A Review on Cultural Design Elements for Mobile Applications User Interface

Shamsul Arrieya Ariffin[(✉)], Nur Saadah Fathil, Maizatul Hayati Mohamad Yatim,
Muhammad Zulhilmi Samsuri
Universiti Pendidikan Sultan Idris, Perak, Malaysia
shamsul@fskik.upsi.edu.my

Abstract—This study examined the use of cultural design elements in the existing design guidelines for mobile applications. Cultural design elements are used to include cultural values in the development of mobile applications. This research reviews existing design guidelines to identify cultural design elements' practicality in mobile applications. This study conducts a literature review (PRISMA), including identification, screening, and eligibility. The keywords "Application", "Design Guidelines", and "User Interface" were searched on ACM Digital Library, IEEE Xplore, and Scopus between 2017 and 2021, including 2022, with 281 articles before filtering and three articles selected after filtering. This review shows that cultural design elements in the mobile application played an essential role in getting a high usability rate for users. However, cultural design elements are still less used in the development of mobile applications. As a result, future research will focus on developing guidelines for mobile applications with cultural design elements appropriate for today's technological era in a local context.

Keywords—mobile application, user interface, cultural design elements, design guidelines

1 Introduction

The development of technology today has expanded to broad applications. This development has affected various industry sectors, including the mobile application industry. Many mobile applications have developed quickly in the new era of technology [1]. Mobile applications have become commonplace in the lives of people all around the world [2], [3]. This development can be seen in Information and Communication Technology (ICT), which has led to the ubiquitous use of smartphones in today's world [4]. The advancement of mobile application technology also affects today's students by offering the latest modern features that lead to more efficient use [5], [6]. Mobile applications now can also be seen entering the education sector, leading to digital literacy and positively affecting student motivation today [7]–[9]. In line with the advancement of this technology, it needs to be aligned with the local community's culture. This need is due to the recommendation that today's technology development

maintains local cultural values [10]. Following the use of mobile applications has entered the education sector today, which affects the lifestyle of students, it is necessary to embed cultural values in the development of mobile applications used in education to cultivate and preserve those cultural values since school [11]. However, the use of cultural design elements in the development of mobile applications today is still less intensified [12]–[14]. The study aims to investigate the use of cultural design elements in the existing design guidelines in mobile applications, User Interface (UI) development and observe the need for usability. The goal of this study focuses on the need for technology to preserve the importance of culture [15]. UI designers for mobile applications can apply cultural design elements to develop the user interface for an application to use and maintain such elements in the digital era. The study focuses on the need to incorporate cultural design elements into the development of mobile application design following the high increase in mobile application usage.

2 Related works

2.1 Mobile learning applications

Mobile learning applications are a new educational system used today [16]. This study is due to technological changes affecting various sectors, including the education sector. The use of mobile applications in the education sector began to rise as the world faced the COVID-19 pandemic, which changed the landscape of the way various sectors of the time worked, including the education sector [7]. This study shows the excellent role mobile applications play in helping the education sector deal with the problems involved with time and place constraints. The use of mobile applications shows a positive effect on students and teachers. The reason is that the use of mobile applications can be seen to increase student motivation and involvement in learning activities [17]. Increased motivation and involvement of students in teaching and learning activities can help increase student achievement, and mobile applications can also contribute to digitally literate students. In line with this development, mobile applications can apply cultural values in their development that can influence students. This research is in line with UNESCO's recommendations in making today's technology preserve cultural values, as well as the role of the education sector in nurturing cultural values in schools [10], [11]. To meet this need, researchers will look at using the five existing design guidelines to see the use of cultural elements in the development of mobile applications.

2.2 The existing design guidelines

Designing a good interface requires processes that need to be understood. Design guidelines have provided the designers with rules to follow in developing the UI. For example, Human-Computer Interaction (HCI) has developed design guidelines to assist designers with creating UI for mobile applications [18], [19] for designing and evaluating the UI [20]. Design guidelines assist designers in the development of valuable and usable systems. The study review focused on existing commonly used design

guidelines in HCI. This study only discussed the five existing design principles and guidelines for mobile applications in UI development.

ISO 9241-11:2018 for Ergonomics of Human-System Interaction. ISO 9241-11:2018 is one of the design guidelines in UI development [21]. The term "ISO" stands for the International Organization for Standardization [22]. Usability is defined by the ISO 9241-11:2018 for Ergonomics of Human-System Interaction Standard as a characteristic of quality in use that results from perceived effectiveness, efficiency, and satisfaction [22]. Based on this definition, ISO also defines usability as three attributes: (1) effectiveness, (2) efficiency, and (3) satisfaction. The two most common measurements in ISO 9241 are effectiveness (which assesses how well a user can complete tasks correctly) and efficiency (which measures how quickly a user can complete a goal with the resources and available tools) [23]. There is a clear connection between effectiveness and efficiency; the UI is simple and easy to engage with, leading to better task performance. Likewise, user satisfaction is impacted by both efficiency and effectiveness [24].

Nielsen's Ten Usability Heuristics. Jakob Nielsen suggests ten user interface design principles. Nielsen's Ten Usability Heuristics are one of the design guidelines [21]. Nielsen's usability refers to the ease with which a user can use a program to complete a specific task [24]. They are called "heuristics" because they are more like general guidelines than precise usability recommendations [24]. Nielsen's Ten Usability Heuristics have been applied to assess various design interface styles [25]. The following are the ten heuristics: (1) system status visibility, (2) match between system and the real world, (3) user control and freedom, (4) consistency and standards, (5) error prevention, (6) recognition rather than recall, (7) flexibility and efficiency of use, (8) aesthetically pleasing and minimalist design, (9) assistance to users to recognize diagnose, and recover from errors, and (10) help and documentation [24], [25].

Shneiderman's Eight Golden Rules. Shneiderman's Eight Golden Rules are well-known design guidelines in UI development [22]. Shneiderman has provided eight golden rules for interface design [26]. The principles presented by Shneiderman were derived from experience heuristically and can be applied to most interactive systems once they have been refined, extended, and interpreted [27]. The following are the eight golden rules: (1) strive for consistency, (2) enable frequent users to use shortcuts, (3) offer informative feedback, (4) design dialogue to yield closure, (5) offer simple error handling, (6) permit easy reversal of actions, (7) support internal locus of control, and (8) reduce short-term memory load [26].

Norman's Seven Principles. Norman's Seven Principles is also one of the existing design guidelines [22]. For instance, Donald Norman has provided seven principles in UI design development, developed to evaluate the interaction between humans and computers [22], [28]. The following are the related seven principles: (1) utilizing theoretical and practical knowledge, (2) simplifying task structures, (3) making things visible, (4) getting the mapping right, (5) converting constraints into advantages, (6) design for error, and (7) when all fails, standardize [28].

Culturally Appropriate Design Guidelines. Meanwhile, Culturally Appropriate Design Guidelines (CADG) assist application developers in developing applications that ease the use of developed applications for local users [29]. A typical example is the use of local languages in application systems. CADG combines general usability with

cultural elements. These guidelines' general usability and cultural elements have shown that they complement each other and significantly impact [23]. The following are the six general usability elements: (1) accessibility, (2) consistency, (3) good ergonomic and minimalist user interface design, (4) readability and ease of recall, (5) efficiency and flexibility, and (6) realistic error management. The following are the cultural design elements: (1) suitable content for the local culture, (2) aesthetic value according to local culture, (3) local language, and (4) philosophical values [23]. This design element indicates the potential of using this guideline for mobile applications in the creative industry.

2.3   Lack of cultural design elements

The results of several previous studies show that there is still a lack of use of cultural design elements in the development of mobile learning applications or mobile applications. In a study that focuses on the development of mobile applications for health use in Arab countries, it is stated that there is still a lack of empirical studies investigating and confirming the use of cultural design elements in their development [30]. In addition, the study on mobile applications for the creative industry also stated that there is still less use of cultural design elements in mobile applications today [31]. Furthermore, the study conducted for the scope of mobile learning applications in the Malaysian context also stated that there is still a lack of cultural design elements used in developing the application [32]. This research indicates that the need for cultural design elements is less intensified and leads to a lack of use in developing mobile learning or mobile applications today.

3   Methodology

In this section, the literature review analysis process is described. The following section will explain how the literature was reviewed, which studies were deemed appropriate, and the discussion of the context of the previous study. The study used adaptations from the study by Shaffril et al. [33] to conduct a literature review analysis. The stages of literature review analysis are shown in Figure 1.
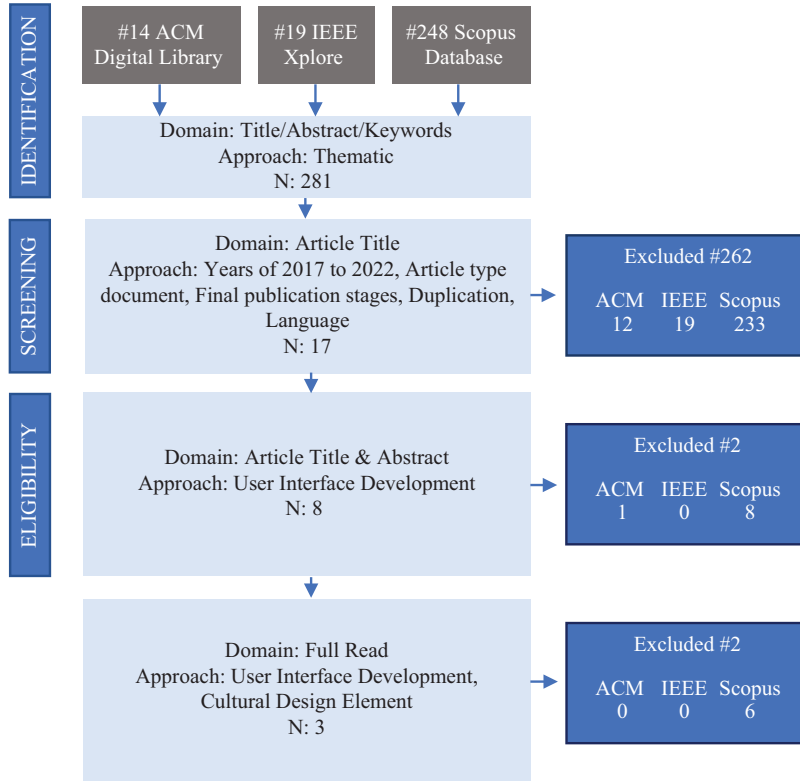
Fig. 1. The Flow Diagram (Adapted by Shaffril et al., [1])

3.1 Identification

According to Figure 1, the first process is identification. Identification is looking at any synonyms, relevant topics, and variations of the study's main keywords. Its goal is to give a selected database more possibilities for searching more similar documents for review [34]. In this process, the authors used keywords generated from the research questions suggested by Okoli [35]. The keywords used in the search were "Application", "Design Guidelines", and "User Interface", using Boolean (AND) operators. Each search of the generated keywords was used in three databases: ACM Digital Library, IEEE Xplore, and Scopus. The study used three databases with broad coverage of the HCI literature [36]. Searches in this process used domain for the titles, abstracts, and keywords and a thematic approach [37]. The search process from these three databases resulted in a total of 281 documents.

3.2 Screening

Meanwhile, Figure 1 shows the screening process (second process). All 281 documents were screened by selecting criteria for document selection, which was carried out automatically using the database's sorting function. Considering the difficulty of reviewing all published documents, Okoli [35] recommended choosing the period for conducting their review. This review covered the period from 2017 to 2021, including 2022, as part of the inclusion criteria. In addition, only articles type and articles published in the final stages of publication were considered for the review and in English. As a result of this process, 264 articles were excluded as they did not meet the inclusion criteria. Meanwhile, this study removed zero duplicate articles. The researcher selected 17 articles in the third process.

3.3 Eligibility

Additionally, Figure 1 also shows eligibility as the third process. Likewise, the researcher manually checked the remaining article based on the criteria after the screening process. In this process, the articles were read by looking at their titles and abstracts. The focus of this study is on user interface development in this process. Rather than the development of the whole application, nine articles were excluded. Consequently, this study selects eight articles. Additionally, after full perusal of the articles, only three articles were selected that fulfilled the need of the review objective.

4 Findings

This section will discuss two themes the author set: (1) similarity and differences between elements used in the existing design principles and guidelines, and (2) implementation of the elements in the previous study. This study showed several similarities and differences in the use of design elements found in five existing guidelines as discussed in the study. Additionally, this study demonstrated the use of cultural design elements in the CADG design guidelines. The study also showed the design elements implemented in the application development process from previous studies.

4.1 Similarity and differences in design elements

Using all elements in the existing design principles and guidelines demonstrates that not all used similar elements and had different use elements. Table 1 compares all the uses of elements and the similarity and differences.

Table 1. Comparison of design guidelines

Element	CADG [38]	Norman [39]	ISO [40]	Nielsen [41]	Shneiderman [42]
Accessibility	✓	–	–	–	–
Affordance	–	✓	–	✓	–
Consistency	✓	✓	–	✓	✓
Constraints	✓	✓	–	✓	–
Efficiency	✓	–	✓	✓	–
Error Handling	–	–	✓	✓	✓
Error Prevention	✓	–	–	✓	–
Feedback	–	✓	–	–	✓
Local Culture	✓	–	–	–	–
Mapping	✓	✓	–	✓	✓
Match Between System and The Real World	–	–	–	✓	–
Permit Easy Reversal of Actions	–	–	–	–	✓
Satisfaction	–	–	✓	–	–
Shortcuts	–	–	–	–	✓
User Control and Freedom	–	–	–	✓	✓
Visibility	–	✓	–	✓	✓

Based on Table 1 demonstrates that all design guidelines had similar and different uses of elements. Table 1 also shows that only CADG used cultural design elements in their design guidelines. This study indicates that cultural design elements are still underused in existing design principles and guidelines. Thus, indicating the need to conduct further research on the use of cultural design elements in design principles and guidelines for developing design applications and making technology a platform that preserves cultural values, as stated by UNESCO [10].

4.2   Implementation

Previous studies have also demonstrated the use of design elements in implementing UI. In addition to the design mentioned above guidelines, past studies have found several other design guidelines. Results from a previous study search conducted found three articles examining the use of elements used in design guidelines in building UI [38], [43]–[49]. Only three out of the eight articles [43], [44], [50] discussed the use of cultural design elements in UI development. This study examined three more articles that discussed the need for cultural design elements in UI development and noted the use of cultural design elements and other elements in developing mobile application UI.

Smartphone application for low-literacy users. The first study was related to developing smartphone applications for low-literate users. This study aimed to develop actionable guidelines in the design of smartphone UI for the use of low-literate users. This framework comprised thirteen guidelines developed based on learning from multiple domains. This study used different design guidelines from the existing design guidelines discussed above. This study utilized Actionable UI Design Guidelines. The thirteen guidelines were divided into five themes: (1) input/output model, (2) visual design, (3) content and information architecture, (4) help menu, and (5) human in the loop [34]. Table 2 shows the thirteen guidelines used for smartphone applications for low-literate users.

Table 2. 13 Guidelines for smartphone application for low-literate users

Guidelines	Themes	Cultural Design Element
Utilize multiple modes of interaction	Input/Output Model	
Leverage numerical literacy	Input/Output Model	
Keep a minimalist, clean interface	Visual Design	
Incorporate visual cues	Visual Design	
Avoid jargon	Content and Information Architecture	
Break down information within and across screens	Content and Information Architecture	
Simplify navigation structure	Content and Information Architecture	
Assist in using the application	Help Menu	
Include short, simple instructions in the Help menu	Help Menu	
Adopt audio and video help tutorials	Help Menu	
Adopt a culturally responsive design	Human in the Loop	✓
Leverage human facilitators	Human in the Loop	
Enable customization	Human in the Loop	

Table 2 shows that the framework uses the cultural design element in humans in the loop themes. The results from this study showed that cultural elements are needed to provide the framework for developing smartphone UI that meets the needs of low literacy users, for example, by adopting guidelines for using a culturally responsive design based on local language and culture.

Mlearn Website of Universiti Pendidikan Sultan Idris. The second study discussed the development of the Mobile Learn Website of Universiti Pendidikan Sultan Idris. This study evaluated the use of CADG guidelines for mobile learning websites. This CADG guideline had ten design elements that were divided into two parts: (1) general usability elements and (2) cultural design elements [23]. Table 3 shows the CADG guidelines for the MLearn Website of Universiti Pendidikan Sultan Idris.

Table 3. CADG elements

Guidelines	Element	Cultural Design Element
Accessibility	General Usability Elements	
Consistency	General Usability Elements	
Good ergonomics	General Usability Elements	
Readability	General Usability Elements	
Efficiency and flexibility	General Usability Elements	
Realistic error management	General Usability Elements	
Suitable content for local culture	Cultural Design Elements	✓
Aesthetic value according to local culture	Cultural Design Elements	✓
Local language	Cultural Design Elements	✓
Philosophical values	Cultural Design Elements	✓

Table 3 shows that CADG guidelines used four cultural design elements. This study showed that the CADG guidelines discussed and highlighted cultural design elements' need for and importance in developing UI. Likewise, the study findings also showed that the usability of mobile applications increased with the increase in cultural design elements.

mHealth application for Arab users

Table 4. UI component in cultural design elements

UI Component
Messages and labels
Images
Layout
Symbols and icons
Language
Colour
Font
Information architecture

The third study was related to UI development for the mHealth application for Arab users. This study was conducted to play a critical cultural role in UI design for Arab users. This study only involved cultural design elements, namely the Local Culture Element in the UI component, which consisted of eight components that needed to be used with cultural elements. Table 4 shows the eight components of local cultural elements. However, this study did not specify the design guidelines used in developing this UI for the mHealth application for Arab users.

Table 4 shows the cultural design element focused on the UI component in developing mHealth applications for Arab users. The study conducted by this article indicated that the use of cultural design elements provided a high level of consumption and user satisfaction. This study also stated the importance of cultural design elements usage in UI development because an application affects the quality of usability of users [51].

Conclusion from the review. The previous three studies indicated that cultural design elements play a significant role in developing mobile application UI design. Using cultural design elements to develop mobile applications' UI design can provide high usability results. This study indicates that cultural elements are indispensable in developing mobile application UI design.

5 Discussion

As shown in Table 1, this study presented several findings that stated the elements of similarities and differences used in the five existing design guidelines, ISO 9241-11:2018, Nielsen's Ten Usability Heuristics, Shneiderman's Eight Golden Rules, and Norman's Seven Principles, and CADG. In addition, this study demonstrated the use of cultural design elements in the previous study. Based on the previous studies' results, this study identified the design guideline elements used in mobile applications UI development. This section comprises a study discussion that provides a clear picture of the benefits, challenges, and opportunities related to the existing design guidelines.

5.1 Benefits

The findings from these review papers show that the use of cultural design elements in the development of mobile applications helps to achieve a satisfactory usability rate [23], [34], [51]. Usability plays an essential role in HCI application development. Incorporating usability into application development aims to increase users' enjoyment, efficiency, and productivity [20]. The findings of this study also show the importance of cultural design elements in the development of mobile applications. This research indicates a need for empirical research on cultural design elements and how to apply them in mobile application development.

5.2 Challenges

Based on the existing design guidelines, there is still a lack of use of cultural design elements in UI design development [38], [41], [52]–[55]. Past studies have stated that the development of UI that meets the priorities, differences, and needs of a culture affects the usability of applications [44]. In addition, UNESCO also stated the need to preserve cultural values in today's digital era [15]. This study suggests that local scarcity content has been emphasized as a national issue. Therefore, there is a need to use design guidelines that use cultural design elements in building UI design.

5.3 Opportunities

Cultural design guidelines in UI design development can help maintain cultural values in today's technology era [15]. In addition, it can also provide applications that achieve a high level of usability with a production UI design that contains cultural design elements [44]. And UI development designs containing these cultural elements can further disseminate culture in this technology era [56].

6 Conclusion

This study found that cultural design elements in existing design principles and guidelines are rarely used. Additionally, a previous study showed that cultural design elements play an essential role in usability. A future study will be conducted on using cultural design elements to meet the current need to create digital content with cultural elements as the basis. This study can apply this need for the use of the creative industry in Malaysia to develop a digital content design. The reason is that the creative industry in Malaysia is one of the essential sources of economic growth and cultural proliferation [56].

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8 References

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9 Authors

Shamsul Arrieya Ariffin is a Head Researcher of Special Interest Group (SIG) for Educational Usability Testing, Consortium of Excellent for Creative Industry & Culture. He is a senior lecturer at Universiti Pendidikan Sultan Idris (UPSI), Department of Computing, Faculty of Art, Computing and Creative Industry, Tanjong Malim, Perak, Malaysia. He has more than 25 years of experience in the IT field. His research specializes in mobile learning aiming and HCI to assist users in bridging the digital gap between culture and technology. (email: shamsul@fskik.upsi.edu.my).

Nur Saadah Fathil is a Special Interest Group (SIG) member for Educational Usability Testing, Consortium of Excellent for Creative Industry & Culture. She is a lecturer at Universiti Pendidikan Sultan Idris (UPSI) Faculty of Art, Computing, and Creative Industry, Department of Computing, Tanjong Malim, Malaysia. Her research interests are Human-Computer Interaction (HCI) and Game-Based Learning. (email: nursaadah@fskik.upsi.edu.my).

Maizatul Hayati Mohamad Yatim is a Special Interest Group (SIG) member for Educational Usability Testing, Consortium of Excellent for Creative Industry & Culture. She is a senior lecturer at the Computing Department, Faculty of Art, Computing and Creative Industry, Universiti Pendidikan Sultan Idris (UPSI), Tanjong Malim, Perak, Malaysia. Her research interests are in Human-Computer Interaction (HCI) and Game-Based Learning. (email: maizatul@fskik.upsi.edu.my).

Muhammad Zulhilmi Samsuri is a Special Interest Group (SIG) member for Educational Usability Testing, Consortium of Excellent for Creative Industry & Culture. He is a Master's postgraduate student of Science in Human-Computer Interaction at the Computing Department, Faculty of Art, Computing and Creative Industry, Universiti Pendidikan Sultan Idris (UPSI), Tanjong Malim, Perak Malaysia. (email: mu.zulhilmi.samsuri@gmail.com).