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Author post-print (accepted) deposited by Coventry University's Repository

Original citation & hyperlink:

Alsswey, A & Al-Samarraie, H 2021, 'The role of Hofstede's cultural dimensions in the design of user interface: The case of Arabic', *Artificial Intelligence for Engineering Design, Analysis and Manufacturing: AIEDAM*, vol. 35, no. 1, pp. 116-127.
<https://dx.doi.org/10.1017/S0890060421000019>

DOI 10.1017/S0890060421000019

ISSN 0890-0604

ESSN 1469-1760

Publisher: Cambridge University Press

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The role of Hofstede's cultural dimensions in the design of user interface: The case of Arabic

Abstract

A User Interface (UI) design that meet the preferences, differences and needs of group of users can potentially increase the usability of a system. Users, in general, feels more familiar with the context that reflect their cultural values and practices. The Arabic culture plays a significant role in how Arab users interact and communicate with technologies. The customs, artefacts and traditions of the Arab world are different in nature from the Western cultures. Thus, it is essential to consider these differences when designing the UI prototype. This study investigated the role of certain cultural preferences in the design of UI for Arab users. A think-aloud approach and Hofstede's cultural dimensions were used on 23 Arab users to generate the necessary design guidelines for the UI of mobile health application. Then 78 participants were recruited to evaluate the proposed UI design. The usability results showed high satisfaction among Arab users about the role of culture in the design of the UI. Findings from this study can be used by designers and developers to aid their design of UI for group-specific cultural preferences and values.

Keywords: Culture, HCI, Hofstede dimensions, mobile UI design, Arab users

1. Introduction

In human-computer interaction, the design of an effective interface is a critical task because it requires a deep understanding of the end-users' characteristics in order to meet their needs and preferences (Al-Samarraie, Sarsam, & Guesgen, 2016; Faghih, Azadehfar, Reza, & Katebi, 2014). This means that services and facilities need to be presented for users in a simple and intuitive manner. Otherwise, users of the system may experience unsatisfactory behaviors. The interaction process of a user with the interface involves both human and systems components. Providing an effective interaction, often, requires an interface that meet certain perceptual, cognitive, and cultural properties of human information processing (Proctor & Vu, 2006). Users interact with the interface differently based on their cultural differences and values such as religion, language, and habits (Alsswey, Umar, & Al-Samarraie, 2018). Considering these differences in the design of UI could be essential for its acceptance and usability (Khaddam & Vanderdonckt, 2014). The epistemology of Arab culture tends toward a reflection of Islamic values, which also shape the social learning process itself (Abokhodair & Vieweg, 2016). This is why not all cultural aspects (e.g., images, symbols or phrases words) acceptable in Western countries are accepted by individuals of other cultures. For example, the use of cash boxes, as a symbol for saving money for children, in the form of pig heads is not preferred and is avoided to some extent in the Arab world.

Based on statistics in 2017, the population of Arab countries totaled around 421 million, which constitutes 5.6% of the world population. Arab countries have witnessed a rapid growth in technology take-up. Currently, there are more than 175 million Arabs using the internet. Hence, developing a set of guidelines for the design of an interface based on Arab culture is likely to enhance the usability and satisfaction of the user. However, the process of tailoring an interface for a particular user group is a challenging task (Richer & Drury, 2006; Sarsam & Al-Samarraie, 2018). The first challenge is to know 'what are the cultural aspects that need to be investigated', while the second challenge is 'how to implement the cultural values into the design of an interface'. This has been further discussed by Jones and Marsden (2006) who argued that supporting mobile technology use requires looking at people's culture to continue their learning conversations across contexts. Therefore, this study provides an in-depth understanding of the role of culture in the design of UI based on Hofstede's dimensions. These guidelines are believed to help designers make optimal decisions while designing an interface for mobile applications. This study also explored how the design of cultural-based interface would influence Arab users' satisfaction. The remainder of this paper is structured as follows: Section 2 describes the background of this study; Section 3 describes the proposed design guidelines; Section 4 presents the evaluation method of this study; Section 5 presents the descriptive results; Section 6 discusses the obtained results and future works; and Section 7 addresses the practical implications.

2. Background of the study

2.1 Culture

Culture is defined as a combination of certain beliefs, customs, values, and attitudes that distinguish individuals of one group from another (Hofstede, 2001). The word 'culture' has many definitions based on the context of use (Fulk, 2008). In general, the reason behind using cultural models is to understand specific cultural differences that can be used for classifying a group of people. Cultural models such as Hampden-Turner and Trompenaars (1993), Hall (1976), Hofstede (2001) and others have been commonly used in the literature for various purposes. Hofstede's model is among the key models used for studying human-computer interaction and cross-cultural challenges in UI design.

Our review of the literature (e.g., Islam & Bouwman, 2016; Saidin, Singh, & Drus, 2017; Sherman & Craig, 2018) showed that culture became a vital aspect in the design process of a system. Marcus (2000) claimed that cultural preferences can even differ from one country to another. For example, color symbolism arises from political, religious, historical and linguistic associations, which results in a wide range of cultural connotation, both from positive and negative perspectives. In addition, America symbolizes itself with red, white, black, and yellow colors, while China uses blue, red, white, black, and yellow. This is because in Buddhism, yellow is considered the color of humility. In Christianity, white is commonly used to express clear morals. However, in the Islamic culture, green and black colors are commonly used. These differences can stretch deeper than it looks; they present different cultural values, thus different preferences. Based on this, Marcus, Baumgartner, and Chen (2005) reviewed the culture dimensions proposed by Hofstede (2001) and claimed that culture might be related to one's choice of design elements. This led us to consider the following hypothesis:

H₀₁: There is no significant difference in users' satisfaction with regard to their cultural differences when using UI based-culture.

Age has also been found to influence individuals' decision to use or adopt technology. For example, Burton-Jones and Hubona (2005) stated that age can be used as a measure of personal resources (or perceived behavioral control). This assumption was based on Venkatesh and Morris's (2000) research who argued that age reduces perceived behavioral control because self-efficacy and cognitive skills decrease as people age. In addition, previous studies have also showed that in design preferences can be found among different age groups (Chadwick-Dias, McNulty, & Tullis, 2002). Overall, preferences for UI design can be said to be influenced by the age group of individuals. Therefore, the following hypothesis was shaped:

H₀₂: There is no significant difference in users' satisfaction with regard to their age group when using UI based-culture.

2.2 Hofstede's dimensions of the Arab culture

Hofstede (1980) conducted an empirical study on cultural attributes by analyzing data collected from surveying 53 countries between the years 1968-1972. The survey questions were designed mostly to measure work-related values and identify national-level cultural characteristics that are common among all respondents (Hofstede, 1980). The analytical dimensions are as follows:

1. Individualism versus collectivism: This dimension is associated with the integration of individuals into primary groups. Individualism is where people give the priority to themselves and their interests, while in collectivism, the group is given more priority than self-interest.
2. Power distance: Refers to the members of society who face unequal distribution of power such as social status and prestige, mental or physical abilities, law and wealth.
3. Uncertainty avoidance: Related to the level of vulnerability or stress in a society in the face of an unknown future. Uncertainty avoidance can be defined as the extent to which members of a certain culture group feel threatened by ambiguity and try to avoid it.
4. Masculinity versus femininity: Related to the separation of emotional roles between women and men in different societies. Masculine societies are characterized by values such as gender roles, ambitions and the acquisition of wealth. For example, in Jalapates culture, women are not allowed to work on certain jobs.
5. Long-term versus short-term orientation: Focuses on peoples' efforts either in the future, present, or past. Long-term orientation takes place when people focus on the future and are willing to delay short-term social success, or even short-term emotional gratification in order to prepare for the future. Short-term orientation takes place when people give attention to the present or the past more than the future.
6. Indulgence versus restraint: Related to gratification versus control of basic human desires related to enjoyment of life.

From the Hofstede's perspective, Figure1 shows a cultural comparison between China, Finland, Arab countries and World average. Although the Arab world is composed of 23 countries, the cross-cultural comparison of Hofstede's dimensions clearly shows the uniqueness of the Arab world as a single state.

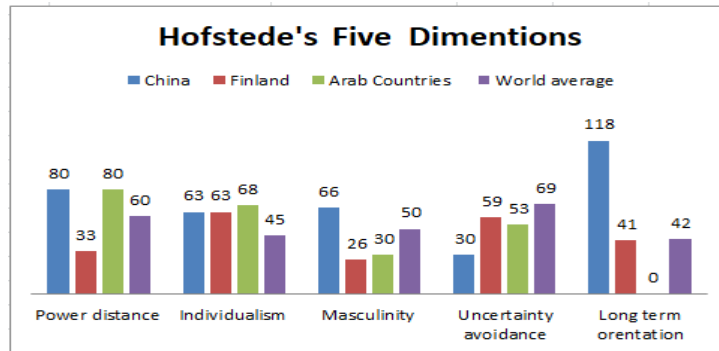


Figure 1: Hofstede's five cultural dimensions

From Figure 1, it can be clearly seen that Arab countries do not share common values in cultural dimensions with other countries like China and Finland. For example, compared to Finland, Arab culture was found to have a higher power distance, higher individualism, higher masculinity, and lower uncertainty avoidance. Despite these cultural differences, there seems to be some similarities between Arab countries from traditional, linguistic, and religious perspectives. Moreover, religion is determined as one of the most vital factors shaping Arab culture. Islam as a religion is symbolized by certain cultural features such as honor, loyalty, flexibility, and trust (Kalliny & Gentry, 2007; Shahin & Wright, 2004). In addition, Arab society is still regarded as more conservative than Western society (Benaida, 2014). The cultural dimensions of Hofstede show that the power distance score for the Arab world was 80%, which is considerably high because, in the Arab world, decisions and orders are made by leaders and then delegated to subordinates to execute the directives. In the uncertainty avoidance dimension, the Arab world scored 68%. This score may represent the act of an individual taking minimum risks to perform a task rather than trying new methods. And on the individualism dimension, the Arab world scored 38%, which mainly due to its collectivist society where the concept of 'togetherness' is considered very important for Arab countries. In addition, the Arab world on the masculine dimension obtained a score of 53% due to gender equality. Finally, there were no scores available for the long-term orientation dimension of the Arab culture. Since Arab culture encourages planning, it can be considered as a long-term planning culture (Obeidat, Shannak, Masa'deh, & Al-Jarrah, 2012).

2.3 Culture and UI design

Many human-computer interaction researchers (e.g., Ackerman, 2002; Dormann and Chisalita, 2002; Marcus and Hamoodi, 2009) have concluded that certain cultural aspects can be used in the design of UI. This includes studies on Web design based on Hofstede's dimensions. For example, Callahan (2005) carried out a study on the design of university Websites in different countries. The findings showed that white, purple or blue were the commonly used colors in Malaysian Websites (a low power distance country), while in Sweden (a feminine country), white background was commonly used in the design of their university Websites. Also, Marcus and Krishnamurthi (2009) conducted a study in Japan, Korea, and the United States to examine the UI components of social networking sites (SNS). They observed the symmetrical design for Korean SNS (high uncertainty avoidance) and asymmetrical design for USA SNS (low uncertainty avoidance). The findings showed that several differences in design preferences, such as color and image, were related to certain culture values.

Investigating the cultural aspects that affect UI usability such as font, color and language are crucial to enhance the acceptance of the system (Evers & Day, 1997). Several studies (e.g., Al-Badi, 2009; Alostath, Almoumen, & Alostath, 2009; Mushtaha & De Troyer, 2007; Tolba & Mourad, 2011) have been conducted to develop strategies for cross-cultural UI design, especially in Website design and desktop PCs. The reported findings from these studies confirmed that addressing cultural differences in the design of an interface would improve system acceptance, usability and help users to effectively interact with the system. For example, every color is regarded as an important cultural aspect and can be used to communicate particular feelings and meanings. Individual preferences for colors and shapes strongly depend on a different variety of factors such as culture, gender, social bias and psychological conditions (Long, 2017). India commonly uses red and saffron color in the design of their Websites to represent purity and sensuality, dynamism, and fertility (Weay, Abdullah, Masood, & Muniandy, 2015).

Language, on the other hand, has a direct impact on the usability of any UI (Khanum, Fatima, & Chaurasia, 2012), and it is determined as the backbone of communication for users with the interface. It plays a significant role in expressing certain feelings, ideas, senses, emotions, and messages. Therefore, using a suitable language when designing an interface can increase users' interaction with the system.

Images are also perceived differently by various cultures (Cyr, Head, & Larios, 2010). Ross and Gao (2016) stated that images may help enhancing user experience and thus having an important impact on the design of UI. In some cases, the design of an image may be offensive for people from other cultures. For example, some types of images are not acceptable in the Arab world (e.g., images of portraying drinking behavior). For this reason, images used in the design of Websites and applications should be culturally sensitive.

The design of a page layout received a great attention recently, particularly when designing an application for multiple cultures (Ross & Gao, 2016). It consists of several units that are arranged in a convenient way within the interface in order to help users easily find relevant links, menus, icons and other UI components. Therefore, it is necessary to keep the application simple and clear to facilitate its usage by a wider community of users. In addition, some cultures view content differently from others, for example, Arab people read from right to left, whilst British, Americans, Japanese, and others read from left-to-right.

The literature also showed the role of icons and symbols in the design of UI. Icons are commonly used to express information about functionality of the system without using words (Czaja, Rogers, Fisk, Charness, & Sharit, 2009). Still, end-users may face difficulties in recognizing certain icons in different situations in which the meaning of an icon may be interpreted differently from one culture to another. For example, Korean users tends to recognize more standard icons than American users, while Americans tends to recognize abstract icons more than Koreans (Kim & Lee, 2005). In addition, font is an important element in designing mobile UI because it directly affect individuals' moods, feeling, silliness, elegance, agitation, friendliness, and joy (Strizver, 2014). Font also plays a significant role in facilitating users' navigation, buttons selection, headings, contents and other important components. Therefore, font should be used appropriately according to the legibility and usability of the interface.

Finally, the information architecture components are used by designers to decide which information the user should see and what types of activities a user may attempt. These components are also used to link all elements of the interface such as icons, layouts, colors and buttons based on their relative importance to other visual elements. To enhance user interaction with the environment, a higher degree of attentiveness and thoroughness is needed (Farage, Miller, Ajayi, & Hutchins, 2012). From the literature's point of view, cultural values of an interface can be characterized by symbols and icons, font, language, images, and color. In countries with high uncertainty avoidance like in most Arab countries, the interface should be designed with a focus on color, language, and image in order to enhance the usability and user acceptance of the interface. In this study, UI components such as messages and labels, images, information architecture, layout, icons, language, color, and font were considered in developing culturally-based design guidelines for Arab users.

3. UI design components

The relationships between the identified UI components and Hofstede's dimensions are mapped in Figure 2. Based on Hofstede's dimensions of culture, this study hypothesized that UI components (messages and labels, images, information architecture, layout, icons, language, color, and font) and cultural dimensions (power distance, uncertainty avoidance, individualism versus collectivism, masculinity versus femininity) would influence UI usability and satisfaction.

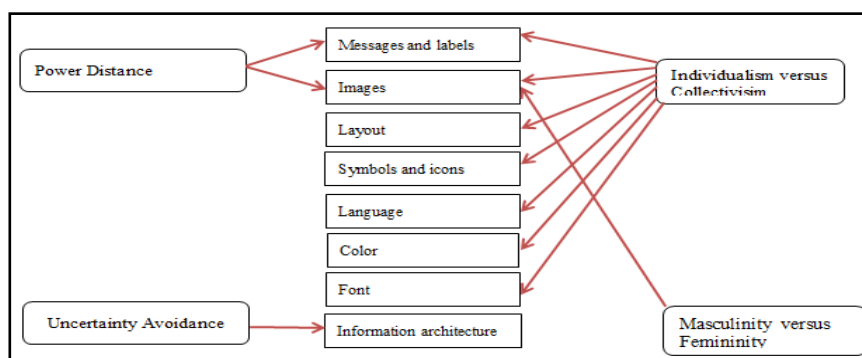


Figure 2: The relationship between Hofstede's dimensions and UI components

1. Power distance: This dimension was incorporated into the design of UI by categorizing system users into several groups based on the level of privileges for using the system. UI components such as images, messages and labels should be considered during the design process. Images should be designed to represent important sources of strength. Several researchers supported the use of images in UI design. For example, Geissler (2001) reported that images and labels in the interface may create positive feelings and responses among users.

2. Uncertainty avoidance: Based on Hofstede’s dimensions, Arab society does not like to take a risk and prefers to use traditional and established methods rather than trying out new ways. To apply this dimension in the UI design, designers should consider the properties of information architecture during the design process by avoiding complex screens and menus, unclear language, uncommon icons and symbols, and inconsistent grouping functions. Meanwhile, designers should also focus on simple design properties, in order to avoid confusion among users of the system (Farage et al., 2012; Pearson & Pearson, 2008).
3. Individualism versus collectivism: Hofstede (2001) stated that individuals in Arabic society have a high concern for devotion, reputation, dignity, shame, honour, and pessimism. Previous studies such as Barber and Badre (1988) and Khanum et al. (2012) stated that color is one of the strongest cultural aspects that represents different meanings. Colors (e.g., green, blue, and black) that represent the Arab culture and their habits are inherited from the Islamic eras. As such, this dimension was linked to six UI components namely, color, language, layout, icons and symbols, font, and images. This mapping is supported by Mushtaha and De Troyer (2012) and Marcus and Hamoodi (2009) who reported that Arabs prefer green and blue colors because they represent their culture. In addition, Khanum et al. (2012) stated that language is the backbone of communication on any interface, and has a direct impact on the user’s perceived usability of it. In addition, Ahmed ALsswey, Bin Umar, and Bervell (2018) reported that language is one of the most vital cultural aspects that reflect identity of societies which may positively influence users’ acceptance of a system. Thus, the use of Arabic language in the design of UI was due to its role in enhancing the acceptance and satisfaction of users when interacting with the display. The display of the content could be arranged from right to left (Ross & Gao, 2016). In fact, using layouts to display information from right to left can help meet the demands of Arab readers, which are mainly derived from their religious beliefs. The literature also showed the role of using icons and symbols in UI design. Previous studies noted that icons have a direct correspondence with the elements of an interface, particularly through saving space and conveying information about the functionality of the system without using words (Rigou et al., 2019). Also, icons and symbols allow immediate recognition and better recall, and create certain visual effects (Gefen, Karahanna, & Straub, 2003; Horton, 1991). Fisk, Czaja, Rogers, Charness and Sharit (2009) indicated that when the meaning of an icon or a symbol is relevant to users’ culture, they are likely to be satisfied. Avoiding unacceptable symbols in Arab culture is also important and could enhance user acceptance of the technology because Arab users tends to avoid products or technologies that contain culturally offensive images, such as pig head, the Star of David, etc. Finally, arabic fonts were also found to be an important UI component for Arab users. In many cases, interface designers tend to use Arabic fonts that are difficult to read or understand (Khanum et al., 2012). The Arabic font design must also be treated carefully because the characters in the Arabic language have overhanging and looping features in which few typographers have a native understanding of the script.
4. Masculinity versus Femininity: Hofstede’s dimensions revealed that Arab society has a more equal and balanced relationship between male and female. Using pictures of both males and females together in the design of an interface (i.e. Applications, systems and websites) is likely to achieve a balance. Table 1 presents the proposed UI-design guidelines based on Hofstede’s dimensions for Arab users.

Table 1: Proposed guidelines

Hofstede’s dimension	Level	UI components	Recommendations
Power Distance	High	Images	<ul style="list-style-type: none"> • Use images of main buildings and places • Apply privileges for system users
		Label and messages	<ul style="list-style-type: none"> • Use short messages and clear words
Uncertainty Avoidance	High	Information architecture	<ul style="list-style-type: none"> • Use limited options • Use simple design • Use simple and public UI components

Individualism and Collectivism	High Individualism	Images Language Layout Color Icons and symbols Font	<ul style="list-style-type: none"> • Use images of public and historical places • Use Arabic language • Use layout from right to left • Use green, blue and black colors • Use icons and symbols that symbolise Arab history and civilization • Use common Arabic fonts (e.g., الرقعة ، النسخ)
Masculinity versus Femininity	Equal Masculinity versus Femininity	Images	<ul style="list-style-type: none"> • Use images of both genders

3.1 Thinking aloud method

In this study, a think-aloud approach was used to collect information about the participants' perceptions of cultural aspects in UI design. Think-aloud is a research method in which participants speak aloud any words in their mind as they complete a task (Charters, 2003). A total of 23 Arab users were recruited in the design phase. These interviewees were randomly selected, in which they were from various age groups and education levels. Each interviewee was given an information sheet describing the purpose of the study. In addition, a consent form was administered to each participant, which was signed and returned before the interview. Each interviewee was knowledgeable that the interview session would consist of two parts: demographic assessment (Part A), and design preferences (Part B) related to language, color, layout, information architecture, font, images, labels and messages and symbols and icons. Table 2 shows the general demographic characteristics of interviewees.

Table 2: Demographic characteristics of interviewees

	Information	Number of participants	Percentage
Age	18-23	3	13.0%
	24-29	5	21.8%
	30-35	7	30.4%
	≥ 36	8	34.8%
Gender	Female	10	43.5%
	Male	13	56.5%
Level of education	School level	3	13.0%
	Diploma degree	6	26. %
	Bachelor's degree	11	47.8%
	Master's degree	2	8.8%
	Ph.D. degree	1	4.4%
Experience with mobile application	1-3	2	8.7%
	4-6	6	26.0%
	7-9	10	43.5%
	≥10	5	21.7%

As shown in Table 2, the majority of participants were older than 36 years (n: 8; 34.8%). As for gender distribution, out of the 23 participants, 13 of them (56.5%) were male and 10 (43.5%) were female. In terms of users' experience with mobile applications, the mainstream of users (n: 10, 43.5%) had experience between 7-9 years. Table 3 shows the relevant statistics related to UI design preferences obtained from the participants.

Table 3. Thinking aloud method statistics

UI components	Percentage
1 Arabic language	100%
2 Arabic fonts	100%
3 Color	91.3% Green (95.2%) black (82.6%), blue (73.9%), red (69.5%) and yellow (65.2%).

4	Layout	86.9%
5	Labels and messages	82.6%
6	Information architecture	73.9%
7	Icons and symbols	65.2%
8	Images	60.8%

In this study, we performed the think-aloud method in two steps. First, we gathered data from the 23 participants during a think-aloud session. Here, we made sure that all the questions asked were as infrequently as possible because participants may easily get distracted when engaging in a problem-solving activity (Ericsson & Simon, 1998). Then, follow-up questions about UI design components were asked. Other UI components, such as links and navigation, were ignored due to the limited evidence found in the literature about their role in Arab society.

When the participants were asked how the design elements can be used to ensure a culturally acceptable design, they identified that Arabic language and font type "الرقعة" to be the most important cultural elements in UI design. In addition, some interviewees (n:8) recommended a font type of "النسخ والرقعة", while the majority preferred "الرقعة" font type. When the participants were asked about the color choice, the majority (95.2%) showed preferences for green, followed by black (82.6%), blue (73.9%), red (69.5%) and yellow (65.2%). As for the layout, 20 interviewees (86.9%) showed high preference for layout from right to left, in view of their reading style. In addition, a total of 19 interviewees (82.6%) agreed about the importance of labels and messages in the design of UI. They reported that labels and messages should be clear, simple and short. By contrast, 17 interviewees (73.9%) highlighted the importance of information architecture, particularly to ensure consistency and continuity of the design. Finally, a total of 15 interviewees (65.2%) reported the importance of designing icons and symbols to be in line with the cultural values and customs of the Arabic world. Based on these suggestions, we designed a culturally mobile platform (mHealth) for Arab users to learn about various healthcare topic. Figure 3 shows the main screens of the proposed mHealth application.



Figure 3: The proposed mHealth application

4. Method

Descriptive statistics analyses were used to investigate Arab users' satisfaction level with mHealth application. In addition, Friedman Test was also used to explore differences in-between cultural and age groups.

4.1 Instrument

For the UI evaluation process, a questionnaire was used to obtain quantitative data from the selected sample. The questionnaire used in this study was adapted Chin, Diehl, and Norman (1988). The first section of the questionnaire obtained the participants' background information. In the second section, 15 closed ended items were distributed to the participants to evaluate the usability of the proposed mHealth UI design-based culture. For this, the Questionnaire for User Interface Satisfaction (QUIS) was used to measure users' attitude towards 6 interface factors (language (2 items), font (3 items), icons and symbols (3 items), layout (2 items), color (2 items) and overall application (3 items). The rating scale for the items was based on five-point Likert scale: strongly disagree, disagree, not sure, agree and strongly agree.

5.2 Sample and data collection

In this study, the target population was Arab users from three different Arab countries (e.g., Jordan, Syria and Palestine) with experience in using mobile applications. This study employed a purposive sample technique to recruit the participants for this study. A total of 110 questionnaires were distributed and only 89 questionnaires were returned, which represent 80.9% of total responses. Out of the 89 questionnaires returned, 11 questionnaires were not answered fully, leaving us with 78 questionnaires for data analysis. Based on Table 4, the mainstream of the participants (n: 32 or 41.1%) were within the 23–29 age group, followed by 23 participants (29.5%) who were within the ages of 17–22 years, 15 participants (19.2%) within the ages of 30–35 years, 5 participants (6.4%) within 36–41 age group, and only three participants (3.8%) were equal or over 42 years

old. In addition, 41 (52.6%) participants were male and 37 (47.4%) were female. A total of 29 (37.2%) participants were Jordanian, 26 (33.3%) Palestinian, and 23 (29.5%) Syrian. The mainstream of the participants (n: 31 or 39.8%) reported to have 7–9 years of experience in using mobile applications, followed by 23 participants (29.5%) who had 4–6 years of experience.

Table 4: Demographic information of the participants

Criteria	Information	Frequency	Percentage of sample
Age	17-22	23	29.5%
	23-29	32	41.1%
	30-35	15	19.2%
	36-41	5	6.4%
	≥ 42	3	3.8%
Gender	Male	41	52.6%
	Female	37	47.4%
Country of origin	Jordan	29	37.2%
	Palestine	26	33.3%
	Syria	23	29.5%
Level of Education	School level	18	23.0%
	Bachelor's degree	52	66.7%
	Master's degree	7	9.0%
	PhD degree	1	1.3%
Usage experience	1-3	9	11.5%
	4-6	23	29.5%
	7-9	31	39.8%
	≥10	15	19.2%

5 Results

The reliability test using Cronbach's alpha was conducted to assess the consistency and internal reliability of the items used in this study. The overall reliability result was 0.843 indicating acceptable reliability value (van Griethuisen et al., 2015).

5.1 Descriptive statistics

Descriptive analysis was used to analyze the collected data from the evaluation survey. The satisfaction level of the participants was determined by the interval level equation which was adapted from Landell (1997) and applied by several authors (Awajan & Dweik, 2010; Azman, Silva, Samah, Man, & Shaffril, 2013; Pihie & Bagheri, 2012; Saari & Mat Rashid, 2013; Wimolmas, 2013):

$$\text{Interval level} = \frac{\text{maximum point} - \text{minimum point}}{\text{number of levels}}$$

By applying the above equation, the interval level can be calculated as follows: $5 - 1/3 = 1.33$. Constructs were evaluated at three levels of satisfaction: Low level (1 to 2.33), moderate level (2.34 to 3.67) and high level (3.68 to 5). The highest value indicates high satisfaction of users with the mHealth UI, whilst the lowest value indicates low satisfaction of users with the mHealth UI. The values shown in Table 5 indicates that the participants had a high level of satisfaction with the UI design for mHealth application with a mean value of 4.17 (SD: 0.560). All the means values for the satisfaction items were in the range of 3.94 to 4.30. The overall users' satisfaction of mHealth based on the proposed culturally design guidelines recorded a highest mean value (\bar{x} : 4.30; SD: 0.485), followed by layout (\bar{x} : 4.24; SD: 0.464), icons and symbols (\bar{x} : 4.23, SD: 0.532), and color (\bar{x} : 4.18, SD: 0.510) respectively. The choice of language recorded the lowest mean value (\bar{x} : 3.97; SD: 0.703). Based on these, it can be said that Arab users were strongly satisfied with the UI design-based culture.

Table 5: Descriptive statistics results of Arab users' satisfaction with the mHealth UI

No.	Satisfaction	Mean	Standard Deviation (SD)
1.	Language	3.941	0.723
2.	Font	4.174	0.597
3.	Color	4.180	0.510
4.	Icons and symbols	4.234	0.532

5.	Layout	4.246	0.464
6.	Overall application	4.301	0.485

5.2 Friedman Test

Friedman test was employed to examine for any statistically significant differences in Arab users' satisfaction with regard to their country of origin (Jordan=Jor, Palestine= Pls, and Syria=Syr). It was essential to test whether in-between cultural preferences across countries exist or not between users from different Arab countries. For the grouping effects on the language used in the design of the UI, the results (see Table 6) indicated no significant differences among Jor, Syr, and Pls groups ($\chi^2(0.182) = 0.930$, $p = 0.835$). This may be related to the fact that most of Arab countries share the same language (Arabic language). The results also showed no significant differences in users' preferences for the font type among Jor, Syr, and Pls groups ($\chi^2(0.217) = 0.892$, $p = 0.806$). This can be due to the users' familiarity with the "الرقعة" font type in reading. In addition, there were no significant differences between groups with regard to the layout design ($\chi^2(0.190) = 1.021$, $p = 0.152$), which is due to that Arab people read and write from right to left. Regarding the choice of color, there were no differences among groups ($\chi^2(0.194) = 0.911$, $p = 0.828$). It is possible that the chosen colors have the same meanings for all Arab countries because they were shaped based on the Islamic standards in the past. For the grouping effects on users' choice of icons and symbols, the results showed no significant differences among groups ($\chi^2(2.130) = 1.100$, $p = 0.122$). This can be linked to the fact that Arab cultures are, for the most part, traditional and involves many practices and norms revolving around Islamic beliefs and customs. Finally, for the grouping effects on the overall application design, we also found no significant differences among groups ($\chi^2(0.184) = 1.121$, $p = 0.166$). This was expected because Arab users, in general, shares similar Islamic values, thus shaping their cultural preferences toward the design of UI. We also carried out Dunn-Bonferroni post hoc tests and there were significant differences between the Jor Group and the Syr Group ($p = 0.032$), the Pls Group and the Syr Group ($p = 0.014$) with regard to the role of color in UI design. The Dunn-Bonferroni test also showed no significant differences between the three cultural groups with regard to the language used in the design of UI, layout, icons and symbols, and overall perception of UI design. However, these non-significant results may be due to certain cultural associations which participants from different countries share. For example, cross-language similarity may have created a sense of control over the interface. It is also possible that the choice of font and layout in UI design for the Arabic culture have remained basically unchanged, thus no significant differences can be established. It is also worth noting that icons and symbols are routinely applied across a wide range of user interfaces to increase users' familiarity and confidence.

Table 6: Friedman test results for country of origin

	Jor Group (n=29)	Pls Group (n=26)	Syr Group (n=23)	F (df)	Chi-square (χ^2)	Sig
Language						
M	3.911	4.053	3.842	0.182	0.930	0.835
SD	0.213	0.197	0.310			
Font						
M	4.144	4.172	4.253	0.217	0.892	0.806
SD	0.142	0.162	0.173			
Layout						
M	4.294	4.440	4.271	0.190	1.021	0.152
SD	0.182	0.146	0.157			
Color						
M	4.216	4.224	4.132	0.194	0.911	0.828
SD	0.183	0.149	0.179			
Icons & symbols						
M	4.282	4.380	4.071	2.130	1.100	0.122
SD	0.168	0.196	0.145			
Overall						

M	4.173	4.184	4.381	0.184	1.121	0.166
SD	0.161	0.172	0.183			

Friedman Test (see Table 7) was also used to examine for any statistically significant differences in Arab users' satisfaction with regard to their age group (18-23; 23-29; and 30-35). Age groups greater than 36 were not considered in this test due to the small number of participants. Users' satisfaction with the language used in the design of the UI was not significant among the three age groups ($\chi^2(0.133) = 0.850, p = 0.723$). As for the font type used in the design of UI, the results showed significant differences among users ($\chi^2(6.623) = 8.052, p = 0.042$). In addition, there were significant differences between groups with regard to the layout design ($\chi^2(5.149) = 7.510, p = 0.047$). Regarding the choice of color, there were no differences among groups ($\chi^2(0.171) = 0.740, p = 0.604$). As for users' choice of icons and symbols, the results showed no significant differences among groups ($\chi^2(1.006) = 0.946, p = 0.600$). The results showed no significant differences with regard to overall application design ($\chi^2(0.137) = 1.130, p = 0.268$). The Dunn-Bonferroni test was also used to determine differences between users' UI satisfaction with regard to their age groups. The results showed a significant difference in font type between the 17-22 Group and the 30-35 Group ($p = 0.022$). We also found a significant difference in users' satisfaction with the layout between the 17-22 Group and the 30-35 Group ($p = 0.022$). However, we did not find any significant differences between the three age groups with regard to their perception of the language used, color, icons and symbols, and overall satisfaction of the interface. These non-significant results can be due to the reasons discussed above.

Table 7: Friedman test results for age group

	17-22 (n=23)	23-29 (n=32)	30-35 (n=15)	F (df)	Chi-square (χ^2)	Sig
Language						
M	4.102	3.961	4.130	0.133	0.850	0.723
SD	0.105	0.1536	0.361			
Font						
M	3.690	4.621	4.010	6.623	8.052	0.042
SD	0.115	0.091	0.126			
Layout						
M	4.743	3.781	4.056	5.149	7.510	0.047
SD	0.082	0.135	0.131			
Color						
M	3.951	4.720	4.331	0.171	0.740	0.604
SD	0.130	0.105	0.122			
Icons & symbols						
M	4.661	4.281	3.432	1.006	0.946	0.600
SD	0.515	0.211	0.100			
Overall						
M	4.680	4.411	4.053	0.137	1.130	0.268
SD	0.113	0.103	0.141			

6. Discussion and future works

This paper examined the role of Hofstede's dimensions of Arab culture in an attempt to develop UI design guidelines for Arab users. The literature was used as the main source for extracting the UI design elements. Then, a thinking-aloud method was used to conceptualize the design components for Arab culture. These components were mapped across the dimensions of power distance, individualism and collectivism, uncertainty avoidance, and masculinity versus femininity.

The result of users' satisfaction toward the cultural-based mHealth UI design was high. This indicates that the integration of certain cultural values into the design of UI would enhance users' abilities to effectively use technologies. The findings showed that the design layout was highly perceived by Arab users when using mHealth application. It is assumed that using a layout that meet users' cultural and emotional needs may facilitate their information processing and enable them to maintain cognitive consistency. In addition, the design layout of most mobile applications is from left to right, which does not reflect their own culture. This finding on the design of UI layout is supported by Ross and Gao (2016), who stated that following a specific culture that is recognizable by specific user groups is essential for promoting the adoption of a new system.

The results also showed that both icons and symbols were highly perceived by Arab users. One reason to this is that the intended context can be recognized more quickly with icons and images than by reading a text message or label. This finding is in line with Meyer's and Bernier (2010) study which states that product design should consider and be compatible with the targeted culture and social values. Arab users also showed a high satisfaction level towards the chosen UI colors. This finding also supported by different previous studies on the role of color in designing cultural-based interface, such as that by Walton, Vukovic, and Marsden (2002) and Plass (1998). These authors recommend the need for designing products that are restricted to a particular culture or group of cultures. In addition, this finding is in line with the work of Hasan, Al-Sammerai, and Kadir (2011), who stated that red and yellow are frequently used in Arab culture to attract the attention of people.

The choice of font type and language in the design of UI also recorded a high score of satisfaction among users. This indicates that using local language in UI design is essential for ensuring the acceptance and success of any technology and product in society-specific cultural practices (Hudson & Hall, 1997; Mirri, Rocchetti, & Salomoni, 2018). The findings are also supported by few previous studies on the use of formal language in UI design. For example, Medhi et al. (2011) stated that the usability of an interface improves when the designer or developer consider the native language of the end-users. In order to confirm whether differences in users' satisfaction were constant across countries of similar culture, we used Friedman Test. The results showed no significant differences exist among groups with regard to users' satisfaction with the interface. This is due to that Arab countries are determined as one unit that share the same cultural aspects, religious beliefs and customs (Benaïda, 2014; Kalliny & Gentry, 2007; Shahin & Wright, 2004). In addition, differences in users' satisfaction with regard to their age groups were also examined. In terms of language, color, icons and symbols, and overall satisfaction with the use of UI design-based culture, the results showed no significant differences between different age groups. However, significant differences were found among users with regard to the font of the UI. This can be reasoned to that individuals' preferences to different font types may vary depending on their age group. For example, younger individuals tend to use smaller font size than individuals of other age groups (Darroch, Goodman, Brewster, & Gray, 2005). The results also showed significant differences between groups with regard to the layout design, which can be linked to that younger users are more used to modern design layout than other age groups.

Despite these findings, this study has some limitations that could be considered in future work. First, four out of six dimensions of Hofstede were used in this study. As per Hofstede's (2001) study, the rest of the dimensions were not applied because limited information was gathered from Arab countries. In addition, the proposed guidelines may not provide a full picture regarding the relationship between culture and design of UI in Arab countries. Second, the UI design was limited to the Arab culture, therefore making it difficult to generalize the results to populations of other cultures. Based on these limitations, it is proposed that future studies may employ other cultural models like Hall (1976) to design culturally UI guidelines. Future studies may also consider examining the acceptance of users towards culturally UI design among users of different cultures.

7. Practical implications

Since many countries in the Arab world lacks usability guideline to support usable and effective mobile app UI design, this study findings adds new insights into the design of Arabic UI by introducing new design guidelines that are relevant to users of certain cultural backgrounds. For example, using Arabic language with certain type of fonts in the design of mobile UI can give an accurate expression to users which can be characterized by clarity, serenity, quality and integrity of the structures. This is because Arabic font has several different types and styles rated from easy-to-read (e.g., الرقعة ، النسخ) to hard-to-read (e.g., خط الثلث). This study also adds to the current Nielsen's usability guidelines in that it shows the importance of color choice in the design of UI for Arab users, offers clarity of view, attracting the attention of users, aesthetics and expression of many different meanings according to their culture. In addition, this study provides clue to UI designers about the importance of avoiding certain symbols when designing interfaces for Arab users. Based on these, it can be said that the implications of the proposed culturally UI design provides substantial benefits not only for the designer or developer of mobile applications, but also for the users of mobile applications. Numerous practical suggestions, such as

encouraging users to use applications and systems in relation to their cultural values may reflect positively on their technological applications. The following is a summary of the proposed guidelines:

1. Language: Using formal language and common words in UI design will improve understanding of the content and consequently decrease the time for a user to learn the system.
2. Font: Avoiding the use of font types that may cause users to avoid the system is essential in the design of UI.
3. Color: Using culturally colors in the Arab world such as green, blue, and black can increase users' satisfaction with the system by increasing their level of attention and concentration on the task at hand.
4. Layout: The choice of layout should be based on the target culture of the specific language society, because the arrangement of UI components may influence users' abilities to process information effectively.
5. Information architecture: Using a simple design (relevant function groups) can help users become more effective in their information searching. The design also should be centered around theory, research and practice to properly reflect the requirements of the different cultures.
6. Symbols and icons: Using symbols and icons that are relevant to the target cultural and religious values can increase users' satisfaction with the system.
7. Label and messages: Using feedback messages and clear labels in the design of any interface might increase users' confidence in using the system.
8. Images: Images should reflect the collectivist nature of Arab people. For example, UI designers should avoid images of women wearing short or skimpy clothes as it is not common for women in the Arab world.

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APPENDIX

Questionnaire for User Interface satisfaction

Language

- 1 Using formal language in this interface improve my understanding of the content
- 2 Using common words in this interface decrease the time for a user to learn the app

Font

- 3 Using common font type in this interface would be easy for me to understand the contents of this app
- 4 The font used in this app is readable and clear
- 5 This design avoide the use of common font types that may cause me to avoid using it

Colour

- 6 The colour of components in this design is clear
- 7 The colour of the interface components is attractive

Icons and symbols

- 8 The icons and symbols used in this app are easy to recognize
- 9 The icons and symbols used in this app are releveant to my culture
- 10 The icons and symbols used in this app are common

Layout

- 11 The design of this app is simple and not complex to use.
- 12 The app is easy to navigate

Overall

- 13 The design of this app is satisfying
- 14 The design of this app is wonderful
- 15 The design of this app is flexible