



Master's Thesis
Computer Science
Thesis no: MCS-2012-07
Month Year: 2012/05

Mobile Internet User Experience

A Systematic Literature Review

Waqas Ali

School of Computing
Blekinge Institute of Technology
SE-371 79 Karlskrona
Sweden

This thesis is submitted to the School of Engineering at Blekinge Institute of Technology in partial fulfillment of the requirements for the degree of Master of Science in Computer Science. The thesis is equivalent to 20 x 2 weeks of full time studies.

Contact Information:

Author: Waqas Ali

Email: waqaassali@gmail.com

University advisor:

Dr. Kari Rönkkö

School of Computing
Blekinge Institute of Technology
SE-371 79 Karlskrona
Sweden

Internet : www.bth.se/com

Phone : +46 455 38 50 00

Fax : +46 455 38 50 57

ABSTRACT

Mobile Internet is currently considered as the future for the Internet. Apparently the number of mobile handset sold as compared to desktop PCs is noticeable. These hints depict the potential of mobile Internet and the future market strongly relying on mobile devices. But at the same time mobile internet users are growing slower in numbers. Particularly in market where the internet access is very simple through computers, mobile internet users seems not very enthusiastic to use internet on mobile phones. Author of this study supposed on the basis of literature findings that this lack of interest is due to an unsatisfactory mobile internet user experience. This thesis work is an effort into the complex area of mobile internet and shed some light on how to improve user experience for mobile internet.

The main focus of this research work is the identification of hurdles/challenges for mobile internet user experience and explores the concepts present in academia. In order to understand it properly, the author performed a systematic literature review (SLR). The overall objective of SLR is to examine the existing work on thesis study topic. This in depth study of literature revealed that mobile internet user experience is categorized into aspects, elements and factors by different researchers and considered as a central part of mobile internet user experience. There are few other factors that affect and make this job complicated and difficult such as usage context and user expectations. In this work current problems of the mobile internet user experience are identified systematically that never happened before and then discussed in a way that provide a better understanding of mobile internet user experience to academia.

To fulfill the aim and objectives author of this study conducted the detailed systematic review analysis of the empirical studies from year 1998 to 2012. The research studies were identified from the most authentic databases that are scientifically and technically peer reviewed such as Scopus, Evillage, IEEE Xplore, ACM digital library. From SLR results, we have found different aspects, elements, factors and challenges of mobile internet user experience. The most common challenge faced by user and reported in academia was screen size, input facilities, usability of services, and data traffic costs.

The information attained during this thesis study through academia (literature) is presented in a descriptive way which reflects that there is an emerging trend of using internet on mobile devices. Through this study author presented the influencing perspective of mobile internet user experience that needs to be considered for the advancement of mobile internet. The presented work adds contribution in a sense as to the best of knowledge no systematic review effort has been done in this area.

Key Words: Mobile internet, User experience, Aspects of MIUX, Elements of MIUX, Factors of MIUX.

ACKNOWLEDGMENTS

In terms of this work I want to say big Thanks to my supervisor, Dr. Kari Rönkkö for providing the supportive working environment and for being a great mentor.

TABLE OF CONTENTS

| | |
|--|-------------|
| MOBILE INTERNET USER EXPERIENCE | I |
| A SYSTEMATIC LITERATURE REVIEW | I |
| ABSTRACT | III |
| ACKNOWLEDGMENTS | IV |
| TABLE OF CONTENTS | V |
| LIST OF FIGURES | VI |
| LIST OF TABLES | VII |
| LIST OF ABBREVIATIONS | VIII |
| 1 INTRODUCTION | 9 |
| 1.1 AIMS AND OBJECTIVES | 10 |
| 1.2 EXPECTED OUTCOMES | 10 |
| 1.3 RESEARCH QUESTIONS | 10 |
| 1.4 LITERATURE REVIEW | 10 |
| 2 RESEARCH DESIGN | 12 |
| 2.1 SYSTEMATIC LITERATURE REVIEW | 12 |
| 2.2 SYSTEMATIC REVIEW DESIGN AND EXECUTION | 12 |
| 2.2.1 <i>Planning the review</i> | 13 |
| 2.2.2 <i>Conducting the review</i> | 17 |
| 2.2.3 <i>Reporting the Review</i> | 20 |
| 2.3 VALIDITY THREATS | 20 |
| 2.3.1 <i>Conclusion Validity</i> | 20 |
| 2.3.2 <i>Internal Validity</i> | 21 |
| 2.3.3 <i>Construct Validity</i> | 21 |
| 2.3.4 <i>External Validity</i> | 21 |
| 3 MIUX IN RELATION TO ACADEMIC RESEARCH RESULTS | 22 |
| 3.1 RESEARCH MOTIVATION | 25 |
| 4 THEORY | 26 |
| 4.1 MOBILE INTERNET USER EXPERIENCE | 26 |
| 4.1.1 <i>Mobile Internet</i> | 26 |
| 4.1.2 <i>User Experience</i> | 28 |
| 4.2 MIUX CONCEPT AND COMPONENTS | 28 |
| 4.2.1 <i>USER</i> | 29 |
| 4.2.2 <i>CONTEXT</i> | 30 |
| 4.2.3 <i>SYSTEM</i> | 32 |
| 5 DISCUSSION | 35 |
| 5.1 MIUX GUIDELINES | 41 |
| 6 CONCLUSION | 43 |
| 7 REFERENCES | 45 |

LIST OF FIGURES

| | |
|---|----|
| Figure 1 Thesis Structure..... | 11 |
| Figure 2 Steps for Selecting Literature Using Tollgate Approach (Afzal et al., 2009)..... | 15 |
| Figure 3 Ways of accessing MI (A. Kaikkonen, 2011)..... | 28 |
| Figure 4 Elements affecting MIUX (Kaasinen et al., 2009)..... | 29 |
| Figure 5 Technology Acceptance Model for MI (TAMM) (Kaasinen et al., 2009)..... | 29 |
| Figure 6 A conceptual framework of use context for MI (I. Lee & Kim, 2005)..... | 31 |

LIST OF TABLES

| | |
|--|------|
| Table 1 Terminologies used in this Thesis | viii |
| Table 2: Inclusion exclusion criteria | 14 |
| Table 3: Data Extraction Strategy | 16 |
| Table 4: Research Papers Retrieved From Different Databases..... | 18 |
| Table 5: Stage 1 (Paper selected from primary studies)..... | 18 |
| Table 6: Stage 2 (Papers selected from primary studies) | 19 |
| Table 7: Stage 3 (Paper selected from primary studies)..... | 19 |
| Table 8: Stage 4 (Paper selected from primary studies)..... | 19 |
| Table 9: Selection of Research Studies | 20 |
| Table 10: Distribution of Primary Studies for MIUX perspective | 36 |
| Table 11: Comparison of the activities on computer and mobile phone in 2007 and 2010. (**) marked have statistically very significant change in mobile, and (*) have statistically significant differences. Grayed activities are more common..... | 40 |

LIST OF ABBREVIATIONS

| Terms/Abbreviations | Definition |
|----------------------------|---------------------------------|
| UX | User experience |
| MIUX | Mobile Internet User experience |
| UCD | User centred design |
| HCI | Human computer interaction |
| WWW | Web or World Wide Web |
| MI | Mobile Internet |
| ISP | Internet service provider |
| WAP | Wireless application protocol |
| PC | Personal Computer |
| Author | Waqas Ali |

Table 1 Terminologies used in this Thesis

1 INTRODUCTION

The world to a greater extent consists of surroundings and objects created by mankind and people living in this world are bound to interact with these objects every single day for instance in work places, public places even at home. In today's world people are living in a more technical world than ever and are surrounded by information technology artifacts which increased the intention to the usage of technology greater than before. The result of this usage in many ways shapes our behavior and our ways of everyday life.

The contribution of information technology can be seen everywhere in our daily lives in which the internet is one of them. The internet has developed from ARPANET of 1968 and from a university collaboration network of 1983 to a worldwide system of interconnected computer networks. The first World Wide Web (www, web) pages were published 1991 at CERN. In 1998, the first mobile device supporting Web access was introduced Kaikkonen (2009). Since that time, users praised internet to be available on the handset which resulted the phenomenon of Mobile Internet (MI).

The MI is often handled as the next killer application for mobile phones and other portable devices. Kaasinen, Roto, Roloff, Väänänen-Vainio-Mattila, & Vainio, (2009) defines MI as “*using the Internet on mobile devices, excluding traditional laptop computers*”. There is no simple answer when it comes to define MI because MI can be seen as a number of ways and known through many technical terms and buzzwords like WAP, GPRS, EDGE, UMTS, 3G and 4G etc. The value of MI to the users is based on the wide selection of services rather than any one individual service Kaasinen (2008).

Few years ago, WAP flopped because of false marketing promises, prices and different values to users. Current effort in MI is following the same footsteps by the still same over complex system which results poor delivery of less than ideal user experience. In everyday life, people always have a wide range of experience, for example, the breathtaking experience, the exotic experience, the grief experience, and so on. Therefore, human experience is a complex phenomenon all the time, because people always live in a world with other people and other things Peng et al. (2009).

UX is a relatively new concept in today's Information Technology (IT) world. Thayer & Dugan (2009) attempted to define the UX and are agreed upon that UX is not a directly measureable event. They believe that it is “an event” but an “infinite amount of smaller experience, relating to context, people and products”. During the last decade most conducted studies generated insight into MI use. However the focus of the studies has switched from the user interface to user experience Kaikkonen (2009). User experience can be improved by a better understanding of users and usage contexts, by developing mobile services that better serve the needs of mobile users, easing service discovery and by developing the infrastructure needed for the MI Kaasinen et al. (2009).

As technology usage has increased and taken a commonplace, and to make the internet access on mobile devices a success. There is a need to understand and explore the UX, in general, and specifically to investigate the UX of MI that is the objective of this study. The exploration and investigation of the literature in the area provides definitions, perceptions, key concepts and elements of the MIUX that ultimately helps to explore/create ways to improve the user experience of mobile Internet. In addition, on the bases of SLR findings we will able to create own new design directions and solutions that can help to improve MIUX.

1.1 Aims and objectives

The aim of this study is to explore and investigate the MIUX to create design directions and solutions to improve the MIUX. The sub goals to achieve the overall objective of this research activity are:

- To identify the view of MIUX.
- To show the key concepts and elements of successful MIUX.
- Analysis and synthesis of above results, we will create design guidelines that can improve MIUX.

1.2 Expected Outcomes

The expected outcomes in this research are related to the MIUX. Following are the main list of outcomes.

- Identified aspects, concepts, factors and elements of MIUX reported in the literature.
- Own analysis and synthesis of above results, own created design directions and solutions that can improve MIUX.
- Discussions, conclusion and design guidelines for improving MIUX.

1.3 Research questions

In order to examine the evidences of MIUX perspective author have the following research query: To reveal the state of the art of MIUX in order to better understand the challenges and benefits of this area of research. To achieve the answer for this query there is a need to address the following questions:

RQ 1 What views of MIUX are reported in the literature?

RQ 2 What concepts of MIUX are reported in the literature?

RQ 3 How own created design directions and solutions can help to improve MIUX?

1.4 Literature Review

There are different approaches usually used to conduct literature review i.e. traditional review, systematic review, meta-analysis and meta-synthesis (Kitchenham, 2004)Petersen, Feldt, Mujtaba, & Mattsson (2008). Traditional reviews try to summarize results of a number of research studies, while lacking the foundation of a systematic method of broadly locating the original articles. Systematic Review is a scientific approach to identify, evaluate and interpret the available research related to specific research questions Kitchenham (2004). It uses a more rigorous and well-defined method to review the research articles Petersen et al. (2008). It is a prerequisite of meta-analysis and meta-synthesis review techniques Kitchenham (2004).

Meta-analysis is a type of systematic review that uses statistical technique to obtain a quantitative synthesis. It takes the findings from the number of different studies on the same subject area, and analyze them by statistical techniques Kitchenham (2004)(Petersen et al., 2008). Meta-synthesizes is also the type of systematic review. It is the non-statistical method which uses both

qualitative and quantitative studies as data of analysis (Petersen et al., 2008). It evaluates and interprets the findings of various sort of reviewed research papers. It involves synthesizing and analyzing key points in each article (Petersen et al., 2008).

We will use systematic review to search, collect and summarize the evidence available regarding aspects, factors, elements, concepts of MIUX. The well-defined methodology makes it less probable that results of the literature are unfair (Kitchenham, 2004). Moreover, it also aids in providing the background knowledge so that to properly position new research activities.

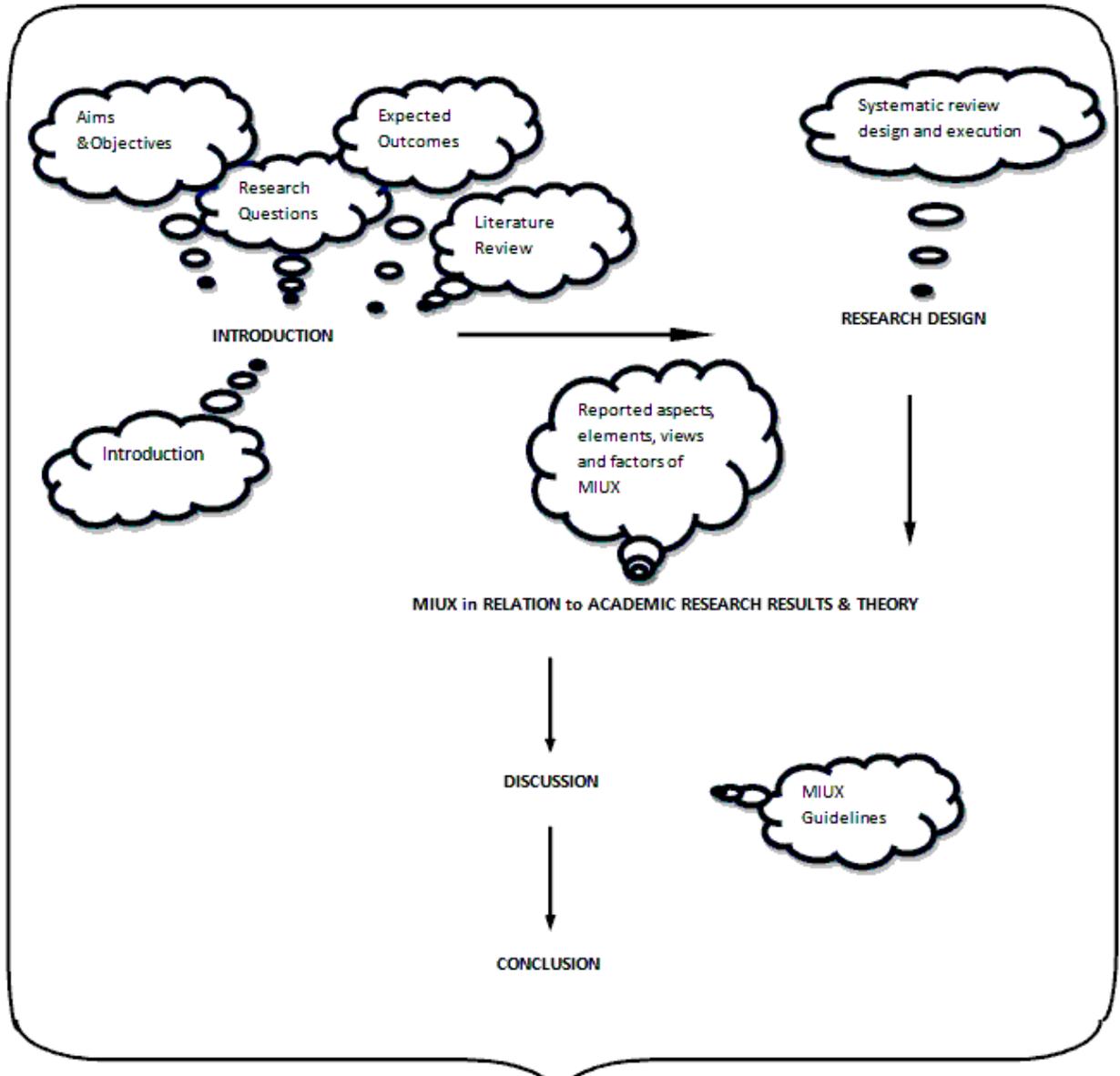


Figure 1 Thesis Structure

2 RESEARCH DESIGN

2.1 Systematic Literature Review

The systematic literature review (SLR) is the main research method used to answer the Research Questions (RQs) described in **Section 1.3**. A Systematic Literature Review (SLR) is defined as a process of identifying, assessing and interpreting all available research evidence with the purpose to provide the answers for specific research questions Keele (2007). Systematic literature review is also called systematic review, is a systematic approach to identify, evaluate and interpret research available about a particular area of interest Kitchenham (2004). SLR is a structured and predefined search strategy that provides an unbiased approach to identify the primary studies and to comprehensively aggregate the published literature Kitchenham (2004). According to Petersen et al. (2008) “as a research area matures there is often a sharp increase in the number of reports and results made available, and it becomes important to summarize and provide overview”. The most common reasons for SLR are mentioned by Kitchenham (2004) as follows:

- “To summarize the existing evidence concerning a treatment or technology.
- To identify any gaps in current research in order to suggest areas for further investigation.
- To provide a framework/background in order to appropriately position new research activities”.

And the main features of SLR which differentiate it from an ordinary literature review have been summarized by Kitchenham (2004) as follows:

- “A systematic review is performed under a predefined review protocol specifying the project research questions and methods being used in the review procedure.
- The search strategy for each systematic review is designed to cover and detect as much relevant papers/documents as possible and is documented to ensure the readers about its completeness and reliability.
- Primary study selection in systematic review is based on a carefully/explicitly designed inclusion/exclusion criteria which meets the research questions of the review.
- Systematic review uses extraction forms or other reviewing tools to specify the information needed to be extracted from primary studies and evaluates them via a quality assessment section.”

2.2 Systematic review design and execution

Systematic review design and execution consists of following three phases:-

- Planning the review
- Conducting the review
- Reporting the review

2.2.1 Planning the review

This phase is mainly concerned with the development of review protocol and the steps to conduct literature review in a systematic way (Kitchenham & Charters, 2007)

Purpose of Systematic Review

To perform the SLR we will follow the guidelines provided by Keele (2007) and the procedure by Kitchenham (2004). The purpose for conducting the systematic review is that this field is interdisciplinary, which increase the complexity of the area. That is constructing a review is a challenging process because we often need to draw on theories from a variety of fields.

Defining research questions

To understand the MIUX, the following research questions will be answered by the systematic review.

Q1: What views of MIUX are reported in the literature?

Q2: What concepts of MIUX are reported in the literature?

Review Protocol Development

A review protocol defines the procedures that will be used to carry out a specific systematic review (Kitchenham, 2004). It aids in minimizing the probability of researcher bias (Kitchenham, 2004). The review protocol consists of search strategy, study selection criteria, quality assessment criteria, data extraction form, and data synthesis strategy.

2.2.1.1.1 Search Strategy

Search strategy aids in answering the research questions effectively. The search strategy for this research is based on the following steps:

a) Key Words

Following are the keywords extracted from the RQs:

- User Experience (UX)
- Mobile
- Internet
- Terminologies, concepts, perceptions, elements

Adding possible synonyms or relevant terms to above keywords:

- User centered design (UCD), human centered design (HCD), interaction design
- Mobile
- Internet, Web, WWW, web browsing
- Terminologies, concepts, perceptions, key elements, definitions, attributes and factors

b) Search String

The articles will be selected based on the full-Text search criteria. Following is the search string developed from the keywords mentioned above.

((*"user experience" OR UX OR "user centered design" OR "human centered design" OR "interaction design"*) AND (*mobile*) AND (*internet OR web OR WWW OR "web browsing" OR computing*) AND (*term* OR perception* OR element* OR attribute* OR factor**))

c) *Resources*

Following electronic sources of relevance for software engineering subjects are searched:

- *ACM Digital Library*
- *IEEE Xplore*
- *EiVillage2(Compendex, Inspec)*
- *Scopus*

As in 1998, the first mobile device supporting Web access was introduced Kaikkonen (2009) therefore we searched the electronic databases from 1998 till 2012 including.

2.2.1.1.2 *Study Selection Criteria*

The study selection criteria are used to identify the research articles appropriate for the research scope. The articles were selected on the basis of title, abstract, introduction and conclusion that matches best with our research questions. The inclusion of the articles was done by using tollgate method (Afzal, Torkar, & Feldt, 2009), in which the articles will be selected by using keywords, synonyms, alternate words, and revised keywords mentioned above. This method consists of different stages starting from stage one to four described in the Table 2 below.

a) *Inclusion criteria*

Inclusion criteria that was used to select the research articles are described in the table below.

Table 2: Inclusion exclusion criteria

| <i>Stage</i> | | <i>Criteria</i> |
|--------------|-----------------------------|---|
| 1 | Overall | <ul style="list-style-type: none"> - English - Date of publication - Full text - Non-duplicate - Other? |
| 2 | Title and abstract | <ul style="list-style-type: none"> - Contains search words - Focuses on the key words used for search string |
| 3 | Introduction and conclusion | <ul style="list-style-type: none"> - Contains empirical background - Mainly focus on MIUX concepts |
| 4 | Full text | <ul style="list-style-type: none"> - Presence of empirical data in the paper - Main focus on aspects, factors and elements of MIUX. |

b) *xclusion criteria*

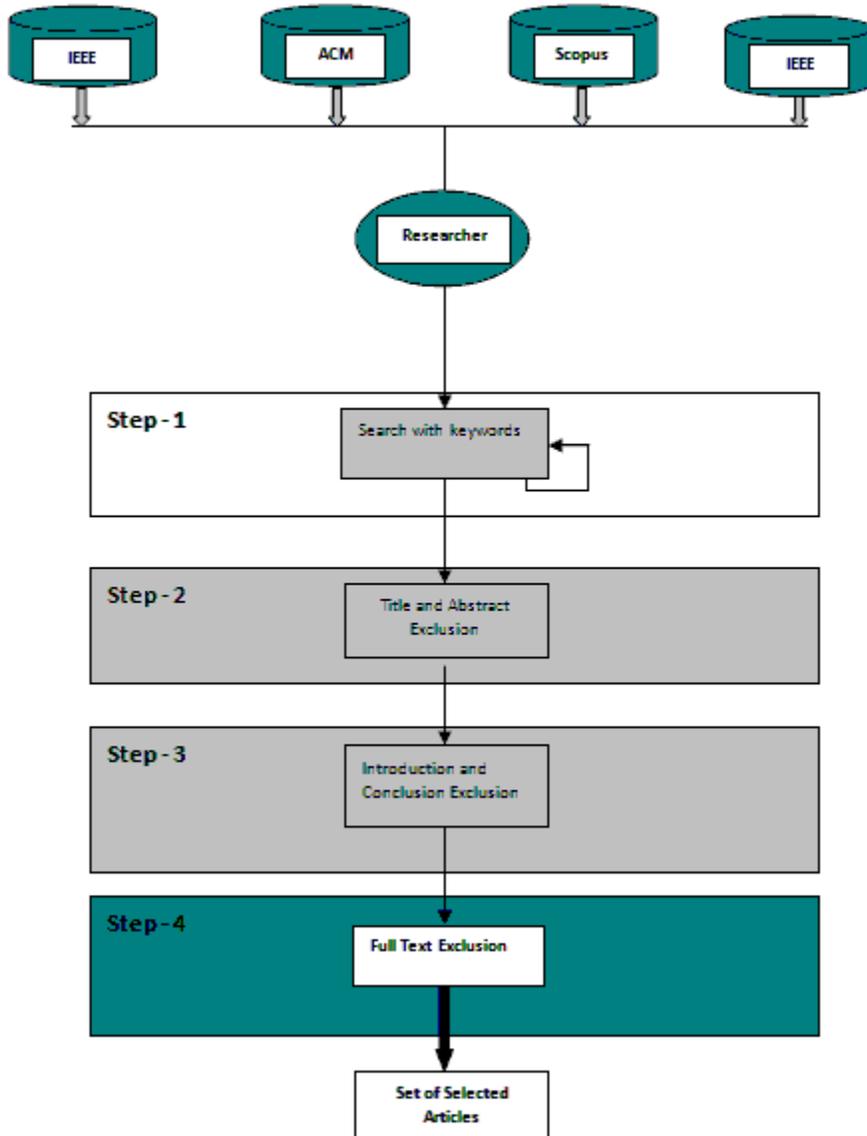


Figure 2 Steps for Selecting Literature Using Tollgate Approach (Afzal et al., 2009).

The research articles were excluded that didn't meet the criteria mentioned above in Table 2. The first phase of research resulted in a total of 932 papers. Table 4 shows the distribution of papers before duplicate removal among different sources.

The exclusion was done using a tollgate approach Figure 2. To begin with, author of this study excluded 748 references out of a total of 932 primarily based on a title and abstract, which were clearly out of scope and did not relate to the research questions. Then by removing duplicate article, author identified 70 references out of 184. Then by adding introduction and conclusion in the process author selected 46 articles out of 70. This application of detailed exclusion criteria resulted

in 46 remaining references, which were further filtered out by reading full text. A final figure of 25 references was considered as the selected primary studies.

2.2.1.1.3 Data Extraction Strategy

Author of this study used the Microsoft Excel (MS) spread sheet to extract the data from the primary studies. Data extraction strategy will be used to collect all the relevant information required to address the research questions and data synthesis.

Table 3: Data Extraction Strategy

| General Information Regarding Research Study/Articles | |
|---|---|
| Title Of Article | |
| Name Of Author | |
| Publication Year | |
| Retrieval search query | |
| Empirical Background | |
| Environment Of Study | |
| Background | |
| Subjects Of Investigation | |
| Study | |
| MIUX | <p><i>What are the Views on MIUX ?</i></p> <ul style="list-style-type: none"> ○ Aspects ○ Concepts ○ Factors ○ Framework ○ Elements |
| Data Analysis | |
| | <p>What are the views of MIUX are reported?</p> <p>Are the aspects, factors, elements, Framework and models discussed?</p> <p>Which aspects, factors, elements, Framework and models are discussed?</p> |
| Quality Assessment Criteria | |
| Is the aim of the study clearly explained? | Yes No Partially |
| Is the research method/technique clearly stated? | Yes No Partially |
| Are the UX or UX of MIrelated definitions, concepts, terminologies, etc. presented? | Yes No Partially |
| Are the empirical evidences provided in the study? | Yes No Partially |
| Are validity threats of the study analyzed? | Yes No Partially |

2.2.1.1.4 *Quality Assessment Criteria*

As suggested by Kitchenham (2004), we developed a checklist to assess the quality of the selected primary studies. The primary studies were evaluated based on the quality criteria presented in above table.

2.2.1.1.5 *Data Synthesis Strategy*

Collecting and summarizing the results of the primary studies is called data synthesis Keele (2007) Kitchenham & Charters (2007). Synthesis can be qualitative (non-quantitative or narrative) and it is sometimes possible to complement with a quantitative summary Keele (2007). In descriptive synthesis extracted information about the studies (i.e. intervention, population, context, sample sizes, etc) should be tabulated in a manner to answer the review Keele (2007). Homogeneous or heterogeneous types of results should be identified and extracted into structured tables Keele (2007). Line of argument synthesis, an approach to qualitative synthesis, is used when researchers are concerned about what they can infer about a topic as a whole from a set of selective studies that look at a part of the issue Keele (2007).

The first step of the synthesis was to identify the aspects, concepts, terminologies, etc related to the UX of mobile Internet. The original terms (UX of mobile Internet) were extracted into a data extraction form and then placed into structured tables. Finally, primary studies were grouped with similar findings or results.

2.2.2 **Conducting the review**

Identification of Research

The main reason of a systematic review is to determine, evaluate and interpret the available research related to particular research questions. The search strategy for this research is based on different steps which are mentioned in section 2.2.1.1.1, that aims to answer the research questions effectively. The keywords are identified from the research questions which aim to find out the research articles regarding “MIUX”. Then these keywords are revised to choose synonyms and alternative words, in order to cover large numbers of publications. Finally the Boolean operators ‘AND’ and ‘OR’ are used to identify the related areas.

Publication bias is one of the major problems in systematic review. According to Kitchenham & Charters (2007) “*Publication bias refers to the problem that positive results are more likely to be published than negative results*” Kitchenham & Charters (2007). Following are the steps that are used to address this problem Kitchenham & Charters (2007):

- Scanning the grey literature
- Scanning conference proceedings
- By approaching professionals in order to know about any unpublished results.
- And also by performing manual searching online.

The reference manager software Mendeley is used for managing large number of references that are acquired from a systematic literature search.

Selection of Primary Studies

The research articles are selected based on the tollgate approach, which consists of three different stages motioned in Table 2, under section 2.2.1.1.2. We used the same search string for each database according to its own specific format requirements. The following table 4 shows the details of search string used in this research study.

Table 4: Research Papers Retrieved From Different Databases

| SR# | Database | Search String | Total no. Of Articles |
|-----|---------------------|--|-----------------------|
| 1 | Scopus | TITLE-ABS-KEY(("user experience" OR UX OR "user centered design" OR "human centered design" OR "interaction design") AND (mobile) AND (internet OR web OR WWW OR "web browsing" OR computing) AND (term* OR perception* OR element* OR attribute* OR factor*)) | 200 |
| 2 | Engineering Village | ((("user experience" OR UX OR "user centered design" OR "human centered design" OR "interaction design") AND (mobile) AND (internet OR web OR WWW OR "web browsing" OR computing) AND (term* OR perception* OR element* OR attribute* OR factor*)) | 254 |
| 3 | IEEE | ((("user experience" OR UX OR "user centered design" OR "human centered design" OR "interaction design") AND (mobile) AND (internet OR web OR WWW OR "web browsing" OR computing) AND (term* OR perception* OR element* OR attribute* OR factor*)) | 157 |
| 4 | ACM | ((("user experience" OR UX OR "user centered design" OR "human centered design" OR "interaction design") AND (mobile) AND (internet OR web OR WWW OR "web browsing" OR computing) AND (term* OR perception* OR element* OR attribute* OR factor*)) | 321 |

2.2.2.1.1 Paper selected from Primary Studies

In stage one, the inclusion of articles was done on the basis of following criteria:

Table 5: Stage 1 (Paper selected from primary studies)

| | | |
|----------|----------------|--|
| 1 | Overall | <ul style="list-style-type: none"> - English - Date of publication - Full text - Non-duplicate - Other? |
|----------|----------------|--|

By following the above mentioned criteria, we have found a total number of 932 articles from the selected databases. In order to identify duplicates papers, classify research articles, make the references, and to sort out the research papers we used Mendeley reference management software.

In stage two, the articles were included on the basis of criteria mentioned below in Table 6

Table 6: Stage 2 (Papers selected from primary studies)

| | | |
|----------|---------------------------|---|
| 2 | Title and abstract | <ul style="list-style-type: none"> - Contains search words - Focuses on the key words used for search string - Non duplicate |
|----------|---------------------------|---|

By following the above mentioned criteria, we have included a total of 184 articles out of 932 based on title and abstract. Then by removing duplicate articles, author identified 70 articles out of 184.

In stage three, the inclusion of articles was done on the basis of criteria mentioned below in Table 7:

Table 7: Stage 3 (Paper selected from primary studies)

| | | |
|----------|------------------------------------|--|
| 3 | Introduction and conclusion | <ul style="list-style-type: none"> - Contains empirical background - Mainly focus on MIUX concepts |
|----------|------------------------------------|--|

By following the above mentioned criteria, we have found 46 articles out of 70 based on introduction and conclusion.

In the four and final stage, the inclusion of articles was done on the basis of criteria mentioned below in Table 8:

Table 8: Stage 4 (Paper selected from primary studies)

| | | |
|----------|------------------|---|
| 4 | Full text | <ul style="list-style-type: none"> - Presence of empirical data in the paper - Main focus on aspects, factors and elements of MIUX. |
|----------|------------------|---|

By following the above mentioned criteria, we have included a total of 25 articles out of 46 as the selected primary studies. The details are shown in the Table 9.

Table 9: Selection of Research Studies

| <i>Sr.#</i> | <i>Database</i> | <i>Stage 1</i> <i>Total No. of Articles Found</i> | <i>Stage 2</i> | | <i>Stage 3</i> <i>Introduction and Conclusion</i> | <i>Stage 4</i> <i>Full-Text</i> |
|-------------|---------------------|--|---------------------------|-----------------------|--|------------------------------------|
| | | | <i>Title and Abstract</i> | <i>Non-Duplicates</i> | | |
| 1 | Engineering Village | 254 | 30 | } 70 | → 46 | → 25 |
| 2 | ACM | 321 | 15 | | | |
| 3 | SCOPUS | 200 | 94 | | | |
| 4 | IEEE | 157 | 45 | | | |

Data Synthesis

Data synthesis is an important phase of systematic review which involves collecting and summarizing the results of the included primary studies Kitchenham (2004). In order to answer our research question, the raw data collected from the data extraction form were categorized and analyzed. These raw data were tabulated and charted to present the differences and similarities of the selected primary studies.

2.2.3 Reporting the Review

The final phase of systematic review is reporting the systematic review results and spreading the results to potentially interested parties Kitchenham (2004). The main part of this research is devoted to report the systematic review, initiating from the planning phase till execution phase.

2.3 Validity Threats

No matter how good the research was conducted, there is always a factor which can influence the reliability and accuracy of the results. The main threats relevant to research methods applied for this research study consist of systematic literature review. According to Kitchenham & Charters, (2007), there are four different types of validity threats i.e. conclusion validity, internal validity, external validity and construct validity. Author of this study did his best to describe all possible validity threats and plan for minimizing the affect of it in the research study. The validity threats that falls under each of above four categories are described below:-

2.3.1 Conclusion Validity

Conclusion validity is related to the reliability of the research study results Kitchenham & Charters, (2007). It is also concerned with issues that affect/limit the ability to draw the correct conclusions from the research Kitchenham & Charters, (2007).

For a systematic review the main risk concerns the ability of the author to select accurate research publications for the review and data extraction. The reliability, to select accurate papers for the review, of the systematic literature review is increased by following the review protocol (See section 2.2.1). Moreover, one of the main aims of defining a review protocol is to reduce researcher bias Kitchenham & Charters, (2007) by defining the inclusion/exclusion criteria explicitly. Inconsistency in the extracted data or incorrect terms leads to incorrect classification of the research results Petersen et al., (2008). To minimize the data extraction threat and to increase the consistency of the extracted data, author used a designed data extraction form.

2.3.2 Internal Validity

Internal validity is concerned with the deductions, whether accurate or not, from the gathered data (Creswell, 2009).

A threat with the systematic literature review is associated with publication biasness. To overcome this threat the defined review protocol is strictly followed where inclusion/exclusion criteria, search string, selected electronic databases etc are described explicitly. The Tollgate method (Afzal et al., 2009) is used to cope the validity issue. It is a statistical method for evaluating the consistency of agreement among any constant number of raters (Afzal et al., 2009). Another threat to internal validity is the fewer number of primary studies and huge number of rejected studies. So there is a threat of missing the relevant research studies. To avoid this threat a study selection criteria was set for the inclusion/exclusion of research studies by author of this thesis. The selection criterion consists of four stages which were implemented on the results of the search strings. The set criteria were clear and well known to author in order to avoid misunderstandings. This procedure helped a lot to avoid the threat related to the selection of primary studies.

2.3.3 Construct Validity

Construct validity assess the use of accurate definition and measures associated with the variables (Creswell, 2009) .

The threat related to construct validity was to miss any important publication from the databases due to construction of inappropriate search string. In order to minimize this threat, author consulted with the university librarians at BTH. They guided us a lot for the refinement of search string. Furthermore, author of this study also contacted different database experts of IEEE explorer, ACM digital library and Scopus for the refinement of search string. Their suggestions really helped us a lot to make a search string that covers the maximum hits.

2.3.4 External Validity

A threat to the external validity might be the missing of primary studies. As, the systematic literature review was conducted between the year 1998 and 2012 including and first primary study found in 1998. This was a low potential threat to the external validity for this systematic review.

3 MIUX IN RELATION TO ACADEMIC RESEARCH RESULTS

There are different studies conducted to define MIUX which are explained below.

Kaasinen et al. (2009) in their paper “User experience of MI analysis and recommendations”, analyses the issues related to MI from the end user perspective. They mentioned the aspects of MIUX such as users and usage contexts, Improving services and services discovery, Improving Infrastructure and explained the each aspect as well. Authors used a TAMM model as an example and stated that the perceived value, perceived ease of use, and trust towards the MI all trigger the intention to use. If the adoption phase is also seen as being easy, people will start using the mobile internet. In this paper author also mentioned the elements that affect the MIUX. They stated that three main elements are the user’s internal state, the context of use, and the actual MI system. The system, in turn, consists of four main components in the case of the mobile Internet: the device, the software needed to use the Internet on the device, the network to transfer the packages, and finally the services available through the Internet.

Lee & Kim (2005) in their paper “Use Contexts for the Mobile Internet: A Longitudinal Study Monitoring Actual Use of MI Services” proposed a framework on one of the elements of MIUX that affect the MIUX i.e. the context of use of mobile services that reflect characteristics of the mobile internet. They define a use of context through adapted definition “*the full set of personal and environmental factors that may influence a person when he or she is using a MI service*”. They conducted longitudinal monitoring study to explore this context; through this study they explained two contexts for instance personal and environmental. They explained their study in four parts. First they identified critical use context factors for MI services and formulated a framework of use contexts for MI services. Secondly they explain the longitudinal monitoring method in detail. Then they presented their results from the monitoring study. And the finally they discussed the study’s limitations and the implications of its results.

A. Kaikkonen (2008) in the article “Full or Tailored Mobile Web- Where and How do People Browse on Their Mobiles” conducted a global online survey and a set of interviews to know some interesting usage patterns of MI users, such as, full web and mobile tailored web are used for slightly different reasons. It also discusses the MI users usage patterns vary in different countries, for example, in Asia MI users are often female with non-technical background, whereas, in Europe and North America users are still early adopters. Mobile tailored operator portals are being used by Asian users while European and North American users are more familiar with full web and newest gadgets. The author described the problem with mobile tailored approach to Internet that it did not satisfy users in every usage situations. One solution to the problem was to allow mobile phone browsers to access full web content. Current commercial web browsers at that time allow users to access the full web content and not just the limited number of sites designed for mobile tailored world. The web pages were shown in width of mobile phone display, called narrow layout, using these mobile web browsers, but from users view point this was not optimal way of showing web pages. The users had problems with the understanding the structure and content of the web page.

Hinman, Spasojevic, & Isomursu (2008) in their paper “They Call It “Surfing” for a Reason: Identifying MI needs through PC deprivation” identified the needs of the MI users by comparing it with PC (personal computer) internet in order to design a handset interface solution. To cope this problem authors used case study as a methodology and used two methods to collect data i.e. interviews that are contextual in nature and online diaries. Through these methods authors acquired

design implications for instance *design for partial attention and interruption (When designing for the Mobile Web, design with interruptions in mind. You must understand the limitations of content consumption on a mobile device. Users can be interrupted at any time by the physical environment, such as a text message from a friend or an important call.)* and different but interesting research findings such as *Exploring Internet content on a mobile device requires a high investment of time often with a low value return.* Authors of this study also found the form factors (standing, walking), environmental factors (highly variable environment) with respect to MI and visual cues of the Mobile-Internet experience (options are not always apparent, one view at a time etc).

C. A. Taylor, Anicello, et al., (2008) in their paper “A Framework for Understanding MI Motivations and Behaviors” adopted retrospective interviews to elaborate voice mail messages captured during study to address their research question i.e. why do people access information via the MI and to improve the MIUX. Authors proposed a framework for understanding usage of MI which accommodates mobile design, development, and research communities with a valuable tool for further study of MI use and for creating product and services that improve the MI user experience. The framework is a result of data analysis followed by the guidelines of grounded theory. During analysis authors characterized the motivational and behavioral data on the basis of factors that affect the MIUX for instance (Utilitarian and hedonic). In this study authors also find the usage pattern of motivational and behavioral data such as (Awareness, time management etc).

Kenichi, (2004) in the article “Internet use via mobile phone in Japan” explained the usage of MI through exploring social and cultural factors in mobile Internet. Survey is the method used to address this purpose of study. Survey result showed very interesting findings about one of the aspect of MI (understanding the users and usage) i.e. *The respondents most frequently see friends or relatives with whom they communicate through email via mobile phone, whereas they less frequently see friends or relatives with whom they communicate by email via PC .Friends or relatives with whom they communicate by email via mobile phone live in a geographically closer location than those with whom they communicate by PC mail. Ages of friends (or relatives) communicating by email via mobile phone are closer to the respondent’s age, than if communicating via PC mail.* Regarding social factors through survey results author explained that MI serves social factors such as social-ability. In the concluding remarks author said that the Japanese MI has evolved from mobile phones and pagers (e.g., pager friends), rather than from PCs. The mobile Internet, therefore, is not an extension or substitute for the PC Internet in Japan. Another conclusion made by author is that cross-cultural studies are needed to more systematically explore cultural influences on a broader range of telecommunication behaviors.

Nielsen & Fjuk, (2010) in their article “The Reality beyond the Hype: MIs Primarily an Extension of P C-Based Internet” deployed focus group interviews which recruited mature and advanced users in terms of volume of data traffic generated from MI usage. Through this specific user recruitment approach authors wanted to identify the services used by these “advanced” users in result the usage was limited to e-mail and news websites and simple inquiries to databases such as Wikipedia and Google. They argue that MI usage is interrelated with and is an extension of the personal computer (PC) based Internet. *The discussion is based on three different angles: MI usage that is related to PC-based Internet usage, MI usage that is different from PC-based Internet usage, and cost issues influencing the choice between MI and PC-based Internet.* This discussion revealed different points but the most important advantage of MI is its accessibility when on the move and example is the response of user (“*Not to have to switch on my laptop on the way, but I had a beep when I received an e-mail, I read it and could answer and make decisions. I could make people do things, manage them. Some people were surprised that I could manage half the company with this handset yes, that’s exactly what I do.*”). The main problem under study was to explore actual usage activities and motivating factors for those who really use MI. One of the usage activity is mentioned

by author is to kill time (“*When you are on the station and waiting for the subway or train and read some news . . . checking whether the trains are on schedule.*”). In the end authors conclude that the mobile phone primarily acts as a substitute when a PC is not at hand the further a user is away from a PC, the greater value the MI has.

H. Kim, Kim, Lee, Chae, & Choi, (2002) in their paper “An Empirical Study of the Use Contexts and Usability Problems in Mobile Internet” recruited 37 participants and collect the data through log of their usage and a pocket diary to address the problems related to user context and usability. To address first problem author define user context by proposing a framework and definition ‘*any personal and environmental information that may influence the person when he/she is using Mobile Internet*’. They divided the context as personal context and environmental context and then divided these two contexts into further components. Through this research authors came to know that people used MI most frequently when they felt joyful, when they were in a calm and quiet environment, and when they used one hand. This often describes the context of an office or a bedroom, which is totally opposite to the widely held belief that MI would be used often while outdoors and on the move. The other part of the problem was related to usability and addressed through Mobile Information Architecture framework by using identified contextual factors. The results of this study have several implications both from a theoretical and practical perspective. From the theoretical perspective, this study provides a framework of use contexts and usability problems in Mobile Internet. It also presents a data collection method that can collect reliable data about contexts and usability problems in Mobile Internet. From the practical perspective, the study’s results indicate that MI is used heavily in a few contexts. The result implies that MI service providers do not have to take into account all possible contexts, but should focus on the key contexts through developing specialized applications.

Lehtonen et al., (2006) in their paper “Towards User-Friendly Mobile Browsing” advocates the proxy server solution (TutMobi) for the problem faced by MI users during using web pages on the Internet through web browser. Author addressed two problems such as long download time and high bandwidth consumption. The solution provided by authors for first problem is through comparing three web sites (CNN, www.iltalehti.fi, Google) on different browser (Opera) as compare to their proposed method and proved that, TutMobi browser is more than 35% faster than Opera Mini and more than 85% faster than Opera mobile browser when average download times of three previously mentioned web pages are considered. To address second problem authors observed a single web page and in result their proposed solution i.e. TutMobi server saved huge bandwidth.

Wäljas, Segerståhl, Väänänen-Vainio-Mattila, & Oinas-Kukkonen, (2010) in their paper “Cross-Platform Service User Experience: A Field Study and an Initial Framework” engaged the designer on one aspect of MIUX i.e. improving services, through a framework and draw their attention to the issue of designing when they designed the web services for the multiple user interface (MUI). Authors of this study describes that improving mobile services can play a major role for enhancing the MIUX and MI users will easily manage the interaction when using the mobile services on their devices. Authors used diaries and interview method and proposed a conceptual framework for system and cross platform services of user experience based on field investigation.

Bamford, Coulton, & Edwards, (2007) in their article “Space-Time Travel Blogging Using a Mobile Phone” shed light on Location based services. Locoblog is an online diary service in which users take and share personal photos from their daily lives through Internet enabled mobile device. Authors of this study choose travelers from 14 countries to share their experiences online which show the diversity of this service. Authors mentioned that (LBS) are an important element of MI but unfortunately couldn’t get the success. To support this claim they introduced the blogging

system i.e. Locoblog. The basic aim of the study was to quickly and easily allow people to share photos, write stories, and update family and friends about their location whilst traveling but this study also exposed general activities and usage dimension of the users when using online diaries such as their entry style and entry type. After the success of this trial author concludes that such services are now very realizable and as the mobile industry continues to evolve we believe this type of service will find its way into more general and widespread use.

Su, (2010) in the paper “MI experience research based on TAM” describes that The Technology Acceptance Model is based on a solid framework to identify issues that may affect user acceptance of technical solutions. They also mentioned that by combining TAM with other research approaches can give fruitful results and they proved it in their work. They used a TAM model and flow experience theory in their study. Then by using TAM and flow experience theory they build their own model which involves four factors of MI experience such as level of challenge, user skills, perceived ease of use and perceived usefulness. It proposes marketing strategies about the M-internet experience which help enterprises to expand their M-internet services market design M-internet experience and provide the theoretical basis for market strategy. At last this article puts forward marketing strategy according to the model of the MI experience. According to the model, it provide the means which are easing the MI operation, establishing room of the MI experience, providing differentiated services to customers and positioning customers’ perceived usefulness correctly. It provides a theoretical basis for expanding its MI services market and making market strategy as well.

Cui & Roto, (2008) in their paper “How People Use the Web on Mobile Devices” did a study on user and usage aspect of MI by using contextual inquires method and phone logs for usage of web via mobile devices. Through this approach they figured out contextual factors such as spatial, temporal, social, and access factors that affects when using the web, in result they propose the web activity taxonomy. They also proposed a framework based on user activity.

3.1 Research Motivation

From the discussion above it is concluded that there are some experience reports and opinions which states the execution of MIUX in different projects Kaasinen et al. (2009) I. Lee & Kim, (2005) A. Kaikkonen (2008) C. A. Taylor, Anicello, et al., (2008). The perspective in which MIUX is discussed in these papers is Understanding the users and usage, Improving services and services discover, Improving device hardware and software, Improving infrastructure: connectivity, network proxies, pricing policies, guidelines and standards, User internal state, The context of use, Actual MI system, factors affecting mobile internet, models Kaasinen et al. (2009) I. Lee & Kim, (2005) A. Kaikkonen (2008) C. A. Taylor, Anicello, et al., (2008) (Hinman et al., 2008) Nielsen & Fjuk, (2010) Lehtonen et al., (2006) Wäljas et al., (2010) Bamford et al., (2007) Su, (2010) Cui & Roto, (2008). These researchers also noted that MI experience has become one of the new experiences in life this means that more studies and evidences are required in order to understand the MIUX.

Therefore the purpose of this study is to systematically evaluate the empirical evidence available, in order to better understand these benefits and challenges of MIUX. By benefit, it means that how the MIUX can be improved through this and other efforts i.e. helpful for resolving certain issues related to MIUX. Similarly by challenges author mean that those factors which creates hurdles during designing the MIUX.

4 THEORY

In this chapter, author of this study describes the theories related to research topic assessed from literature in a descriptive way. The 25 primary studies were related to research topic i.e. MIUX through different perspectives mentioned by Kaasinen et al. (2009) V. Roto & Kaasinen, (2008) Hassenzahl, M., & Tractinsky, N. (2006). In The Second International Workshop on Mobile Internet User Experience V. Roto & Kaasinen, (2008) identified four aspects where MIUX can be improved, these aspects are: understanding the users and usages of mobile Internet better, improving services, improving device hardware and software, and improving infrastructures such as connectivity, cost, service discovery, network proxies, guidelines and standards. Another step to improve the UX is carried out by Hassenzahl, M., & Tractinsky, N. (2006) they explained that different elements affect UX the three main elements are user's internal state, context of use, and the system being used. In the case of MI system consists of four main components: the device, the Web browser on the device, the network connection, and finally the Web sites. Then Kaasinen et al. (2009) in a journal article identified that MIUX is also affected by different factors and solution would make Internet usage on a mobile device an enjoyable experience.

In the coming chapters author of this study will shed some light on the aforementioned classification identified by different researchers that can provide the space to give the suggestions for the improvement of MIUX because it is difficult to replace the whole system due to many constraints for instance heavy cost but it is more feasible and possible to provide the solutions for the short comings of a existing system. Relevant information describing the distribution of primary studies within each perspective is shown in Table.

4.1 Mobile Internet User Experience

4.1.1 Mobile Internet

A common misconception about the meaning of the MI is that it would be a portable version of the familiar desktop Internet Nielsen & Fjuk, (2010). The current situation of MI is a result of historical development. To understand the MI phenomena closer look may be helpful. In this section author will portray the picture of MI with respect to context and highlight the influence of MI on UX. This piece of information is fetched through Wikipedia 2012 (History of the internet).

The human communication begins long ago via mail services, newspaper, radio or televisions are some means of communication media. In late 1960s the internet has developed from ARPANET and one idea of ARPANET was to have one terminal to address them all. The development of this network was based on a Request for Comments (RFC) system, which defined the character of the Internet as a peer based structure. Everybody can contribute by adding ideas; objections or features and the good ones shall convince the community and persist. RFCs are still used, and pages like Wikipedia, social bookmarking and all kind of user-generated content (blogs, YouTube or Un-conferences) still reflect this idea. User contribution and low regulation are core values of the Internet which make it highly complex.

The initial service for communication was remote login and File Transfer Protocol (FTP) was an extended version of the same service. Then chat and e-mail were developed as a medium for communication between remote sites. Email was a killer application because of cheap and fast way of communication. The next important thing was Hyper Text Transfer Protocol (HTTP) and Hyper

Text Markup Language (HTML) used to share information with other communities. Having Gopher, Viola WWW (and Mosaic later) as the interface, the first web browsers were born.

The initial network was for non-commercial only (research, military etc). The increase in commercial users happened when commercial Internet service provider (ISP) joined for instance Universities, Schools etc. This increase in users without university background shifted the focus and increased the amount of information available on the web; commercial and community content appeared. Growing amount of users and low cost of global communication the web created new business possibilities. This created a closer relationship between companies and their customers. The online shop concept removed dependency on retailers creating the possibility to directly buy goods from the manufacturer for lower prices and higher convenience. This boom of selling goods and services online lead to the dot com bubble. This dot com bubble burst and can be seen as representative for Internet business hype and left users with the impression that Internet companies are as virtual as web sites and may appear and disappear.

Technology and online culture advanced a bit since the burst of the dot com bubble. The Internet became global meeting place for people. It gives the possibility to find out what is going on at the other side of the world, creating possibilities for friends and strangers to connect, exchange ideas and maintain relationships. This classification of user's behavior is currently a hot topic and means to provide useful recommendations to people. Multimedia is the other current hot topic. Today's high bandwidth available in the developed world enables fast transfer of large amounts of data. Web radio and online film streaming are becoming common and watching TV on mobile phones has been attempted since the introduction of UMTS. The users care for functionality not a technology. If instead of the Internet the solution was based on magic, users would still use it.

Talking to somebody without being physically present is by now an extension to our body. Mobile telephony was developed half a century ago. By 1991, GSM 2G was introduced in Europe using devices of half a kilo while having stand by times of less than a full day. The introduction of SMS happened in 1995, being the first real surprise success story for mobile phones. The other developments in mobile communications were uninspired. While data transfer speed was increased on network side (2.5G, 2.75G to current 3G networks), manufacturers added features like cameras and music players to the phones in the hope to find the next killer application. Internet access via specialized mobile WAP sites was promised to be "the Internet on the phone". All these enhancements gave better ways for users to do things they could already do before. This is not sufficient, for a killer application one must provide an unprecedented user experience far better and cheaper than expected. Simply giving access to the web via mobile devices will therefore not be any killer application.

MI which is a combination of the Internet with mobile devices, has become popular recently and can be described in different ways H. Kim et al., (2002).MI means using the internet on mobile devices, excluding traditional laptop computers. The general definition of MI according to Wikipedia is "access to the Internet from a mobile device, such as a smart phone or laptop via integrated capabilities or via an independent device". Virpi Roto, (2006) defines MI as any access to Internet with a mobile browser. Terms like mobile web, one web, and mobile broadband are also often used to explain the word MI Nielsen & Fjuk, (2010). MI involves internet usage and is normally described by short bursts of activities such as e-mail Kaasinen, (2005a). Using internet on mobile device involves using the different kinds of internet content and services V. Roto & Kaasinen, (2008). However A. Kaikkonen, (2011) explained MI as any Internet access with mobile phones and portrayed a different approach to explain the MI when accessing the services on internet. A. Kaikkonen, (2011) clarify that MI can be divided into two parts i.e. full web and mobile

tailored web, furthermore MI can be accessed in different ways for instance web browser, it's up to the user to choose the right approach for their desired service.

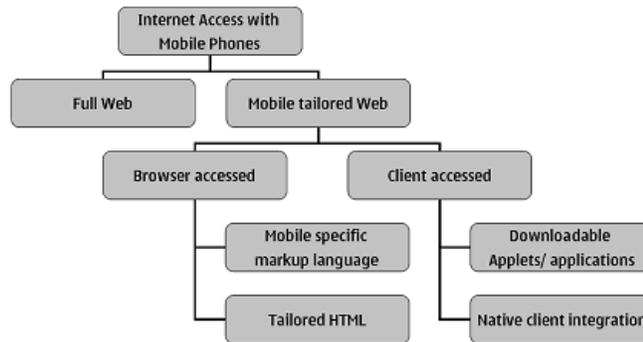


Figure 3 Ways of accessing MI A. Kaikkonen, (2011)

4.1.2 User Experience

The term UX has been around since the late 1970s and associated with Don Norman's self-assigned job title of "User Experience Architect" at Apple, Inc. Its complexity and late identification results not a successful clarity and no consensus on one definition. A detailed discussion of this topic can be found in V. Roto, (2006).

While every definition in general is ideal in its own environment but the author of this study perceive the UX through his study topic i.e. MIUX and is adopted by V. Roto & Kaasinen, (2008).

"a term that describes user's feelings towards a specific product, system, or object during and after interacting with it. Various aspects influence the feelings, such as user's expectations, the conditions in which the interaction takes place and the system's ability to serve user's current needs."

This definition can be divided into different parts with respect to study research topic for instance Aspects of MIUX: understanding the users and usage, improving services and services discovery, improving device hardware and software and improving infrastructure. Elements of MIUX: user's internal state, the context of use and actual mobile internet system. Factors of MIUX: Satisfaction in use, Aesthetic attributes etc V. Roto & Kaasinen, (2008).

The dimensions described in this section shows that UX is highly complex that is why it is difficult to create a specific experience. Most important thing is to know the user and reflect this in development process. This can be done via following factors: product factors, contextual factors and user factors. Detail on these factors can be found in the below sections.

4.2 MIUX Concept and Components

The complex system of UX (4.1.2) gets even more complex when combined with the domain system of MI. MIUX can be defined by many perspectives. Different authors have presented different concepts to define and describe MIUX in different contexts, some of which are presented in this section.

MIUX refers to the “overall feelings of a person about using the internet on a mobile phone” Kaasinen et al. (2009). Nevertheless actual UX appeared from the user interaction (before and after) with a system (mobile) for instance contents and services accessed available on the internet, there are many drawbacks that might ruin the MIUX such as If the connection is slow, pages will not load quickly enough V. Roto & Kaasinen, (2008). These pitfalls can be eliminated by understanding the elements that affect the MIUX: *user’s internal state, context of use, and the system being used* V. Roto & Kaasinen, (2008). Ideal situation to cope all these drawbacks will be if all the components in the MI system work reliably so that the user experience is good enough for the broad audience. Different components from end user perspective can affect the MIUX. The domain of MI can be divided into six layers, each has their specific impact on the UX: Kaasinen et al. (2009).

- User
- Context
- Device
- Internet software
- Connection
- Service

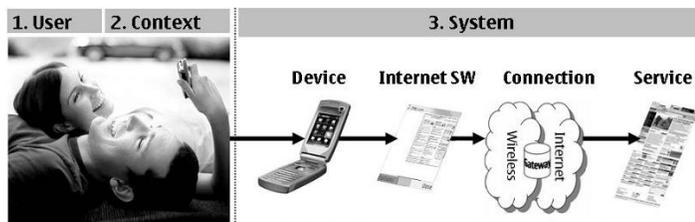


Figure 4 Elements affecting MIUX Kaasinen et al. (2009)

4.2.1 USER

The key to understand the MIUX is to understand the users and use situations of mobile Internet V. Roto & Kaasinen, (2008). To support this claim V. Roto & Kaasinen, (2008) define MIUX concept as users approach to use and expectations from MI. Furthermore they demonstrated their concept by adapting a well-known model i.e. Technology Acceptance Model for MI (TAMM), which is based on five concepts: usefulness, ease of use, attitudes towards use, actual use and intention to use with respect to usage of MI as shown in FIG below.

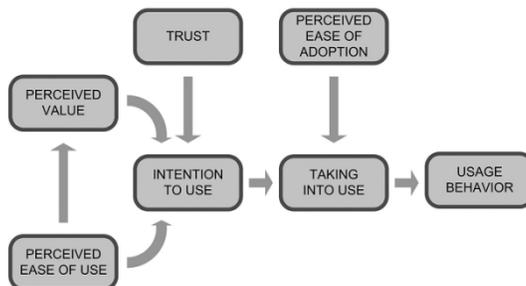


Figure 5 Technology Acceptance Model for MI (TAMM) Kaasinen et al. (2009)

After using the above example Kaasinen et al. (2009) concluded that lower the expectations of users results positive MIUX, it also depicts that MI system might not be flawless but it does not means that MIUX has to be poor.

Understanding the users of MI associated with identification of the potential users of MI and this aspect is highlighted in A. Kaikkonen (2008) study. This effort makes clear in the survey that there were no gender differences when it involves MI and MI is accessed by everyone e.g. engineers, technical IT professionals, non-technical users, in healthcare sector etc. A study by A. Kaikkonen (2008) also reveals that nationwide differences contribute the huge impact on MI for instance in Asia users were non-technical females and in Europe and North America users were technical and early adopters. Secondly identification of users: why they are potential users also plays a crucial part in understanding MIUX. Roto & Kaasinen, (2008). C. A. Taylor, Anicello, et al., (2008) highlight this aspect and proposed a framework on the basis of user behavior and motivation to elaborate same issue. The key component that derives the motivation of users are two main factors i.e. Hedonic and pragmatic. They mentioned the sub factors Hedonic: curiosity, diversion, social connection, social avoidance and Pragmatic: awareness and time management. These findings depict the user goals when they used MI which can be used to improve the MIUX. The current improvement in knowledge of MI is totally noticeable still different issues related to MI usage affect and reduced MIUX such as downloading time. Zhou, Chander, & Inamura, (2010) have studied the user interaction of MI to cope the same issue and proposed a framework based on a user activity which involves 3 steps: Monitoring the log files, Interaction history of users and Users current interaction context.

4.2.2 CONTEXT

Another crucial component takes into account when discussion about MIUX is considered i.e. context. ISO 13407:1999 define context as “the characteristics of the users, tasks and the environment in which the system is used” Kaasinen, (2005a). V. Roto, (2006) mentioned context as “any information that can be used to characterize the situation of an entity, an entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.”

Context of Use

Context with respect to MIUX can be defined in totally different manners for instance H. Kim et al., (2002) mentioned “any personal and environmental information that may influence the person when he/she is using Mobile Internet.” I. Lee & Kim, (2005) distinguished MI from conventional internet through the ability to provide service anywhere and at anytime. This characteristic of MI depicts the intention towards the context of use. I. Lee & Kim, (2005) define mobile context of use as “the full set of personal and environmental factors that may influence a person when he or she is using a mobile Internet service”.

It is cleared from these definitions that mobile context is a very complex phenomena and involves different types of context which directly affect MIUX. Kaasinen et al. (2009) mentioned that Physical, Social, Temporal and Task context have major contribution to shape the MIUX. I. Lee & Kim, (2005) divided context of use into two categories i.e. personal and environmental context and explained by proposing a framework in (Figure 6).

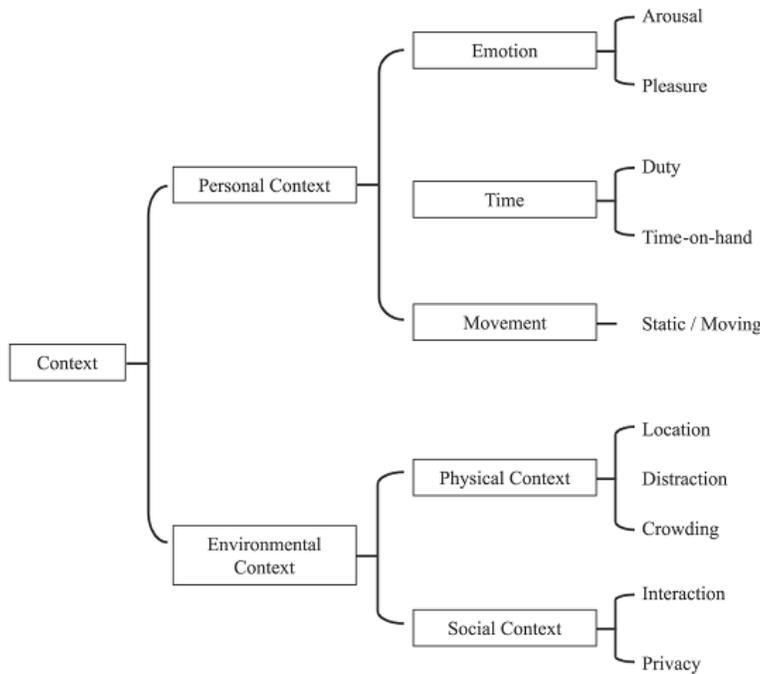


Figure 6 A conceptual framework of use context for MI I. Lee & Kim, (2005)

- Personal Context: *Emotions (Arousal, pleasure), Time (Duty, Time-on-band), Movement (static/movement)*
- Physical Context: *Acoustics/sound/noise, lighting conditions, activity level, location, Distraction, Crowding, weather/environment*
- Social Context: *Number of users/bystanders, relation of users, cultural background, Interaction, Privacy*
- Temporal Context: *Time of day, urgency of the task*
- Task Context: *Goal of activity, concurrent/subordinate activities*
- Virtual Context: *Other products, required features, affection to the device, online activity, context*

As we can perceive from above text that there is a wide range of contexts that affect MIUX, so the prediction and assumption of the correct context is impossible Kaasinen et al. (2009) Virpi Roto, (2006). Virpi Roto, (2006) suggested that this might be possible through investigating the MIUX in the real context moreover the author quoted an example study in which it is concluded that the real time context is a central influencer on MIUX. Another contextual hurdle for MIUX is the complication of the system. It requires all the stakeholders (users, device manufacturers etc) to deliver seamless experience Virpi Roto, (2006). A positive example in a delivery of MIUX is

Japan, where sophisticated network, device manufacturers, content providers and software maker together produced a NTTDOCOMO system Kenichi, (2004)Virpi Roto, (2006).

4.2.3 SYSTEM

From MIUX perspective system is a single entity but consists of several layers for instance device, connection, service etc. the following description is based and modified from Virpi Roto, (2006) V. Roto & Kaasinen, (2008) (Kaasinen, 2009).

DEVICE

Nevertheless mobile device is very different device to use internet as compare to personal computer. The important feature that differentiates the mobile device includes the display, keys, memory space, processing power, and battery life. The typical mobile device features are display sizes, processor power, storage capacity, power consumption, navigation tools, text input interface, broadband bearers and many variants of web tools, such as browsers, media players, application viewers or positioning tools. The soft factors of device which directly influence the MIUX are

- Appeal: *Elegance, look and feel*
- Brand: *Perceived value, differentiation, image*
- Interaction: *Styles/modes of interaction, intuitiveness*
- Responsiveness: *Amount of feedback, speed of interaction*
- Usability: *Ease of use, recognisability, required level of attention, gazeability*

Every factor mentioned above affect the MIUX and hard to measure quantitatively. They can be shaped in the design process but hard to design. Now days a mobile device have lot of features and facilities that provides opportunity to a user to connect to the physical world to the mobile internet. Some preinstalled features such as cameras and preinstalled applications gave users an access to fetch content and services from online world.

NETWORK

Networks have the central role in the whole process. Network is in middle of the whole system and controlling like a spider. Network is a medium and work as a pipe line to transport the data. Another main factor of network is ensuring the quality of service (QoS), transfer speed and security.

- Availability : *Network coverage, connection breakdowns*
- Reliability : *Security, error rate*
- Transfer : *Transfer rate, congestion, QoS, gateway speed, transfer cost*

BROWSER

The challenge for (ISP) is to deal with the variety of browsers and then ensure to provide the accessibility of context by all the different browsers. The browser is a medium to display web pages and usually only application to serve that purpose. Not every browser has ability to access full web contents. Opera, Netfront, Web viewer and doris are the example of web browsers allow users to access full web contents. UX factors that affect browsers are:

- Functionality: *Supported activities and content, comfort functions*

- Interaction: *Styles/modes of interaction, intuitiveness, visualization*
- Usability: *Ease of use , Recogniseability, required level of attention*

WEB PAGE

MIUX refers to access the web pages available on the internet on small screen. Finding a relevant web page is not an easy task, since there are more than 50 billion web pages out there. For users these are the most important part of the UX. Aforementioned and below mentioned factors should support the web pages not interfere.

- Access: *Public/restricted access, required input*
- Appeal: *Layout, design, aesthetics, look & feel*
- Content: *Usefulness, interest, value*
- Familiarity: *Recogniseability, conformity with web trends*
- Functionality: *Core functionality, comfort functionality*
- Interaction: *Styles of interaction, workflow, intuitiveness*
- Technology: *Site structure, frameworks*
- Trust: *Trusted content, information storage policy, EULA, reputation*
- Usability: *Ease of use, required attention, user feedback, clarity*

SERVICES

The main purpose of launching MI was to facilitate the ways of accessing information and services. The services included in MI are Global positioning system (GPS), Picture and Video mails as well as standard e-mails etc. Big audience heard about MI in late 90s, when Japans NTTDocomos i-mode was introduced and bit later (WAP) approach was introduced which uses (WML) language specially design for small phone type devices. I-mode operators were using their own internet approach using limited set of HTML language and provide the webpage access to their users. On the other hand WAP uses separate application and paid little attention to the web services. This results i-mode a huge success worldwide and WAP could not develop any success story; possible factors were related to WAP usability for instance slow connection setup and response time. I-mode users were free from these hurdles due to their packet based network.

It is difficult to replace the whole system due to many constraints for instance heavy cost but it is more feasible and possible to provide the solutions for the short comings of a existing system like Lehtonen et al., (2006) proposed a proxy server solution for the same problem (response time). Another study by (Yao, Kanhere, & Hassan, n.d.) suggests that it may be worth exploring policies and technologies that can enhance data rates and reliability by seamlessly combining services from multiple providers.

Apparently the notion that goals of MI users are different from the desktop users creates different factors that heavily affect MIUX such as Kaasinen et al. (2009) mentioned trust becomes increasingly important as mobile services get and more rooted in personal lives of people. Kaasinen et al. (2009) mentioned that relying on standards, taking into account device limitations, optimizing navigation, checking graphics and colors, keeping it small, using the network sparingly, helping and guiding user input as well as giving consideration to users on the go are the other key issues. Among these concerns giving value to the users is the most highlighted subject for MIUX. The services based on mobile values are *mostly to always online, Location based services, Internet*

connected applications and widgets, from general to personal, from expensive to cheap internet, from semi private to private internet, Novel interaction possibilities and work related services. Another important aspect of MIUX with respect to services is service discovery. This involves availability of services easily from networks: easy ways to take the services into use, and to adapt the services and user interface according to the usage context. Detail on these aspects of services can be found in Related Work.

5 DISCUSSION

In this chapter author of this study will shed light on the views related to the MIUX in literature. This will provide a chance to address RQ 1 and to achieve the ultimate goal of this thesis study that is to gain the insight into how to improve the MIUX. One possible way to achieve this objective is by identifying the key differences in consuming the internet content on mobile phones instead of PC. By bringing up this comparison will provide an opportunity to point out the challenges in the form of factors that affect MIUX.

Through literature study it is uncovered that there is no consensus on one standard definition of MIUX caused the research community to exploit this area. So it is possible to differentiate the study research topic into two views. One point of view focuses on the success of MI. The other dimension, which is the one taken by Nielsen & Fjuk, (2010) analyses and portrayed the contradictory picture with regard to the real use of MI. Nielsen & Fjuk, (2010) does not consider the MI as a separate domain they argue that MI is interrelated with and is an extension of the personal computer (PC) based internet. Both approaches towards MIUX are complementary. The author of this study lists the basic differences between the PC internet and mobile internet to elaborate the view point of aforementioned theories; emphasizes on the point that mobile devices and PC being different and resulting in different interaction and UX when using internet. The following list of differences are based and modified from the studies mentioned in Table for instance Ishii, (2004) (Hinman et al., 2008) Nielsen & Fjuk, (2010) A. Kaikkonen, (2011).

Historic Development and Interaction differences: From the beginning Computer and phone are completely opposite and contradicting technologies for instance computer development started as an information processor and became a communication device. On the other hand phone grew into an opposite direction. The usage of computer was only in office environments and communication takes place asynchronously such as mail and web page. While in phone the way of communication is synchronous from the beginning later SMS asynchronous communication was introduced. Using the internet on PC means the user can access the information by entering an address, this activity results the access menu on the same screen but in mobile phone there is a need to remember prior stages of the task because of modal approach for screens and menus overlapping.

Form Factor: The PC has a standard form factor usually seated (stationary). The PC is usually has a screen at least 800x600 pixels. The medium of interaction between users and PC takes place through a powerful and standardize combination of keyboard and mouse. On the other hand mobile phone is totally different and diverse device because of the manufacturers and form factors as well for instance: standing, walking, seated etc. In mobile phones the medium of interaction for users is a variable size/resolution screen and a control device being a keyboard, stylus or both.

Device Character: The input and output mechanism in PC is more standardized and operated in a controlled environment. There is a possibility that many users can share the PC while the mobile phone is considered as a personal device in most cases. Therefore personal preference and lifestyle have a bigger impact on the device than the necessity of owning one.

Activities and Goals: PC is a tool for work. The goal when using PC is to accelerate the task and also used to get work done. The goals when using mobile phone are establish communication, receiving information and entertainment. Mobile phone is a device with limited input mechanism; if the creation of information on a phone is possible the input limitation caused the processing more cumbersome.

Usage Context: Activities on both computer and mobile are totally depend on usage context. Usage of computer is more static: like the office, home or public places where the user can focus on the computer. The mobile phone is often used on the move or in dynamic contexts like busses, park benches or when walking down the street. This type of usage caused different factors like light setting, noise level etc.

Another objective of showing the differences between PC and Mobile phone internet is that one can see these differences specific to services, applications more interesting when accessed through mobile device. For instance categories like *informational, interactive, transactional, workflow and web services* make sense on mobile devices more than collaborative work environments, online communities and web portals. However industry seems not happy so far assuming “users want the web just like on the desktop” due to current status of MI. The same issues were mentioned in Nielsen & Fjuk, (2010). They mentioned in their study that only 14% of the Europeans who have a mobile phone use MI regularly, i.e., at least once a month. Furthermore, the weekly usage of MI (defined as 3G) and WAP in Norway has increased less than 1% from 2005 to 2008. On the other hand in Asia countries like Japan and Korea enjoys the highest diffusion rate of MI. The number of Internet enabled mobile phones is over 54 million, which is 77% of the total mobile phones Kenichi, (2004). Kenichi, (2004) mentioned that users needs have promoted the mobile Internet in Japan, rather than technology or policy. Nevertheless focusing on specific demands therefore brings an advantage when creating the MIUX.

Author of this thesis identified through literature study that MIUX is categorized into different perspective by different authors such as aspects, factors and elements. For instance V. Roto & Kaasinen, (2008) further categorized MIUX aspects into four parts which will help to improve the MIUX; understanding the users and usages of mobile Internet better, improving services, improving device hardware and software, and improving infrastructures. For the holistic explanation to the reader’s on these aforementioned categories below Table 10 is the findings/evidence of this study which supports the same argument i.e. to reveal nitty gritty details of MIUX with respect to MIUX perspective.

Table 10: Distribution of Primary Studies for MIUX perspective

| MIUX | Authors | Year | Title | References |
|----------------|--------------------------------------|------|--|------------|
| ASPECTS | Hoyoung Kim et al. | 2002 | An Empirical Study of the Use Contexts and Usability Problems in Mobile Internet | 11 |
| | Kenichi Ishii | 2004 | Internet use via mobile phone in Japan | 10 |
| | Inseong Lee et al. | 2005 | Use Contexts for the Mobile Internet: A Longitudinal Study Monitoring Actual Use of Mobile Internet Services | 14 |
| | Kaasinen, E. Timo Lehtonen et al. | 2005 | User acceptance of mobile services value, ease of use, trust and ease of adoption | 5 |
| | | 2006 | Towards User-Friendly Mobile Browsing | 15 |
| | Will Bamford et al. | 2007 | Space-Time Travel Blogging Using a Mobile Phone | 2 |
| | yanqing.cui, virpi.ROTO | 2008 | How People Use the Web on Mobile Devices | 3 |
| | Rachel Hinman et al. | 2008 | They Call It “Surfing” for a Reason: Identifying mobile Internet needs through PC deprivation | 4 |

| | | | | |
|-----------------|-------------------------------|------|--|----|
| | Anne Kaikkonen | 2008 | Full or Tailored Mobile Web- Where and How do People Browse on Their Mobiles? | 8 |
| | Carol A. Taylor et al. | 2008 | A Framework for Understanding Mobile Internet Motivations and Behaviors | 22 |
| | Eija Kaasinen et al. | 2009 | User Experience of Mobile internet – Analysis and Recommendations | 7 |
| | Su hailin | 2009 | Mobile internet experience research based on TAM | 21 |
| | Petter Nielsen Annita Fjuk | 2010 | The Reality beyond the Hype: Mobile Internet is Primarily an Extension of PC-Based Internet | 16 |
| | Minna Wäljas1 et al. | 2010 | Cross-Platform Service User Experience: A Field Study and an Initial Framework | 23 |
| | Dong Zhou et al. | 2010 | Optimizing User Interaction for Mobile Web Browsing | 25 |
| | Jun Yao et al. | 2011 | Mobile Broadband Performance Measured from High-Speed Regional Trains | 24 |
| | | | An Empirical Study of the Use Contexts and Usability Problems in Mobile Internet | |
| ELEMENTS | Hoyoung Kim et al. | 2002 | | 11 |
| | Kenichi Ishii | 2004 | Internet use via mobile phone in Japan | 10 |
| | Inseong Lee et al. | 2005 | Use Contexts for the Mobile Internet: A Longitudinal Study Monitoring Actual Use of Mobile Internet Services | 14 |
| | Kaasinen, E. | 2005 | User acceptance of mobile services value, ease of use, trust and ease of adoption | 5 |
| | Bamford, W et al. | 2007 | Space-Time Travel Blogging Using a Mobile Phone | 2 |
| | yanqing.cui, virpi.oto | 2008 | How People Use the Web on Mobile Devices | 3 |
| | Rachel Hinman et al. | 2008 | They Call It “Surfing” for a Reason: Identifying mobile Internet needs through PC deprivation | 4 |
| | Anne Kaikkonen | 2008 | Full or Tailored Mobile Web- Where and How do People Browse on Their Mobiles? | 8 |
| | Eija Kaasinen et al. | 2009 | User Experience of Mobile internet – Analysis and Recommendations | 7 |
| | Minna Wäljas1 et al. | 2010 | Cross-Platform Service User Experience: A Field Study and an Initial Framework | 23 |
| | Dong Zhou et al. | 2010 | Optimizing User Interaction for Mobile Web Browsing | 25 |
| | | | An Empirical Study of the Use Contexts and Usability Problems in Mobile Internet | |
| FACTORS | Hoyoung Kim et al. | 2002 | | 11 |
| | Kenichi Ishii | 2004 | Internet use via mobile phone in Japan | 10 |
| | Inseong Lee et al. | 2005 | Use Contexts for the Mobile Internet: A Longitudinal Study Monitoring Actual Use of Mobile Internet Services | 14 |
| | Kaasinen, E. | 2005 | User acceptance of mobile services value, ease of use, trust and ease of adoption | 5 |
| | Timo Lehtonen et al. | 2006 | Towards User-Friendly Mobile Browsing | 15 |

| | | | |
|--|------|--|--------|
| Bamford, W et al. yanqing.cui, virpi.oto | 2007 | Space-Time Travel Blogging Using a Mobile Phone | 2 |
| Rachel Hinman et al. | 2008 | How People Use the Web on Mobile Devices They Call It “Surfing” for a Reason: Identifying mobile Internet needs through PC deprivation | 3 4 |
| Carol A. Taylor et al. | 2008 | A Framework for Understanding Mobile Internet Motivations and Behaviors | 22 |
| Su hailin | 2009 | Mobile internet experience research based on TAM | 21 |
| Petter Nielsen Annita Fjuk | 2010 | The Reality beyond the Hype: Mobile Internet is Primarily an Extension o f P C-Based Internet | 16 |
| Minna Wäljas1 et al. | 2010 | Cross-Platform Service User Experience: A Field Study and an Initial Framework | 23 |
| Dong Zhou et al. | 2010 | Optimizing User Interaction for Mobile Web Browsing | 25 |
| un Yao et al. | 2011 | Mobile Broadband Performance Measured from High- Speed Regional Trains | 24 |

In Table 10 author of this thesis have pointed out selected studies in which MI and UX is the centre of focus regarding thesis research questions. Authors of these studies attempted to explain their views on study related topic which are plausible. On the basis of Table 10 study’s author of this thesis finds out some aspects, factors and elements which heavily influence MIUX according to the group of authors. For example Kenichi, (2004) portrayed the holistic picture on the huge effects of UX and success of MI in Japan. The author explained this phenomena through an example of high school students “In the mid 1990s, it was very common for Japanese high school students to have chats with their distant friends called “beru-tomo” (pager friends) using pagers. Beru-tomo did not know each other’s names and had never met, but they constantly exchanged messages by pagers every day, around 17 percent of high school students had “beru-tomo”. When mobile phones became more popular than pagers, they switched to these new media. Since then, the number has increased rapidly and exceeded 4 million in March 2002.” Similarly Nielsen & Fjuk, (2010) explained that 82% of iPhone users use the MI five times more than average use of MI. But this is not only a function of the handset design. One reason for this high usage is that Apple sells not only a mobile phone but also a value added network where new services can easily be bought from an application store. Another appealing story for the importance of MIUX is NTT DoCoMo has managed to develop a popular service platform and marketplace for MI services in Japan Ishii, (2004). While Apple is a handset producer and NTT DoCoMo an operator, a key factor behind their success has been significant effort and investments in user experience that makes it easy to discover and start using new services. A brief description on other MIUX perspectives fetched from Table studies that has a significant impact is given below.

Context of Use: Most of the authors mentioned in Table 10 have a consensus that this aspect of UX greatly affects the MI. They believe that the situation in which interaction takes place totally paint a different picture of MIUX for different environments. Likewise cultural probe of users also affect the MIUX. Detail on this aspect can be explored in following studies H. Kim et al., (2002) Ishii, (2004) I. Lee & Kim, (2005) Bamford et al., (2007) V. Roto & Kaasinen, (2008) Anne Kaikkonen, (2008) Hinman et al., (2008) Kaasinen et al. (2009).

Expectations and Prior Experiences: The expectation factor is discussed several time in the studies mentioned in Table 10. For instance Kaasinen, (2005b) elaborated that when users access mobile maps and cell based positioning the accuracy was especially important because it turned out

from the users feedback that the users had lot of expectations of the positioning accuracy of cell based positioning. Virpi Roto, (2006) explained expectation factor in her study findings into two steps: First when users access internet on their mobiles they open their favorite web sites. The need for accessing these sites is at least as big as on a desktop browser, so they found the utility high. Secondly it is understood that viewing the large pages on mobile phone is out of place, it does not mean that user's expectations are low. However the possible earlier failure experiences with WAP sites have made them expect failures with the full web as well. As on mobile devices users are able to achieve something which means that overall user experience is positive. This depicts that the importance of internal expectations for the system as an influencer to user experience. Kaasinen, (2005b) Lehtonen et al., (2006) C. A. Taylor, Anicello, et al., (2008) (Haumont, n.d.) Hinman et al., (2008) Peng et al., (2009)

Cultural Probe: For the development of society access to information is a major factor. Mobile Internet has the power to serve the purpose, especially in developing countries where PC penetration is low. While many issues mentioned in earlier chapters mostly apply on developing countries for instance (Brazil, India, and Pakistan etc). These developing countries have a strong usage of Opera Mini browser which reflects that people in these countries use internet on mobile devices as compare to PC due to different factors for instance missing infrastructure (power shortage). Among other factors that heavily affect MIUX author of this study found cultural factors are the most influential factors for success or failure of MIUX. The importance of this challenge is identified by different authors such as Nielsen & Fjuk, (2010) Ishii, (2004) V. Roto & Kaasinen, (2008). Culture plays a major role in how the MI based services are used. In some cultures, MI is the only source of using the internet because PC penetration is low. This introduces totally different requirements for mobile services than in cultures where mobile access is an alternative to desktop web access. For example in Japan the growth rate of PC internet is lower than MI. Compared to the high penetration rate of the mobile Internet, the rate of PC Internet use is relatively low, due to evolution from mobile phones and pagers (e.g., pager friends), rather than from PCs.

Utilitarian, non utilitarian, Emotions and Satisfaction in use: Hedonic, pragmatic, emotions and satisfaction in use are the factors that also acquired intention of group of authors mentioned in - Table. User satisfaction or satisfaction in use is also a key factor in MIUX but authors believe that it may come from other non utilitarian factors such as trust Virpi Roto, (2006) for instance Kaasinen, (2005b) quoted the experiences of production staff when defining the trust factor. The authors explain that when the same staff read the online newspaper regardless of agents imperfection it quickly gained the confidence of the users. Because of their intense involvement in the software design, the users felt strong ownership of the designed system. This contributed to the satisfaction of the users and the ease with which the users adapted to the agent. Another example is found in the Virpi Roto, (2006) article as mentioned in Table 10 in her effort to explain the MIUX; conducted interviews and asked users in what kind of situations they access internet on their mobile devices. The author found that people use MI to fulfill specific *needs* or when someone has some time to kill. The author discovered that user's goals are *utilitarian, hedonic* or mixture of these.

Emotions can be of two type i.e. negative emotions and positive emotions. These two types of emotions play a vital role for attaining the complete picture of UX Virpi Roto, (2006) I. Lee & Kim, (2005).

There are other different UX factors that affect the adoption of MI. These factors are extracted from the same studies mentioned in Table 10. These factors are as follow **Multimedia:** Music, Cameras, Games, MMS, **Hardware:** Poor H/W power, Small screen, Cognitive aspects of users, Affective aspects of users, **Internet services:** Location aware services, Mobile accessories.

After analyzing it is fairly evident from the Table 10 findings that MI is affected not only by the mobile service properties, wireless connections, various device types, browsers, proxies, and service discovery but also by other factors such as user emotions, expectations and prior experiences.

Another way to express the view point on MIUX is by defining the usage of internet on a mobile device and ways of accessing internet. As technology emerges the technology usage also appears in new manners like access of internet on mobile with WLAN. These changes in technology have the huge impact on every aspect of MIUX as well for instance in A. Kaikkonen, (2011) study “accessing Internet with WLAN has increased from 2007 to 2010 less than 1/3 of respondents in 2007 said the last time they accessed Internet on mobile, they used WLAN, in 2010, 45% of the respondents reported so. The difference is statistically significant ($p < 0.03$). In 2010, all respondents had mobile phone with WLAN capability in 2007 approximately 30% of respondents had WLAN equipped phones”. This thesis study topic can be explored through different aspects and one perspective is mentioned in Table 10. Another way to address the perspective of MIUX is through monitoring the activities performed on PC internet and MI. This approach is carried out by Anne Kaikkonen (2011) through adopting online survey and their study produced a fruitful results mentioned below.

Table 11: Comparison of the activities on computer and mobile phone in 2007 and 2010. (**) marked have statistically very significant change in mobile, and (*) have statistically significant differences. Grayed activities are more common Anne Kaikkonen (2011).

| | Mobile 2007 | Mobile 2010 | Computer 2007 | Computer 2010 |
|--|-------------|-------------|---------------|---------------|
| Searching info with search engines (**) | 38.80% | 57.90% | 42.40% | 53.30% |
| Reading news/weather/sports (**) | 40% | 56.60% | 39.70% | 34.80% |
| Reading email (**) | 38.50% | 57.10% | 41.20% | 51.70% |
| Writing emails (**) | 23.30% | 34.80% | 43.30% | 56.60% |
| Reading online discussion groups (**) | 23.30% | 35.80% | 38.80% | 54.60% |
| Participating online discussions(**) | 12.10% | 24.20% | 39.40% | 50.80% |
| Viewing pictures (**) | 33.90% | 50.40% | 43.90% | 53.80% |
| Sharing pictures (**) | 27,2% | 50.40% | 41.50% | 49.60% |
| Viewing videos | 18:5% | 35.40% | 44.80% | 57.90% |
| Downloading applications(**) | 32.70% | 55.80% | 44.20% | 49.20% |
| Downloading media content (*) | 21.80% | 36.30% | 39.40% | 45% |
| Playing games (**) | 24.80% | 40% | 33.60% | 37.90% |
| Listening to music(*) | 33.60% | 55% | 39.40% | 47.50% |
| Searching contact info(**) | 34.20% | 51.30% | 34.80% | 40.80% |
| Viewing maps/searching actions/routes(**) | 28.20% | 57.10% | 43.30% | 46.70% |
| On-line shopping (**) | 4.80% | 15.80% | 41.20% | 55.80% |
| Online travel eg.bookings or flight check in(**) | 5.50% | 15% | 36.40% | 50.40% |
| On-line auctions | 8.80% | 11.70% | 35.60% | 40.40% |
| Classified adverts(eg.cars property)(*) | 4.20% | 10.80% | 28.20% | 37.50% |

| | | | | |
|------------------------------|--------|--------|--------|--------|
| Business/financial info | 13.60% | 26.30% | 31.20% | 44.60% |
| Viewing "lifestyle" data(**) | 17.30% | 26.30% | 27.60% | 34.60% |

The above findings gave an idea about the success story of MI. It depicts that internet access on mobile phones has increased from 2007 to 2010. This study also depicts that activities in 2007 were mostly done by computers are done increasingly by mobile devices for instance online map and findings contact information which may shed light on Nielsen & Fjuk, (2010) prediction was correct to some extent i.e. MI is an extension of the personal computer (PC) based internet. There are not many studies that support this claim but the evidences demonstrated by Hinman et al., (2008) are plausible for instance in their research finding they mentioned that when users talked about accessing the Internet on their device, they would often use the language of the PC: browsing, email, etc. This argument can be explained by quoting an example of their research finding, when asked to users about MI and the reply was “They call it surfing for a reason, you know because it’s a flow. It’s like following a wave of information. If you can’t click on links, you can’t follow that wave and you can’t easily click on links on a mobile phone.” Another reply about using the internet on mobile phone was “E-mail was why I even signed up for Internet service on my phone. I thought it would be really convenient to check my email from anywhere. But then after I got the service I realized that it was really only practical to check email because it is just too difficult to type emails using the keypad. Plus it takes so long to download. It really isn’t worth the price.”

5.1 MIUX guidelines

In this thesis, I have exposed that MI as a system has many different components, which increase the complexity. This complexity makes this domain an interesting research area. In current stage of this domain it is not possible to make all these components work completely flawless to provide a positive UX. But adding a new knowledge to this domain through investigation of a complex system may help to see the potential building blocks of UX. Consequently author of this thesis utilized the Systematic literature review approach to provide a road map to the designers when they design for MIUX. The very first point in terms of design direction by author of this study is that it will be a valuable as a whole if MI is considered as a product and as an integral part of a system.

As I mentioned earlier that with the help of Systematic literature review author of this study found different ends of this domain such as there is no consensus on one standard definition of MIUX. In result there are many different interpretations of this domain which results the uncertainty as a whole. For instance some researchers shed light only on factors of MIUX, some focused on elements that affect MIUX and some of them put emphasis on aspects of MIUX.

To cope all these issues first of all author of this thesis collected all these different concepts of MIUX with the help of SLR in one umbrella which has never been done before. Table distinguished the findings of this study and can be seen as evidence. Then on the basis of these findings author have provided a list of factors for designers of MIUX as an initial guideline because these factors can be seen as a potential hurdles when designing for MIUX. Designers should not ignore this list and just design a perfect mobile browsing experience. The key to design an enjoyable product is a vision, vision of a perfect world. So the reason of pointing out the set of factors in this thesis was to help the designer to avoid the current problems. There is no doubt that ignoring the facts may lead to disastrous UX. A brief description on these factors is given below and detail on these factors can

be fetched from Chapter 5 and 4 under the heading **Error! Reference source not found. Error! Reference source not found.**

Factors like Context of use, Expectation and Prior Experiences, Adding Price awareness and user expectation factor may act as a catalyst for the whole process of MIUX if considered as it should be. With the help of these underline factors and the principles provided by Virpi Roto, (2006) in her study will make a huge difference when designing for MIUX. These principles deal with the same key UX factors that are mentioned in this thesis study and are given below.

USER: *“Access to the mobile optimized web and to the full web, Support the usage patterns familiar from a PC*

CONTEXT: *Provide the web in one hand (do not require two hands), Provide minimal attention user interface*

SYSTEM: *Provide a good web page visualization method for a small screen, Overcome the possible lack of full keyboard by smart software to support text input, Provide cost information and simple ways to cut the costs down, Minimize the response times for page downloads, Save battery power when it is getting empty”.*

Through in depth study it is uncovered that in this domain there are many stakeholders involved in the design process which affect the MIUX. So it is suggested that if one company takes the job or responsibility of designing for MIUX can help to solve the big issue. To support this claim author of this thesis highlighted the example of MI used in Japan. For instance DoCoMo NTT is the standalone company in Japan that handles all the components on the system side such as requirements for mobile devices, browsers, and provides the connection and gateways etc. The user obtains everything from DoCoMo for instance the device and the connection, and DoCoMo decides the pricing. Surfing on MI is a normal routine for Japanese people. This success depicts that DoCoMo has obviously succeeded in providing positive user experiences for mobile browsing Kenichi, (2004).

(Anne Kaikkonen & Roto, 2003) in their study they performed an analysis on the different WAP pages. In result they proposed guidelines for WAP applications design. There is no doubt that these guidelines belong to the WAP application but they are totally valuable and fit in our research domain. They are still valid and highly recommended for general MI design. Below is the list of issues on which authors provided guidelines that clearly are applicable also for our research area, detail can be fetched from the main source (Anne Kaikkonen & Roto, 2003) :

- Navigation is a necessary evil that is not a goal in itself and should be minimized
- Focus on user goals and needs
- Customize service
- Show current location at two different levels: Relative to the Web as a whole, and relative to the site’s structure
- Support search and multiple views”. Writing search keywords is laborious, so should we simplify and save screen space by leaving a search out?

6 CONCLUSION

From past 10 to 15 years the mobile industry has experienced a huge revolution. Smart devices have already captured the traditional wired telephone system. Mobile devices become the status symbol and play a vital role in people lives. Due to this change experts expect that the mobile industry will lead the future in every aspect of life. Nevertheless the success of this revolution is dependent in the hands of consumers. So it is essential for the vendors to take care of the needs of their target audience.

This thesis is based on one research query i.e. *to reveal the state of the art of MIUX in order to better understand the challenges and benefits of this area of research?* To achieve the answer for this question there were three sub questions that fulfill the requirement of main query. To address the main research query author of this thesis performed a SLR. The presented work add contribution in a sense as to the best of our knowledge no systematic review effort has been done in this area with specifically focuses on highlighting the concepts and challenges in the form of factors. First of all there is no consensus on one standard definition of MIUX; results in different interpretation of this study topic which confused the general reader/users. During this thesis study, different definitions, terminologies, factors and concepts of UX are identified. The identification of these different terminologies and concepts of UX are considered as another contribution of this thesis study. This contribution has summed up all the possible and important factors, concepts and terminologies (See chapter 4), presented by different authors in literature. This SLR approach is considered as one of the major contribution of this thesis study. Identification, collection and presenting the evidences in a descriptive way will facilitate the practitioners, researchers and students. It will provide them a platform and made it easy for the readers to pick up the particular MIUX concept of their interest and extract the information accordingly. The findings of the analysis of the identified factors, terminologies and concepts of UX are provided in the Chapter 5. Brief descriptions on RQs are given below.

RQ 1 What views of MIUX are reported in the literature?

In this thesis one aspect was to explore the different views of UX in terms of mobile internet. So through this thesis study author found some essential result. In literature two main views on MIUX were presented in chapter 5. Both the concepts are complementary. However, the paper by Nielsen & Fjuk, (2010) Hinman et al., (2008) provides another research approach that analyzes MIUX by describing the details of a PC Internet deprivation study used to gather information on Mobile Internet needs and actual usage of MI. This comparison of theories also explains the **RQ1** of this thesis study.

RQ 2 What concepts of MIUX are reported in the literature?

This detailed literature study revealed that MIUX as a concept is categorized in different concepts for instance aspects, elements and factors by different researchers. In academia (literature), different definitions and terminologies are present for MIUX but still no consensus is found on one single definition of MIUX. Somehow these definitions address similar aspects, elements and factors of MIUX but these different interpretations of MIUX may confuse the general users. The 25 primary studies were distributed among the MIUX concept; Aspects, Elements and Factors. This categorization of literature provides the author an opportunity to elaborate and shed light on these three different concepts. It portrayed a holistic picture of this thesis topic that helps to

accommodate the reader of this thesis to get the clear picture of MIUX. This categorization also provides the opportunity to address the **RQ2** of this thesis study. A brief description on this categorization is given below.

ASPECTS: Aspects of MIUX were discussed in 16 papers out of 25. It includes understanding the users and usage of MI, improving devices hardware and software, improving infrastructure. The research trend is more towards on understanding how users are challenged by screen size, input facilities, usability of services, and data traffic costs. There is a limited academic literature on actual MI usage but through studies like C. A. Taylor, Anicello, et al., (2008) Kenichi, (2004) Nielsen & Fjuk, (2010) Hinman et al., (2008) author of this study find that the MI usage umbrella include different aspects that affect MIUX for instance MI service usage, service discovery, cost confusion etc. A number of articles on these identified challenges can be found in above Table.

ELEMENTS: Elements of MIUX were discussed in 11 papers out of 25. It includes user internal state, context of use and the system being used in our case mobile Hassenzahl & Tractinsky (2006). The comprehensive work on these elements was carried out by Hassenzahl & Tractinsky (2006) they explained the user's internal state in terms of different attributes such as predispositions, motivation, mood, expectations, needs, etc. On the other hand, complexity, functionality, purpose, usability, etc can be considered as examples of the characteristics of the designed system. They explained the context of use as the social/organizational settings, voluntariness of use and meaningfulness of the activities, etc. At the end, this all point out towards countless design and experience opportunities.

FACTORS: Factors affecting MIUX were discussed in 14 papers out of 25. In literature, different UX factors such as multimedia and aesthetics are identified by different authors that may influence the adoption of MI. But the main categorization of factors was done by Law, Vermeeren, Hassenzahl, & Eds, n.d.(2007) in their work. They divided the factors into two aspects i.e. hedonic and pragmatic. Hedonic aspect usually refers to the accomplishment of be-goals of any product or service. Pragmatic aspect is the ability of any product or service to perform do-goal.

RQ 3 How own created design directions and solutions can help to improve MIUX?

From the findings of **RQ1, RQ2** and aforementioned outcomes it was analyzed that different authors have presented different interpretations of MIUX in literature. It was also noticed that every author in literature was focusing on some of the factors of MIUX but there is a limited academic literature on actual MI usage which was not sufficient to understand the MIUX at broad spectrum. So author of this thesis proposed some guidelines. The main objective of these guidelines is to accommodate the designer with the holistic vision when they design for MI. These guidelines and direction does not provide the extensive list but an initial road map when targeting at a good MIUX.

The main question in terms of MIUX will be “What does the user want to do with the mobile internet?” This will be difficult to answer but open new possibilities with the passage of time.

7 REFERENCES

- Afzal, W., Torkar, R., & Feldt, R. (2009). A systematic review of search-based testing for non-functional system properties. *Information and Software Technology*, 51(6), 957-976. Elsevier B.V. doi:10.1016/j.infsof.2008.12.005
- Bamford, W., Coulton, P., & Edwards, R. (2007). Space-Time Travel Blogging Using a Mobile Phone. *Design*, 1-8.
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications, Inc.
- Cui, Y., & Roto, V. (2008). How people use the web on mobile devices (pp. 905-914). ACM.
- Hassenzahl, M., & Tractinsky, N. (2006). User experience - a research agenda. *Behaviour & Information Technology*, 25(2), 91-97. doi:10.1080/01449290500330331
- Haumont, S. (n.d.). dotMobi , a Key Enabler for the Mobile Internet.
- Hinman, R., Spasojevic, M., & Isomursu, P. (2008). They call it surfing for a reason: identifying mobile internet needs through pc internet deprivation (pp. 2195-2208). ACM.
- Ishii, K. (2004). Internet use via mobile phone in Japan. *Telecommunications Policy*, 28(1), 43-58. doi:10.1016/j.telpol.2003.07.001
- Kaasinen, E. (2005a). *User acceptance of mobile services: Value, ease of use, trust and ease of adoption*. Citeseer.
- Kaasinen, E. (2005b). User acceptance of location-aware mobile guides based on seven field studies. *Behaviour & Information Technology*, 24(1), 37-49. doi:10.1080/01449290512331319049
- Kaasinen, E. (2009). User acceptance of mobile services. *International Journal of Mobile Human Computer Interaction (IJMHCI)*, 1(1), 79-97.
- Kaasinen, E., Roto, V., Roloff, K., Väänänen-Vainio-Mattila, K., & Vainio, T. (2009). User experience of mobile internet: analysis and recommendations. *International Journal of Mobile Human Computer Interaction (IJMHCI)*, 1(4), 4-23. Retrieved from <http://www.igi-global.com/article/user-experience-mobile-internet/37458>
- Kaikkonen, A. (2008). Full or tailored mobile web-where and how do people browse on their mobiles? (p. 28). Retrieved from <http://dl.acm.org/citation.cfm?id=1506307>
- Kaikkonen, A. (2011). Mobile internet, internet on mobiles or just internet you access with variety of devices? (pp. 173-176). ACM.
- Kaikkonen, Anne. (2008). Full or Tailored Mobile Web- Where and How do People Browse on Their Mobiles ? *Human Factors*, 2008, 10-12.
- Kaikkonen, Anne, & Roto, V. (2003). Navigating in a mobile XHTML application. *Proceedings of the conference on Human factors in computing systems - CHI '03*, 329. New York, New York, USA: ACM Press. doi:10.1145/642667.642669
- Kenichi, I. (2004). Internet use via mobile phone in Japan. *Telecommunications Policy*, 28(1), 43-58. doi:10.1016/j.telpol.2003.07.001
- Kim, H., Kim, J., Lee, Y., Chae, M., & Choi, Y. (2002). An Empirical Study of the Use Contexts and Usability Problems in Mobile Internet. *Sciences-New York*, 00(c), 1-10.
- Kitchenham, B. (2004). Procedures for performing systematic reviews. *Keele, UK, Keele University*, 33.
- Kitchenham, B., & Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. *Engineering*, 2(EBSE 2007-001).
- Law, E., Vermeeren, A., Hassenzahl, M., & Eds, M. B. (n.d.). Towards a UX Manifesto COST294-MAUSE affiliated workshop. *Structure*, (September 2007).
- Lee, I., & Kim, J. (2005). Use contexts for the mobile internet: a longitudinal study monitoring actual use of mobile internet services. *International Journal of Human-Computer Interaction*, 18(3), 269-292.

- Lehtonen, T., Benamar, S., Laamanen, V., Luoma, I., Ruotsalainen, O., Salonen, J., & Mikkonen, P. T. (2006). Towards user-friendly mobile browsing (p. 6). ACM.
- Nielsen, P., & Fjuk, A. (2010). The Reality beyond the Hype: Mobile Internet is Primarily an Extension of PC-Based Internet. *The Information Society*, 26(5), 375-382.
- Peng, H., Song, H., Zhang, Z., Chen, Y., Zou, X., & Xiao, L. (2009). A Study on User Experience of Online Games (Vol. 1, pp. 185-189). Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5319083
- Petersen, K., Feldt, R., Mujtaba, S., & Mattsson, M. (2008). Systematic mapping studies in software engineering (pp. 71-80).
- Roto, V. (2006). *Web browsing on mobile phones: Characteristics of user experience*. Citeseer.
- Roto, V., & Kaasinen, E. (2008). The second international workshop on mobile internet user experience (pp. 571-573). ACM.
- Roto, Virpi. (2006). *WEB BROWSING ON MOBILE PHONES - CHARACTERISTICS OF USER EXPERIENCE* Doctoral Dissertation. *Technology*.
- Su, H. (2010). Mobile Internet Experience Research Based on TAM (pp. 1-4). IEEE.
- Taylor, C. A., Anicello, O., Somohano, S., Samuels, N., Whitaker, L., & Ramey, J. A. (2008). A framework for understanding mobile internet motivations and behaviors. ACM. Retrieved from <http://dl.acm.org/citation.cfm?id=1358744>
- Taylor, C. a., Anicello, O., Somohano, S., Samuels, N., Whitaker, L., & Ramey, J. a. (2008). A framework for understanding mobile internet motivations and behaviors. *Proceeding of the twenty-sixth annual CHI conference extended abstracts on Human factors in computing systems - CHI '08*, 2679. New York, New York, USA: ACM Press. doi:10.1145/1358628.1358744
- Wäljas, M., Segerståhl, K., Väänänen-Vainio-Mattila, K., & Oinas-Kukkonen, H. (2010). Cross-platform service user experience: a field study and an initial framework (pp. 219-228). ACM.
- Yao, J., Kanhere, S. S., & Hassan, M. (n.d.). Mobile Broadband Performance Measured from High-Speed Regional Trains.
- Zhou, D., Chander, A., & Inamura, H. (2010). Optimizing user interaction for web-based mobile tasks (pp. 68-76). IEEE.