

# A Research Agenda for Mobile Usability

## ABSTRACT

The turn of this century marked an increased focus for research on mobile usability in the field of Human Computer Interaction. A challenge, however, exists in that many scholars define and operationalize usability differently. With the introduction of mobile commerce circa 1999, a review of relevant peer-reviewed literature would highlight areas of past emphasis and opportunities for future research specific to mobile usability.

This paper presents a research agenda for mobile usability that consists of two parts. In doing so, a framework is adapted for the taxonomy of empirical usability studies. Then, results of a qualitative review of 45 empirical mobile usability studies include: i) a summary of the core and peripheral usability dimensions measured; ii) a detailed analysis of contextual factors studied; and iii) key findings that provide the basis for a research agenda in mobile usability.

## Author Keywords

Mobile, usability, efficiency, effectiveness, satisfaction, wireless, context, qualitative review.

## ACM Classification Keywords

H5.m. Information interfaces and presentation, miscellaneous: HCI, Theory and Methods.

## INTRODUCTION

Mobile devices are becoming increasingly popular, having already reached well over one billion mobile subscribers. A recent forecast by the UMTS forum (2005) estimates that the global number of subscribers will be between 1.7 to 2.6 billion for mobile voice and 600 to 800 million for mobile data. Although progress has been made in terms of technological innovations, there are obvious limitations and challenges for mobile device interfaces due to the characteristics of mobile devices (i.e., the size of small screens, non-traditional input methods, and navigational difficulties) (Nah et al. 2005). Thus, usability is more important for mobile than for other technologies, especially since many mobile applications remain difficult to use.

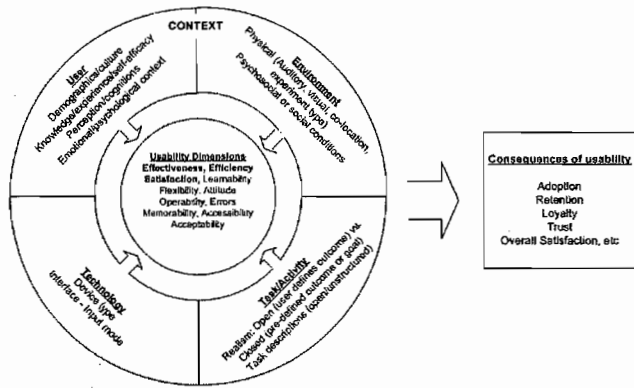
## Research Motivation & Objectives

Usability has been the focus of discussion (Venkatesh et al. 2003) and described by varying definitions in both academia and industry for a long time. The central theme of these definitions is to denote the quality of interaction which takes place (Bennett 1979) when people employ a particular technology artifact for a specific task in a specific setting. The turn of this century marked an increased focus on mobile usability studies for research in the field of Human Computer Interaction. Although a considerable volume of research on general usability exists, due to the novelty of mobile technology relatively few studies have been conducted on mobile usability. Even worse, only 41 percent of mobile usability papers are empirical in nature (Kjeldskov and Graham 2003). Thus, this research aims to fill this gap and in doing so will also provide a roadmap for future mobile usability studies that will be of value to this relatively young research area. Specifically, this study addresses the following research question: *What are the key formation and evaluation dimensions of usability in mobile technology usability studies?*

To this end, this paper describes the qualitative review of 45 empirical mobile usability studies. First, the taxonomy used for the coding in this review is briefly discussed. Then, the procedure along with the results emerging from this review are presented, including: i) a summary of the core and peripheral usability dimensions measured; ii) a detailed analysis of contextual factors studied; and iii) key findings providing the basis for a mobile usability research agenda.

## PROCEDURE

This qualitative review began with the search for empirical mobile usability studies literature. Multiple databases were used to minimize the chance of omitting relevant studies. Then, references from the retrieved studies were cross-referenced. Hand searching of appropriate journals in this research included journals ranked among the top 10 in terms of perceived quality, as well as journals deemed relevant to the field of usability by the authors.



**Figure 1. Usability Framework (Coursaris & Kim, 2006)**

Specific criteria were set for the selection of articles sought in this literature review: i) a mobile technology was studied; ii) the study was empirical in nature; iii) the time frame for included studies was from 2000 onward. A conscious decision was made to not limit the reviewed literature to peer-reviewed journal articles, as it would significantly reduce the reviewed articles, given the relative infancy of the mobile usability field. The above procedure resulted in the identification of 45 empirical mobile usability studies.

### Framework of Empirical Mobile Usability Studies

A framework (see Figure 1) proposed by Coursaris and Kim (2006) will be used in the analysis of contextual factors measured in the studies reviewed. The framework contains three elements. First, the outer circle shows the taxonomy of contextual factors impacting usability, namely: user, task, technology, and environment characteristics. Second, the inner circle shows the usability dimensions found to have been measured in the reviewed empirical mobile usability literature. Third, the box on the right shows a list of consequences being impacted by usability and studied in the reviewed literature.

## RESULTS

### Analysis of Usability Measurement Dimensions

During the evolution of HCI, the conceptualization of usability has varied extensively. The broad set of definitions and measurement models of usability complicate the generalizability of past studies at the level of the latent usability variable. Therefore, a usability study may be of limited value if it were not to be based on a standard definition and operationalization of usability. A literature review performed by Coursaris and Kim (2006) highlighted the usability dimensions measured and the relationships validated in empirical research on mobile usability. Upon review of the measures' relative appearance in the reviewed literature (percentages shown in parentheses) the core constructs for the measurement of usability appear to be: i) Effectiveness (62%): Accuracy and completeness with which specified users achieved specified goals in particular environment; ii) Efficiency (33%): Degree to which the

product is enabling the tasks to be performed in a quick, effective and economical manner or is hindering performance; and iii) Satisfaction (20%): The degree to which a product is giving contentment or making the user satisfied. These three dimensions also reflect the ISO 9241 standard making a strong case for its use in related future studies. The use of this standard would allow for consistency with other studies in the measurement of usability (Brereton 2005). At least one of the three constructs was used in the work of researchers cited in the literature review. The remaining measures reflect peripheral dimensions measured in empirical mobile usability studies, including: Learnability (11%), Accessibility (7%), Operability (4%), Memorability (2%), Flexibility (2%), and Acceptability (2%).

Beyond the benefit of a standard view of usability, three key findings emerge from the above data. First, any single peripheral usability dimension was measured in fewer than 12 percent of the studies reviewed. Second, accessibility appears to be one of the most underserved research areas having been studied in only seven percent of the studies reviewed. This observation may come as a surprise, given the growing popularity of accessibility research in less conventional (e.g. non-IS, non-peer-reviewed) publication outlets, and the increasing levels of legislative support and community interest. Further exploration of this construct, including its role with the remaining usability dimensions, is warranted. Third, aesthetic / hedonic constructs were not studied in any of these studies, even though there is support for the effect of such factors on performance (Marcus 1989) and by extension performance. These findings in turn call for a critical review of the current operationalization of usability as several dimensions are not captured in the international standard defined by ISO 9241 set back in 1998. Cause-effect relationships should also be investigated between the peripheral and the core usability dimensions.

### Analysis of Contextual Usability Factors

The next sets of analysis pertain to the contextual factors studied among the empirical mobile usability studies reviewed. In doing so, the independent variables studied are described under each of the four contextual framework categories of Figure 1. Overall, empirical mobile usability studies have been focused on task characteristics (56%), followed by user (26%), technology (22%), and environment characteristics (7%) (note: distribution exceeds 100% as multiple areas may have been studied in a single study). Hence, there is a *lack of empirical research on the impact of the environment on mobile usability*.

*Task characteristics:* The framework called for the identification of either closed or open tasks. Closed tasks were mostly used (69%), while open tasks were used in 22 percent of studies (and 9% did not report). Hence, there is a *relative lack of research involving open and unstructured tasks*. Also, effects of *task interactivity and task complexity* on mobile usability were not investigated.

*User characteristics:* The most prominent user-related variable studied in empirical mobile usability research was (prior) experience, focusing on either novices (25%), experts (16%), or both (9%). Also, cultural dimensions (7%) and job-specific roles (i.e. physicians, engineers) (4%) were measured – convenient samples of students made up 24 percent of studies. Disability (here, visual impairment) was only explored once (i.e. 2%). No empirical mobile usability research studied gender or age, and motion was investigated in 13 percent of studies. From these statistics it becomes apparent that *research has been limited in both the range and frequency of user characteristics studied.*

*Technology characteristics:* The most popular variable investigated in these studies pertaining to the technology used was the interface. These studies involved mobile phones (47%), PDAs (47%), Pocket PCs (4%), and various interfaces (16%) including a desktop, a tablet PC, a discman, and wearable or prototype devices. Again, these frequencies exceed 100 percent, because a few studies involved multiple devices. Thus, there is *lack of research as it relates to technology beyond the interface.*

*Environment characteristics:* Less than seven percent of studies explored dynamic factors, i.e. lighting and noise levels. Hence, there is *lack of research on physical, psychosocial, and other environment-specific factors.*

*Methodology characteristics:* The final sets of analysis pertain to the experiment setup and methodology. Laboratory studies were conducted most often (58%), followed by field studies (22%), while 11 percent of studies involved both (9% did not report). Hence, *lab-tested mobile usability research is dominant.* Next, multiple methodologies were identified in these studies, including: device data (51%), questionnaires (47%), direct observation (33%), interviews (27%), focus groups (4%), and voice mail diaries (2%). Frequencies of methodology used exceed 100 percent, because most studies (53%) involved a multi-method approach. Specifically, device data were most commonly triangulated with questionnaire (13%), observation (7%), or interview data (4%). However, with only 13 percent of the studies being the case there is *limited research that contrasts self-reported with device data.*

## CONCLUSION

This research pioneers in analyzing contextual factors and measurement dimensions investigated in the empirical body of knowledge of mobile usability studies published to-date. Findings described above enhance our understanding of mobile usability research considerations and serve as the basis for a research agenda in this field. This domain would benefit by further emphasis placed on the complexity of contextual usability, and answering such research questions as those within and/or between each of the areas below:

*Technology:* “Beyond the interface” - How do technology components beyond the interface (e.g. network connectivity reliability, memory) impact the usability of mobile devices?

*User:* “Study the *human* in HCI” - What other user characteristics (e.g. cognitive aptitude, mental models, physical ability) should be considered when studying mobile usability? More research is also needed on variables previously investigated (e.g. experience and efficacy).

*Task:* “Real world – real tasks” How do task complexity and task interactivity impact mobile usability? By considering these two dimensions and designing studies with open tasks research approximates real-world situations and results improve in their external generalizability.

*Environment:* “Usable Anytime, Anywhere” - How do conditions in the environment impact mobile usability? A higher rate of field studies and/or complex lab studies will enhance our understanding of such dynamic factors (e.g. urgency, wind) and their effects on mobile technology.

Adding to the research agenda, measurement considerations are also outlined: i) Accessibility – increasing research in this area may improve the usability of products and services for often overlooked audiences; ii) Hedonics - Which factors impact the aesthetic appeal of a mobile device / service and how do they impact usability? iii) Usability – What are the relationships between various usability measurement dimensions? Should usability be redefined to reflect additional utilitarian and/or hedonic dimensions?

The elaborate scope of the research agenda outlined above highlights the importance and potential of mobile usability research. These questions and recommendations are hoped to stimulate further research in this domain, the results of which expand both the scholarly body of knowledge, but also have direct and tangible benefits for everyday users.

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## APPENDIX A. STUDIES REVIEWED

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