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In-house software development process:
A User-centered Approach

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Abbreviations

CI	Contextual Inquiry
CW	Cognitive Walkthrough
ERP	Enterprise Resource Planning
HCI	Human-Computer Interaction
ISI	Interaction Sequence Illustration
IT	Information Technology
SUS	System Usability Scale
UI	User Interface
UX	User Experience

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Chapter 1

Introduction

In this chapter, the background and reasoning for the thesis is described together with the focus and limitations of the research. In the text, research problems and the structure of the thesis will be also defined.

1.1 Motivation and aim of the thesis

In the 1980s, when the usage of personal computers (PCs) became more common, software design practices were still falsely assuming that the users were knowledgeable and competent in computer science. As an outcome, big part of the users were practically incapable of using operating systems and applications. During these times, the concepts of Human Computer Interaction (HCI) and usability, became important. Since then, the design process of interactive software for common people has emphasized usability. This process is called human-centered design. [7]

The term Enterprise Resource Planning (ERP) was invented in the early 1990s.[11] The purpose of the ERP software is to offer techniques and concepts for integrated and thorough management of business, as well as making it more efficient. The usage of ERP software has increased globally and nowadays even service organizations have invested a lot of resources in ERP implementation.[12, 5]

Despite the importance of the efficiency aspect, the usability of ERP systems is not a widely studied topic. However, weaknesses in usability may lead into a low productivity and make it harder for users to achieve their goals.[16]

The aim of this thesis is to examine how the usability of a service-oriented ERP system can be enhanced by integrating usability inquiries, inspections and measures into the software development process. In the research, one well defined business process is examined and the state of its usability in the system is determined by using variety of applicable methods:

- Contextual Inquiry to define the business process.
- Cognitive walkthrough for usability inspection.
- Interaction Sequence Illustration (ISI) to measure the amount of interaction steps and to understand them.
- System Usability Scale (SUS) to give a global view of subjective assessments of usability.
- Remote Usability Evaluation (by using log data) to evaluate usability in distributed locations.

The measurements are focused on time, error rate and user satisfaction.

According to the ISO standard of Human-centered design for interactive systems [8], many benefits can be gained by using human-centered methods as a part of software development process. The productivity of an individual user can be increased together with the operational efficiency of an organization. Usable and useful systems also reduce training and help-desk costs, as well as stress and discomfort, because they are understandable by the users. In other words, human-centered design improves the UX (User Experience).

The benefit of human-centered design (for software development process) is increased total life cycle of a product and likelihood of project succeeding on time and within the budget. Human-centered approach also decrease the risk of software being rejected by the users, or failing to meet the requirements. [8]

1.2 Background and research questions

The subscriber of this thesis is a middle-sized company which is offering information services globally and practicing in-house software development. Because of the fast pace of growth, the company is willing to reform their current ERP system as well as the whole software development process. This thesis tries to join usability perspective into this process and give answers to following research questions.

- ***How usability methods can help to identify critical disparities in the usage of a system?***

Understanding the differences in the system usage between individuals can help to understand and deploy best practices throughout the organization and therefore improve efficiency.

- ***How the use efficiency is affected by the usability measurements?***

  It is important to find the most effective and usable user interface solutions and thus decrease the average time spent on tasks. Local differences can be tracked with remote usability measurements.

- ***What usability methods can be practically joined with the software development process of an ERP system?***

  Finding practical and efficient usability methods to be joined with the software development process can improve the quality of the end product.

1.3 Scope and structure of the thesis

This thesis covers research about usability of the in-house software development process, and its scope does not include any other aspects of the process. The literature research consists of a few usability methods and though the target of the research is ERP software, literature about them are not covered in the thesis. The results of the research may not be suitable for every organization.

The first actual chapter of the thesis is about the usability methods. Every usability method used in the research is discussed carefully. In the second chapter, the process experiment is being introduced. It covers the experiment steps and the implementation details. In the third chapter, the data gathered in the experiment, and the implementation process is being analyzed. In the last chapter the research will be summarized and discussed.

Chapter 2

Methods

In order to be able to discover reliable research data, the research methods must be understood thoroughly. In this research, the data is gathered with a few types of usability methods and they are selected according to their practicality and utility. Inquiries are used to study the business process and the process itself is measured from many different aspects and also remote evaluation is utilized to gather data easily from distributed locations.

Methods are used in different stages of the research to follow the structure of human-centered design principles. These methods are described in detail in the following chapter.

2.1 Remote Usability Evaluation

There are many ways to implement remote usability evaluation. In this paper, the data logging approach is being discussed. In the context of usability, logging means practices for mechanically recording the usage of a system.

Usage data of an application can offer valuable information about users' actions and can therefore be utilized in the process of improving software's usability. Even if logging can not replace the traditional usability methods, it provides many advantages over them. Logging is automatic, objective and it doesn't require direct observation. The data is gathered from the actual running application. [3]

2.1.1 Evaluation process

According to Bateman et al. [3] log-based usability evaluation process consist typically of three stages (see Figure 2.1). The first is called *application instrumentation* and in that stage logging capability is added to the application.

In other words, instrumentation is a process which determines what data will be logged from the usage of an application. In order to gain useful data, successful decisions in instrumentation stage are crucial. Bateman et al. also assert that if wrong decisions are made and therefore large amount of low-level data has been collected, it might be challenging to interpret and might not reveal any value. On the other hand they remark that if only high-level events is logged, internal structures may remain undiscovered. Consequently both, low-level and high-level usage data need to be tracked and logged. Sometimes, when log data doesn't supply enough information for interpretation, contextual information is needed. Generally, it requires a significant amount of effort and vigilance to be able to gather all the essential data to be analyzed. [3]

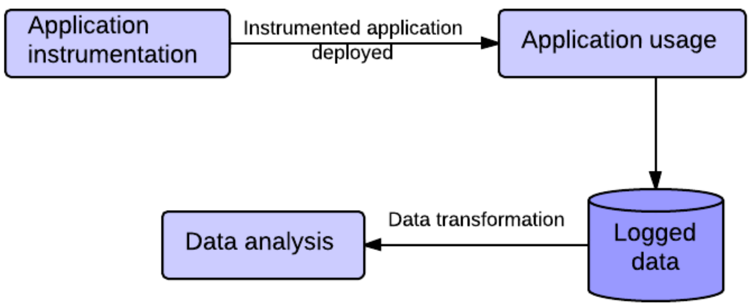

Figure 2.1: Process for log-based usability evaluation. [3]

The second stage of log-based usability evaluation process is *application usage*. It is a stage where the instrumented application is used in authentic or simulated situation. The log data is collected unobtrusively while the user is performing his tasks with the application. [3]

The final stage of the process is *data analysis*, in which a few different approaches can be used [3, 10]:

- Synchronize and searching
- Transforming event streams
- Performing counts and summary statistics
- Detecting, comparing and characterizing sequences
- Visualizing

This part of the process will be described in more detail in the following subsection Log data analysis and pattern creation.

2.1.2 Log data analysis and pattern creation

In order to gain beneficial usability information from user interface events, the log data has to be analyzed thoroughly. According to Hilbert and Redmiles [10], there are several approaches to sort out important usability information out of log data and to make it more understandable for humans. The first one of them is called ***synchronization and searching***.

It is often challenging to interpret user interface events alone and thereby discover valuable higher level events without any contextual information. The purpose of the synchronization and searching is to combine user interface event data with other informative data, such as observations or video recordings, in order to increase the understanding about the context of use. These two forms of data are complementary and can together provide wider understanding about the usability of a system. Observations or video recordings may supply additional information about the user interface event appeared in the log, or vice versa. However, there are few disadvantages with synchronization and searching techniques. For example video recording and observation typically require the presence of the observer. Furthermore, using video recording as a part of evaluation, produces a lot of data and can be inefficient to analyze. It might also have an disturbing affect on user's behavior. [10]

The second approach is ***transformation***. Transformations combine selection, abstraction and recording to transform events into more beneficial form of information. This information can then be utilized for instance in detecting, comparing or characterizing human behavior patterns. Selection is basically segregating useful information out of mass of user interface related events by filtering out irrelevant data or by selecting the relevant data. Example of selection could be a situation where the user has been writing a lot of text, generating a lot of data in the log, and trying to find save button from different menus. From the usability point of view, text inputs as log events are probably not that relevant, but time consuming browsing between different menus can be a sign from usability issues. [10]

Abstraction can be used to combine different events into a more understandable event sequences or patterns. For example user typing into different text fields and then clicking a button in a web page could be interpreted as a login activity. However, in this kind of situation user interface event logs, must be supplemented with contextual data to be assured that the event sequence is really what it appears to be. Recording means generating new sets of events based on selection and abstraction. Less effort is required to analyze new sets of raw data because earlier analyzing techniques can be exploited. [10]

The third way of generating tangible usability information out of user interface log data is to use ***counts and summary statistics***. Counts and summary statistics are calculations based on usability-related metrics gathered from the log data. For instance, calculating the time spent on a specific task (performance time), can be critical information in usability evaluation. [3, 10]

Detecting, comparing and characterizing sequences are approaches which utilize sequence information of events. Sequence detection refers to an action in which ready-defined sequences are tried to be identified from the mass of source sequences. Sequence comparison is executed by usability analyst and it is made between two sequences. These two sequences can be generated for example by subjects or subject groups. In any case, the purpose of sequence comparison is to compare actual usage against some defined ideal usage. Sequence characterization uses the source sequences to create a model to summarize all features of interest in those source sequences. [3, 10]

The last approach for log-based data analysis is called ***visualization***. In visualization, transformed and analyzed data is presented in a graphical form. General way to visualize data is to use charts, but it is possible to use other visualization techniques such as heat maps based on clicks or mouse traveling. [3, 10]

2.2 Contextual Inquiry

`TÄHÄN VIELÄ p1-raven pdfstä juttua.` Contextual Inquiry is an unstructured interview method, but it has some qualities which differs it from traditional unstructured interviews.[14] It was originally developed to meet three requirements. Firstly it was supposed to identify a design process for systems that will be used similarly in different business contexts and in different cultures. It was also supposed to identify a convenient process for gathering user information in limited time and finally to identify a way to acquire information about users' work in eligible format. In addition to those requirements, the technique was noticed to be capable of much more. CI cherish participatory design and, because of that quality, users are able to involve in the design. Users' contributes to the design by providing a deep understanding about the nature of the work. This is done through inquiry and it's a basis for fundamental work concepts. [15]

2.2.1 Fundamentals of Contextual Inquiry

Contextual Inquiry can be said to be an apprenticeship compressed in time. The basis of the method is premised on the idea of user being the expert instead of the interviewer, but unlike an apprentice, the interviewer neither learns the work by doing it, nor has the same amount of time available for learning. [4] CI differs from the traditional master-apprenticeship model in other ways also. A few fundamental principles of Contextual Inquiry are said to be essential in order to meet the specific needs of design problems [4, 1]. These principles are understanding the context of the work, creating a partnership, interpreting the work and steering the focus during the interview. [4]

Understanding the **context** of the work is the baseline of Contextual Inquiry. To gain the understanding about the work structure, the interviewer must pursue understanding about the details of users' work and these details can be found by following the users' actions at work. In general, it is important that interviewer avoids gathering abstract or summarized information about the context.[4]

It is essential to create collaborative environment and a **partnership** between the user and the interviewer while the real life work structure and activities are tried to be understood thoroughly. Partnership is an equal relationship between the interviewer and the user. In comparison to traditional interview or master-apprentice approaches, partnership doesn't give any power advantage to either parties. Instead, it fosters the interviewer's expertise to see the work structure and the user's expertise to do the work. There are many advantages in partnership approach. For example by paying attention to details and structure of work, interviewer can also teach the user to attend to them. In the best case scenario the interviewer and the user watch the work structure and think about design possibilities together. In this kind of scenario it is common that the work is suspended, while the parties discuss about the work structure, and then return again. For interviewer asking feedback for design ideas is also encouraged.[4]

Even if a partnership should be created between the parties, the interviewer should still be able to steer the interview and keep the **focus** of the conversation on work-related topics relevant to the design [4]. The focus point should be decided before the research takes place, and data gathering should have a deliberated and precise goal. This goal or focus should be dependent on the information needs of the design.[1]

The success of Contextual Inquiry and system design depends on the facts gathered, but the facts are not enough. They are a starting point.*"From the fact, the observable event, the designers makes a hypothesis, an initial inter-*

pretation about what the fact means or the intent behind the fact."[4] In other words, **interpretations** are needed and they are critical for success. In the final version of the system, interpretations have to be correct or the system fails. This is why it is important to share and validate the interpretations with the customer early enough. [4]

As soon as thorough understanding about the work is available, design for a system model can be created.[15]

2.2.2 Contextual Inquiry in practice

Practical preparations of CI includes careful planning. The first phase of planning is to set the focus for the research. Focus can be for example a definition of a problem which need to be solved. It creates ground rules for the interview and it is therefore easier for the interviewer to steer the conversation. After the focus has been set, the inquiry itself need to be designed. The challenge in inquiry design is to find a way to determine underlying issues which cause problems in the work. If CI is used to help the design process of a new system, another challenge is to get the designers and the users to work together in order to define new ways of working and to develop a system design to support them. [4]

The structure of the interview is considerably straightforward. First task of the interviewer is to introduce the CI process and ask permission to record the conversation and work. The interviewer has to also make it clear that understanding the work of the user is the primary target of the research, and that all the misunderstandings should be corrected. The next step of the interview is to clarify the rules. In traditional Contextual Inquiry process it is desirable for the interviewer to interrupt and ask questions and correspondingly for the user to indicate if the time convenient for interruption. The third part of the CI is the actual interview, which consist of observation, asking direct questions, suggesting interpretations, writing notes and recording the whole chain of events. Finally the interviewer should wrap up the interview, ensure that everything is understood correctly and summarize the process. This is the last chance for the user to revise misunderstandings. [4]

2.3 Cognitive Walkthrough

Cognitive walkthrough (CW) was developed in the early nineties and it was originally intended to help reviewing 'walk-up-and-use' interfaces, such as Automatic Teller Machine (ATM). CW is a formal usability inspection method for professionals involved in the development process. The key concept behind CW is to use theory as a guide for design review. It is easy to understand and apply and therefore feasible to use in a regular development process. [9, 13] Cognitive walkthrough can be accomplished by using detailed design specification of the user interface which has been received after requirement analysis and functionality definition processes. The walkthrough can be also performed on a paper simulation, minimal prototype or fully functional prototype of the UI. Formally cognitive walkthrough evaluates design's ease of learning by exploring it. [18]

2.3.1 Preparations

2.3.2 Analysis

2.4 Interaction Sequence Illustration

Considering the practical impacts of the thesis, it is important to use methods and measures which can shore up the software development process in a real-use context. This is why the process and it's interactions are reviewed using ISI method, which utilizes authentic use context and real users. [17] ISI was originally developed for evaluating the usability of IT tasks carried out in healthcare industry, but there are no defined reasons why it could not be utilized in different environments.

2.4.1 Description of the Interaction Sequence Illustration

Interaction Sequence Illustration is a low level analysis method for human-computer interaction. It uses data acquired during the contextual inquiry process and doesn't gather any of its own. However, the inquiry data has to be complemented with documentation about interaction activities. There are three objectives for ISI method to handle. The first is to demonstrate how the user perceives the system. The second one is to identify and document activities, and to discover problems. The first two objectives creates the third one, which is to support the user-centered design and development. [17] The strength of ISI lies in the analysis of data and it can be used to compare the interaction sequences of two of or more UI implementations. On the other hand it can provide prominent information on only one UI's interaction sequence.

2.4.2 Utilization of the Interaction Sequence Illustration

The utilization of Interaction Sequence Illustration can be simplified in seven steps (see Figure 2.2). First the data need to be collect (notes and screenshots) alongside Contextual Inquiry interview. Then the screenshots need to be arranged in the right order and all the superfluous data need to be removed. The third phase is to count the interaction steps based on screenshots and activity analysis. After the analysis the screenshots needs to be modified and important details highlighted. Then the sequence numbers as well as a detailed description text should be added to give a profound understanding about the actions. The outcomes of the method are illustration, or illustrations depending on the number of research objectives, of the interaction stages. Every stage contains step-by-step illustration (or illustrations) of user-computer interaction. [17]

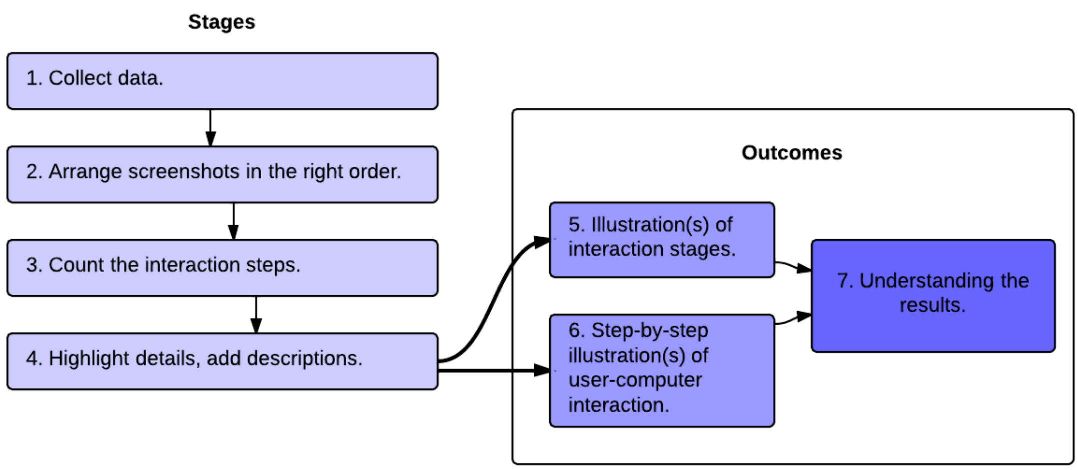

Figure 2.2: Interaction Sequence Illustration steps and outcomes.

2.5 System Usability Scale

In his paper Brooke [6] argued that usability is not any real existing quality, but a good usability artifact is *appropriate to its purpose*. In other words "the usability of any tool or system has to be viewed in terms of the context in which it is used, and its appropriateness to that context" [6]. Still in many cases, context related usability evaluation is not desirable. The reason for this is that a large scale context analysis is usually neither cost-efficient nor practical.[6] SUS responds to these challenges by offering an easy and quick way to get subjective ratings about the usability of a system. It is not limited to any specific technology, which makes it universal tool for usability evaluation. [2]

2.5.1 Description of the System Usability Scale

System Usability Scale (see SUS form) is a ten-item *Likert scale*, meaning that every item consist of the scale of five, ranging from "Strongly disagree" to "Strongly agree". The questionnaire is generally being filled right after the possibility to use the system to be evaluated. The focus should be on immediate responses and too much time shouldn't be given to the respondents. [6] `TÄHÄN LISÄÄ!!! TEN YEARS OF SUS -ARTIKKELISTA`

2.5.2 System Usability Scale in practice

The outcome of SUS is a single value which express the overall usability of the system. The value consist of all the items and none of them are meaningful as such. System Usability Scale can be calculated by first summing the score contribution (range from 0 to 4) from each item. Before summing the scale positions of the items 1,3,5,7 and 9 need to be subtracted by one and the scale positions of the items 2,4,6,8 and 10 need to be subtracted from 5. The last step is to multiply the sum of the scores by 2.5 to get the overall SUS value, which will range from minimum of 0 to maximum of 100. [6] The resulting single score is an easy-to-understand measure, and can therefore be discussed with the wide range of stakeholders. [2]

2.6 Other measures

The last process measurements used in the research are simply the time which was consumed while carrying out the task and the success rate of the task.

Chapter 3

Process experiment

Human-centered design consist a few activities and iterative process (see Figure 3.1). [8] The empirical part of this thesis adapts human-centered desing principles and the steps of the process experiment are highly linked to its activities. The steps are described in detail in section 3.1. This chapter will also describe the implementation phases of the experiment.

TÄHÄN JOTAIN CONTEXTUAL DESIGNISTÄ!!!!!

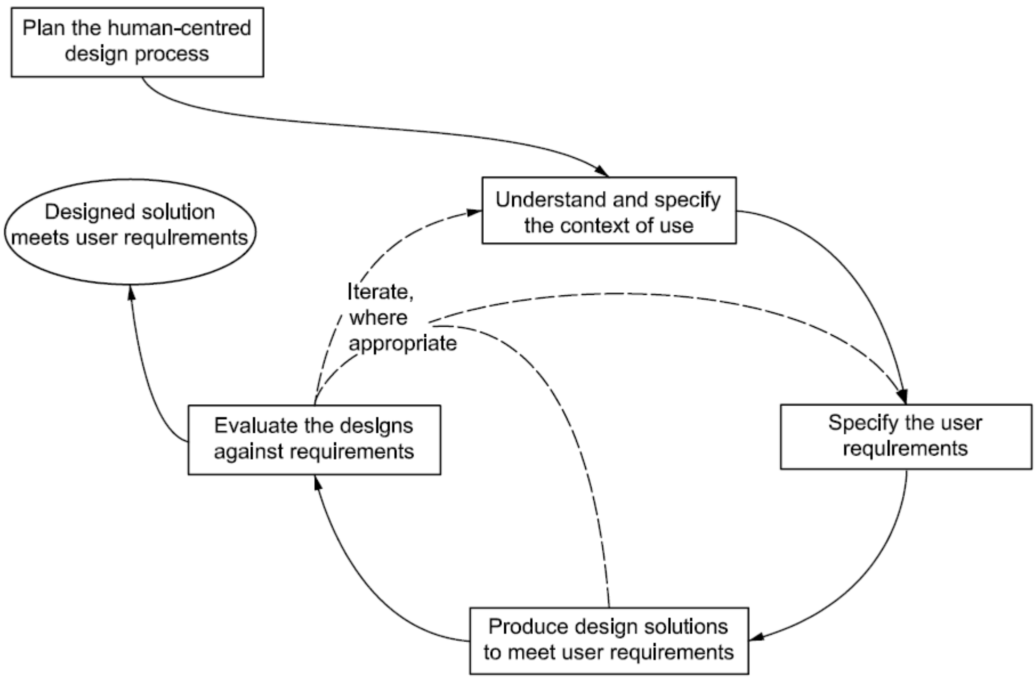

Figure 3.1: Human-centered design activities.[8]

3.1 Steps

- Creating the model for gathering data
- Modified contextual inquiry
- Process measurement methods
- Analysis 1.
- Prototype creation
- Remote evaluation - process measurement methods.
- Analysis 2.

3.2 Implementation

`Kuinka monta osallistujaa, millainen ympäristö, missä maassa, minkä ikäisiä osal`
`kauanko tehneet työtä kuinka testaus sujui`

Chapter 4

Analysis

4.1 Results

-Comparison between country offices -Comparison between individuals (esim. kuinka kauan kesti tietyn toiminnon tekeminen) / Overall comparison (esim. kaikkien koehenkilöiden yhteinen kehitys.) - Interaction sequence illustration (esim. kuinka monta steppiä ennen ja jälkeen)

4.2 Implementation analysis

-Should these methods be implemented as a part of the process or not.

Chapter 5

Discussion and conclusions

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Appendix A

SUS form

System Usability Scale

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5