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Cost justifying usability a case-study at Ericsson

Parisa Yousefi
Pegah Yousefi

School of Computing
Blekinge Institute of Technology
SE 371 39 Karlskrona
Sweden

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Contact Information:

Author(s):

Parisa Yousefi

Address: Näktergalsvagen 5,
Rödeby, 371 30

E-mail: Parisa.Yousefi@ericsson.com

Pegah Yousefi

Address: Drottninggatan 36,
Karlskrona, 371 37

E-mail: Pegah.Yousefi@ericsson.com

External advisor(s):

Helen Sjelvgren

Ericsson

Address: Ölandsgatan 6
Karlskrona, 371 23

Phone: +46 10 7158732

University advisor(s):

Dr Kari Rönkkö, Ph.D

Jeff Winter Licentiate

School of Computing
Blekinge Institute of Technology
SE – 371 39 Karlskrona
Sweden

Internet : www.bth.se/com
Phone : +46 455 38 50 00
Fax : +46 455 38 50 57

Abstract

Usability in Human-computer Interaction and user-centered design is indeed a key factor, in success of any software products. However, software industries, in particular the attitude of revenue management, express a need of a economic and academic case, for justification of usability discipline.

In this study we investigate the level of usability and usability issues and the gaps concerning usability activities and the potential users, in a part of charging system products in Ericsson. Also we try identifying the cost-benefit factors, usability brings to this project, in order to attempt 'justifying the cost of usability for this particular product'.

In this exploratory research, a number of article sources such as Compendex, Inspec, IEEE Xplore, ACM Digital Library are used. Studies are then selected after reading titles, abstracts and keywords, then chosen if relevant to the subject, and the next article was searched iteratively, based on the previous presented keywords. A flexible research design approach was applied as the main research methodology.

A usability test was performed on the specific GUI, in order to detect the potential problems; which might have passed the usability checkpoints in the development cycle. A recommendation list was then produced for possible improvements in product and processes used.

As conclusions, tangible and non tangible values of usability tasks are highlighted. We also conclude that performing usability activities bring enormous values and save so much of overhead costs in our product. Another conclusion is that in order to secure all usability and user demands we need to involve them more in early GUI design, get more feedback and perhaps perform more detailed usability tests.

Keywords: *cost justification, usability, usability test, cost benefit models*

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Parisa Yousefi, Pegah Yousefi
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Section1- Overview

1 INTRODUCTION

In this globalized age where the boundaries are nullified, software technology is considered as one of the most dominant and growing industries. Today, software is practically everywhere; from iPod as a simple entertainment instrument to more vital tools such as an artificial heart for human survival. New and complex software applications were introduced by the birth of third generation computer hardware during 1960s which imposed enormous challenges to software development. The complexity under the constant and rapid changes of society, the complex nature of software technology, understanding human nature, social and cooperative aspects throughout the process of setting up large software applications are good examples of challenges posed to both industry and research [60].

This evolution resulted in software systems of much greater scale and complexity that eventually led to failures such as time and cost overruns, ineffective and unreliable software products as well as late delivery. As more such complex products in terms of features and functionality are used in our daily lives, the demands for user-oriented systems that are capable of satisfying expectation of a varied and wide range of user communities , has also increased. This has led to realization of the usability's important role as one of the main competitive parameters in the raise of value added to the services and products in software industry [8].

Usability is tightly related with User Centered Design (UCD) and Human-Computer Interaction (HCI). The concept of UCD was introduced during 80s in University of California San Diego (UCSD) [75].”*UCD is a broad term to describe design processes in which the end-user influences how a design takes shape*” [25].UCD focuses on developing products which answer the needs of user. The field Human-computer Interaction (HCI) however, focuses on computer and software designs. HCI contains many disciplines but its main concern is computers. System design is a vital part of the design process and HCI involves the design, implementation and evaluation of interactive systems [28].

Companies and organizations can be forced to pay high costs when employees choose or are told to use a poor usability and user unfriendly product. Once frustrated users leave; the enterprises lose money and credibility [61][29]. Products that are more difficult to use, incur high costs of support for enterprises which can result on spending huge amount of money on rework [117].These impacts can be utterly avoided or mitigated, by utilizing a process focusing on usability engineering and UCD techniques concurrent with product development. UCD regimen adjoins series of techniques that help development teams deduce, accumulate, apprise and evaluate target user's aspects, characteristic, goals, motives and inspirations; in their work flow. The above is achieved by tasks such as [28] [26]:

- Observing people while performing activities and tasks that the special product is offering and wants to aid, accelerate, expedite, innovate or automate.
- Determining people's abilities, attitudes, intentions, annoyances and accomplishments as they use and interact with different systems.

- Creating designs which reinforce aid and expedite or automates, while having the intended user's abilities, skills, goals, aims and so on.
- Analysing and testing these designs by letting a group of intended users, carry out activities provided by the product.
- If necessary revising the design, based upon the outcomes from testing.

The definition of HCI according to ACM SIGCHI curricula for human-computer interactions is (Last updated in June 2004) "*A discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them*" [59]. Here interfaces are prolonged and ideally motivating interactions between human actors and their artifacts [63]. Perhaps the link between UCD and HCI can be defined by a field called usability [8]. Different definitions and explanations of usability, mostly connect the dots between user and designs [75]. According to international standard ISO 9126, usability is defined as one of main attributes of the product quality [8].

Production of usable, safe and functional systems are main objectives of HCI, These goals can be summarized as to "develop or improve the safety, utility, effectiveness, efficiency, and usability of the systems that include computers" [35]. The other purpose of HCI, by introducing usability, is boosting and improving the work or leisure environments, safety and efficiency [103]. Efficiency and effectiveness and usability are the key factors when talking about HCI, a successful product must be self evident, not too complicated nor too simple and shallow; When referring to usability, it is very essential to strive and **comprehend** the factors of human relation with the system and environment such as ergonomic, psychological, social and organizational factors. It is to **develop** techniques and models as well as checkpoints to ensure that the design of the systems are satisfying the demands of users, in order to **accomplish** the HCI goals mentioned before (safety, effectiveness, efficiency, usability of the system) [82][97].

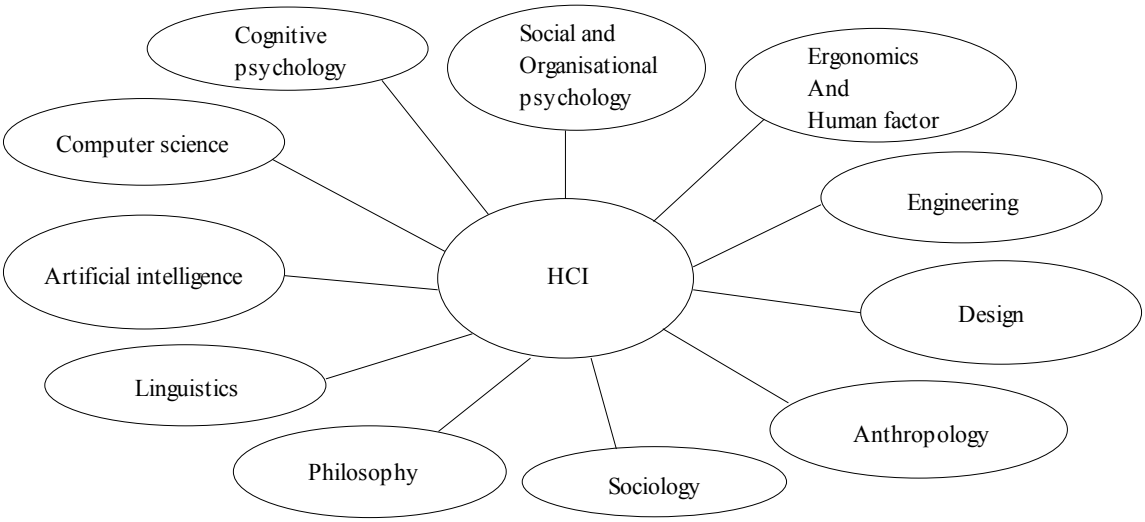

Figure 1: The disciplines that contributes to HCI [82]

As technology grows and matures over time, to keep abreast and acquainted transformation and changes, which technologies suggests, is very essential in order to fulfill the goals of HCI and usability; As the term usability is quite dependent on the

context which it will be used in and is subject to change over time [11].

1.1 Background

The benefits of better usability are not always well-identified nor calculated [84]. Even though market forces drive designers towards the creation of systems that are increasingly easy to use, management's concern and awareness is concentrated on time, money and resources allocated to the projects [58]. As a result of changes in the focus from long-terms achievements to near-term deliverable and profits, the usability of many applications is poorly designed and practiced [50]. Also, timing aspects of design and production of product forces the market towards more competitive edge, meaning that the focus is to provide the market with new and improved technology oriented products and neglecting the needs of end-users [121]. Another issue to consider is that it is not always easy to identify and characterize the complexity of the potential target group and there is risk of excluding the right end-user category.

The challenges mentioned above highlight the significant role of usability evaluation in mass market such as telecommunication which is characterized by fierce competition. According to Dix et al. usability evaluation helps to “assess our designs and test our systems to ensure that they actually behave as we expect and meet the requirements of the users” [3]. Usability testing has become a vital part of the software development life-cycle. There are numerous number of usability testing objectives among which we can point out some, such as; increase in performance, efficiency, user satisfaction and assurance of learn-ability [51].

Despite the fact that many organizations have started to take usability more seriously the average computer system designers and developers have not yet completely endorsed this new perspective. Introducing usability activities throughout all the stages of product development life cycle has been a challenge since the appearance of such activities almost fifty years ago [84]. Assessment and improvement of usability can be systematically approached using usability engineering disciplines. Usability engineering is ”a process through which usability characteristics are specified, quantitative and qualitative values in the development process are measured throughout the process” [120]. Cost Justifying Usability, is the science of justifying the values and cost of efforts made to improve usability in the context of overall product life cycle [8].

Two of many potential benefits of usability that can be highlighted are higher productivity and end-user satisfaction [85]. Usability engineering claims to be a feasible approach in order to improve usability of human-interaction interfaces by defining the usability level in advance and ensuring the achievement of that level thereafter. In other words, it is ”a process through which usability characteristics are specified, quantitatively and early in the development process, and measured throughout the process” [48]. To calculate the cost and estimate the benefits of usability engineering life cycle, usability engineering can be employed as a structured process. Good usability practices can lead to reduced training and support cost, increase in productivity, higher customer satisfaction and loyalty, more positive brand image in today's market and last but not least higher profitably [78].

Although there exist quite a considerable number of guidelines in order to maximize usability, the level of usability in software products has not yet reached to its highest level of maturity. This has been proven in both new and modified products which suffer from poorly planned usability and as a consequence of this, reduction in profitability or even

total failure of the products in today's competitive market. Human variability is among many obstacles on the road towards usability maximization, that points to huge and diverse range of physical and mental characteristics of human beings [108]. Another reason that usability is not yet reached its maturity in the industry, could be that the cost and benefit gained due to increased usability is not visible to the management [84]. Unfortunately usability activities are perceived as time consuming and costly. “Usability engineering has been competing for resources against other project groups who do have objective cost-benefit data available for management review” [3].

Investing on usability engineering producing the software and marketing it, throughout the software life-cycle, results in better profitability and higher Return on Investment (ROI) [8]. One can define usability ROI as ”the model for usability that quantifies the value of every dollar invested in up front usability efforts over the lifetime of a design, this is based on the idea that the cost of redesign increases the later in the development cycle and that structured usability efforts help to detect the problems earlier when they are cheaper to fix” [8].

Investigating in usability areas in order to make the best business decisions in software design requires a major review and understanding of existing models and literature. Lack of economic arguments, models and measures for introducing usability in any specific situation such as the development of telecommunication systems at Ericsson can make the argument for usability seem weak. However there are many different principles which can make the argument that usability plays a crucial role in the success of the software stronger. Arguments such as Return on Investment (ROI) and different cost-benefit models (CBM) can be in favor of making usability engineering justified in software development processes.

It is well known that Cost Justifying Usability (CJU) can demonstrate how money can be saved whilst products and services are improved, still CJU has not found its way out in industry and it has not taken the position it deserves [8]. The focus of this thesis is justifying usability activities for Ericsson in Karlskrona, to emphasize the advantages of usability and the values added by it to the business. The study is performed by a case-study that has been carried out on the Rating Management Application (RMA) graphical user interface made by Ericsson Rating Engine (ERE) group. The contribution of this study is to identify the product's weaknesses and strengths regarding usability and justification of the cost, bear upon by usability activities and the cost it opposes by lack of it, in the industry. The contribution of this thesis to academy is to firstly provide examples of successful cost justifying usability for industrial cases. Secondly based on industrial case provide better understanding of what mechanisms and factors competes with or hinders cost justifying usability efforts. By this industrial case study we provide example and explanation of why, together guidelines for improvements.

The thesis is partly conducted on the basis of secondary research which involves collection analysis, synthesize of information through review of existing research. The review is carried at the basis of the articles published in journals, conferences and books. The motivation behind the selection of resources is dependent on the fact that the methods discussed in these collections of literature help in further identification of the means and tools that can improve usability in human-computer interaction services and products. Furthermore, a case-study was performed on the ground of findings from the previous stage in order to suggest adequate and applicable improvements for the current situation at

Ericsson, and the lack of justification for usability in terms of costs therefore dis-acknowledgment of the usability tasks and in contrast its importance is demonstrated. The thesis is presented as a result of an exploratory study in the context of cost justifying usability and a series of usability testing workshops with internal end-users in Ericsson.

As usability activities find their ways into software development at Ericsson, which is the fifth largest software company in the world [105], there is a need to tackle the problem of integrating usability activities with design and production processes to put the result of performed usability practices to good use [123]. Considering that, our customers are forced to operational changes in order to meet the competition from new operators, our systems and products must evolve to support the new market situation. These customers (operators) need a flexible and powerful system so they can keep ahead of the market. On the other hand, to keep the business running Ericsson also needs to attract new operators. These operators demand a running system with no downtime and easy to use and maintain by inexperienced personnel. This new business market, poses new usability requirements on the user interface of the system. The services and functionality offered to the user are influenced by the presentation of it to the user. An average of 48% of the code in software development has been devoted to user interfaces during recent years. Therefore it would be reasonable to allocate effort in this field [95].

There are several projects ongoing at Ericsson in order to verify that users can actually perform the tasks as easily and as efficiently as it is stated in the requirements. The Delta method is an approach that is used and supports usability activities in a number of projects at Ericsson corporation [74]. Also there have been several workshops and User Interface (UI) reviews performed for better improvement of the issues regarding the usability.

The first part of the thesis is the literature review and is presented in chapter 3, 4 and 5, the review focuses on understanding of cost justifying and its history and definition of the terms related to this subject; also different Cost-Benefit Models and Return on Investment has been explained. In chapter 6 problem definition is presented and the data is collected by performing many interviews and a usability test. We continued the study with discussions, results and analysis of the data, in the last section the conclusion is presented and the research questions are answered.

1.2 Research questions

As written in the introduction, performing usability activities during development can be neglected or sacrificed over functionality or time constraints or due to cost issues [8]. Lack of demonstrating cost justifying usability in industrial organizations and software developing companies, by any means, is the reason to see such activities as insignificant. Therefore it is vital to justify the cost of usability or lack of it, and emphasize the effects brought by the presence or absence of usability to the software products. Illustrating Return on Investments, Cost Benefit Models and the profitability values brought by usability tasks, can contribute to increased understanding of the challenge. The following research questions have been addressed in order to meet the defined aims and objectives of this research:

1. To what extent is usability and CJU implemented in the industrial case?
2. What factors have influenced the extent of implemented usability and CJU in this case-study?
3. What guidelines are needed to remedy identified shortcomings and contribute to improvements of usability and CJU in the studied case?

1.3 Research methodology

There exist many different forms of research, among which exploratory research has been employed to capture the complexity and richness of cost justifying usability during the course of research in this thesis. The genre of exploratory research allows the researchers to gain information and insight of vague problems [8].

This study is exploratory. First a literature review was conducted focusing on cost justifying usability. Thereafter a flexible research design approach was employed as the main research approach of the real world research part at Ericsson, a case study was applied as the research methodology.

1.4 Expected Outcomes

This research provides general guidelines that facilitate the usability practitioners, future researchers even students interested in overall cost justifying usability issues. The result of this exploratory research can be used in order to give a significant insight into the current situation of cost justifying usability application in industry.

The main focus in this study is, to justify the cost of usability and to explain the disadvantages and detriment due the lack of such activities in concern with current status of usability activities. This is done by studying the Account Information Refill (AIR) User Interface (UI), that is a Refill Management Account (RMA) based GUI and used in Charging System (CS) product, which serves as industrial example of application to which usability and CJU can be applied. Emphasizing the effects of inadequate and insufficient usability activities in tangible and intangible revenue of Charging System product. Providing an overview on impressions of internal users, which leads to extract recommendations for improvements of usability for this particular GUI can be contemplated.

1.5 Aims and Objectives

The aims and objectives of this thesis are :

- Presenting an insight into the usability activities and cost justifying usability applied in the industry.
- Measuring the level of usability, usability awareness and cost justification of it in the industry, by taking Ericsson as a case study.
- Presenting advantages and disadvantages brought to the product by usability and cost justifying usability.
- Providing an overview of end user's impressions about a particular product at Ericsson.
- Presenting recommendations to improve usability and cost justifying usability for a specific product at Ericsson and also generalization of these recommendations into some extent for other companies with such nature and issues.

Section2- Research Methodology

2 THE RESEARCH METHODOLOGY

This chapter gives a description of the research methodology used in this study. We have performed a case study in which the main influence comes from theoretical sampling to set up the case study, and as a part of the case study we conducted a usability test to collect the data about how the GUI is used in actual customer site and how can it be improved.

2.1 An overview of Research Methodology

This thesis follows a mixed research methodology approach of both quantitative and qualitative methods. The purpose of the study is fulfilled in various phases. At the initial step, we thoroughly reviewed the literature regarding different topics such as HCI, usability, usability testing, cost justifying usability also case study and exploratory research approach, these keywords helped us in choosing the next interesting topics we could use including, cost benefit models, Return on Investment, etc. After in depth study, the usability testing use cases and questionnaire were designed. Using these, a workshop was held with end-users at Ericsson premises. Among many different methods available, case study was chosen as the main method to achieve the goals of this thesis and draw conclusions.

2.2 Literature Review

In the primary phase of this study, a detailed review in the context of usability has been performed. The relevant published materials such as different literature, conference proceedings and journals were studied. We used different database search engines to search for needed materials. Among which we can point out to Electronic Library Information Navigator (ELIN), Google and Google Scholar.

2.3 Case Study

A case study is an ideal research methodology when a holistic and in-depth investigation of a single individual, group or event is needed [80]. Basically it is a technique for answering who, why and how questions by examination of a single instance or event. According to Yin a case study is defined as ”an empirical inquiry that investigates a contemporary phenomenon within its real-life context, specially when the boundaries between the phenomenon and the context are not clearly evident” [124]. Case study as a well-established strategy can be based on a mix of both quantitative and qualitative methods.

For many years, researchers have used case studies in variety of science, particularity social science, as both a research and a teaching vehicle. Many well-known case study researchers such as Yin, Stake and Feagin, have suggested techniques and methods to organize and conduct this research strategy in a successful way. The need for case study has a basis on investigation of complex phenomenon within its real-life context.

There exist three different types of case study research; exploratory, descriptive and

explanatory. He also differentiates between single and multiple case studies [124]. Stake, 1995, categorizes case studies as intrinsic, instrumental or collective [6]. The choice among theses categories depends upon the goal /objectives of the investigation, the degree to which the investigator has control over the subject of phenomenon [124]. A case can be interpreted different, Yin suggests that the term case refers to ”an event, an entity, an individual or event a unit of analysis” [69]. While Colin Robson in his book ”Real World research” refers to case as a wide range of study of individuals, a community, a social group and organization or study of an event roles and relationships [92].

A case study focuses on a detailed contextual investigation of a phenomenon with the main concern of leading from particular cases into generalizable results [92]. There are several criticism on the case studies. Bent Flyvbjerg examines the following five common misunderstanding about case-study research; (a) the value of theoretical knowledge is more than practical knowledge (b) the study of particular case can offer no ground for establishing the generality of findings (c) case-study research is more suitable for generating hypothesis, not building theory (d) the case-study has a bias towards verification,(e) it is most often difficult to generalize and summarize on the ground of specific case studies [40]. All these critiques can be addressed by carefully planning and designing the case-studies. The characteristics of a good case study are [92]:

1) All data about the case is gathered in a result from a combination of methods.
2) The data is organized on the basis of assumptions and characteristics that highlights the purpose of the research.
3) The case should be chosen so it can properly formulate a practice or a problem.
4) A case study narrative is developed in detail and readable format that can integrate and summarize key information around the case study.
5) The analysis phase can be performed in different layers.
6) A report could be written by participants that allows them to be engaged in this process further.

We started by gathering information and data using interviews, surveys and personal understanding of the system. As experienced system developers, we realized that the subject of usability in the product we work with is not taken very seriously; all these data was collected with the help of our colleagues and experienced users of this particular product (1st characteristic of a good case study). The next stage based on assumptions and characteristics, our preliminary research questions with a broader scope also formulating our problem definition was derived (2nd and 3rd characteristics). Further we performed a usability test, developing our case studies from experience and after conducting the usability test, we carefully analyzed and summarized the collected data (4th and 5th characteristics). We also reported our findings as a presentation to usability team and the management group at Ericsson. In chapter 8 of this report you will find more detailed information about the case study and the usability test performed at Ericsson.

Yin defines the process of design of a case study as relating the data collected to the research questions and also it should indicate the data that should be gathered and thereby analyzed. He also presented five conditions as important component of a case study design: first, the type of question posed, in terms of ”who”, ”what”, ”why”, ”how” and ”where”. Second, the extent to which the investigator has control over the events or entities. Third, defining the case in a proper manner so it can cover the unit of analysis posed by questions. Fourth, the data gathered should be connected to the proposition and

finally, the scope and criteria by which the success of the study can be judged [124].

During this thesis,we have have studied how the usability testing is performed, then described another practice for usability which fills the gap between just usability evaluation and actual usability testing. In the next step we performed the designed usability test with involvement of designers, testers and internal end-users. The participants, helped us arrive to valuable points which has been missed during the life time of AIR(RMA) GUI. Further, we evaluated the test results and came to conclusions that helps to improve the usability, as the next and final step in our thesis using exploratory research and literature review we justified the costs of usability activities in this particular product.

Yin states that ”regardless of the type of case study, investigators must exercise great care in designing and doing case studies to overcome the traditional criticism of the method.” [49]. There are differences between high and low quality case study research. Yin represents four criteria that have been used for establishing the quality of empirical research strategies, that are related to case studies. These four criteria are divided to construct validity, internal validity , external validity and reliability.

The 'construct validity' criterion deals with correctness of operational measures and weather these measures and observations cover the concepts under study [49]. There are three main strategies to improve the construct validity factor: using multiple sources of evidence, establishing chain of evidence and review of the report by key informants. In this study we have used triangulation or many different sources of information. During this course of study we have collected many types of data from different sources employing different method and techniques; observations, meetings and interviews with usability staff and studies of existing documents and models. The chain of evidence factor in this study is ensured by providing a detailed outline of the research, where an external reader can follow the evidence from initial research questions to the ultimate results. Finally the participants were asked to review the report to ensure the correctness of information. Furthermore, by discussions and constant involvement of the usability team at Ericsson, we have allowed frequent review and checking of the report.

The 'internal validity' criterion deals with validity of the casual relationship between independent and dependent variables or events. Yin defines three strategies to improve the internal validity as: pattern matching, explanation building and time-series analysis [49].To assure the ”pattern matching ” the patterns from empirical data are compared with the patterns from theory in chapter 9. In this study the strategy of the case study is a mix of exploratory and explanatory. We began initially by exploration of the nature of usability in this particular organization and looked for the patterns in data and came up with usability test to measure the usability. The fact that this study has based on questions such as ”how” and ”why”, is a strong proof that we have followed the case study approach.. The data is collected and analyzed both quantitatively and qualitatively.

The 'external validity' criterion basically deals with generalization of the findings from the study beyond the studied case. It has been always argued that for generalization there is a need for larger number of case studies and a single study is considered as a poor basis for generalization. Yin identifies use of replication logic in multiple case studies as a strategy to improve the external validity [49]. Since this thesis is based on a study in one company and has limited context, we hardly can assure the external validity of the

study. However, we can say that we have created a theory from this study which suggests that much of findings in this study can also be found in a similar context. It is possible to consider the applicability of these findings in a wider context as a future work of this study.

The last criterion is 'reliability' which deals with the quality of reported data, whereby it guarantees if another investigator, performs the same case study by following exactly the same procedures, he/she should arrive exactly to the same findings and conclusions. The are two factors to guarantee reliability: use case study protocol and development of use case study database [49]. The procedure followed in this study such as data collection, usability tasks, questionnaire, data analysis are all recorded and maintained in a case study database. This should assure that the study can be replicated in the same context.

The study performed in this thesis is a single case study since the testing has been performed within the context of Ericsson. The purpose of performing this case study was to generate theory. A good way for testing this theory is to extend the study by performing similar study in other organizations. The biggest threat in this study is the scale of the study. The fact that test was performed on only ten participants make it hard to draw any general conclusions from the result. However it is possible to verify the results by performing more studies in Ericsson. Despite the small scale of the study in this thesis, it gives a foundation for more deep and broad studies, and will allow us following up the results from this study as future work.

2.4 Exploratory Research

Exploratory research is a methodological approach used in precise formulation of problems or issues where there exist few or no deep studies to refer to as the basis [102]. Exploratory research begins with a vague impression of the project in hand and proceeds gradually to higher levels of precision. The focus on conducting such a research is to gain insights and familiarity of the subject of study. In absence of definite models, exploratory research begins with a holistic look at the subject under study and approaches towards clarification of the essence of the problem, through subsequent researches with no expectations in providing conclusive results. Stebbins, develops an expression 'concatenated exploration' [102] to emphasize that exploration describes the overall nature of data collection; not only at the beginning but also to a significant degree throughout the whole process of research. He defines concatenated exploration as "a research process and the resulting set of field studies that are linked together, as it were, in a chain leading, to cumulative ground or inductively generated theory" [102].

Glaser and Strauss state that exploration can be qualitative or quantitative [102]. Many researchers seem to employ a combination of these two methods, with the qualitative method as the primary study and quantitative as the secondary study. As the study continues, quantitative and qualitative data may grow in portion and importance. Accordingly, exploratory research comprises both types of data whatever the ratio and significance in a level of the study or in the entire process itself. Exploratory research often relies on secondary research also known as desk research which involves in gathering and collection from existing researches. Among which in-depth interviews, literature overview, case studies, focus groups and observations can be pointed out. The primary concern in exploratory research is to discover and build theory from data in a process of continuous discovery [55]. The main data in this study is collected in a qualitative manner although we have used the quantitative approach in the case study

performed in Ericsson (Section 4). Both type of data gathered in this thesis has been analysed in their own fashion to provide one another circular feedback which can lead to the theory.

Webb, lists a number of attractive benefits and features of exploratory research. As the main benefit, exploratory research uncovers the boundaries of the environment where the problems, threats or the interests most likely reside; and tries to reveal the 'silent variables' relevance to the research study. Other benefits of exploratory research include the chance to identify any temporary effects, and also to get familiar with key roles and responsibilities involved in the project. In a more practical sense, exploratory research assists the researchers to assess the level of difficulties in conducting the research [115]. Exploratory research suffers from some common miss perceptions [55]. It is often perceived that exploratory research is an initial stage or prior to a research and has been mistaken as a synonymy of 'feasibility study' or 'pilot study' where both methods imply limited exploration. Exploratory research has also been used as a synonym to qualitative research. This misinterpretations narrows down and underestimates exploratory research as an approach to developing theories from data. All this miss-perception indicates a poor understanding of exploratory research. As mentioned before the most appropriate meaning of exploration in this context would be exploration-for-discovery.

Since the intention of our study is to make improvement in usability methods used in Ericsson we have started the research with some per-existing assumptions. Both flexibility and systematic characteristics of this method has made our study more interesting.

As compared to many counterparts such as descriptive research, this method a better candidate in order to reach a deeper understanding of the situation in hand. The reason for such flexibility originates from ”a need to learn from experience of the investigation and from the need to avoid being blinkered by any preconceived notions” [114]. Case studies represent a way to conduct exploratory research on a particular subject or problem. In case studies, the attempt is finding out what is happening and why [47]. This study is performed using exploratory research method with reliance on case studies.

2.5 Collection and Analysis of data

Munhall refers to the research design as logic that links the data and findings of a research to the primary research questions [70]. Since, the data collection reflects the research questions, therefore the data collection approaches and data analysis methods need to be tailored in order to meet the goals of conducting the research. In this section we take a closer look at the methods of data collection and data analysis in both case study and exploratory research perspective. Later we describe how our study has employed these theories and methods in practice.

The divergent nature of the case study method demands a need to collect known data collection and analysis strategy appropriate for case study research. Yin represents six common types of research evidence in case studies; documents, structured interview and surveys, archival records, direct observations, participant-observations and artifacts.

In Our case study we have used these types of research evidence, documents and archival records used in this case study was taken from external documents of Ericsson. The interviews and surveys however was in form of conversations and attending many meetings, coffee-time chats, one to one conversations with designers, testers, internal users

and team leaders of this products as well as management and consultant responsible for usability tasks. During usability test however we had direct observations while participant was performing the test. We also conducted one to one discussions with the participants, in chapters 7 and 8 we present a summery of the interviews and detail on participants.

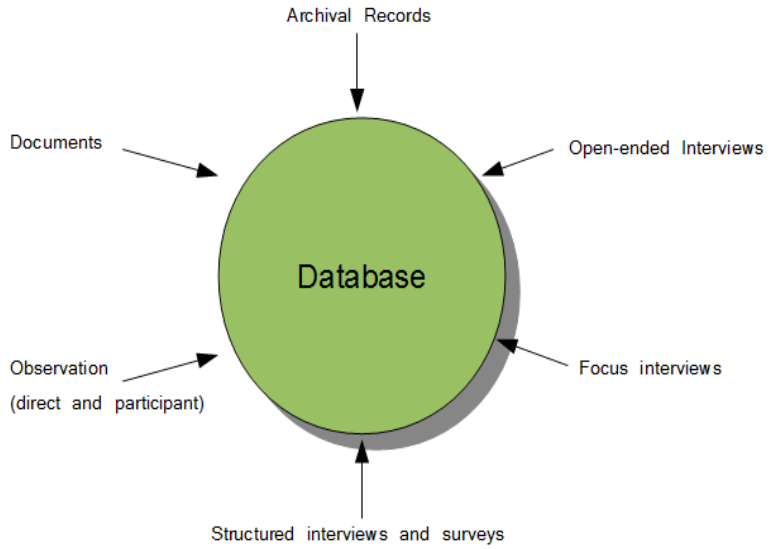

Figure 2: Types of research evidence: Adopted from Yin Case Study Research (3rd ed.) Thousand Oaks, CA : Sage. [70]

Despite the choice of data collection method, interviews have been considered as the most important method by many researchers. However in recent years, 'triangulation' has become a common approach in case studies which refers to data collection through different approaches [60]. Triangulation involves different kinds of data on the same phenomenon, as recommended by Yin. He suggests using different sources of data collection since each of these approaches has got its own pros and cons and all these sources are complementary to each other. In general, cases studies are considered to be more convincing and accurate using different sources.

Documentary resources can be on various format whereas archival records often refer to computer files and records. The advantages of the documentary evidence are that they can be reviewed in a repetitive fashion and have broad coverage regarding time and events [121]. On the other hand, the drawbacks of this method are difficulties in accessing the documents in case study, specially when the documents are blocked due to security issues and can involve bias. Interviews are considered as one of the most important sources of data collection in case study. Many case studies are based on face-to-face interviews. Basically interviews can be highly structured, almost like a verbal survey or they can be open-ended allowing individuals to respond freely to a series of general questions [72]. Interviews performed in case studies are usually open-ended but can also be constructed as structured and focused. The interview method has the advantage of permitting the participants to contribute with their own views regarding the topic under study and also directs the investigator's point of view to the right direction.

Observations are another source of data collection from real events in real time. Observation is defined as ”way of gathering data by watching behavior, events or non-

physical characteristics in their natural setting" [27]. Observation, in this context, can be either direct or participant. Direct observations are when it is possible to watch and observe events as they occur. Whilst participant observation gives the investigators the possibility of participating in the processes, interactions and events happening. There are many positive aspects of observational methods, namely flexibility in assumption of hypothesis. They can however be time consuming, biased and costly. Physical artifacts, enables a shared understanding of the requirements and technical operations. The limitation of this method is the availability of them.

In this study we have used triangulation or multiple resources for data collection. The documents and archives were freely available to us with the conditions that the confidential documents from Ericsson should not be published due to the regulations. A Non-Disclosure Agreement was signed by involved people in this thesis. These documents and records have provided us with information such as existing usability process, projects and applied usability evaluation methods . As experienced system developers, with over 3 years of experience, we have been able to be part of both direct and participant observations. Also we have attended many meetings, informal interviews and open discussions internally before conducting the study. This helped us collect more insight about the system's usability and the issues it has. We have been able to participate during the events throughout this study from participation in testing cycle, project meetings and discussion as employees of Ericsson. Accessing the physical artifacts was a major problem in case of remote testing due to the firewalls. Although in case of co-operative method the GUI was accessible using Java web start. During the usability test, we used notes to collect feedback, suggestions and recommendations from participants. Also after the test, we collected more information from each participants with help of questionnaire. This information regarding the usability test is described more in section 5 of this thesis.

In exploratory research, the relationship between data collection and data analysis is defined as reciprocal, meaning that these processes are typically not consecutive but strongly interlinked and dependent on one another [62]. These processes are more likely to overlap each other. The continuous review of the data collected during the exploratory research has a big impact on the selection of references, the activities performed by the researchers and questioners posed. This characteristic of exploratory design is a key advantage compare to interpretive approaches [62]. The iterative nature of the data analysis process provides evidence to research questions by a continuous attempt to discover matching patterns across the collected data. During exploratory research, investigator tries to collect the data in several attempts throughout the study followed by data analysis in each attempt.

Exploratory research follows a research process with an initial step of laying out the scope of research and central relationships as a frame of reference [62]. The framework in exploratory research provides the investigators with a set of guidelines to collect and interpret empirical evidences [62]. The next step in exploratory research is to gather the information which constitute the research sample of study and thereby conduct the data collections methods in each particular phase of study.

In exploratory there is no point in choosing a representative sample; there is definitely no sign of random sampling from a known population in order to achieve generalization. The sampling in studies following exploratory research of purposive manner [92]. This means

seeking for related data is to develop and refine the emerging theory. The sampling is guided by concepts and constructions that have significant role in developing theory [43]. The main purpose of the data sampled such as choosing the appropriate people to interview and settings to be observed is to satisfy the investigator's needs in a purposive manner . Such a sampling is referred to as theoretical sampling coined by Glaser and Strauss in 1967. They outlined their method as:"Theoretical sampling is the process of data collection for generating theory whereby the analyst jointly collects, codes and analyzes his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges " [124]. This type of theoretical sampling has been used in this study such as choosing the appropriate participants in the study according to each stage study. Some participants, with key roles in usability test team where more frequently involved in the process of research and they have been present almost in all stages of study for further discussions and suggestions. while some other such as participants in usability test were only involved in order to incorporate the new emerging phenomena.

Observing the frustration of users of all categories (testers, internal users) and the struggle and the effort put in teaching and learning of the targeted GUI, the amount of basic usability related bugs in later stage of development on it, made us doubt the effectiveness and scale of the usability engineering tasks performed in industry; an attempt to find out "why usability tasks are neglected in many software industries? despite all the advantages and values, such activities bring to a product." seemed interesting.

Data in exploratory research may be in qualitative, quantitative or a combination of both types [68]. The data can be collected from either primary or secondary sources; directly by the investigators or by someone else for other purposes. Even though both from of data have equal validity values in exploratory research, their analysis is different. Exploratory research, by definition, does not involve exact statistical projections or descriptions thus quantitative analysis is sufficient to present ideas and approaches and explore a topic [54]. As Gaskell has mentioned "The broad aim of (all qualitative data) analysis is to look for meanings and understanding of what is said in the data, but the researcher must interpret (all of) this." [68].

In the studies where qualitative data is involved, serious attention must be given to the analysis of such data. There are systematic ways to perform analysis of qualitative data. There are few topologies to handle the analysis of qualitative data [92]:

1) Quasi-statistical methods where the analysis relies completely on conversion of qualitative data to quantitative format.
2) Template methods where the key codes are driven from the initial research questions and reading and these key codes form a template for analysis of data
3) Editing methods where there are few per-existing key codes and the main key codes are driven from researcher's interpretation which makes this approach more flexible and suitable for exploratory research.
4) Immersion approaches are considered as methods, which are dependent more on interpretation and are least structured.

In our study, the approach taken for analysis of qualitative data is an editing approach. This can be justified by the fact that, there existed no code at beginning of the study. The codes and categories were emerged through the iterative processes, were logged into case study database. Further we have used these codes and patterns to refine the questions and findings in each phase of study.

The purpose of analysis of qualitative data is addressed by finding patterns and relationships in data and thereafter organizing them to theoretical explanations [121]. Qualitative analysis is described as a chain of events where the first step is to define codes and patterns, to the initial research questions and materials such as interviews and observations. In the next step these codes and patterns are studied to discover new patterns, relationships and themes. These findings affect the data collection in the next phase. These evolving processes gradually leads to generalizations in from of theories which can explicitly define the consistency in data found [92]. Our study is characterized by this general process. As mentioned earlier we have collected the materials in database, throughout the study to assure the reliability of the study. The emergence of relationships and themes in each phase has been the main influence to continue the study. We performed analysis after emergence of these thoughts and findings until we concluded this process by formulating a theory that is based on the findings and materials.

To briefly summarize this chapter, this thesis is an empirical study within the industry. There are not that many empirical studies which cover all the important fields of Software Engineering (SE). In other words there are relatively few empirical studies that are conducted and reported in SE. The focus in implementing new technologies has been always higher than evolution of existing ones [99]. The authors of [99] identify “more empirical studies of higher quality and relevance, and more focus on research synthesis and theory building” as contributions in improvement of SE research [99]. This thesis is an effort in conduction of empirical study in software industry

3 COST JUSTIFYING USABILITY

In 1988 the topic of cost justifying usability in HCI was formally introduced by usability engineers in a paper, which mainly focused on incorporating usability in product development cycles; thereafter various studies were performed on impact of low investment on usability subject and the relation to its financial profitability. In 1989 Karat, a professor in HCI field, took user needs as a development objective and developed that in to a development iteration for the UI (User Interface), she then collected the cost benefit data and determined for every dollar invested in usability, there was a 2$ return and profitability even a more detailed study in the same experience showed a 10$ return on investment [30].

Usability has become increasingly important as a primary and vital process of the design and development of software and systems for different parts of society, education, business, industry and government, as well as a topic for research [46]. In 1992, the society for Technical Communication (TC) launched a Professional Interest Committee on Usability (PICU). Also a new group with the title of Usability Professionals Association (UPA) held its first annual conference at Word Perfect's headquarter in Orem, Utah, United States [36]. Norman, in his popular Design of Everyday Things book has characterized usability as ”The next competitive frontier” [76]. By which he meant that since the hardware and software are more in demand and supplied without quantitative differentiation across the market, usability is the only different characteristic of computer systems.

HCI integrated the concerns about tools and methods of software development with the concerns of the usability of the implemented software [18]. As computer use has become more comprehensive the need for research in people and their interactions with computers has grown. The researchers have concentrated on theoretical, physical and psychological aspects of this process [32].

Concurrent to the Internet getting widely available for public in 1990's, Bias and Mayhew wrote their first book on cost justifying usability. The intention of this book was providing suggestions and methods which professionals, could use to secure the needs of users in order to quantify the benefits and costs of expenditures borne by usability activities. As growth of different networks, Internet, e-commerce and web in general, the need for usability and different methods and testing the outcome became more and more necessary. Bias and Mayhew built on the existing book and added chapters about web and their usability issues that is how the 'Bible of usability' was introduced. Also in 1992 Pressman published a book regarding development cycles in which it uncovered that 80% of the software costs are consumed during maintenance which most of those are due to bad design plans [8].

Also during the 90's, Wixon and Jones performed a case study on a Digital Equipment Cooperation (DEC) product which presented positive financial ROI in usability [28]. There are several well documented reports about case studies highlighting positive ROI regarding implementation of human factors. These case studies demonstrate the benefits for many technologies, processes and industries [98]:

- Websites

- Software
- Computers
- Intranet
- Electronics
- Office ergonomics
- Workplace ergonomics / manual material handling
- Industrial production lines
- Forestry
- Automotive
- Aircraft
- Petroleum
- Healthcare
- Nuclear and electrical power plants

Recent development on different technologies has made this subject have extreme growth and importance. Quantification of the methods used in development process is the only common language between program managers, developers, markets and sales. The need of having usability laboratories and deep study of the HCI and UI became a necessary part of success plan for every company, as it is a proven profitability factor in any software system, whether it is a traditional software or a web design [59].

In 1997, Lund published a paper which addresses the alternative methods of usability cost justification with the focus on new ideas and improvements in usability. Since August 1999 a newsletter of usability testing professionals has been published quarterly. Jamieson and Reising have reported their findings on cost-benefit frameworks for advanced Human-Machine Interface (HMI) in 2004. Aaron Marcus and Associates, published a paper, presenting good examples and statistics with concentration of the ROI for usable User Interface (UI) design [66]. Work within the area of cost justification of usability has been of high interest among researchers and professionals in this field . Mayhew, also published her paper ”Make a Stronger Business case for usability” in which she refers to cost-justification as an effective tool to support usability engineering services [76]. Recent publications in this field illustrates the cost benefit of usability in web applications and services [8].

3.1 Importance of Cost justifying usability over time

There are many different aspects in usability besides profitability or success of a software. Considering the range of the users, the vast application of software today plays a very important role in our development decisions. Usability has been transferred to general public, a very big market for professionals of other subjects such as photographers, musicians, graphic artists, doctors, teachers and many other categories which use different computer products as a tool for their daily work. User groups for all these tools needs to be aimed at, while designing and producing them, they might need training in order to use these software.

On the other hand we have other user interfaces such as web shops, Internet banking, telephones etc. which aim at yet again another group of users. Can all these groups of users be trained and educated to use the systems? That clearly is just not possible. New technologies and new content breed new usability disputes. The world is dynamic and subject to change and innovation and new techniques to make life easier, are an inevitable part of life. These techniques will have to aim service users and users demands [8].

Mistakes in products are repeated again and again but in different places and different systems, there is always lack of usability, but it is subject to place and system [65].Various services in diverse cultures demands distinctive usability tasks and of course each product needs its own usability tasks [66]. There are different known value propositions which usability can add to our services and products.

Because there have been many well-documented examples of cost savings with usability engineering, sound statistics can be applied generally to user-interface development. These statistics serve as benchmarks. The value propositions in terms of cost, time, profitability brought by usability activities, help us justify the cost associated by it. Here we present a list of these value propositions, you can read more of these success stories regarding performing usability activities in a product in appendix B.

Value proposition: High return on savings and product usability
Product usability and therefore its savings will increases, by having 50% increase of improvements the efficiency improves by over 7 times [64]. Once a system is in development, correcting a problem costs 10 times as much as fixing the same problem in design. If the system has been released, it costs 100 times as much relative to fixes in-design [44].

Value proposition: Save development costs
Costs will decrease by performing those changes in earlier development cycles [35][34]. When managers were polled regarding the reasons for the inaccurate cost estimates, the top four reasons were issues that could have been addressed by following best practices in usability engineering. These include frequent requests for changes by users, overlooked tasks, users lack of understanding of their own requirements, and insufficient communication and understanding between users and analysts.[4][79][98].

Value proposition: Save development time
Planning and enforcing usability activities results in visibility in problems with product and saves development time [10][31].

Value proposition: Reduce maintenance costs
“One [well-known] study found that 80 percent of software life-cycle costs occur during the maintenance phase. Most maintenance costs are associated with “unmet or unforeseen” user requirements and other usability problems.” [83].

Value proposition: Save redesign costs
Designing the product and correcting the usability problems as soon as it's found can help save the redesign costs. If the fundamental basis of any product is done by thinking and checking if that works, the product will not have to go under redesign phase [90][67].

Value proposition: Increase Revenue
Usable products lead to substantial cost savings and sales. Unusable products most often prevent a customer from accomplishing a productivity task or retrieving information necessary to make an e commerce purchase. Online shoppers spend most of their time and money at websites with the best usability [73][42][79].
Value proposition: Increase transactions/purchases
By understanding your customer expectations and needs, and designing your product lists accordingly, you can significantly increase your sales , sometimes by 40% [111][33].

Value proposition: Increase product sales
The magnitude of usability improvements is usually large. This is not a matter of increasing use by a few percent. It is common for usability efforts to result in a hundred percent or more increase in traffic or sales. [122] [56].

Value proposition: Increase traffic (size of audience)
Directly relates to websites and online shopping as it makes them easier to use therefore increases the number of visits and increases transactions measurably[5][53].

Value proposition: Retain customers (frequency of use)
Again relates to the web sites and the increase of traffic by their good designs and usability factors[2][56].

Value proposition: Attract more customers (increase appeal)
Efficiency, effectiveness , comfort of use , simplicity are the top reasons for customers to use a system and also advertising it (mouth to mouth) [73][35].

Value Proposition: Increase market share (competitive edge)
"Usability is one of our secret weapons“ [56]. Usability brings a competitive edge to the product by improving effectiveness. “User-centered design benefits users, the users’ company, and the vendor company. Increased usability, increases productivity and job satisfaction while decreasing customer support needs and documentation requirements. When users feel more effective with their work, rates of absenteeism and employee turnover are lowered. All of these benefits are in alignment with fulfilling successful business goals “[98].

Value proposition: Increase success rate, reduce user error
A product with good usability prevents frustration of users and increases their success in performing any task, it also helps user navigations and minimizes their errors [73].

Value Proposition: Increase efficiency/productivity (reduce time to complete task)
“With its origins in human factors, usability engineering has had considerable success improving productivity in IT organizations” [9].

Value Proposition: Increase user satisfaction
“When systems match user needs, satisfaction often improves dramatically. In a 1992 Gartner Group study, usability methods raised user satisfaction ratings for a system by 40%.” [9].

Value Proposition: Increase job satisfaction/decrease job turnover
The users (experienced), working with the system will have more satisfaction and as mentioned before, lesser error and frustration by users means decrease of job turnover [96].

Value Proposition: Increase ease of use
“Incorporating ease of use into your products actually saves money. Reports have shown it is far more economical to consider user needs in the early stages of design, than it is to solve them later. ” [52].

Value Proposition: Increase ease of learning
Ease of learning not only reduced the cost of training and maintenance but also helps in sales and marketing of the product [9].

Value Proposition: Increase trust in systems
"Studies clearly shows that consumers' trust concerns can significantly be alleviated by providing relevant information when and where users need it" [9].

Value Proposition: Decrease support costs
With Increase of user satisfaction, efficiency and effectiveness, and minimizing user errors, support costs decreases [9].

Value Proposition: Reduce training/documentation cost
Companies can save a lot of money and resources, for each hour of usability engineering; this also improves productivity [9].

Value proposition: Litigation deterrence and safety
"Chaplains cites two independent studies that showed a 54% reduction in rear-end accidents with the use of human factors improvement: the centered high-mount brake light on autos."[8].

By increasing usability in any software related industry, if not all these values, quite many of them is brought to company, in our case most of these values can be identified except the value propositions directly related to Web sites such as increase of traffics, and transaction.

3.2 Agile system development

Technology and users industry demands a better and well polished method of designing software, therefore in 2001 a group of software developers worked toward a more advance developing model call agile system development. This method is based on customer collaboration couplings to the software. The agile software development manifesto according to people who have set the method, the values of agile methods are [1]:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

These four agile principles ensure the flexibility of the methodology in designing any product**.**

Individuals and interactions over processes and tools: it emphasizes the relationships more than the institutionalized process and empowers the development teams by boosting their team spirit.

Working software over comprehensive documentation: continues turn out a tested product or new releases at frequent cycles and intervals, hourly, daily, bi-monthly or even monthly basis by keeping the design simple but as advanced as possible; thus lesser documentation burden in a suitable level to save time and money is accentuated.

Customer collaboration over contract negotiation: the connection and relation between the customer and system developers is done mainly based on strict contracts, however a viable relation is maintained between them and if any changes needs emerging should be communicated and these enhancements are allowed if mutually agreed upon. Thus reduction of dissatisfaction for both side is ensured.

Responding to change over following a plan: flexibility in projects can cause major turnovers, during the development process, development group can comprise software developers and customer representative. Any emerging changes during the process should and will be communicated well and the consequent changes can be done at any stages of the evolution.

Ericsson always welcomes innovation and follows the latest methods to achieve the user satisfaction, following agile methodology makes it possible to make good business solutions while closely working with customers. Customers as shareholders can see the progress of their intended product and can collaborate closely with developers to ensure a successful system. Agile software technology, dedicates the flexibility of the project which can help the developers focus and employ usability tasks and activities.

4 USABILITY COST BENEFIT MODELS

One of challenges in bringing usability into development processes of software life cycles is that the benefits of usability are not transparent to identify or calculate, especially in management eyes when time, resources and delivery dates are the constraints or main factors in development. Usually usability tasks are sacrificed over deliveries, resources and time constraints, regardless of the benefits it will bring to the project [57].

In order to convince management about such activities, the appraisal of such advantages seems beneficial, however that is only one reason to study different cost benefit models of usability. The other aspect of having those tasks as a part of development will be discussed and some of these methods will be compared in this sub chapter.

Different aspects in which these Usability Cost Benefit Models (UCBM) are explained, are: product development, marketing and sales, customer support and customer needs as well as end users. Also the level of their documentations over these factors are studied and distinguished [8].

The cost-benefit analysis is a method of analysing projects for investment purposes .In the usability cost-benefit analysis of the usability activities, the expected costs (e.g., personnel costs) and the benefits (e.g., lower training costs) are identified and quantified [19]. The method has three steps as [15]:

- The financial value of expected project cost and benefit variables should be identified.
- The connection between expected costs and benefits should be analysed using sophisticated or simple selection techniques.
- The investment decision can be made thereafter.

Here is an overview of usability cost benefit models, which mostly has been discussed with different related case studies in the book Cost-Justifying Usability by Bias and Mayhew also one of the most recently discussed models, published by Bevan.

4.1 Cost Benefit Models by Ehrlich and Rohn

In this case the potential benefits of performing usability tasks are analysed from the vendor company, corporate customer and end user point of view, stating that both company and customer gain benefits by incorporating usability into product development projects. However the overall formula to calculate the value of usability benefits is not clearly presented in this model.
According to Ehrlich and Rohn, the vendor companies can identify the benefits from three different aspects [8]:

- Increasing sales
- Reducing support costs
- Reducing development costs

In most cases the impact of better usability in sales is cumbersome to confirm, by studying the significant effect of usability and its role in buying decisions, this impact can be analysed. On the other hand if in any product, the usability factor is poor and there are many users for that product the cost of support increases drastically; where companies can make great savings by less need for support and customer trainings. Focusing on products

with improved usability factors, can help companies save on product development time and costs which is the developer training and hidden costs of peer support and also the productivity increases while developing [8]. It is estimated that this kind of hidden support cost for every PC is between $6.000 and $15.000 every year [14].

4.2 Cost Benefit Model by Karat

Focusing on human factors while working and calculating the usability benefits by cost benefit calculations is the approach Karat suggests for her cost benefit models. The benefits are identified as [8]:

- Increasing sales
- Increasing user productivity
- Decreasing personnel cost through smaller staff turnover

Better usability can give the product and therefore the development organization a competitive edge and increases the sales. Consumer organizations can acquire more benefits when end user productivity is enhanced through deprecating task time, reducing staff turnover by better usability.

The method has three steps as [15]: The first step in usability cost benefit analysis is that all anticipated and expected costs and benefits are identified and quantified, in second step cost and benefits are categorized into tangible (which is easy to measure) and intangible (not easily measured), financial values of all tangible costs and benefits is determined in third step. In addition to that, usability cost benefit analyses are linked to business cases, to determine an explicit and objective base in making investment decisions [57].

4.3 Cost Benefit Models by Mayhew and Mantei

Mayhew and Mantei argue that cost-benefit analysis of usability is best made by focusing the attention on the benefits that are of most interest to the audience for the analysis [87]. In this method relevant categories of benefit for the target audience are preferred and benefits are estimated and handed over the vendor companies. The benefit categories for companies can be [8]:

- Increasing sales
- Decreasing customer support
- Making fewer changes in late design life cycle
- Reducing cost of providing training

In order to estimate each benefit, a measurement unit is chosen and an assumption concerning the magnitude of the benefit for each unit is made [8]. The number of units then multiplies estimated benefit per unit [87].

4.4 Cost Benefit Model by Bevan

The advantages of improved usability in an organization during development, sales, use and support are estimated by Bevan. This method is one of the most recent published peppers and describes cost benefit calculations with a slightly different point of view [86].

While developing systems for in-house use, usability benefits can play an important role in development, use and support, by improving revenue and saving in sale. The total amount of benefit from better usability can be calculated by adding all identified individual

benefits together. Bevan discusses mainly about usability benefits through increased sales, less need for training and increased productivity [87].

4.5 The Characteristics of Usability Cost Benefit Models

Different benefit categories of the above models according to Jokela and Rajanen will be compared in this section. This is, to study these models and see if they have covered the benefits [86].

The benefit categories are:

1. Benefits for product development
2. Benefits for marketing and sales
3. Benefits for customer support
4. Benefits for end users

4.5.1 Benefits for the product development

Different categories of usability benefits affecting the product development for the above models are:

1. Less need of resources
2. Prioritization of product features
3. Less need of future redesign

The above categories suggest that development companies can cut development costs and time. Proper use of resources in terms of manpower and time they spend on developing a product plays a huge role in success of a product. Ehrlich, Rohn and Bevan identify the ability of functionality prioritization is as valuable as usability benefits. However, Bevan on the other hand, identifies the reduced need for architectural redesign to make future versions of product easier to use as a potential benefit [86].

4.5.2 Benefits for marketing and sales

Categories identified in marketing and sales of the product relating to usability are:

1. Gaining competitive edge
2. Increasing customer satisfaction

Estimating the effect that usability has on sales of a product is very cumbersome, but there are reports of cases which is possible to link the sales to good usability points [86]. There have been cases in which the growth of revenues has reached to 80%, after fixing serious usability issues in the second release of the product [122].

This issue can be seen in reverse situations that poor usability have caused more impacts on sale and vendor companies reputation and market share particularly in tightly controlled markets [86].
Growth of customer satisfaction results on good advertisement and more customers for the products and increases the sale. Almost all the mentioned models identify these benefits and factors.

4.5.3 Benefits for customer support

Categories related to usability benefits for customer support identified are:

1. Reducing product support cost
2. minimizing the demand for end user training

The difference between training for usability-engineered system and a system designed without usability engineering can be even several days [59].

Training of end users can be official or unofficial, official training are usually conducted by development companies or customer organizations and unofficial is by skilled peers (as many of us ask other friends or co-workers for help). Only Karat has not identified the last category, which is the benefits for end users.

4.5.4 Benefits for end users

During the product use, two categories of usability benefits, identified are:

1. Increased productivity
2. less need for support

The end users take the most advantage of usability, when the most frequent tasks consumes lesser times. It is estimated that productivity within the service sector would rise 4-9% annually if every product were designed for usability [64]. Having better usability in a product leads to lesser time spent on doing a task, minimizes rework, trial and error and brings customer satisfaction also reduces the need for support. All the models except Karat's model have identified these points.

4.6 The Cost Benefit Factors

It is an important issue from quality management's perspective to know how customers choose brand of products or specific models and to get familiar with the usability factors that affect their decision. Demonstrated by Bias and Mayhew, 1994, considering usability to software development process can save up to hundreds of billions of dollars of Return of Investment (ROI) in a year. As parsing through existing literature examples abound where companies have lost money due to poor usability and also examples where usability science application has resulted in significant cost benefits. Improved usability can be translated to the following cost reduction categories [8]:

- Reduction in training cost
- Reduction in errors introduced by operators
- Reduction in support and maintenance cost
- Reduction in possible injuries in work environment and the time lost
- Reduction in costs involved in implementation of and better user acceptance
- Reduction in lead time for new products
- Reduction in product liability costs and associated insurance cost

Even though these factors are listed as primary focus in employing usability science but they are not considered as ultimate factors within professional usability science as a centerpiece of product development. According to Bias and Mayhew, these factors are considered as essential factors, however they define the important factors in professional usability science in large cooperation as: 1) better position in competitive market 2) reduction of risks. The risk can implicates to the risk of failure such as failed product. These two factors are mainly concerned with the gain of profits as a result of competitive and successful product rather than cost reduction factors listed above. Usability has many potential benefits to the development organizations among which Mikko Rajanen points out to: 1) increase in productivity 2) customer satisfaction [87].

The process of introducing the usability science is not visible, not even to the brightest usability teams. Bias and Mayhew claim that usability science should be marketed and sold in accordance to their requirements and limitations of corporate executive. The concern for objective findings is been a reason for usability to compete for resources against other project groups who have objective cost-benefit data ready for management

review [58]. Apart from funding limitations there is need to prove the nature of usability as a viable and critical asset in project developments which is worthy of investing on [8].

5 RETURN ON INVESTMENT

In the section of importance of cost justification over time, we described the value propositions brought by usability, to any product; different well documented examples and statistics were presented. While discussing cost justifying usability, clearing how can we have turnovers in any product is the most important aspect of argument, in this chapter definitions and facts about return on investments and practical implication of it will be explained. Understanding general terms of usability ROI, in this thesis will help us light the path toward our usability test and justification of that for one of the most important products in Ericsson, this chapter will be then used in our pilot study as a guideline and will be referred.

5.1 Definition of ROI

As mentioned in the previous chapter, one of the purposes of performing usability tasks and improving the usability of any product is to gain tangible and intangible profit. The values of cost justifying usability and UCD in product development have been discussed in many literatures and a summary of that is presented in this chapter.

In general, Return On Investment (ROI), concerns general business cases, the following definition has reference to that: "A performance measure used to evaluate the efficiency from an investment or to compare the efficiency of a number of different investments. To calculate ROI, the benefit (return) of an investment is divided by the cost of the investment; the result is expressed as a percentage or a ratio. The return on investment formula [88][89]:

$$ROI = \frac{(\text{Gain from Investment} - \text{Cost of Investment})}{\text{Cost of Investment}}$$

Return on investment is a very popular metric because of its versatility and simplicity. That is, if an investment does not have a positive ROI, or if there are other opportunities with a higher ROI, then the investment should be not be undertaken" [88]. Concerns about cost-justifying usability activities, was wanted somewhat by economists in late 1990s, but return - on - Investment (ROI) concerns resurfaced with a vengeance as the dot-com bubble burst in 2001, recession loomed, and corporations stared looking more closely at UCD activities and their impact on ROI. The tight business market and corporate emphasis on understanding the contribution of UCD to ROI led to pleas in usability forums for hard data, clear examples, and best practices for cost-justifying UCD activities [20].

There are many ways to calculate the ROI regarding usability in the project, which has been discussed in many different literatures; however it is good to consider both perceived and measured (actual) ROI. In many situations perceived ROI is affected by many factors, measured ROI is not always the way it was forecast. The reality behind the relation between these two types of ROI was investigated in a work-shop on ROI [94].According to this workshop, sometimes the products had lesser ROI than expected due to [94]:

- History: events such as terrorist attacks which disrupt the world economy can result in less sale and revenue.

- Market strategies: In case of unveiling many products with weak advertising budget, product can have lesser market demand.
- Unexpected software bugs: unintentional introduction of a serious software bug, after fixing a known issue, and not discovering of that problem until the release of product, can cause customer dissatisfaction and reduction of sales.
- Competition: stealing the market share by a competitor which offers cheaper and better UI can affect the sales and profits.

Of course many more factors can affect the sales and ROI. In this chapter different category, effects, advantages and disadvantages of ROI will be reviewed. Usability ROI can be categorized into three different components [118]:

1. Internal ROI
2. External ROI
3. Social ROI

These different categories will be discussed briefly in following sections, different ROI, challenges of measuring it for user centered developments and the components involving the process of demonstrating ROI for these activities, will be briefly described.

In order to actuate the benefits of UCD, carrying out a cost-benefit analysis can result in a guide, to plan investment of financial resources and maximizing the profit seems beneficial. There is a growing body of literature that demonstrates a positive return on investment for implementing human factors and ergonomics initiatives.

5.2 Internal ROI

Internal ROI refers to benefits that save the organization's money when developing products or services. This can take the form of decreased development costs, preventing the need for redesign, and reduced time in getting the product to market [98].

Internal ROI aims at anticipated or real efficiencies which take place during the development of a service that can be associated to usability group. It is believed that UCD activities are elaborating the development processes and the perceived internal ROI. The actual internal ROI is a measured improvement in development life cycle. Usability activities that aggrandize and emphasize, coherent product requirements, discard major hinders, in early stages of development, improve reuse of designed components, increase the information exchange and communication between the product team and reduce the cost of development, which reinforces Internal ROI [118].

Improvements to product development which minimize costs, annihilate rework, boost efficiency of development team and other internal stockholders, are main focus of Internal ROI. The perceived profit after sale (external ROI) can not be achieved, if the UCD practitioners does not contribute to the Internal ROI, which is removing the obstacles and ambiguities of requirements, by communicating and fixing the foreseen problems before they grow bigger and not manageable [119].

The values delivered by usability tasks can be underestimated, as the actual ROI can not be seen in the whole picture of development process; usually it is easier to point out the tasks done by other parts of development project such as design and test, as factors of success, rather than usability tasks. One suggested way according to Bias and Mayhew, for

getting the product team to believe in the value of UCD, is to first conduct usability activities with no direct costs to product team and demonstrating the benefits of those activities in development process (no direct cost such as cut down on number of meetings) known as "on spec UCD project" [118].

The plus side of on spec UCD activity is that, it shows how smoothly the usability activities can fit in project life cycles and cuts the costs and reveals the issues with requirement and development itself. However the risks that on spec project can have, can be, discloser of some big problems in the product that was not truly obvious and is considered to be taboo; also involving in mature phases of development which considered to be too late, as any negative feedback of usability can lead to quite delicate and strong resentment or negative social ROI [8].

To reduce the above risks it's suggested to pick a product which is believed to have no fatal flawed and it's in need of usability such that the product quality is not affected, and plan that in early development process such as evaluation of prototype, and design concepts [8].

5.3 External ROI

External ROI refers to benefits that increase the profitability of products or services by making them better for the customer. This can take the form of increased sales, increased market share, decreased customer support and service costs, decreased return rate, and improved user experience [98].

When the usability practitioners add more value to profit of any product sale in any company, by making the service better and more user friendly, the external ROI is achieved. The external ROI does not concern development efficiencies, unlike internal ROI; instead it considers the more profitable sales to the customers. There are two levels of external ROI:

- UCD and usability engineering covers the course of action and perceptions of users and customers, and it is closely related to how much of improvement the user experience can handle or how can we address explicit usability goals. The focus in this level is mostly on more usable and useful, efficient and satisfactory product and the related ROI subject which needs to be considered is, how much of profits the usability enhancement has produced?

- The second level of external ROI is broader, the effect of improved user experience on growth of sales and abatement of post sale expenses or enough share of usability in external ROI that shows commodious results backing the usability activities, will be aimed at. (One way to boost the profit is by reduction of expenses in development phases called "Internal Return on Investment, IRI") [8] [98].

External ROI evokes the comparison of pre and post measurements of usability, such as assessing the product usability in past and current developed product with usability activities, which is called historical measures. As a matter of choice, current usability of a product can be measured and improvement of usability in it can be predicted and measured to assess the understanding of the improvement planned in next release of that product, this method is called predictive testing or proforma analysis [12]. Of course it is possible to make a concurrent or simultaneous measurement; that is the comparison is

made with other products (competitors) as it is very difficult to gather historical data about pre usability activities in a product [94].

As most of the product's usability is involved in the absolute latest stage of the development, no historical data would be available to compare with post UCD activities. One more challenge in external ROI is to justify the costs beard by measuring the usability while the budget of the product is already been assigned to development or usability tasks for the new parts of the product. However it is crucial to somehow measure the usability in order to assign budget to these activities while planning a development [119].

Direct measures of external ROI are the improvements to the user experience that increase profits directly; these improvements either increase revenue or lower the cost of supporting released products. Indirect measures of external ROI are improvements to the user experience that increase user productivity or customer satisfaction and thus increase profits indirectly. In financial discussions these are often called “hard dollars” and ”soft dollars” respectively [85].
To demonstrate the external ROI some major categories of improved user experience can be measured, these categories can be [8]:

1. First time use
2. The learning experience
3. User performance by experienced users(“continued use”)
4. Need for customer support and service
5. Customer satisfaction and attitudes

5.3.1 First time use

Some services or products and Web sites can be used directly without any training, some variables which are measurable are [8][96]:

- Number of errors made during initial use
- Success rate in achieving stated goals with the product
- Types and severity of errors
- Time wasted by errors compared with productive time
- Users’ perception of their success or failure
- Time of performing a specific task
- Number of requests for assistance or calls to customer support during specific tasks

5.3.2 The learning experience

For more complex products, users need better understanding of systems or education and trainings, which affects both internal and external ROI. The variables involved in reduction of costs of learning on the ROI are [8][110]:

- Costs of training and materials or documentation
- Time spent away from job on formal training
- Customer support during first months of use
- The time which users spend in order to seek help (online, documents or customer support)
- Time spent by colleagues, to help the users, train or troubleshoot

5.3.3 User performance by experienced users

One of the major challenges in measuring ROI usability for experienced users can be that, most of the usability assessments are done when experienced users are new to a part of system or products are launched for the first time. Introducing changes in these projects with highly experienced users can be quite difficult due to their resistance toward change, as they have already learnt and mastered the older versions of it by spending time and resources [96].

Usability practitioners are needed to design and conduct a quantitative usability test comparing users' productivity with the two defected systems (a complex study involving controlled training sessions on the new application before the test sessions and statistical analysis of the data). "If the stakeholders in the target audience were shown they would not lose productivity, they would be more willing to cooperate in deploying the new tool" [110].

5.3.4 Need for customer and support and service

Today one of the necessary factors of any service is the customer support and services, which different vendor companies offer to the customer, after lunching the products; contacts made by users toward the customer service, plays an important role in profitability of the company. The lesser calls, the more profitability!

Different factors or variables in measuring the contribution of usability tasks to reduce customer support can be [96]:

- Number of helps needed
- Duration of each case
- Duration the customer waits "on hold"
- Percentage of escalated calls
- Frequency of the topics
- Use of FAQ (Frequently asked questions)

Many of this information can be collected using the logs, call duration, escalation reports and such, in companies.

5.3.5 Customer satisfaction and attitudes

Customer satisfaction is a part of definition of usability by ISO (International Organization for Standardization) "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and *satisfaction* in a specified context of use". This aspect is usually measured alongside with other factors of user experience mentioned above, many usability designs, post tasks include a satisfaction questionnaire, and these questionnaires can be in the form of [8] :

- Surveys
- Ethnographic interviews
- Competitive analysis
- Frustration meter

The relation between satisfaction and performance is close and yet different from user perception of success, this is quite a factor for external ROI.

5.4 Social ROI

Social ROI refers to the perception that human factors and ergonomics initiatives are beneficial, and can affect both Internal and External ROI. Internal Social ROI includes the perception of stakeholders that a given initiative provides a benefit, which in turn, increases management "buy in." External Social ROI consists of customer's positive perceptions of the organization due to past satisfactory experiences and demonstrated trustworthiness, which leads to improved branding and strengthened corporate image [98].

As it is often very difficult to measure the impacts of UCD on the product ROI, internal social ROI is quite substantial and takes time to establish [77]. Social ROI with internal perspective, deals with the perceptions of stake-holder in and organization that UCD practitioners add values to the development process [8]. In many environments the contributions of that part in organization to ROI, is not obvious, providing methods of measurements for social ROI, helps improving them, hence improving of ROI; the methods used for different projects can vary.

Considering iterative measures of our perceived value to development, such as internal satisfaction for members of the development product, surveys to measure effectiveness and values of usability tasks in and organization which collects suggestions for improvements, as a dynamic phenomenon will help measuring the social ROI. Some of social ROI's measurements can include [22]:

- The number of invitations that UCD practitioners receive to planning and management meetings
- How frequent the senior management mentions the usability group in their announcement or meetings.
- The number of product team members who are involved in UCD
- The number of project teams requesting help and people visit, call or ask questions from usability team
- The number of people believing on the contribution of usability tasks for an efficient development process and more profitable product.

Beyond the quality of data, as base of ROI calculation other factors are critical in verifying the influence of ROI arguments, such as:

- People involved; they need to have the ability to have strategic business vision or be pragmatist and experiment with new methods also the ability of making credible presentation of ROI argument for usability and build the trust with the visionary person.
- It is very crucial to tie ROI arguments to the business goals and strategies of organization, as it can help achieving the goals and has the ability to take them further with introducing a new type of valuable partnership.
- Critical world events affecting the business such global marketplace and movement of jobs to low cost countries, increase life expectancy rate around the globe, lack of skills in certain areas of expertise, and such, in such situations ROI argument can be heard by visionaries and help them in achieving business goals to win the global market challenges.

Understanding different types of ROI can help us measure the ROI in any product as the project is cost justifying usability. In next sections of this chapter specific constructive and

destructive effect of ROI also a suggested method of establishing a ROI measurement framework will be reviewed to help understanding of ROI measurement in practice [8] [88].

5.5 Specific ROI measurements and effects

Specific benefits for human factors and ergonomics initiatives include:

- Assembly job redesign: 10.76% first year ROI & 30.10% subsequent year ROI
- Workstation redesign: 15% increase in productivity
- Robotic case palletizer: 17% ROI over a 10 year period
- Log truck redesign: $6900 investment & $65,000 return = 1:9.4 first year cost-benefit ratio
- Electric utility tool replacement: $300,000 capital investment paid back in 4 months
- Motherboard redesign: $581,495/year factory savings & $142,105/year customer savings
- Computer usability: 200% – 500% return on a 6% budget investment

These benefits arise by increasing and decreasing cost related aspects of the development, manufacturing, distribution, sales and support activities. These increases and decreases include those shown below [98].

Increased	Decreased
➢ Ease of use ➢ Ease of learning ➢ Satisfaction, trust & loyalty ➢ Repeat purchases ➢ Purchase recommendation ➢ Safety & health ➢ Productivity & work quality ➢ Satisfaction & commitment ➢ Sales & market share ➢ Stock value ➢ Brand recognition	➢ Accidents, injuries & illnesses ➢ Lost workdays ➢ Error rates ➢ Training time ➢ Absenteeism & turnover ➢ Development costs ➢ Need for redesign & recall ➢ Support & service cost ➢ Labour costs ➢ Equipment damage ➢ Maintenance costs ➢ Insurance rates

Table 1: Effect of UCD on products [98]

Uncritically acceptance of ROI in showing the value of UCD, may distort the discussion of value in destructive ways; on the other hand, certain benefits of ROI in showing the benefits of UCD in products can have many constructive elements; some of these constructive elements can be [66][8]:

- Linking UCD to an important business outcome, which is the profitability.
- It surpasses the “discount approach”, which results on viewing usability as a task which can be minimized.
- Enables the usability engineer drive valuable discussions about intended users and their beneficial factors.
- Transcends significant of limited “time to market” that mostly dominated the busi-

ness vision.

In contrast, the destructive elements of ROI can be [66][8]:

- It can justify UCD as a cost demanding task in contrast to all other costs.
- It might lead to a highly theoretical and speculative analysis of UCD.
- Encourages isolation of UCD from all other factors of determining success of a product.
- Covers the importance of risk reduction.

Calculating benefits and ROI on any project is quite difficult task. Introducing a framework or a method which these facts can be selected in a systematic manner, can greatly help in demonstrating of ROI and suggests possible measures and solutions identifying the business goals. As the ability to demonstrate the return on investment (ROI), becomes more crucial to long term success of UCD [66], visualizing quantitative and qualitative values of usability programs in different organizations becomes more vital. In order to build a successful measurement tool, a framework that the ROI value can be measured and analyzed from different perspectives is needed [66][17].

According to a case study by special interest group papers in year 2003 (meeting the challenge of ROI on UCD) the components of a ROI process is demonstrated as figure 3, goals and objectives, focuses on measurement process. Measurements taken as each user centered activity are analyzed and mapped back to the business goals, in this process one faces many challenges,after user centered activities, measuring ROI can cause better and trimmed UCD activities resulting in higher ROI [11].

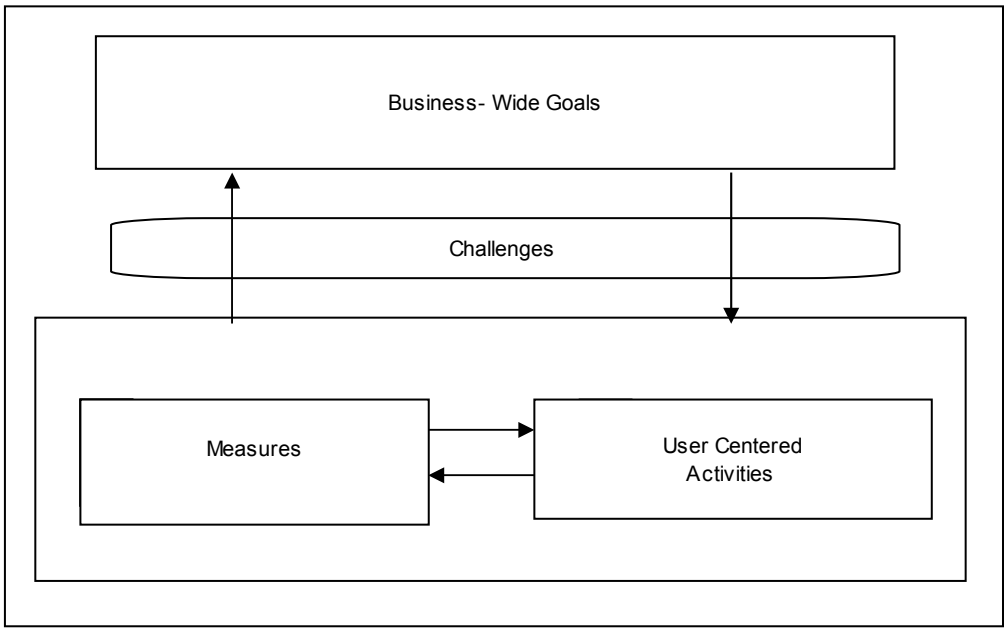

Figure 3: Components of ROI

Individual factors have impacts on ROI in an organization that can provide the context for group discussions in different approaches in calculating ROI they include [11]:

- Type of the product (service, hardware, software, web …)
- Application domain (e-commerce, finance,telecommunications ...)
- Company size
- Usability group size and importance
- Maturity of process (user centered software) and type of client (internal or external)

Section4- Case-Study

6 ERICSSON'S CHARGING SYSTEM PRODUCT AND USABILITY

In this chapter, a history of Ericsson and an overview of charging system product and how usability tasks are performed in this company are presented. By knowing the overall picture of the company and this specific product, it is easier to understand the problems and challenges that our company confronts when it comes to usability. Note that a lot of details can not be reviled due to sensitivity of this product, however we tried our best to describe the facts about our company without jeopardizing those sensitive details.

As presented in introduction chapter this is a case study, done to justify the cost of usability;this is achieved by not only by personal experience as software developer and solution integrator but by conducting different interviews and performing a usability test and evaluation to identify the missing points and tasks and to see how is this related to cost and how can that cost could be substantiated.

6.1 History of Ericsson

Founded by Lars Magnus Ericsson in 1876 as a telegraph equipment repair shop, it is now one of the Sweden's largest companies providing telecommunication and data communication systems such as mobile networks, billing and charging system solutions. According to Ericsson's website, the vision of this company is to be prime driver in an all-communicating world; a world where people can use voice, data, images and videos to share ideas and information whenever and wherever they want. The core values of Ericsson however are: respect, professionalism and perseverance in the daily work and the way they do business.

More than 40 percent of world's mobile calls pass through Ericsson's networks, and Ericsson does businesses with 175 countries around the world, and is the leader in telecoms technology and one of the most innovative companies in the world. Customer satisfaction is the most important factors of success, for Ericsson [23].Offering many products such as [23]:

- Mobile access (second generations (2G), Global System for Mobile Communications (GSM))
- Fixed broadband access
- Radio access networks
- Charging system solutions
- Multimedia and on line solutions
- Broad band solutions
- TV and IPTV solutions

Ericsson in Karlskrona mainly works with software development, especially in products such as pre-paid charging solutions, which will be presented below.

6.2 Charging system solutions

Convergent charging and billing or charging system solutions, is a software solution in telecommunications industry, enabling management of users and services for operators, solutions commonly known as prepaid or postpaid and access methods such as

mobile telephony, fixed telephony and the most recent ones broadband and IPTV.

Ericsson's charging system solution is mainly developed in Karskrona, and is claimed to be one of the world's most flexible solutions in convergent charging [91].

The Convergent Charging & Billing based on BSCS and Charging System provides a single revenue management solution for all subscribers and services. Its key features include [23]:

- Pre-integrated functionality for customer, product and order management
- Discount and promotion handling
- Balance management and real-time rating
- Flexibility in service offerings, segmentation, pricing and promotions

Based on BSCS and Charging System, the solution is pre-verified, assuring shorter deployment times and reduced risk while also offering highly scalable, real-time charging. As a prime integrator, a complete offering of supporting products and services, is also provided.

This solution provides a unified way of handling all customers and services, as well as flexible, built-in tools that allows the customer to easily configure new offerings, campaigns, cross-service bundles and discounts.

With fewer systems to maintain, costs fall. At the same time, it can quickly adapt to new user demands and capture new business opportunities. The user experience is further enhanced with real-time user notification, which leads to greater usage and loyalty, and therefore higher and sustainable revenue [19].

6.2.1 Key capabilities

The Charging System allows handling the charging of all services and users in real time. The system rates and reserves the necessary funds for the user as an integral part of service delivery. This prevents credit overruns while giving service providers control of credit and users more spending control.

Its key features include [19]:

1. More flexibility in pricing and discounting of services with Ericsson Rule Engine (ERE)
2. Virtually unlimited possibilities to package and bundle services and promotions with an increased number of dedicated account and usage accumulators
3. Flexible refill logic, which enables you to target promotions based on desirable refill behaviour

The key advantages are [19]:

- Real-time charging for all services to avoid revenue leakage
- User segmentation to reward loyal customers, to provide faster reaction to customer needs and to speed up the launch of market campaigns
- Ability to provide real-time bonuses and discounts to further build user satisfaction and avoid churn

Ericsson is the world leader in Charging System/Prepaid System, with 100 customers across 70 countries using Ericsson solutions. Globally, substantial shares of mobile

prepaid users, more than 130 million subscribers, are connected to Ericsson Charging Systems. Over 250 customers in more than 90 countries have adopted Ericsson's intelligent network solutions with over 500 applications deployed worldwide [37].

6.3 Usability in Charging System

As charging system software is quite vast, different sub parts of this system are made by different software development units and integrated together after each individual part is done and tested. Usually each of these sub parts have their own UI (User Interfaces), and each unit develops and tests their own part of the product and delivers it to a compound system testing or quality assurance node for the entire system.

Quality is the primary goal in every stage; usability is though to be important alongside with the quality of the system besides other quality factors. In order to have the same rules of usability and design for Ericsson products, an expert usability team including many experts in the field and number of experienced system and GUI designers, have frequent meetings and decide over the factors involve; describe the conduction of the usability test and evaluation also discuss the usability competence drive within the organization.
There are two main responsibilities for this group [100]:

- Building usability competence
- Discipline driver for usability activities

To build the usability competence among each software development unit in the Charging System portfolio, many different steps and activities needs to be taken into consideration; Different guideline documents indicating important instructions for UI is extracted by the usability team, some of these documents regarding building the usability competence, at Ericsson can be:

- Quick guide describing how to conduct a UI review (a quick guide is usually a document owned and made by Ericsson and contains different check points)
- Quick guide describing how to conduct a usability study (User test method), including user recruitment, test environment and etc.
- Overall evaluation guide from usability team and testers on the way of working.

In order to perform usability testing a 3-step roadmap is suggested by the usability group in which it clarifies when and how the usability testing be done. This unit also goes through a list of usability issues identified during UI reviews and comes up with suggested solutions and notes how to solve it in future releases.

All these activities are done in order to make all existing GUIs in Ericsson products have the same look and feel; this is achieved by having a document called 'Design guidelines', which should be followed when a new GUI is developed, in addition to that different methods can will be used to assure the usability of any product, for example UI review is one the most used methods in Ericsson. The other activity which drives toward the usability is a usability evaluation done by Sigma Kudos consulting company

The primary focus when it comes to usability of ERE RMA GUI, is to check if the 'Design guidelines' documentation holds meaning that each unit needs to check the golden document and make sure that those rules have been designed properly. However this document is not all about usability, except the first usability guideline which is to 'ensure

the user satisfaction while upgrade, migrate and configuration of the system ', this guideline is high level and brief and could be interpreted in different ways. The rest of this document is basic usability checkpoints such as colour, branding strategies and such.

6.3.1 User Interface Review at Ericsson

A UI review or Cognitive Walk through, is a relatively quick and easy method to evaluate a User Interface (UI) without involving actual users. One or several evaluators, which can be designers, testers and/or usability experts, step through all steps needed to fulfill a certain task in a structured way while trying to view the UI from the user's perspective. It is important to not only use the designers and testers that are developing and testing the UI when conducting the UI Review. Other project members that are not very familiar with the UI might have other perspectives and therefore identify other issues that the designers and testers who have been working with the UI might miss (home-blindness) [109].

According to usability guidelines at Ericsson, user test responsibilities can be formatted into different steps described in presented table [107] .Table 2, highlights the test activities, tasks and responsibilities concerning those actions are described, the tests should be done using this guideline [71], the methods and details can be decided by testers at Ericsson.

Test Activity	Task	Responsibility
Planning	Identification of user scenarios to be run. Find test responsible. Defining and getting test users. Define test observers. Definition on test environment requirements. Make a test schedule.	Usability engineer with assistance from developer.
Preparation	Design user scenarios Document input and expected results for each user scenarios.	Developer or usability engineer
Execution	Perform/ Run test	Test responsible and test users supervised by usability engineer and developer
Record	Capture results and mark progress	Test responsible and usability engineer
Conclusion	Make a redesign list and usability/ visual requirements	Usability engineer together with developer

Table 2: User test responsibility

In a UI review, one or several task can be evaluated. It is important to focus on tasks that are the most common and relevant to the users, but of course less common tasks should not be forgotten. During each step in the walk through the evaluators should focus on the flow and behaviour of the UI, i.e. not only the user tasks are understood and supported, but

also on the look and feel parts, for instance colour, fonts, language and so on are reviewed. In practice UI review does not focus on user satisfaction, also this method has its own limitations such as the test can be done with just designers and testers and no involvement of users, as it is easier and quicker but it does not bring any values to the product. Most of the usability evaluations done in AIR product is of the type, and usually does not involve any users. However involvement of the users in such tests can make the feedback loop shorter and saves a lot of time in early stages of development.

6.3.2 Usability evaluation done by consultant companies for Charging System product

Most recently, in order to accentuate the usability activities, Ericsson formally assigned a task of usability test to Sigma kudos company as a pilot project. In this assignment the consultants whom mainly take care of the documentation tasks in Charging System products, were suppose to look into the usability and evaluate that. The strategy they had was to go through the design rule and guidelines made by the usability team and make sure those guidelines are covered. They used a template which mainly focuses on simple usability standards, the user satisfaction and how the customer's use this GUI was missed throughout this evaluation. In appendix F, we present a sample of the guidelines and questionnaire they used.

6.4 Challenges in usability of Charging System GUI

The charging system software demands high quality and needs to be delivered in a very short time to the market, to ensure the quality of the system as mentioned before there exist many documented testing, starting from basic, functional and non-functional test in development teams and then regression test in different time intervals until the first quality assurance criteria is met. Then the compound testing is done, which is after integration of the systems; and then different levels of acceptance testing are done in many more different stages.

The utility or functionality of the system in comparison with the success rate of working with a software and whether it is likeable, determines profitability factors in any system. The next step however is the cost factors, the relation between the capital and money spent and consequences brought by usability to the product and organization gives the ability to perform tasks and activities to improve the usability which directly relates to acceptance of the product by customers and therefore profitability [13]. Where there is no feedback of the usability of the GUI from users, we will not have any idea about where do we stand and what are the directives or the next step to empower the product with it, usability test is one way, the next step is to argue where should the usability tasks be performed and how the money spent on these tasks brings us value.

Usability test however demands the user (Ericsson's solution integrators as experienced users who is sent to customer sites to upgrade, migrate and integrate the system) to perform a set of tests and as Ericsson usability group sets rules and regulations to develop the GUIs, there is the need of testing and checking for those rules in different stages of the process, just like testing; however this is quite difficult and expensive to do so and as mentioned in latter chapters it will be sacrificed due to time constraints and scope of the requirements.

The other challenge which can be of importance is the user categories for this system, this includes immediate users such as testers, configuration testers and experienced system

configurations which help the customers during installations, upgrades, configurations and supports which will be discussed later on.

6.5 Open end-interviews and discussions with colleagues

As Ericsson employees with many years of experience, we have attended many meetings, discussions and one to one interviews with different colleagues in Ericsson. Many interesting discussions and different view points was observed, usually the market unit and the management have confidence in the product which is based on the market response, feedback and forecasts; from the discussions with them, the impression is that from them, usability means functionality. The problem with this way of thinking is that even though the product is one of the best, usability can get sacrificed over functionality and in this case even be mistaken by it. Also the other risk as we observed was that, the time dedicated to usability evaluation was limited by program manager who is responsible for the cost of the projects [meeting on 2010-05-11, driven by usability team"Ways of Working and usability pilot", Johan L, Program Manager].

The other scenario was the feedback from ERE design team, surprisingly they had no idea how the customer uses the GUI and how do they set it up, the only information they had was that, customers with configuration in other releases use some sort of migration script to migrate their system. Also they had just attended an interview with two experienced users which was not much of a usability test nor evaluation, but just simple questions of how often do you use it? What sorts of problems have you encountered at customer site? (total of 8 questions) [meeting on 2010-06-21, One to One discussion with ERE team, Elisabeth F, ERE team leader and Helen S usability group team leader].

We also had discussions with other designers and testers of AIR-RMA-ERE GUI which with the help of ERE GUI logic, they develop the actual AIR functionality. Setting up scenarios with GUI and how the end users actually use it is quite unknown therefore it is tested with pure intuitions and perceptions. Sigma Kudos consultants whom were in charge of the usability evaluation pilot project had the same view toward the GUI. initially they are responsible for documentation and have worked with examples of GUI configuration, however they have very little idea about how the GUI is being configured in actual customer site [meetings and discussions, during May and June 2010, Dag B, Designer, Fredrik S ,Designer, Marie H, System tester].

During the usability test which was conducted involving the experienced users and system integrators,we had many discussions, including how do they use the system at customer site, what is the direct feedback they get from customers and if they suggest any improvements? We have used some comments and discussions in conclusions chapter, but the overall impression was that, it is very costly and sometimes cumbersome to train and educate new groups of people specially at the customer site. They also mentioned that customers can use the GUI in many different ways and that can cause some misunderstanding of the functions later on, and it is difficult to troubleshoot the misconfiguration. Most of them pointed out the errors messages and thought it is sometimes misleading.

We used some of these discussions together with results from usability, as an input for our recommendations made in the last chapters.

Number	Name	Experience in charging system in year	Role	Sex	Age category	Date of usability-test	Time of usability-test
1	Glendale G	Less than 3	Business Configuration	Female	30-35	2010-08-23	15:00-16:00
2	Oliver S	Over 10	Business Configuration	Male	40-45	2010-08-24	10:00-11:00
3	Dev J	Less than 3	Business Configuration	Male	25-30	2010-08-24	15:00-16:00
4	Kristofer S	Over 3	Solution integrator	Male	25-30	2010-08-25	15:00-16:00
5	Peter E	Less than 10	Senior Business Configuration & Market/sales	Male	25-30	2010-08-26	09:00-10:00
6	Nathalie A	Less than 3	Solution integrator	Female	25-30	2010-08-26	14:00-15:00
7	Fredrik S	Over 14	Senior System Developer	Male	35-40	2010-08-26	15:00-16:00
8	Carina A	Over 10	Senior System Developer	Female	50-55	09/01/10	15:00-16:00
9	Liselotte P	Over 15	Senior System Tester	Female	50-55	09/03/10	10:00-11:00
10	Helena L	Less than 3	System Tester	Female	30-35	09/03/10	15:00-16:00

Table 3: information about participants in usability test- please note that for security reasons according to NDA document of Ericsson we can not mention their full name.

During this work we had many interviews with the usability team and the team leader, they also agreed that despite the importance of usability, we have not performed any usability evaluation nor usability tasks which directly relates to customer satisfaction, effectiveness and efficiencies, learn-ability and even how the customer actually uses the system. And that is due to lack of time, sources and access to range of users on demand(usually the experienced users are abroad or off-site performing integration at customer site)[16].

Section5- Result and Analysis of usability test

7 TEST CONDUCTION

The main purpose of the usability test in this thesis was to evaluate the GUI of RMA (Rating Management Application) by testing it on internal end-users at Ericsson (a table including the participant information was presented in chapter 6.4). This allowed us to investigate and identify the errors and possible areas of improvement for this GUI, and also it helped us seeing the importance of existing usability tasks and thereafter justification of the cost imposed by it. Using this technique we carefully created a scenario with realistic situation (so that the task is done by configuring only one GUI and can be simulated in real time, to observe if the task is successfully done), wherein each individual performed number of use cases while we observed them and took notes (for more information about the use cases please refer to appendix A, due to security reasons the step by step instructions, which included the snapshots of the GUI can not be published). Several different test instruments such as scripted instructions, pictorial instructions and post-test questionnaire were used to get feedback from participants. Also we employed popular methods of cooperative evaluation and remote testing to gather the data during the testing. In the beginning, the plan was to only perform the test using cooperative method but then we decided to employ the remote testing as well.

Cooperative evaluation, advised by Ericsson as is a variation of think-aloud protocol which has been established as an effective approach to usability evaluation [16]. Think-aloud protocol (TAP), is a data collection methodology in usability studies where the main focus is to observe the users while encouraging them to 'think-aloud'; to say what they think and wonder throughout the test [7]. The think-aloud data is referred to as verbalized thought deduced by users while completing the task [45]. By this method, the participants attempt to carry out defined tasks while they are able to speak their thoughts and elucidate any difficulties encountered during the test. The evaluators record the user's emotional reactions using different methods such as tape recording, video recording, computer logging, user notes and pencil and paper. Cooperative evaluation attempts to make this process more natural by turning it to a conversation where the participant is encouraged to speak their minds and evaluators are able to clarify their points of confusion [38]. Cooperative evaluation is considered to be a more relaxed approach of TAP where the evaluators are not forced to sit in solemn silence.

Remote testing is a cost-effective approach that is employed when the evaluators and participant is the test are separated in space and/or time. Elimination of transportation cost and time is one of the undeniable advantages of this method. The evaluators send the test materials to the participants and the participants are obliged to take notes of the problems and difficulties they faced during their performance. Remote testing allows the evaluators to gather more feed back from a larger number of users and uncover more problems. one of the main challenges with this method is the difficulty to grasp the non-verbal cues and body language. Applying tools such as video, audio and network connections during the test can assist the evaluators in monitoring the participants [106].

Questionnaire is an inexpensive way to collect different types of data from a target population in a fast and easy way. It is crucial to design a questionnaire well so the questions have clarity and convey the same meaning to different types of respondents.

Questionnaires are considered cost efficient compare to face-to-face interviews, mainly due to large sample size of respondents and large geographic areas. Questionnaires are known to most people and nearly everyone has experienced completing one. The result can be presented as tables, graphs and pictogram. Another advantage of the questionnaires is the reduction of bias since the questions are uniform and there are no verbal or visual clues to affect the respondents [38].

In this study, the designed questionnaire was reviewed and verified not only by performing pilot test but also with the help of usability team leader and according to the standards of Ericsson's Online Mediation product in order to keep the consistency and standards within Ericsson's different products. This questionnaire was filled by the test participants after the usability test. It was designed in relation to the tasks as well as some general questions about efficiency, effectiveness, satisfaction (comfort / likeability). These questions are of different types: multi-choice questions, questions which can be answered as free text (open ended), and there are two questions: "Were you able to complete this task on existing GUI in the first attempt? (First question)" or "Did you need assistance/help during this task (11th question)?" which should be answered by yes or no (bipolar questions); the last task was to simulate the usability testing, which actually shows if the participant completed the task successfully or not. The fact that the task could have been either simulated or not, it has been a major reason for choosing bipolar questions.

7.1 Piloting the Test

A pilot test was conducted by us [Parisa Y as conductor of the test and Pegah Y, Fredrik S as participant as they are experienced user and solution integrators, on 2010-08-25] as a preliminary test of data collection tools and procedures in order to identify and eliminate possible problems. In order to prevent bias in the test, the person who had designed the task (from experience and discussion with other system developers), was the conductor and the users had not seen the tasks before. This practice allowed us to make corrective changes and adjustments before the actual performance of the test with the targeted group. During the pilot test, we simulated the actual test in a smaller scale to ensure that the questions are appropriately designed and can lead us to collection of right data. The feedback from this phase assure the instruments and their likelihood to work as we expected in 'real world' circumstances.

7.2 Usability Test Conduction

As mentioned earlier in this chapter, in order to fulfill the aims and objectives of the usability testing in this thesis we decided to conduct the usability test in two different ways. In the beginning of the test, we choose to employ the cooperative evaluation which is highly dependent on Think-aloud protocol. With the difference that participants have more freedom during the test and are allowed to ask questions and take help when needed. Later, we chose to use remote testing in order to access geographically distant and specialized users. Using remote testing, we tried to extend our data collection from Sweden to Lebanon.

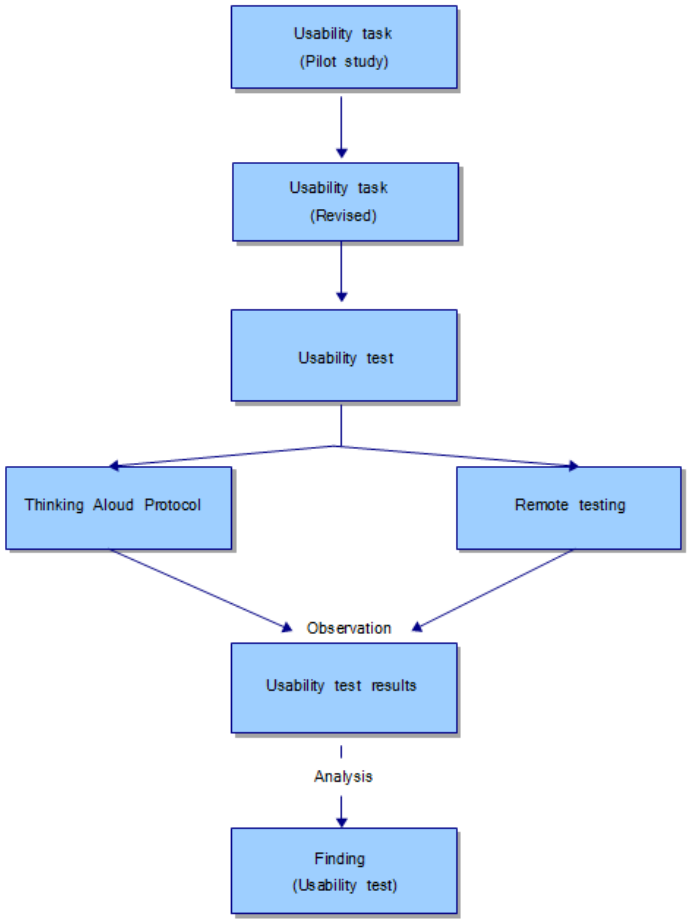

Figure 4: Usability Testing Process

The usability test consisted of a number of use cases which users had to perform, a detailed description of these use cases are presented in chapter 7.3 and the actual instruction is presented in appendix A. The test was started with a brief overview of use cases, procedure of the test and objectives to conduct such a test was presented to each participant (table 3, chapter 6.5). The users had to perform a set of predefined use cases that were presented both in written and pictorial formats. The participants were free to chose the format they wanted to follow during the test. These use cases were generated following standard RMA documentation at Ericsson. The task start state and completion was clearly stated. The stop condition in this task was to be able to simulate the logic created following the use cases. After the stop condition has been reached, the users were presented with the next stage of the test which was answering the questionnaire.

The questionnaire was designed and developed after careful consultation with experts in RMA interface [included: Parisa Y(system developer), Pegah Y(system integrator), Fredrik S (system developer), Dag B (system developer)]. To present the objective of the questionnaire clearly and specifically, questions were designed in two types: fixed-alternative and open-ended. The fixed alternative questions provided the participants with fixed alternative such as multiple options and rank scaling [appendix C, example question 1]. On the other hand, the open-ended questions allowed the participants to freely express the answer at the same time made the information more difficult to analyze [appendix C, example question 29]. The questions were pre-tested (in the pilot study) and revised to

discard ambiguity and get a better feed back. In order to run and analyze the result of questions, we employed a commercial user research tool called AddUse [113]. Using this tool, the result of the survey is visualized in graphical way and it can also be exported to Microsoft Excel to view the result as diagrams. We used the Excel sheet to create our own graphical result.

After completion of the tasks and questions the test was finished. Throughout the usability test, we both observed and provided the participants with help. We wrote down the observations while the participants were performing the tasks [appendix D]. The time each participant performed the use cases was recorded as well. During the test we reminded the participants to think-aloud and speak their minds and opinions. In the case of remote testing we were in different location and were not in the same time zones.

Conducting the test sessions with remote testing was similar to conducting the test session with local method. The participants stepped through the instructions and completed the test. Although we faced Test-blocking issues which prevent us to finish or even start the test despite all the preparations for the remote testing. Among these issues we can highlight system and connection performance issues. Also another obstacle was loss of control over participant's environment which made the troubleshooting more difficult.

7.3 Participant Selection Method

In the process of choosing the right participants, Ericsson usability team advices were also taken into account. The usability test was performed with total number of 15 participants. Among these participants; 9 individuals were appointed to participate in cooperative evaluation , 4 individuals in remote testing and the remaining 2 were involved in the pilot test. The participants were chosen from two different departments at Ericsson: BUGS (Business Unit Global Services) and Product Development Unit (PDU). The participants hold different roles and responsibilities in each department but all with Charging System background. In BUGS, 5 Solution Engineers in two different level of assessed and experienced and one senior Solution Architect were involved in the test. In PDU, both experienced and non-experienced testers and developers were included [for details refer to table 3, chapter 6.5].

The participants were required to have basic knowledge of charging system to be able to participate in the usability. The experienced integrators usually work with only one or two products of many products in the charging system. There are only 16 people working as solution integrators for charging system products in Karlskrona, and not all of them have the specific knowledge or have worked with the ERE/RMA GUI at customer's site. Also due the reasons such as traveling most of the times to be present at customer's site and being involved in tightly scheduled projects, mostly they were not able to be a part of usability test conducted in this thesis.

Two evaluators supervised the usability test, one taking notes and monitoring the reactions of each participant while the other guided the participant whenever needed and got engaged actively in conversations with participants. The evaluators also wrote down the mistakes that individual made throughout the test. The time of performance for specified tasks was recorded as well. Due to security and confidentiality reasons (NDA), test sessions were not recorded using video or audio.

7.4 Test Environment

The usability test was conducted at Ericsson, Karlskrona. Each participant was individually booked for the test with the timing that suits him or her the best during the working hours. The test sessions were conducted in quiet and peaceful rooms based on the availability in order to minimize possible distractions and interruptions. The printed out papers of use cases in both written and pictorial format were+ handed out to the participants. Some participants had to use the evaluators' laptop to be able to access the latest versions of RMA GUI. The chair, tables, monitor, keyboard and mouse used for the test were the standard ones at Ericsson, although the participants had the freedom to bring their own accessories for their own comfort. Microsoft Internet Explorer was used for both accessing the RMA GUI and the questionnaire since it is the only supported web browser in Ericsson.

7.5 Recording

The participants had the freedom to express their opinions and thoughts throughout the test. In order to record such input data, we prepared a note beforehand to fill in with important information such as:

- Name of the participants
- Duration to complete the tasks
- Number of errors made
- Successfully completed tasks
- Unsuccessful task

The information gathered was used as the input for presentation of the result and analysis phase [appendix D].

7.6 Task definition

We have designed 4 different tasks(use cases), rationally related, which performs meaningful actions on a subscriber account and simulating it in real time system. These tasks are designed such that only ERE-RMA AIR GUI needs to be configured in order to complete the tasks. The AIR product as a part of charging system product with many GUI's, has two different GUI's as mentioned before, Account Voucher Information Manager (AVIM) and ERE-RMA AIR GUI. The designed tasks can not possibly cover the features in the GUI as it is a very complex one, however the GUI is quite consistent, which makes it possible to choose only one scenario. The tasks are designed as below to present the logic for the most basic functionality of AIR product:

- Create a subscriber having activation date, service category, expiration date and a 100 SEK as balance in the account.
- To perform a refill and add 200 SEK to the account.
- To perform a date adjustments by adding certain days to expiration of the account and the service days.
- And simulating the above tasks to make sure the system works

The GUI used in this test is the next version of an existing GUI but it has the look and feel of the last version (release), which is already at customer sites and being used in real-time; except that the user has not seen the new functionalities added to the system. This test is

done with live development GUI, not the live operator GUI. The difference is that development GUI can be adjusted and if any problem has been found can be fixed immediately as development is ongoing and the next software drop is in process: the customer GUI, however can not be configured once it is live and the system is used by millions of subscribers. Focusing on usability improvement in this GUI is our intention [appendix A].

8 RESULTS AND ANALYSIS

Test result from participant's observation can vary from one participant to another. In most cases, the result of a usability test is a log written down by the observer regarding the participant's actions during the test. Throughout the usability test, the observer collects lots of data in their logs [21]. A list of the usability problems can be easily created by reviewing the logs from usability test sessions. This list can indicate incidents such as the errors that user have made, problems faced while performing the task due to insufficient information, or was not sure what action to take next.

Once these problems are categorized they should be prioritize which can vary from a binary break down of problem to ”catastrophic” and ”minor” to a more continuous rating of problems such as the total time spent on a specific problem. Redmon-Pyle describes the catastrophic problems as those where the user fails to finish the task or thinks that the task is completed while it is not. In the other hand, minor problems are specified as the problems that do not help in achievement of the goals in usability test. The unit of analysis could be of some kind of utterance such as a defined themes, a particular sentence or even a paragraph [112].

8.1 Test Participants

In total 10 participants performed the usability test and answered the questionnaire. 9 of these participants performed the test locally using cooperative technique whereas only 1 participated in remote testing technique. In addition to this participant, 3 more were also involved in remote testing although due to Ericsson firewalls, they could not finish the tasks completely but they answered some parts of questionnaire. Also they forwarded their suggestions regarding the possible usability improvement in RMA GUI. The person who could participate in testing had already the latest version of the RMA GUI installed in her work environment [table 3,chapter 6.5 and figure 5 in chapter 8.2 provides more detailed description about participants and the overall outcome].

8.2 Test Result

In the usability test, each participant performed 4 use cases according to the manual provided to them [appendix A]. This manual is inspired by one of the Ericsson documents provided for administrators and professional users. In both techniques the participants preferred to follow the scripted presentation of use cases. Visualization of various data has become popular during the last few decades [21]. Using this approach, large amount of data can be analyzed and comparing the data between different participants. Remote testing method, and the fact that only one participant succeeded to perform the test, the result is only presented for one participant.

The results for both tests are depicted below both in table and graphical presentation. The successful tasks are denoted with ”Successful” whereas the unsuccessful tasks are denoted with ”Unsuccessful”. In the task description, the last task is to simulate the refill, which is a functionality in ERE-RMA-AIR GUI that upon simulation, the actual tasks will be performed and the final result (adding 200 SEK which makes the total balance 300) will be visible (successful) or it simply indicates the failure of refill process(unsuccessful). Other factors such as Total time to complete, Time to Support, Total Time without Support and Number of errors are also represented.

Participant ID	Total Time to Complete	Time to Support	Total Time Without Support	Number of Errors	Successful/Unsuccessful
1	09:06	00:00	09:06	0	Success
2	13:24	02:53	10:31	2	Success
3	19:27	04:18	15:09	3	Success
4	23:42	05:16	18:26	2	Unsuccessful
5	20:08	07:37	12:31	5	Success
6	27:13	08:21	18:52	2	Unsuccessful
7	37:24	17:38	19:46	2	Success
8	32:19	15:09	17:10	4	Success
9	38:14	10:51	27:23	3	Unsuccessful
10	50:47	31:38	19:09	2	Unsuccessful

Figure 5: Usability Test Result

Further, we have presented these factors graphically with descriptions as below:

- Total Time to complete the task : Figure 6 , presents the total time to complete the task for every participant. The time to help every participant is presented by red color while the green color reflects the total time every participant has spent on the task without taking help and support from the observers.
- Number of Errors Factor and Successful/Unsuccessful Factor: Figure 7, presents the number of errors each participant made during whole the test. The pink color represents the successful task and the blue color represents the Unsuccessful ones.
- Number of Errors Factor to the Total Time Factor: Figure 8, presents the ratio of number of errors to the total time to complete the task for each participant.

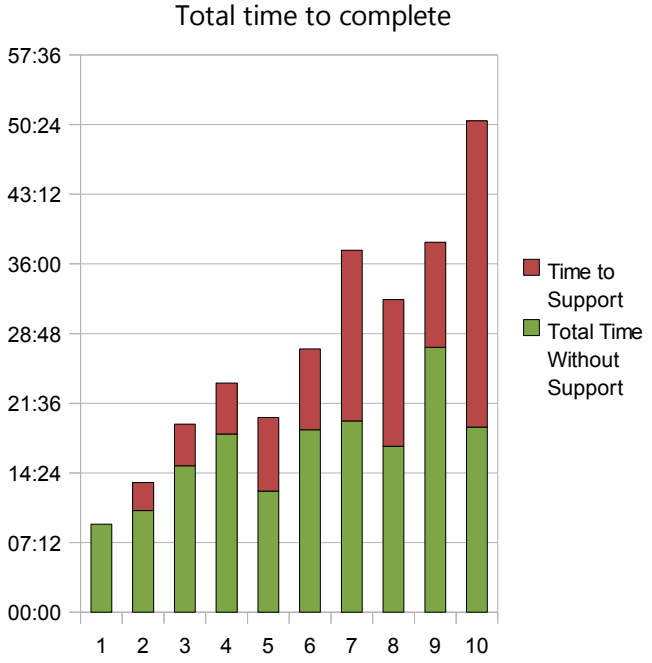

Figure 6: Total Time to Complete

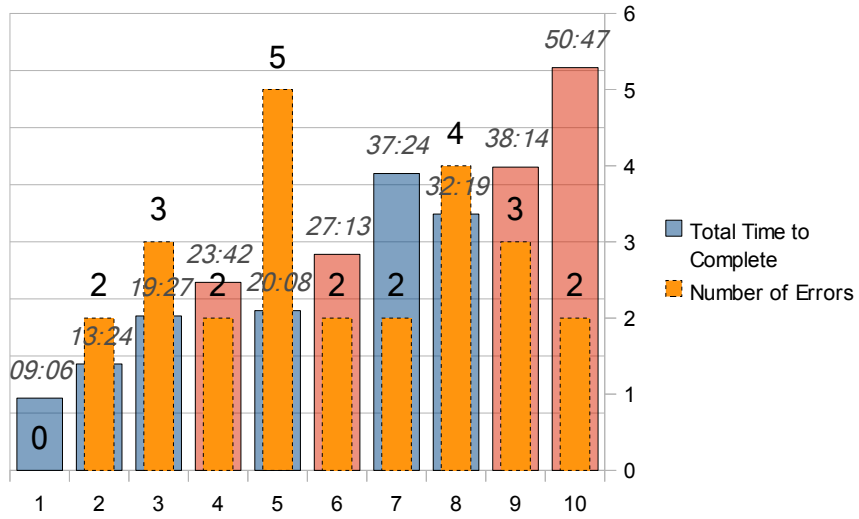

Figure 7: Number of Errors Factor and Successful/Unsuccessful Factor

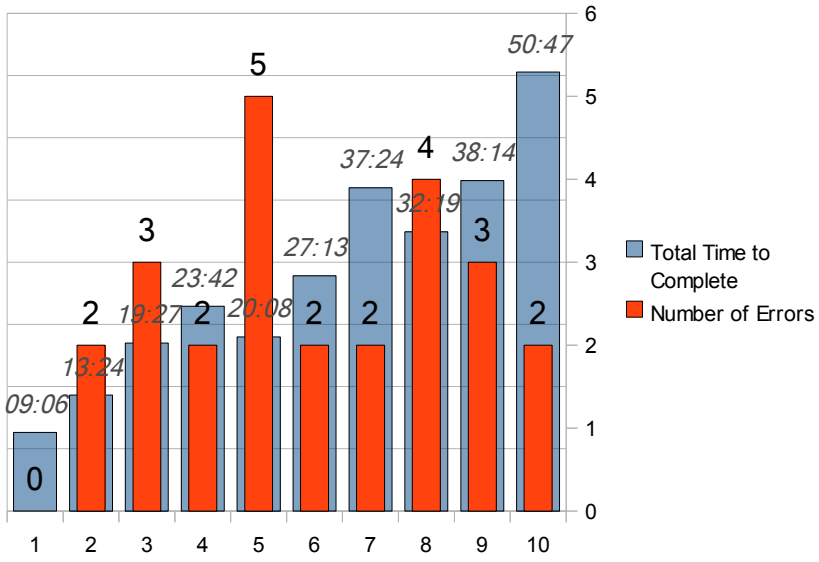

Figure 8: Number of Errors Factor to the Total Time Factor

As it is presented in the above table Participant number 1 has performed the test without any help or errors. This is due to the fact that participant number 1 has been involved in both design and test of RMA GUI.

8.3 Usability Test

Every participant had to perform 4 use cases where:

- The first use case was to ”Setup a Basic Refill Tree”
- The second use case was to ”Setup a Basic Account Refill”
- The third use case was to ” Set up the Logic in Basic Refill Tree to perform an Account Refill”
- The fourth use case was to ”simulate” the tree.

For an overview of available refill services, see the following figure. The use cases in this study only cover the Account Refill part.

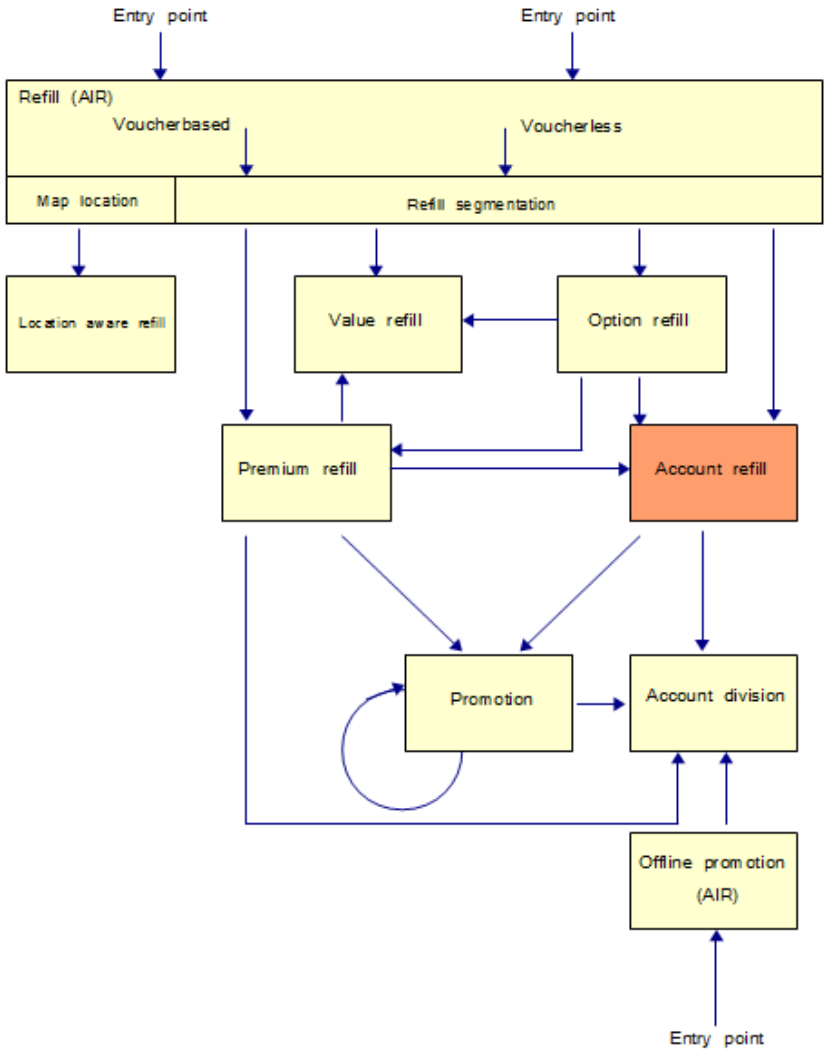

Figure 9: An overview of Refill

The whole purpose of these use cases was to setup logic for an account refill where money is added to a subscriber's account and the account's expiry dates are extend. The participants had to build the logic for account refill in first 3 use cases and simulate it in last use case to verify he logic. In both test methods participants faced issues that we noted

down. These issues are listed below.

- It was difficult for most of the participants to link the tree with logic behind of it.
- In most of the cases, error messages did not mean anything to the users nor could they use it to fix the problems.
- Some participants believed that so many steps were involved to set up such a simple logic.
- The users were not aware of the purpose of each step taken in the instruction.
- In most of the cases where the participants made mistakes, they did not notice it till they get into real troubles such as not being able to simulate the logic.
- According to few participants, it was difficult to grasp the concepts of all available fields for building up Nodes, Conditions and Modifiers.
- They also faced inconsistency in the language of the GUI, for example in some cases the Swedish word of ”stäng” is used instead of ”close”.
- The users without previous experience could not find icons such as run the simulation
- The main issue for quiet few of participants was to understand the difference between definition and root of a tree.

Apart from all the above points, participants shared their thoughts with sentences such as:

- How can I start?
- I was confused by
- I think the most confusing part was
- I wonder where can I find
- I have to reread part
- Can you explain
- It is difficult to”

8.4 Usability Test Observations

The respondents were instructed to complete the tasks with additional task to concurrently verbalize their thoughts. The respondents varied considerably in the degree to which they were able to say loud what they thought during the test. Therefore, we constantly encouraged the respondents during their moments of silence by statement such as ”Please say out loud what you think”. To record participants cognition and emotions we collected two types of data:

- observation data regarding the respondent's behavior
- observation think aloud data by listening to verbal expressions of respondents

To clarify and complete the observational data collected from respondents actions and thoughts, we had to check the information by asking questions such as ”Did I hear you say.” or ”You had a pause for a while there, what did you think?”. Unfortunately due to security and confidentiality (NDA) issues we were not able to record any of these observational data neither on audio nor on videotape.

In the case of remote testing, it was not possible to record such observational data. Due to security, it is only allowed to use the tools provided and supported by Ericsson. Therefore

we used available tools such as Lotus Sametime, Sametime is security-rich and enterprise instant messaging which also is integrated with voice (VoIP). We also were able to share the desktops during the test using.

8.5 Why Usability Test?

Performing usability test and usability evaluation can be part of the activities done as usability task [8]. The feedback and data collected from usability test can play vital role deciding how to invest in further in development of GUI. The Advantages of usability testing for organization and users can be, first, Increasing total revenue by growth of: transactions, conversion and hence turnover ,returning customers and new customers through word of mouth advertising. The second advantage can be stimulating the use of the GUI by Increasing the success ratio, efficiency (less time to complete a task)and satisfaction of user and decreasing the number of errors and stoppers for them. The third organizational advantage can be saving on development and maintenance by saving development costs and decreasing the development time also reducing maintenance cost [116] .

Usability test has advantages for the user as well, it is a positive experience and develops trust in the organization, and they will be more satisfied by getting the idea that their view points matters. Performing usability test was a way to collect data and have one to one interaction with our experienced users.

Most of the advantages for the organization such as increasing revenue management and saving development and maintenance has direct relationship with cost and usability. Usually a usability test framework helps practitioners conduct the usability tests [8], In our case study we used a usability test to collect more information not only about using the GUI and how it is configure by experienced users at the customer site, but also a way to collect their feedback and view points about justification of the usability available in this GUI in terms of cost and the negative effects brought by lacking the usability. As there is certainly lack of usability activities in the software development process in this particular case, it seemed interesting to find out how deep it has affected the users, considering the fact that it is hard to introduce new ideas and usability changes for experienced users in any product [8]. In the next chapter we will look more into the types of values and benefits and affects in our case study at Ericsson.

9 COST JUSTIFICATION OF USABILITY ACTIVITIES IN ERICSSON

In this chapter the our findings during the usability test and justifying the need of usability tests and activities in relation with costs, in this specific case-study will be discussed and illustrated. This chapter helped us understand the case-study better and also to draw conclusions from this study.

Benefits of performing usability actives in many perspectives, and the difference between Cost Benefit Models (CBM) were described in detail in chapter 4, we also discussed the importance of usability in software industry, how and when usability activities can be deployed in software engineering. In chapter 3 and 5, we have discussed the definition of ROI and how it is categorized, in chapter 5.

Value propositions brought by usability-engineering to any product were described, using many examples, we believe these value propositions are the result of usability tasks, even at Ericsson company. This value propositions directly points to savings in terms of costs and time, in design and maintenance and even redesigning of a system; reducing costs in those stages; attracting customers and market share; increasing ease of use and reducing training and customer dissatisfaction.

In chapter 4, the benefits of usability for different parts of business, according to many usability gurus, have been categorized and compared, by studying those categories the need to usability in production process is being emphasized on. As mentioned an overview to those benefit categories [86]:

Benefits	Affect
Benefits for Product development	1. Less need of resources 2. Prioritization of product features 3. Less need of future redesign
Benefits for marketing and sales	1. Gaining competitive edge 2. Increasing customer satisfaction
Benefits for customer support	1. Reducing product support cost 2. Minimizing the demand for end user training
Benefits for end users	1. Increased productivity 2. Less need for support

Table 4: Benefits of performing usability tasks [86]

9.1 Benefits for Product development

Ericsson at Karlskrona, uses the Agile mindset in software developing which means in a team of software development, with set user stories or system specifications, a group of designers and testers are constantly producing deliverables to the next stage of the chain which can be different stages of quality assurance.

Applying usability activities and usability tests in early stages of product development, will bring enormous advantages to development process, and as Ericsson's agile mind set allows, these tasks can be done based on intervals and even when it seems necessary. The combination of usability activities and agile mind set helps prevent redesign in latest stage of development. Looking at early usability activities in a project and involvement of users in early stages of development reduces, late change requests made by customers and can save money.

For this specific product Account Information Refill (AIR), the GUI is produced from the main ERE GUI, with more or less the same logic; this means if in case there is any basic usability issue the correction of that specific bug needs to be done at the ERE product. This can be a very expensive process, in which it can be cut by performing usability test as soon as a logic has been developed in the ERE product itself.

Product development teams can save a lot as it will need lesser resources, to correct a bug. A bug in the GUI, regardless of if it is simple usability fault or a huge functionality defect, is definitely cheaper to be found in early stages of software development [59][104].

Consider finding a bug (or simply suggesting an improvement in system specification), such as having an **Esc** button on one of the windows in the GUI,in order to fix this problem the entire cycle of development should be repeated; the specification comes from system management group, the basic GUI rules come from the ERE node and the direct user for that will be AIR node, which that specific functionality specified by system management is developed in one of the teams; after the developer in AIR node finds the bug or wants to make the suggestion, he/she should write a bug report, in next stage, that will go back all the way to system management or the ERE team and it will then be fixed, tested, packaged and delivered to the AIR node; meanwhile the developers should put that task on hold and obviously the development will be delayed and the next stage user of that GUI should wait as a result.

The time consumed at this stage can be saved, the redesign of that can be cut short and that time can be used for prioritization of product features, therefore less waste versus more profit, by early usability testing.

9.2 Benefits for marketing and sales

Delivering the product, with high quality and on-time to the customer is one of the Key Performance Indicators (KPI) goals at Ericsson. This simple fact will help the competition against different companies, who want to capture the potential business in the market Ericsson is active in [63].

This quality refers to not only functionality and features but how it looks and feels (usability) which can bring a very strong marketing advantage for Market Unit (MU) and Ericsson’s salesmen. According to one of the sales-people during discussions in our

usability test, when a customer sees the advantages of our GUI over the other competitors, we have secured the sale, as they know that they can get any feature they wish for.
Customer satisfaction is another perspective of this area, good usability for customers means ease of use and less money to be paid for different courses, trainings, supports, etc. [63] To effectively harness the competence of the consumer, software developing companies must: engage their customers in an active, explicit, and ongoing dialogue; mobilize communities of customers; manage customer diversity; and concrete personalized experiences with a customer, which is partly done by usability tests for them to respond to their needs [81].

9.3 Benefits for customer support and end users

The other important fact that can be looked upon is, performing usability test in different stages in a systematic way can help the different users and then the customers (they are two different categories, users are experienced users at Ericsson whom are sent to perform installation, upgrade and migration of products at the customer sites which is usually different operators) trust the system more, learn it easier, and reduces the need to waste any time (money) when they are configuring the system.

Ericsson is by the customer's side, giving them support in all the stages, starting from installation of the software for new vendors, upgrading the system from current on-air system to a higher version and maintenance of the system in-use. In case of any emergency or discovery of a bug, three lines of support are there to help the customers; level one more or less to identify if the problem is a genuine one or if it is just misunderstanding of the functions or misconfiguration of the system; If it is needed to escalate the problem then a second line of support which are more closer to design centre will try to fix the problem; if severe, the third line will be informed, and the third line is no one but the design units, which gets the change request or the trouble report.

The development, test, repackage and all of the other production process has to be done from the beginning, meanwhile it is the company which has to pay all these costs, as product support cost; Usability test as a part of quality assurance in many different stages, can minimize the risk of having bugs therefore reducing the product support.

Different layers of users, for charging system product, which can be identified in this case can be:

- Designers in different projects, as they have to use ERE base GUI to develop their features (also known as third line support)
- Testers in the same projects, as those features have been developed, to configure the system, understand and test it in the best possible way
- Different compound testers, as they need to configure many GUI of the same type (ERE) to be able to test the whole system
- Ericsson resources, which configure the system around the world (second line support)
- Ericsson resources, which support the system around the world (first line support)
- The final customer (Operators) around the globe

If the usability is checked in every stage or at least after each design activity for the GUI, the usability issues can be fixed and tested in shorter time with much lesser cost and it makes it much easier to be learnt by the immediate user.

The cost which is used to teach these users in different part of organization, and mastering those GUI (therefore the product) can decrease a great deal. This clearly reduces demand for end user training and increases the productivity of all the end users, including testers and designers using ERE logic as bases of the GUI. The latter is very important as, the productivity of the designers and testers increases drastically and need of support decreases. When we talk about the support to these groups we even refer to help provided by colleagues with more competence, this will be discussed more in following subsections.

9.4 Affect of Usability on Internal ROI

In chapter 5, different ROI categories and the effect of usability on it was described. ROI brought by usability activities and its justification regarding AIR GUI in charging system product, gives a strong argument toward cost justifying usability, we will try to identify different types of ROI and its challenges in our organization.

As Internal ROI targets the anticipation of efficiencies during development cycles (chapter 5.2), the improvements which are directly caused by a better usability and conducting periodic usability tests, at Ericsson, in regards with Internal ROI are identified as:

- Decrease of development costs
- Prevention of redesign
- Reduction of time to get the product to market
- Increases the efficiency of development team
- Promotion of the external ROI

Being aware and fixing the usability problems in the ERE GUI, will empower the development teams as they will make lesser design mistakes and can scan the product for more severe bugs as there is more time to spare, instead of trouble shooting the usability issues, this decreases the costs and helps finding the problems and prevention of redesign which makes us save time and costs, therefore the product will be launched in market in a greater speed.

Involving the global customer care and system integrators, which have the closest relation to customer and are assumed to be our expert users will help us identify what are the most useful usability features which they need? And how are they really using the system? Also what improvements do they need to have, to help them be more efficient and satisfied? These are the issues that are needed to be checked, in the usability tests for ERE-GUI; that though should be done as a process after every change which might affect the GUI (there are many GUIs for our product, AIR is only one of the GUIs in this complex system).

The challenge which can be seen in this method, in such product like AIR GUI which is in latest stages of development before the customer uses the GUI, is in fact the disclosure or exaggeration of the problems found in usability of the system, this might affect the internal, external and social ROI in a negative way, as in late stages of development, a forgotten mistake or a minor problem can be hard and expensive to fix.

Just having the usability team and conducting the design rules while designing the GUI, does not help us identify and improve the usability of product, simple usability norms and issues will be taken care of, at this stage; however, the users needs and recommendations will be of a great use in achieving their satisfaction, efficiency and effectiveness.

Ericsson products, do have the best quality and technical details one could wish to use; and also we do have the most experienced users and system ingrate engineers globally [107], by involving them more in the usability team, and taking the decisions together, we can have even a better product, with lesser overhead costs; as the most basic usability demands form user site will be thought and integrated in the software much earlier in the development process.

The ratio between usability issues that could be cut far before the launching product, or during the latest stages of test and quality assurance of that release, to the cost that fixing those bugs in late stages or even when the product is out in the market can be described as(the calculation is based on experience and arbitrary observations, and has no actual business value, the exact calculation can not be revealed based on the NDA agreement with Ericsson):

- Imagine a TR found at the late stage in software cycle after design; test, system integration, integration test, acceptance test before even being launched at customer (usually this makes a case as discussed before, and it is costly in terms of quality, social ROI, internal ROI, external and the reputation of the vendor name).
- Calculating an average 2-3 days to reproduce and observing the bug and fixing the actual bug in design level by one person and multiplying it by number of people involve in the next stages of process (and estimate of between 5-10 other people), multiplying the wages they earn based on hours an approximate (60x1000SEK) 60 000 SEK per bug.
  People involved in support (3lines)xHours spend investigating and solving xHourly wages
- Also having in mind, the different levels of customer care, and the price Ericsson must pay for each bug or issue found to the customer as compensation (again the amount can not be revealed and a part of NDA).
- This amount can be easily cut by better investigation of usability in the product.

9.5 Affect of Usability on External ROI

As a complex product, charging system has many GUIs based on ERE GUI, in order to configure any system in the world, different system integration engineers which are highly experienced users to parts of this system, have to get together and configure the system at the site for customer. Reduction in cost of training and materials for these users which includes formal training and them being away from the job for a certain period of time, and duration to gain the right competence by trial- error, reading the documents, asking other experienced users etc. can be a very strong business goal.

Measuring external ROI is a very difficult process however it can be done by studying the factors such as number of helps, duration of each case, percentage of escalated calls. During our usability test we observed that the time they spend on trouble shooting varies, but still lack of relevant information such as proper error codes consumes much more time than expected. Performing the use cases presented in the actual test, even though, the tasks was not the most complicated one, without problem or error which actually was related to usability was seldom. It either took a long time to perform the tasks correctly or they simply failed to recover the system, in the given time!

The same users defiantly object, in case of major usability changes in the product that

takes them away from their comfort zone, but a lot of their ideas and assessments can be used in development phase, which will bring a lot of beneficial suggestions, in terms of money and time. It is also vital to investigate how the customers have configured the system and are using it; the closest link to the actual customer to Research and Development (R&D) unit is this group of users. Perhaps by spreading this information we can show the customer that we care for satisfaction and we cross the fine line of profitability by doing so. Taking surveys, interviews and analysis of those results from these experienced users, or simply involving them in the usability team is the best possible way to achieve the External ROI. Different suggestions which have come up during the usability study will be presented in conclusion part of the report.

9.6 Affect of Usability on Social ROI

As mentioned in chapter 5, social ROI is concerning the participation of designer, testers, developers and users with usability team and engineers, and affect both internal and external ROI in a great deal.

At Ericsson the sales and market unit, the solution integrators, system management, system architects and the actual operators work very closely; there are many different conferences, meetings, user group discussions and close collaborations. At the R&D sites, different usability groups with different categories of members and variety of task and objectives along with the best usability engineers work toward a better and more professional product. In charging system unit simple usability tests are done in a routine form in quality assurance phases, but the questions are: how useful are these groups and how can we improve in this field? The best option is to narrow down the gap between the operators and users with designers of the product to get a strategic business vision.

To get early feedback from users, in different parts of development and applying it constructively in the process of development, we need to include the right group of correspondents in usability team or usability tests and activities. From time to time there are different studies conducted by the usability team for these groups of user, but a systematic usability test in which measuring values with the focus on categories such as satisfaction, effectiveness, efficiency and the level of comfort and general feedbacks, or even a retrospective, containing what is working fine? And what needs improvement? Will provide great guide lines on how our product could be improved.

According to one of the participants in our workshop, “our GUI looks good, and has a lot of functionality which is very good selling point, the customers love it once they get a demo of it but in real world most of those complex features are not used, just because it is cumbersome to set the system and maintain it”.

Section6- Epilogue

10 CONCLUSIONS

In this chapter we try summarizing the evidences for our conclusions and have a recap of the overall findings in the thesis. We also go back to research questions and point out how it was answered in this report, also the future work we recommend to be done at Ericsson in regards with usability improvement will be discussed.

10.1 Conclusions

As most of the managers and decision makers in developing software intend to reduce the costs, usability gets neglected and sacrificed for time constraints it is important to show that usability activities brings values in terms of money, this is cost justification of usability, which is described in previous chapters. The problem with presenting actual cost by multiplying the hours(used for rethinking, redesigning, retesting, repacking and releasing the software after the software has been released and the usability problem, or any other software bug, found) is illustrating of this fact.

In order to bring customer collaboration, their expectation, flexibility toward the changes in the system and fast delivery with the least overhead costs feasible, we need to identify the problems as early as possible, by performing usability activities involving our users as soon as design is over, alongside with functionality test we can partly achieve this. Most of the findings in this case study has been in line with what any usability text book says(we will have some of these points in recommendation chapter). The conclusion based on the performed case study in this thesis is that, the reason that the usability engineering principle is not widely used in organizations is due to deprivation of cost justifying usability and therefore not recognizing significant values brought by it.

The objectives of the thesis was to first understand the usability and means of having it in an industrial product, and implication of it in terms of cost and profit that those particular activities brings to our product, and also to study Ericsson as an example of a Swedish company in order to understand what usability activities exists, and why. Also to apply state of the art knowledge within usability, and identify improvement possibilities. To formulate guidelines based on the results achieved. To fulfil these objectives, HCI and UCD and their importance in any software development vendor are described using many different literatures,a use case-study has been performed in Ericsson presenting real industry.

In different software development life cycles using diverse methods, it is crucial to put the usability activities in correct phases of the method. Ericsson Agile methodology and mindset is used for development and is on focus by managers to deliver the systems on time, with highest quality to the customer; to cut the extra costs which includes usability related bugs in later stages of development, it is crucial to use usability-engineering and activities in our development, using agile as a flexible software development method, can give freedom of enhancing usability activities and therefore reducing cost of training and increasing the user satisfaction .

A usability test was conducted to get feedback from experienced users at system

integration unit, use cases used in the test was taken from real scenarios which integrators might come across while configuring a system(the use cases we presented in this thesis, is now used as a part of training for experienced users at Ericsson), the use cases were discussed and decided by high competence system developers.

We identified many issues concerning usability for AIR charging system GUI, and collected feedback about the charging system GUI. The user group targeted in this test were very experienced users, trained to be able to install, upgrade and configure the system; this group globally support the customer (operators) and they are closest link to the market and how our GUI is used in reality. Discussions made during the test will be presented as recommendations list in later chapters.

10.2 Answering Research Questions

Before answering the research questions, we present a quick recap of the values, usability brings to the project

- Delivers high return on saving and product usability.
- Usability practices save development time, costs and reduce maintenance costs and save the redesign costs.
- Usability affects sales, by increasing transactions, purchases, product sales and size of audience retains, attracts customers therefore increasing the market share and empowering the competitive edge.
- Enhances effectiveness and efficiency by increasing the success rate and reducing the user error and reducing the time to interact and complete a task.
- Embellishes the user satisfaction and job satisfaction therefore decreases the job turn over.
- Reinforces ease of use and learning therefore reduces costs in training and documentation, it also increases trust in systems and decreases the cost of support.

Adding so many value points to the system by a phase of activity is quite important and can be expanded by demands and focusing more and more [8].

The profits of ROI which is brought by usability, discussed in chapter 5, can be internal, external and social to the organization, and relates to benefits brought to the organization. Internal ROI directly relates to savings during production and can be of decreasing the lead time for development and getting the product to the market in a shorter time or services. The external ROI however relates to profitability brought by activities which has resulted better, more useful for the customer and can relate to all the factors relating to increasing user experience and decreasing costs related to training and such. Social ROI however is the perception that stockholders and designers(Internal Social ROI) as well as the customers and users (External ROI) have about the product [98].

- To what extent is usability and CJU implemented in the industrial case?

Unfortunately despite so many years of usability oriented research and practice around the world, experience shows that usability activities are often very little and usually is done by autodidact people or groups. Most of industrial research has shown a lack of cost justifying usability, which can win the arguments in favor of usability tasks and expenditure, when the management tend to stress and value functionality over usability [8].

Usability tasks are done not as completely separated tasks which should be evaluated and done by usability engineers but as an integrated part of software developer's skill. This may indicate the non existence of formal HCI or usability training, and can result in neglecting of users and poor usability for the product. The benefits which usability brings to our products and in general the term CJU is not a familiar concept for developers, program managers and management.

This case study shows that, even though the importance of HCI and UCD is known in the industry, user involvement in development process is not yet as much as it should be. Different usability methods and techniques suiting specific needs of each industry, is often missing or vague. Also usability evaluation in different stages of process is usually not following any standards therefore missing the bottlenecks or problems cause by lack of usability. The responsibilities concerning usability can be vague, and people are usually satisfied by following a general level of design guidelines. In this case study the only this general level is evolved and known, the other responsibilities and tasks such as design, functionality, details in GUI and functionality regarding usability can be improved.

- What factors have influenced the extent of implemented usability and CJU in this case-study?

By studying the case study of the UI of charging system product at Ericsson, specifically AIR-RMA-ERE GUI (Account Information-Rating management- Ericsson Rating Engine) with an objective view toward the usability of the GUI, interviewing and collecting information, conducting a usability test and gathering the user views via survey, many usability tasks such as usability tests and collecting feedback from customers and users of this specific GUI can be improved or redefined.

We believe the management attitude toward usability tasks, and the resources allocated to such tasks play a very important role in decisions made in this concern. In the other hand however system developers try to imply the rules and basic usability design mostly based on their intuitions rather than proper training. Usability activities during design process for this particular project, has been shortened to just a design guideline document, which has more or less no direct indication of usability, simply because of lack of awareness about the values usability brings to the project.

The other factor influencing the implementation of usability is time, as in a very competitive market this factor is one of the most important ones, the customer presses for early deliverables; this can affect the way everything works as quality is as important and therefore all the time and resources is allocated to development phases such as design, test and integration.

Most of the users are very used to or comfortable using the GUI as they are highly experienced, however they do admit that there is the need of some improvements. Performing different usability tasks and evaluations which collects the information of this sort can always help the organization not only with profitability but also by user satisfaction and therefore more marketing and sales. Values such as reducing the development time, reducing errors and faults, reducing the training costs can be direct advantages for the organization. In chapter 4,5 we have summarized these factors.

What is being done at the moment, which is checking a basic design rules and regulations, does not evaluate the usability completely, we do agree that by doing so 80% of basic us-

ability problems (by looking at trouble reports from different testing stages at organization) can be found and solved; but most of the values brought by usability-engineering will be missed as there is no structured usability activities in different development stages.

As measuring the values usability brings to the product is very difficult, and products are sold according to the functionality that they offer,not their usability advantages over other products, also because of the general idea that performing usability tasks can put negative effect on time that the product reaches to the customers, usability can be underestimated. What is being missed in most of organizations is cost justifying the usability, if any organization is aware of the savings and profitability, brought to the product by usability, we can see promoting this fact and having a higher revenue.

- What guidelines are needed to remedy identified shortcomings and contribute to improvements of usability and CJU in the studied case?

At this stage with all the information from literature review and the overview of company usability problems, a list of recommendation and improvements for usability in this particular product was educed, this list was then presented to a group of system developers and trimmed to a final list of recommendations, in an attempt to illustrate that having proper usability activities not only helps the quality but brings many more advantages, valuable by tangible and non tangible costs. In the next section we present specific answer to this specific question.

10.3 Guidelines and Recommendations

The guidelines presented here, are derived from not only the literature review the we have done but also considering the organizational data and situation, according the information collected by interviews and usability tests. According to value propositions discussed in chapter 3, values that usability offers to the organization such as high return on saving and product usability, cost reductions as we can save on development cost and time, maintenance and redesign costs will drop drastically. The other value added will be increasing revenue by more sales, trust on the product,therefore more market share. Effectiveness of the product will increase by increasing the success rate and reducing the user error. Efficiency and user satisfaction will increase and training, support, documentation costs will be minimized.

Considering all these values and the effort(or negligence) in most of the organizations, it can be recommended to :

- Organizing a usability team, containing not only developers and system technicians but some experienced user, with more feedback from the actual users.
- Performing usability evaluations which can provide clear recommendations at a conceptual level, which can be communicated well considering technical constraints [8].
- It is also recommended to perform the same kind of usability evaluation after the improvements have been done on the GUI, it is easier to show the return on the cost spent.
- Keeping track of the cost forced by lack of usability in the product such as fixing usability deficiencies in late stages of development, the major errors made by customers due to usability problems.

- Collecting feedback from market and sales about how the customers choose the product they buy can be a great way to understand how important usability is to profitability of the product.
- Raising the awareness of management about importance of their support in usability activities and making that a part of design processes.
- Emphasizing more of usability training and educations, and gaining support of developers can also promote usability.
- Assigning more clear tasks and responsibilities regarding usability can also promote usability and usability-awareness.
- Justification of usability and the profitability brought by it to the product can be another way of increasing trust and awareness of usability importance.
- Developing more relevant user stories which can include not only the GUI but the whole functionality; knowing different categories of users and the value for that category instead of thinking about one range of users (professional users) can be helpful.

Comments and discussions during usability test and some certain questions in the questionnaire (question number 29,discussions regarding question number 2), has resulted in a set of recommendations and suggestions for future work, for usability in AIR and all of the nodes included in charging systems. A list of guidelines particularly for Ericsson usability level is presented in appendix G.

10.4 Future Work

Usability activities are commonly the most neglected and sacrificed tasks in software development cycles [8]. We believe it is very important to perform certain future work to promote these tasks and highlight the importance of it, in more projects. In order to drive general conclusions in this field, more studies of this nature needs to be performed in the industry, this study was an indication of poor cost justification of usability. Considering charging system product, the guidelines and recommendation list mentioned in latter sub chapter can be performed as future work.

Another interesting academic research could be to study the usability team and to identify the groups of people involving in this teams and to define clear responsibilities and task definitions for this group and the impact of these teams in organization and the usability in the products. Also, alternate ways or processes of measuring the costs after usability improvements, which gives quick feedback regarding usability and before/after activities can be an interesting topic for further studies.

10.5 Future Work at Ericsson

Involving the same user groups while organizing the user guides' documentations, can be very appealing, as the right information will be written in those documents. These documents can be then used in online help for the GUI, the right investments on this tasks makes a very good turnover. Last but not least, methods of UCD can be chosen, guidelines on how and when in the used software engineering method the usability tasks must be performed, should be looked into.

The most important step in-line with this case study is to work on the usability test

performed during this task and make a usability test template that can be used in, interval usability testing which was recommended in improvement list by usability team. Simple usability issues found during this thesis has to be investigated and fixed; trouble reports describing the problems and some suggestions regarding how to fix them is the way forward, fixing those issues are dependent to ERE node, if the designers decide to fix this.

The next step can be to have a global user group, to debate and demand the usability tasks in charging system; we mentioned that the right group of people should involve in usability team, also we know that the, users of charging system product are experienced users working in many countries and regions, to gather their feedbacks, charging system usability team at Ericsson needs to somehow stay connected with this user groups, we recommend using internal Ericsson and Intranet and on line forums to be place of sharing experiences and suggestions for improving the charging system GUIs, also user group conferences which Ericsson conducts every year can be used by having the usability team presenting future work and collecting customer feedback.

10.6 Personal Reflection

After presenting results of this thesis to Ericsson, we were chosen to be a part of the usability team at Ericsson. So far we have received great feedback from the people attending our presentations, most of these designers and usability practitioners have a agreed with these results and that fact that we do not allocate enough resources for usability; and that subject of CJU brings awareness about this fact. We hope to continue with future work presented in this thesis as a way forward for improvements in the industry.

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APPENDIX A: USE CASES

Use Case 1: (Creating a new rating period in refill)

Setup a Basic Refill tree

1. Open the available selection trees by clicking on the corresponding symbol to the left, then select the **Refill** selection tree

2. Right-click on the **Refill** selection tree and select **New Rating Period** from the context-sensitive menu.

3. Enter the Rating Plan ID (the structure ID) in the **Ratingplan** field as **AIR** and the name of the selection tree structure in the **Name** field as Test(your name), and then click **OK**.

4. Choose **Start date** as **Now.**
5. The Rating Period is located in the **Saved** sub node.

Use Case 2: (Creating a new rating period in refill)

Setup a Basic Account refill tree
1. Open the available selection trees by clicking on the corresponding symbol to the left, then select the
Account refill selection tree

2. Right-click on the **Account refill** selection tree and select **New Rating Period** from the context-sensitive menu.

3. Enter the Rating Plan ID (the structure ID) in the **Ratingplan** field as **AIR** and the name of the selection tree structure in the **Name** field as Test(your name), and then click **OK**.

6. Choose **Start date** as **Now.**
7. The Rating Period is located in the **Saved** sub node.
8. Open the Rating Period.

4. Open the **RatingPlan** and Select and right-click on **Root**, to insert a node on the same level select **Add child>Node** from the context-sensitive menu.
- A node is inserted in the selection tree structure. The input fields are displayed to the right
- To move the node down (so the definition is above right click and choose Move down option)

5. Enter *Node1* in the **Name** field found in the **Settings** tab.

6. Right click on the node and select **Add child >Modifier** from the context-sensitive menu to insert a modifier, choose **Refill type** and set **Refill type** as **Account Refill.**

7. Select and right-click on modifier **Refill type**, to insert a node on the same level, select **Add child>Node** from the context-sensitive menu.

8. Enter *Main* in the **Name** field found in the **Settings** tab.

9. Click on *Main* Select **Add child >Modifier** from the context-sensitive menu to insert a modifier.

7. Open the **Name** drop-down list containing all available modifiers.

10. Select the **Set period** option from the **Name** drop-down list.
- Select the option as **NewCreditClearanceGracePeriod.**
- Set **New value** (days) as *20*.

11. *Main* Select **Add child >Modifier** from the context-sensitive menu, Select **Add child >Modifier** from the context-sensitive menu to insert a modifier.

12. Open the **Name** drop-down list containing all available modifiers.

13. Select the **Set period** option from the **Name** drop-down list.
- Select the option as **NewServiceRemovalGracePeriod.**

- Set **New value** (days) as *25*.

14. Select and right-click on last modifier, to insert a node on the same level select **Add >Node** from the context-sensitive menu.
15. Enter *AddAmount* in the **Name** field found in the **Settings** tab.

16. Select and right-click the *AddAmount* node. Select **Add child >Condition** from the context-sensitive menu to insert a condition, choose **SegmentationID** condition
-Select **comparison** as **Exact match**
-Select the option **Case sensitive**
-Select **Fixed value** in compare with field
- Mark **Value or field to compare** with as *def1*

17. Click on SegmentaionID condition Select **Add >Modifier** from the context-sensitive menu to insert a modifier.

18. Open the **Name** drop-down list containing all available modifiers.

19. Choose **Add amount** modifier.
-Set **Input field** as **MainAccountBalance**.
-Set **Field to add** as **TransactionAmount**.
-Set **Output field** as **NewMainAccountBalance**.

20. Please save your tree.
21. Activate this tree by right clicking and set Activated in this ERE.

Use Case 3: (Creating a new rating period in Refill)
1. Open the Refill selection tree by clicking on the corresponding symbol to the left of the tree, and then select the **Refill** selection tree.

2. Right-click on the Rating Period and select **Edit Selection Tree** from the context-sensitive menu (double-clicking the selection tree structure gives the same result).

3. Select and right-click on **Root**, to insert a node select **Add child>Node** from the context-sensitive menu.
- A node is inserted in the selection tree structure. The input fields are displayed to the right.
- To move the node to a lower lever right click and choose move down option.

4. Enter *SetVoucherGroupIdAsSegmentationId* in the **Name** field found in the **Settings** tab.

5. Select and right-click the *SetVoucherGroupIdAsSegmentationId* node. Select **Add child >Condition** from the context-sensitive menu to insert a condition, choose **VoucherBased** condition
-Select **comparison** as =
-Select **Fixed value** in compare with field
- Mark **Value or field to compare with**

6. Right click on condition you just made and select **Add >Modifier** from the context-sensitive menu to insert a modifier.

7. Open the **Name** drop-down list containing all available modifiers.

8. Select the **Set segmentation ID** option from the **Name** drop-down list.
- check the option copy from **Voucher Group ID.**

9. Select and right-click on *SetVoucherGroupIdAsSegmentationId*, to insert a node on the same level select **Add>Node** from the context-sensitive menu.

10. Enter *SetSegmentation* in the **Name** field found in the **Settings** tab.

11. Select and right-click on *SetSegmentation*, to insert a node on the same level select **Add child>Node** from the context-sensitive menu.

12. Enter *Voucherless* in the **Name** field found in the **Settings** tab.

13. Select and right-click the *Voucherless* node. Select **Add child >Condition** from the context-sensitive menu to insert a condition, choose **RefillProfileID**
-Select comparison as **Exact match.**
- check the option **CaseSentive.**
-Select **Fixed value** in compare with field.
-Choose **Value or field to compare** with 1 .

14. Select **Add child >Modifier** from the context-sensitive menu to insert a modifier,

choose **Set segmentation Id**, and set **Segmentation ID** as *def1*.

15. Click on *SetSegmentation* node, to insert a node on the same level select **Add child>Node** from the context-sensitive menu.

16. Enter *RefillSegmentationList* in the **Name** field found in the **Settings** tab.

17. Right click and select **Add child >Modifier** from the context-sensitive menu to insert a modifier, choose **Refill segmentation**

18. Click on **Edit** in the List field.

19. Click on the Add Segmentation ID icon (right-clicking in the **List** window and select **Add segmentation ID** from the context-sensitive menu gives the same result).
- The **Add Segmentation ID** window is displayed.

20. Enter *def1* in the **Segmentation ID** field

21. Click OK.

22. Double-click in the white empty field next to the Segmentation ID field to display the Edit selection window.

23. Select the **Account refill AIR** tree from the Refill tree drop-down list.

24. Enter *1* in the **Refill selection ID** field.

Use Case 4: Simulation

1. Click Simulation from top of your **Refill tree**
2. Click to create a new case (cell phone icon with a plus)
    -You may name it as you wish
    - Set the **starttime** as now
3. Click in the part **Internal**
4. Check the check-box by **Currencies IN**
    Add
    Currency as SEK
    Conversion as 10.0
    Decimals 0
    And **truncate** true
5. Check **Today**
6. Click **input**
7. Click on **Client** and mark **RefillProfileID** and set it as 1
8. Click and mark the **Transactionamount** in client part and set it to 100 SEK
9. Open the **Account** part
10. Click on **ServiceClass** part and set the **Permanent ServiceClass** as 1
11. Click on **LifeCycle** part at set **CreditClearanceGracePeriod** as 10
12. Click on Balance part and set **MainAccountBalance** as 200.
13. Run the simulation

APPENDIX B: Usability Success Stories

Value proposition: High return on savings and product usability

Some statistics

"The rule of thumb in many usability-aware organizations is that the cost-benefit ratio for usability is $1:$10-$100. Once a system is in development, correcting a problem costs 10 times as much as fixing the same problem in design. If the system has been released, it costs 100 times as much relative to fixing in-design" [44]. "The average user interface has some 40 flaws. Correcting the easiest 20 of these yields an average improvement in usability of 50%. The big win, however, occurs when usability is factored in from the beginning. This can yield efficiency improvements of over 700%." [64].

Value proposition: Save development costs

Some Examples

"Savings from earlier verses later changes: Changes cost less when made earlier in the development life cycle. Twenty changes in a project, at 32 hours per change and [a minimal] hourly rate of $35, would cost $22,400. Reducing this to 8 hours per change would reduce the cost to $5,600. Savings = $16,800." [35]."A financial services company had to scrap an application it had developed, when, shortly before implementation, developers doing a User Acceptance (UA) test found a fatal flaw in their assumptions about how data would be entered. By this time, it was too late to change the underlying structure, and the application never implemented." [34].

Some Statistics

"When managers were polled regarding the reasons for the inaccurate cost estimates, the top four reasons were issues that could have been addressed by following best practices in usability engineering. These include frequent requests for changes by users, overlooked tasks, users' lack of understanding of their own requirements, and insufficient communication and understanding between users and analysts."[4]."A study of software engineering cost estimates showed that 63% of large software projects significantly overran their estimates. When asked to explain their inaccurate cost estimates, software managers cited 24 different reasons and, interestingly, the four reasons rated as having the highest responsibility were related to usability engineering. Proper usability engineering methodology will prevent most such problems and thus substantially reduce cost overruns in software projects." [79][98].

Value proposition: Save development time

Some Examples

"Usability techniques allowed a high-tech company to reduce the time spent on one tedious development task by 40% [9]. At another company, usability techniques helped cut development time by 33-50%." [10].

Some Statistics

"Conklin (1991) states that speeding up development is a key goal for integrating usability effectively into product development and that a one quarter delay in bringing a product to market may result in the loss of 50% of the product's profit." [9]."Increased revenues accrue due to the increased marketability of a product with demonstrated usability, increased end-user productivity, and lower training costs. Conklin states that another usability goal is speeding up market introduction and acceptance by using usability data to improve marketing literature, reach market influences and early adopters, and demonstrate the product's usability and reduced training cost." [31][9].

Value proposition: Reduce maintenance costs

An Example

"[Usability engineering techniques] are quite effective at detecting usability problems early in the development cycle, when they are easiest and least costly to fix. By correcting usability problems in the design phase, American Airlines reduced the cost of those fixes by 60-90%." [9].

Some Statistics

"One [well-known] study found that 80 percent of software life-cycle costs occur during the maintenance phase. Most maintenance costs are associated with "unmet or unforeseen" user requirements and other usability problems." [83]."Martin and McClure found that $20-30 billion was spent worldwide on maintenance. Studying backlogs of maintenance work shows that an "invisible" backlog is 167% the size of the declared backlog. Anonymous study data show that internal development organizations are spending the majority of their resources on maintenance activities and thus cannot initiate development of strategic new systems." [67].

Value proposition: Save redesign costs

An Example

"Sun Microsystems has shown how spending about $20,000 could yield a savings of $152 million dollars. Each and every dollar invested could return $7,500 in savings." [90].

Sales: Increase Revenue

Usable products lead to substantial cost savings and sales. Unusable products most often prevent a customer from accomplishing a productivity task or retrieving information necessary to make an e commerce purchase. Online shoppers spend most of their time and money at websites with the best usability [73]. Good navigation and website design make it easier for users to find what they're looking for and to buy it once they've found it [42]. Because there are so many poorly designed websites, when customers find one that "works", they tend to do repeat business and gain trust in the organization. Usable products also lead to good product reviews. Publications devote space just to this one factor, and good reviews lead to increased sales[79].

Value proposition: Increase transactions/purchases

Some Statistics

"You can increase sales on your site as much as 225% by providing sufficient product information to your customers at the right time. In our recent research, we found that the design of product lists directly affected sales. On sites that did not require shoppers to bounce back and-forth between the list and individual product pages, visitors added more products to their shopping cart and had a more positive opinion of the site. By understanding your customer expectations and needs, and designing your product lists accordingly, you can significantly increase your sales." [111]."One study estimated that improving the customer experience increases the number of buyers by 40% and increase order size by 10%." [33].

Value proposition: Increase product sales

Some Examples

"Wixon & Jones did a case study of a usability-engineered software product that increased revenue by more than 80% over the first release of the product (built without usability work) [122]. The revenues of the usability-enhanced system were 60% higher than projected. Many customers cited usability as a key factor in buying the new system." [9].

“After move.com completed the redesign of the home “search” and “contact an agent” features based on a UI consulting firm's recommendations, users ability to find a home increased from 62% to 98%, sales lead generation to real estate agents increased over 150%, and [move.com’s] ability to sell advertising space on move.com improved significantly.” [93].

Some Statistics

“The magnitude of usability improvements is usually large. This is not a matter of increasing use by a few percent. It is common for usability efforts to result in a hundred percent or more increase in traffic or sales.” [73]. “Convoluted e-commerce sites can lose up to half of their potential sales if customers can't find merchandise, according to Forrester Research, Inc.” [56].

Value proposition: Increase traffic (size of audience)

Some Examples

“IBM’s Web presence has traditionally been made up of a difficult-to navigate labyrinth of disparate sub-sites, but a redesign made it more cohesive and user-friendly. According to IBM, the massive redesign effort quickly paid dividends. The company said in the month after the February 1999 re-launch that traffic to the Shop IBM online store increased 120 percent, and sales went up 400 percent.” [5]. “At HomePortfolio.com we monitored site traffic, observed consumers in usability studies and worked with internal business groups. This helped us make changes that made the site's purpose clearer and increased transaction rates measurably. The change increased the traffic up 129% the week we put it up.” [53].

Value proposition: Retain customers (frequency of use)

Some Statistics

“More than 83 percent of Internet users are likely to leave a Web site if they feel they have to make too many clicks to find what they’re looking for, according to Andersen’s latest Internet survey.” [2].“A bad design can cost a Web site 40 percent of repeat traffic. A good design can keep them coming back. A few tests can make the difference.” [56].

Value proposition: Attract more customers (increase appeal)

An Example

“Staples.com determined that the key to online success and increased market share was to make its e-commerce site as usable as possible. Staples.com spent hundreds of hours evaluating users' work environments, decision-support needs, and tendencies when browsing and buying office products and small business services through the Web. Methods included data gathering, heuristic evaluations, and usability testing. [They achieved these results]:

- 67% more repeat customers
- 31-45% reduced drop-off rates
- 10% better shopping experience
- 80% increased traffic

Increased revenue” [35].

A Statistic

“In a 1999 study of Web users, respondents were asked to list the five most important reasons to shop on the Web. Even though low prices definitely do attract customers, pricing was only the third-most important issue for respondents. Most of the answers were related to making it easy, pleasant, and efficient to buy. The top reason was “Easy to place an order” by 83% of the respondents.” [73].

Value Proposition: Increase market share (competitive edge)

An Example

"Usability is one of our secret weapons." The secret weapon appears to be working. Schwab's main Website for U.S. Investors, www.schwab.com, handles more than $7 billion in securities transactions a week, with more than 2 million active customer accounts holding $174 billion in assets. With those numbers, one might wonder why Schwab would need to make any changes to its Web site at all. But Schwab knows it cannot afford to coast; as more and more newcomers get online, and the competition for their dollars increases, more e commerce sites are making ease of use a differentiators. "A year ago, it was a rush to put up applications and functionality," Thompson says. "It's now a rush to be useful." [56].

Some Statistics

“The importance of having a competitive edge in usability may be even more pronounced for e-commerce sites. Such sites commonly drive away nearly half of repeat business by not making it easy for visitors to find the information they need (Manning). The repeat customers are most valuable: new users at one e-commerce site studied spent an average of $127 per purchase, while repeat users spent almost twice as much, with an average of $251.” [98].

Use: Improve effectiveness

User-centered design benefits users, the users’ company, and the vendor company. Increased usability increases productivity and job satisfaction while decreasing customer support needs and documentation requirements. When users feel more effective with their work, rates of absenteeism and employee turnover are lowered. All of these benefits are in alignment with fulfilling successful business goals [98].

Value proposition: Increase success rate, reduce user error

Some Examples

“One study at NCR showed a 25% increase in throughput with an additional 25% decrease in errors resulting from redesign of screens to follow basic principles of good design.” [41].“On Disney.com, for example, when UIE asked users to find the hotel closest to the monorail at Disney World, about 20 percent became lost in Disneyland and didn’t even know it. ‘If one in five people who came to the theme parks got lost,’ Spool says, ‘Disney would fix it.’ Disney On line's Senior Vice President and General Manager Ken Goldstein notes that Disney Online is already committed to developing an easy-to use Internet design. While Disney Online did not have anything to do with Spool's tests, Goldstein is interested in his findings. ‘As the next generation of Disney.com evolves,’ Goldstein says, ‘we will continue to respond to customer input through our own usability testing.’” [56].

Some Statistics

“A study from Zona Research found that 62% of Web shoppers have given up looking for the item they wanted to buy online (and 20% had given up more than three times during a two-month period).” [73].“In Jared Spool's study of 15 large commercial sites, users could only find information 42% of the time even though they were taken to the correct home page before they were given the test tasks.” [73].

Value Proposition: Increase efficiency/productivity (reduce time to complete task)

Some Examples

“With its origins in human factors, usability engineering has had considerable success improving productivity in IT organizations. For instance, a major computer company spent $20,700 on usability work to improve the sign-on procedure in a system used by several thousand people. The resulting productivity improvement saved the company $41,700 the

first day the system was used. On a system used by over 100,000 people, for a usability outlay of $68,000, the same company recognized a benefit of $6,800,000 within the first year of the system's implementation. This is a cost-benefit ratio of $1:$100." [9]."To build a model intranet, Bay Networks spent $3 million and two years studying the different ways people think about the same thing. The result: all think alike about the $10 million saved each year." [39].

Some Statistics

"Inadequate use of usability engineering methods in software development projects have been estimated to cost the US economy about $30 billion per year in lost productivity (see Tom Landauers' excellent book The Trouble with Computers). By my estimates, bad intranet Web design will cost $50-100 billion per year in lost employee productivity in 2001 ($50B is the conservative estimate; $100B is the median estimate; you don't want to hear the worst-case estimate!). Bad design on the open Internet will cost a few billion more, though much of this loss may not show up in gross national products, since it will happen during users' time away from the office." [98]."On a corporate intranet, poor usability means poor employee productivity; usability guru Jakob Nielsen estimates that any investment in making an intranet easier to use can pay off by a factor of 10 or more,especially at large companies." [56].

Value Proposition: Increase user satisfaction

An Example

"One airline's IFE (In-flight Entertainment System) was so frustrating for the flight attendants to use that many of them were bidding to fly shorter, local routes to avoid having to learn and use the difficult systems. The time-honoured airline route-bidding process is based on seniority. Those same long-distance routes have always been considered the most desirable. For flight attendants to bid for flights from Denver to Dallas just to avoid the IFE indicated a serious morale problem." [24].

A Statistic

"When systems match user needs, satisfaction often improves dramatically. In a 1992 Gartner Group study, usability methods raised user satisfaction ratings for a system by 40%." [9].

Value Proposition: Increase job satisfaction/decrease job turnover

An Example

"Humantech, Inc., studied ergonomic office environments and productivity for 4000 managerial, technical, and clerical workers in a broad cross-section of North American industries. Surveys showed that video display terminal workers had twice as many complaints of neck and shoulder discomfort, eye strain was reported three times as often, and there were higher rates of absenteeism less job satisfaction, and increased (30%) turnover." [96].

Value Proposition: Increase ease of use

A Statistic

"Incorporating ease of use into your products actually saves money. Reports have shown it is far more economical to consider user needs in the early stages of design, than it is to solve them later. For example, in *Software Engineering: A Practitioner's Approach*, author Robert Pressman shows that for every dollar spent to resolve a problem during product design, $10 would be spent on the same problem during development, and multiply to $100 or more if the problem had to be solved after the product's release." [52].

Value Proposition: Increase ease of learning

A Statistic

"A study by *Computer + Software News* (1986) found that users rated ease of use second at 6.8 out of 10, while ease of learning was rated fourth at 6.4 on a scale of important purchase factors." [9].

Value Proposition: Increase trust in systems

An Example

"User trials were used to redesign the EuroClix Website before its launch. In its first six months, it convinced more than 30,000 users to sign up. This study clearly shows that consumers' trust concerns can significantly be alleviated by providing relevant information when and where users need it." [9].

Value Proposition: Decrease support costs

Some Examples

"At Microsoft several years ago, Word for Window's print merge feature was generating a lot of lengthy (average = 45 minutes) support calls. As a result of usability testing and other techniques, the user interface for the feature was adjusted. In the next release, support calls 'dropped dramatically'; Microsoft recognized 'significant cost savings." [9].

*"*A certain printer manufacturer released a printer driver that many users had difficulty installing. Over 50,000 users called support for assistance, at a cost to the company of nearly $500,000 a month. To correct the situation, the manufacturer sent out letters of apology and patch diskettes (at a cost of $3 each) to users; they ended up spending $900,000 on the problem. No user testing of the driver was conducted before its release. The problem could have been identified and corrected at a fraction of the cost if the product had been subjected to even the simplest of usability testing." wrote the researcher." [9].

Value Proposition: Reduce training/documentation cost

Some Examples

"In another company, business representatives did a cost-benefit analysis for a new system and estimated that a well-designed GUI front end had an Internal Rate of Return of 32%. This was realized through a 35% reduction in training, a 30% reduction in supervisory time, and improved productivity, among other things."[34]."At one company, end-user training for a usability-engineered internal system was one hour compared to a full week of training for a similar system that had no usability work. Usability engineering allowed another company to eliminate training and save $140,000. As a result of usability improvements at AT&T, the company saved $2,500,000 in training expenses." [9].

A Statistic

"A study by *Computer + Software News* (1986) found that information systems managers rated ease of training seventh (out of 10) on a scale of important purchase factors." [9].

Value proposition: Litigation deterrence and safety

Some Examples

"Although software makers don't seem liable to the same sorts of litigation as, for example, a manufacturer of medical equipment, poor usability may be an element in lawsuits. For example, the Standish Group reported that American Airlines sued Budget Rent-A-Car, Marriott *Corporation, and Hilton Hotels after the failure of a $165 million car* rental and hotel reservation system project. Among the major causes of the project's

disintegration were “an incomplete statement of requirements, lack of user involvement, and constant changing of requirements and specifications,” all issues directly within us ability's purview.” [112][101].“Poor usability is a potential element in lawsuits and other litigation. The US government’s recent case against Microsoft hinged on a usability question: Are users well-served when the browser and operating system are closely integrated?” [42].

A Statistic

“Chapanis cites two independent studies that showed a 54% reduction in rear-end accidents with the use of human factors improvement: the centered high-mount brake light on autos.”[8].

APPENDIX C :SURVEY QUESTIONNAIRE

Usability/Effectiveness(UTE)

1. Were you able to complete this task on existing GUI in the first attempt?
Yes , NO
2. If not-where did it go wrong? Try to describe how it happened? Free text

3. How often do you fail setting up a tree, in your daily work?
Always, Often, Sometimes, Rarely, Never

4. How often do you make a wrong selection of tree in this system?
Always, Often, Sometimes, Rarely, Never

5. How often do you think completing a task takes too long time compared with what you expected?
Always, Often, Sometimes, Rarely, Never

6. How often do you have to configure trees using this system?
Always, Often, Sometimes, Rarely, Never

7. How often do you fail to configure a working tree using this system?
Always, Often, Sometimes, Rarely, Never

8. How often do you complete a task on first attempt?
Always, Often, Sometimes, Rarely, Never

Efficiency(UTEF)
9. How long time did it take you to complete this task?
0-10min, 11-20 min, 21-30min, 31-40min, above 40min

10. How much time do you usually spend at customer site completing such tasks?
0-10min, 11-20 min, 21-30min, 31-40min, above 40min

11. Did you need assistance/help during this task?
Yes, No

12. If yes, how much time did you need to get help?
0-10min, 11-20 min, 21-30min, 31-40min, above 40min

13. How much time do you need to spend looking for help/additional information to be able to complete such tasks?
0-10min, 11-20 min, 21-30min, 31-40min, above 40min

14. How often do you have to correct self made errors?
Always, Often, Sometimes, Rarely, Never

15. Can you easily recover an error in this system?
Yes, No
16. How easily can you recover an error in this system? (Using the error messages)

Extremely easy, Very easy, Fairly easy, Difficult, very Difficult

Usability/satisfaction/comfort(UTSC)
17. Do you find consistency in the functionality of this system?
Yes, No

18. How consistent do you find this system to be?
Least consistent , Consistent enough, Quite consistent, Inconsistent, Very inconsistent

19. How understandable do you find the system messages to be?(five choices scale of 1 to 5)
Not at all,very little understandable , Understandable ,Quite understandable ,very Understandable

20. Do you find the system to be customized to your personal liking?
Yes No

21. If not what do you like to change to make it more appealing to you ?
Free text

22. Do you find the interface elements self explanatory?
Yes No

23. To what degree do you find the interface elements self explanatory?(five choices scale of 1 to5)
Not at all-2-3-4 totally

Usability/Satisfaction/Likability (UTSL)
24. How attractive is the interface to the user?(five choices scale of 1 to 5)
Not at all-Very

25. Does this software have appealing graphics?(five choices scale of 1 to 5)

Not at all – very

26. How often do you use simulation?(five choices scale of 1 to 5)
Not at all-very often

27. Do you have adequate guides/error messages/help for your simulation?(five choices scale of 1 to 5)

Not at all-very

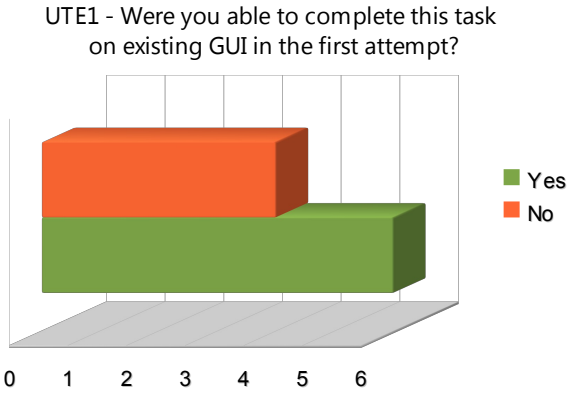
28. Do you think it is easier using a wizard or examples or migration from old systems?
Yes No

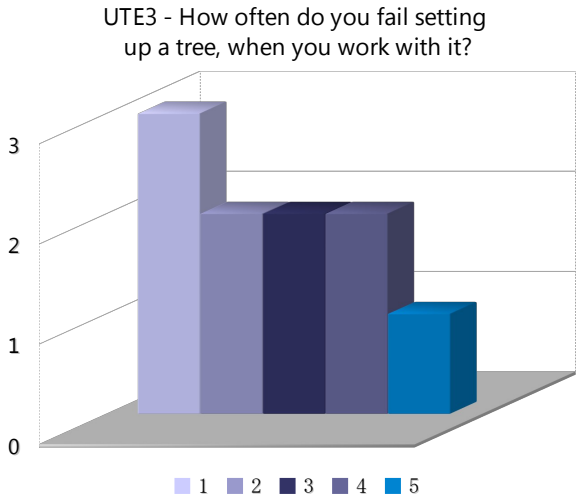
29. Please indicate if you have any suggestions for improvements, for the system?Free text

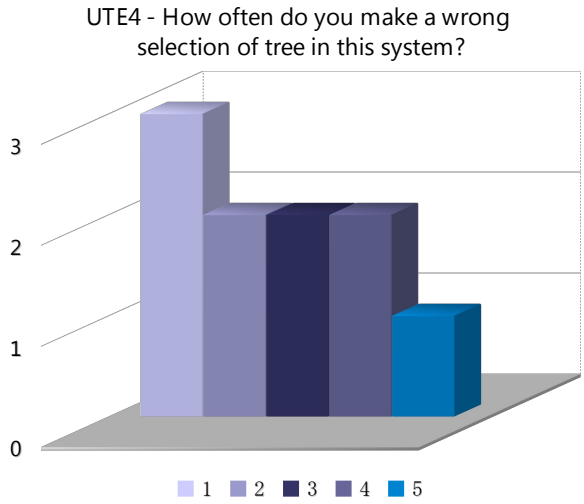
APPENDIX D: RECORD SHEET

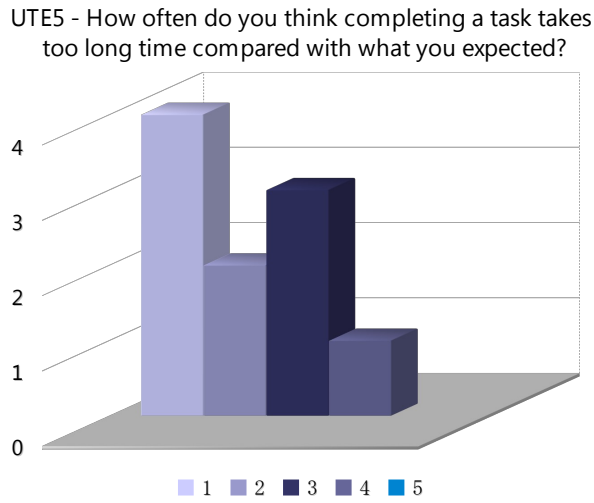
Usability test number	
Name of the Participant	
Gender	
Country	
Duration to complete the task	
Number of errors	
Comment	
Use case is completed, Yes/NO	
Recommendation	

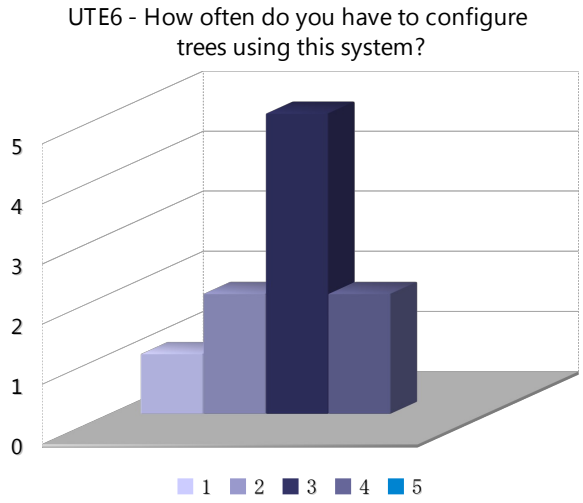
APPENDIX E: RESULT GRAPHS

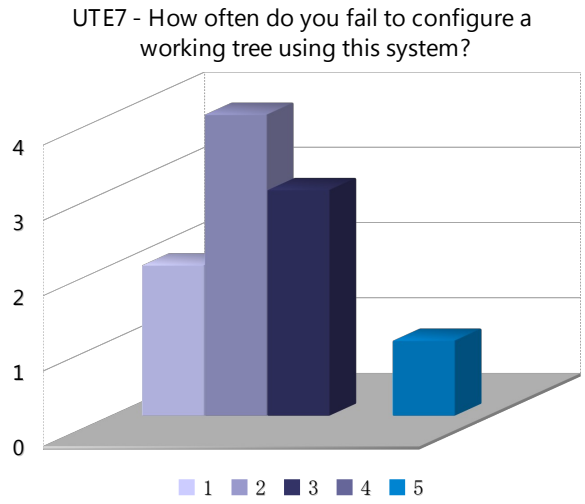


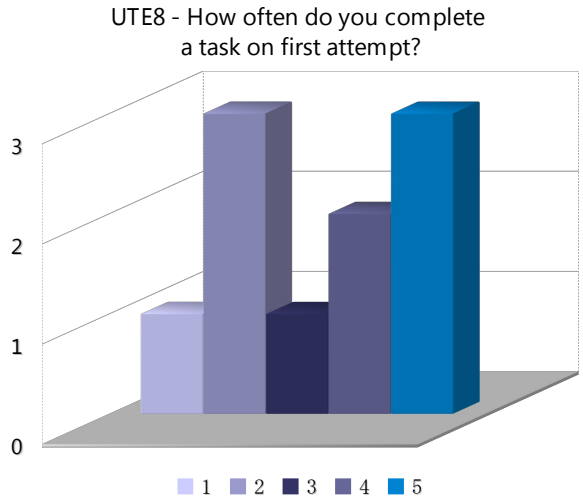




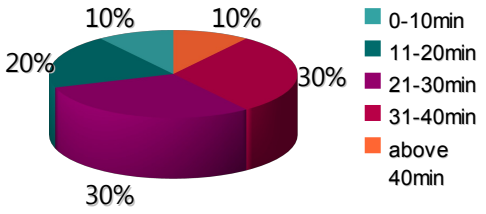

UTE5 - How often do you think completing a task takes too long time compared with what you expected?
4
3
2
1
0
1 2 3 4 5


UTE6 - How often do you have to configure trees using this system?
5
4
3
2
1
0
1 2 3 4 5

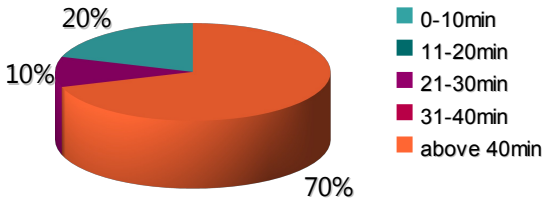

UTE7 - How often do you fail to configure a working tree using this system?
4
3
2
1
0
1 2 3 4 5


UTE8 - How often do you complete a task on first attempt?
3
2
1
0
1 2 3 4 5

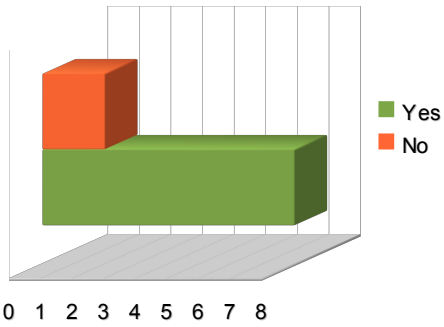
UTEF1 - How long time did it take you to complete this task?



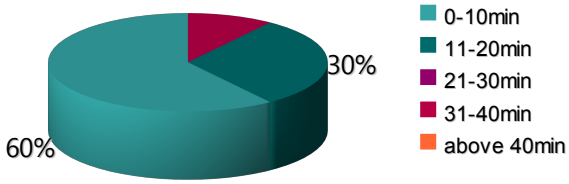
UTEF2 - How much time do you usually spend at customer site completing such tasks?



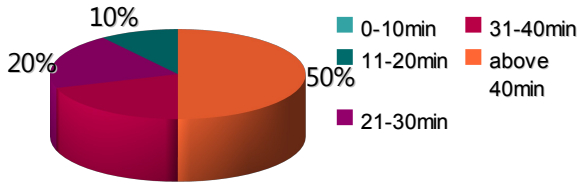
UTEF3 - Did you need assistance/help during this task?



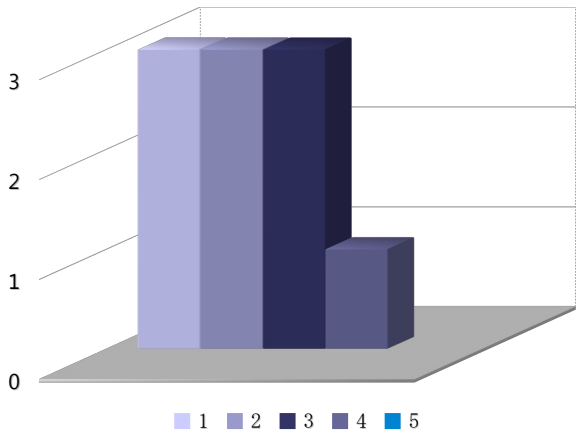
UTEF4 - If yes, how much time did you need to get help?

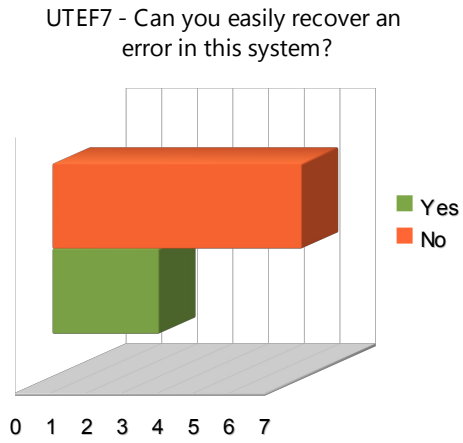


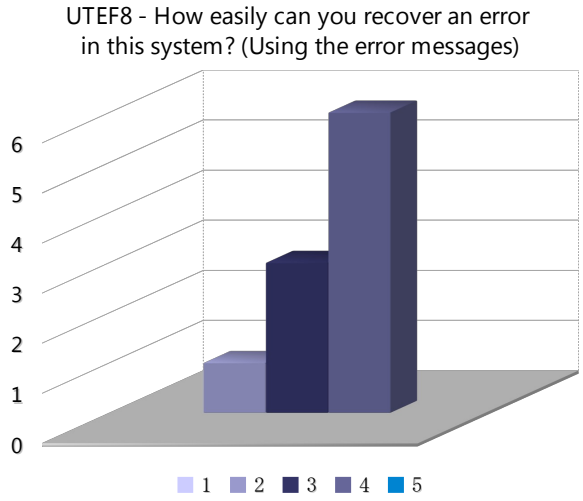
UTEF5 - How much time do you need to spend looking for help/additional information to be able to complete such tasks?

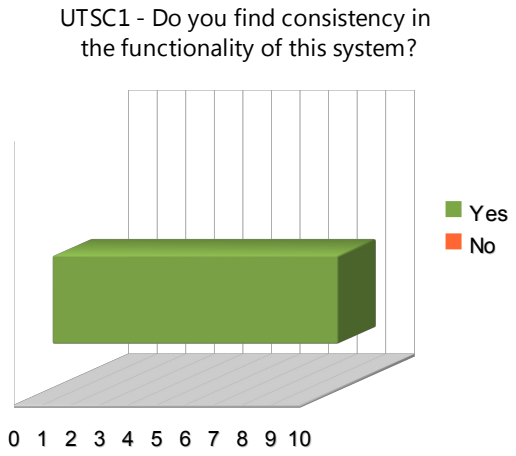


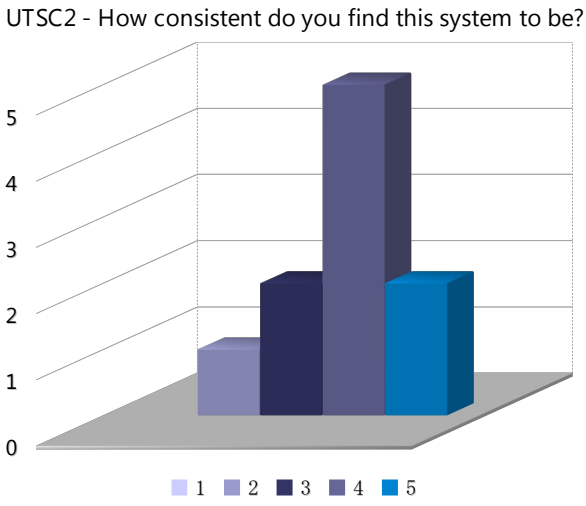
UTEF6 - How often do you have to correct self made errors?

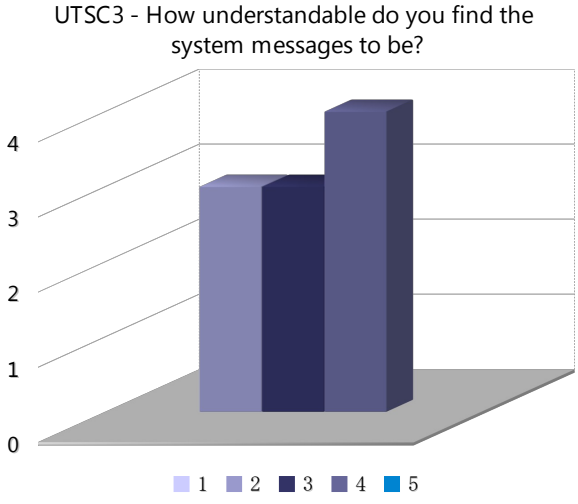



UTEF7 - Can you easily recover an error in this system?
Yes
No
0 1 2 3 4 5 6 7

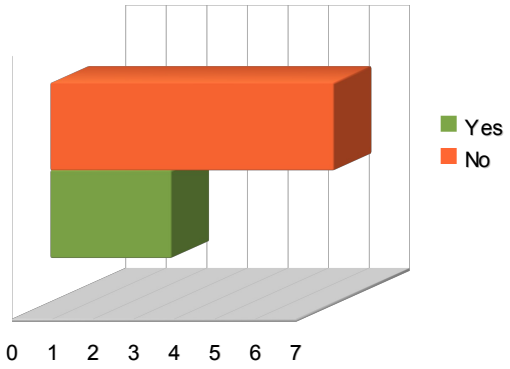

UTEF8 - How easily can you recover an error in this system? (Using the error messages)
6
5
4
3
2
1
0
1 2 3 4 5


UTSC1 - Do you find consistency in the functionality of this system?
Yes
No
0 1 2 3 4 5 6 7 8 9 10

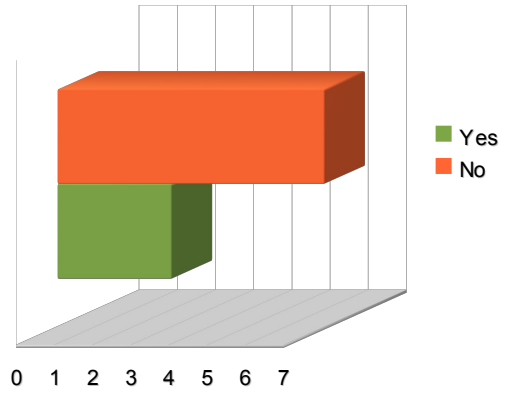

UTSC2 - How consistent do you find this system to be?
5
4
3
2
1
0
1 2 3 4 5


UTSC3 - How understandable do you find the system messages to be?
4
3
2
1
0
1 2 3 4 5

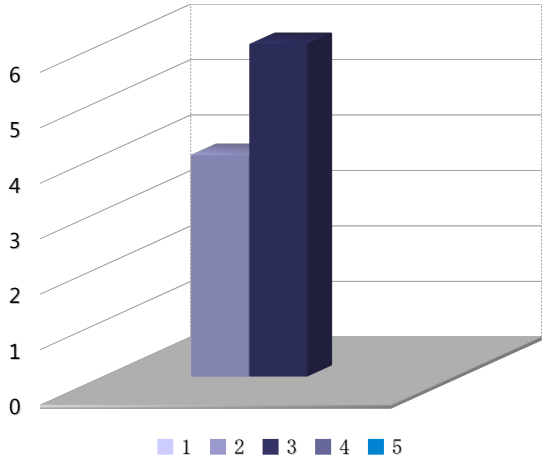
UTSC4 - Do you find the system to be customized to your personal liking?

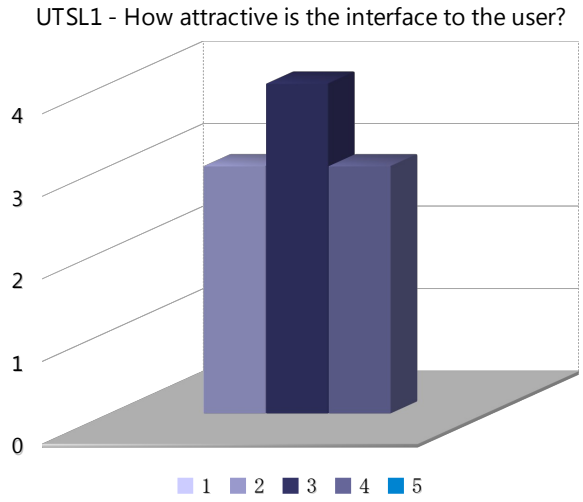


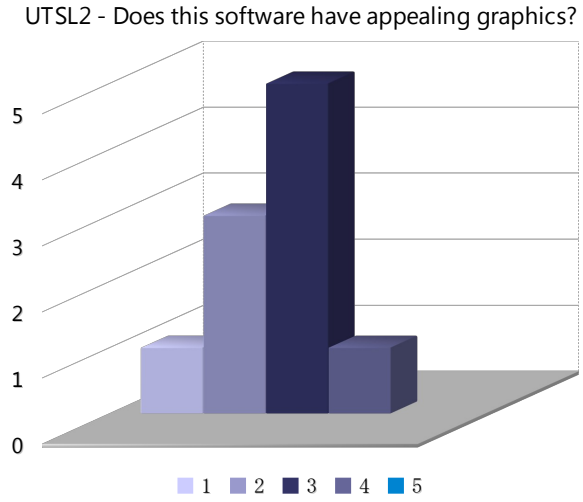
UTSC6 - Do you find all interface elements self explanatory?

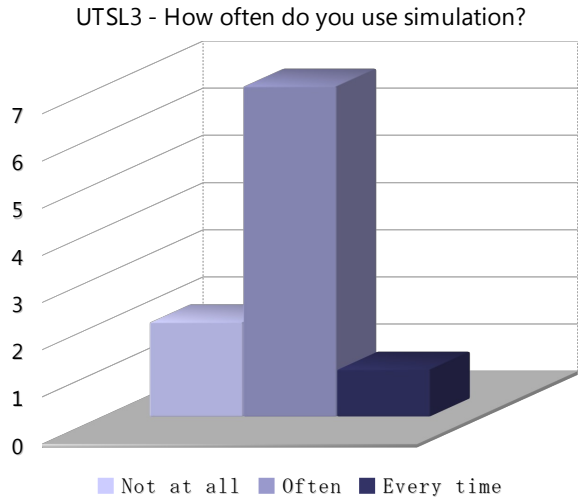


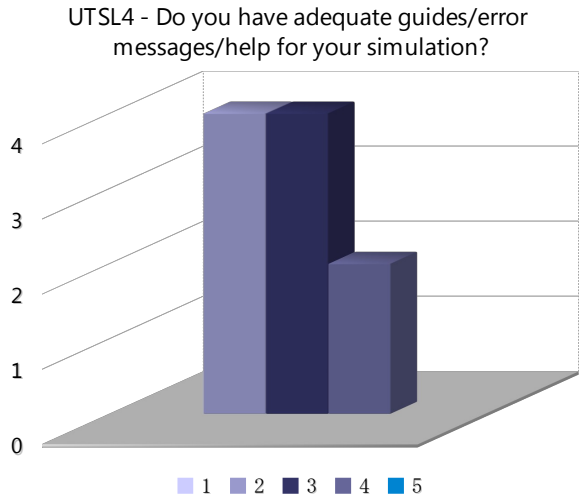
UTSC7 - To what degree do you find the interface elements self explanatory?

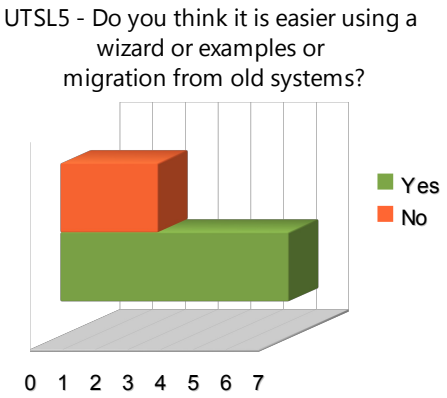



UTSL1 - How attractive is the interface to the user?
4
3
2
1
0
1 2 3 4 5


UTSL2 - Does this software have appealing graphics?
5
4
3
2
1
0
1 2 3 4 5


UTSL3 - How often do you use simulation?
7
6
5
4
3
2
1
0
Not at all Often Every time


UTSL4 - Do you have adequate guides/error messages/help for your simulation?
4
3
2
1
0
1 2 3 4 5


UTSL5 - Do you think it is easier using a wizard or examples or migration from old systems?
Yes
No
0 1 2 3 4 5 6 7

APPENDIX F: USABILITY EVALUATION REFERENCE BY KUDOS

KUDOS®

Window title		
Evaluated by (name):		
Date and time of evaluation		
Metric	**How to score**	**Score**
1. Number of clicks to get here	Number of clicks to get to window from the standard entry point	
2. Time to load window	At most 10 seconds. Start with a running browser. 1 = < 5 seconds 2 = 6 to 14 seconds 3 = > 14 seconds	
3. Frequency of use	1 = window is used frequently 2 = window is used infrequently 3 = window is used rarely (for example at install time only)	
4. People who use this window	1 = users on their own 2 = users under expert direction 3 = experts	
5. Number of other window you need to visit to complete a task on this window	The number of pop-ups and/or links to other windows that must be followed to complete the task you do on this window (ignore things like links to copyright statement).	
6. Consistency	Window respects look and feel of tool as a whole, and uses the same terminology and conventions 1 = yes 2 = no	
7. Window width	Optimized for 770 pixels, but with a liquid layout that works at anything from 620 to 1024 pixels. 1 = as above 2 = minor visual problems at extremes 3 = parts of system unreadable at different size	

3

KUDOS®

Window title	
Evaluated by (name):	
Date and time of evaluation	

Metric	How to score	Score
8. Liquid vs. frozen layout	Liquid. In a liquid layout, items move relative to each other if the browser window is resized. 1 = liquid 2 = not liquid	
9. Window length	One or two full screens is best. No more than three full screens (currently 1000 to 600 pixels). 1 = 1 full screen 2 = 2 to 3 full screens 3 = > 3 full screens	
10. Frames	No 1 = no 2 = yes	
11. Follows corporate style or identity guidelines	1 = yes 2 = no	
12. Footer navigation links	Use for 'footnote style' links such as copyright and contact info. At most, 7 links across the bottom of the window. A single line when displayed in the common size of window. 1 = yes 2 = no	
13. Help placement	Upper right. 1 = yes 2 = no	
14. Body text color	Black 1 = yes 2 = no	
15. Default body text size	12 points 1 = yes 2 = > 9.5 points 3 = < 9.5 points	
16. Body text size frozen	No. Always use relative sizes that make it possible for users to make the text larger or smaller as desired. 1 = yes 2 = no	

KUDOS

Window title	
Evaluated by (name):	
Date and time of evaluation	

Metric	**How to score**	**Score**
17. Body text typeface	Sans serif. 1 = yes 2 = no	
18. Background	White	

KUDOS

Window title	
Evaluated by (name):	
Date and time of evaluation	

Metric	**How to score**	**Score**
34. Task sequencing user driven	Users can select and sequence tasks (when appropriate) rather than the system taking control of the user's actions. Action support agents (wizards etc) are available but are optional and are under user control. 1= yes 2 = somewhat 3 = no	
35. Task sequencing natural	Do options and tasks reflect the model and logic of product use? 1= yes 2 = somewhat 3 = no	
36. **Skills**	The system supports, extends, supplements or enhances the user's skills, background knowledge and expertise. 1= yes 2 = somewhat 3 = no	
37. Respectful interaction	The user is treated with respect. The design reflects the user's professional role, personal identity or intention. For example there are no inappropriate assumptions or impositions. The design does not wastes the user's time or cause extra work, and is appropriate to the context of use. 1= yes 2 = somewhat 3 = no	
38. **Aesthetically pleasing**	The design is aesthetically pleasing, with an appropriate balance of artistic and functional values. The window is not too empty or too crowded. Too much empty space can create a visual imbalance on the window for the user, just as a crowded window does. 1 = yes 2 = no	

APPENDIX G: Recommendation list for Ericsson

Improvement of simulation in RMA GUI	According to a study done for Ericsson, comparing this product and other competitors also a participant with marketing background [16], simulation for charging product is a competitive edge for our product, most of the billing and charging systems offered by our competitors do not have the simulation, or not at this detailed level, for big operators it is crucial to test their changes before launching it in real time. Simulation should be done with much more instructions; having a help button for simulation and trouble shoot instructions can be helpful.
Templates configuration	Instead of example tree documentation, it is recommended to have pre configured tree structured which can be accessed by a button and will import those example trees to the ERE, which can be updated and changed according to the needs as usually basic configuration is the most difficult and time consuming one.
Consistent look and feel for all of the GUIs	Charging system as a very complex product, has many different parts (nodes) integrated in the system, which works independently yet has very close relation to other nodes building charging system, the positive part is that if any of these boxes goes down, the software still works and has a very good recovery, the negative part is that in order to configure the system you need to configure at least 5 complex GUIs, mastering these GUIs is usually impossible with have the same look and feel for all the GUIs it is easier to manage the system and perhaps helps the competence of the users working with the system.
Customer feedback	Continues feedback from experienced user and customers of charging system is the greatest asset to development groups in Ericsson, conducting usability test and reviewing the performance can be a very good way to collect feedback.
Conducting periodic usability test	Tightly coupled with the previous recommendation, performing usability test to collect comments from users in a recurrent manner, so the comments are

	continues and up to date.
Fixing simple usability issues	During the usability test, some basic usability issues were found, trouble reports have been raised (a table of these issues will be presented in Ericsson usability group)
More organized documents	The existing documents can be a bit more organized, as one of the participant said during usability test: ” having the document is better than not having it, but it will be more easy to have it in an organized manner you will never go through the whole document on the fly help for each window can be one improvement”.
Involving right people in usability team	Involving some of users closer to customers in usability team, representing the end user group can enlighten a lot of problems and hidden issues.

Table 4: Recommendations for improvements in charging system product

APPENDIX H: ABBREVIATIONS

2G - Second Generation

AIR - Account Information Refill

AVIM - Account Voucher Information Manager

BSCS - Business Support & Control System

BTH - Blekinge Tekniska Högskolan

BUGS - Business Unit Global Services

CBM - Cost Benefit Model

CJU - Cost Justifying Usability

CS - Charging System

DEC - Digital Equipment Cooperation

ELIN - Electronic Library Information Navigator

ERE- Ericsson Rating Engine

GSM - Global System for Mobile Communications

GUI - Graphical User Interface

HCI - Human-Computer Interaction

HMI - Human-Machine Interface

IRI - Internal Return on Investment

ISO - International Organization for Standardization

KPI - Key Performance Indicators

MU - Market Unit

NDA - Non-Disclosure Agreement

PDU - Product Development Unit

PICU - Professional Interest Committee on Usability

R&D - Research and Development

RMA - Rating Management Application

ROI - Return on Investment

TAP - Think-aloud protocol

TC - Technical Communication

UCBM - Usability Cost Benefit Models

UCD - User Centered Design

UCSD - University of California San Diego

UI - User Interface

UPA - Usability Professionals Association

VoIP - Voice over IP