

DIFFERENT APPROACHES TO MODELING USABILITY IN THE CONTEXT OF MOBILE APPLICATION CHALLENGES

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Abstract. Smart Devices provide a variety of specific computing and connection features that influence user quality *needs*. In some cases, mobile applications have user interfaces and features that do not fully meet user requirements. An important area of research is the identification of those key elements that can characterize the quality of a mobile application *within a usage model*. The purpose of this article is to identify, based on a comparative analysis and existing usage patterns adapted to mobile applications, those features of use that best meet the quality requirements of users.

The study analyzes five classic *models* of use and three mobile-friendly models, identifying a number of 14 elements that can shape the usability of a mobile application.

Keywords: Usability, Human Computer Interaction, Mobile Technology, Quality.

JEL classification: Innovation; Research and Development; Technological Change

1. Introduction

Currently, mobile technology is a field that is boosted by the adoption and deeper integration into mobile users of smart mobile devices that have redefined how we communicate, search for information, or interact with business.

According to the latest statistics [1], the number of mobile device users will exceed the 5 billion mark in 2019, so the mobile technology penetration will be at 67% of the total global population. The introduction of combined data and voice services coupled with technological advances and lower purchase prices have led to a change in the number of smart compared to classic *devices, available on the market*.

As a natural consequence of the growth of the smart mobile market, we are witnessing the emergence of a large number of mobile applications, which forces developers to find solutions to deliver high-quality applications tailored to the ever more sophisticated user needs to keep them involved and thus ensure the long-term use of mobile devices, services and applications. Usability is a basic feature in determining the quality of interactive mobile applications, focusing on measuring users' satisfaction and performance in a dynamic context of use.

Due to the unique features of mobile devices as well as network restrictions or imposed by environmental factors dynamics, there has been a change in the traditional way of *doing* usability studies, and developers have to identify new approaches to *personalize* usability modeling mobile applications [2].

Based on the motivation to improve user perception of the quality of mobile applications and understanding how to use them, the article analyzes various approaches to modeling mobile

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application usability to discover how a person perceives a mobile application after interacting with it [3]. The analysis ultimately converges towards proposing usability features that meet user quality requirements.

In Chapter 2, we present the concept of usability as a component in determining the quality of a mobile application. Chapter 3 provides an analysis of the various mobile-friendly usability models to identify those elements that can contribute to a new approach to mobile usability modeling. In chapter 4, we present the subsequent conclusions and approaches.

2. Usability adapted to mobile technologies

In the literature, there is no consensus on the definitions of usability of interactive systems. Despite this shortcoming, it is fully accepted that usability is a basic element in determining the quality of software products. For this purpose, a variety of models have been developed to specify and measure their usability [4].

The ISO / IEC 9126-1 standard specifies two different structures of the software quality models: Internal and external quality and Quality in use. Internal and external quality is modeled by a set of six system quality features. In the 2001 revised edition, the usability definition in 9126-1 was slightly modified as follows: "Usability is the ability of the software to be understood, learned, used and considered attractive by the user when used under specified conditions" The usability of the ISO / IEC 9126 standard is part of a detailed design of software products and has the ultimate goal of adapting to the user's needs (context of ISO 9241-11). The three main elements are: understandability, learnability and operability [5] [6].

The ISO / IEC 9241-11: 2008 [7] defines usability as follows: "A software product is usable when allowing a user to perform their tasks with effectiveness, efficiency and satisfaction in a specific context of use." The three components of usability are defined as: Effectiveness, Efficiency, and Satisfaction that is given by the comfort and acceptability of use.

The ISO/IEC 25010 [8] - The quality model is represented by ISO 20010: 2011 and it is an updated version of the quality model described by the 9126-1: 2000 standard. ISO 25010 combines internal and external quality models with product quality, providing two distinct models: Product Quality Model and Quality in Use Model. The usability feature highlights the ease of use of the system and includes how its quick use can be learned, but also whether the interface is attractive and whether the people in question can use it. The quality model in use analyzes the characteristics of the interaction of different stakeholders with the product. For this reason, the quality of use is associated with usability. The six usability-specific elements are: Appropriateness, Recognizability, Learnability, Operability, User Error Protection, User interface Aesthetics, Accessibility.

Nielsen [9] defines five usability features that may be used to software development: Efficiency, User Satisfaction, Learning, Memorability and User Errors.

Abran et al. [4] proposes an enhanced usability model based on ISO 9126-1 [5], ISO 9241-11 [7], Nielsen [9], Dix et al. [10], defining usability as a combination of five characteristics: Effectiveness, Efficiency, Satisfaction, Learnability and Security, along with a set of specific measures.

Traxler, et al. [11] highlights the elements of mobile technologies that are taken into account in the usability assessment process: the considerable variety of devices and connectivity types; nature of fragmented, context-dependent use; screen size; short battery life and recharge dependence; variation of transfer speeds in mobile networks; new ways of communicating and socializing; data security; connectivity with other devices; personal styles and usage restrictions.

Similarly, other authors [12] define the following factors: Mobile Context; Connectivity, Screen Size; Display Resolution; Processing Capability and Power; Data Entry Methods.

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In addition to the factors outlined above, mobile device manufacturers and application developers have created and imposed their own user constraints on application development. These features define as an evaluation model for those applications stored in major mobile stores [13] [14].

In the following section we present the main usability models which evaluate the mobile applications.

3. Usability models for mobile applications

Due to the particularities of mobile devices, traditional methods used in usability testing cannot be directly applicable to a mobile environment. Therefore, it is necessary to develop and adopt appropriate methodologies for assessing the usability of mobile applications based on specific usability models [12].

Harrison, et al. [15] support the need for mobile-friendly models. They have developed the PACMAD model. The purpose of their model was to extend existing usability models such as Nielsen or ISO in the context of mobile applications. The PACMAD model, similar to ISO 9241-11, identifies three factors that should be considered in mobile application design and will influence the final design of the user interface: User, Goal, and Context of use.

The PACMAD model identifies seven attributes, relevant to global usability: Effectiveness, Efficiency, Satisfaction, Learnability, Memorability, Cognitive Load, Errors. Based on these attributes may be defined sets of measures to be used in the final evaluation of a mobile application. Cognitive Load is the main contribution of PACMAD to measure the impact of mobile use on user performance in other tasks. In a mobile context, a user can perform more tasks in addition to the actual use of the application, so it is necessary to quantitatively assess the level of cognitive processing required to use the application.

Zhang & Adipat [12] identified nine usability elements used to measure the quality of a mobile application. These are: Learnability, Efficiency, Memorability, User Error, User Satisfaction, Effectiveness, Simplicity, Comprehensibility, and Learning Performance.

Norelyza et al. [16] proposes an analysis of the main models and guidelines, identifying two areas of activity in which the usability elements specific to mobile applications may be framed: industrial construction and business. To evaluate mobile applications for business, the authors identify eight elements, namely: Installation, Learnability, Efficiency, Effectiveness, User Satisfaction, Mobile Context, Safety and Support. For the field of industrial construction, 13 elements complying with ISO standards have been identified to ensure the development of a mobile quality application: Efficiency, Effectiveness, User Satisfaction, Learnability, Demand of User Attention, Presentation, Human- Computer Interaction, Navigation, Data Sourcing Map, Mobile Context, Safety, and Support.

Table 1 shows the usability characteristics identified in the above-mentioned models.

Table 1. Comparison of usability element in various model

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Mobile app usability element	Model for usability element							
	ISO 9126-1	ISO 9241-11	ISO 25010	Nielsen	Abnan	Pacmad	Zhang	Norelyza
Understandability	x	-	-	-	-	-	-	-
Learnability	x	-	x	x	x	x	x	x
Operability	x	-	x	-	-	-	-	-
Effectiveness	-	x	-	-	x	x	x	x
Efficiency	-	x	-	x	x	x	x	x
User satisfaction	-	x	-	x	x	x	x	x
Appropriateness recognizability	-	-	x	-	-	-	-	-
User error protection	-	-	x	x	-	x	x	-
User interface aesthetics	-	-	x	-	-	-	-	-
Accessibility	-	-	x	-	-	-	-	-
Memorability	-	-	-	x	-	x	x	-
Security	-	-	-	-	x	-	-	-
Cognitive Load	-	-	-	-	-	x	-	-
Simplicity	-	-	-	-	-	-	x	-
Comprehensibility	-	-	-	-	-	-	x	-
Learning performance	-	-	-	-	-	-	x	-
Demand of user attention,	-	-	-	-	-	-	-	x
Presentation	-	-	-	-	-	-	-	x
Human-computer interaction	-	-	-	-	-	-	x	x
Navigation	-	-	-	-	-	-	-	x
Data sourcing map	-	-	-	-	-	-	-	x
Installation	-	-	-	-	-	-	-	x
Mobil context	-	-	-	-	-	-	-	x
Safety	-	-	-	-	-	-	-	x
Support	-	-	-	-	-	-	-	x

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From the study of the usability elements proposed for the evaluation of mobile applications, we will choose those compatible elements in at least three studied models. According to Table 1, we can identify six elements: Learnability, Effectiveness, Efficiency, User satisfaction, User error protection, Memorability. Based on studies in the literature, eight additional usability elements have been selected to analyze the compatibility of user-specific usability elements [15] [16]: Cognitive Load, Demand of user attention, Human-computer interaction, Navigation, Mobile context, Security, Support, Installation.

4. Conclusions

The continuous evolution of mobile device technical performance and the diversification of the range of services provided to users have prompted mobile application developers to consider the usability concept as a critical factor influencing the quality of a mobile application.

In order to achieve high-quality mobile applications, developers need models tailored to these technologies to identify the key elements that meet the user's quality requirements, especially in terms of designing user interfaces.

The degree of usability is influenced by the particular features of a mobile device such as variable connectivity, screen size, limited processing capabilities, limited duration of power supply, mobile context, etc. Therefore, existing usability models fail to adequately capture the complexity of the interaction between the user and the application.

In order to make a proposal on a new approach to usability, this article aims to present several exigent models in the literature, appropriate to be adapted to the development of mobile applications. Based on this analysis, 14 elements have been proposed that can be used to model the usability of a mobile application.

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