderly people's attitude will have a positive effect on their intention to use mHealth UI design-based culture.

The proposed research model of this study is shown in Fig. 2.

2.2.7 Moderating effects

Prior studies indicated that age is a significant demographic factor that has direct and moderating impact on adoption, intention, and acceptance of technology [38, 54, 55]. Several authors have reported that including age as a moderator would improve the explanatory power of the TAM model [54]. Venkatesh, Morris [38] stated that age is a vital moderator factor within their UTAUT model. They found that

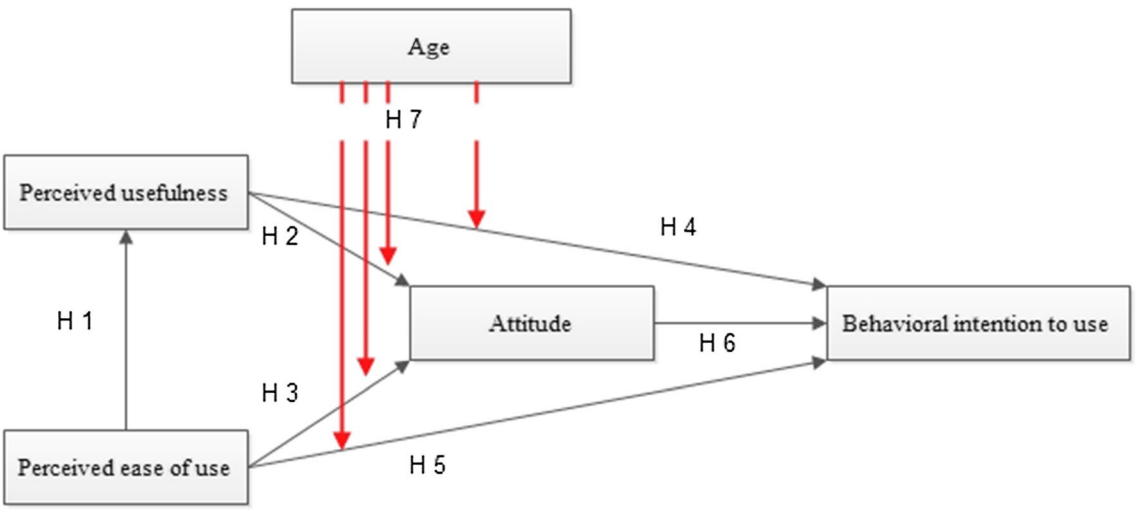

Fig. 2 The proposed model

within an organizational domain, the relationship between performance expectancy (including perceived usefulness) and behavioral intention was stronger for younger staff members. In the context of computer and Internet, Czaja, Charness [56] found that elderly people have low self-efficacy when it comes to the use of technology. It is evident that age can significantly moderate the impact of certain determinants on behavioral intention. Based on the findings of Venkatesh, Morris [38], the age group can potentially (i) moderate the effect of perceived usefulness on the behavioral intention of users (ii) moderate the effect of perceived ease of use on the behavioral intention of users (iii) the effect of subjective norm on behavioral intention. Hence, this study hypothesized that:

H7 The influence of perceived ease of use and usefulness toward attitude and behavioral intention will be moderated by age.

2.3 mHealth UI design-based culture

This study developed an mHealth UI design-based culture as an attempt to determine its acceptance among elderly Arab users. The use of mHealth in this study was to keep elderly people informed about medication time-schedule, dosage, and directions. This mHealth app also includes general information about the common and/or specific illnesses in the Arab world (e.g., causes, effects, symptoms, and precautions). Figure 3 displays a graphical image of the mHealth UI design-based culture used in this study.

The design of this app was based on the Arab culture, language, traditions, and value system that obtained from Arab cultural guidelines suggested by Alsswey, Umar [12] to help elderly people in the Arab world learn about various health-related aspects. In designing the UI, we used three colors (blue, green, and black) that are directly relate to the Arab culture to increase the Arab users' acceptance and use of mHealth. For example, it is believed that the green color symbolizes the Islamic belief; the black color symbolizes a specific period in the Islamic era; and the blue color symbolizes the sky and sea. However, other colors, such as red and yellow, were used to add more contrast to the design of UI. These colors are often used in designing applications for Arab users to increase their attention and interaction with the content [57, 58].

In addition, a font size of 12 pt and a font type of "الرقعة" were used in the design of mHealth UI to format the text for display. The use of these formats in the design of mHealth UI was for a number of reasons including the easiness to read and understand the content, popularity among Arab users, and ease of writing [59]. The information architecture of the mHealth app was designed based on previous studies on the Arab culture, such as Hall [60] and Hofstede [61]. These studies marked the Arab culture with certain characteristics related to taking less risk, the preference for simple structure, and avoidance of complex visual stimuli and activity. Furthermore, the direction of writing and reading in the Arabic system is from right to left. Hence, the UI layout in this study was designed from right to left. Finally, a notification system, including labels and messages, was used in the mHealth app to notify the users about their progress and other positive feedback related to their actions.

3 Research methodology

3.1 Research method

A quantitative method was employed in this study to examine the influence of the independent construct of

Fig. 3 Screen shoots of the mHealth UI design-based culture

TAM on the intention of elderly people to use mHealth UI design-based culture. A questionnaire was distributed to gather data from 81 participants. The use of questionnaires to investigate constructs that would influence the acceptance or rejection of the technology is common [62].

3.2 Questionnaire

The questionnaire for this study was adopted from Davis [37] and slightly modified to fit the domain of this study. The items used in the TAM model have been validated in many prior studies such as Ntaliani, Costopoulou [63] and Alharbi and Drew [64]. All the items were translated to Arabic and linguistically and culturally adapted to our setting by using the back-translation technique. To ensure the clarity and accuracy of the translated questionnaire, two bilingual experts scanned the translated items independently and no disagreements occurred. The questionnaire was structured into five sections: Section one emphasized on the demographic information of participants such as age, gender, experience in using mobile applications, and educational qualifications. Sections two, three, four and five were designed to measure responses associated to the TAM model constructs (PU, PEOU, AT, and BI). All constructs were evaluated at five levels of Likert-type scale. Participants were asked to choose from 5 points Likert-type scale with 1 = SD (Strongly Disagree), 2 = D (Disagree), 3 = N (Not Sure), 4 = A (Agree) and 5 = SA (Strongly Agree).

We also measured the reliability of the translated questionnaire. Reliability refers to the stability or consistency of a measurement instrument [65]. In this study, Cronbach's alpha of 0.7 and above was used to test the translated items. As shown in Table 1, the Cronbach's alpha value for all items were larger than 0.70, thus suggesting an acceptable reliability [66].

3.3 Participants

In this study, the target population was elderly Arab users from various backgrounds aged 60 years and above with at least 1 year of experience in using mobile applications. A purposive sample technique was used to gather the sample for this study. One hundred questionnaires were distributed, but a total of 85 questionnaires were received from the elderly people, which constituted 85% response rate from the survey. Among the 85 sets of questionnaires returned, there were incomplete responses from four respondents, leaving 81 questionnaires for further data analysis. Table 2 shows the descriptive statistics of the participants demographic information.

Table 1 The results of reliability analysis

Constructs	Items	Cronbach's alpha
PU	6	0.878
PEOU	7	0.796
AT	4	0.725
BI	3	0.703
Overall reliability	20	0.897

Table 2 Demographic information statistics for participants

	Information	Number of participants	Percentage
Age	60–64	65	80.2%
	65–69	10	12.4%
	70–74	4	4.9%
	75–79	2	2.5%
	≥ 80	0	0%
Gender	Male	60	74.1
	female	21	25.9%
Level of education	School level	26	32.1%
	Diploma degree	23	28.4%
	Bachelor's degree	15	18.5%
	Master's degree	8	9.9%
	PhD degree	9	11.1%
Experience in using mobile apps	1–3	15	18.5%
	4–6	28	32.9%
	7–9	24	29.6%
	≥ 10	14	17.3%

Based on Table 2, the majority of participants (n: 65; 80.2%) were between the age range of 60–64 years. 25% of the participants were between 75 and 79 years old. None of the participants were 80 years or older. As for the gender distribution, the majority of the participants (n = 60, 74.1%) were male and 21 (25.9%) were female. With regards to the level of education, the majority of the participants had a school level qualification (n: 26; 32.1%); 9.9% of them had master's certificate; only 9 participants had a Ph.D. degree (11.1%). As for the participants' experience in using mobile applications, most of them had experience between 4 and 6 years (32.9%), 24 participants had 7–9 years (29.6%), 15 had 1–3 years of experience, and 14 had 10 years or more of experience (17.3%) in using mobile apps.

4 Results

To determine the relationship between acceptance constructs (PEOU, PU, AT, and BI) toward the mHealth UI design-based culture, pearson's correlation analysis was applied, as it is the most commonly used measure of correlation to show the degree of linear relationship between variables [67]. Table 3 shows the correlation results between perceived

Table 3 Pearson correlation between variables

Factors	BI	AT	PEOU	PU
BI	1	0.641**	0.622**	0.322**
AT		1	0.760**	0.345**
PEOU			1	0.379**
PU				1

**represent $P \leq 0.01$

ease of use, perceived usefulness, attitude, and behavioral intention.

Table 3 shows that the correlation between perceived ease of use, perceived usefulness, attitude, and behavioral intention were significant and positive. Based on the Pearson correlation results, correlation between 1 and 0.3 is considered small; 0.3–0.5 is considered medium; and 0.5–1.0 is considered large [68]. The results showed that there is a small significant positive correlation between perceived ease of use and perceived usefulness ($r = 0.379^{**}$, $p < 0.01$). Additionally, the results indicated that there is a small significant positive correlation between perceived usefulness and attitudes toward using mHealth UI design-based culture ($r = 0.345^{**}$, $p < 0.01$). Furthermore, there is a large significant positive correlation between perceived ease of use and attitudes ($r = 0.760^{**}$, $p < 0.01$). Similarly, the relationship between attitude and behavioral intention of elderly people was significantly positive and large ($r = 0.641^{**}$, $p < 0.01$).

4.1 Factors affecting elderly users' BI to use mHealth UI design-based culture

To examine the constructs influencing elderly users' acceptance of mHealth in this study, a multiple regression analysis was performed. Before performing the regression analysis, the appropriateness of the regression was measured to guarantee that there is no violation of the assumptions of normality, outliers, and multicollinearity. All responses were found to be normally distributed and no extreme outliers were detected. As for the multicollinearity test, according to Kock [69], the variance inflation factor (VIF) was used in this study. VIF values below 3.0 indicates no multicollinearity problem. Based on this, all the VIF values (see Table 4) for the dependent and independent variables were ranged between 1.000 and 2.258, below the 3.0 threshold [69].

Table 4 Multicollinearity statistics

Independent variables	Dependent variable		
	BI	AT	PU
PEOU	1.857	1.065	1.000
PU	1.312	1.065	
AT	2.258		

4.2 Multiple regressions between PEOU, PU, AT and BI

To test the predictive significance between the dependent and independent variables, a multiple regression analysis was used. Table 5 shows the regression coefficients values of two regression models (model 1: PU on PEOU; model2: PU and PEOU on AT; model3: AT, PEOU, and PU on BI) constructed using a stepwise regression method. The results showed that two independent constructs were appeared to be the positive predictors of elderly people's intention to use mHealth UI design-based culture.

The behavioral intention of elderly users was found to be positively associated with perceived ease of use ($\beta = 0.760$, $p < 0.05$), perceived usefulness ($\beta = 0.322$, $p < 0.05$) and attitude ($\beta = 0.641$, $p < 0.05$). Attitude was found to be the strongest predictor of elderly users' intention to use mHealth UI design-based culture. The result also showed that elderly users' attitude was significantly influenced by perceived ease of use ($\beta = 0.760$, $p < 0.05$) and perceived usefulness ($\beta = 0.345$, $p < 0.05$). It is anticipated that the elderly users' perception of mHealth usefulness was due to its easiness ($\beta = 0.760$, $p < 0.05$).

4.3 The moderating effect

The moderate relationships between perceived usefulness, perceived ease of use, and attitude on behavioral intention were analyzed using SPSS PROCESS. Both attitude and behavioral intention were considered as dependent variables, perceived usefulness and perceived ease of use were considered as independent variables, and age as a moderator

Table 5 Results of the multiple linear regression analysis between PEOU, PU, AT, and BI

Models	Unstandardized coefficients		Standardized coefficients	t	sig
	B	SE	Beta		
Model1					
PU → PEOU	0.515	0.141	0.379	3.642	0.000
Model2					
PU → AT	0.278	0.085	0.345	8.262	0.000
PEOU → AT	0.834	0.018	0.760	10.406	0.000
Model3					
AT → BI	0.629	0.085	0.641	7.425	0.000
PEOU → BI	0.760	0.095	0.622	7.062	0.000
PU → BI	0.255	0.084	0.322	3.021	0.003

Table 6 The moderating effect of age

H	Proposed relationships	R2	F	df1	df2	*P*	Int_1	Type
7a	Age × PU → BI	0.2123	22.71	1.0000	77.0000	0.001	0.0893	Supported
7b	Age × PEOU → BI	0.2356	32.63	1.0000	77.0000	0.003	0.964	Supported
7c	Age × PU → AT	0.0026	0.1721	1.0000	77.0000	0.635	0.2764	NOT supported
7d	Age × PEOU → AT	0.0270	5.2626	1.0000	77.0000	0.563	0.2245	NOT supported

variable. Table 6 presents the results obtained from performing SPSS PROCESS which includes the interaction effect between the independent and the moderator variables. The age group of elderly Arab users was categorized into: 60–64 years, 65–69 years, and 70–72 years. The results showed a significant moderating effect of age on the relationship between perceived ease of use, perceived usefulness, and behavioral intention.

We hypothesized that the effect of PU of mHealth UI design-based culture on users' behavioral intention will be moderated by age. As shown in Table 6, the coefficient of interaction was 0.0893 and statistically different ($p < 0.001$). The result also showed that the moderation effect was significant for perceived usefulness of mHealth. Here, R2 = 0.2123, F (1, 77) = 22.71, $p < 0.001$ (H7a was supported). We also hypothesized that the effect of perceived usefulness on elderly users' intention will be moderated by age. The moderation result was significant (R2 = 0.2356, F (1, 77) = 22.71, $p < 0.003$), $H7_b$ was supported. Based on these, it can be said that age moderate the relationship between perceived usefulness, perceived ease of use, and behavioral intention. This result is supported by many prior studies which showed the significant role of age in stimulating users' acceptance of technology [38, 70, 71]. In addition, the effect of perceived usefulness of mHealth UI design-based culture on users' attitude was not moderated by age (R2 = 0.0026, F (1, 77) = 0.1721, $p < 0.6350$), and, thus, $H7_b$ was not supported. The same was found for the effect of perceived ease of use of mHealth on elderly users' attitude (R2 = 0.0270, F (1, 77) = 0.5.26, $p < 0.5630$), thus, $H7_d$ was not supported. This shows that age may not necessarily affecting all the constructs relationships, which is supported by Riskinanto, Kelana [72] who assessed users' adoption of technology using TAM.

5 Discussion

The results of this study showed that all TAM constructs namely perceived usefulness, perceived ease of use, and attitude had a significant positive influence on elderly users' behavioral intention to use mHealh UI design-based culture, which is consistence with the original TAM outcomes. In addition, the results revealed that elderly users had positive intentions to use the proposed mHealth app UI. A positive influence of perceived ease of use and perceived usefulness of mHealth on elderly users' attitude was reported. This result is consistent with findings from other previous studies (e.g., [51, 73]).

Perceived ease of use of mHealth UI design-based culture had a strong significant relationship with elderly users' attitude. A possible reason to this positive relationship may be that the main design elements of the mHealth UI (e.g., layout, images, colors, font, language, and buttons) were convenient, clear, and simple, thus making it easier for elderly users to complete their tasks as effectively and efficiently as possible. These results are consistent with various studies that found perceived ease of use to have a strong correlation with individuals' attitude [74, 75]. In addition, the results of this study are in line with those proposed earlier [76] and [77] that different cultural factors, such as icons, colors, language and symbols, should be considered in the design of an interface that reflects their cultural value and background.

Moreover, the results indicated that perceived ease of use and attitude had positively affect elderly users' intention to use mHealth. This might be due to the elderly users believe that using mHealth UI design-based culture would be free from mental and physical constraints. Attitude, on the other hand, was found to be the strongest predictor of elderly users' intention to use mHealth. This indicates that the participants were able to sense the cultural values in the design of mHealth, which resulted in a better appreciation of the interface. This finding is in line with some previous studies (e.g., [75, 78]), which suggest a possible link between culture and attitude of an individual towards technology acceptance.

This study also found a significant relationship between ease of use and usefulness of mHealth design-based culture. The influence of perceived ease of use on perceived usefulness makes sense conceptually [79], and consistent with previous studies (e.g., [80, 81]. It can be assumed that application usefulness is linked to the real use of an application where users are provided with relevant experience and background knowledge which helped them interact more with the content. In addition, elderly users were able to execute their tasks effectively by interacting directly with a representation designed to convey thoughts, ideas, or emotions. Adding the cultural design principles into the design of mHealth applications can potentially increase elderly people's knowledge of various health matters, thus building the sense of

technology usefulness. Meanwhile, the benefits obtained from using mHealth depend on the design characteristics of the interface and its suitability for users. Concerning the usage of technology for health purposes, Lim, Xue [82] found that perceived usefulness and perceived ease of technology can be used to predict users' intention to use mobile applications for browsing and searching health information.

Finally, differences were also found in the relationship between attitude and behavioral intention with regard to the moderating variable of age. This study also found that age to moderate the relationship between perceived ease of use, perceived usefulness, and elderly people's intention to use mHealth UI design-based culture. This result is supported by several previous studies such as Venkatesh, Morris [38], who demonstrated the role of age in in the acceptance of new technology. Also, no moderating effect of age was found on the relationship between perceived usefulness, perceived ease of use, and attitude. This may be due to the fact that elderly people are less confident in their skills to use mobile devices. This led us to assume that elderly Arab users may prefer to depend on other health sources of information (e.g., TV, doctors and family members). This result is in line with the result reported in the work of Taha, Sharit [83], who mentioned that elderly people are generally satisfied with the health information they can find from other sources than those who search for information online.

6 Limitations and future works

This study has some limitations that could be addressed in future work. First, the original TAM model was used in this study instead of the new version, which may reveal new interesting insights. Second, the sample of this study was restricted to the elderly people from Arab countries. Third, the design of the interface was based on people's cultural value and background, thus making it difficult to generalize the results to populations of different cultures. This is because each culture has its own customs, values and habits that differ from those of other cultures and regions. Fourth, the moderating effect of other demographic characteristics such as gender, experience of using mobile application, and educational level were not considered in this study. Examining the effect of these moderating variables on the relationships between acceptance factors may reveal new findings.

Based on these limitations, it is suggested that future studies should focus on investigating the relationships between elderly people's preferences to use certain design characteristics (e.g., color, language, layout and images) from a cultural perspective and their acceptance. Future studies may also consider the use of other theoretical frameworks like UTAUT and UTAUT 2 to strengthen the analytical and conceptual framework for mHealth acceptance among elderly people. In addition, future studies may recruit sample from other countries to further assess if the acceptance of elderly people vary between cultures or regions. Finally, the effect of other moderating variables, such as gender and experience, on elderly people's use of mHealth should be also addressed in future work.

7 Conclusion

Elderly people's use of technology is picking up due to the heavy reliance on mobile and Web applications to share or retrieve content. This study attempted to understand how mHealth UI design-based culture can affect elderly people's acceptance of this design. The TAM model was employed to evaluate the influence of independent constructs (PEOU, PU and AT) on the elderly users' intention to use mHealth. The results depicted that elderly Arab users had a positive attitude toward using mHealth designed with consideration of their cultural background. Moreover, this study offers support for the TAM model that attitude is the main factor in clarifying the behavioral intention toward technology use based on culture. In addition, age differences in elderly users of mHealth was found to significantly moderate the relationship between perceived ease of use, perceived usefulness, and behavioral intention only. Findings from this study offer a new insight into the role of culture in promoting users' acceptance of mHealth. It also encourages mobile designers and developers to consider the many facets of culture while developing mHealth applications.

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